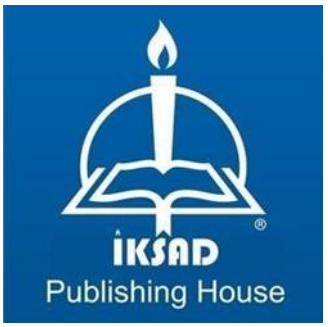
7th INTERNATIONAL CUKUROVA AGRICULTURE AND VETERINARY CONGRESS

March 9-10, 2024
Adana / TÜRKİYE

CONFERENCE PROCEEDINGS BOOK

EDITORS
Assoc. Prof. Dr. H. Turan AKKOYUN
Assoc. Prof. Dr. Seyithan SEYDOŞOĞLU

7th INTERNATIONAL CUKUROVA AGRICULTURE AND VETERINARY CONGRESS



IKSAD Publishing House

Institution of Economic Development and Social Researches

All rights of this book belongs to IKSAD Publishing House. Without permission of the publisher, can't be duplicate or copied. Authors of chapters are responsible both ethically and juridically.

The Licence Number of Publicator: 2014/31220) Gölbaşı, Adıyaman Province, TÜRKİYE

TÜRKİYE TR: +90 342 606 06 75 USA: +1 631 685 0 853

E mail: iksadyayinevi@gmail.com www.iksadyayinevi.com

Copyright © 2023 by İKSAD publishing house All rights reserved

7th INTERNATIONAL CUKUROVA AGRICULTURE AND VETERINARY CONGRESS

7th INTERNATIONAL CUKUROVA AGRICULTURE AND VETERINARY CONGRESS

March 9-10, 2024 / Adana, Türkiye

PROCEEDINGS BOOK
(Abstracts & Full Texts)

EDITORS

Assoc. Prof. Dr. H. Turan AKKOYUN

Assoc. Prof. Dr. Seyithan SEYDOŞOĞLU

Cover Design: Arzu ALTUNTAŞ

ISBN: 978-625-367-680-3

DOI: https://doi.org/10.5281/zenodo.10870563

https://www.ziraatkongresi.org/

ISSUED: March 25, 2024

7th INTERNATIONAL CUKUROVA AGRICULTURE AND VETERINARY CONGRESS

EVALUATION PROCESS AND POLICIES

All applications have undergone double blind peer review process. In addition, each paper was accepted and the process of publishing in the book was carried out through editorial oversight. The published papers were presented and discussed at the meeting. Full texts and abstracts published in accordance with the Symposium Policy have been prepared in accordance with ethical rules and APA standards. Authors of all papers are both ethically and legally responsible.

PARTICIPANTS COUNTRIES

Türkiye, Russia, Serbia, Iraq, Algeria, Bosnia, Hungary, Nigeria, Indonesia, Georgia, Malaysia, Brazil, India, Taiwan, Bulgaria, Poland, Romania, Pakistan, Morocco

TOTAL ACCEPTED ARTICLES: 306

The Number of Accepted Papers from Türkiye: 120
The Number of Accepted Full Papers from Other Countries: 134
The Number of Total Papers: 254

7th INTERNATIONAL CUKUROVA AGRICULTURE AND VETERINARY CONGRESS

CHAIRPERSONS OF THE ORGANIZING BOARD

Assoc. Prof. Dr. H. Turan AKKOYUN

Siirt Üniversitesi

SYMPOSIUM COORDINATORS

Assoc. Prof. Dr. Seyithan SEYDOŞOĞLU

IKSAD Scientific Support Coordinator

7th INTERNATIONAL CUKUROVA AGRICULTURE AND VETERINARY CONGRESS

ORGANIZING BOARD

Prof. Dr. Hakan Bayraktar-Ege Üniversitesi
Prof. Dr. Banu Yücel-Ege Üniversitesi
Prof. Dr. Emine Küçüker-Siirt Üniversitesi
Prof. Dr. İsmail Hakkı Ekin- Van Yüzüncü Yıl Üniversitesi
Prof. Dr. Ziya İlhan-Balıkesir Üniversitesi
Prof. Dr. Murat Tunçtürk - Van Yüzüncü Yıl Üniversitesi
Prof. Dr. Kenan Yıldız - Tokat Gaziosmanpaşa Üniversitesi
Prof. Dr. Ersin Akıncı- Kahramanmaraş Sütçü İmam Üniversitesi
Prof. Dr. Önder Türkmen-Necmettin Erbakan Üniversitesi
Prof. Dr. Rüstem Cangi- Tokat Gaziosmanpaşa Üniversitesi
Doç. Dr. Mahire Bayramoğlu - Akkoyun-Siirt Üniversitesi
Doç. Dr. Özgül Gülaydın- Siirt Üniversitesi
Doç. Dr. Zeynep Bozkan Ünal -Adnan Menderes Üniversitesi
Doç. Dr. Ahmet Uyar -Hatay Mustafa Kemal Üniversitesi
Doç. Dr. Turan Yaman -Van Yüzüncü Yıl Üniversitesi
Doç. Dr. Aydın Şükrü Bengü- Bingöl Üniversitesi
Doç. Dr. Murat Genç - Atatürk Üniversitesi
Doç. Dr. Emin Şengül-Atatürk Üniversitesi
Doç. Dr. Sevinç Aydın-Tunceli Munzur Üniversitesi
Doç. Dr. Songül Akın- Dicle Üniversitesi
Dr. Öğr. Üyesi Ali Gülaydın - Siirt Üniversitesi
Dr. Öğr. Üyesi Hava Şeyma İnci - Bingöl Üniversitesi
Dr. Öğr. Üyesi Dilek ŞENTÜRK – Dicle Üniversitesi

7th INTERNATIONAL CUKUROVA AGRICULTURE AND VETERINARY CONGRESS

SCIENCE AND ADVISORY BOARD

Prof. Dr. Tekin Şahin-Siirt Üniversitesi
Prof. Dr. Derviş Özdemir- Atatürk Üniversitesi
Prof. Dr. Fikret Çelebi- Atatürk Üniversitesi
Prof. Dr. Zehra Ekin- Van Yüzüncü Yıl Üniversitesi
Prof. Dr. Murat Kara-Siirt Üniversitesi
Prof. Dr.Tuncay Tufan - Siirt Üniversitesi
Prof. Dr. Alper Durak-Malatya Turgut Özal Üniversitesi
Prof. Dr. Ferit Çelik-Van Van Yüzüncü Yıl Üniversitesi
Prof. Dr. Arda Yıldırım- Tokat Gaziosmanpaşa Üniversitesi
Prof. Dr. Ebubekir Altıntaş- Tokat Gaziosmanpaşa Üniversitesi
Prof. Dr. Selim Aytaç -Ondokuz Mayıs Üniversitesi
Prof. Dr. Yakup Özkan, Eskişehir Osmangazi Üniversitesi
Prof. Dr. Halil İbrahim Oğuz-Adıyaman Üniversitesi
Prof. Dr. Nazım Şekeroğlu-Gaziantep Üniversitesi
Prof. Dr. Ahmet Öztürk-Ondokuz Mayıs Üniversitesi
Prof. Dr. Yalçın Tahtalı- Tokat Gaziosmanpaşa Üniversitesi
Prof. Dr. Mutalip Gündoğdu- Bolu Abant İzzet BaysaL Üniversitesi
Prof.Dr.Mehmet Fırat Baran- Siirt Üniversitesi
Prof.Dr.Çetin Karademir- Siirt Üniversitesi
Prof.Dr.Emine Karademir- Siirt Üniversitesi
Doç.Dr Doğan Arslan- Siirt Üniversitesi
Doç.Dr.Gülen Özyazıcı- Siirt Üniversitesi
Doç.Dr.Harun Bektaş- Siirt Üniversitesi
Doç.Dr.Mehmet Arif Özyazıcı- Siirt Üniversitesi
Doç.Dr.Yasemin Bektaş- Siirt Üniversitesi
Doç.Dr.Behçet Ünal- Siirt Üniversitesi
Doç. Dr. Halil Erdem- Tokat Gaziosmanpaşa Üniversitesi
Doç. Dr. Erdal Ağlar- Van Yüzüncü Yıl Üniversitesi
Doç. Dr. Hakan Aydın- Atatürk Üniversitesi
Doç. Dr. Recep Gümüş-Sivas Cumhuriyet Üniversitesi
Doç. Dr. Özgür Yaşar Çelik -Siirt Üniversitesi
Doç. Dr. Gülşah Akgül-Siirt Üniversitesi
Doç. Dr. Barış Akgül-Siirt Üniversitesi
Doç. Dr. Görkem Örük-Siirt Üniversitesi
Doç. Dr. Nurhan Keskin- Van Van Yüzüncü Yıl Üniversitesi
Doç. Dr. Orhan Karakaya-Sakarya Üniversitesi
Doç. Dr. Şeyda Çavuşoğlu- Van Yüzüncü Yıl Üniversitesi
Doç. Dr. Atilla Çakır, Bingöl Üniversitesi
Doç. Dr. İsa Coşkun -Kırşehir Ahievran Üniversitesi
Doç. Dr. Serdar Altun- Atatürk Üniversitesi
Doç. Dr. Kıvanç Irak- Siirt Üniversitesi
Doç. Dr. Burçak Aslan Çelik- Siirt Üniversitesi

7th INTERNATIONAL CUKUROVA AGRICULTURE AND VETERINARY CONGRESS

SCIENCE AND ADVISORY BOARD

Doç. Dr. Volkan Gül-Bayburt Üniversitesi
Doç. Dr. Nüket Bilgen-Ankara Üniversitesi
Doç. Dr. Yalçın Yaman, Siirt Üniversitesi
Dr. Öğr. Üyesi Tuğba Uzun-Siirt Üniversitesi.
Dr. Öğr. Üyesi Erman Gülendağ- Siirt Üniversitesi
Dr. Öğr. Üyesi Şule Melek -Bingöl Üniversitesi
Dr. Öğr. Üyesi Mehmet Kartal-Gelişim Üniversitesi
Dr.Öğr.Üyesi Fatma Karagözoğlu-Dokuz Eylül Üniversitesi
Dr.Öğr.Üyesi Çağrı Kale- Van Yüzüncü Yıl Üniversitesi
Dr.Öğr. Üyesi Ömer Faruk Keleş- Van Yüzüncü Yıl Üniversitesi
Dr.Öğr. Üyesi Mehmet Yıldız-- Atatürk Üniversitesi
Dr.Öğr. Üyesi Ufuk Kaya-Hatay Mustafa Kemal Üniversitesi
Dr.Öğr. Üyesi Muazzez Yeşilyurt- Siirt Üniversitesi
Dr.Öğr. Üyesi Füsun Erhan Bayçumendur--Sivas Cumhuriyet Üniversitesi
Dr.Öğr. Üyesi Osman Bulut-Muğla Sıtkı Koçman Üniversitesi
Dr.Öğr.Üyesi Öznur Yılmaz Koç- Siirt Üniversitesi
Dr.Öğr. Üyesi Gülsen Kirman-Siirt Üniversitesi
Dr.Öğr. Üyesi Mehmet Irmak-Siirt Üniversitesi
Dr.Öğr.Üyesi Devran Coşkun-Siirt Üniversitesi
Dr.Öğr.Üyesi Cahit Özcan-Siirt Üniversitesi
Dr.Öğr. Üyesi Tarık Şafak-Kastamonu Üniversitesi
Dr.Ali Osman Turgut-Siirt Üniversitesi
Dr. Öğr.Üyesi Efe Kurtdede-Ankara Üniversitesi
Dr.Öğr. Üyesi Ayfer Fındık- Siirt Üniversitesi
Dr.Öğr.Üyesi Barış Can Güzel- Siirt Üniversitesi
Dr.Öğr.Üyesi Caner Kayıkçı- Van Yüzüncü Yıl Üniversitesi
Dr.Öğr.Üyesi Bedriye Bilir-Kahramanmaraş Sütçü İmam Üniversitesi
Dr.Öğr.Üyesi Emin Kaplan Bingöl Üniversitesi
Dr.Öğr.Üyesi Abdullah Güler Bingöl Üniversitesi
Dr.Öğr.Üyesi Uğur Özentürk Atatürk Üniversitesi
Dr.Öğr.Üyesi Fatih Gökmen-Iğdır Üniversitesi
Dr.Öğr.Üyesi Umut Ateş-Sakarya Üniversitesi
D.Ögr.Üyesi Akife Dalda Şeker-Erciyes Üniversitesi
Dr.Öğr.Üyesi Özlem Çakmakcı- Van Yüzüncü Yıl Üniversitesi
Dr.Ögr.Üyesi Fulya Uzunoğlu-Hatay Musafa Kemal Üniversitesi
Dr.Öğr.Üyesi Fatih Demirel--Iğdır Üniversitesi
Dr.Öğr.Üyesi Barış Eren--Iğdır Üniversitesi
Dr.Öğr.Üyesi Ömer Eltas-Atatürk Üniversitesi
Dr.Öğr.Üyesi Uğur Özentürk Atatürk Üniversitesi
Dr.Öğr.Üyesi Fatma İşbilir-Siirt Üniversitesi
Dr.Öğr.Üyesi Kadir Sulu -Siirt Üniversitesi
Dr.Öğr.Üyesi Banu Kandil-Siirt Üniversitesi

7th INTERNATIONAL CUKUROVA AGRICULTURE AND VETERINARY CONGRESS

SCIENCE AND ADVISORY BOARD

Dr.Ahmet Sümbül-Sivas Cumhuriyet Üniversitesi
Dr.Serap Demirel-Van Yüzüncü Yıl Üniversitesi
Dr.Ahmet Say-Erciyes Üniversitesi
Arş.Gör.Kübra Geçmez-Siirt Üniversitesi
Arş.Gör.Aydın Genç-Bingöl Üniversitesi
Prof. Dr. Mohammed Alizadeh Khaledabad / Urmia University Faculty Of Agriculture
Prof. Dr. Mohsen Esmaiili / Urmia University, Faculty Of Agriculture
Prof. Dr. Mousa Tavassoli / Urmia University Faculty Of Veterinary Medicine
Doç. Dr. Ali Soleimanzadeh / Urmia University Faculty Of Veterinary Medicine
Doç. Dr. Amir Rahimi / Urmia University, Faculty Of Agriculture
Doç. Dr. Esmaeil Rezaei-Chiyaneh / Urmia University, Faculty Of Agriculture
Doç. Dr. Farnaz Malekifard / Urmia University Faculty Of Veterinary Medicine
Doç. Dr. Hamed Khalilvandi-Behroozyar/ Urmia University, Faculty Of Agriculture
Doç. Dr. Mahdi Ghiyasi / Urmia University, Faculty Of Agriculture
Doç. Dr. Rahim Mohammadi / Urmia University Faculty Of Veterinary Medicine
Doç. Dr. Siamak Asri-Rezaei / Urmia University Faculty Of Veterinary Medicine
Dr. Öğr. Üyesi Saber Amiri / Urmia University Faculty Of Agriculture
Dr. Öğr. Üyesi Markéta Mıhálıková / Water Resources, Czech University Of Life Sciences, Czech Republıc
Araş Görv Songül Ötkün-Siirt Üniversitesi
Simge Sude Gerçeker-Gelişim Üniversitesi

7th INTERNATIONAL CUKUROVA AGRICULTURE and VETERINARY CONGRESS

March 09-10, 2024
Adana/ TÜRKİYE

CONGRESS PROGRAM

Online (with Video Conference) Presentation

IMPORTANT, PLEASE READ CAREFULLY

- To be able to make a meeting online, login via https://zoom.us/join site, enter ID instead of "Meeting ID or Personal Link Name" and solidify the session.
- The Zoom application is free and no need to create an account.
- The Zoom application can be used without registration.
- The application works on tablets, phones and PCs.
- Moderator - responsible for the presentation and scientific discussion (question-answer) section of the session.

Points to Take into Consideration - TECHNICAL INFORMATION

- Make sure your computer has a microphone and is working.
- You should be able to use screen sharing feature in Zoom.
- Attendance certificates will be sent to you as pdf at the end of the congress.
- Requests such as change of place and time will not be taken into consideration in the congress program.
- If you think there are any deficiencies / spelling mistakes in the program, please inform by e-mail until March 20, 2024 (17:00) at the latest.
- **(All speakers required to be connected to the session 15 min before the session starts)**
- Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
- **Before you login to Zoom please indicate your name_surname and HALL number, exp. Hall 1, Gülen**

OPENING CEREMONY

Date: 09.03.2024

Ankara Local Time: 09:00-10:00

Congress President

Assoc. Prof. Dr. H. Turan AKKOYUN

Siirt University

Keynote Speaker

Prof. Dr. Hakan İNCİ

Bingöl University

Keynote Speaker

Prof. Dr. Mürsel KÜÇÜK

Siirt University

PARTICIPATING COUNTRIES

Türkiye, Russia, Serbia, Iraq, Algeria, Bosnia, Hungary, Nigeria, Indonesia, Georgia, Malaysia, Brazil, India, Taiwan, Bulgaria, Poland, Romania, Pakistan, Morocco

TOTAL ACCEPTED ARTICLES

Türkiye: 120

Other Countries: 134

09.03.2024
Ankara Local Time: 15:30-17:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.

IN-PERSON SESSION

Veue: Türkmen Riverside Hotel Adana
Sinanpaşa, Hacı Sabancı Blv. No:26, 01220 Yüreğir/Adana

MODERATOR: Erhan AYNA

AUTHOR	AFFILITION	ABSTRACT TITLE
Hale Yıldız Yeter Çilesiz Tolga Karaköy	*Sivas University of Science and Technology*	Recombinant DNA Technology and Its Applications in Plants
İbrahim Halil Güngör	*Fırat University*	Determination of The Effects of Ginkgo Biloba Extract on Short-Term Storage of Ram Semen With The Casa Device
Pınar Coşkun	*Bingöl University*	Use of Propolis in The Biosynthesis of Zinc Nanoparticle
Gökçenur Sanioğlu Gölen Kadir Akar	*Van Yüzüncü Yıl University*	Nucleic Acid Amplification Techniques Used in Microbiology
Erhan Ayna Ömer Faruk Keleş Hacı Ahmet Çiçek Zabit Yener	*Ayna Veterinary Clinic*	A Case of Cutaneous Neurofibroma in a Dog

09.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-1, HALL-1 / OTURUM-1, SALON-1

MODERATOR: Mahire BAYRAMOĞLU AKKOYUN

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Mazhar Burak Can Sümeyra Can	*Bayburt Provincial Directorate of Agriculture and Forestry*	Effects of Nanotechnological Applications in Animal Nutrition
Mazhar Burak Can	*Bayburt Provincial Directorate of Agriculture and Forestry*	Use of Natural Antioxidants as Feed Additives
Irem Dehmen Fatih Sezer	*Çanakkale Onsekiz Mart University*	Expression of Glycosylation-Related Genes Under Stress in *Cicer arietinum*
Jiyan Tunç Elif Babacanoğlu Çakır	*Van Yüzüncü Yıl University*	Prediction of Sex by The Effect of Sex Genes on Phenotypic Traits
Ferit Yıldız Serhat Yıldız	*Van Yüzüncü Yıl University*	The Role of the Ministry of Agriculture and Forestry in Agricultural Training and Extension Activities and Farmer Training and Extension Activities in Türkiye
Ilnura Ibragimovna Fayzullina Ilya Nikolayevich Medvedev	Russian Biotechnological University	Hematological Characteristics of First-Calf Cows
Ilya Nikolayevich Medvedev Ilnura Ibragimovna Fayzullina	Russian Biotechnological University	Physiological Features of Blood Parameters of Steer Cows of The Black-And-Brown Breed
Bratislav Pešić Nikola Stolic Nebojsa Zlatković Aleksandra Jevtic	Department of Agricultural and Food Studies in Prokuplje	The Use of Robots in Poultry Production
Mohammad Yawuz Jamal Angham Ahmed Sara Asaad Israa Naem	University of Baghdad	Evaluating, Knowledge, Attitudes and Practices Regarding Antimicrobial Use and Resistance Among Group of Medical Students
Seda Karapınar Seda Deveci Birsen Öztürk	Istanbul Technical University	Sımultaneous Determınatıon Of Mıcroelements In Hydroponıc Nutrıent Solutıons By Flow Injectıon Analysıs

09.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-1, HALL-2 / OTURUM-1, SALON-2

MODERATOR: Zeynep BOZKAN ÜNAL

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Başak Özten Hacer Tüfekci	*Yozgat Bozok University*	Some Productivity Characteristics of Akkaraman Sheep Flocks in The Smallholder Family Farm Structure
Merve Eda Eker Özkacar Sibel Karakaya	*Ege University*	Evaluation of Wild Edible Plants in Terms of Sustainable Nutrition: Use of Trachystemon Orientalis in Bakery Products
Hatice Barışık Fatma İlhan	*Selçuk University*	Candidate Genes Associated With Milk Yield and Quality Traits in Sheep and Goats
Seray Dönmez Nida Ünlü Eminur Elçi	*Niğde Ömer Halisdemir University*	Antibacterial Effects of Some Herbal Extracts Against Plant Pathogenic Streptomyces Spp.
Tuğba Eroğlu Nida Ünlü Eminur Elçi	*Niğde Ömer Halisdemir University*	The Causal Agent of Black Rot on Cabbage
Zeynep Bozkan Ünal Aylin Ateş Sümbül Serap Birincioğlu	*Aydın Adnan Menderes University*	A Case of Pedunculated Mass (Fibromyxoma) on The Head Area of A Budgerigar (Melopsittacus undulatus)
Nihad Habeeb Mutlag	*Kufa University*	Evaluation the Antagonistic Ability of Biocontrol Fungi Against Some of Pathogenic Fungi Isolated from Wastewater
Ali Ihsan Azeez Imad Khalaf Azeez	*University of Diyala*	The Effect of Planting Distances on Growth Characteristics and Yield of Yellow Maize
Raeda Abd Al-Redha Sabet Mohammed H. Noor Aljana Mohammed Radwan Mahmoud	*Al-Muthanna University*	Effect of Humic and Fulvic Acids on the Growth of Maize Cultivars
Pranathi.T.M Suganthi P	*R.M.K. Engineering College*	Internet-of-Things Smart Agriculture:Toward Marking the Fields Talk

09.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-1, HALL-3 / OTURUM-1, SALON-3

MODERATOR: Sevil CANTÜRK

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Deniz Çakar Ebru Derelli Tüfekçi Seçil Akilli Şimşek	*Çankırı Karatekin University*	The Determination of Sensitivity of Phytophthora × cambivora and P. cinnamomi Isolates to Phosphorous Acid by Assessing ABCA1 Gene Expression Levels
Nergis Gizem Kirkhan Sibel Karakaya	*Ege University*	Investigation of In Slico Binding Capacity of Some Anthocyanins on α-Amylase and α-Glucosidase Activıties
Sevil Cantürk Birhan Kunter	*Cukurova University*	The Effects of Spur and Cane Pruning on Phenology, Yield and Some Quality Characteristics of Hasandede Grape Cultivar
Zeynep Bozkan Ünal Ezgi Sude Aybak	*Aydın Adnan Menderes University*	Diagnosis and Treatment of Retrobulbar Abscess in Domestic New Zealand Rabbit
Jelena Lutovac	*3Megatrend University*	Accounting Policy in The Function of Making Decisions on The Basis of Financial Statements in The Company
Jelena Lutovac	*Megatrend University*	Basic Observation of Financial Reporting and Management of Heterogeneous Companies In The Republic of Serbia
Jelena Lutovac	*Megatrend University*	Adoption of A Realistic Financial Reporting Model in Heterogeneous Companies in Small Economies Like The Republic of Serbia
Máté Maurer Szilvia Stranczinger Zsuzsanna Szőke László Szemethy	*University of Pécs*	First Insight into The Mycotoxin-Related Investigation of Hungarian Game Species
Moses Adeolu Agoi Solomon Abraham Ukpanah Opeyemi Elizabeth Adewunmi Olasunkanmi Julius Olatunde Oluwanifemi Opeyemi Agoi	*Lagos State University of Education*	Access Control as Technological Gateway to Data Security: an Intrinsic Study of Cloud Computing Development

09.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-1, HALL-4 / OTURUM-1, SALON-4

MODERATOR: Aynur BİLMEZ ÖZÇINAR

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Gülşah Çavuş Sibel Karakaya	*Ege University*	Some Physicochemical Properties and Browning Index of Biscuits Made With Amaranth Flour
Keziban Sinem Tulukoğlu Kunt Gazal Arslansoy Ilayda Aruk Mustafa Özden	*Niğde Ömer Halisdemir University*	Antifungal Activity of Essential Oil from Origanum spp. Against Black Rot Disease of Apple
Cihan Çakmakçı	*Van Yüzüncü Yıl University*	Use of Computer Vision in the Digital Transformation of Livestock Farming: A Facial Detection System for Goats using a Deep Learning Approach Based on YOLOv8
Doğan Arslan Aynur Bilmez Özçınar	*Siirt University*	Use of Medicinal and Aromatic Plants for Medical Purposes and Studies Conducted on This Topic
Simge Selvi Hatice Basmacioğlu-Malayoğlu	*Ege University*	The Use of Moringa Plant in Poultry Feeding As A Protein Source and Feed Additive
Görkem Öztürk Belma Doğan Öz	*Siirt University*	Bibliometric Analysis of Published Articles on Technical Efficiency in Agriculture: The Case of Ulakbim (2003-2023)
Tesfaye Mengie Kassie Szemethy László Róbert	*University of Pécs*	Assessing the practice of Community-Based Forest Management in Northwest Ethiopia
Ikenna Charles Ukwuaba Sunday Ifeanyi Ukwuaba Ifeyinwa Cynthia Ukwuaba	*University of Nigeria*	Smallholder Commercialization: Analysis of the Socio-economic and Institutional Constraints to Market Orientation and Participation Among Rice Farming Households in Southeast Nigeria
Favour C. Uroko	*University of Nigeria*	Religious Crisis and Food Insecurity in Nigeria Since 2023: Any Hope

09.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-1, HALL-5 / OTURUM-1, SALON-5

MODERATOR: Ali Beyhan UÇAK

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Müslüm Rüzgar Mehmet Fırat Baran	*Siirt University*	Input Usage and Gross Profit Analysis in Strawberry Production (Batman Province Example)
Pharm A. Dinesh Babu R. Jothilakshmi R.Srinivasan	*Bharath Institute of Higher Education and Research Chennai*	Some Natural Isolated Compounds As Anticancer Agents
Usman Abdullahi Abba Gambo Fatima Abubakar	*Lake Chad Research Institute*	Evaluation On Base Line Survey Of Newly Developed Pearl Millet Varieties Super-Sosat Under Natural Field Conditions In North East Nigeria
Mehmet Fidan Ali Beyhan Uçak Cafer Gençoğlan	*Siirt University*	Effect of Restricted Irrigation Practices on Morphological Parameters of Second Crops Corn
Ruken Konuk Ali Beyhan Uçak Firat Pala	*Siirt University*	Effect of Limited Irrigation Practices on Weed Population in Clearfield Sunflower Plant
Raden Aji Christine Wulandari Zeda Erdian Achmad Haris Imam Fahrur Razi	*University of Lampung*	The Important Role of Agroforestry in Increasing Community Income in Supporting the Resilience of Sustainable Agricultural Systems in Sumber Agung Village, Kemiling District, Lampung Province
Nabila Daud Aryanti Rizki Adinda Dhea Ayu Lestari Christine Wulandari	*Univeristas Lampung*	Partisipasi Masyarakat Dalam Mendukung Keberhasilan Rehabilitasi Hutan Dan Lahan Di Taman Hutan Raya Wan Abdul Rachman
Kheynad Vinanda Arum Tri Kurniawan Nur Ahmad Fadli Christine Wulandari	*Universitas Lampung*	Analysis of Agroecosystem Management of Coffee Plants in Lampung Using the SWOT Method
Marine Metreveli	*International Center for Caucasus Tourismj*	Rural Tourism for Organic Farming in Georgia

09.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-1, HALL-6 / OTURUM-1, SALON-6

MODERATOR: Zekiye ŞENGÜL

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Zekiye Şengül	*Siirt University*	Digital Solutions for Sustainable Beekeeping: The Potential of Blockchain Technology
Ali Sarioğlu Sabri Akın	*Harran University*	The Effect of Potassium Applications on Physiological Characteristics of Wheat Plant Under Drought Conditions
Safiye Kaçkın Heydem Ekinci Necla Şaşkın Bekir Erol Ak	*Harran University*	Effects of Some Absorbent Substances on The Browning Rates of Pomegranate (*Punica granatum* L.) Plant Under in Vitro Conditions
Zehra Günbeği Heydem Ekinci Bekir Erol Ak Necla Şaşkın	*Harran University*	Determination of The Proliferation Performance of Ucb-1 (P. Atlantica X P. İntegerrima) Pıstacıa Rootstock Under in Vitro Conditions
Derya Ömerosmanoğlu Bülent Hallaç	*Yildiz Technical University*	Determınatıon of The Antimicrobial Activity of Some Commercially Available Antiseptics/Disinfectants Against İmportant Food Pathogens
Nadia Al-Muslimawi Dhia Ibrahim	*University of Baghdad*	Effect of Adding Ginseng (Panax Ginseng) Extract and Early Acclimatization on Some Physiological Traits of Broiler Chickens Exposed Later to Heat Shock
Lusiana Tursina Silaban Christine Wulandari Indra Gumay Febryano Susni Herwanti	*University of Lampung*	Community Social Capital in Supporting Forest Sustainability
Ashenafi Miresa	*Jimma University*	Natural Mineral Spring Water (hora) and Surrounding Soils in Southwestern Ethiopia: Farmers' Feeding Practices and Their Perception About Its Nutritional Roles on Animal Performance
Ademola Olaitan Idowu Hadejia Isah Fati Oyewale Felicia	*Alvan-Ikoku University of Education*	Addressing Food Insecurity: Implementing Sustainable Agricultural Policies to Combat Hunger in Nigeria

09.03.2024
Ankara Local Time: 12:30-14:30

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-2, HALL-1 / OTURUM-2, SALON-1

MODERATOR: Hülya HANOĞLU ORAL

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Eylül Berfin Birgül Nazli Özkurt Harun Bektaş Yasemin Bektaş	*Siirt University*	Effects of Chitosan Applications on Abiotic Stress Factors in Plants
Nazli Özkurt Eylül Berfin Birgül Harun Bektaş Yasemin Bektaş	*Siirt University*	Effect of Priming Applications Against Bacterial Diseases in Plants
Hülya Hanoğlu Oral	*Muş Alparslan University*	Evaluation of Chemical Composition and In Vitro True Digestibility of Hulls of Buckwheat Seeds
Damla Önder Shahad Waleed Khalid Khalid Sercan Önder Ümit Erdoğan	*Isparta University of Applied Sciences*	Analysis of Volatile Oil Composition and Fatty Acid Profiles of Cardamom Seeds
Bedriye Bilir Hava Şeyma İnci	*Kahramanmaraş Sütçü İmam Üniversitesi*	Effects of Earthquakes on Agriculture, Forest and Rangeland
Bedriye Bilir Hava Şeyma İnci	*Kahramanmaraş Sütçü İmam Üniversitesi*	The Assessment of Some Agricultural Properties of The Soils of Şirnak University Mehmet Emin Acar Campus
Raymond Oriebe Anyasi Harrison Ifeanyichukwu Atagana Desmond Chiagozie Agbo Joyce Onyenaturuchi Anyasi Raymond	*University of South Africa*	Enhancement of the Growth of Nicitiana tabacum by Indole Acetic Acid (IAA) Used in Soil Treatment Against Organic Contaminant Pollution
Mzia Kokhia Oleg Gorgadze Manana Lortkipanidze David Nebieridze Madona Kuchava	*Ilia State University*	Organic Farming in Georgia
David, I. A Oladimeji, Y. U. Yusuf, O. Abdulrahman, S. Hussaini, A.S. Magaji, B.D1	*Ahmadu Bello University*	Effects of Risk Management Strategies on the Efficiency of Rice Farmers in Kebbi and Ebonyi States Nigeria

09.03.2024
Ankara Local Time: 12:30-14:30

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-2, HALL-2 / OTURUM-2, SALON-2

MODERATOR: Aydın Şükrü BENGÜ

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Metehan Kutlu Neffel Kürşat Akbulut	*Necmettin Erbakan University*	Characterization of Anogenital Distance and Clitoris Length in Akkarman Ewes and Their Relationship with Fertility
Selda Karadağ Turgut Kırmızıbayrak Buket Boğa Kuru	*Kafkas Üniversitesi*	Pekin Duck Breeding in Türkiye
Fatma Nuray Şimşek İpek Erdem Aykut Zerek Bilal Dik Mehmet Yaman	*Hatay Mustafa Kemal University*	The First Case of Menacanthus pallidulus (Neumann, 1912) (Phthiraptera: Amblycera: Menoponıdae) on A Chicken (Gallus gallus domesticus Linnaeus, 1758) in Türkiye
Burçak Aslan Çelik Rıdvan Yılmaz Tacettin Çiftçi Özgür Yaşar Çelik Adnan Ayan Özlem Orunç Kılınç Gürkan Akyildiz Kerem Ercan	*Siirt University*	A Survey of the Prevalence and Genotypes of Cryptosporidium Spp., and Giardia duodenalis in Shelter Dog in Batman, Türkiye
Özgür Yaşar Çelik Servet Sekin	*Siirt University*	The Prevalence of Leishmaniasis in Dogs in Dicle and Hani Districts of Diyarbakir
Frada Setia Mona Lutfi Nur Latifah Lusiana Br Pardede Christine Wulandari	*University of Lampung*	Identification of Agroforestry Plant Potential in Kph of Lampung Province
Meryem Tourabi	*Alvan-Ikoku University of Education*	Insecticidal Properties of Chemically Characterized Essential Oils Extracted from Moroccan Mentha longifolia: In Vitro and In Silico Analysis
Zainab Hussain Abdulshaheed Mohanad Hazim Halboos	*University of Kufa*	Evaluation of Groundwater Quality in Some Areas Near the Najaf Sea / Iraq
Kaviya R Suganthi P	*R.M.K. Engineering College,*	Harnessing biotechnology for sustainable food production

09.03.2024
Ankara Local Time: 12:30-14:30

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-2, HALL-3 / OTURUM-2, SALON-3

MODERATOR: Yasemin ÜSTÜNDAĞ

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Bahar Erden Mustafa Barış Akgül Sevdet Kılıç	*Siirt University*	A Case of Peritoneopericardial Diaphragmatic Hernia in a Cat
Yasemin Üstündağ Mehmet Kartal	*Dokuz Eylül University*	Sexual Dimorphism in Experimental Animal Modeling
Yasemin Üstündağ Mehmet Kartal	*Dokuz Eylül University*	The Effects of Seratonin in Aggressive Dogs
Zeynep Asutay	*Bitlis Eren University*	Development of Strategies to Reduce the Negative Effects of Pesticides in Honey Bees
Izzet Beyoğlu	*Bingol University*	The Use of Prebiotics in Poultry and Prebiotics Employed for This Purpose
Feyza Döndü Bilgin	*Aydın Adnan Menderes University*	Advanced Mixed Crop-Forage-Livestock Management Concept for Temperate Regions: LivestockPlus
Mohammed Mohammed Ndagi Musa Idris Abubakar Mohammed Goga Huduzaratou Abdul-Hamidu Abdullahi	*Ahmadu Bello University*	Effect of Banditry Activities on Agricultural Output in Rafi Local Government Area of Niger State, Nigeria
Sani, A.A Oladimeji, Y.U Magaji, B. D Hussaini, A.S Ibrahim, H. A.	*Ahmadu Bello University*	Determinants of Crop Farmers' Efficiency during Pre-Peak and Post Peak Boko Haram Insurgency Periods in North East, Nigeria
Liliam Sayuri Sakamoto Jair Minoro Abe Jonatas Santos De Souza Luiz Antonio De Lima	*Paulista University*	Optimization of Incidents in The Irrigation System Using Dlp – Data Loss Prevention Paraconsistent

09.03.2024
Ankara Local Time: 12:30-14:30

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-2, HALL-4 / OTURUM-2, SALON-4

MODERATOR: Ahmet UYAR

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
İlker Şen Melisanur Ural Nazli Büyükyıldız	*Sivas Cumhuriyet University*	Treatment of an Open Wound with Tissue Loss Using a Randomized Skin Flap in a Cat
Ahmet Uyar	*Hatay Mustafa Kemal University*	A Case of Congenital Generalized Tuberculosis in a Calf
Taha Can Taş Recep Gümüş	*Sivas Cumhuriyet University*	Effect of Boric Acid on Some Minerals in Serum in Rats
Songül Ötkün Özgül Gülaydin Muazzez Yeşilyurt	*Siirt University*	Comparing Identification Kit with MALDI-TOF MS Technique in the Identification of Staphylococcus Species Isolated from Various Clinical Samples
Ziad Shakeeb Al Sarraf	*University of Mosul*	Simulation Model of Agriculture Irrigation Emitter for Anti Clogging Drip
Busari M.B. Oladejo N.A.	*University of Ilorin*	Comparative Qualitative Phytochemical Content and Antimicrobial Activities of Methanol Extract of Calotropis Procera Flower and Its Latex
Fettouch Houari	*University of Mostaganem*	Infinite Order of Growth of Solutions to Diffirential Equations
Anita Pandey	*Kirodimal govt. arts and Science College*	Agriculture Waste Management for a Sustainable Environment with Special Reference to Chhattisgarh, India
Mouassa Bochra Lynda Sahraoui S.Maziz Bettahar	*University Chadli Benjdid*	Survey on the Diagnosis and Management of Viral Hemorrhagic Disease in Rabbits by Field Veterinarians in Eastern Algeria
Sadiq, M.S Singh, I.P Ahmad, M.M Gama, E.N Sambo, A.A	*FUD*	Spectral Effects Of Eco-Innovations' Adoption On Sustainable Livelihoods' Resilience Among Small-Scale Wheat Farmers In Jigawa State Of Nigeria

09.03.2024
Ankara Local Time: 12:30-14:30

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-2, HALL-5 / OTURUM-2, SALON-5

MODERATOR: Ali GÜLAYDIN

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Serdar Odacı	*Samsun Veterinary Control Institute Directorate*	Prevalence of Pneumonia in Cases Sending to Samsun Veterinary Control Institute Pathology Laboratory Between 2019-2023
Sevdet Kiliç Mahsum Başak Mustafa Barış Akgül Gülşah Akgül	*Siirt University*	Possible Unilateral Iris Melanoma in A Cat
Ali Gülaydın M. Hattap Soysal	*Siirt University*	Peritoneopericardial Diaphragmatic Hernia (PPDH) in Cats and Dogs: A Consolidated Analysis of Scientific Findings from Various Studies
Ömer Faruk Gökcecik A. Anil Çağirgan	*Izmir/Bornova Veterinary Control Institute*	The Major Viral Diseases Transmitted By The Vectors and The Role of The Vectors in The Transmission
Murat Arıkan Ramazan Yıldız	*Mehmet Akif Ersoy University*	Investıgatıon of Small Anımal Veterinary Surgeons' Attention to Hand Hygiene
Murat Arıkan Ramazan Yıldız	*Mehmet Akif Ersoy University*	Importance of The Use of Personal Appropriate Protective Equipment (Ppe) in Small Anımal Clinics
Muhammad Faisal	*Universiti Malaysia Sarawak*	Progressions In Multiparty Computation And Preserving Privacy In Tête-À-Têtes
Muhammad Faisal Reema Shaheen Munir Ahmad	*Allama Iqbal Open University*	Rules of Risk Manager in Integrated Risk Management System (Irms) in It Industry
Nitika Saini Barinderjit Singh	*I.K. Gujral Punjab Technical University,*	Minerals and Heavy Metal Content Identification in Pomace and Peel of Kinnow
Tanweer Alam Awadesh Prasad	*V. K. S. University*	Perovskite-Based Materials for Energy Applications
Hamisu Muhammad	*School of Science and Technology*	Simulation And Construction of Microcontroller Based Electronic Circuit With Sms Reporting Facilities for Irrigation Plant

09.03.2024
Ankara Local Time: 12:30-14:30

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-2, HALL-6 / OTURUM-2, SALON-6

MODERATOR: Özgül GÜLAYDIN

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Subhom Ghosh Akash Santra Atanu Koley Monalisa Halder	*Abacus Institute of Engineering and Management*	Genetic application in Agriculture
Muazzez Yeşilyurt Özgül Gülaydın	*Siirt University*	Phenotypic and Genotypic Characterization of Biofilm Formation in Staphylococcus aureus Isolates
Fatma Işbilir	*Siirt University*	Macroscopic and Microscopic Description of Spleen Development in The 2nd And 3rd Trimester in Hamdani Crossbreed Sheep (Ovis aries)
Seemant Tiwari	*Southern Taiwan University of Science and Technology*	Predicting Wind Speed With the ARIMA Algorithm
Sureyya Yigit	*New Vision University*	Differing Understandings and Interests Regarding European Agriculture
Deepali Tomar	*Himalayiya University*	Success of Micro, Small and Medium Enterprises in Uttarakhand
Sulaiman Muhammad Bello Rilwan Lawal Tanimu Ahmed	*Federal College of Education*	Application of Data Envelopment Analysis on Integrated Crop-Livestock Enterprises in Kaduna, Nigeria
Ewuola, Muslim Kayode Usman, Achor Miriam	*University of Abuja*	Sequence Analysis and Amino Acids Substitutions of Adiponectin Gene in Some Poultry Species
Subhashish Dey	*Gudlavalleru Engineering College*	Utilization of Reclaimed Sewage Water in Concrete
Subhashish Dey	*Gudlavalleru Engineering College*	Influences of Admixtures on Chloride Resistance of Self Compaction Concrete
Rampravesh Kumar	*Bharath Institute Of Higher Education And Research*	Depression : Diabetes Mellitus

09.03.2024
Ankara Local Time: 15:00-17:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-3, HALL-1 / OTURUM-3, SALON-1

MODERATOR: Andrey Popatanasov

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Berat Selim Tokgöz	*Adana Veterinary Control Institute*	Determination of the Prevalence of IBR and BVD in a Dairy Herd
Ayyoub Ammar Zineb El Mouridi Asmae Nouira Said Boughribil	*University Hassan II Casablanca*	Assessment Of The Impact Of Radıoactıve Caesıum And Strontıum On Moroccan Agrıculture: Soıl Analysıs And Wheat Growth Patterns
Muhammed Zahid Atlı	*Siirt University*	Investigation of the Morphological and Histological Structure of The Kidneys in Hamdani Crossbreed (Ovis aries) Sheep Fetus
Tolga Meriç Dümbek Zeynep Bozkan Ünal	*Muğla Sıtkı Koçman University*	Uses of Fluoroscopy in Cats and Dogs
Andrey Popatanasov	*Bulgarian Academy of Sciences*	Hormopriming with Cytokinins and Impacts on the Germination of Helianthus annuus L.
Ganya, Adamu Hauni Dauda, Hauwa Ango, Monica Asabe Ibrahim	*Usmanu Danfodiyo University*	Agriculture as the Foundation of Nigerian Economic Enterprise
Krupa-Małkiewicz Marcelina Ochmian Ireneusz Agata Jurkiewicz	*West Pomeranian University of Technology Szczecin*	Effects of Chitosan and Silver Nanoparticles on Tomato Plant Growth Under Heavy Metal Stress Conditions
Huțu Dana Amariei Sonia	*Stefan cel Mare University of Suceava*	Substituting Sugar with Apple Puree in Muffins: Impact on Physical and Textural Characteristics
Mezerket Amina Hammache Miloud Cantalapiedra-Navarrete Carolina Castillo Pablo Palomares-Rius Juan Emilio	*Ecole Normale Supérieure (ENS) Kouba*	Molecular Characterization of Potato Cyst Nematodes From The Province Of Béchar, South-Western Algeria

09.03.2024
Ankara Local Time: 15:00-17:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-3, HALL-2 / OTURUM-3, SALON-2

MODERATOR: Ahmet UYAR

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Ahu Kayalarli Acartürk	*Veterinary Control Institute*	Current Approaches to Anthrax Diagnosis
Ilhan Sabancilar Murat Yolcu	*Bitlis Eren University*	Determination of Cytotoxic Level of Alpha Amanitin in Lung Cancer Cell Line
Burak Batuhan Laçin Ali Çinar	*Atatürk University*	Role of Keap1/NRF2/HO-1 Pathway in Lipopolysaccharide-Induced Septic Lung Injury in Rats
Barış Can Güzel	*Siirt University*	Investigation of The Morphological and Histological Structure of The Liver in Hamdani Crossbreed Sheep (*Ovis aries*) Fetus
Esra Bilici	*Uşak University*	In cancer cell: crispr cas9
Uğur Sesiz	*Şırnak University*	The Effect of Salinity Stress on Germination and Seedling Growth of Durum Wheat
Marinache Ramona Marinescu Valentina	*University of Bucharest*	African Swine Flu Epidemic in Romanian Media
Marinescu Valentina Marinache Ramona	*University of Bucharest*	Agrıculture in Romanian Media
Ewetola, E.A., Ogunrinde, J.O., Aborode, M. A., Alabi, D.A.	*Ladoke Akintola University of Technology*	Influence of Legume/Maize Cropping Systems and Rhizobium on Soil Physical Properties, Growth and Yield of Maize (*Zea mays* L.)
Kamran Faghihi Mehdi Kheirandish Mohammad Kazem Mohammadi	*Faghihi Inductrial and Manufacturer Company*	New Biostimulant (Vogor Stimulant) as a Plant Grow Promoter for Plant Germination Enhancement and Increase The Yield of Friut Production
Alatise, S.P. R. Ibrahim M. J. Abubakar	*Federal College of Freshwater Fisheries Technology*	Utilization of Toasted Velvet Beans (Mucuna pruriens) Seed Meal as a Protein Source for Clarias gariepinus Fingerlings

09.03.2024
Ankara Local Time: 15:00-17:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-3, HALL-3 / OTURUM-3, SALON-3

MODERATOR: Volkan GÜL

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Serpil Aygörmez Aydın Genç	*Kafkas University*	Apoptosis, Autophagy and Inflammation in Metabolism
Çiğdem Kirsüleymanoğlu Dilek Çelikler	*Ondokuz Mayıs University*	A General Overview of Microplastics in The Muscle and Liver of Some Fish Species
Abdullah Karasu Caner Kayikci	*Van Yuzuncu Yil University*	A Case of Congenital Scrotum Hernia in a Lamb
Ali Osman Turgut Davut Koca Ali Ünver	*Siirt University*	Comparison of Blood Bhba Measurement Devices for Diagnosis of Subclinical Pregnancy Toxemia in Sheep: a Field Study
Ömer Eltas	*Atatürk University*	Discriminant Analysis and Its Use in The Veterinary Field
Kezban Uçar Çifçi	*Yozgat Bozok University*	Molecular Mechanism and Anticancer Effect of Cannabinoids in HGC27 Gastric Cancer Cells
Edin Hrelja Amina Sivac	*University of Sarajevo*	Analysis of Change of Land Cover in The Area of The Municipality of Ilidža
Amna Mirza Chayanika Uniyal	*Jamia Millia Islamia University*	Factoring Importance of Gender Perspectives in Agrarian Reforms, with Special Focus on National Mission on Sustainable Agriculture (NMSA) in India
Vadym Solovei Elena Trotsenko	*National Scientific Center «Institute for Soil Science and Agrochemistry*	Integration of Automated Systems in The Agricultural Sector: Process Management Optimization
Rida Zulfiqar	*University of Szeged*	The Impact of Political Pressure on Judicial Independence: A Comparative Analysis of India and the UK

09.03.2024
Ankara Local Time: 15:00-17:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-3, HALL-4 / OTURUM-3, SALON-4

MODERATOR: Murat GENÇ

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Uğur Özentürk Murat Genç	*Atatürk University*	Behavioural Needs of Laying Hens
Murat Genç Uğur Özentürk	*Atatürk University*	Welfare in Cattle Transportation and Effects of Transportation Conditions
Emin Şengül Samet Tekin	*Atatürk University*	Effects of Gallic Acid on Nrf-2 and HO-1 Levels on ACR-Induced Kidney Damage in Rats
Merve Bolat Aslıhan Atasever Fikret Çelebi	*Ataturk University*	The Role of Cox Enzyme and Prostaglandia in the Development of Gastric Ulcer
Aslıhan Atasever Merve Bolat Fikret Çelebi	*Ataturk University*	Oxidative Stress and Nrf2/HO1 Pathway
Mouassa Bochra H.Saoudi	*University Chadli*	Review on Life Reproduction of The Gilthead Seabream (Sparus Aurata)
Enrico Gonçalves Fábio Albarici	*Federal Institute of Education, Science, and Technology of Southern Minas Gerais*	Enhancing Urban Planning Through 3d Mapping of Trees in Conflict With Electrical Infrastructure
Eshika M Hemashree V Thenmozhi M	*Federal Institute of Education, Science, and Technology of Southern Minas Gerais*	Insights into the Adoption of GM Crops in India and Public Perception: A Survey
Neacsu Ana Gheorghe Daniela	*Institute of Physical Chemistry Ilie Murgulescu*	Evaluation of The Energy Content and The Qualitative Characteristics of Renewable Energy Resources from Some Agricultural Crops
Ivan Pavlovic Jovan Bojkovski Aleksandra Tasic Marija Pavlovic Violeta Caro Petrovic Nemanja Zdravkovic	*Scientific Institute of Veterinary Medicine of Serbia*	Biosecurity Measure in Treatment of Pastures to Prevent Gastrointestinal Helminth Infections of Small Ruminants

09.03.2024
Ankara Local Time: 15:00-17:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-3, HALL-5 / OTURUM-3, SALON-5

MODERATOR: Sevinç AYDIN

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Mahire Bayramoğlu Akkoyun	*Siirt University*	Evaluation of The Antihemolytic Effect of Peucedanum Longifolium Waldst. & Kit Plant.
Sevinç Aydın	*Munzur University*	Analysis of Some Biochemical Contents of Endemic Thyme (Thymus Haussknechtii Velen) Species
Turan Yaman	*Van Yüzüncü Yıl University*	A Case of Hydronephrosis in a Wistar Albino Rat
Mesud Kaplan Mehmet Berköz	*Van Yuzuncu Yil University*	Investigation of The Anti-Inflammatory Effect of Atranorin Treatment
Recep Erdil Mehmet Berköz	*Van Yuzuncu Yil University*	Investigation of Antiproliferative, Antimetastatic, Apoptotic and Anti-Inflammatory Activities of Diosmin on Laryngeal Cancer
Elyoussfi Chaimae Hajar Soujaa Yahya El Hammoudani Hassani Zerrouk Mohammed Nadira Mourabit Saida Aarab	*University Abdelmalek Essaâdi*	Contribution of Bacillus Species to Alleviating Drought Stress
Madan Lal Regar	*National Institute of Fashion Technology Jodhpur*	Sustainability in Fashion
Noureddine Mechouk Georgiana Deak Zihad Bouslama Angela Monica Ionică Corina Gina Toma Andrei Daniel Mihalca	*University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca*	First Record of Angiostrongylus Vasorum in Algeria
Cornelia Nichita	*University of Bucharest*	Antioxidant Bio Nanocarrier System Based On Achillea millefolium L. Standardized Extract And Chitosan Polymer

09.03.2024
Ankara Local Time: 15:00-17:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-3, HALL-6 / OTURUM-3, SALON-6

MODERATOR: Erman GÜLENDAĞ

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Isa Coşkun Huseyin Cayan Osman Tolga Özel Emine Doğan Emine Bilginoglu	*Kirsehir Ahi Evran University*	The Effect of Low Dose Phytobiotic Supplementation to Diet on Performance, Cecal Lactobacillus Count, Intestine Histomorphology, Meat Quality Characteristics and Ileal Muc2 Gene Expression in Quails from 1 To 35 Days of Age
Osman Bulut	*Mugla Sitki Kocman University*	Acquired Bilateral Cataract Caused By Nutritional Deficiency İn A Kitten
Ibrahim Yurdakul	*Sivas Cumhuriyet Universitesi*	Hepatocellular Carcinoma in a Mixed Breed Dog
Münire Turhan	*Bingol University*	Nosema Cerenea
Erman Gülendağ	*Siirt University*	Comparison of Statistical Performance of Different Multiple Comparison Tests in One-Way Analysis of Variance
Erman Gülendağ	*Siirt University*	Common Mistakes Made by Researchers in Biostatistics and How to Avoid Them
Gheorghe Giurgiu Manole Cojocaru	*Deniplant-Aide Sante Medical Center*	Gut Dysbiosis in Dogs With Spinal Cord Injury: Impact of Polenoplasmin
Khadiga Mussa Ala Hasan Al-Lahaibat Shaymaa Y. Alkufi Mohammed S. Mechee	*University of Tripoli,*	A Fractional α-Transform for Converting Third-Order Fractional Differential Equation to Ordinary Differential Equation
Brahmi Zahia Gherissi Djallel Eddine	*University of Souk-Ahras*	Transformative Technologies: Unleashing Ai's Potential for Precision Breeding in She-Camels
Sharmistha Sarma Kalita Bhaben Tanti	*Salbari College*	Physio-Biochemical Response of Some Traditional Joha Rice Variety of Assam Under High Temperature Condition

10.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-4, HALL-1 / OTURUM-4, SALON-1

MODERATOR: Volkan GÜL

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Ceyda Dadali Yeşim Elmaci	*Ege University*	Microalgae as Food
Ceyda Dadali Yeşim Elmaci	*Ege University*	Sensory Quality of Plant Protein-Based Foods
Volkan Gül Firat Sefaoğlu	*Bayburt University*	Contribution of Environmentally Friendly Agricultural Waste to Recycling
Volkan Gül Firat Sefaoğlu	*Bayburt University*	Negative Effects of Climate Change Due to Global Warming on Our Country's Agriculture
Ali Imran	*Government College University*	Agro-Industrial Waste Utilization and Characterization: Insights from Antioxidants and Phenolics Analysis
Farhaoui Mohamed Slimani Chahid	*Sidi Mohamed Ben Abdellah University*	Analysis of Water Scarcity Effects on Farmland Valuation
Okeke Lordwilliams Ikenna Rasheedul Haque Abdul Rahman Bin S Senathirajah Fakir Mohamed Bin Omar Din	*MAHSA University*	Exploring Employee Turnover Intention in Private Organisation in Malasia
Adeniyi Olarewaju Adeleye Hamzat Adamu Mohammed Bello Yerima	*Federal University Dutse*	Detection of Bacterial Loads on the Skin of Fishes Harvested for Human Consumption in River Hadejia, Northwest Nigeria
P. Pandiyan G.Sathyamurthy G. Subash Chandrabose	*Annamalai university*	Survival Time of Cancer Patients Using Burr Distribution
Mazouzi Nourdjihane K.Boutemak A.Haddad	*University of Saad dahlab Blida -1*	Elaboration and characterization of biopolymer composites films based on Hydroxypropyle methylcellulose HPMC reinforced with pectin

10.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-4, HALL-2 / OTURUM-4, SALON-2

MODERATOR: H.Turan AKKOYUN

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Kıvanç Irak	*Siirt University*	Senolytics
Tarık Şafak Efe Durukan Öznur Yılmaz Koç Ali Rişvanli Metin Bayraktar	*Siirt University*	Predicting The Risk of Postpartum Disease in Dairy Cows According to Metabolic Status and Calving Type at Partutation
H.Turan Akkoyun	*Siirt University*	Protective Effects of Sodium Tetraborate on Trace Elements and Some Blood Parameters in Lead-Applied Rats
Saima Tufail Bushra Parveen Kashif Abbas Ameer Fawad Zahoor	*Government College University Faisalabad*	Synthesis, Characterization and Biological activity ofNi(II), Cu(II), Co(II) andMn(II) complexes of 3,5-dichloro-2-hydroxybenzaldehyde based ligand
Chokri Bayoudh Afifa Majdou Messaoud Mars	*Research Laboratory "Production and Protection for a Sustainable Horticulture"*	Optimizing in Vitro Regeneration Protocols of Tunisian Local Pears (*Pyrus communis* L) And Figs (*Ficus carica* L)
Muhammad Amjad Syed Makhdoom Hussain	*Government College University*	Evaluation of different types of biochar on growth performance and body composition of C. carpio fingerlings
Elsa Cavaco Rui Isıdoro	*Polytechnic University of Beja*	Living conditions of immigrant workers in the agricultural sector in Southern Portugal
Ghanshyam Barman	*UkaTarsadia University*	Enhancing Soil Fertility And Crop Productivity Through Organic Manure: A Sustainable Approach

10.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-4, HALL-3 / OTURUM-4, SALON-3

MODERATOR: Ece UYAR

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Mehmet Hanifi Yalçin Sema Alaşahan	*Necmettin Erbakan University*	Distinctive Features of Guinea Fowl Eggs and Morphological Transformations in The Cranial Region Throughout Chick Development
Orhan Çorum Murat Yüksel Devran Coşkun Duygu Durna Şerafettin Kartal Mustafa Cellat Kamil Üney	*University of Hatay Mustafa Kemal*	Comparative Pharmacokinetics of Marbofloxacin in One- Two- and Four-Month-Old Calves
Fatma Akın Devran Coşkun Orhan Çorum Kamil Üney	*University of Hatay Mustafa Kemal*	Prostaglandin E1 Analoğu; Misoprostol
Ece Uyar Mustafa Akin Ayşe Nalbantsoy	*Ege University*	Formulation and Characterization of Multivitamins for the Feed Industry by Double Emulsion Encapsulation Method
Nancy lilly Maria C.S. Suganthi P	*R.M.K. Engineering College*	Sustainability 2.0: Harnessing the Power of Innovation to Heal Our Planet
Kayalvızhı.V Suganthi P	*R.M.K. Engineering College*	Sustainability 2.0: agriculture biotechnology
Parvatha srini K P Suganthi P	*R.M.K. Engineering College*	Comprehensive Overview of All Branches of Food Engineering: Innovations, Challenges, and Future Prospects
Poojitha N Suganthi P	*R.M.K. Engineering College*	Mathematical Modeling for Sustainable Water Resources Management: A Review of Methods and Applications
Priyajothi N Suganthi P	*R.M.K. Engineering College*	Advances in Plant Protection

10.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-4, HALL-4 / OTURUM-4, SALON-4

MODERATOR: Aydin Şükrü BENGÜ

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Hülya Serap Moğul Altay Savalan	*Sağlık Bilimleri Unıversıty*	Evaluation of the Immunostimulatory Effect of Biocompatible Polymers in Adjuvant Systems
Makbule Gökce Uğur Aydoğdu	*Balıkesir University*	Mefenamic Acid Intoxication in A Cat
Leyla Gündüz	*Siirt Training and Research Hospital*	Prevalance and Importance of Entamoeba Histolytica İnfections by Region in Our Country
Aydin Şükrü Bengü	*Bingol University*	Evaluation of Our Foods in Terms of Fat Quality İndex
Nataliia Didenko Anastasiia Sardak Serhii Kolomiiets	*Institute of Water Problems and Land Reclamation*	No-Till Influence On The Dynamics Of Chernozem Properties İn Ukraine
Priyavarshini A Suganthi P	*R.M.K. Engineering College*	Sustainable Strategies in Plant Protection: Integrating Biological, Cultural, and Chemical Approaches
P Sıddharth Suganthi P	*R.M.K. Engineering College*	Improving Access to Clean Water in Rural Areas: Innovative Solutions for Sustainable Development
K.Monika Suganthi P	*R.M.K. Engineering College*	Advancements in Agricultural Practices: Nurturing Sustainability and Resilience
Sam Jones J Suganthi P	*R.M.K. Engineering College*	Enviromental Sustainability: An Abstract on Biosystems engineering
Anjum Naeem Haroon Zaman Khan Ahmad Nawaz Asif Iqbal Farrukh Saleem Muhammad Ashfaq Wahid Muhammad Bilal,Ahmad Ali	*University of Agriculture,*	Soybean Yield And Nodulation Response To Inoculums And Nitrogen Rates

10.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-4, HALL-5 / OTURUM-4, SALON-5

MODERATOR: Emine KÜÇÜKER

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Muhammad Bilal Hussain Marwa Waheed Farhan Saeed Muhammad Afzaal Bushra Niaz	*Government College University Faisalabad*	Bitter melon (Momordica charantia): A Hub of functional bioactive components
Laksita M Suganthi P	*R.M.K. Engineering College*	Sustainability 2.0: Biosysytems Engineering Environment
Marwa Waheed Muhammad Bilal Hussain Farhan Saeed Muhammad Afzaal Bushra Niaz	*Government College University Faisalabad*	Turmeric (Curcuma longa L.): Chemical components and their clinical applications
Mahalakshmi AVNK Suganthi P	*R.M.K. Engineering College*	An Overview of Food Engineering Branches: From Chemistry to Packaging
Stanislava Stateva	*Institute of Plant Genetic Resources*	Possibility of long-term storage of Petunia hibrida L.
Bate Garba Barde Sam-Uket Nwuyi Okori Yunana Bitrus Duhu	*Federal University Dutse*	Effects of Fiproforce and Calatropis procera Extract on Germination Rates of Rice (Oryza sativa) and Macroinvertebrates Abundance
Valery V. Belakhov Irina V. Boikova	*Technion – Israel Institute of Technology*	Preparation Of New Organofluorine Derivatives Of B-D-Ribofuranoside: Synthesis, Acute Toxicity And Insecticidal Activity
Emine Küçüker Erdal Ağlar	*Siirt University*	Evaluation of Türkiye and World Pistachio Production
Emine Küçüker Erdal Ağlar	*Siirt University*	Evaluation of Irrigated and Dry Production in Pistachio Cultivation

10.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-4, HALL-6 / OTURUM-4, SALON-6

MODERATOR: Hakan İNCİ

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Alexandrov V.S	*Kazan National Research Technical University named after A.N. Tupolev*	Noise approach to the analysis of the qualitative composition of the soil
Pham Vu Khuong Duy Quan Thi Ai Lien	*Can Tho University*	Genetıc Dıversıty Of Brassıca Integrıfolıa Populatıon
G. Akashkumar	*Can Tho University*	The Pharmacist's Role In Medication Therapy Counseling
G.Premanand R.Saravanan R.Srınıvasan	*Bharath Institute of Higher Education And Resarch*	Immunotherapy
Selvakumar Saravanan R Srinivasan R	*College of Engineering and Technology*	Bharath institute of higher education and research
Pooja.p R.Saravanan R.Srinivasan	*Bharath Institute of Higher Education and Research*	Innovative Methods to Aim for the Mycolic Acid Biosynthesis Pathway in the Creation of Tuberculosis Treatments
Arwa Rafie Bhumika Sharma Arrat Banday Ritika Shukla	*Jamia Milia Islamia University*	Infectious and Contagious Diseases in Animals : A Study of Policy Framework in India
Hakan İnci	*Bingol University*	Effects of Bee Products on Health
Günsel Kirman Engin Deveci Sevgi Irtegün Kandemir Zafer Pekkolay Gülsüm Pektanç Şengül Ramazan Atiç	*Siirt University*	Investigation of the Regulation of Src(Proto-onkogene Tyrosine-Protein Kinase) and Src-Related Mapk (Mitogen activated protein kinase) and Stat3 (Signal transducer and activator of transcription 3) Signaling Pathways in Type 1 and Type 2 Diabetic Patients

10.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

SESSION-4, HALL-7 / OTURUM-4, SALON-7

MODERATOR: Adeleke, Oluwaseun Aderonke

Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Tejasri Sahasra	*Vikas College of Pharmaceutical Sciences*	Recent Updates In Carbohydrate Metabolism
Firoza Ramazanova Aytan Mammadova	*Institute of Soil Science and Agrochemistry*	Morphological State Of Soils In The Dry Subtropical Zone Of Azerbaijan
Vikram banda Saikumar jarpula	*Vikas College of Pharmaceutical Sciences*	Lipid metabolism in inflammation-related diseases
Razia Kausar Sana Riaz Shah Nawaz M. Abdullah Sarmad Rehan Umer Sharif	*University of Agriculture*	Comparative Effect Of Moringa Oleifera Seed And Leef Powder On Digestive System In Ducks (Anas platyrhynchos)
Adeleke, Oluwaseun Aderonke	*University of Ibadan*	Utilisation of Indigenous Medicine among Rural Dwellers in Oke-ogun Area of Oyo State, Nigeria
Sai Krishna P B Suganthi P	*R.M.K. Engineering College*	Towards Sustainable Livestock Management: Strategies, Challenges, and Opportunities
V. Pavıthra Suganthi P	*R.M.K. Engineering College*	An Abstract on Application of Mathematics in Zootechnics
R R Sanjana Suganthi P	*R.M.K. Engineering College*	An Abstract on Application of mathematics in plant protection
Sanjani K Suganthi P	*R.M.K. Engineering College*	Harvesting Harmony: Cultivating Sustainability through Agroecology
Nguyen Thi Ngoc Hoa Khuu Thi Phuong Dong	*Can Tho University*	Developıng Of Traceabılıty Systems For Agrıculture Supply Chaın: Evıdences From Shrımp Products In Mekong Delta, Vıetnam

10.03.2024
Ankara Local Time: 10:00-12:00

(All speakers required to be connected to the session 15 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.
Before you login to Zoom please indicate your name_surname and hall number,
exp. Hall 1, Akkoyun

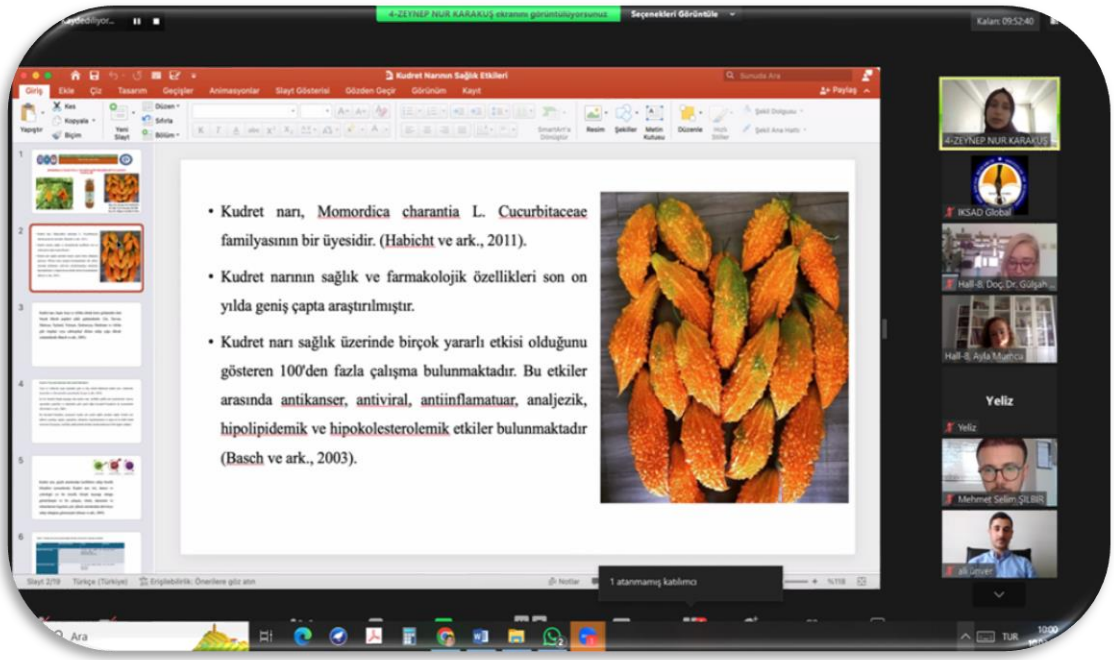
SESSION-4, HALL-8 / OTURUM-4, SALON-8

MODERATOR: Gülşah ÇALIŞKAN KOÇ

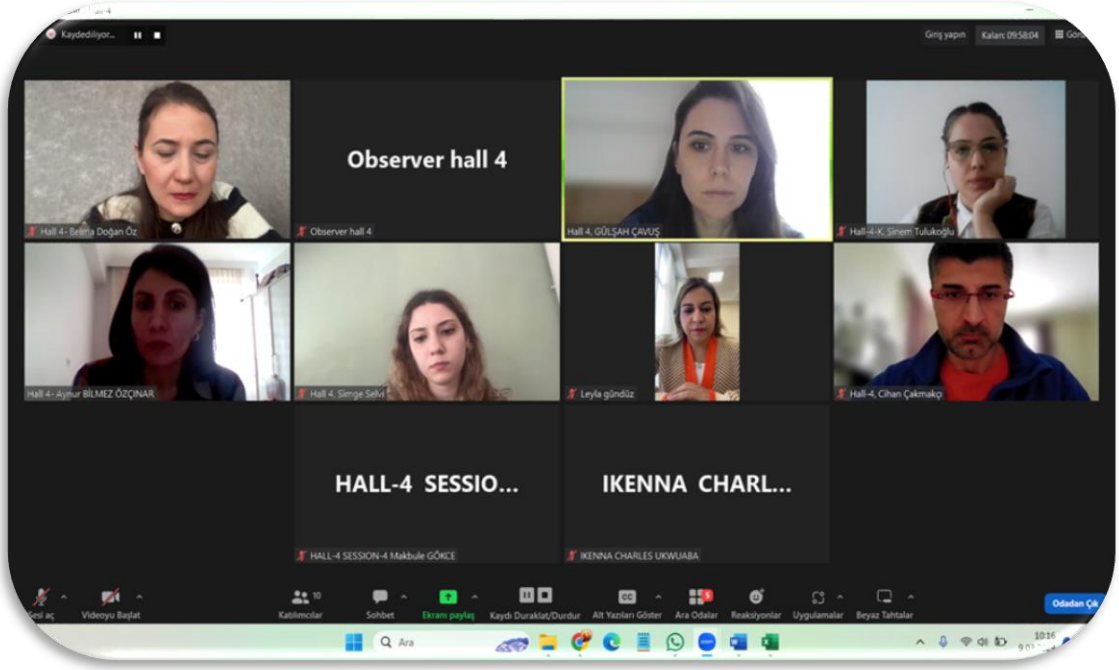
Meeting ID: 858 1117 0419
Passcode: 777777

AUTHOR	AFFILITION	ABSTRACT TITLE
Zeynep Nur Karakuş Gülşah Çalışkan Koç Yasemin Çelebi	*Uşak University*	Bioactive Compounds And Health Benefits Of Momordica Charantia L. Lecturer
Zeynep Nur Karakuş Yasemin Çelebi Gülşah Çalişkan Koç	*Uşak University*	Bioactive Components And Health Benefits Of Kumquat (Fortunella Sppp.) Fruits
Yeliz Tekgül Barut	*Aydın Adnan Menderes University*	Mycotoxins and reduction methods in the food industry
Selma Lubabe Erdoğan	*Alanya University*	Investigating The Potential of Using Edible Seaweeds As A Functional Food Source In Gastronomy
Selma Lubabe Erdoğan	*Alanya University*	Examination Of The Possibilities Of Using Superfoods In The Field Of Gastronomy
Aise Deliboran Yilmaz Isik Hasan Aslan Abdullah Suat Nacar Tuba Yasemin Tekgul Hatice Kara Mustafa Harmankaya Sait Gezgin	*Olive Research Institute*	Biofortication of Maize Herbage with Nutrients as Affected by Foliar Sodium Selenate Application
S. Elmazouzi H. Mabraka F. Allali A. Zourif A. Salima I. Zerdani N. Touach A. Benzaouak Y. Naimi	*Hassan II University of Casablanca*	Catalyzing Sustainability: Harnessing Microbial Fuel Cells for Efficient Wastewater Treatment and Renewable Energy Generation
Mehmet Selim Şılbır Safa Hacıkamiloğlu Elnaz Latifian Orhan Kurt	*Iğdır University*	Approaches To Prevent Food Waste And Utılızatıon Of Waste Into Agrıcultural Productıon
Ayla Mumcu Ferişte Öztürk Güngör Zeynep Şeyda Erdemir Tiraş Erkan Susamci Seda Ersus	*Olive Research Institute*	Avaılabılıty Of Olıve Leaf Extract In Food Products As An Antımıcrobıal Preservatıve
Aybüke Kaya Veysi Acıbuca	*Hatay Mustafa Kemal Üniversitesi*	The Current Situation of Forage Crops in Mersin Province

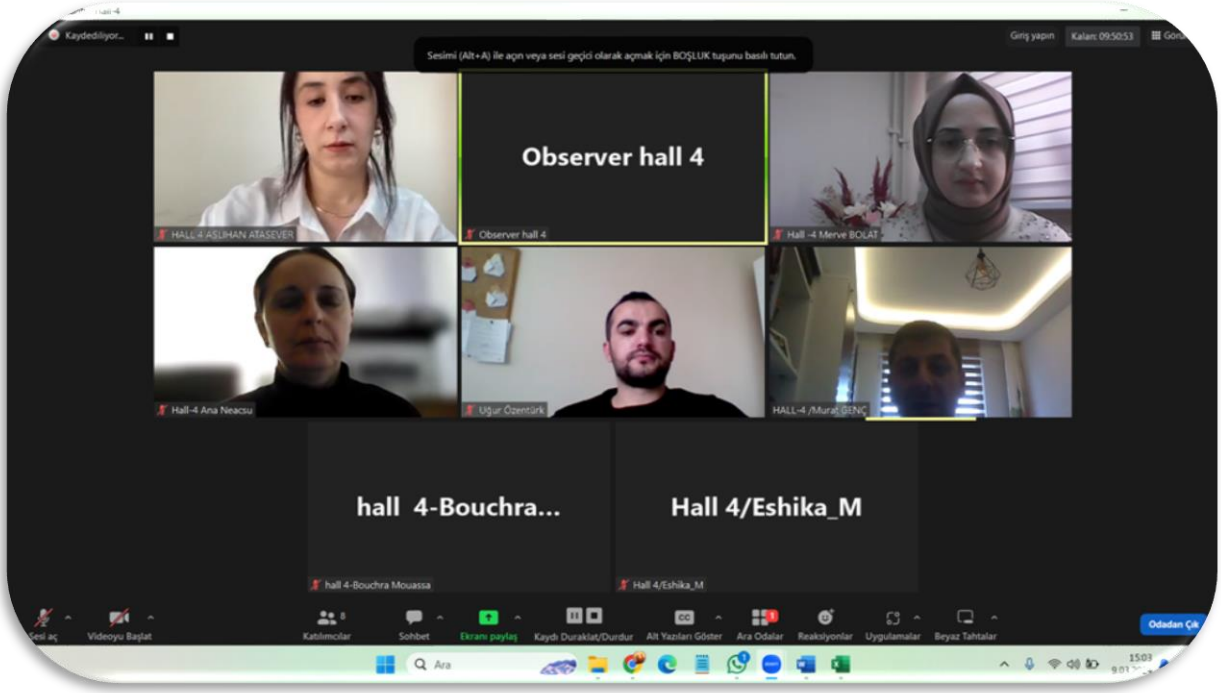
SYMPOSIUM PHOTOS



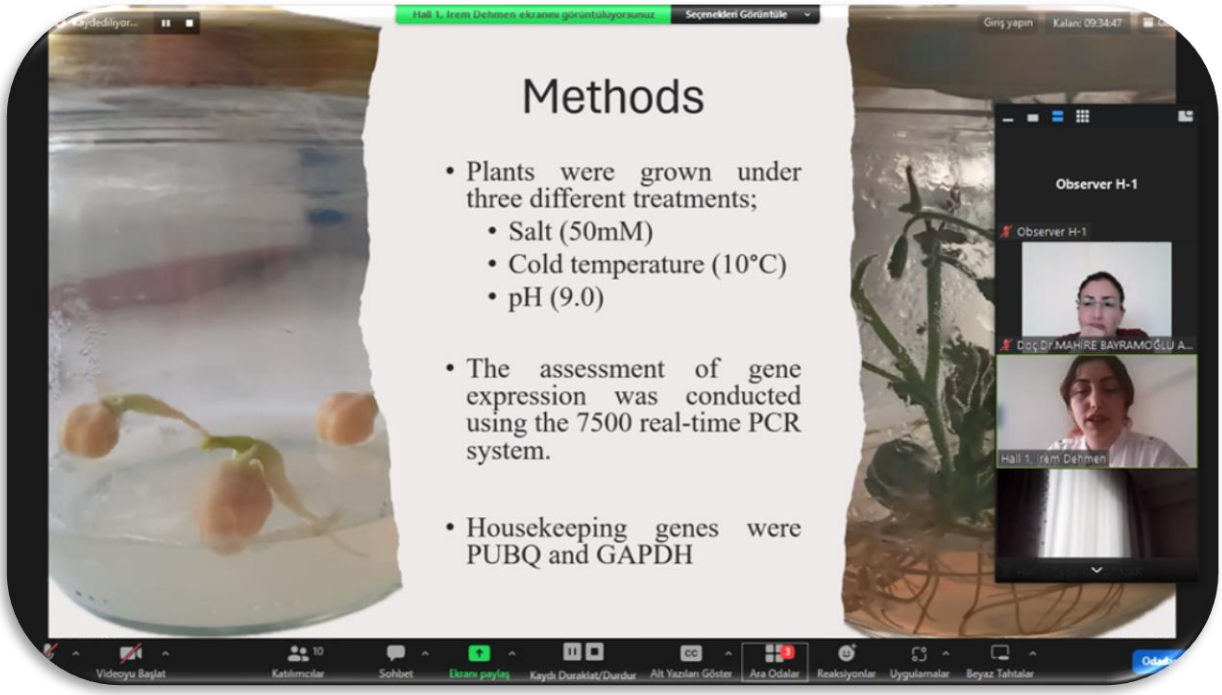
SYMPOSIUM PHOTOS



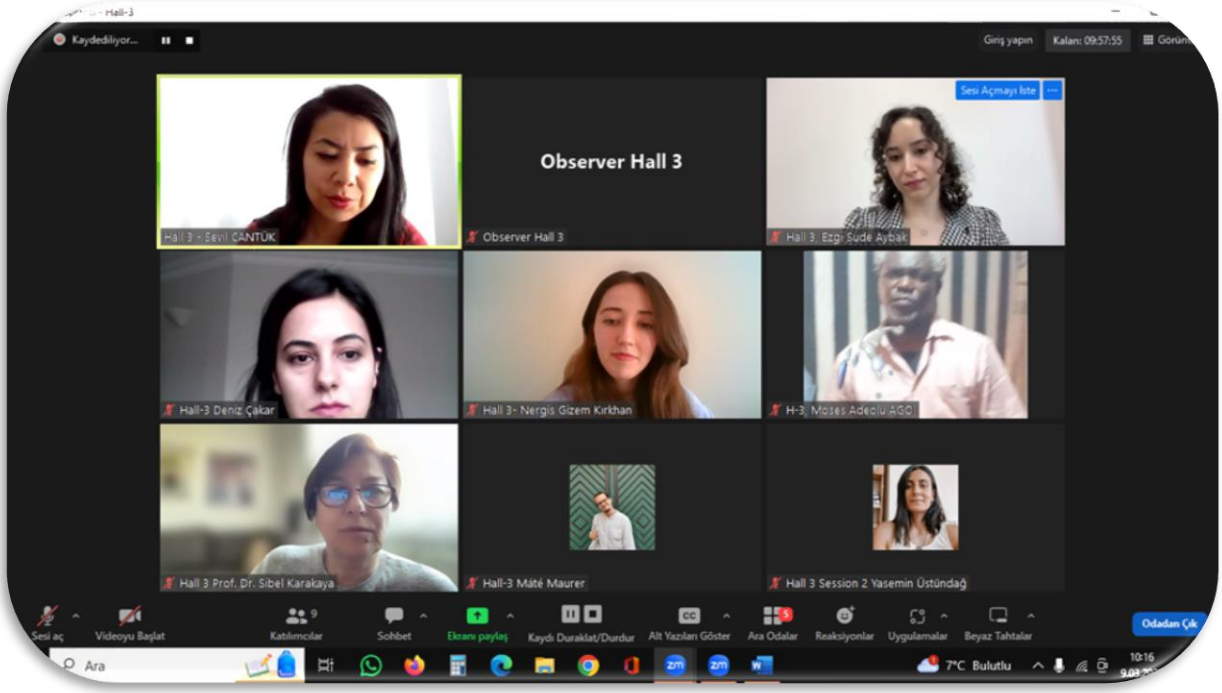
SYMPOSIUM PHOTOS



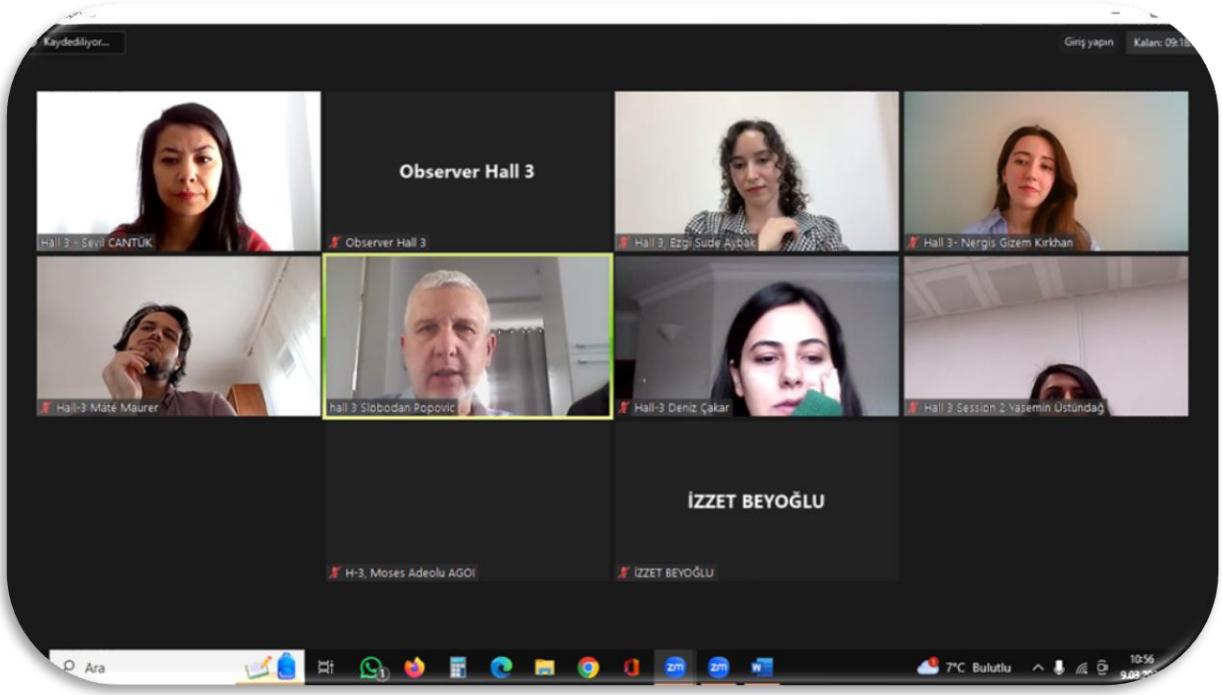
SYMPOSIUM PHOTOS

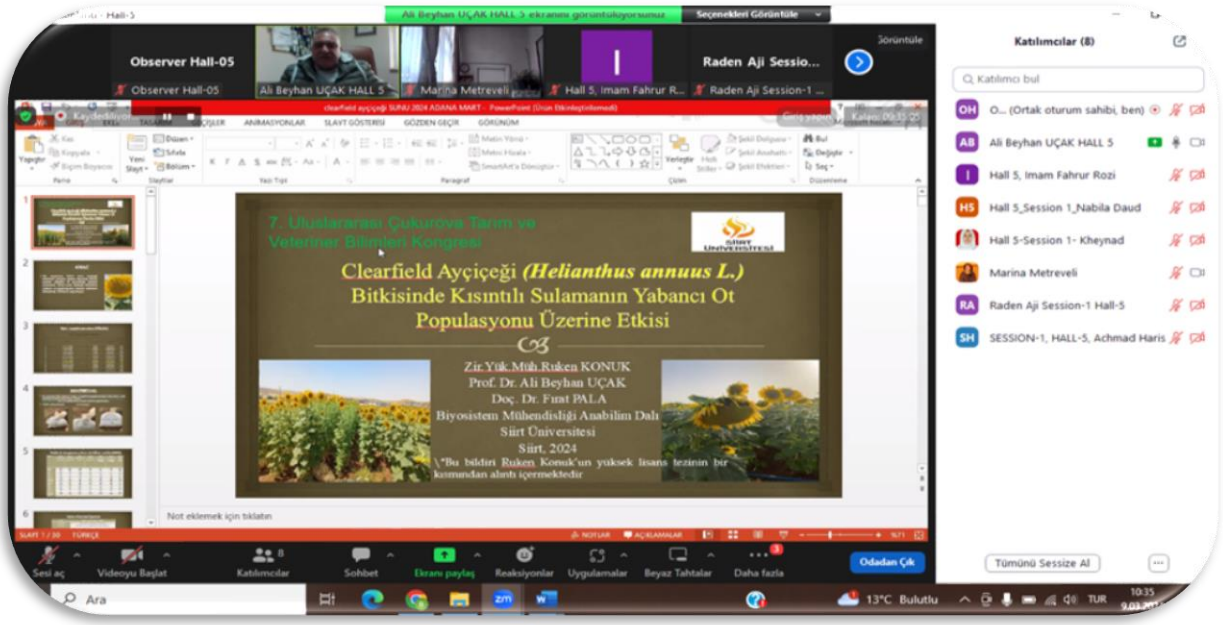


SYMPOSIUM PHOTOS

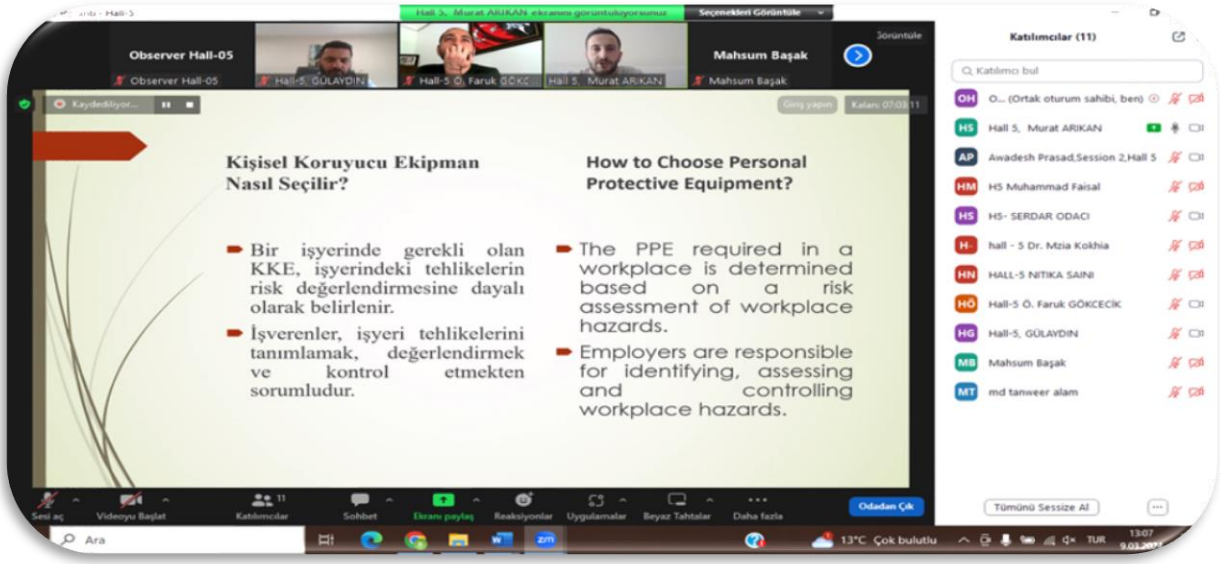


SYMPOSIUM PHOTOS





SYMPOSIUM PHOTOS



CONTENTS

AUTHOR	TITLE	Page No
ABSTRACT		
Uğur Sesiz	The Effect of Salinity Stress on Germination and Seedling Growth of Durum Wheat	1
İbrahim Halil Güngör	Determination of The Effects of Ginkgo Biloba Extract on Short-Term Storage of Ram Semen With The Casa Device	2
Pınar Coşkun	Use of Propolis in The Biosynthesis of Zinc Nanoparticle	4
Erhan Ayna Ömer Faruk Keleş Hacı Ahmet Çiçek Zabit Yener	A Case of Cutaneous Neurofibroma in a Dog	6
Irem Dehmen Fatih Sezer	Expression of Glycosylation-Related Genes Under Stress in *Cicer arietinum*	8
Jiyan Tunç Elif Babacanoğlu Çakır	Prediction of Sex by The Effect of Sex Genes on Phenotypic Traits	10
Ilnura Ibragimovna Fayzullina Ilya Nikolayevich Medvedev	Hematological Characteristics of First-Calf Cows	12
Ilya Nikolayevich Medvedev Ilnura Ibragimovna Fayzullina	Physiological Features of Blood Parameters of Steer Cows of The Black-And-Brown Breed	13
Mohammad Yawuz Jamal Angham Ahmed Sara Asaad Israa Naem	Evaluating, Knowledge, Attitudes and Practices Regarding Antimicrobial Use and Resistance Among Group of Medical Students	14
Seda Karapınar Seda Deveci Birsen Öztürk	Sımultaneous Determınatıon Of Mıcroelements In Hydroponıc Nutrıent Solutıons By Flow Injectıon Analysıs	15
Zeynep Bozkan Ünal Aylin Ateş Sümbül Serap Birincioğlu	A Case of Pedunculated Mass (Fibromyxoma) on The Head Area of A Budgerigar (Melopsittacus undulatus)	17
Nihad Habeeb Mutlag	Evaluation the Antagonistic Ability of Biocontrol Fungi Against Some of Pathogenic Fungi Isolated from Wastewater	19
Raeda Abd Al-Redha Sabet Mohammed H. Noor Aljana Mohammed Radwan Mahmoud	Effect of Humic and Fulvic Acids on the Growth of Maize Cultivars	20
Pranathi.T.M Suganthi P	Internet-of-Things Smart Agriculture:Toward Marking the Fields Talk	21
Sevil Cantürk Birhan Kunter	The Effects of Spur and Cane Pruning on Phenology, Yield and Some Quality Characteristics of Hasandede Grape Cultivar	22
Zeynep Bozkan Ünal Ezgi Sude Aybak	Diagnosis and Treatment of Retrobulbar Abscess in Domestic New Zealand Rabbit	24
Máté Maurer Szilvia Stranczinger Zsuzsanna Szőke László Szemethy	First Insight into The Mycotoxin-Related Investigation of Hungarian Game Species	26

Moses Adeolu Agoi Solomon Abraham Ukpanah Opeyemi Elizabeth Adewunmi Olasunkanmi Julius Olatunde Oluwanifemi Opeyemi Agoi	Access Control as Technological Gateway to Data Security: an Intrinsic Study of Cloud Computing Development	27
Cihan Çakmakçı	Use of Computer Vision in the Digital Transformation of Livestock Farming: A Facial Detection System for Goats using a Deep Learning Approach Based on YOLOv8	28
Tesfaye Mengie Kassie Szemethy László Róbert	Assessing the practice of Community-Based Forest Management in Northwest Ethiopia	30
Ikenna Charles Ukwuaba Sunday Ifeanyi Ukwuaba Ifeyinwa Cynthia Ukwuaba	Smallholder Commercialization: Analysis of the Socio-economic and Institutional Constraints to Market Orientation and Participation Among Rice Farming Households in Southeast Nigeria	31
Favour C. Uroko	Religious Crisis and Food Insecurity in Nigeria Since 2023: Any Hope	32
Pharm A. Dinesh Babu R. Jothilakshmi R.Srinivasan	Some Natural Isolated Compounds As Anticancer Agents	33
Nabila Daud Aryanti Rizki Adinda Dhea Ayu Lestari Christine Wulandari	Partisipasi Masyarakat Dalam Mendukung Keberhasilan Rehabilitasi Hutan Dan Lahan Di Taman Hutan Raya Wan Abdul Rachman	34
Kheynad Vinanda Arum Tri Kurniawan Nur Ahmad Fadli Christine Wulandari	Analysis of Agroecosystem Management of Coffee Plants in Lampung Using the SWOT Method	35
Marine Metreveli	Rural Tourism for Organic Farming in Georgia	36
Nadia Al-Muslimawi Dhia Ibrahim	Effect of Adding Ginseng (Panax Ginseng) Extract and Early Acclimatization on Some Physiological Traits of Broiler Chickens Exposed Later to Heat Shock	37
Ashenafi Miresa	Natural Mineral Spring Water (hora) and Surrounding Soils in Southwestern Ethiopia: Farmers' Feeding Practices and Their Perception About Its Nutritional Roles on Animal Performance	38
Olaitan Idowu Hadejia Isah Fati Oyewale Felicia	Addressing Food Insecurity: Implementing Sustainable Agricultural Policies to Combat Hunger in Nigeria	39
Metehan Kutlu Neffel Kürşat Akbulut	Characterization of Anogenital Distance and Clitoris Length in Akkarman Ewes and Their Relationship with Fertility	40
Fatma Nuray Şimşek İpek Erdem Aykut Zerek Bilal Dik Mehmet Yaman	The First Case of Menacanthus pallidulus (Neumann, 1912) (Phthiraptera: Amblycera: Menoponıdae) on A Chicken (Gallus gallus domesticus Linnaeus, 1758) in Türkiye	42
Burçak Aslan Çelik Rıdvan Yılmaz Tacettin Çiftçi Özgür Yaşar Çelik Adnan Ayan	A Survey of the Prevalence and Genotypes of Cryptosporidium Spp., and Giardia duodenalis in Shelter Dog in Batman, Türkiye	45

Özlem Orunç Kılınç Gürkan Akyildiz Kerem Ercan		
Özgür Yaşar Çelik Servet Sekin	The Prevalence of Leishmaniasis in Dogs in Dicle and Hani Districts of Diyarbakir	48
Meryem Tourabi	Insecticidal Properties of Chemically Characterized Essential Oils Extracted from Moroccan Mentha longifolia: In Vitro and In Silico Analysis	50
Zainab Hussain Abdulshaheed Mohanad Hazim Halboos	Evaluation of Groundwater Quality in Some Areas Near the Najaf Sea / Iraq	51
Kaviya R Suganthi P	Harnessing biotechnology for sustainable food production	52
Bahar Erden Mustafa Barış Akgül Sevdet Kılıç	A Case of Peritoneopericardial Diaphragmatic Hernia in a Cat	53
Yasemin Üstündağ Mehmet Kartal	Sexual Dimorphism in Experimental Animal Modeling	55
Yasemin Üstündağ Mehmet Kartal	The Effects of Seratonin in Aggressive Dogs	57
Mohammed Mohammed Ndagi Musa Idris Abubakar Mohammed Goga Huduzaratou Abdul-Hamidu Abdullahi	Effect of Banditry Activities on Agricultural Output in Rafi Local Government Area of Niger State, Nigeria	59
Liliam Sayuri Sakamoto Jair Minoro Abe Jonatas Santos De Souza Luiz Antonio De Lima	Optimization of Incidents in The Irrigation System Using Dlp – Data Loss Prevention Paraconsistent	60
Ahmet Uyar	A Case of Congenital Generalized Tuberculosis in a Calf	61
Songül Ötkün Özgül Gülaydin Muazzez Yeşilyurt	Comparing Identification Kit with MALDI-TOF MS Technique in the Identification of Staphylococcus Species Isolated from Various Clinical Samples	63
Ziad Shakeeb Al Sarraf	Simulation Model of Agriculture Irrigation Emitter for Anti Clogging Drip	66
Busari M.B. Oladejo N.A.	Comparative Qualitative Phytochemical Content and Antimicrobial Activities of Methanol Extract of Calotropis Procera Flower and Its Latex	67
Fettouch Houari	Infinite Order of Growth of Solutions to Diffirential Equations	68
Anita Pandey	Agriculture Waste Management for a Sustainable Environment with Special Reference to Chhattisgarh, India	69
Mouassa Bochra Lynda Sahraoui S.Maziz Bettahar	Survey on the Diagnosis and Management of Viral Hemorrhagic Disease in Rabbits by Field Veterinarians in Eastern Algeria	70
Serdar Odacı	Prevalence of Pneumonia in Cases Sending to Samsun Veterinary Control Institute Pathology Laboratory Between 2019-2023	71
Sevdet Kiliç Mahsum Başak Mustafa Barış Akgül Gülşah Akgül	Possible Unilateral Iris Melanoma in A Cat	73

Ali Gülaydın M. Hattap Soysal	Peritoneopericardial Diaphragmatic Hernia (PPDH) in Cats and Dogs: A Consolidated Analysis of Scientific Findings from Various Studies	75
Muhammad Faisal	Progressions In Multiparty Computation And Preserving Privacy In Tête-À-Têtes	77
Muhammad Faisal Reema Shaheen Munir Ahmad	Rules of Risk Manager in Integrated Risk Management System (Irms) in It Industry	78
Nitika Saini Barinderjit Singh	Minerals and Heavy Metal Content Identification in Pomace and Peel of Kinnow	79
Tanweer Alam Awadesh Prasad	Perovskite-Based Materials for Energy Applications	80
Hamisu Muhammad	Simulation And Construction of Microcontroller Based Electronic Circuit With Sms Reporting Facilities for Irrigation Plant	81
Subhom Ghosh Akash Santra Atanu Koley Monalisa Halder	Genetic application in Agriculture	82
Seemant Tiwari	Predicting Wind Speed With the ARIMA Algorithm	84
Sureyya Yigit	Differing Understandings and Interests Regarding European Agriculture	85
Deepali Tomar	Success of Micro, Small and Medium Enterprises in Uttarakhand	87
Sulaiman Muhammad Bello Rilwan Lawal Tanimu Ahmed	Application of Data Envelopment Analysis on Integrated Crop-Livestock Enterprises in Kaduna, Nigeria	88
Ewuola, Muslim Kayode Usman, Achor Miriam	Sequence Analysis and Amino Acids Substitutions of Adiponectin Gene in Some Poultry Species	89
Subhashish Dey	Utilization of Reclaimed Sewage Water in Concrete	90
Subhashish Dey	Influences of Admixtures on Chloride Resistance of Self Compaction Concrete	91
Rampravesh Kumar	Depression : Diabetes Mellitus	92
Ayyoub Ammar Zineb El Mouridi Asmae Nouira Said Boughribil	Assessment Of The Impact Of Radıoactıve Caesıum And Strontıum On Moroccan Agrıculture: Soıl Analysıs And Wheat Growth Patterns	93
Tolga Meriç Dümbek Zeynep Bozkan Ünal	Uses of Fluoroscopy in Cats and Dogs	94
Andrey Popatanasov	Hormopriming with Cytokinins and Impacts on the Germination of Helianthus annuus L.	96
Ganya, Adamu Hauni Dauda, Hauwa Ango, Monica Asabe Ibrahim	Agriculture as the Foundation of Nigerian Economic Enterprise	97
Krupa-Małkiewicz Marcelina Ochmian Ireneusz Agata Jurkiewicz	Effects of Chitosan and Silver Nanoparticles on Tomato Plant Growth Under Heavy Metal Stress Conditions	99
Huțu Dana Amariei Sonia	Substituting Sugar with Apple Puree in Muffins: Impact on Physical and Textural Characteristics	100

Ahu Kayalarli Acartürk	Current Approaches to Anthrax Diagnosis	101
Barış Can Güzel	Investigation of The Morphological and Histological Structure of The Liver in Hamdani Crossbreed Sheep (*Ovis aries*) Fetus	103
Marinache Ramona Marinescu Valentina	African Swine Flu Epidemic in Romanian Media	105
Marinescu Valentina Marinache Ramona	Agrıculture in Romanian Media	106
Ewetola, E.A., Ogunrinde, J.O., Aborode, M. A., Alabi, D.A.	Influence of Legume/Maize Cropping Systems and Rhizobium on Soil Physical Properties, Growth and Yield of Maize (*Zea mays* L.)	107
Kamran Faghihi Mehdi Kheirandish Mohammad Kazem Mohammadi	New Biostimulant (Vogor Stimulant) as a Plant Grow Promoter for Plant Germination Enhancement and Increase The Yield of Friut Production	108
Abdullah Karasu Caner Kayikci	A Case of Congenital Scrotum Hernia in a Lamb	109
Ali Osman Turgut Davut Koca Ali Ünver	Comparison of Blood Bhba Measurement Devices for Diagnosis of Subclinical Pregnancy Toxemia in Sheep: a Field Study	111
Kezban Uçar Çifçi	Molecular Mechanism and Anticancer Effect of Cannabinoids in HGC27 Gastric Cancer Cells	113
Edin Hrelja Amina Sivac	Analysis of Change of Land Cover in The Area of The Municipality of Ilidža	115
Amna Mirza Chayanika Uniyal	Factoring Importance of Gender Perspectives in Agrarian Reforms, with Special Focus on National Mission on Sustainable Agriculture (NMSA) in India	116
Rida Zulfiqar	The Impact of Political Pressure on Judicial Independence: A Comparative Analysis of India and the UK	117
Mouassa Bochra H.Saoudi	Review on Life Reproduction of The Gilthead Seabream (Sparus Aurata)	118
Enrico Gonçalves Fábio Albarici	Enhancing Urban Planning Through 3d Mapping of Trees in Conflict With Electrical Infrastructure	119
Eshika M Hemashree V Thenmozhi M	Insights into the Adoption of GM Crops in India and Public Perception: A Survey	120
Neacsu Ana Gheorghe Daniela	Evaluation of The Energy Content and The Qualitative Characteristics of Renewable Energy Resources from Some Agricultural Crops	121
Ivan Pavlovic Jovan Bojkovski Aleksandra Tasic Marija Pavlovic Violeta Caro Petrovic Nemanja Zdravkovic	Biosecurity Measure in Treatment of Pastures to Prevent Gastrointestinal Helminth Infections of Small Ruminants	122
Turan Yaman	A Case of Hydronephrosis in a Wistar Albino Rat	124
Elyoussfi Chaimae Hajar Soujaa Yahya El Hammoudani Hassani Zerrouk Mohammed	Contribution of Bacillus Species to Alleviating Drought Stress	126

Nadira Mourabit Saida Aarab		
Madan Lal Regar	Sustainability in Fashion	128
Noureddine Mechouk Georgiana Deak Zihad Bouslama Angela Monica Ionică Corina Gina Toma Andrei Daniel Mihalca	First Record of Angiostrongylus Vasorum in Algeria	129
Cornelia Nichita	Antioxidant Bio Nanocarrier System Based On Achillea millefolium L. Standardized Extract And Chitosan Polymer	131
Isa Coşkun Huseyin Cayan Osman Tolga Özel Emine Doğan Emine Bilginoglu	The Effect of Low Dose Phytobiotic Supplementation to Diet on Performance, Cecal Lactobacillus Count, Intestine Histomorphology, Meat Quality Characteristics and Ileal Muc2 Gene Expression in Quails from 1 To 35 Days of Age	132
Münire Turhan	Nosema Cerenea	135
Erman Gülendağ	Comparison of Statistical Performance of Different Multiple Comparison Tests in One-Way Analysis of Variance	137
Erman Gülendağ	Common Mistakes Made by Researchers in Biostatistics and How to Avoid Them	139
Gheorghe Giurgiu Manole Cojocaru	Gut Dysbiosis in Dogs With Spinal Cord Injury: Impact of Polenoplasmin	141
Khadiga Mussa Ala Hasan Al-Lahaibat Shaymaa Y. Alkufi Mohammed S. Mechee	A Fractional α-Transform for Converting Third-Order Fractional Differential Equation to Ordinary Differential Equation	142
Brahmi Zahia Gherissi Djallel Eddine	Transformative Technologies: Unleashing Ai's Potential for Precision Breeding in She-Camels	143
Sharmistha Sarma Kalita Bhaben Tanti	Physio-Biochemical Response of Some Traditional Joha Rice Variety of Assam Under High Temperature Condition	144
Ali Imran	Agro-Industrial Waste Utilization and Characterization: Insights from Antioxidants and Phenolics Analysis	145
Farhaoui Mohamed Slimani Chahid	Analysis of Water Scarcity Effects on Farmland Valuation	146
Okeke Lordwilliams Ikenna Rasheedul Haque Abdul Rahman Bin S Senathirajah Fakir Mohamed Bin Omar Din	Exploring Employee Turnover Intention in Private Organisation in Malasia	147
Adeniyi Olarewaju Adeleye Hamzat Adamu Mohammed Bello Yerima	Detection of Bacterial Loads on the Skin of Fishes Harvested for Human Consumption in River Hadejia, Northwest Nigeria	149
P. Pandiyan G.Sathyamurthy G. Subash Chandrabose	Survival Time of Cancer Patients Using Burr Distribution	150
Mazouzi Nourdjihane K.Boutemak	Elaboration and characterization of biopolymer composites films based on Hydroxypropyle	151

A.Haddad	methylcellulose HPMC reinforced with pectin	
Tarık Şafak Efe Durukan Öznur Yılmaz Koç Ali Rişvanli Metin Bayraktar	Predicting The Risk of Postpartum Disease in Dairy Cows According to Metabolic Status and Calving Type at Partutation	152
H.Turan Akkoyun	Protective Effects of Sodium Tetraborate on Trace Elements and Some Blood Parameters in Lead-Applied Rats	154
Saima Tufail Bushra Parveen Kashif Abbas Ameer Fawad Zahoor	Synthesis, Characterization and Biological activity ofNi(II), Cu(II), Co(II) andMn(II) complexes of 3,5-dichloro-2-hydroxybenzaldehyde based ligand	156
Chokri Bayoudh Afifa Majdou Messaoud Mars	Optimizing in Vitro Regeneration Protocols of Tunisian Local Pears (*Pyrus communis* L) And Figs (*Ficus carica* L)	157
Muhammad Amjad Syed Makhdoom Hussain	Evaluation of different types of biochar on growth performance and body composition of C. carpio fingerlings	158
Ghanshyam Barman	Enhancing Soil Fertility And Crop Productivity Through Organic Manure: A Sustainable Approach	159
Orhan Çorum Murat Yüksel Devran Coşkun Duygu Durna Şerafettin Kartal Mustafa Cellat Kamil Üney	Comparative Pharmacokinetics of Marbofloxacin in One- Two- and Four-Month-Old Calves	160
Ece Uyar Mustafa Akin Ayşe Nalbantsoy	Formulation and Characterization of Multivitamins for the Feed Industry by Double Emulsion Encapsulation Method	163
Nancy lilly Maria C.S. Suganthi P	Sustainability 2.0: Harnessing the Power of Innovation to Heal Our Planet	165
Kayalvızhı.V Suganthi P	Sustainability 2.0: agriculture biotechnology	166
Parvatha srini K P Suganthi P	Comprehensive Overview of All Branches of Food Engineering: Innovations, Challenges, and Future Prospects	167
Poojitha N Suganthi P	Mathematical Modeling for Sustainable Water Resources Management: A Review of Methods and Applications	168
Priyajothi N Suganthi P	Advances in Plant Protection	169
Hülya Serap Moğul Altay Savalan	Evaluation of the Immunostimulatory Effect of Biocompatible Polymers in Adjuvant Systems	170
Makbule Gökce Uğur Aydoğdu	Mefenamic Acid Intoxication in A Cat	172
Nataliia Didenko Anastasiia Sardak Serhii Kolomiiets	No-Till Influence On The Dynamics Of Chernozem Properties İn Ukraine	174
Priyavarshini A Suganthi P	Sustainable Strategies in Plant Protection: Integrating Biological, Cultural, and Chemical Approaches	175

P Sıddharth Suganthi P	Improving Access to Clean Water in Rural Areas: Innovative Solutions for Sustainable Development	176
K.Monika Suganthi P	Advancements in Agricultural Practices: Nurturing Sustainability and Resilience	177
Sam Jones J Suganthi P	Enviromental Sustainability: An Abstract on Biosystems engineering	178
Anjum Naeem Haroon Zaman Khan Ahmad Nawaz Asif Iqbal Farrukh Saleem Muhammad Ashfaq Wahid Muhammad Bilal,Ahmad Ali	Soybean Yield And Nodulation Response To Inoculums And Nitrogen Rates	179
Muhammad Bilal Hussain Marwa Waheed Farhan Saeed Muhammad Afzaal Bushra Niaz	Bitter melon (Momordica charantia): A Hub of functional bioactive components	181
Laksita M Suganthi P	Sustainability 2.0: Biosysytems Engineering Environment	182
Marwa Waheed Muhammad Bilal Hussain Farhan Saeed Muhammad Afzaal Bushra Niaz	Turmeric (Curcuma longa L.): Chemical components and their clinical applications	183
Mahalakshmi AVNK Suganthi P	An Overview of Food Engineering Branches: From Chemistry to Packaging	184
Bate Garba Barde Sam-Uket Nwuyi Okori Yunana Bitrus Duhu	Effects of Fiproforce and Calatropis procera Extract on Germination Rates of Rice (Oryza sativa) and Macroinvertebrates Abundance	185
Valery V. Belakhov Irina V. Boikova	Preparation Of New Organofluorine Derivatives Of B-D-Ribofuranoside: Synthesis, Acute Toxicity And Insecticidal Activity	186
Alexandrov V.S	Noise approach to the analysis of the qualitative composition of the soil	187
Pham Vu Khuong Duy Quan Thi Ai Lien	Genetıc Dıversıty Of Brassıca Integrıfolıa Populatıon	188
G.Premanand R.Saravanan R.Srınıvasan	Immunotherapy	189
Pooja.p R.Saravanan R.Srinivasan	Innovative Methods to Aim for the Mycolic Acid Biosynthesis Pathway in the Creation of Tuberculosis Treatments	190
Günsel Kirman Engin Deveci Sevgi Irtegün Kandemir Zafer Pekkolay Gülsüm Pektanç Şengül Ramazan Atiç	Investigation of the Regulation of Src(Proto-onkogene Tyrosine-Protein Kinase) and Src-Related Mapk (Mitogen activated protein kinase) and Stat3 (Signal transducer and activator of transcription 3) Signaling Pathways in Type 1 and Type 2 Diabetic Patients	191
Tejasri Sahasra	Recent Updates In Carbohydrate Metabolism	193

Vikram banda Saikumar jarpula	Lipid metabolism in inflammation-related diseases	194
Razia Kausar Sana Riaz Shah Nawaz M. Abdullah Sarmad Rehan Umer Sharif	Comparative Effect Of Moringa Oleifera Seed And Leef Powder On Digestive System In Ducks (Anas platyrhynchos)	195
Adeleke, Oluwaseun Aderonke	Utilisation of Indigenous Medicine among Rural Dwellers in Oke-ogun Area of Oyo State, Nigeria	197
Sai Krishna P B Suganthi P	Towards Sustainable Livestock Management: Strategies, Challenges, and Opportunities	198
V. Pavıthra Suganthi P	An Abstract on Application of Mathematics in Zootechnics	199
R R Sanjana Suganthi P	An Abstract on Application of mathematics in plant protection	200
Sanjani K Suganthi P	Harvesting Harmony: Cultivating Sustainability through Agroecology	201
Nguyen Thi Ngoc Hoa Khuu Thi Phuong Dong	Developıng Of Traceabılıty Systems For Agrıculture Supply Chaın: Evıdences From Shrımp Products In Mekong Delta, Vıetnam	202
Selma Lubabe Erdoğan	Investigating The Potential of Using Edible Seaweeds As A Functional Food Source In Gastronomy	203
Selma Lubabe Erdoğan	Examination Of The Possibilities Of Using Superfoods In The Field Of Gastronomy	205
Aise Deliboran Yilmaz Isik Hasan Aslan Abdullah Suat Nacar Tuba Yasemin Tekgul Hatice Kara Mustafa Harmankaya Sait Gezgin	Biofortication of Maize Herbage with Nutrients as Affected by Foliar Sodium Selenate Application	207
S. Elmazouzi H. Mabraka F. Allali A. Zourif A. Salima I. Zerdani N. Touach A. Benzaouak Y. Naimi	Catalyzing Sustainability: Harnessing Microbial Fuel Cells for Efficient Wastewater Treatment and Renewable Energy Generation	208
Frada Setia Mona Lutfi Nur Latifah Lusiana Br Pardede Christine Wulandari	Identification of Agroforestry Plant Potential in Kph of Lampung Province	210

FULL TEXT

Hakan İnci	Effects of Bee Products on Health	211
Gökçenur Sanioğlu Gölen Kadir Akar	Nucleic Acid Amplification Techniques Used in Microbiology	217
Mazhar Burak Can Sümeyra Can	Effects of Nanotechnological Applications in Animal Nutrition	229
Mazhar Burak Can	Use of Natural Antioxidants as Feed Additives	237
Ferit Yıldız Serhat Yıldız	The Role of the Ministry of Agriculture and Forestry in Agricultural Training and Extension Activities and Farmer Training and Extension Activities in Türkiye	246
Bratislav Pešić Nikola Stolic Nebojsa Zlatković Aleksandra Jevtic	The Use of Robots in Poultry Production	262
Başak Özten Hacer Tüfekci	Some Productivity Characteristics of Akkaraman Sheep Flocks in The Smallholder Family Farm Structure	269
Hatice Barışık Fatma İlhan	Candidate Genes Associated With Milk Yield and Quality Traits in Sheep and Goats	277
Seray Dönmez Nida Ünlü Eminur Elçi	Antibacterial Effects of Some Herbal Extracts Against Plant Pathogenic Streptomyces Spp.	292
Tuğba Eroğlu Nida Ünlü Eminur Elçi	The Causal Agent of Black Rot on Cabbage	306
Deniz Çakar Ebru Derelli Tüfekçi Seçil Akilli Şimşek	The Determination of Sensitivity of Phytophthora × cambivora and P. cinnamomi Isolates to Phosphorous Acid by Assessing ABCA1 Gene Expression Levels	317
Jelena Lutovac	Accounting Policy in The Function of Making Decisions on The Basis of Financial Statements in The Company	330
Jelena Lutovac	Basic Observation of Financial Reporting and Management of Heterogeneous Companies In The Republic of Serbia	336
Jelena Lutovac	Adoption of A Realistic Financial Reporting Model in Heterogeneous Companies in Small Economies Like The Republic of Serbia	342
Keziban Sinem Tulukoğlu Kunt Gazal Arslansoy Ilayda Aruk Mustafa Özden	Antifungal Activity of Essential Oil from Origanum spp. Against Black Rot Disease of Apple	347
Simge Selvi Hatice Basmacioğlu-Malayoğlu	The Use of Moringa Plant in Poultry Feeding As A Protein Source and Feed Additive	358
Görkem Öztürk Belma Doğan Öz	Bibliometric Analysis of Published Articles on Technical Efficiency in Agriculture: The Case of Ulakbim (2003-2023)	374
Müslüm Rüzgar Mehmet Fırat Baran	Input Usage and Gross Profit Analysis in Strawberry Production (Batman Province Example)	386
Usman Abdullahi Abba Gambo Fatima Abubakar	Evaluation On Base Line Survey Of Newly Developed Pearl Millet Varieties Super-Sosat Under Natural Field Conditions In North East Nigeria	400

Mehmet Fidan Ali Beyhan Uçak Cafer Gençoğlan	Effect of Restricted Irrigation Practices on Morphological Parameters of Second Crops Corn	409
Ruken Konuk Ali Beyhan Uçak Firat Pala	Effect of Limited Irrigation Practices on Weed Population in Clearfield Sunflower Plant	418
Raden Aji Christine Wulandari Zeda Erdian Achmad Haris Imam Fahrur Razi	The Important Role of Agroforestry in Increasing Community Income in Supporting the Resilience of Sustainable Agricultural Systems in Sumber Agung Village, Kemiling District, Lampung Province	427
Ali Sarioğlu Sabri Akın	The Effect of Potassium Applications on Physiological Characteristics of Wheat Plant Under Drought Conditions	438
Safiye Kaçkın Heydem Ekinci Necla Şaşkın Bekir Erol Ak	Effects of Some Absorbent Substances on The Browning Rates of Pomegranate (*Punica granatum* L.) Plant Under in Vitro Conditions	453
Zehra Günbeği Heydem Ekinci Bekir Erol Ak Necla Şaşkın	Determination of The Proliferation Performance of Ucb-1 (P. Atlantica X P. İntegerrima) Pıstacıa Rootstock Under in Vitro Conditions	463
Derya Ömerosmanoğlu Bülent Hallaç	Determınatıon of The Antimicrobial Activity of Some Commercially Available Antiseptics/Disinfectants Against İmportant Food Pathogens	474
Lusiana Tursina Silaban Christine Wulandari Indra Gumay Febryano Susni Herwanti	Community Social Capital in Supporting Forest Sustainability	484
Eylül Berfin Birgül Nazli Özkurt Harun Bektaş Yasemin Bektaş	Effects of Chitosan Applications on Abiotic Stress Factors in Plants	492
Nazlı Özkurt Eylül Berfin Birgül Harun Bektaş Yasemin Bektaş	Effect of Priming Applications Against Bacterial Diseases in Plants	501
Hülya Hanoğlu Oral	Evaluation of Chemical Composition and In Vitro True Digestibility of Hulls of Buckwheat Seeds	511
Damla Önder Shahad Waleed Khalid Khalid Sercan Önder Ümit Erdoğan	Analysis of Volatile Oil Composition and Fatty Acid Profiles of Cardamom Seeds	523
Bedriye Bilir Hava Şeyma İnci	Effects of Earthquakes on Agriculture, Forest and Rangeland	534
Bedriye Bilir Hava Şeyma İnci	The Assessment of Some Agricultural Properties of The Soils of Şirnak University Mehmet Emin Acar Campus	555
Raymond Oriebe Anyasi Harrison Ifeanyichukwu Atagana Desmond Chiagozie Agbo Joyce Onyenaturuchi Anyasi Raymond	Enhancement of the Growth of Nicitiana tabacum by Indole Acetic Acid (IAA) Used in Soil Treatment Against Organic Contaminant Pollution	570

David I. A Oladimeji Y. U. Yusuf O. Abdulrahman S. Hussaini, A.S. Magaji, B.D1	Effects of Risk Management Strategies on the Efficiency of Rice Farmers in Kebbi and Ebonyi States Nigeria	583
Selda Karadağ Turgut Kırmızıbayrak Buket Boğa Kuru	Pekin Duck Breeding in Türkiye	592
Gülşah Çavuş Sibel Karakaya	Some Physicochemical Properties and Browning Index of Biscuits Made With Amaranth Flour	604
Merve Eda Eker Özkacar Sibel Karakaya	Evaluation of Wild Edible Plants in Terms of Sustainable Nutrition: Use of Trachystemon Orientalis in Bakery Products	617
Nergis Gizem Kirkhan Sibel Karakaya	Investigation of In Slico Binding Capacity of Some Anthocyanins on α-Amylase and α-Glucosidase Activıties	628
Zeynep Asutay	Development of Strategies to Reduce the Negative Effects of Pesticides in Honey Bees	644
Izzet Beyoğlu	The Use of Prebiotics in Poultry and Prebiotics Employed for This Purpose	672
Feyza Döndü Bilgin	Advanced Mixed Crop-Forage-Livestock Management Concept for Temperate Regions: LivestockPlus	695
Sani, A.A Oladimeji, Y.U Magaji, B. D Hussaini, A.S Ibrahim, H. A.	Determinants of Crop Farmers' Efficiency during Pre-Peak and Post Peak Boko Haram Insurgency Periods in North East, Nigeria	713
İlker Şen Melisanur Ural Nazli Büyükyıldız	Treatment of an Open Wound with Tissue Loss Using a Randomized Skin Flap in a Cat	722
Taha Can Taş Recep Gümüş	Effect of Boric Acid on Some Minerals in Serum in Rats	732
Sadiq, M.S Singh, I.P Ahmad, M.M Gama, E.N Sambo, A.A	Spectral Effects Of Eco-Innovations' Adoption On Sustainable Livelihoods' Resilience Among Small-Scale Wheat Farmers In Jigawa State Of Nigeria	740
Ömer Faruk Gökcecik A. Anil Çağirgan	The Major Viral Diseases Transmitted By The Vectors and The Role of The Vectors in The Transmission	774
Murat Arıkan Ramazan Yıldız	Investıgatıon of Small Anımal Veterinary Surgeons' Attention to Hand Hygiene	789
Murat Arıkan Ramazan Yıldız	Importance of The Use of Personal Appropriate Protective Equipment (Ppe) in Small Anımal Clinics	797
Muazzez Yeşilyurt Özgül Gülaydın	Phenotypic and Genotypic Characterization of Biofilm Formation in Staphylococcus aureus Isolates	803
Fatma Işbilir	Macroscopic and Microscopic Description of Spleen Development in The 2nd And 3rd Trimester in Hamdani Crossbreed Sheep (Ovis aries)	816
Berat Selim Tokgöz	Determination of the Prevalence of IBR and BVD in a Dairy Herd	828
Muhammed Zahid Atlı	Investigation of the Morphological and Histological Structure of The Kidneys in Hamdani Crossbreed (Ovis aries) Sheep Fetus	838

Mezerket Amina Hammache Miloud Cantalapiedra-Navarrete Carolina Castillo Pablo Palomares-Rius Juan Emilio	Molecular Characterization of Potato Cyst Nematodes From The Province Of Béchar, South-Western Algeria	850
Ilhan Sabancilar Murat Yolcu	Determination of Cytotoxic Level of Alpha Amanitin in Lung Cancer Cell Line	858
Burak Batuhan Laçin Ali Çinar	Role of Keap1/NRF2/HO-1 Pathway in Lipopolysaccharide-Induced Septic Lung Injury in Rats	866
Esra Bilici	In cancer cell: crispr cas9	876
Alatise, S.P. R. Ibrahim M. J. Abubakar	Utilization of Toasted Velvet Beans (Mucuna pruriens) Seed Meal as a Protein Source for Clarias gariepinus Fingerlings	887
Serpil Aygörmez Aydın Genç	Apoptosis, Autophagy and Inflammation in Metabolism	895
Çiğdem Kirsüleymanoğlu Dilek Çelikler	A General Overview of Microplastics in The Muscle and Liver of Some Fish Species	910
Vadym Solovei Elena Trotsenko	Integration of Automated Systems in The Agricultural Sector: Process Management Optimization	933
Uğur Özentürk Murat Genç	Behavioural Needs of Laying Hens	937
Murat Genç Uğur Özentürk	Welfare in Cattle Transportation and Effects of Transportation Conditions	958
Emin Şengül Samet Tekin	Effects of Gallic Acid on Nrf-2 and HO-1 Levels on ACR-Induced Kidney Damage in Rats	976
Merve Bolat Aslıhan Atasever Fikret Çelebi	The Role of Cox Enzyme and Prostaglandia in the Development of Gastric Ulcer	984
Aslıhan Atasever Merve Bolat Fikret Çelebi	Oxidative Stress and Nrf2/HO1 Pathway	992
Mahire Bayramoğlu Akkoyun	Evaluation of The Antihemolytic Effect of Peucedanum Longifolium Waldst. & Kit Plant.	1000
Sevinç Aydın	Analysis of Some Biochemical Contents of Endemic Thyme (Thymus Haussknechtii Velen) Species	1008
Mesud Kaplan Mehmet Berköz	Investigation of The Anti-Inflammatory Effect of Atranorin Treatment	1024
Recep Erdil Mehmet Berköz	Investigation of Antiproliferative, Antimetastatic, Apoptotic and Anti-Inflammatory Activities of Diosmin on Laryngeal Cancer	1036
Osman Bulut	Acquired Bilateral Cataract Caused By Nutritional Deficiency İn A Kitten	1049
Ibrahim Yurdakul	Hepatocellular Carcinoma in a Mixed Breed Dog	1058
Ceyda Dadali Yeşim Elmaci	Microalgae as Food	1068
Ceyda Dadali Yeşim Elmaci	Sensory Quality of Plant Protein-Based Foods	1076
Volkan Gül Firat Sefaoğlu	Contribution of Environmentally Friendly Agricultural Waste to Recycling	1083
Volkan Gül Firat Sefaoğlu	Negative Effects of Climate Change Due to Global Warming on Our Country's Agriculture	1096

Kıvanç Irak	Senolytics	1106
Elsa Cavaco Rui Isıdoro	Living conditions of immigrant workers in the agricultural sector in Southern Portugal	1118
Mehmet Hanifi Yalçin Sema Alaşahan	Distinctive Features of Guinea Fowl Eggs and Morphological Transformations in The Cranial Region Throughout Chick Development	1122
Fatma Akın Devran Coşkun Orhan Çorum Kamil Üney	Prostaglandin E1 Analoğu; Misoprostol	1132
Leyla Gündüz	Prevalance and Importance of Entamoeba Histolytica İnfections by Region in Our Country	1145
Aydin Şükrü Bengü	Evaluation of Our Foods in Terms of Fat Quality İndex	1156
Stanislava Stateva	Possibility of long-term storage of Petunia hibrida L.	1163
Emine Küçüker Erdal Ağlar	Evaluation of Türkiye and World Pistachio Production	1170
Emine Küçüker Erdal Ağlar	Evaluation of Irrigated and Dry Production in Pistachio Cultivation	1179
G. Akashkumar	The Pharmacist's Role In Medication Therapy Counseling	1187
Selvakumar Saravanan R Srinivasan R	Bharath institute of higher education and research	1195
Arwa Rafie Bhumika Sharma Arrat Banday Ritika Shukla	Infectious and Contagious Diseases in Animals : A Study of Policy Framework in India	1201
Firoza Ramazanova Aytan Mammadova	Morphological State Of Soils In The Dry Subtropical Zone Of Azerbaijan	1215
Zeynep Nur Karakuş Gülşah Çalışkan Koç Yasemin Çelebi	Bioactive Compounds And Health Benefits Of Momordica Charantia L. Lecturer	1226
Zeynep Nur Karakuş Yasemin Çelebi Gülşah Çalişkan Koç	Bioactive Components And Health Benefits Of Kumquat (Fortunella Sppp.) Fruits	1239
Yeliz Tekgül Barut	Mycotoxins and reduction methods in the food industry	1252
Mehmet Selim Şılbır Safa Hacıkamiloğlu Elnaz Latifian Orhan Kurt	Approaches To Prevent Food Waste And Utılızatıon Of Waste Into Agrıcultural Productıon	1263
Ayla Mumcu Ferişte Öztürk Güngör Zeynep Şeyda Erdemir Tiraş Erkan Susamci Seda Ersus	Avaılabılıty Of Olıve Leaf Extract In Food Products As An Antımıcrobıal Preservatıve	1271
Aybüke Kaya Veysi Acıbuca	The Current Situation of Forage Crops in Mersin Province	1285
Ömer Eltas	Discriminant Analysis and Its Use in The Veterinary Field	1295
Ali Ihsan Azeez	The Effect of Planting Distances on Growth Characteristics and Yield of Yellow Maize	1310

Imad Khalaf Azeez		
Doğan Arslan Aynur Bilmez Özçınar	Use of Medicinal and Aromatic Plants for Medical Purposes and Studies Conducted on This Topic	1322
Zekiye Şengül	Digital Solutions for Sustainable Beekeeping: The Potential of Blockchain Technology	1332
Hale Yıldız Yeter Çilesiz Tolga Karaköy	Recombinant DNA Technology and Its Applications in Plants	1362

ABSTRACT

THE EFFECT OF SALINITY STRESS ON GERMINATION AND SEEDLING GROWTH OF DURUM WHEAT

Uğur SESİZ (ORCID: 0000-0003-1234-4276)
Sirnak University, Agriculture Faculty, Field Crop Department, 73300, Şırnak, Türkiye
Email: usesiz@sirnak.edu.tr

ABSTRACT
Salt, primarily in the form of sodium chloride (NaCl), can have a negative impact on wheat growth and yield. This phenomenon is known as salinity stress. This research investigated the effects of different NaCl doses on coleoptile length, root length, seedling length, fresh and dry weights of both root and shoot, germination rate, and germination power in three durum wheat (*Triticum durum* L.) varieties. The experiment was conducted in a growth chamber using a factorial randomized complete plot design with four replicates. Seeds from each durum wheat variety were germinated in petri dishes containing NaCl solutions at 0, 50, 100, or 150 mM. Plants were then grown in the chamber for ten days, after which coleoptile length, root length, seedling length, fresh and dry weights of both root and shoot, germination rate, and germination power were measured. The results showed that increasing salt stress negatively affected all varieties. There appears to be a contradiction in the literature regarding durum wheat's response to salt stress. While some studies suggest it has positive effects, further research is needed to clarify its role in plant stress tolerance.
Keywords: Durum wheat, *Triticum durum*, salinity, germination, seedling development

GİNKGO BİLOBA EKSTRESİNİN KOÇ SPERMASININ KISA SÜRELİ SAKLANMASI ÜZERİNE ETKİLERİNİN CASA CİHAZI İLE BELİRLENMESİ

İbrahim Halil GÜNGÖR (ORCID: 0000-0002-5250-1478)
Fırat Üniversitesi, Veteriner Fakültesi, Dölerme ve Suni Tohumlama Anabilim Dalı, Elazığ, Türkiye
Email: ihgungor@firat.edu.tr

ÖZET
Ginkgo Biloba (Egb 761-GB) Çin'de bulunan yaklaşık 30m boyunda bir ağaç olup, bu ağacın yapraklarından 27 basamaklı bir ekstraksiyon işlemi sonucunda elde edilen bir bitki ekstresidir. Bu ekstraksiyon işlemi sonucunda içerisinde çok güçlü antioksidan özellikleri barındıran bir bileşen elde edilmektedir. Bu çalışma antioksidan özellikleri bilinen Ginkgo Biloba toz ekstresinin farklı dozlarının koç spermasının kısa süreli saklanması sırasında motilite ve kinematik parametreler üzerine etkinliğini araştırmak amacıyla yapılmıştır. Bu amaçla toz Ginkgo Biloba ekstresi distile su ve tris-yumurta sarısı sulandırıcısı ile sulandırılarak farklı deney grupları (Grup 1: %4 GB, Grup 2: %2 GB, Grup 3: %1 GB, Grup 4: %0,5 GB, Grup 5: %0,25 GB ve Grup 6: Kontrol) oluşturuldu. Bu spermaların sıcaklığı soğutma kabininde 5°C'ye düşürüldü ve 24 saat sonra tüm deney gruplarında CASA cihazı yardımıyla motilite ve kinematik parametre tayinleri yapıldı. Bu analizlerin akabinde 144 saat sonra aynı analizler tekrarlandı. Bu işlem ile farklı dozlarda Ginkgo Biloba ekstresi içeren sulandırılmış-soğutulmuş spermaların 24. ve 144. saatlerdeki motilite ve kinematik parametre değerleri açısından kontrol ve deney grupları arasındaki farklılıklar belirlendi. Kontrol grubuna göre %4 GB içeren grup hem 24 hem de 144. saatlerde total, progresif, rapid, medium motilite ile VCL, VSL ve ALH gibi kinematik parametrelerde önemli azalmalar meydana getirmiştir. Kontrol grubuna göre %0,25 GB içeren grubun hem 24 hem de 144. saatlerde progresif motilite ve VSL gibi spermatozoonların doğrusal yönde hareketlerini gösteren parametrelerde önemli artış oluşturduğu tespit edilmiştir. Bu verilere ek olarak 24. saat sonunda kontrol grubuna göre %0,25 GB içeren grubun LIN ve WOB gibi kinematik parametrelerde artış sağladığı belirlenmiştir. 144. saat sonunda ise kontrol grubuna göre %0,25 GB içeren grubun total, progresif ve rapid motilite ile VCL, VSL, VAP ve BCF gibi parametrelerde önemli artışlar sağladığı görülmüştür. Sonuç olarak; koç sperması kısa süreli (144 saat boyunca) saklanmak istendiğinde %0,25 GB içeren tris-yumurta sarısı solüsyonu ile sulandırılma işleminin yapılmasının spermatozoonların motilite ve kinematik parametre gibi canlılık ve hareket kabiliyetini gösteren özelliklerinde artış sağlayacağı belirlenmiştir. Ayrıca %0,25 GB ekstresinin 144 saatlik bir saklama süresi boyunca spermatozoonları koruyacağı kanaatindeyiz.
Anahtar Kelimeler: CASA, Sperma, Ginkgo Biloba, Koç, Soğutma

DETERMINATION OF THE EFFECTS OF GINKGO BILOBA EXTRACT ON SHORT-TERM STORAGE OF RAM SEMEN WITH THE CASA DEVICE

ABSTRACT

Ginkgo Biloba (Egb 761-GB) is an approximately 30m tall tree found in China, and it is a plant extract obtained from the leaves of this tree through a 27-step extraction process. As a result of this extraction process, a component with very strong antioxidant properties is obtained. This study was conducted to investigate the effectiveness of different doses of Ginkgo Biloba powder extract, known for its antioxidant properties, on motility and kinematic parameters during short-term storage of ram semen. For this purpose, different experimental groups (Group 1: %4 GB, Group 2: %2 GB, Group 3: %1 GB, Group 4: %0,5 GB, Group 5: %0,25 GB ve Group 6: Control) were created by diluting powder Ginkgo Biloba extract with distilled water and tris-egg yolk diluent. The temperature of these semen was reduced to 5°C in the cooling cabinet, and 24 hours later, motility and kinematic parameters were determined in all experimental groups with the help of the CASA device. Following these analyses, the same analyzes were repeated 144 hours later. With this process, the differences between the control and experimental groups in terms of motility and kinematic parameter values at the 24th and 144th hours of the diluted-cooled semen containing different doses of Ginkgo Biloba extract were determined. Compared to the control group, the group containing 4% GB caused significant decreases in kinematic parameters such as total, progressive, rapid, medium motility and VCL, VSL and ALH at both the 24th and 144th hours. Compared to the control group, it was determined that the group containing 0.25% GB caused a significant increase in parameters that show the linear movement of spermatozoa, such as progressive motility and VSL, at both the 24th and 144th hours. In addition to these data, at the end of the 24th hour, it was determined that the group containing 0.25% GB had an increase in kinematic parameters such as LIN and WOB compared to the control group. At the end of the 144th hour, it was observed that the group containing 0.25% GB provided significant increases in parameters such as total, progressive and rapid motility, and VCL, VSL, VAP and BCF, compared to the control group. In conclusion; It has been determined that when ram semen is wanted to be stored for a short time (for 144 hours), diluting it with tris-egg yolk solution containing 0.25% GB will increase the properties of spermatozoon, such as motility and kinematic parameters, which indicate vitality and mobility. We also believe that 0.25% GB extract will protect spermatozoa during a storage period of 144 hours.

Keywords: CASA, Semen, Ginkgo Biloba, Ram, Cooling

ÇİNKO NANOPARTİKÜLÜNÜN BİYOSENTEZİNDE PROPOLİS KULLANIMI

Pınar COŞKUN (ORCID:0000-0002-9170-5799)
Bingöl Üniversitesi, Fen Bilimleri Enstitüsü, Arı ve Arı Ürünleri Anabilim Dalı, Bingöl-Türkiye
Email: pinarcoskun55@gmail.com

ÖZET
Çinko oksit (ZnO) nanopartikülleri, gıda katkı maddeleri, diyet takviyeleri, güneş kremleri ve antibakteriyel maddeler de dahil olmak üzere çeşitli uygulamalardaki çok yönlülükleriyle giderek daha fazla tanınmaktadır. Yüksek yüzey alanı ile hacim oranı ve kuantum boyut etkisi gibi benzersiz fizikokimyasal özellikleri, bu uygulamalar için ideal adaylar yapmaktadır. Yaygın kullanımlarına rağmen, ZnO NP'lerin sentezi genellikle çevre ve insan sağlığı için zararlı olabilecek kimyasal yöntemler içerir. Bu çalışma, bu nedenle, propolis ekstraktının doğal indirgeyici ve stabilizatör yeteneklerinden yararlanarak ZnO nanopartiküllerini üretmek için sürdürülebilir bir alternatif olarak biyosentez yaklaşımına odaklanmaktadır. Propolis, içerdiği bileşenler nedeniyle sağlık için birçok faydalı özelliğe sahip çok değerli bir arı ürünüdür. Biyosentez yoluyla sentezlenen NP'lerin yapısal özellikleri bitki türüne, ekstrakt bileşimine, sentez koşullarına ve saflaştırma yöntemlerine bağlıdır. Propolis özütü ve çinko asetat bir beherde hazırlandıktan sonra 50°C'de bekletilmiştir. Bu sürenin sonunda çözelti santrifüjlenmiş, yıkanmış ve 40°C'de etüvde kurutulmuştur. Biyosentezlenen ZnONP'ler X-ışını kırınımı (XRD), geçirimli elektron mikroskobu (TEM), Termogravimetrik analiz (TGA), Dinamik ışık saçılımı (DLS) ve Fourier Transform Kızılötesi (FTIR) analizleri ile karakterize edilmiştir.TEM görüntüsüne göre, ZnONP'ler çiçek benzeri bir yapı kümesi göstermektedir, PDI değerleri 0.72'dir, bu da ZnONP'lerin homojen bir boyut dağılımına sahip olduğunu göstermektedir. Zeta potansiyeli -14,5 mV olarak bulunmuştur. XRD sonuçları ZnONP'lerin hekzagonal kristal yapıya sahip olduğunu göstermiştir. Bu araştırma, doğal bir indirgeyici ve stabilize edici ajan olarak propolis özütü kullanılarak ZnO nanopartiküllerinin başarılı bir şekilde biyosentezlendiğini göstermiştir. Ayrıca, propolis kullanımı, propolisin tıbbi özellikleri nedeniyle sentezlenen nanopartiküllerin biyouyumluluğunu ve potansiyel sağlık yararlarını artırmada etkili olabilir.
Anahtar Kelimeler: Biyosentez, Çinko oksit, Nanopartikül, Propolis

USE OF PROPOLIS IN THE BIOSYNTHESIS OF ZINC NANOPARTICLE

ABSTRACT

Zinc oxide (ZnO) nanoparticles are increasingly recognized for their versatility in various applications, including food additives, dietary supplements, sunscreens, and antibacterial agents. The unique physicochemical properties of ZnO NPs, such as their high surface area to volume ratio and quantum size effect, make them ideal candidates for these applications. Despite their widespread use, the synthesis of ZnO NPs often involves chemical methods that can be harmful to the environment and human health. This study, therefore, focuses on the biosynthesis approach as a sustainable alternative, leveraging the natural reducing and stabilizing capabilities of propolis extract to fabricate ZnO nanoparticles. Propolis is a very valuable bee product with many beneficial properties for health due to the components it contains. The structural properties of NPs synthesized through biosynthesis depend on the plant species, extract composition, synthesis conditions and purification methods. Propolis extract and zinc acetate were prepared in a beaker and then kept at 50°C. At the end of this period, the solution was centrifuged, washed and dried in an oven at 40°C. The biosynthesized ZnONPs were characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM), Thermogravimetric analysis (TGA), Dynamic light scattering (DLS) and Fourier Transform Infrared (FTIR) analyses.According to TEM image, ZnONPs show a cluster of flower-like structure, PDI values are 0.72, which shows that ZnONPs have a homogeneous size distribution. Zeta potential was found to be -14.5 mV. XRD results showed that ZnONPs have a hexagonal crystal structure. This research demonstrated the successful biosynthesis of ZnO nanoparticles using propolis extract as a natural reducing and stabilizing agent. Additionally, the use of Propolis may be effective in increasing the biocompatibility and potential health benefits of synthesized nanoparticles due to the medicinal properties of propolis.

Keywords: Biosynthesis, Zinc oxide, Nanoparticle, Propolis

BİR KÖPEKTE KUTANÖZ NÖROFİBROMA OLGUSU

Dr. Erhan AYNA* (ORCID: 0000-0002-8895-4153)
Ayna Veteriner Kliniği, Adana-Türkiye
Email: ayna.erhan@hotmail.com

Dr. Öğr. Üyesi Ömer Faruk KELEŞ (ORCID: 0000-0002-7869-5311)
Van Yuzuncu Yil University, Department of Pathology, Faculty of Veterinary Medicine, Van-Türkiye
Email: ofkeles@yyu.edu.tr

Hacı Ahmet ÇİÇEK (ORCID: 0009-0002-5154-7498)
Van Yuzuncu Yil University, Department of Pathology, Faculty of Veterinary Medicine, Van-Türkiye
Email: haciahmet99@gmail.com

Prof. Dr. Zabit YENER (ORCID: 0000-0002-6365-5843)
Van Yuzuncu Yil University, Department of Pathology, Faculty of Veterinary Medicine, Van-Türkiye
Email: zyener@yyu.edu.tr

ÖZET

Periferik sinir kılıfı (PSK) tümörleri, sinir kılıfını oluşturan hücrelerden (Schwann hücreleri, fibroblastlar veya perinöriyal hücreler) kaynaklanan heterojen bir neoplazm grubudur. Evcil hayvanlarda PSK tümörleri; nörofibrom, schwannom, perineurioma ve bunların malignant formları olarak sınıflandırılmıştır. Köpek ve atlarda dermal nörofibromlar son zamanlarda insanlarda olduğu gibi büyüme şekillerine göre lokalize, pleksiform veya diffüz olmak üzere alt tiplere ayrılmıştır. Köpek nörofibromu, Schwann hücreleri, epinöriyal hücreler ve fibroblastlar dâhil olmak üzere değişken hücre tiplerinin karışımından oluşan nadir, iyi sınırlı, intranöral veya infiltre edici ekstranöral benign bir PSK tümörüdür. Bu tümörler köpeklerde genellikle orta yaş üstü, büyük ırklarda kaydedilmiştir. Kutanöz nörofibromlar genellikle tek bir kitle (soliter) olarak rapor edilmiştir. Bu olgumuzu skrotum bölgesinde şişlik ve ağrı şikayeti ile kliniğimize getirilen 11 yaşlı Pit Bull ırkı bir köpek oluşturdu. Cerrahi girişim ile tümöral kitle başarı ile opere edildi. Makroskobik olarak tümöral kitle 2.6x2.1x0.8 cm boyutlarındaydı. Tümörün dış yüzeyi ülseratif, hemorajik, nekrotik ve enfekte görünümdeydi. Yapılan histopatolojik incelemede tümör hücrelerinin; fibrovasküler stroma içinde sıkıca paketlenmiş, iç içe geçmiş akıntı görünümünde ve iğsi hücre (spindle cell) demetlerinden oluştuğu, çok düşük mitotik aktiviteye sahip olduğu saptanmıştır. Nörofibromların, schwannomlardan çok daha fazla sayıda değişken fibroblastik kollajen üreten neoplastik hücreye ve az sayıda neoplastik schwann hücrelerine sahip olduğu kaydedilmiştir. Bu nedenle neurofibromlarda immunohistokimyasal olarak tümör hücrelerinin S100 için seyrek olarak pozitif reaksiyon gözlendiği kaydedilmiştir. Nitekim olgumuzda yapılan immunohistokimyasal boyamada, S100 için az sayıda tümör hücresinin reaksiyon gösterdiği saptanmıştır. Histopatolojik ve immunohistokimyasal bulgular doğrultusunda olgu kutonöz nörofibroma olarak teşhis edilmiştir. Sonuç olarak nadir görülen nörofibroma olgusu Pit Bull ırkı köpeğin skrotum derisinde, makroskobik ve mikroskobik bulgularıyla sunulmuştur.

Anahtar Kelimeler: Nörofibroma, Köpek, Histopatoloji

A CASE OF CUTANEOUS NEUROFIBROMA IN A DOG

ABSTRACT
Peripheral nerve sheath (PNS) tumours are a heterogeneous group of neoplasms arising from the cells (Schwann cells, fibroblasts or perineurial cells) that make up the nerve sheath. PNS tumours in domestic animals are classified as neurofibroma, schwannoma, perineurioma and their malignant forms. Dermal neurofibromas in dogs and horses have recently been subdivided into localised, plexiform or diffuse subtypes according to their growth pattern as in humans. Canine neurofibroma is a rare, well-circumscribed, intraneural or infiltrating extraneural benign PNS tumour composed of a mixture of variable cell types including Schwann cells, epineurial cells and fibroblasts. These tumours have been recorded in dogs, usually in middle-aged, large breeds. Cutaneous neurofibromas are usually reported as a single mass (solitary). In this case, a 11-year-old Pit Bull dog was brought to our clinic with complaints of pain and swelling in the scrotum. The tumoural mass was successfully operated with surgical intervention. Macroscopically, the tumoural mass was 2.6x2.1x0.8 cm in size. The outer surface of the tumour was ulcerative, haemorrhagic, necrotic and infected. Histopathological examination revealed that the tumour cells were tightly packed in the fibrovascular stroma, had an intertwined discharge appearance and consisted of spindle cell bundles with very low mitotic activity. Neurofibromas have a much higher number of variable fibroblastic collagen-producing neoplastic cells and fewer neoplastic schwann cells than schwannomas. Therefore, in neurofibromas, immunohistochemical positive reaction of tumour cells for S100 is observed in a small number of cells. Indeed, in the immunohistochemical staining performed in our case, it was found that few tumour cells reacted for S100. According to the histopathological and immunohistochemical findings, the case was diagnosed as cutaneous neurofibroma. In conclusion, a rare case of neurofibroma in the scrotum of a Pit Bull dog was presented with macroscopic and microscopic findings.
Keywords: Neurofibroma, Dog, Histopathology

STRES ALTINDA YETİŞEN *CICER ARIENTIUM*'LARDA GLİKOZİLASYONLA İLGİLİ GENLERİN İFADESİ

Irem DEHMEN* (ORCID: 0009-0005-6867-2406)
Çanakkale Onsekiz Mart University, School of Graduate Studies, Department of Molecular Biology and Genetics, Çanakkale-Türkiye
Email: iremdehmen@stu.comu.edu.tr

Asst. Prof. Fatih SEZER (ORCID: 0000-0002-9436-0191)
Çanakkale Onsekiz Mart University, Faculty of Science, Department of Molecular Biology and Genetics, Çanakkale-Türkiye
Email: fatihsezer@comu.edu.tr

ÖZET
Gittikçe artan vegan, vejetaryen ve glutensiz yaşam tarzını benimseyen insan sayısı nedeniyle, özellikle hayvansal protein alternatifleri için talep artmaktadır. Nohut (Cicer arietinum L.), ete bitkisel tabanlı bir protein alternatifi sunması ve glutensiz, yüksek proteinli un alternatifi olarak hizmet etmesi açısından umut vaat eden bir çözüm olarak öne çıkmaktadır. Bu çalışma dört glikozilasyonla ilişkili genin (MNS1, MNS3, ALG10 ve GCS1) ifadelerini çeşitli stres koşullarında araştırmayı amaçlamaktadır. Nohut fideleri, tarımsal ortamlarda sıkça karşılaşılan çeşitli stres senaryolarını taklit eden yüksek tuz konsantrasyonları, yüksek pH seviyeleri ve soğuk sıcaklıklara maruz bırakıldı. Bu uygulamalar, nohut genlerinin çevresel stres faktörlerine tepki mekanizmalarını açığa çıkarmak için özenle tasarlanmıştır. Kapsamlı gen ifade analizleri yoluyla, her bir genin ifade profillerinde önemli değişiklikler gözlemlendi ve nohutun olumsuz koşullara tepki olarak kullandığı adaptasyon stratejileri ışığa çıkarıldı. Stres uyarıcıları ile gen ifadeleri arasındaki karmaşık etkileşimi açığa çıkararak, bu araştırma sadece nohut biyolojisini anlayışımızı artırmakla kalmaz, aynı zamanda zorlu ortamlarda başarılı bir şekilde gelişebilen dayanıklı nohut çeşitlerinin geliştirilmesi için temel oluşturur. Bu çalışmanın bulguları tarımsal sektör için büyük potansiyele sahiptir, çünkü bitkilerde stres toleransının moleküler mekanizmalarına dair içgörüler sunar ve değişen çevresel zorluklar karşısında sürdürülebilir gıda üretimi uygulamalarının yolunu açar. Çanakkale Onsekiz Mart Üniversitesi BAP birimine araştırmama sağladığı finansal destek için (Different Stress Factors' Effect on N-Glycan Profiling of Cicer Arietinum L.- FYL-2023-4303), TÜBİTAK'a 2210-A kapsamıyla burs desteğinde bulunduğu için ve tüm laboratuvar ekibime her türlü destekleri için teşekkür ediyorum.
Anahtar Kelimeler: Glikozilasyon, stres koşulları, *Cicer arietinum,* gen ifadesi

EXPRESSION OF GLYCOSYLATION-RELATED GENES UNDER STRESS IN *CICER ARIETINUM*

ABSTRACT

With the increasing number of individuals adopting vegan, vegetarian, and gluten-free lifestyles, the demand for substitutes, especially for animal-based proteins, has been on the rise. Chickpea (*Cicer arietinum* L.) stands out as a promising solution, offering a plant-based protein alternative to meat and serving as a gluten-free, high-protein flour substitute. Recognizing its potential, this study aims to explore the intricate gene expression patterns of four glycosylation-associated genes (MNS1, MNS3, ALG10, and GCS1) under diverse stress conditions. Chickpea seedlings were subjected to a range of treatments including high salt concentrations, elevated pH levels, and cold temperatures, mimicking various stress scenarios commonly encountered in agricultural settings. These treatments were meticulously designed to elucidate the response mechanisms of chickpea genes to environmental stressors. Through comprehensive gene expression analyses, significant alterations were observed in the expression profiles of each gene, shedding light on the adaptive strategies employed by chickpea in response to adverse conditions. By unraveling the intricate interplay between stress stimuli and gene expression patterns, this research not only enhances our understanding of chickpea biology but also lays the groundwork for developing resilient chickpea varieties capable of thriving in challenging environments. The findings of this study hold immense potential for the agricultural sector, offering insights into the molecular mechanisms underlying stress tolerance in crops and paving the way for sustainable food production practices in the face of evolving environmental challenges. I would like to thank Çanakkale Onsekiz Mart University BAP (Different Stress Factors' Effect on N-Glycan Profiling of Cicer Arietinum L.- FYL-2023-4303) for funding this research, TÜBİTAK for 2210-A scholarship programme and my lab team for making this research possible.

Keywords: Glycosylation, Stress conditions, *Cicer arietinum*, Gene expression

CİNSİYET GENLERİNİN FENOTİPİK ÖZELLİKLER ÜZERİNDEKİ ETKİSİ İLE CİNSİYETİN TAHMİNLENMESİ

Jiyan TUNÇ
Van Yüzüncü Yıl Üniversitesi, Ziraat Fakültesi, Zootekni Bölümü, Van, Türkiye
Email: 21910001180@yyu.edu.tr

Doç. Dr. ELİF BABACANOĞLU ÇAKIR* (ORCID: 0000-0002-6329-315X)
Van Yüzüncü Yıl Üniversitesi, Ziraat Fakültesi, Zootekni Bölümü, Van, Türkiye
Email: elifbabacanoglu@yyu.edu.tr

ÖZET

Kanatlı hayvan türlerinde yapılan araştırma sonuçları cinsiyet genlerinin birçok etkisi sayesinde fenotipik özellikler aracılığı ile embriyonun cinsiyeti tespit edilmektedir. Kuluçkadan önce ve kuluçka esnasında yumurtaya ait bazı kabuk özelliklerinin veya embriyo gelişimi esnasında bazı uygulamaların embriyonun dişi/erkek olup-olmadığına dair sonuçlar sayesinde cinsiyet tahmin edilmektedir. Bu çalışmada, etlik damızlıklara ait toplam 70 adet yumurtanın kuluçkadan önce yumurta ağırlığı ve yumurta şekil indeksi ölçüldükten sonra yumurtalar standart kuluçka koşulları 37.5 C sıcaklık ve %60 nemde kuluçkalanmıştır. Kuluçkadan önce yumurta ağırlığı, şekil indeksi, kuluçkanın 18. gününde yumurtanın su kaybı ve bireysel çıkış bölmelerinde çıkış yapan günlük yaştaki civcivlerin kanat tüylerine göre cinsiyet saptandıktan sonra çıkışta cinsiyet oranı tespit edilmiş ve civcivin çıkış yaptığı kabuklarda kabuk kalınlığı ölçülmüştür. Kabukların kalınlık ölçümleri yumurtanın sivri, ekvator ve küt kısımları olmak üzere üç bölümden üç tekerrür olacak şekilde ölçülmüştür. Çıkışta kuluçkalanan 70 adet yumurtanın %40'ından erkek, %60'ından dişi civciv elde edilmiştir. Yumurta ağırlığı (P=0.957) ve su kaybının (P=0.122) cinsiyet üzerinde etkisi önemsiz bulunmuştur. Yumurtanın şekil indeksi dişi civcivlerde %72.42 ± 0.41, erkek civcivlerde % 74.21 ± 0.49 (P<0.001) ve kabuk kalınlığı dişi civcivlerde 0.32 ± 0.001 mm, erkek civcivlerde 0.28 ± 0.001 mm (P<0.001) olarak saptanmıştır. Sonuç olarak, bu çalışmada fenotipik özelliklere dayalı olarak tespit edilen cinsiyet tayininde yumurta şekil indeksi düşük ve kabuk kalınlığı yüksek olan yumurtalardan dişi civcivlerin çıkış yaptığı ortaya çıkmaktadır.

Anahtar Kelimeler: Cinsiyet tahmini, fenotipik özellik, şekil indeksi, kabuk kalınlığı, civciv

PREDICTION OF SEX BY THE EFFECT OF SEX GENES ON PHENOTYPIC TRAITS

ABSTRACT
Researchs on poultry species have shown that the sex of the embryo can be determined by phenotypic traits through many effects of sex genes. The sex of the embryo can be predicted by the results of some eggshell characteristics before and during incubation, or by some practices during embryo development to determine whether the embryo is male or female. In this study, a total of 70 eggs of broiler breeds were incubated under standard incubation conditions of 37.5 °C temperature and 60% humidity after egg weight and egg shape index were measured before incubation. Egg weight, shape index, egg water loss on the 18th day of incubation, and sex ratio at hatching were determined according to the wing feathers of day-old chicks that hatched in individual hatching pens, and shell thickness was measured in the shells from which the chicks hatched. The thickness of the shells was measured in three replicates from three parts of the egg: the pointed, equatorial and blunt parts of the egg. At hatching, 40 % male and 60 % female chicks hatched from the 70 eggs were obtained. Egg shape index and shell thickness were 72.42 ± 0.41%, 0.32 ± 0.001 mm in female chicks and 74.21 ± 0.49%, 0.28 ± 0.001 mm in male chicks, respectively and both of traits significant value was $P<0.001$. In conclusion, the sex determination based on phenotypic characteristics in this study revealed that female chicks hatched from eggs with low egg shape index and high shell thickness.
Keywords: Sex Prediction, Phenotypic Trait, Shape İndex, Shell Thickness, Day-Old Chick

HEMATOLOGICAL CHARACTERISTICS OF FIRST-CALF COWS

Ilnura Ibragimovna FAYZULLINA
Russian Biotechnological University, Moscow, Russia

Ilya Nikolayevich MEDVEDEV
Russian Biotechnological University, Moscow, Russia
Email: ilmedv1@yandex.ru

ABSTRACT
Introduction. Pregnancy greatly affects the health of young cows, especially before their first calving. This greatly affects hematological parameters, which are a reflection of the oxidant-antioxidant balance, metabolic rate and overall viability. Purpose: to find out the hematological features of first-calf heifers 2 weeks before calving. Materials and methods. 22 first-calf heifers were examined. The animals were crossbreds - 50% blood of the Black-and-White breed and 50% blood of the Holstein breed. Inspection and blood sampling was performed from them 2 weeks before calving. The content of formed elements, levels of glucose, total protein, albumin, cholesterol, triglycerides, globulin, non-esterified fatty acids, haptoglobin, malondialdehyde, and total antioxidant capacity were determined in the blood of first-calf heifers using traditional methods. Mathematical processing of the received results is carried out. Results. First-calf heifers two weeks before calving had all the indicators taken into account at the normal level. The content of total protein in their blood was 68.1±0.92 g/l. The amount of albumin and globulin they also had was optimal. The content of haptoglobin in their blood at the time of observation was 2.3±0.22 mmol/l. The glucose level in the animals was within the normal range, indicating the normal functioning of carbohydrate metabolism. The amount of non-esterified fatty acids in their blood was found to be low, with average levels of cholesterol and triglycerides. The total antioxidant capacity of blood in first-calf heifers was low - 0.66±0.11 mmol/l, which provided a slightly increased content of malondialdehyde in their blood. The amounts of erythrocytes and hemoglobin in the blood of first-calf heifers were quite high with a high content of total leukocytes, lymphocytes and neutrophils in it. This indicated a very high resistance of their organism against various infections. Conclusion. For first-calf heifers, 2 weeks before calving, the perfection of metabolic and oxidative processes in their body is characteristic. The optimal level of their hematological parameters shows their high viability and overall resistance to any infectious agents. The found levels of malondialdehyde and antioxidant activity in first-calf heifers confirm their metabolic health and readiness of their body for calving.
Keywords: cattle, blood, heifers, pregnancy, protein, lipids, lipid peroxidation.

PHYSIOLOGICAL FEATURES OF BLOOD PARAMETERS OF STEER COWS OF THE BLACK-AND-BROWN BREED

Ilya Nikolayevich MEDVEDEV
Russian Biotechnological University, Moscow, Russia
Email: ilmedv1@yandex.ru

Ilnura Ibragimovna FAYZULLINA
Russian Biotechnological University, Moscow, Russia

ABSTRACT
Introduction. Modern science defines the last three weeks before calving in cattle as physiologically very significant. Interest in this period is due to the fact that cows at this stage of ontogenesis experience a number of quantitative and qualitative changes that have adaptive value. Purpose: to evaluate the peculiarities of blood parameters in first-calf heifers and recalving cows of black-and-brown breed 3 weeks before calving. Materials and methods research. In the study, 47 steer cows of black-and-brown breed (body weight 460-650 kg at the age from 2 to 5 years 4 weeks before the expected calving) were taken. The volume of milk yield for the previous lactation was not less than 6000 liters in repeatedly bred cows. We observed first-calf black-and-brown cows (22 heads) and recalving black-and-brown cows (25 heads) 3 weeks before intended calving. The main hematologic parameters were determined in cows by traditional methods of research. Student's t-criterion was calculated, assuming a significance level of $p<0.05$. Research results. Three weeks before calving, the recorded parameters differed between the groups of observed animals. In terms of total protein, first-calf heifers were initially 16.4% inferior to recurrently calving cows. Albumin tended to be lower in first-calf cows (4.6%). Re-calving cows had higher blood globulin levels before calving (by 34.8%). No significant differences were found between cow groups in glucose levels before calving. The content of non-esterified fatty acids in blood was higher in first-calf heifers by 50.0%. The levels of cholesterol and triglycerides in their blood were inferior to those of second calves by 18.9% and 38.1%, respectively. Erythrocyte and hemoglobin levels in first-calf heifers tended to be inferior to those of older cows by 2.3% and 7.5%, respectively. In first-calf heifers, leukocyte and lymphocyte levels were significantly higher by 15.5% and 28.2%, and neutrophil counts were inferior by 10.7% to values found in recalf cows. Conclusion. This observation helped to identify changes in the hematologic profile of black and sow cows before calving in first-born and second-born cows. It can be considered that black and sperm heifers have a more pronounced blood reaction at the end of pregnancy. This allows us to consider these features as adaptive simultaneously to pregnancy and to the process of growth being completed in them.
Keywords: cows, heifers, pregnancy, blood, adaptation, hematological parameters.

EVALUATING, KNOWLEDGE, ATTITUDES AND PRACTICES REGARDING ANTIMICROBIAL USE AND RESISTANCE AMONG GROUP OF MEDICAL STUDENTS

Mohammad Yawuz JAMAL
University of Baghdad
Email: mohammed.ahmed@copharm.uobaghdad.edu.iq

Angham AHMED
University of Baghdad
Email: angham.ali@copharm.uobaghdad.edu.iq

Sara ASAAD
University of Baghdad
Email: sarra.asaad1200m@copharm.uobaghdad.edu.iq

Israa NAEM
University of Baghdad
Email: Israa.Ahmed@copharm.uobaghdad.edu.iq

ABSTRACT
Background: Self-medication putting antibiotics' benefits at risk. It resulted in underdeveloped countries bearing an increased economic burden, failure in treatment, he growth of bacteria that are resistant to antibiotics, and a higher risk of exposure to and infection of the general public by such pathogens. The aim of this study was to assess knowledge, Attitudes and practices regarding antimicrobial use and resistance among group of medical students of final year pharmacy students and medicine students at Baghdad universities in Iraq. Method: A descriptive cross-sectional study descriptive and institution-based study, between September - November 2023. A self-administered questionnaire was used to assess the knowledge, attitude and practice of antibiotic use, in addition assess how they feel about their medical education has prepared them to dispense for pharmacist and prescribe for physician upon graduation. Result: the total number of students was 642(328 medicine and 314 pharmacy). The survey shows that although 94.7% of the students had good knowledge, only 65.4% of them really practiced it. There was significant (P-value< 0.05) difference in the total attitude score according to the participant gender. In other words, female participant had significant higher positive attitude compared to male participants. There was significant (P-value< 0.05) difference in the total attitude, behavior, and practice scores according to the participant participants' college type. In other words, pharmacy students had significant higher total attitude behavior, and practice scores compared to medical students. **Conclusion:** students' level of knowledge was more than adequate but need more education for improvement their practice Significant work has to be done on improvements.
Keywords: antibiotic; pharmacy students; medicine students; antimicrobial resistance.

HİDROPONİK BESİN ÇÖZELTİSİ İÇERİSİNDEKİ MİKROELEMENTLERİN AKIŞ ENJEKSİYON ANALİZİ İLE EŞ ZAMANLI BELİRLENMESİ

Seda KARAPINAR (ORCID: 0000-0002-7198-7522)
Istanbul Technical University, Faculty of Science and Letters, Department of Chemistry, İstanbul, Türkiye
Email: babacanse@itu.edu.tr

Seda DEVECİ (ORCID: 0000-0002-4227-868X)
Specialist Chemist, Mir Arge San. Tic. A.Ş, Department of Chemistry Research, İstanbul, Türkiye
Email: sddeveci@gmail.com

Prof. Dr. Birsen ÖZTÜRK (ORCID: 0000-0002-0978-0977)
Professor, Istanbul Technical University, Faculty of Science and Letters, Department of Chemistry, İstanbul, Türkiye
Email: demirata@itu.edu.tr

ÖZET
Hidroponik tarım, topraksız tarım sistemlerinin bir türü olup, onu geleneksel tarımdan ayıran en belirgin özelliği, bitkileri beslemek için doğrudan mineral bakımından zengin solüsyonlar kullanmasıdır. Besin kaynağı, bitki büyümesini birçok açıdan önemli ölçüde etkiler. Bitkilerin büyümesi hem N, P ve K gibi makro besinlerden hem de mikro besinlerden etkilenir. Bu nedenle bitkilerin büyümesinde birincil faktörlerden biri olan besin çözeltisinin, bitkilerin ihtiyaç duyduğu tüm gerekli besin maddelerini içermesi önemlidir. Günümüzde mahsul beslenmesini optimize etmek için besin solüsyonu kullanmak (gübreleme veya sıvı gübreleme), toprakta yetiştirilen sera mahsullerinde ve hidroponik kültürde popüler bir uygulamadır. Dünyada tarımsal araştırmalar "yerinde ve spesifik uygulama" odaklıdır. Ulusal ve uluslararası sera işletmelerinin çoğunda, besin çözeltisinin iyon kontrolü pH ve elektriksel iletkenliğin (EC) otomatik ölçümü ile yapılmakta, çözelti içeriği EC değişimine göre takip edilmektedir. Ancak EC toplam elektriksel iletkenlik değeri olduğundan sistemdeki her iyonun konsantrasyonu hakkında bilgi veremez. Bu nedenle besinler için bireysel ve gerçek zamanlı düzeltmeler yapmak mümkün değildir. Böyle bir tespit yöntemi ile bitkinin ihtiyaç duyduğu iyondan daha fazla veya daha az gübreleme yapılacak, bu durumda bitkiden yeterli verim alınamayacaktır Besin maddelerinden özellikle mikro miktarlarda olan Cu ve Zn'nun (az veya çok olmasında sorun yaratabilen iyonlar) ölçümünün tam yapılması ve ayarlanması önemlidir. Bu çalışmada özellikle bu iyonların hassas şekilde ölçümlerinin yapılmasına ait otomasyona uygun, iş gücünden tasarruf sağlayan ve kısa sürede çok sayıda numunenin analizine imkân veren FIA sisteminin kullanıldığı bir yöntem geliştirilmiştir.
Anahtar Kelimeler: hidroponik tarım, hidroponik besin çözeltisi, mikroelementler, akış enjeksiyon analizi

SIMULTANEOUS DETERMINATION OF MICROELEMENTS IN HYDROPONIC NUTRIENT SOLUTIONS BY FLOW INJECTION ANALYSIS

ABSTRACT

Hydroponic farming is a type of soilless farming systems, and the most distinctive feature that distinguishes it from conventional farming is that it directly uses mineral-rich solutions to feed plants. The nutrient supply notably influences the plant growth in many facets. The growth of plants is impressed both by macronutrients such as N, P, and K and by micronutrients. For this reason, it is important that the nutrient solution, which is one of the primary factors in the growth of plants, contains all the necessary nutrients that plants need. Today, using nutrient solution to optimize crop nutrition (fertilization or liquid fertilization) is a popular practice in soil-grown greenhouse crops as well as in hydroponic culture. Agricultural research in the world is focused on "in situ and specific application". In most national and international greenhouse enterprises, the ion control of the nutrient solution is done by automatic measurement of pH and electrical conductivity (EC), the solution content is followed according to the EC change. However, since EC is the total electrical conductivity value, it cannot give information about the concentration of each ion in the system. Therefore, it is not possible to make individual and real-time corrections for nutrients. With such a determination method, more or less fertilization will be made than the ion needed by the plant, in this case, sufficient yield will not be obtained from the plant. It is important to precisely measure and adjust the nutrients, especially micro amounts of Cu and Zn (ions that can cause problems if they are too little or too much). In this study, a method was developed that uses the FIA system, which is suitable for automation, saves labor and allows the analysis of a large number of samples in a short time, especially for precise measurements of these ions.

Keywords: hydroponic farming, hydroponic nutrient solution, micronutrients, flow injection analysis

BİR MUHABBET KUŞUNDA (*MELOPSITTACUS UNDULATUS*) BAŞ BÖLGESİNDE PEDİKÜLLÜ KİTLE (FİBROMİKSOMA) OLGUSU

Doç. Dr. Zeynep BOZKAN ÜNAL (ORCID:0000-0003-4233-6496)
Aydın Adnan Menderes University, Faculty of Veterinary Medicine, Department of Veterinary Surgery, Aydın/ Türkiye
Email: zbozkan@adu.edu.tr

Aylin ATEŞ (ORCID:0000-0001-6917-6192)
Aydın Adnan Menderes University, Faculty of Veterinary Medicine, Department of Veterinary Surgery, Aydın/ Türkiye
Email: aylinates20@gmail.com (Responsible Author)

Prof. Dr. Sümbül Serap BİRİNCİOĞLU (ORCID:0000-0001-5815-6508)
Özel Apatoloji Laboratuvarı Sağlık Hizmetleri, Kızılkanat Sağlık Sitesi, Alsancak/İzmir/Türkiye
Email: serapbirincioglu@gmail.com

ÖZET
Bu olgu sunumunu, Aydın Adnan Menderes Üniversitesi Veteriner Fakültesi Araştırma ve Uygulama Hastanesi'ne baş bölgesinden büyük hacimli sarkan bir kitle şikayetiyle getirilen 11 yaşlı, dişi muhabbet kuşu (*Melopsittacus undulatus*) oluşturdu. Ayrıca, hastada başını yukarıda tutamama, iştahsızlık ve halsizlik gibi bulgular da mevcuttu. Anamnezinde baş bölgesindeki kitlenin yaklaşık 6 ay önce mercimek tanesi kadar olduğu, son 1 ayda aşırı büyüdüğü bilgisi verildi. Klinik olarak palpasyonla yapılan muayenesinde baş bölgesinden sarkan yapının sert, soğuk ve ağrısız olduğu tespit edildi. Anamnez ve klinik muayene sonucunda kitlenin tümöral bir yapı olabileceği düşünüldü. Genel durumunu desteklemek amacıyla vitamin-mineral takviyesi uygulanmasının ardından operatif olarak kitlenin alınmasına karar verildi. Operasyon boyunca hastanın anestezisi maske ile izofloran verilerek sağlandı. Operasyon bölgesi rutin asepsi-antisepsi kurallarına göre hazırlandı. Tümör, çevre dokuların bütünlüğü korunarak total olarak eksize edildi. Hasta operasyondan sonra uyanana kadar oksijen kabininde tutuldu ve sonrasında taburcu edildi. Hastaya analjezik ve antibiyotik tedavisi reçete edildi. Eksize edilen kitlenin histopatolojik incelemesi yapıldı. Histopatolojik incelemeler sonucunda kitlenin benign karakterli mezenşimal tümör, fibromiksoma olduğu belirlendi. Olgunun post operatif uzun vadedeki sağlık durumuna ilişkin hasta sahibinden bilgi alınamadı. Sonuç olarak büyüme gösteren/göstermeyen ve bening/malign tümöral oluşumlar muhabbet kuşlarının genel sağlık durumunu ciddi anlamda bozabilir. Bu yüzden muhabbet kuşlarındaki kitlesel oluşumlar boyut gözetmeksizin dikkate alınmalıdır.
Anahtar Kelimeler: Fibromiksoma, Kitle, Mezenşimal, Muhabbet kuşu, Tümör

A CASE OF PEDUNCULATED MASS (FIBROMYXOMA) ON THE HEAD AREA OF A BUDGERIGAR *(MELOPSITTACUS UNDULATUS)*

ABSTRACT

In this case report, an 11-year-old female budgerigar (*Melopsittacus undulatus*) was brought to Aydın Adnan Menderes University, Faculty of Veterinary Medicine, Research and Application Hospital with the complaint of a large pendulous mass on the head. The patient also had symptoms such as an inability to hold her head up, loss of appetite, and weakness. In her anamnesis, it was reported that the formation in the head area was the size of a lentil grain about 6 months ago and had grown excessively in the last 1 month. On clinical examination with palpation, it was found that the mass on the head region was hard, cold, and painless. As a result of anamnesis and clinical examination, the mass was thought to be a tumoral structure. After vitamin-mineral supplementation to support her general condition, it was decided to remove the mass surgically. The patient was anesthetized with isofluorane through a mask during the surgery. The operation area was prepared according to routine asepsis-antisepsis rules. The tumor was completely excised, preserving the integrity of the surrounding tissues. Following the operation, the patient was kept in the oxygen cabin until waking up and was then discharged. Analgesics and antibiotics were prescribed. Histopathologic examination of the excised mass was performed. A histopathologic examination revealed that the mass was a benign mesenchymal tumor, fibromyxoma. No information was obtained from the patient's owner regarding the long-term postoperative health status of the patient. As a result, growing/non-growing and benign/malignant tumor formations can seriously impair the general health of budgies. Therefore, mass formations in budgies should be taken into consideration regardless of size.

Keywords: Budgerigar, Fibromyxoma, Mass, Mesenchymal, Tumor

EVALUATION THE ANTAGONISTIC ABILITY OF BIOCONTROL FUNGI AGAINST SOME OF PATHOGENIC FUNGI ISOLATED FROM WASTEWATER

Nihad Habeeb MUTLAG
Kufa University-Faculty of Science –Department of Ecology
Email: nuhadh.alazerjawi@uokufa.edu.iq

ABSTRACT
This study was conducted to evaluate the role of isolates of the fungus *Trichoderma. harzianum* and *Pleurotus ostreatus* in the antagonistic activity of 8 fungi isolated and diagnostic from from the Al-Barakia wastewater treatment plant on potato dextrose(PDA) agar and potato dextrose broth(PDB) media, The diagnosed 8 isolates by polymerase chain reaction (PCR) technique. Where these results show the prevalence of fungi *Acrimnium sp, Alternaria.alternatie, Aspergillus.terrus, Aspergillus.flavus, Aspergillus.oryza, Aspergillus.caespitosis , Aspergillus.tubingesis , Aspergillus.niger* All isolates diagnosed in this study were diagnosed by (Nihad.H Mutlag,Douaa F.Hussien 2021). This study showed that *T. harzianum* and *P. ostreatus* have a high antagonistic ability against filamentous and pathogenic fungi through double culture on petri dish ,PDA media that gave asignificant differences of inhibition zone for biocontrol fungi against pathogenic fungi that isolated and diagnosed from waste water that reach (1,2)degrees of Bell scale which consist of 5 degrees ,also the results appears a significant weights of fungal mass after incubation of biocontrol fungi and pathogenic fungi for 21 days ,that gave ,also *T. harzianum* and *P. ostreatus* isolates have a high antagonistic ability against filamentous and pathogenic fungi through double culture on on PDB media that gave asignificant differences in the weight of biomass that calculated after 21 days of incubation which gave the following weights (3.99,4.12,4.23,4.55,4.67, 4.77,4.85,4.98) gm for *T. harzianum* with 8 isolates respectively ,while with *P. ostreatus* gave biomass weights reach (4.54,4.69,4.87,4.88,4.96,5.12,5.23,5.43)gm respectively in compare with control that gave (3.22,4.10)gm for *T. harzianum* and *P. ostreatus* respectively.
Keywords: *T. Harzianum*, *P. Ostreatus, Aspergillus.niger*

EFFECT OF HUMIC AND FULVIC ACIDS ON THE GROWTH OF MAIZE CULTIVARS

Raeda Abd AL-REDHA SABET
Agriculture College, Al-Muthanna University, Al-Muthanna, Iraq

Mohammed H. NOOR ALJANA
Agriculture College, Al-Muthanna University, Al-Muthanna, Iraq

Mohammed Radwan MAHMOUD
Agriculture College, Al-Muthanna University, Al-Muthanna, Iraq
Email: modrn@mu.edu.iq

ABSTRACT
A field experiment was carried out in the spring season 2022 in the organic fertilizer project in Thi Qar Governorate, Shatrah District, 40 km to the north of the city. The factorial experiment includes two factors. The first factor includes four varieties of maize (Furat, ZP, Kaws and Maha), which were varieties approved by the Ministry of Agriculture and are sourced from the Agricultural Research Department, Department of Yellow Maize. The second factor was levels of humic acids (without the addition of control treatment and 10, 20 and 30 liters) of fulvic and humic acids. The results indicate that there was a significant superiority of humic acids treatments at a concentration of 30 liters on the plant height, number of days to flowering, and the concentration of phosphorus and potassium in the plant. As for the cultivars, the Maha cultivar was superior in the number of flowering days, the Furat cultivar on the leaf area, and the Kaws cultivar on the concentration of potassium and phosphorus. As for the interaction, the combination (Control x Kaws cultivar) excelled on the number of days to flowering, the combination (treatment 20 liters x Furat cultivar) on leaf area, the combination (treatment 20 liters x Kaws cultivar) on plant potassium concentration, the combination (treatment 40 L × Maha cultivar) on plant phosphorus concentration.
Keywords. Humic, Fulvic, Growth, Maize cultivars.

INTERNET-OF-THINGS SMART AGRICULTURE: TOWARD MARKING THE FIELDS TALK

Pranathi. T. M.
R.M.K. Engineering College, Student, Mathematics, Chennai, India
Email: 230080.ec@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India
Email: psi.sh@rmkec.ac.in

ABSTRACT
Despite the perception people may have regarding the agricultural process, the reality is that today's agriculture industry is data-centered, precise, and smarter than ever. The rapid emergence of the Internet-of-Things (IoT) based technologies redesigned almost every industry including “smart agriculture” which moved the industry from statistical to quantitative approaches. Such revolutionary changes are shaking the existing agriculture methods and creating new opportunities along a range of challenges. This article highlights the potential of wireless sensors and IoT in agriculture, as well as the challenges expected to be faced when integrating this technology with the traditional farming practices. IoT devices and communication techniques associated with wireless sensors encountered in agriculture applications are analyzed in detail. What sensors are available for specific agriculture application, like soil preparation, crop status, irrigation, insect and pest detection are listed. How this technology helping the growers throughout the crop stages, from sowing until harvesting, packing and transportation is explained. Furthermore, the use of unmanned aerial vehicles for crop surveillance and other favorable applications such as optimizing crop yield is considered in this article. State-of-the-art IoT-based architectures and platforms used in agriculture are also highlighted wherever suitable. Finally, based on this thorough review, we identify current and future trends of IoT in agriculture and highlight potential research challenges.
Keywords: Internet-of-Things, agriculture, industry

HASANDEDE ÜZÜM ÇEŞİDİNDE KISA VE KARIŞIK BUDAMANIN FENOLOJİ, VERİM VE BAZI KALİTE ÖZELLİKLERİNE ETKİSİ

Assist. Prof. Dr. Sevil CANTÜRK* (ORCID: 0000-0001-6055-7191)
Çukurova University, Faculty of Agriculture, Department of Horticulture, Adana - Türkiye
Email: scanturk@cu.edu.tr

Prof. Dr. Birhan KUNTER (ORCID: 0000-0001-7112-1908)
Ankara University, Faculty of Agriculture, Department of Horticulture, Ankara - Türkiye
Email: marasali@agri.ankara.edu.tr

ÖZET
Asmalarda ürün budaması, omcalar üzerinde bırakılan verimli kış gözü sayısının düzenlendiği önemli kültürel uygulamalardandır. Uygun budama zamanı ve bırakılacak göz sayısı, iklim koşulları ve kültürel uygulamalara bağlı olarak değerlendirilmekle birlikte, çeşidin büyüme ve gelişme fizyolojisi ile de ilişkilendirilmesi gereken bir konudur. Çeşit-ekoloji ilişkisine uygun budama zamanı ve göz sayısı belirlenmelidir. Bu çalışmada, özgün ekolojisi Ankara-Kırıkkale- illerinin oluşturduğu bölge olan Hasandede üzüm çeşidinde kısa ve karışık budama uygulamalarının, fenolojik gelişme durumu, sürme oranı, omca verimi ve bazı kalite özellikleri üzerine etkisi incelenmiştir. Çalışmada kullanılan omcalar Kırıkkale / Keskin koşullarında (Olunlu Köyü), kendi kökleri üzerinde kurulu ve sulanmayan yer bağlarında yetiştirilmektedir. Deneme omcaları benzer gelişme kuvvetinde olanlardan seçilmiştir. Yörenin geç budama davranışına uygun olarak 26.03.2017 tarihinde budama yapılmıştır. Omcalarda kısa (2 göz) ve karışık (2 ve 5 göz) budama uygulanmıştır. Elde edilen bulgulara göre sürme safhası kısa budama uygulamasında, çiçeklenme, tane tutumu ve ben düşme safhaları ise karışık budama uygulamasında daha erken gerçekleşmiştir. Budama tiplerinin üzümün olgunluk safhası üzerinde farklılık meydana getirmediği saptanmıştır. Omca üzerinde bırakılan gözlerin sürme oranı, kısa budamada %72.3, karışık budamada %80.7 olarak belirlenmiştir. Omca verimi kısa budamada 2 kg olarak belirlenirken, karışık budamada 5 kg düzeyinde ürün alınmıştır. Çalışmanın yürütüldüğü alanda Hasandede üzümleri sofralık değerlendirilmeye uygun olarak hasat edilmiştir. Üründe titre edilebilir asitlik %3 olarak ölçülmüş ve budama uygulamaları arasında farklılık göstermemiştir. Suda çözünebilir kuru madde miktarı kısa budanan omcalarda 18oB, karışık budanan omcalarda 19oB olarak ölçülmüştür. Bulgular genel olarak değerlendirildiğinde, karışık budama uygulaması ile sürme oranı bakımından olumlu sonuçlar elde edilmiş ve Hasandede üzüm çeşidi için Kırıkkale koşullarında, yarı-uzun ürün dallarının bırakıldığı karışık budamanın önerilebileceği sonucuna ulaşılmıştır.
Anahtar Kelimeler: Hasandede üzüm çeşidi, budama, fenoloji, verim, kalite

THE EFFECTS OF SPUR AND CANE PRUNING ON PHENOLOGY, YIELD AND SOME QUALITY CHARACTERISTICS OF HASANDEDE GRAPE CULTIVAR

ABSTRACT

Winter pruning is an important cultural practice regulating the number of productive winter buds left on the grapevines. Although the appropriate pruning time and the number of buds to be left are determined depending on climatic conditions and cultural practices, they are also associated with the growth and development physiology of the grape cultivar. Pruning time and number of buds left should be determined by the cultivar-ecology relationship. In this study, the effects of spur and cane pruning on the phenological stages, rate of bud break, yield and some quality characteristics of Hasandede grape cultivar, which is unique to Ankara-Kırıkkale region, were investigated. The vines have been traditionally grown own-rooted and non-irrigated vineyards in Kırıkkale / Keskin conditions. Trial vines were selected from those with the same moderate vegetative vigor. Spur (2 buds) and cane (2 and 5 buds) pruning were applied to the vines. Pruning was carried out in the late period in accordance with the local practice on 26.03.2017. The results showed that, the bud break occurred earlier in the spur pruning application, while the flowering, berry set, and véraison phases occurred earlier in the cane pruning. Pruning types did not make any difference in the ripeness stage of grapes. The bud break rate was 72.3% in spur pruning and 80.7% in cane pruning. While vine yield was determined as 2 kg in spur pruning, 5 kg was obtained in cane pruning. Hasandede grapes were harvested for fresh consumption criteria. The titratable acidity of grapes was measured at 3% and did not differ between pruning treatments. The soluble solid content was measured as 18oB in spur pruned vines and 19oB in cane pruned vines. When the findings were evaluated, positive results were obtained with cane pruning in terms of bud break rate, and it was concluded that cane pruning could be recommended for the Hasandede grape cultivar in Kırıkkale conditions.

Keywords: Hasandede grape cultivar, pruning, phenology, yield, quality

EVCİL YENİ ZELANDA IRKI TAVŞANDA RETROBULBER APSENİN TANI VE TEDAVİSİ

Doç. Dr. Zeynep BOZKAN ÜNAL (ORCID: 0000-0003-4233-6496)
Aydın Adnan Menderes University, Faculty of Veterinary Medicine, Department of Veterinary Surgery, Aydın-Türkiye
Email: zbozkan@adu.edu.tr

Ezgi Sude AYBAK* (ORCID: 0000-0001-5701-6159)
Aydın Adnan Menderes University, Faculty of Veterinary Medicine, Department of Veterinary Surgery, Aydın-Türkiye
Email: ezgisudeaybak@gmail.com

ÖZET
Retrobulber apseler, retrobulber boşlukta purulent materyal toplanması ile karakterizedir ve penetran yabancı cisimler, endodontik enfeksiyon, lokal yaralanma veya enfeksiyonun kan dolaşımından yayılması gibi sebeplerden kaynaklanabilir. Bu olgu sunumunda, sol gözünde bir süre önce başlayan ve hızla ilerleyen ekzoftalmi şikayetiyle kliniğe getirilen 4 yaşlı, 3 kg ağırlığındaki, erkek, Yeni Zelanda ırkı tavşan konu edildi. Anamnezde hastaya daha önce topikal olarak göz damlaları uygulandığı ancak sonuç alınamadığı, bu süreçte hastanın genel durumunun çok az etkilendiği, iştahsızlık ve halsizlik gibi bulguların son dönemde hafif düzeyde şekillendiği belirtildi. Yapılan göz muayenesinde ekzoftalmi nedeniyle göz kapaklarının kapanamadığı ve bunun yanı sıra ileri derecede kseroftalmi şekillendiği, korneal ödem ve üçüncü göz kapağının protrüzyonu bulunduğu belirlendi. Tam kan analizinde tüm veriler referans değerler içindeydi. Tanı amaçlı BT ve oküler ultrason kullanılan hastada retrobulber alanda apse ile uyumlu bir kitle olduğu tespit edildi. Hastanın genel durumunu desteklemek ve göz küresinin bütünlüğünü korumak amaçlı birkaç gün medikal tedavi önerilerek operatif müdahale gerçekleştirilmesine karar verildi. Ancak tedaviye rağmen şiddetlenen korneal lezyonlar ve ülserasyon nedeniyle, gözün enükleasyonuyla beraber apsenin uzaklaştırılması işlemi gerçekleştirildi. Postoperatif antienflamatuar ve antibiyotik tedavisinin yanısıra lokal olarak bölgeye dren uygulanarak düzenli takibi sağlandı ve yakalık takıldı. Hasta 1 aylık takibin sonunda tamamen iyileşti. Evcil tavşanlarda retrobulber apse ile sık karşılaşıldığı belirtilse de hastalığın epidemiyolojisi, klinik/radyolojik/ultrasonografik bulgular eşliğinde tanısı, tedavisi ve tedavi sonuçları hakkında sınırlı bilgi bulunmaktadır. Bu çalışmanın amacı, bir evcil tavşanda retrobulber apsenin klinik bulguları, teşhisi, tedavi ve tedavi sonuçları hakkında bilgi vermektir.
Anahtar Kelimeler: Ekzoftalmi, Retrobulber apse, Tavşan, Tomografi, Ultrason

DIAGNOSIS AND TREATMENT OF RETROBULBAR ABSCESS IN DOMESTIC NEW ZEALAND RABBIT

ABSTRACT

Retrobulbar abscesses are characterized by the collection of purulent material in the retrobulbar space and can be caused by penetrating foreign bodies, endodontic infection, local injury or spread of infection through the bloodstream. In this case report, a 4 years old, 3 kg, male, New Zealand rabbit was brought to the clinic with the complaint of exophthalmos in the left eye which started a while ago and progressed rapidly. In the anamnesis, it was reported that topical eye drops were previously applied to the patient but no results were obtained, the general condition of the patient was slightly affected in this process, and the findings such as loss of appetite and lethargy were mild in the last period. The ophthalmologic examination revealed that the eyelids could not close due to exophthalmos, as well as advanced xerophthalmos, corneal edema and protrusion of the third eyelid. All data in the complete blood analysis were within reference values. Diagnostic CT and ocular ultrasound were used and a mass compatible with abscess was detected in the retrobulbar area. Medical treatment was recommended for a few days to support the general condition of the patient and to maintain the integrity of the eyeball until the operative intervention was performed. However, due to the corneal lesions and ulceration that worsened despite the treatment, removal of the abscess with enucleation of the eye was performed. In addition to postoperative anti-inflammatory and antibiotic treatment, a drain was applied locally and regular follow-up was maintained and a collar putted on. The patient fully recovered after 1 month of follow- up. Although it has been reported that retrobulbar abscesses are frequently diagnosed in domestic rabbits, there is limited information about the epidemiology of the disease, its diagnosis with clinical/radiologic/ultrasonographic findings, treatment and outcomes. The purpose of this study was to provide information about the clinical findings, diagnosis, treatment and outcomes of retrobulbar abscess in a domestic rabbit.

Keywords: Exophthalmos, Retrobulbar abscess, Rabbit, Tomography, Ultrasound

FIRST INSIGHT INTO THE MYCOTOXIN-RELATED INVESTIGATION OF HUNGARIAN GAME SPECIES

Máté MAURER (ORCID: 0009-0006-1916-1762)
University of Pécs, Faculty of Science, Institute of Biology, Department of Agricultural Biology, Pécs, Hungary.
Email: maurermate97@gmail.com

Szilvia STRANCZINGER (ORCID: 0000-0002-6947-4605)
University of Pécs, Faculty of Science, Institute of Biology, Department of Plant Biology, Pécs, Hungary.
Email: sziszi55@gamma.ttk.pte.hu

Zsuzsanna SZŐKE (ORCID: 0000-0001-9302-1115)
Hungarian University of Agriculture and Life Sciences Institute of Genetics and Animal Biotechnology, Reproductive Biology and Toxicology Group, Gödöllő, Hungary.
Email: Ferenczine.Szoke.Zsuzsanna@uni-mate.hu

László SZEMETHY (ORCID: 0000-0001-7834-7619)
University of Pécs, Faculty of Science, Institute of Biology, Department of Agricultural Biology, Pécs, Hungary.
Email: laszlo.szemethy@gmail.com

ABSTRACT
Today, one of the most complex consequences of climate change is the increased spread of molds and the mycotoxins they produce. Global research has shown that nearly 80% of the world's grain production is infected with at least one type of mycotoxin. Based on research conducted on domestic and laboratory animals, it can be established that the currently known mycotoxins have extremely diverse, harmful effects on birds and mammals alike. At the same time, significantly less attention is paid to wild animals and the natural vegetation that serves as food. In our research, we mainly investigate the appearance of mycotoxins in different game species, like European roe *(Capreolus capreolus)* and European hare *(Lepus europaeus).* The aim of our research is to determine what effects mycotoxins have on the body of these wild animal, and to see what type of food sources have the most mycotoxins. The data collected from individuals harvested during hunting season, by professional hunters at agricultural habitat. Our first results confirm several of our assumptions. We detected the presence of mycotoxins in the examined organs in all habitats and in both species, but at the same time there is great variability between areas and within the area. Cultivated plants made up most of the animals' diet, but natural species were also present in large numbers. The relationship between the proportion of cultivated plants in the diet and the mycotoxin content of the organs has not yet been conformed. These first results show that this topic needs further investigations.
Keywords: mycotoxins, game species, Hungary, agricultural habitat, hunting

ACCESS CONTROL AS TECHNOLOGICAL GATEWAY TO DATA SECURITY: AN INTRINSIC STUDY OF CLOUD COMPUTING DEVELOPMENT

Moses Adeolu AGOI (ORCID: 0000-0002-8910-2876)
Lagos State University of Education, Lagos Nigeria
Email: agoi4moses@gmail.com

Solomon Abraham UKPANAH
Lagos State University of Education, Lagos Nigeria
Email: ukpanahz@gmail.com

Opeyemi Elizabeth ADEWUNMI
Lagos State University of Education, Lagos Nigeria
Email: Opeyemiez225@yahoo.com

Olasunkanmi Julius OLATUNDE
Lagos State University of Education, Lagos Nigeria
Email: Olatundeolasunkanmi4z@gmail.com

Oluwanifemi Opeyemi AGOI
Obafemi Awolowo University, Osun Nigeria
Email: oluwanifemiagoi@gmail.com

ABSTRACT
The advent of technology has brought countless innovations alongside with modernization. Cloud computing technology has made vivid attempts to find solutions to the ever changing needs of cloud users but the issues of trust have held back its users by challenges such as data security. Access control attempts to moderate the accessibility to resources/services made by cloud users based on authentication, authorization attributes to subjects, objects attributes as well as system attributes in conformation to set policies. The mechanism behind Access control aims at either granting or denying access to specific data for security purpose against unauthorized users. This paper identified some measures that can be used to support trustful development and security of cloud computing technology. The paper further discussed some of the aspects that weigh most in the users' trust in cloud computing technology and also described how access control can help to gain user's trust for guaranteed data security. In order to gather relevant information for the paper discussion, questions were drafted and administered to respondents using online Google form. The responses collected were collated and subjected to reliability analysis. Conclusively, recommendations were made to cloud vendors and users on how to best optimize the use of cloud computing technology so as to ensure the availability, integrity and confidentiality of data.
Keywords: Access Control, Technological Gateway, Data Security, Cloud Computing System.

HAYVANCILIĞIN DİJİTAL DÖNÜŞÜMÜNDE BİLGİSAYARLI GÖRME KULLANIMI: KEÇİLER İÇİN YOLOv8 TABANLI DERİN ÖĞRENME YAKLAŞIMI İLE YÜZ ALGILAMA SİSTEMİ

Dr. Öğr. Üyesi Cihan ÇAKMAKÇI (ORCID: 0000-0001-6512-9268)
Van Yüzüncü Yıl University, Faculty of Agriculture, Department of Agricultural Biotechnology, Animal Biotechnology Section, Van-Türkiye.
Email: cakmakcicihan@gmail.com

ÖZET
Çiftlik hayvanlarının vücut kısımlarının görüntülerden veya videolardan doğru şekilde segmente edilmesi, etkili bir hayvancılık yönetimi için bireysel tanıma, sağlık izleme, davranış çalışmaları ve hassas tarım uygulamaları açısından kritik öneme sahiptir. Bu çalışma, derin öğrenme tabanlı nesne algılama ve segmentasyonu için özel olarak geliştirilmiş You Only Look Once (YOLOv8) mimarisinin YOLOv8n versiyonunu kullanarak görüntülerden keçi yüzlerinin otomatik olarak algılanması ve segmentasyonunu amaçlamaktadır. Yaklaşımda, 107 adet etiketlenmiş keçi yüzü görüntüsünden oluşan özel bir veri seti üzerinde, 261 katman ve 3 milyondan fazla parametreye sahip bir YOLOv8n segmentasyon modeli aktarım öğrenmesi ile eğitilmiştir. Model, AdamW optimizasyon algoritması kullanılarak optimize edilmiş olup, toplu işlem boyutu 8 ve eğitim döngüsü sayısı 100 olacak şekilde yapılandırılarak eğitilmiştir. 45 keçi yüzü görüntüsünden oluşan bağımsız bir test setinde yapılan değerlendirmede, modelin genel doğrulama maskesi mAP50'sinin %94.2 ve mAP50-95'inin %76.5 olduğu gözlenmiştir. Özellikle, model 0.5 IoU eşik değeri altında %93.9'luk bir mask kesinliği ve %94.1'lik bir hassasiyet elde etmiş olup, bu da keçi yüzü segmentasyonu gibi zorlu görevler için yüksek performansı işaret etmektedir. NVIDIA RTX 3050 GPU kullanılarak 640x640 çözünürlükteki bir görüntü için 13.6ms'lik çıkarım hızı elde edilmiş olup, bu da canlı hayvan izleme ve yüz tanıma uygulamaları için gerçek zamanlı analiz imkânı sunmaktadır. Ek eğitim verileri kullanılarak modelin genelleme yeteneğinde iyileştirmeler yapılabilir. İleride, modelin daha da optimize edilmesi, farklı hayvan türlerinde uygulanması ve çeşitli çevresel koşullara karşı genelleme performansının arttırılması ile ilgili araştırmalar yürütülebilir.
Anahtar Kelimeler: derin öğrenme, bilgisayarlı görme, YOLOv8, keçi yüz tespiti, segmentasyon

USE OF COMPUTER VISION IN THE DIGITAL TRANSFORMATION OF LIVESTOCK FARMING: A FACIAL DETECTION SYSTEM FOR GOATS USING A DEEP LEARNING APPROACH BASED ON YOLOv8

ABSTRACT

Accurate segmentation of livestock body parts from images or videos is crucial for effective livestock management, encompassing individual recognition, health monitoring, behavioral studies, and precision farming. This study introduces a deep learning-based instance segmentation model tailored for automated detection and segmentation of goat faces in images. The approach involves transfer learning for training a YOLOv8n segmentation model, comprising 261 layers and over 3 million parameters, on a custom dataset of 107 annotated images containing goat faces. The model was optimized using the AdamW optimizer and trained for 100 epochs with a batch size of 8. Evaluation on a held-out test set of 45 goat face images demonstrated the model achieved an overall validation mask mAP50 of 94.2% and mAP50-95 of 76.5%. Notably, the model exhibited a mask precision of 93.9% and recall of 94.1% at an IoU threshold of 0.5, highlighting its capability for precise segmentation tasks such as goat face segmentation. The inference speed of 13.6ms per 640*640p image using an NVIDIA RTX 3050 GPU enables real-time analysis in livestock monitoring and facial recognition applications. Further improvements in robustness and generalization are anticipated through additional training data. Future research avenues include further optimization of the model and its extension to diverse animal species and environmental conditions.

Keywords: deep learning, computer vision, YOLOv8, goat face detection, segmentation

ASSESSING THE PRACTICE OF COMMUNITY-BASED FOREST MANAGEMENT IN NORTHWEST ETHIOPIA

Tesfaye Mengie KASSIE (ORCID: 0000-0002-5828-5446)
University of Pécs, Faculty of Science, Department of Agricultural Biology, Pécs, Hungary
Email: tesfayemengie@gmail.com

Prof. Szemethy László RÓBERT (ORCID: 0000-0001-7834-7619)
University of Pécs, Faculty of Science, Department of Agricultural Biology, Pécs, Hungary
Email: szemethy.laszlo@pte.hu

ABSTRACT
Community-based Forest Management (CBFM) efforts are critical to sustainable natural resource governance in Northwest Ethiopia. This study investigates the various aspects of CBFM, emphasizing practical implementation in the context of the Awi Administrative Zone. Using a mixed-methods approach, data were obtained from 412 farmers, nine agricultural experts, nine local managers, nine District administrators, and 40 scholars using questionnaires, Key informant interviews, and focus group discussions. Data were analyzed quantitively and qualitatively. The quantitative data were analyzed by the Likert scale with SPSS23 software. Our findings highlight the complex relationship between traditional ecological knowledge and modern scientific approaches to forest resource management. We look at the practical aspects of CBFM, from community-led conservation efforts to sustainable harvesting techniques, emphasizing the importance of indigenous knowledge alongside modern methodologies. Furthermore, this study will investigate CBFM's socioeconomic impacts, focusing on its contributions to livelihood enhancement and community empowerment. CBFM project in the Northeast part of Ethiopia have facilitated biodiversity protection and environmental resilience by integrating local perspectives with broader developmental goals. However, obstacles such as land tenure, resource conflicts, and capacity restrictions continue, needing adaptive methods and legislative reforms. This presentation contributes to the ongoing discussion on sustainable natural resource management by offering empirical insights into the dynamics of CBFM in the Awi Administrative Zone of Northwest Ethiopia. It promotes a comprehensive approach recognizing the linkages between indigenous knowledge systems and contemporary practices for creating inclusive and resilient forest governance models.
Keywords: CBFM, Indigenous Knowledge, Sustainable natural resource

SMALLHOLDER COMMERCIALIZATION: ANALYSIS OF THE SOCIO-ECONOMIC AND INSTITUTIONAL CONSTRAINTS TO MARKET ORIENTATION AND PARTICIPATION AMONG RICE FARMING HOUSEHOLDS IN SOUTHEAST NIGERIA

Ikenna Charles UKWUABA
Department of Agricultural Economics, Faculty of Agriculture, University of Nigeria, Nsukka
Email: ikenna.ukwuaba@unn.edu.ng

Sunday Ifeanyi UKWUABA
Department of Agricultural Economics, University of Agriculture and Environmental Sciences, Umuagwo, Imo state, Nigeria

Ifeyinwa Cynthia UKWUABA
Department of Agricultural Economics, Faculty of Agriculture, University of Nigeria, Nsukka

ABSTRACT
Commercial transformation of subsistence farming is crucial in ensuring sustainable household food security and poverty reduction. Various socioeconomic and institutional obstacles constitute a bottleneck to the commercialization of smallholder rice farmers especially in developing countries like Nigeria. The study evaluated the market orientation and participation indices as well as the constraints to market orientation and participation among smallholder rice farming households. Multistage sampling techniques were used in the selection of 288 smallholder rice farmers. Primary data was collected from the respondents with the aid of a semi-structured questionnaire. The market orientation index and Heckman's two-stage model were used to realize the objectives. The results of the market orientation index of the farmers showed a moderate market orientation index of 0.52 while that of participation was 0.72. The result of the of the socioeconomic and institutional constraints to smallholder rice commercialization showed that high cost of inputs, land fragmentation and lack of capital ranks among the major constraints limiting the extent of market orientation while poor road networks, long distance to market and lack of market information hinders the intensity of market participation among smallholder rice farmers in southeast, Nigeria. Therefore, to achieve smallholder commercialization goal, efforts must be made to eliminate or at least minimize these threats to boasting smallholders' income and standard of living.
Keywords: Commercialization, Smallholders, Rice, Constraints, Nigeria

RELIGIOUS CRISIS AND FOOD INSECURITY IN NIGERIA SINCE 2023: ANY HOPE

Favour C. UROKO
Department of Religion and Cultural Studies, Faculty of the Social Sciences, University of Nigeria Nsukka
Email: Favour.uroko@unn.edu.ng

ABSTRACT
This paper provides a thorough examination of the intertwined dynamics between religious tensions and food scarcity in Nigeria. Religious conflicts, often rooted in historical grievances, doctrinal differences, and political manipulations, have resulted in widespread violence, displacement, and social disintegration across various regions of Nigeria. These conflicts not only disrupt communities but also disrupt agricultural activities, exacerbating food insecurity by impeding farming practices, disrupting food distribution networks, and displacing farmers from their lands. Concurrently, Nigeria faces significant food insecurity challenges, stemming from a combination of factors including limited agricultural productivity, inadequate infrastructure, environmental degradation, and economic instability. The impact of climate change further exacerbates these challenges, leading to crop failures, livestock losses, and diminished food supplies, particularly in vulnerable regions. The intersection of religious crisis and food insecurity creates a vicious cycle, with food shortages often exacerbating existing tensions and conflict, while religious discord hampers efforts to address food insecurity through social disruption and displacement. Addressing the complex nexus of religious crisis and food insecurity requires a multifaceted approach that integrates conflict resolution mechanisms, sustainable agricultural practices, and targeted humanitarian interventions. Promoting interfaith dialogue, fostering inclusive governance structures, and investing in agricultural resilience are critical steps towards mitigating the underlying drivers of conflict and food insecurity. This paper underscores the importance of evidence-based policymaking and international cooperation in addressing the root causes of religious crisis and food insecurity in Nigeria. By adopting a comprehensive approach that addresses both immediate needs and underlying structural issues, Nigeria can pave the way for a more peaceful, prosperous, and resilient future for all its citizens.
Keywords: Religious crisis, food insecurity, ecoterrorism, religion, ethnicity

SOME NATURAL ISOLATED COMPOUNDS AS ANTICANCER AGENTS

B. Pharm
Faculty of Pharmacy Bharath Institute of Higher Education and Research Chennai, India

A. Dinesh BABU
B. Faculty of Pharmacy Bharath Institute of Higher Education and Research Chennai, India

Assoc. Prof. R. JOTHILAKSHMI
Faculty of Pharmacy Bharath Institute of Higher Education and Research Chennai, India

Prof. Dr. R. SRINIVASAN
Faculty of Pharmacy Bharath Institute of Higher Education and Research Chennai, India

ABSTRACT
Worldwide cancer is the major cause of death. Almost 8.8 million people died due to different types of cancer such as lung cancer, liver cancer, breast cancer, stomach cancer, blood cancer etc. They various countries and some private organizations are spending trillions dollars for the research in cancer. According to report of WHO treatment cost of cancer is approximately and this amount is increasing per year. Despite of huge work the exact cause of genesis is still unknown. Couples of therapies like chemotherapy, radiation, surgery and targeted therapy are available with some detrimental effect. Now scientists are seeking lead molecule from naturally occurring substances due to high safety margin as compared to current approaches. Natural phytochemicals are prominent strategy for prevention, treating, and curing cancer. There are many phytochemicals from herbs having potent anticancer property. Generally these phytochemicals treat cancer by different mechanisms like augmenting apoptosis, cell cycle arrest, targeting to some specific cancer inducing proteins, increasing cytotoxicity etc. This is our little attempt to gather information of phytochemicals having anticancer property such as Etoposide, Curcumin, Vincristine, etc. with postulated mechanism. Etoposide is effective in lung cancer, ovarian cancer by inhibiting type II Topoisomerase. Various research revealed that Curcumin is effective in different types of cancers by increasing apoptosis and targeting specific gene such as MDM2 oncogene is inhibited through the ETS2 transcription factor by modulation of signaling pathway PI3K/mTOR in breast cancer. Vincristine shows anticancer property by oncogenic EWS-FLI1 fusion protein inhibition which cause G2-M phase cell cycle arrest & reduce tumor. This review depicts few phytochemicals having anticancer property such as Etoposide, Curcumin, vincristine, etc. with possible mechanism.
Keywords: Etoposide, Curcumin, Cancer, Topoisomerase, Augmenting, Apoptosis

PARTISIPASI MASYARAKAT DALAM MENDUKUNG KEBERHASILAN REHABILITASI HUTAN DAN LAHAN DI TAMAN HUTAN RAYA WAN ABDUL RACHMAN

Nabila DAUD*
Jurusan Kehutanan, Fakultas Pertanian, Univeristas Lampung Jl. Soemantri Brojonegoro, Gedong Meneng, 35145, Bandar Lampung, Lampung, Indonesia
Email: nabiladaud17@gmail.com

Aryanti Rizki ADINDA
Jurusan Kehutanan, Fakultas Pertanian, Univeristas Lampung Jl. Soemantri Brojonegoro, Gedong Meneng, 35145, Bandar Lampung, Lampung, Indonesia

Dhea Ayu LESTARI
Jurusan Kehutanan, Fakultas Pertanian, Univeristas Lampung Jl. Soemantri Brojonegoro, Gedong Meneng, 35145, Bandar Lampung, Lampung, Indonesia

Christine WULANDARI
Jurusan Kehutanan, Fakultas Pertanian, Univeristas Lampung Jl. Soemantri Brojonegoro, Gedong Meneng, 35145, Bandar Lampung, Lampung, Indonesia

ABSTRACT
Community activities in the form of active participation play a role in the sustainability of forest land in the Wan Abdul Rachman Forest Park. There are still many people who do not consider sustainable forest land preservation when participating in managing forest land which they have the right to manage. This causes a decrease in the quality and quantity of forest land, requiring rehabilitation to restore forest and land functions by involving the community considering that the community itself has a large role in land management. Successful rehabilitation of forests and land can occur if the community participates from planting, management to harvesting by practicing sustainable principles. In this way, the community manages the land optimally and still pays attention to its sustainability. This means that the community not only uses the land, but the community also plays a role in developing a land restoration system or model as well as the participation of personnel with skills in managing land in a sustainable manner. This research aims to identify forms of community participation in supporting forest rehabilitation and the level of community participation in supporting the success of forest rehabilitation in the Wan Abdul Rachman Forest Park. The research method used is desk study/literature study. The research results show that community participation in form, thoughts, energy, assets, skills and social aspects can support the success of forest and land rehabilitation by implementing sustainability principles.
Keywords: Participation, Community Tahura

ANALYSIS OF AGROECOSYSTEM MANAGEMENT OF COFFEE PLANTS IN LAMPUNG USING THE SWOT METHOD

Kheynad*
Jurusan Kehutanan, Fakultas Pertanian, Universitas Lampung
Email: kheynadkhan913@gmail.com

Vinanda Arum TRI KURNIAWAN
Jurusan Kehutanan, Fakultas Pertanian, Universitas Lampung

Nur Ahmad FADLI
Jurusan Kehutanan, Fakultas Pertanian, Universitas Lampung

Christine WULANDARI
Jurusan Kehutanan, Fakultas Pertanian, Universitas Lampung
Program Studi Magister Kehutanan, Fakultas Pertanian, Universitas Lampung Jln. Prof. Dr. Soemantri Brojonegoro No. 1 Gedung Meneng, Bandar Lampung

ABSTRACT
Coffee is widely cultivated by farmers in Lampung. The coffee commodity in Lampung is included in the five largest coffee productions in Indonesia. The coffee commodity in Lampung has been selected for a long time, this makes the coffee plants in Lampung fall into the old category which has resulted in a decline in coffee fruit production. Agroecosystems are a system used by farmers to improve welfare by utilizing ecosystems with agricultural plants that have economic value. Apart from improving the farmer's economy, this system can also minimize impacts caused by climate and community activities. The aim of this research is to determine the success of coffee plant agroecosystem management using SWOT analysis. This research uses a case study method from several previous studies. Analysis of actual research data uses the SWOT (Strengths, Weaknesses, Opportunities and Threats) method, a technique used to identify strengths, weaknesses, opportunities and threats to develop strategic plans. The results of this research will reveal the aspects that support the success of coffee management in Lampung using an agroecosystem system.
Keywords: agroecosystem, commodities, agriculture, SWOT

RURAL TOURISM FOR ORGANIC FARMING IN GEORGIA

Marine METREVELI
International Center for Caucasus Tourismj, Tbilisi, Georgia
Email: icct.ngo.2007@gmail.com

ABSTRACT
Rural tourism can play an important role in organic farming. Tercently ICCT experts have been invited to the project "Healthy Soil for Safe Products" funded by the Rustaveli Foundation. The main goal of the project is to help farmers, i.e. beneficiaries from different regions of Georgia, to raise awareness about rural tourism and start entrepreneurial activities. Rural tourism combined with organic farming is a novelty in ICCT's practice, as it is quite a different task to contribute to the development of rural tourism and organic farming as a core project and therefore the value of my responsibility is much higher. Along with poverty alleviation, migration reduction, gender equality, environmental conservation, rural tourism remains a leading player and a major stimulant for development of organic farming, which provides the basic background for the production of safe food that retains such a high value. The project aims to provide beneficiaries with training on various topics related to rural tourism and its link to organic farming. ICCT with 15 years of experience in the field of rural/agritourism has accumulated knowledge to share with the beneficiaries as potential rural tourism entrepreneurs among farmers. It is well known that Georgia is an agricultural countryand many farmers are motivated to gain an additional sourc of income along with the opportunity to manage an effective service of hosting the tourists Also combined develipment of rural tourism and organic farming have many benefits: strengthening of local economy, creating jobs and new businesses; developing and promoting enterpreneurship, integration with outer world, intercultural relations. Rural tourism helps to provide "sustainable" or "green" tourism. The connection of organic agriculture with rural tourism is gradually becoming as positive evidence to identify the actors of local communities to successfully develop in rural tourism**.**
Keywords: rural tourism, organic farming, healthy food, enterpreneurship, business

EFFECT OF ADDING GINSENG (*PANAX GINSENG)* EXTRACT AND EARLY ACCLIMATIZATION ON SOME PHYSIOLOGICAL TRAITS OF BROILER CHICKENS EXPOSED LATER TO HEAT SHOCK

Nadia AL-MUSLIMAWI
University of Baghdad, College of Agricultural and Engineering Sciences, Department of Animal Production, Baghdad, Iraq

Dhia IBRAHIM
University of Baghdad, College of Agricultural and Engineering Sciences, Department of Animal Production, Baghdad, Iraq, 0000-0002-8126-1215, avphdidk@yahoo.com,

ABSTRACT
This experiment was conducted to study the effect of addition of *Panax ginseng* extract to drinking water and early acclimatization on some physiological traits of broiler chickens exposed later to heat shock. A total of 540, one day old un sexed Ross 308 ,broiler chicks were randomly allocated in to 12 sub treatment groups in 4 ×3 factorial experiment to evaluate the interaction between four types of early acclimatization by exposing the five day old chick to 38-40ºC for 0,2,4 and 6hours (assigned P0,P2,P4 and P6 resp.) and three type of ginseng extract supplemented to the drinking water G0 (control),ginseng extract alone 120mg (G1) and ginseng extract 8mg with vitamins and mineral mixture (pharmaton) (G2). Nine birds (42 days old) from each previous treatments were selected and subjected to heat shock by elevating the environmental temperature to38-40ºC for three hours .The statistical Analysis for the experiment data showed that early acclimatization and addition of *Panax ginseng* extract to the drinking water after later heat shock had no effect on body temperature ,heterophil lymphocyte ratio (H/L ratio) , hemoglobin (Hb) and pact cell volume (PCV) but the interaction between early acclimatization and ginseng addition has some significant effect ($P<0.05$) with H/L ratio ,Hb ,PVC. We concluded that early acclimatization periods and ginseng extract addition alone and with minerals and vitamins did not give a good results so we suggest to increased acclimatization periods and ginseng extract addition and heat shock temperature in another experiments.
Keyworlds: early acclimatization; ginseng (*Panax ginseng)* extract; broiler chickens

NATURAL MINERAL SPRING WATER (*HORA*) AND SURROUNDING SOILS IN SOUTHWESTERN ETHIOPIA: FARMERS' FEEDING PRACTICES AND THEIR PERCEPTION ABOUT ITS NUTRITIONAL ROLES ON ANIMAL PERFORMANCE

Ashenafi MIRESA
Jimma University

ABSTRACT
Natural mineral water (termed hora in Afan Oromo) and surrounding soils are the most important source of mineral supplement traditionally used for livestock in many parts of Ethiopia. However, there is limited information about its feeding practices and effect on animal performance. Thus, the present study is aimed to assess farmers' feeding practices and attitudes about the role of hora and surrounding soils on animal performance. Data were collected from 385 households in four districts (Bedele, Dabo, Gechi and Boracha) through face-to-face interviews using a semi-structured questionnaire with the help of KoboCollect application. Data were analyzed using SPSS version 26. Overall, (72.3%) of respondents reported hora is an important sources of mineral supplement for livestock. Higher percentage of respondents in Boracha (78.1%) routinely supplement their animals compared with farmers from other districts, with large ruminant were given first priority in supplementation with hora compared to other livestock. Interviewed farmers trekked their animals a distance of 6.5±0.2 km to hora during dry season twice a year. The majority of the farmers (68.1%) perceived that hora supplementation enhanced animal performance in terms of production, reproduction, health, while around 35.1% reported abortions, birth defects, delayed puberty, decreased conception rate and paralysis as perceived negative impacts of excessive consumption of hora on animals. This study indicates that hora provide a perceived vital source of natural mineral supplement to improve livestock productivity and health in the study area. Thus, there is a need for better management and conservation of hora for optimum and sustainable utilization and adequate supplementation to alleviate the negative impacts associated with excessive consumption. Moreover, to support local farmers' perceptions regarding the importance of hora mineral water in animal nutrition and health, further research is needed to determine mineral composition of hora and livestock responses under controlled feeding trials.
Keywords: Ethiopia; farmers' perceptions; feed resources; *hora*; surrounding soil

ADDRESSING FOOD INSECURITY: IMPLEMENTING SUSTAINABLE AGRICULTURAL POLICIES TO COMBAT HUNGER IN NIGERIA ADEMOLA

Olaitan IDOWU
Department of Curriculum & Instructions Alvan-Ikoku University of Education, Owerri
Email: adexventures03@gmail.com

Hadejia ISAH FATI
Department of Curriculum & Instructions College of Education and Legal Studies, Ringim
Email: fatiihadejia@gmail.com

Oyewale FELICIA
Department of General Studies Federal College of Education, Zaria Kaduna State
Email: feiciaoyewale1001@gmail.com

ABSTRACT
Food insecurity remains a pressing challenge in Nigeria, with millions of people facing hunger and malnutrition due to various socio-economic and environmental factors. This research aims to explore the potential of implementing sustainable agricultural policies as a strategy to combat hunger in Nigeria. By analyzing existing literature, policy documents, and case studies, this study investigates the effectiveness of sustainable agricultural practices in enhancing food production, improving food access, and promoting nutritional security in the Nigerian context. The research examines key components of sustainable agricultural policies, including agroecology, smallholder farming, crop diversification, land reform, and access to resources and markets. It assesses the impact of these policies on food security indicators, such as crop yields, dietary diversity, household income, and resilience to climate change and other shocks. Additionally, the study investigates the challenges and opportunities associated with implementing sustainable agricultural policies in Nigeria, considering factors such as institutional capacity, political will, stakeholder engagement, and resource allocation. Through a multidisciplinary approach that integrates insights from agriculture, economics, environmental science, and public policy, this research aims to provide evidence-based recommendations for policymakers, practitioners, and stakeholders involved in addressing food insecurity in Nigeria. By promoting sustainable agricultural practices and policies, it is possible to improve food production, ensure equitable access to nutritious food, and enhance the overall well-being of Nigeria's population, contributing to the achievement of national and global food security goals.
Keywords: Agricultural Policies, Combat Hunger and Food Insecurity

AKKARMAN IRKI KOYUNLARDA ANOGENITAL MESAFE VE KLITORIS UZUNLUĞUNUN KAREKTERIZASYONU VE FERTILITE İLE İLİŞKİSİ

Dr. Öğr. Üyesi Metehan KUTLU (ORCID: 0000-0002-1782-583X)
Necmettin Erbakan University, Faculty of Veterinary Medicine, Department of Obstetrics and Gynaecology, Konya-Türkiye
Email: metehan.kutlu@erbakan.edu.tr (Responsible Author)

Dr. Öğr. Üyesi Neffel Kürşat AKBULUT (ORCID: 0000-0003-3853-9960)
Necmettin Erbakan University, Faculty of Veterinary Medicine, Department of Obstetrics and Gynaecology, Konya-Türkiye
Email: nkakbulut@gmail.com

ÖZET
Sunulan çalışmada, üreme mevsimi içerisinde östrüsları senkronize edilen Akkaraman ırkı koyunlarda anogenital mesafe ve klitoris uzunluğunun karekterizasyonu ve fertilite ile ilişkisi ortaya koymak amaçlanmıştır. Çalışmada 61 baş Akkaraman ırkı koyun kullanıldı. Sünger uygulanmadan önce tüm koyunların anogenital mesafe (AGD) ve klitoris (CLTRS) uzunluğu dijital kumpasla ölçülerek kaydedildi. Her bir parametre için kısa AGD ve uzun AGD, kısa CLTRS ve uzun CLTRS grupları olmak üzere kategorilere ayrıldı. Bu koyunlara 0. gün intravajinal 60 mg medroksiprogesteron asetat içeren sünger uygulandı, süngerler 7 gün süreyle vajinada tutuldu. Tüm koyunlarda uygulamanın yedinci günü süngerler çıkarıldı ve sünger çıkarılması anında 500 IU dozda eCG uygulandı. Östrüs tespiti süngerlerin çıkartılmasından 12 saat sonra başlanarak sabah ve akşam 2 arama koçunun sürüye katılması ile gerçekleştirildi. Östrüste olduğu tespit edilen koyunlar elde aşım yöntemiyle (koç/koyun oranı: 1/6) fertil koçlardan bir tanesi ile çiftleştirildi. Koç katımından sonraki 50. günde çiftleşen hayvanlara ultrasonografik gebelik muayenesi yapıldı. AGD Kısa, AGD Uzun, CLTRS Kısa ve CLTRS Uzun gruplarında sırasıyla östrüs oranı %96.8, %90, %96,9 ve %89.7, konsepsiyon oranı %53.4, %63, %58.1 ve %57.7, gebelik oranı %51.6, %56.7, %56.2 ve %51,7 olarak hesaplandı. Yapılan istatistiksel analiz sonrası gruplar arasında takip edilen parametreler arasında önemli bir fark saptanmadı ($p>0,05$). Sonuç olarak üreme mevsimi içerisinde progestagen uygulamaları ile östrüsları senkronize edilen Akkaraman ırkı koyunlarda anogenital mesafenin ve klitoris uzunluğunun fertilite üzerine farklılık yaratmadığı görüldü. Akkaraman ırkı koyunlarda anogenital mesafe ve klitoris uzunluğunun karekterizasyonu ve fertilite ile ilişkisinin açıkça ortaya konulabilmesi için daha ayrıntılı çalışmalara ihtiyaç olduğu düşünülmektedir.
Anahtar Kelimeler: Anogenital mesafe, fertilite, klitoris, koyun, reprodüktif parametreler

CHARACTERIZATION OF ANOGENITAL DISTANCE AND CLITORIS LENGTH IN AKKARMAN EWES AND THEIR RELATIONSHIP WITH FERTILITY

ABSTRACT

In the presented study, it was aimed to reveal the characterization of anogenital distance and clitoris length and their relationship with fertility in Akkaraman ewes whose estrus was synchronized during the breeding season. 61 heads of Akkaraman ewes used in the study. Before the sponge was applied, the anogenital distance (AGD) and clitoris (CLTRS) length of all ewes were measured and recorded with a digital caliper. For each parameter, they were divided into categories: short AGD and long AGD, short CLTRS and long CLTRS groups. A sponge containing 60 mg medroxyprogesterone acetate was applied intravaginally to these ewes on day 0, and the sponges were kept in the vagina for 7 days. On the seventh day of application, sponges were removed in all ewes, and eCG was administered at a dose of 500 IU at the time of sponge removal. The estrus detection was initiated 12 hours after the removal of sponges and conducted with the participation of two teaser rams in the morning and evening. Ewes on estrus were hand mated with one of the proven rams (ram:ewe ratio of 1:6). Ultrasonographic pregnancy examination was performed on the mated animals on the 50th day after the mating of the ram. In the short AGD, long AGD, short CLTRS and long CLTRS groups, the estrus rate was calculated 96.8%, 90%, 96.9% and 89.7%, the conception rate was calculated 53.4%, 63%, 58.1% and 57.7%, the pregnancy rate was calculated 51.6%, 56.7%, 56.2% and 51.7%, respectively. After the statistical analysis, no significant difference was detected in the parameters monitored between the groups ($p>0,05$). It was concluded that anogenital distance and clitoris length did not make a difference on fertility in Akkaraman ewes whose estrus was synchronized with progestagen applications during the breeding season. It is thought that more detailed studies are needed to clearly demonstrate the characterization of anogenital distance and clitoris length and its relationship with fertility in Akkaraman ewes.

Keywords: Anogenital distance, clitoris, ewe, fertility, reproductive parameters

TÜRKİYE'DE BİR TAVUKTA (*Gallus gallus domesticus* Linnaeus, 1758) İLK *Menacanthus pallidulus* (Neumann, 1912) (PHTHIRAPTERA: AMBLYCERA: MENOPONIDAE) OLGUSU

Fatma Nuray ŞİMŞEK* (ORCID: 0000-0002-2021-3930)
Hatay Mustafa Kemal University, Faculty of Veterinary Medicine, Department of Parasitology, Hatay, Türkiye
Email: fatmanuraysimsek@gmail.com

Research Asist. İpek ERDEM (ORCID: 0000-0002-0086-8294)
Hatay Mustafa Kemal University, Faculty of Veterinary Medicine, Department of Parasitology, Hatay, Türkiye
Email: ipekerdem@mku.edu.tr

Asst. Prof. Dr. Aykut ZEREK (ORCID: 0000-0002-8533-387X)
Hatay Mustafa Kemal University, Faculty of Veterinary Medicine, Department of Parasitology, Hatay, Türkiye
Email: aykutzerek@mku.edu.tr

Prof. Dr. Bilal DİK (ORCID: 0000-0002-7553-5611)
Selcuk University, Faculty of Veterinary Medicine, Department of Parasitology, Konya, Türkiye
Email: bdik@selcuk.edu.tr

Prof. Dr. Mehmet YAMAN (ORCID: 0000-0001-5399-8060)
Hatay Mustafa Kemal University, Faculty of Veterinary Medicine, Department of Parasitology, Hatay, Türkiye
Email: mehmetyaman21@hotmail.com

ÖZET

Ektoparazit enfestasyonları kümes hayvanlarını doğrudan ve dolaylı olarak birçok yönden etkilemektedir. Bunlar arasında bitler yüksek adaptasyon yeteneğine sahip olmakla birlikte, sık enfestasyon yapmaları ve ekonomik kayba yol açmaları sebebiyle hem ticari hem de küçük ölçekli kanatlı yetiştiricileri için önemli bir problemdir. Bitler bütün gelişim safhalarını konaklarının kıl ve tüyleri üzerinde geçiren daimi, zorunlu ektoparazitlerdir. Tüy ve yapağı ile beslenmeleri sebebiyle çiğneyici bitler anlamına gelen Mallophagalar kanatlılar için oldukça önemli olmakla birlikte evcil hayvanlar arasında en çok tavuklarda sorun oluşturmaktadırlar. Yüksek nem, kalabalık yetiştiricilik ve zayıf hijyen koşullarının yaygın olduğu kümes gibi ortamlarda yetiştirilmeleri buna zemin oluşturmaktadır. Enfeste kanatlılarda deri tahrişi, huzursuzluk, kilo kaybı, yem tüketimi ve yumurta üretiminde azalmaya, sekonder enfeksiyonlara neden olabilecek deri lezyonlarına ve ağır bit enfestasyonu durumunda civcivlerde ölüme neden olabilirler. *Menacanthus pallidulus* (Neumann, 1912), kümes hayvanları dahil pek çok kanatlıda görülmektedir. *Menacanthus* türleri kuşların ve özellikle de kümes hayvanlarının göğüs, uyluk ve kloaka çevresinde bulunmaktadır. *Passeriformes* (Ötücü kuşlar) takımındaki kuşlarda oldukça yaygın olarak görülen bu türler, *Galliformes* (Tavuksular) takımındaki,

Gallus gallus (Kırmızı orman tavuğu), *Gallus sonneratii* (Gri orman tavuğu), *Bambusicola thoracica* (Çin bambu kekliği) vb. kümes hayvanlarında da görülmektedir. Bu çalışmanın materyalini oluşturan bit örnekleri, Hatay Mustafa Kemal Üniversitesi (HMKÜ) Veteriner Fakültesi öğrencilerine verilen ödev sonucu elde edilmiştir. Tavuktan toplanan beş adet (4♀ 1♂) bit örneği %70'lik alkol bulunan bir tüpe konularak tür teşhisi amacıyla Selçuk Üniversitesi Veteriner Fakültesi, Parazitoloji Anabilim Dalı'na gönderilmiştir. Yirmidört saat boyunca %10'luk KOH'de saydamlaşmaları sağlanan örnekler Kanada balsam ile lam üzerine sabitlenmiştir. Mikroskopta incelenen bitler ilgili literatürler yardımıyla *M. pallidulus* olarak teşhis edilmiştir. Böylece bu çalışma ile evcil tavukta saptanan *M. pallidulus*'un, Türkiye'deki varlığı ilk kez kaydedilmiştir. Bu bildiride Hatay ilinde evcil bir tavukta bulunan *M. pallidulus*'un erkek ve dişileri hakkında morfolojik bilgiler verilecektir.

Anahtar Kelimeler: Bit, *Menacanthus pallidulus*, evcil tavuk, Türkiye

THE FIRST CASE OF *Menacanthus pallidulus* (Neumann, 1912) (PHTHIRAPTERA: AMBLYCERA: MENOPONIDAE) ON A CHICKEN (*Gallus gallus domesticus* Linnaeus, 1758) IN TÜRKİYE

ABSTRACT

Ectoparasite infestations affect poultry directly and indirectly in many ways. Among these, lice are highly adaptable, but they are an important problem for both commercial and small-scale poultry breeders because they infest frequently and cause economic losses. Lice are permanent, obligate ectoparasites that spend all their development stages on the hair and feathers of their hosts. Mallophagas, which means chewing lice because they feed on feathers and fleece, are very important for poultry, but they cause the most problems in chickens among domestic animals. This is because they are raised in environments such as coops where high humidity, crowded rearing and poor hygiene conditions are common. In infested birds, they can cause skin irritation, restlessness, weight loss, decrease in feed consumption and egg production, skin lesions that may cause secondary infections, and in case of severe lice infestation, death in chicks. *Menacanthus pallidulus* (Neumann, 1912), is seen on many birds, including poultry. *Menacanthus* species are found around the chest, thighs and cloaca of birds, especially poultry. These species, which are mostly common on birds in the order *Passeriformes* (songbirds), are also seen in poultry in the order *Galliformes* (landfowl), such as *Gallus gallus* (red junglefowl), *Gallus sonneratii* (gray junglefowl), *Bambusicola thoracica* (chinese bamboo partridge). The louse specimens that constitute the material of this study were obtained as a result of the homework given to the students of Hatay Mustafa Kemal University, Faculty of Veterinary Medicine. Five louse samples (4♀ 1♂) collected from the chicken were preserved in a tube containing 70% alcohol and sent to Selçuk University, Faculty of Veterinary Medicine, Department of Parasitology for identification of species. The samples were cleared in 10% KOH for 24 hours, then fixed on the slides with Canada balsam. The lice examined under the microscope were identified as *M. pallidulus* according to the relevant literatures. Thus, with this study, the presence of *M. pallidulus* on domestic chickens was recorded for the first time in Türkiye. In this paper, morphological information about the males and females of *M. pallidulus* found on a domestic chicken in Hatay province will be given.

Keywords: Louse, *Menacanthus pallidulus*, domestic chicken, Türkiye

BATMAN İLİ KÖPEKLERİNDE *Cryptosporidium* spp., ve *Giardia duodenalis* PREVALANSI VE GENOTİPLERİNİN ARAŞTIRILMASI

Doç. Dr. Burçak ASLAN ÇELİK* (ORCID: 0000-0002-0130-970X)
Siirt University, Faculty of Veterinary Medicine, Department of Parasitology, Siirt-Türkiye
Email: burcakaslan@siirt.edu.tr

Rıdvan YILMAZ (ORCID: 0009-0004-4004-7038)
Siirt University, Faculty of Veterinary Medicine, Siirt-Türkiye
Email: ridvanyilmaz1403@gmail.com

Tacettin ÇİFTÇİ (ORCID: 0009-0000-0029-5548)
Siirt University, Faculty of Veterinary Medicine, Siirt-Türkiye
Email: tacettin0104ciftci@gmail.com

Doç. Dr. Özgür Yaşar ÇELİK (ORCID: 0000-0001-6365-2688)
Siirt University, Faculty of Veterinary Medicine, Department of Internal Medicine, Siirt-Türkiye
Email: oyc@siirt.edu.tr

Doç. Dr. Adnan AYAN (ORCID: 0000-0002-6564-3416)
Van Yüzüncü Yıl University, Faculty of Veterinary Medicine, Department of Genetic, Van-Türkiye
Email: oyc@siirt.edu.tr

Doç. Dr. Özlem ORUNÇ KILINÇ (ORCID: 0000-0001-6233-7109)
Van Yüzüncü Yıl University, Özalp Vocational School, Van -Türkiye
Email: ozlemkilinc@yyu.edu.tr

Doç. Dr. Gürkan AKYILDIZ (ORCID: 0000-0002-8610-5174)
Marmara University, Faculty of Health Sciences, Department of Basic Health Sciences, İstanbul-Türkiye
Email: gurkanakyildiz@windowslive.com

Doç. Dr. Kerem ERCAN (ORCID: 0000-0003-4914-8578)
Siirt University, Faculty of Veterinary Medicine, Department of Internal Medicine, Siirt-Türkiye
Email: kerem.ercan@siirt.edu.tr

Doç. Dr. Özge OKTAY AYAN (ORCID: 0000-0003-2577-3774)
Van Yüzüncü Yıl University, Faculty of Medicine, Department of Parasitology, Van -Türkiye
Email: ozgeokty09@gmail.com

ÖZET
Cryptosporidium spp. ve *Giardia duodenalis* insanlarda ve bir çok memeli hayvanda görülen ishal ile ilişkili, fırsatçı zoonotik protozoan parazitlerdir. Bu çalışmanın amacı

Batman ili sokak köpeklerinde *Cryptosporidium* spp., ve *Giardia duodenalis* yaygınlığının ve genotiplerinin belirlenmesi amaçlanmıştır. Çalışmanın hayvan materyalini farklı ırk ve cinsiyette toplam 100 barınak köpeği oluşturdu. Köpeklerden alınan taze dışkı örnekleri *Cryptosporidium* spp. yönünden Kinyoun Asit Fast boyama, Giardia yönünden natif-lugol yöntemi ile mikroskop altında incelendi. Daha sonra DNA ekstraksiyonu, Nested PCR analizi ve sekans analizi gerçekleştirildi. Yapılan analizler sonucunda *Cryptosporidium* spp., yönünden tüm örnekler negatif tespit edilirken, Giardia duodenalis bir yaşından küçük iki dişi köpekte %2 oranında pozitiflik tespit edildi. PCR pozitif örneklerin sekans analizleri sonucunda örneklerin asemblaj C ve D örnekleri ile örtüştüğü görüldü. Elde edilen bu sonuçlar Batman ili sokak köpeklerinin *Cryptosporidium* spp. ve *Giardia duodenalis* yönünden insanlar için bir risk taşımadığını gösterse de bu parazitlerin insanlara bulaşmasındaki olası rollerini belirlemek için mümkün olduğunca tekrarlanan dışkı muayeneleri yapılması önerilmektedir.
Anahtar Kelimeler: Cryptosporidium spp., Giardia duodenalis, Assemblage, Moleküler analiz, Batman, Türkiye

Bu çalışma TÜBİTAK-2209A projeleri kapsamında desteklenmiştir (Proje no: 1919B012112193 ve 1919B012109448).

A SURVEY OF THE PREVALENCE AND GENOTYPES OF *Cryptosporidium* SPP., AND *Giardia duodenalis* IN SHELTER DOG IN BATMAN, TURKEY

ABSTRACT

Cryptosporidium spp. and Giardia duodenalis are opportunistic zoonotic protozoan parasites related to diarrhea in humans and many mammals. This study aimed to determine the prevalence and genotypes of Cryptosporidium spp. and Giardia duodenalis in shelter dogs in Batman province. The animal material of the study consisted of 100 dogs of different breeds and sexes. Fresh fecal samples taken from the dogs were examined under the microscope by Kinyoun Acid Fast staining for Cryptosporidium spp. and by the native-Lugol method for Giardia. DNA extraction, nested PCR analysis, and sequence analysis were then performed. As a result of the analyses, all samples were negative for Cryptosporidium spp., while Giardia duodenalis was positive in 2% of two female dogs less than one-year-old. Sequence analyses of PCR-positive samples showed that the samples overlapped with assemblage C and D samples. Although these results show that shelter dogs in Batman province do not carry a risk for humans in terms of Cryptosporidium spp. and Giardia duodenalis, it is recommended that repeated fecal examinations should be carried out as much as possible to determine the possible role of these parasites in human transmission.

Keywords: *Cryptosporidium* spp., *Giardia duodenalis,* Assemblage, Molecular analysis, Batman, Turkey

DİYARBAKIR'IN DİCLE VE HANİ İLÇELERİNDEKİ KÖPEKLERDE LEISHMANIASIS YAYGINLIĞI

Doç. Dr. Özgür Yaşar ÇELİK* (ORCID: 0000-0001-6365-2688)
Siirt University, Faculty of Veterinary Medicine, Department of Internal Medicine, Siirt-Türkiye
Email: oyc@siirt.edu.tr

Prof. Dr. Servet SEKİN
Dicle University, Faculty of Veterinary Medicine, Department of Internal Medicine, Diyarbakır-Türkiye

ÖZET
Leishmaniasis, Phlebotominae sineklerinin kan emerken bulaştırdıkları, memelilerin zorunlu hücre parazitleri olan Leishmania türleri tarafından meydana getirilen, insan ve hayvanlarda ölümcül olabilen paraziter bir hastalıktır. Bu çalışmada Diyarbakır 'ın Dicle ilçesine bağlı Dede ve Durabeyli köyleri ile Hani ilçesine bağlı Sergen ve Çardaklı köylerinde, visseral leishmaniasis'in en önemli rezervuarı durumunda olan köpeklerde canin leishmaniasis seroprevalansının belirlenmesi amaçlanmıştır. Çalışmanın hayvan materyalini toplam 120 köpek oluşturdu. Köpeklerin Veca sephalica antebrachiumundan alınan kan örnekleri immunokromatografik test, Indirect immunofluorescent antibody test (IFAT) ve Polimerase Chain Reaction (PCR) yöntemleriyle incelendi. Araştırma sonucunda örneklerin hiçbirinde seropozitiflik saptanmamıştır. Hastalığın zoonotik yönü ve tehlikesi göz önüne alındığında sahipsiz ve başıboş köpekleri de içerecek şekilde daha geniş popülasyonda araştırma yapılmasının uygun olacağı düşünülmektedir.
Anahtar Kelimeler: Lesihmania, immunokromatografi, IFAT, PCR, Köpek, Diyarbakır

Bu bildiri Dicle Üniversitesi Bilimsel Araştırma Projeleri Koordinatörlüğü tarafından 12-VF-85 koduyla desteklenen projenden üretilmiştir.

THE PREVALENCE OF LEISHMANIASIS IN DOGS IN DICLE AND HANI DISTRICTS OF DIYARBAKIR

ABSTRACT
Leishmaniasis is a fatal parasitic disease of humans and animals caused by Leishmania species, which are obligate cell parasites of mammals and transmitted by Phlebotominae flies while sucking blood. In this study, it was aimed to determine the seroprevalence of canine leishmaniasis in dogs, which are the most important reservoir of visceral leishmaniasis, in Dede and Durabeyli villages of Dicle district and Sergen and Çardaklı villages of Hani district of Diyarbakır. A total of 120 dogs constituted the animal material of the study. Blood samples taken from the Veca sephalica antebrachium of the dogs were analyzed by immunochromatographic test, Indirect immunofluorescent antibody test (IFAT) and Polymerase Chain Reaction (PCR) methods. No seropositivity was detected in any of the samples. Considering the zoonotic aspect and danger of the disease, it is thought that it would be appropriate to conduct research in a larger population including stray and stray dogs.
Keywords: Lesihmania, immunochromatography, IFAT, PCR, Dog, Diyarbakır

INSECTICIDAL PROPERTIES OF CHEMICALLY CHARACTERIZED ESSENTIAL OILS EXTRACTED FROM MOROCCAN *Mentha longifolia*: *IN VITRO* AND *IN SILICO* ANALYSIS

Meryem TOURABI
Alvan-Ikoku University of Education

ABSTRACT
The present study aimed to explore the phytochemical profile, and evaluate the insecticidal properties, of Moroccan *Mentha longifolia* L. essential oil (ML-EO) using in vitro and in silico assays. Noteworthily, as chromatography (GC-MS/MS) revealed that ML-EO is majorly composed of piperitenone oxide (53.43%), caryophyllene (20.02%), and (-) germacrene D (16.53%). It possesses excellent insecticidal activity, a dose of 20 µL/mL produced a complete reduction in fecundity, fertility, and emergence of adult *C. maculatus* with mortality rates reaching 100%. In silico results showed that the antioxidant activity is mostly attributed to α-Cadinol, the antibacterial efficiency is attributed to piperitenone oxide, and antifungal capacity is related to cis- Muurola-4(15),5-diene and piperitenone oxide. Accordingly, ML-EO has high potential to be used as an alternative for preserving food and stored grain and protecting them against insect pests in the food and pharmaceutical sectors.
Keywords: *Mentha longifolia,* α-Cadinol, ML-EO

EVALUATION OF GROUNDWATER QUALITY IN SOME AREAS NEAR THE NAJAF SEA / IRAQ

Zainab Hussain ABDULSHAHEED
Department of Ecology, Faculty of Science, University of Kufa, Najaf, Iraq

Mohanad Hazim HALBOOS*
Department of Ecology, Faculty of Science, University of Kufa, Najaf, Iraq
Email: muhaned.halbus@uokufa.edu.iq

ABSTRACT
Our research goal was to thoroughly analyze major heavy metals and common water quality parameters at 50 different sampling sites across Najaf Governorate, incorporating both agricultural and urban areas to cover a representative portion of this vital groundwater source. Heavy metals quantified through robust ICP-MS analysis included lead, cadmium, nickel, chromium, cobalt, copper, and manganese. Lead contamination was extensive, with 75% of samples exceeding WHO & Iraq guidelines (25 µg/L) by 10 to 35 times at certain urban hotspots. Mean lead levels were the highest ever reported for Najaf at 145 µg/L indicating alarming pollution mainly attributable to municipal waste dumping. Salinity indicators like chloride, hardness, and TDS levels were also consistently above drinking water norms due to naturally high backgrounds combined with impacts of untreated effluents from increasing population clusters. 60% of sites had salinity over 3 times the palatability threshold. Worryingly, coliform bacteria counts substantiated extensive sewage and organic waste contamination. Unsafe levels were discovered in the vicinity of Najaf city as well as some adjoining rural areas with 90% of samples being unfit for direct usage without disinfection. This first systematic analysis indicates extremely heavy contamination of Najaf's vital groundwater reserves by trace metals and microbial agents - calling for urgent measures including source remediation, regulated waste dumping, water treatment before utility supply distribution & community awareness programs to aid conservation.
Keywords: TDS, Najaf, ICP-MS

HARNESSING BIOTECHNOLOGY FOR SUSTAINABLE FOOD PRODUCTION

Kaviya R.
R.M.K. Engineering College, Student, Information technology, Chennai, India.
Email: 1230307.it@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in, 9176968595

ABSTRACT
Agricultural biotechnology is a multidisciplinary field that applies principles of biology and technology to enhance agricultural productivity, sustainability, and food security. This technology involves the use of genetic engineering, molecular biology, and other advanced techniques to develop crops with desirable traits such as resistance to pests and diseases, tolerance to environmental stresses, and improved nutritional content. One of the key areas of focus in agricultural biotechnology is the development of genetically modified (GM) crops. GM crops are engineered to express specific traits that confer advantages such as increased yield, reduced pesticide use, and enhanced nutritional value. For example, scientists have developed GM crops that are resistant to herbicides, allowing farmers to control weeds more effectively without harming the crop plants. Another important application of agricultural biotechnology is the development of genetically modified organisms (GMOs) for animal agriculture. GMOs can be engineered to produce pharmaceuticals, vaccines, or other valuable products in their milk, eggs, or meat. Additionally, GMOs can be used to improve animal health and welfare by reducing the incidence of diseases and improving the efficiency of feed conversion. In addition to genetic engineering, agricultural biotechnology also encompasses other technologies such as markerassisted breeding, tissue culture, and nanotechnology. These technologies enable scientists to accelerate the breeding process, develop disease-resistant varieties, and improve the efficiency of nutrient uptake in plants. Overall, agricultural biotechnology holds great promise for addressing some of the most pressing challenges facing modern agriculture, including the need to feed a growing global population while minimizing environmental impact. By harnessing the power of biotechnology, farmers can produce more food with fewer resources, reduce the use of chemical inputs, and mitigate the effects of climate change on agricultural production.
Keywords: Agriculture biotechnology, genetic engineering, genetically modified crops, sustainability, food security, pest resistance, environmental stresses, nutritional enhancement, marker-assisted breeding, animal agruculture.

BİR KEDİDE PERITONEOPERIKARDIAL DIAPHRAGMATIC HERNIA OLGUSU

Araş. Gör. Bahar ERDEN* (ORCID:0000-0002-8775-6673)
Siirt University, Faculty of Veterinary Medicine, Department of Surgery, Siirt-Türkiye
Email: bahar.erden@siirt.edu.tr

Doç. Dr. Mustafa Barış AKGÜL (ORCID: 0000-0002-9365-9925)
Siirt University, Faculty of Veterinary Medicine, Department of Surgery, Siirt-Türkiye
Email: mbarisakgul@siirt.edu.tr

Araş. Gör. Sevdet KILIÇ (ORCID: 0000-0003-1033-658X)
Siirt University, Faculty of Veterinary Medicine, Department of Surgery, Siirt-Türkiye
Email: sevdet.kilic@siirt.edu.tr

ÖZET
Bu olgu sunumu, 2,5 yaşlı, dişi, British Shorthair ırkı bir kedi oluşturmaktadır. Hasta bir ay önce özel bir klinikte kısırlaştırma operasyonu geçirilmiş. Yara hattıyla ilgili oluşan komplikasyon nedeniyle toraks grafisi çekilmiş ve tesadüfen kalbin normalden daha büyük olduğu saptanmıştır. Özel klinikteki veteriner hekim tarafından Siirt Üniversitesi Araştırma ve Uygulama Hastanesine cerrahi kliniğine sevk edilmiştir. Yapılan genel, elektroradyografik, hematolojik radyografik ve ultrasonografik muayeneler sonucunda hastaya peritoneoperikardial diaphragmatic hernia tanısı konulmuştur. Operasyon kararı verilen hastada preanestezik dönemde 2 saat boyunca preoksijenizasyon antibiyoterapi başlandı. Genel anesteziye alınan hasta entübe edilerek kapalı devre anestezi cihazıyla idamesi sağlandı. Tekniğine uygun olarak operasyon bölgesinin aseptiğinin sağlanması ardından preumbilikal median laparotomi işlemi gerçekleştirildi. Orta hatta bulunan eliptik şekilde diyafram yırtığında karaciğerin ve ince bağırsakların büyük bölümü omentum dahil fıtıklaştığı saptandı. Dikkatli bir şekilde yavaş manipülasyonlarla bağırsak segmentleri abdomen boşluğa alındı. Ardından karaciğerin büyük bir kısmının perikard dokusuna adezyonu tespit edildi. Küt diseksiyonlarla adezyonlar giderildi. Karaciğer dahil olmak üzere tüm fıtıklaşan organlar abdomen boşluğa alınmış oldu. Diyaframın dikiş uygulanacak yara hattı kürete edildi ve monoflament dikiş materyali ile basit sürekli dikiş yöntemiyle onarıldı. Karın duvarı, deri altı bağ doku ve deri tekniğine uygun şekilde kapatıldı. Hastanın anestezi uyandırma esnasında kardiyopulmoner arrest gelişti. Yapılan tüm müdahalelere rağmen hasta ex oldu. Karşılaştığımız olguda olduğu gibi büyük miktarda abdomen organın geçtiği ve özellikle karaciğer dokusunun büyük miktarda adezyona uğradığı olgularda prognozu zayıf olduğu ve operatif gelişimin ölümle sonuçlanabileceği sonucuna varılmıştır.
Anahtar Kelimeler: Kedi, diyafram, fıtık

A CASE OF PERITONEOPERICARDIAL DIAPHRAGMATIC HERNIA IN A CAT

ABSTRACT

This case report is a 2.5 years old, female, British Shorthair cat. The patient underwent a neutering operation in a private clinic one month ago. Thoracic radiography was performed due to a complication related to the wound line and incidentally, it was found that the heart was larger than normal. She was referred to Siirt University Research and Application Hospital by the veterinarian in the private clinic to the surgery clinic. As a result of general, electroradiographic, haematological, radiographic and ultrasonographic examinations, peritoneopericardial diaphragmatic hernia was diagnosed. Preoxygenation antibiotherapy was started for 2 hours in the preanaesthetic period. The patient was placed under general anaesthesia, intubated and maintained with a closed circuit anaesthesia device. Preumbilical median laparotomy was performed after asepticisation of the operation area in accordance with the technique. In the elliptical diaphragmatic rupture in the midline, it was found that most of the liver and small intestines including the omentum were herniated. Intestinal segments were removed into the abdominal cavity with careful slow manipulations. Subsequently, adhesion of a large part of the liver to the pericardial tissue was detected. Adhesions were removed by blunt dissections. All herniated organs including the liver were removed into the abdominal cavity. The wound line of the diaphragm to be sutured was curetted and repaired by simple continuous suturing with monoflament suture material. The abdominal wall, subcutaneous connective tissue and skin were closed according to the technique. Cardiopulmonary arrest developed during awakening from anaesthesia. Despite all interventions, the patient died. It is concluded that the prognosis is poor and operative development may result in death in cases such as the case we encountered in which a large amount of abdominal organs pass through and especially the liver tissue is adhered in large amounts.

Keywords: Cat, diaphragm, hernia

DENEYSEL HAYVAN MODELLEMELERİNDE SEKSÜEL DIMORPHISM

Dr. Yasemin ÜSTÜNDAĞ* (ORCID: 0000-0002-8836-0371)
Dokuz Eylül University, Faculty of Veterinary, Department of Anatomy, İzmir-Türkiye
Email: yasemin.ustundag@deu.edu.tr

Dr. Mehmet KARTAL (ORCID: 0000-0001-7364-0875)
Istanbul Gelişim University, Faculty of Health Science, İstanbul-Türkiye
Email: mkartal@gelisim.edu.tr

ÖZET
Hayvan modeli terimi, insan hastalıklarını araştırmak amacıyla bilimsel araştırmalar sırasında kullanılan canlı, insan olmayan bir hayvanı tanımlar. Bir hayvan modelini içeren araştırmanın amaçları, hastalıkta normal biyolojik süreçlerin nasıl değiştiğini anlamak için temel araştırmalardan, potansiyel bir tedavinin etkinliğinin test edildiği çalışmalara kadar uzanmaktadır. Araştırmada kullanılan birçok farklı hayvan modeli türü vardır ve bunlar insan durumunu tam olarak yansıtmasa da yine de ilgili biyolojiye ilişkin önemli bilgiler sağlayabilir. Ancak aynı türün bireylerinin üreme ile doğrudan ilgisi olmayan morfolojik özelliklerde farklılık gösterdiği seksüel dimorfizm, araştırmacılar tarafından göz ardı edilebilmektedir. Bu durum cinsiyetler arasındaki gerek morfolojik, gerek fizyolojik farklılardan dolayı çalışmanın sonucu değiştirebilmektedir. Tarihsel olarak, hayvan çalışmalarına bakıldığında her iki cinsiyetin yanlış kullanımı yanıltıcı veya eksik sonuçlara yol açmıştır. Yapılan çalışmanın amacı, gelecekte tasarlanacak çalışmalar için, doğru hayvan seçimi kadar cinsiyetin de önemli olduğunu vurgulamaktır. Çünkü erkek ve dişi hayvanlar arasında fizyolojik farklılıklar bulunur. Örneğin, hormonal profiller, metabolik aktiviteler ve organ boyutları cinsiyete bağlı olarak değişebilir. Bu farklılıklar, deney sonuçlarını etkileyebilir çünkü bir ilacın veya tedavi yönteminin farklı cinsiyetler üzerinde farklı etkilere sahip olabileceği anlamına gelir. Literatüre bakıldığında, cinsiyetin astım, artritis, kardiyovasküler hastalıklar, otoimmun hastalıklar, gibi birçok hastalığın yaygınlığını, şiddetini ve seyrini değiştirdiği görülmektedir. Aynı şekilde deneysel çalışmalarda tek cinsiyet kullanımı da çalışmaların doğru şekilde yorumlanmasını önemli ölçüde değiştirmektedir. Bu nedenle, cinsiyet farklılıkları, özellikle hastalık fenotipi, mekanizmaları ve ilaç testi alanındaki çalışmalarda, hayvan modelleri kullanılarak yapılan gelecekteki çalışmalarda ve insan popülasyonlarında potansiyel bir etkileyici faktör olarak düşünülmelidir. Bu yaklaşım, araştırmacıların daha kapsamlı bir anlayışa ulaşmalarına ve hastalıkların tedavisi veya önlenmesi için daha etkili stratejiler geliştirmelerine yardımcı olabilir.
Anahtar Kelimeler: Hayvan modellemeleri, insan hastalıkları, seksüel dimorfizm

SEXUAL DIMORPHISM IN EXPERIMENTAL ANIMAL MODELING

ABSTRACT

The term “animal model” describes a living, non-human animal used during scientific research to study human diseases. The objectives of research involving an animal model range from basic research to understand how normal biological processes change in disease, to studies where the effectiveness of a potential treatment is tested. There are many different types of animal models used in research, which may not fully reflect the human condition. However, sexual dimorphism, where individuals of the same species show differences in morphological characteristics not directly related to reproduction, can be undererstimated by researchers. This situation can change the outcome of the study due to both morphological and physiological differences between genders. Historically, looking at animal studies, the misuse of both genders has led to misleading or incomplete results. The purpose of the study is to emphasize that gender is as important as the correct animal selection for future studies to be designed. Because there are physiological differences between male and female animals. For example, hormonal profiles, metabolic activities, and organ sizes can vary depending on gender. These differences can affect the results of the experiment because it means that a drug or treatment method can have different effects on different genders. Looking at the literature, it is seen that gender changes the prevalence, severity, and course of many diseases such as asthma, arthritis, cardiovascular diseases, autoimmune diseases. Similarly, the use of a single gender in experimental studies also significantly changes the correct interpretation of the studies. Therefore, gender differences, especially in the field of disease phenotype, mechanisms, and drug testing, should be considered as a potential influencing factor in future studies using animal models and in human populations. This approach can help researchers reach a more comprehensive understanding and develop more effective strategies for the treatment or prevention of diseases.

Keywords: Animal models, human diseases, sexual dimorphism

SALDIRGAN KÖPEKLERDE SERATONİNİN ETKİLERİ

Dr. Yasemin ÜSTÜNDAĞ* (ORCID: 0000-0002-8836-0371)
Dokuz Eylül University, Faculty of Veterinary, Department of Anatomy, İzmir-Türkiye
Email: yasemin.ustundag@deu.edu.tr

Dr. Mehmet KARTAL (ORCID: 0000-0001-7364-0875)
Istanbul Gelişim University, Faculty of Health Science, İstanbul-Türkiye
Email: mkartal@gelisim.edu.tr

ÖZET
Saldırganlık, bireyin hayatta kalması ve yaşam bölgesini veya kaynaklarını koruması için gerekli ancak uygunsuz bir şekilde ifade edildiğinde yıkıcı olabilen karmaşık bir sosyal davranıştır. Köpeklerde saldırganlık ise sadece tür, ırk ve cinsiyet özelliklerine göre değerlendirmekten ziyade; agresyonun patofizyolojik süreçleri ve nörobiyolojisi de ele alınmalıdır. Bununla birlikte serotonerjik sistem ve hipotalamik-hipofiz-adrenal (HPA) ekseninin saldırganlığın kontrolünde önemli bir rol oynadığına inanılmaktadır. Yapmış olduğumuz çalışmamızda saldırgan köpeklerin kan ve idrar analaizleriyle vücuttaki serotonin seviyelerinin belirlenmesi amaçlanmıştır. Bu amaçla saldırgan olduğu bir saldırganlık testiyle belirlenen 7 saldırgan köpek ile, 7 sakin huylu köpekten kan ve idrar numuneleri alınmıştır. Alınan numunelerden serumdan seratonin, idaradan ise serotonin metaboliti olan 5-HIAA seviyeleri HPCL tekniğiyle belirlenmiştir. Elde verilen verilerin istatistiksel analizi IBM SPSS 29 programında yapılmıştır. İstatistiksel analiz için normallik analizi ve Independent Samples T Test'i kullanılmıştır. Seratoninin ve 5-HIAA'nın parametreleri saldırgan hayvanlarda, sakin hayvanlara göre normal referans değer aralığından daha düşük seviyede bulunmuştur. Ancak istatistiksel olarak iki grup arasında bir fark olmadığı görülmüştür. Seratonin reseptörlerinin beyindeki dağılımna bakıldığında en fazla koroid pleksüs, lateroseptal çekirdek, globus pallidus ve ventral pallidum, dentat girus, dorsal subikulum, substantia nigra, retiküler ve entorhinal korteksin dış katmanı, hipokampus'un farklı alanları (CA1-CA4), amigdaloid kompleks'in bazı çekirdekleri, hipotalamik çekirdekler ve dorsal rafé gibi limbik sistemi de kapsayan bölgelerde yoğun olduğu görülmüştür. Bu bölgelerden özellikle amigdala ve hipokampus saldırganlığın oluşunda rol alan birincil bölgelerdendir. Elde edilen bulgulara göre köpeklerde kan seratonin seviyelerinin düşük olması saldırganlığa yol açabilmektedir.
Anahtar Kelimeler: Hipokampus, köpek, saldırganlık, seratonin

THE EFFECTS OF SERATONIN IN AGGRESSIVE DOGS

ABSTRACT

Aggression is a complex social behavior necessary for an individual's survival and for protecting their territory or resources, but when expressed inappropriately, it can be destructive. In dogs, aggression should be evaluated not only based on species, breed, and gender characteristics but also considering the pathophysiological processes and neurobiology of aggression. It is believed that the serotonergic system and the hypothalamic-pituitary-adrenal (HPA) axis play important roles in the control of aggression. In our study, we aimed to determine the serotonin levels in the body through blood and urine analyses of aggressive dogs. For this purpose, blood and urine samples were collected from 7 aggressive dogs identified through an aggression test and 7 non-aggressive dogs. Serotonin levels from serum and the serotonin metabolite, 5-HIAA, from urine were determined using HPLC technique. Statistical analysis of the obtained data was performed using IBM SPSS 29 software, including normality analysis and Independent Samples T Test. Parameters of serotonin and 5-HIAA were found to be lower in aggressive dogs compared to non-aggressive dogs, but statistically, no difference was observed between the two groups. Examination of the distribution of serotonin receptors in the brain revealed high concentrations in areas including the choroid plexus, lateroseptal nucleus, globus pallidus and ventral pallidum, dentate gyrus, dorsal subiculum, substantia nigra, reticular and external layer of the entorhinal cortex, different fields of the hippocampus (CA1-CA4), some nuclei of the amygdaloid complex, hypothalamic nuclei, and the dorsal raphe, encompassing limbic system regions. Particularly, the amygdala and hippocampus are primary regions involved in the development of aggression. According to the findings, low blood serotonin levels in dogs may contribute to aggression.

Keywords: Aggression, dog, hippocampus, seratonin

EFFECT OF BANDITRY ACTIVITIES ON FOOD SECURITY IN SHIRORO LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA

Mohammed Mohammed NDAGI
Department of Public Administration, Ahmadu Bello University Zaria, Nigeria

Prof. Musa IDRIS
Department of Public Administration, Ahmadu Bello University Zaria, Nigeria

Abubakar Mohammed GOGA
Department of Public Administration, Ahmadu Bello University Zaria, Nigeria

Hudu ZARATOU
Department of Public Administration, Ahmadu Bello University Zaria, Nigeria

Abdul-hamidu ABDULLAHI
Department of Local Government & Development Studies, Ahmadu Bello University Zaria, Nigeria
Email: mohammedndagi004@gmail.com

ABSTRACT
The increasing wave of armed banditry in Nigeria in recent years has become worrisome. Factors ranging from cattle rustling, kidnapping, rape, assassination and the wanton destruction of lives and property, the high level of poverty, youth's unemployment and underemployment, illegal mining activities, drug abuse, corruption/greedy and limited security presence have been blamed for the incessant armed banditry in the country. This menace does not only pose a threat to national security but also threatens the prospects for food security in the country as it prevents both crop farming and cattle rearing activities. Thus, this study examines the effect of banditry activities on food security. The study is underpinned by Queer Ladder Theory (QLT). The survey research design was adopted, and data were collected from 422 samples of farmers in the Shiroro local government area using an adapted questionnaire. Results using Partial Least Squares Structural Equation Modeling (PLS-SEM) established that banditry activities have a significant nagative relationship with food security. However, Based on the study findings, the study recommended that government should provide a proactive measure from security personnel to curb the menace in the shiroro and the country in general and also government should adequately provide the required farming inputs to boost and revive the agricultural production which serve as the major source of income in the state, thereby mitigate the negative impact of banditry activities on the life of the affected communities. Finally, the study's limitations and suggestions for future research were given.
Keywords: Banditry and food security

OPTIMIZATION OF INCIDENTS IN THE IRRIGATION SYSTEM USING DLP – DATA LOSS PREVENTION PARACONSISTENT

Liliam Sayuri SAKAMOTO (ORCID: 0000-0001-8636-0100)
Paulista University, Production Engineering, Postgraduate Program, São Paulo, Brazil.
Email: liliam.sakamoto@gmail.com

Jair Minoro ABE **(ORCID: 0000-0003-2088-9065)**
Paulista University, Production Engineering, Postgraduate Program, São Paulo, Brazil.
Email: jairabe@uol.com.br

Jonatas Santos DE SOUZA (ORCID: 0000-0002-0052-0132)
Paulista University, Production Engineering, Postgraduate Program, São Paulo, Brazil.
Email: jonatas1516@gmail.com

Luiz Antonio DE LIMA (ORCID: 0000-0003-4228-2387)
Paulista University, Production Engineering, Postgraduate Program, São Paulo, Brazil.
Email: aula.prof.luiz@gmail.com

ABSTRACT
Although several disruptive technologies have been introduced to increase agricultural productivity, much of this information collected may not be properly used to optimize "Precision Agriculture". This work aimed to develop a Paraconsistent DLP tool linked to a Smart Garden System (an Open-Source Arduino platform linked to a soil moisture sensor) to make decisions about possible incidents that could impact production. The methodology used was the capture of this data by a tool with the first layer DLP – Data Loss Prevention developed in Python with a second layer using Paraconsistent Logic Annotated Evidential Eτ, which allowed reusing data that would otherwise be discarded and contributed to improving the project's knowledge. As a result, 39% of the data that would have been discarded in the first analysis, which tended to the objective of this work, was reused, making it possible to increase data capture and detailed analysis, optimizing the prior detection of possible incidents, such as lack of water or defects in irrigation equipment, as well as helping in the conscious use of resources. The purpose of this work was to create means to prevent possible incidents in agricultural production, understanding and reusing data that would be considered developing using the Paraconsistent DLP in the analysis of the Smart Garden System to support decision-making regarding possible incidents in the system. of irrigation.
Keywords: DLP – Data Loss Prevention; Irrigation system; Evidential Annotated Paraconsistent Logic Eτ.

BİR BUZAĞIDA KONJENİTAL GENERALİZE TÜBERKÜLOZİS OLGUSU

Ahmet UYAR (ORCID: 0000-0003-4345-6756)
Hatay Mustafa Kemal Üniversitesi, Veteriner Fakültesi, Patoloji Anabilimdalı, Hatay, Türkiye
Email: ahmetuyar@mku.edu.tr

ÖZET

Amaç: Tüberkülozis hem hayvan ve hem de halk sağlığını olumsuz yönde etkileyen, başta akciğer olmak üzere çeşitli organ ve dokularda kazeifikasyon ve kalsifikasyonla karakterize tüberküllerin oluşumuyla bilinen, kronik ve bulaşıcı özelliğe sahip oldukça önemli bakteriyel zoonoz bir hastalıktır. Bu bildiride bir buzağıda gözlenen eksudatif tip konjenital generalize tüberkülozis vakasının patolojik bulgularla sunulması amaçlandı.
Materyal ve yöntem: Bu olgunun materyalini bir buzağı oluşturdu. Anamnezde buzağının uzun süreli öksürük ve solunum güçlüğü nedeniyle tedavi gördüğü, ancak yapılan tedaviye cevap vermediği belirtildi. Buzağıya sistematik nekropsi yapılarak organ ve dokular makroskobik ve histopatolojik olarak incelendi. Bulgular: Makroskobik olarak akciğerin kaudal loblarının dorsoventral uç kısımları hariç olmak üzere tüm akciğere dağılmış kazeifikasyon ve kalsifikasyonla karakterize nodüller görüldü. Sayısı ve büyüklüğü bakımından daha az olmakla birlikte benzer lezyonlara göğüs kafesi duvarı, mediastinal ve bronşiyal lenf düğümleri, perikart kesesi, diyafragma, karaciğer, dalak ve rumende rastlanıldı. Akciğer yer yer göğüs duvarına ve diyafragmaya yapışmıştı. Kalpte epikardiyal yağ dokusunda orta derecede seröz atrofi vardı. Göğüs boşluğunda transudat birikmişti. Safra kesesinde peteşiyel ve ekimotik kanamalar tespit edildi. Histopatolojik olarak, başta akciğer olmak üzere granulomatöz lezyon görülen organ ve dokuların parankiminde kazeifikasyon nekrozu ve kalsifikasyon, yoğun yangısal hücre infiltrasyonu ve Langhans tipi dev hücrelerden oluşan eksudatif tipte lezyonlar görüldü. Sonuç: Makroskobik ve mikroskobik bulgulara göre bu vakaya eksudatif tip konjenital generalize tüberkülozis tanısı konuldu. Tüberkülozis hastalığının zoonoz karakterde etkene sahip olması, ciddi kontaminasyon riski taşıması ve hem hayvan hem de halk sağlığını önemli ölçüde tehdit etmesi nedeniyle bu vaka sunulmuştur.
Anahtar Kelimeler: Konjenital generalize tüberkülozis, buzağı.

A CASE OF CONGENITAL GENERALIZED TUBERCULOSIS IN A CALF

ABSTRACT

Aim: Tuberculosis is a very important bacterial zoonotic disease with chronic and contagious properties, which negatively affects both animal and public health, and is known for the formation of tubercles characterized by caseification and calcification in various organs and tissues, especially the lungs. In this report, it was aimed to present an oral report of the exudative type congenital generalized tuberculosis case observed in a calf with pathological findings. Material and method: The material of this case was a calf. In the anamnesis, it was stated that the calf was treated for long-term cough and breathing difficulties, but did not respond to the treatment. Systematic necropsy was performed on the calf and organs and tissues were examined macroscopically and histopathologically. Results: Macroscopically, nodules characterized by caseification and calcification were observed scattered throughout the lung, except for the dorsoventral ends of the caudal lobes of the lung. Similar lesions, although fewer in number and smaller in size, were found in the rib cage wall, mediastinal and bronchial lymph nodes, pericardium, diaphragm, liver, spleen, and rumen. The lung was adhered to the chest wall and diaphragm in some places. There was moderate serous atrophy of the epicardial fat tissue in the heart. Transudate had accumulated in the chest cavity. Petechial and ecchymotic hemorrhage were detected in the gallbladder. Histopathologically, exudative type lesions consisting of caseification necrosis and calcification, intense inflammatory cell infiltration and Langhans-type giant cells were observed in the parenchyma of organs and tissues with granulomatous lesions, especially the lung. Conclusion: According to macroscopic and microscopic findings, this case was diagnosed as exudative type congenital generalized tuberculosis. This case is presented because of tuberculosis disease has a zoonotic character, a serious contamination risk and a significant threat to both animal and public health.

Keywords: Congenital generalized tuberculosis, calf

ÇEŞİTLİ KLİNİK ÖRNEKLERDEN İZOLE EDİLEN *STAPHYLOCOCCUS* TÜRLERİNİN TANIMLANMASINDA İDENTİFİKASYON KİTİ İLE MALDI-TOF MS TEKNİĞİNİN KARŞILAŞTIRILMASI

Dr. Öğr. Üyesi Songül ÖTKÜN* (ORCID: 0000-0003-2736-953X)
Siirt University, Faculty of Veterinary Medicine, Department Veterinary Microbiology, Siirt-Türkiye
Email: songulotkun@yahoo.com

Doç. Dr. Özgül GÜLAYDIN (ORCID: 0000-0001-8376-2008)
Siirt University, Faculty of Veterinary Medicine, Department Veterinary Microbiology, Siirt-Türkiye
Email: ozgul.gulaydin@siirt.edu.tr

Dr. Öğr. Üyesi Muazzez YEŞİLYURT (ORCID: 0000-0003-4195-633)
Siirt University, Faculty of Veterinary Medicine, Department Veterinary Microbiology, Siirt-Türkiye
Email: muazzez.yesilyurt@siirt.edu.tr

ÖZET

Staphylococcus cinsi bakteriler birçok canlı türünde önemli enfeksiyonlara neden olmaktadır. Tanımlanmış onlarca türü olan bu bakteri grubunun biyokimyasal test benzerlikleri nedeniyle geleneksel mikrobiyolojik yöntemlerle tür düzeyinde tanımlanması zordur. Nükleik asit amplifikasyonu ve proteomik tabanlı teknikler bu etkenlerin tanısında etkin rol oynamaktadır. Matris destekli lazer desorpsiyon/iyonizasyon uçuş süresi kütle spektrometresi (MALDI-TOF MS) mikroorganizmaların moleküler parmak izini temsilen ribozomal proteinlerinin kütle ve tepe yoğunluk dağılımına göre cins ve tür düzeyinde tanımlanmasında kullanılan güçlü bir tekniktir. Bu çalışmada farklı hayvan türlerinden izole edilen non-aureus *Staphylococcus* türlerinin tanımlanmasında ticari bakteri identifikasyon test kiti (Liofilchem Staph) ve MALDI-TOF MS tekniğinin karşılaştırılması amaçlandı. İdentifikasyon kiti ile identifiye edilen 24 *Staphylococcus xylosus*, 3 *S. lentus*, 2 *S. İntermedius,* 2 *S. haemolyticus*, 1 *S sciuri*, 1 *S. capitis* ve 1 *S. chromogenes* olmak üzere toplam 34 adet *Staphylococcus* cinsi bakteri MALDI-TOF MS ile analiz edildi. Yapılan analizde kit ile *S. xylosus* olarak tanımlanan 24 adet izolatın MALDI-TOF MS ile *S. simulans* (n:8), *S. pseudintermedius* (n=7), *S. felis* (n=3), *S. vitulinus* (n=1) *S. sciuri* (n=1), *S. warneri* (n=1), *S. pasteurii* (n=1) ve *S. saprophyticus* (n=1) olduğu belirlenirken izolatların 1'i identifiye edilemedi. *S. lentus* (n=3) izolatları ise *S. vitulinus* (n=2) ve *S. pseudintermedius* (n=1) olarak tanımlandı. Kit ile *S. intermedius* (n=2) ve *S. haemolyticus* (n=2) olarak identifiye edilen izolatlardan 1'er adedi MALDI-TOF MS ile tanımlanamazken diğerleri *S. pseudintermedius* ve *S. haemolyticus* olarak identifiye edildi. *S. capitis*, *S. sciuri, S. chromogenes* izolatları MALDI-TOF MS ile sırasıyla *S. capitis, S. haemolyticus, S. pseudintermedius* olarak tanımlanırken, ticari kit ile MALDI-TOF MS arasında tür düzeyinde identifikasyonunun %93.54 oranında uyumsuz olduğu tespit edildi. Sonuç olarak *Staphylococcus* cinsi bakterilerin tür düzeyinde tanımlanmasında ticari tanı kiti ve MALDI-TOF MS tekniği arasında yüksek düzeyde uyumsuz sonuç elde edildi. Reaksiyonların doğruluğu inokulum yoğunluğu, inkübasyon

şartları ve sonuçların yorumlanması gibi faktörlere göre değişiklik gösterebilen fenotipik testlere dayanan tanı kitlerinin *Staphylococcus* cinsi bakterilerin tanımlanmasında tek başına kullanılmasının yanıltıcı olabileceği kanısına varıldı.

Anahtar Kelimeler: *Staphylococcus* spp., bakteri identifikasyon kiti, MALDI-TOF MS

COMPARING IDENTIFICATION KIT WITH MALDI-TOF MS TECHNIQUE IN THE IDENTIFICATION OF *STAPHYLOCOCCUS* SPECIES ISOLATED FROM VARIOUS CLINICAL SAMPLES

ABSTRACT

Staphylococcus genus bacteria cause important infections in many species. This bacterial group, which has dozens of identified species, is difficult to identify at the species level by conventional microbiological methods due to biochemical test similarities. Nucleic acid amplification and proteomics-based techniques play an effective role in the diagnosis of these agents. Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) is a powerful technique used for the genus and species-level identification of microorganisms based on the mass and peak density distribution of ribosomal proteins, representing the molecular fingerprint of microorganisms. This study aimed to compare a commercial bacterial identification test kit (Liofilchem Staph) with the MALDI-TOF MS technique in identifying non-aureus *Staphylococcus* species isolated from different animal species. A total of 34 *Staphylococcus* bacterial strains, including 24 *Staphylococcus xylosus*, 3 *S. lentus*, 2 *S. intermedius*, 2 *S. haemolyticus*, 1 *S. sciuri*, 1 *S. capitis*, and 1 *S. chromogenes*, identified by the identification kit were analyzed using MALDI-TOF MS. The analysis revealed that out of the 24 isolates identified as *S. xylosus* by the kit, MALDI-TOF MS identified them as *S. simulans* (n=8), *S. pseudintermedius* (n=7), *S. felis* (n=3), *S. vitulinus* (n=1), *S. sciuri* (n=1), *S. warneri* (n=1), *S. pasteurii* (n=1), and *S. saprophyticus* (n=1), with one isolate remaining unidentified. *S. lentus* (n=3) isolates were identified as *S. vitulinus* (n=2) and *S. pseudintermedius* (n=1) by MALDI-TOF MS. Among the isolates identified as S. *intermedius* (n=2) and *S. haemolyticus* (n=2) by the kit, one of each could not be identified by MALDI-TOF MS, while the others were identified as *S. pseudintermedius* and *S. haemolyticus*. The *S. capitis*, *S. sciuri*, and *S. chromogenes* isolates were identified by MALDI-TOF MS as *S. capitis, S. haemolyticus*, and *S. pseudintermedius*, respectively, while the commercial kit and MALDI-TOF MS showed a discordance rate of 93.54% in species-level identification. In conclusion, a high level of discrepancy was observed in the species-level identification of *Staphylococcus* bacteria between the commercial diagnostic kit and MALDI-TOF MS technique. It was concluded that the use of diagnostic kits based on phenotypic tests, the accuracy of the reactions of which may vary according to factors such as inoculum density, incubation conditions and interpretation of the results, may be misleading in the identification of bacteria of the genus *Staphylococcus*.

Keywords: *Staphylococcus* spp., bacterial identification kit, MALDI-TOF MS

SIMULATION MODEL OF AGRICULTURE IRRIGATION EMITTER FOR ANTI CLOGGING DRIP

Ziad Shakeeb AL SARRAF
Department of Mechanical Engineering, College of Engineering, University of Mosul, Mosul, IRAQ, 00964
Email: ziadalsarraf@uomosul.edu.iq

ABSTRACT
In this research, a drip irrigation emitter was designed using 3D CAD technology. The relationship between flow rate and applied load was simulated using computational fluid dynamics (CFD) technology. Next, the emitter model was fabricated using prototyping/additive manufacturing techniques to experimentally validate the flow behaviour. The results showed differences ranging between 20-28% between the CFD and experimental data. These variances are estimated for several reasons, including assumptions regarding certain flow parameters, limitations and defects in manufacturing the prototype. This study describes the development of a good drip irrigation dripper design that has enhanced resistance to clogging compared to previous drip irrigation dripper designs. This study also highlights the importance of choosing the type of rapid prototyping technology in emitter design.
Keywords: Simulation model, irrigation emitter; CAD; CFD; additive manufacture emitter model

COMPARATIVE QUALITATIVE PHYTOCHEMICAL CONTENT AND ANTIMICROBIAL ACTIVITIES OF METHANOL EXTRACT OF *CALOTROPIS PROCERA* FLOWER AND ITS LATEX

Busari M. B.*
Department of Biochemistry, Federal University of Technology Minna, Nigeria
Email: busari.bola@futminna.edu.ng

Hamzah R. U.
Department of Biochemistry, Federal University of Technology Minna, Nigeria

Oladejo N. A.
Department of Biochemistry, Federal University of Technology Minna, Nigeria

ABSTRACT
Microbial infections are common disease among many ages and sexes. The most pathetic situation about their management is their resistance to the available drugs which warrant for alternative therapy. *C. procera* has been widely used locally in Nigeria to tackle microbial infections. Therefore, this study investigated the phytochemical constituents and *in vitro* antimicrobial activities of methanol extract of *C. procera* flower (MECPF) and its latex (CPL) against *E.coli, Pseudomonas aeruginosa and Staphylococcus aureus*. Maximum inhibitory concentration of both extracts was done against each bacteria at 20 mg/ml, 40 mg/ml and 60 mg/ml using standard methods. MECPF and CPL revealed the presence of phenol, flavonoids, anthraquinone, steroids and terpenoids, while glycoside and tannins are only present in CPL. None of the concentration (20 mg/ml, 40mg/ml and 60 mg/ml) of CPL is however active against *E. coli*, while only 40 mg/ml and 60 mg/ml of MECPF are active against the same organism. The maximum concentration (20 mg/ml) of CPL shows higher zone of inhibition when compared with 60 mg/ml of MECPF on *pseudomonas aeruginos*a. Contradictorily, maximum concentration (20 mg/ml) of CPL shows higher zone of inhibition on *staphylococcus aureus* compared to the maximum concentration (60 mg/ml) of MECPF. Therefore, CPL possesses higher antimicrobial activities on *pseudomonas aeruginosa and Staphylococcus aureus* but lower antimicrobial activities against *E. coli* when compared with MECPF.
Keywords: Antimicrobial activities, *C. procera, pseudomonas aeruginosa, Staphylococcus aureus,*

INFINITE ORDER OF GROWTH OF SOLUTIONS TO DIFFIRENTIAL EQUATIONS

Fettouch HOUARI
University of Mostaganem, Faculty of Sciences Exact and Computer Science,
Department of Mathematics and Computer Science Alegeria
Email: Houari.fettouch@univ-mosta.dz

ABSTRACT
We study the standard notations of the Nevanlinna value distribution theory of meromorphic function on the complex plane and in the unit disc. In addition, for the -iterated order of meromorphic function in is defined by

$$\sigma_n(f)=\limsup_{r\to 1^-}\frac{\log_n^+ T(r,f)}{-\log(1-r)},$$

where and is the Nevanlinna characteristic function of. For an analytic function in we have also

$$\sigma_{M,n}(f)=\limsup_{r\to 1^-}\frac{\log_{n+1}^+ M(r,f)}{-\log(1-r)},$$

where. If is analytic in, Tsuji [[tsu], p.205] gives that
For example, the function satisfies and $\sigma_{M,1}(f)=\mu$.

Obviously, we have
The inequalities (00) are the best possible in the sense that there are analytic functions and h such that and. However, it follows by Proposition 2.2.2 in [lain] that for. The type of a meromorphic function in with is defined by

$$\tau_n(f)=\limsup_{r\to 1^-}(1-r)^{\sigma_n}\log_{n-1}^+ T(r,f);$$

and if is an analytic function in with we have also

$$\tau_{M,n}(f)=\limsup_{r\to 1^-}(1-r)^{\sigma_n}\log_n^+ M(r,f).$$

We signal that also by Proposition 2.2.2 in [lain], we have for .
Definition *meromorphic function in the unit disc is called admissible if*

$$\limsup_{r\to 1^-}\frac{T(r,f)}{-\log(1-r)}=\infty$$

and nonadmissible if

$$\limsup_{r\to 1^-}\frac{T(r,f)}{-\log(1-r)}<\infty.$$

The growth index of the iterated order of a meromorphic function in is defined by
We will use the notation to denote the n-iterated exponent of convergence of the zero-sequence of meromorphic function and to denote the -iterated exponent of convergence of distinct zero-sequence of , which are defined as the following:

$$\lambda_n(f)=\limsup_{r\to 1^-}\frac{\log N\left(r,\frac{1}{f}\right)}{-\log(1-r)} \text{ and } \overline{\lambda}_n(f)=\limsup_{r\to 1^-}\frac{\log \overline{N}\left(r,\frac{1}{f}\right)}{-\log(1-r)}.$$

AGRICULTURAL WASTE MANAGEMENT FOR SUSTAINABLE ENVIRONMENT

Anita PANDEY (ORCID: 0000-0003-0753-3056)
Assistant professor of Zoology, Kirodimal Govt. Art and science college Raigarh, C.G. India
Email: anitashubh2002@gmail.com

ABSTRACT
Chhattisgarh is an agricultural state situated in central India and is famed as a 'Rice bowl' because paddy is produced in abundance. Agricultural wastes have become an increasing concern in recent years because it causes significant environmental problems; however, the agriculture waste may also be used for several beneficial purposes, as cattle feed, wormi- composing. Biogas for energy production. As far as sustainability is concerned, fuel and material derived from organic or agriculture wastes can help in solving the fossil resource crisis. This article is based on our observation and various government schemes for reuse of agriculture waste and is divided into three sections which are :1. agricultural waste characterisation,2. waste reuse and recycling, 3. waste management and minimization. Agricultural waste biomass will help in the growth of a range of value-added products aiding the bio economy. This article makes a comprehensive study of methods and ways used in Chhattisgarh to manage agriculture waste in a sustainable manner.
Keywords: Agriculture, Reuse, Recycle, waste management, Sustainable.

REVIEW ON LIFE REPRODUCTION OF THE GILTHEAD SEABREAM (*Sparus Aurata*)

Mouassa BOCHRA (ORCID: 0009-0007-3766-1274)
University Chadli benjdid, el Tarf, Algeria
Researche lab: Epidemiological surveillance, health, production, reproduction, experimentation, and cellular therapy of domestic and wild animals
Email: Mouassa2903@gmail.com / b.mouassa@univ-eltarf.dz

H. Saoudi
University Chadli benjdid, el Tarf, Algeria
Researche lab: Epidemiological surveillance, health, production, reproduction, experimentation, and cellular therapy of domestic and wild animals
Email: hanisaoudi9@gmail.com

ABSTRACT
The gilthead sea bream is a protandrous hermaphrodite, exhibiting a unique reproductive pattern. In its first two years, it functions as a male, and upon reaching a length of over 30 cm, it undergoes a sex change, becoming female. During the male phase, the gonad is bisexual, featuring functional testicular areas with asynchronous spermatogenesis and non-functional ovarian areas. Ovarian development is also asynchronous, and females engage in batch spawning, capable of laying 20,000-80,000 eggs per day over a period of up to 3 months. Oocyte maturation coincides with a high HSI. Conversely, spawning leads to a decrease in the HSI. The size at first sexual maturity (Lm55) is 18 cm for males and 19 cm for females (The gonadosomatic index (GSI) and hepatosomatic index (HSI) in both females and males serve as indicators of a single reproduction period). This spawning period typically extends from December to January in the Mediterranean, reproduction occurs between October and December. The eggs are spherical and pelagic, with a diameter slightly less than 1 mm and a single large oil droplet. The planktonic larval stage lasts about 50 days at temperatures of 17-18°C.
Keywords: Gilthead seabream, GSI, HSI, Hermaphrodite, Reproduction

2019-2023 YILLARI ARASINDA SAMSUN VETERİNER KONTROL ENSTİTÜSÜ PATOLOJİ LABORATUARINA GELEN OLGULARDA PNÖMONİ PREVALANSI

Serdar ODACI (ORCID: 0000-0001-9485-7053)
Samsun Veteriner Kontrol Enstitüsü Müdürlüğü
Email: serdar.odaci86@gmail.com

ÖZET

Sığırların solunum sistem hastalığı (BRD) kompleksi ekonomik kayıplardan dolayı sığır endüstrisinin en önemli sağlık problemlerden birisidir. Bu hayvanlarda klinik olarak çoğunlukla, anoreksi, yüksek ateş, dispne, seröz veya mukopurulent burun ve gözyaşı akıntısı, nabız ve solunum artışı gibi klinik bulgular görülür. Hastalığın oluşumunda bakım besleme hataları, ani sıcaklık değişimleri, havalandırmanın yeterli olmaması, uygun olmayan barınaklar, farklı yaş gruplarının bir arada tutulması, mevsimsel faktörler, aşılama programlarının uygulanmaması, ani yem değişiklikleri, hayvanların başka bir ortama taşınması gibi hazırlayıcı faktörler ile virus, bakteri, mantar ve paraziter etkenlerde pnömonilerin oluşmasında rol oynamaktadır. Oluşan pnömoninin tipi; etkenin türüne, akciğere giriş yollarına (aerojen, hematojen, lenfojen), hayvanın türü, yaşı ve direncine göre sığırlarda değişiklik gösterebilir. Pnömoniler çeşitli kriterlere göre sınıflandırılabilmektedir. En çok tercih edilen pnömoni sınıflandırılması; bronkopnömoni (fibrinli bronkopnömoni, irinli bronkopnömoni ve aspirasyon pnömonisi) interstisyel pnömoni, embolik pnömoni ve granülomatöz pnömoni'dir. Bu çalışma kapsamında 2019-2023 yılları arasında Samsun Veteriner Kontrol Enstitüsü Müdürlüğü'ne bağlı dokuz farklı ilden (Samsun (n=392), Sinop (n=69), Ordu (n=46), Giresun (n=55), Trabzon (n=26), Rize (n=17), Amasya (n=138), Tokat (n=151) ve Sivas (n=47)) gönderilen 941 sığır ve koyun akciğer numunesi pnömoni yönünden histopatolojik olarak incelendi. Dokular Hematoksilen - Eozin boyama yöntemiyle boyandı ve ışık mikroskobunda incelendi. Enstitüye beş yıllık süre içerisinde gönderilen 941 akciğer numunesinin incelenmesi sonucunda % 42.9 (404 / 941) oranında pnömoni yönünden histopatolojik olarak pozitif bulundu. Dokuz farklı il içerisinde en yüksek pozitiflik oranı % 59.4 ile Amasya ili, %30.9 ile en düşük pozitiflik oranı ise Giresun ilinden gönderilen örneklerden saptandı. Yıllara göre pozitiflik oranları ise 2019 yılında % 44, 2020 yılında % 45, 2021 yılında % 36, 2022 yılında % 37 ve 2023 yılında % 50 pozitif şeklinde saptandı. Bu çalışmada bölgemizde pnömonili vakaların son yıllardaki prevalansı geniş kapsamlı olarak çalışıldı. Hastalığın bölgemizdeki yaygınlığının son yılda ciddi artış gösterdiği saptandı. Bu nedenle pnömoniye neden olan etiyolojik ajanlara göre koruma ve kontrol önlemlerinin alınması gerektiği düşünülmüştür.

Anahtar Kelimeler: Pnömoni, Akciğer, Prevalans

PREVALENCE OF PNEUMONIA IN CASES SENDING TO SAMSUN VETERINARY CONTROL INSTITUTE PATHOLOGY LABORATORY BETWEEN 2019-2023

ABSTRACT

Bovine respiratory disease (BRD) complex is one of the most important health problems of the cattle industry due to economic losses. In these animals generally show clinical signs such as anorexia, high fever, dyspnea, serous or mucopurulent nasal and lacrimal discharge, increased pulse, and respiration. Predisposing factors such as management, climate changes, inadequate ventilation, inappropriate shelters, mix breading in different age groups, seasonal factors, failure to implement vaccination programs, sudden feed changes, moving animals to another environment, and virus, bacteria, fungus, and parasitic agents play a role in the formation of pneumonia. The type of pneumonia may vary in cattle according to the type of the agent, the route of entry into the lung (aerogene, haematogenic, and lymphogenic), the type, age, and resistance of the animal. Pneumonias can be classified as bronchopneumonia (fibrinous bronchopneumonia, purulent bronchopneumonia and aspiration pneumonia) interstitial pneumonia, embolic pneumonia and granulomatous pneumonia. In this study, 941 cattle and sheep lung samples received from nine different provinces (Samsun (n=392), Sinop (n=69), Ordu (n=46), Giresun (n=55), Trabzon (n=26), Rize (n=17), Amasya (n=138), Tokat (n=151), and Sivas (n=47)) of Samsun Veterinary Control Institute between 2019 and 2023 were histopathological examined for pneumonia. The tissues were stained with Hematoxylin - Eosin staining method and examined under light microscope. As a result of the examination of 941 lung samples sent to the institute within a five-year period, 42.9% (404 / 941) were histopathological positive for pneumonia. Among nine different provinces, the highest positivity rate was found in Amasya province with 59.4% and the lowest positivity rate with 30.9% was found in samples sent from Giresun province. The positivity rates according to years were 44% in 2019, 45% in 2020, 36% in 2021, 37% in 2022 and 50% in 2023. In this study, the prevalence of pneumonia cases in our region in recent years was extensively studied. It was determined that the prevalence of the disease in our region has increased significantly in the last year. Therefore, it was thought that protection and control measures should be taken according to the etiological agents causing pneumonia.

Keywords: Pneumonia, Lung, Prevalence

BİR KEDİDE OLASI UNİLATERAL İRİS MELANOMU

Arş. Gör. Sevdet KILIÇ (0000-0003-1033-658X)
Siirt University, Faculty of Veterinary Medicine, Department of Surgery, Siirt-Türkiye
Email: sevdet.kilic@siirt.edu.tr

Arş. Gör. Mahsum BAŞAK* (ORCID: 0000-0003-1257-8283)
Siirt University, Faculty of Veterinary Medicine, Department of İnternal Medicine, Siirt-Türkiye
Email: mahsumbasak@siirt.edu.tr

Doç. Dr. Mustafa Barış AKGÜL (ORCID: 0000-0002-9365-9925)
Siirt University, Faculty of Veterinary Medicine, Department of Surgery, Siirt-Türkiye
Email: mbarisakgul@siirt.edu.tr

Doç. Dr. Gülşah AKGÜL (ORCID: 0000-0003-4804-6502)
Siirt University, Faculty of Veterinary Medicine, Department of İnternal Medicine, Siirt-Türkiye
Email: gulsahvet@hotmail.com

ÖZET
İris melanomu kedilerde, iriste multifocal altın sarısı renginden kahverengiye kadar değişen pigmente alanlarla karakterize metastaz yapma ihtimali yüksek bir neoplazidir. Her yaştaki kedilerde gelişebilmesine rağmen, ırk ve cinsiyet predispozisyonu yoktur. Olgu materyalini Siirt Üniversitesi Veteriner Fakültesi Cerrahi kliniğine getirilen 5 yaşlı, 4,5 kg ağırlığında, dişi, russian blue ırkı, kısırlaştırılmış kedi oluşturmaktadır. Hastanın anamnezinde sağ gözde 2 ay önce iriste kahverengi nokta şeklinde bir pigmente alanın oluştuğu ve bu 2 aylık süreç içerisinde iristeki pigmente alanlarının sayı ve boyutlarının artması sonucu getirildi. Rutin klinik muayene, tonometri, hematolojik ve biyokimyasal incelemeler sonucunda, benzer klinik semptomlara sahip uveal kistler ve iris çilleri elimine edilerek patolojik durumun iris melanomu olduğu kanısına varıldı. Ayrıca mevcut imkanlar doğrultusunda melanom odaklarının sadece iris yüzeyinde tutulum gösterdiği, gözün diğer dokularına ve organlara metastaz yapmadığı tespit edildi. Hastalığın başlangıç evresinde olması, klinik muayeneler sonucunda hastanın genel durumunun iyi olması ve hasta sahiplerinin enükleasyonu kabul etmemesi nedeniyle herhangi bir müdahalede bulunmayarak hastanın gözlem altında tutulmasına karar verildi. Hasta sahibine takip aşamasında odakların kontrol edilmesi ve hastanın gözetim altında tutulmaya devam edilmesi talimatı verildi. Hasta üç ay sonra tekrar kontrole çağrıldığında, melanom odaklarının büyümesi, gözün diğer dokularına veya başka organlara metastaz yapması durumunda enükleasyon yapılmasına karar verildi.
Anahtar Kelimeler: Kedi, Melanom, İris

POSSIBLE UNILATERAL IRIS MELANOMA IN A CAT

ABSTRACT
A tumor known as feline iris melanoma has a high chance of metastasizing and is characterized by multifocal, golden yellow to brown pigmented patches in the iris. Despite the fact that cats of any age can develop this tumor, there is no breed or sex-specific susceptibility. The case material was a female Russian blue cat that was neutered at the age of 5, weighed 4.5 kg, and was taken to the surgical clinic of the faculty of veterinary medicine at the University of Siirt. According to the patient's medical history, a brown spot-like pigmented region had developed on the right eye's iris two months prior, and up until the cat was brought to the clinic, the pigmented patches in the iris grew in number and size. As a result of routine clinical examination, tonometry, haematological and biochemical examinations, uveal cysts and iris freckles with similar clinical symptoms were eliminated and it was concluded that the pathological condition was iris melanoma. In addition, it was determined that melanoma foci were involved only on the iris surface in line with the available possibilities and did not metastasise to other tissues and organs of the eye. Since the disease was in the initial stage, the general condition of the patient was good after clinical examinations and the owner of the patient did not accept enucleation, it was decided not to perform any intervention. The owner of the patient was instructed that during the follow-up phase, the foci should be checked and the patient should continue to be under supervision. When the patient was summoned back for a follow-up examination three months later, it was decided to undertake enucleation in case any potential melanoma foci or metastases had grown in other eye tissues or organs
Keywords: Cat, Melanoma, İris

KEDİ VE KÖPEKLERDE PERİTONEOPERİKARDİYAL DİYAFRAM FITIĞI (PPDH): ÇEŞİTLİ ÇALIŞMALARDAN ELDE EDİLEN BİLİMSEL BULGULARIN BİRLEŞTİRİLMİŞ ANALİZİ

Dr. Öğr. Üyesi Ali GÜLAYDIN* (ORCID: 0000-0002-7200-1040)
Siirt University, Faculty of Veterinary, Department of Veterinary, Siirt-Türkiye
Email: a.guladin@siirt.edu.tr

M. Hattap SOYSAL (ORCID: 0009-0002-6760-8494)
Siirt University, Faculty of Veterinary, Department of Veterinary, Siirt- Türkiye
Email: hattaps990@gmail.com

ÖZET
Kongenital peritoneoperikardiyal diyafram fıtığı, kedi ve köpeklerde nadir görülen ancak önemli bir anomalidir. PPDH, farklı ırklarda ortaya çıkabilir ancak bazı araştırmalar belirli ırkların PPDH'ye yatkınlığını göstermektedir. Oluşum mekanizması tam olarak bilinmemekle birlikte, kedi ve köpeklerde septum transversumun tam gelişmemesiyle ilişkilendirilmektedir. PPDH, semptomatik veya asemptomatik seyredebilir ve semptomlar herhangi bir yaşta ortaya çıkabilir. Yaygın semptomlar arasında egzersiz intoleransı, taşikardi, kusma ve solunum depresyonu yer alırken, fıtıklaşan organa bağlı olarak farklı semptomlar görülebilir. Tanı genellikle direkt radyografiye dayanır ve genişlemiş kalp silueti, perikard kesesinde abdominal organlar ve diyafram ve kalp sınırlarının kaybı gibi bulgular dikkat çeker. Tedavi genellikle operatif olarak fıtıklaşan organların anatomik pozisyonuna alınması ve diaframın onarılmasını içerir. Ancak bazı durumlarda, özellikle semptom göstermeyen hastalarda veya operasyonun uygun olmadığı durumlarda konservatif tedavi tercih edilebilir. Bu derlemede, kedi ve köpeklerde PPDH'nin tanısı, tedavisi ve bakımı gibi konular ele alınarak veteriner hekimlerin bu durumu daha iyi anlaması hedeflenmiştir.
Anahtar Kelimeler: PPDH, kedi, köpek

PERITONEOPERICARDIAL DIAPHRAGMATIC HERNIA (PPDH) IN CATS AND DOGS: A CONSOLIDATED ANALYSIS OF SCIENTIFIC FINDINGS FROM VARIOUS STUDIES

ABSTRACT

Congenital peritoneopericardial diaphragmatic hernia (PPDH) is characterized by the herniation of abdominal organs towards the pericardial sac, representing a rare yet significant anomaly in cats and dogs. While the literature suggests the occurrence of PPDH in different breed groups, certain researchers emphasize the predisposition of specific breeds to PPDH. Although the exact mechanism of PPDH formation remains incompletely understood, it is associated with the incomplete development of the septum transversum in cats and dogs. PPDH may manifest asymptomatically or symptomatically in cats and dogs, with symptoms potentially emerging at any age. Common symptoms include exercise intolerance, tachycardia, vomiting, and respiratory depression. Furthermore, varied symptoms may arise depending on the herniated organ. The diagnosis of PPDH primarily relies on direct radiography. Remarkable findings on thoracic radiographs include an enlarged cardiac silhouette, presence of abdominal organs in the pericardial sac, and loss of diaphragmatic and cardiac boundaries. Generally, direct radiography is sufficient for PPDH diagnosis. However, auxiliary imaging modalities such as ultrasonography and tomography may be employed for the precise identification of the affected organ's position and pathology. The definitive treatment for PPDH involves the operative repositioning of herniated organs and diaphragmatic repair. However, in cases of clinically asymptomatic patients or when surgery is contraindicated, conservative treatment should be considered. This review comprehensively addresses the diagnosis, medical treatment, operative intervention, and postoperative care of PPDH in cats and dogs. The aim is to enhance the understanding of this crucial condition among veterinary professionals for more effective management.

Keywords: PPDH, cat, dog

PROGRESSIONS IN MULTIPARTY COMPUTATION AND PRESERVING PRIVACY IN TÊTE-À-TÊTES

Muhammad FAISAL (ORCID: 0000-0002-5797-766X)
Universiti Malaysia Sarawak
Director (HRIMS), Ministry of Human Rights Commission, Pakistan.
Email: dr.faisalshabbir88@gmail.com

ABSTRACT

Multiparty Computation (MPC) is indeed a fascinating research area within cryptography that goes beyond conventional methods of preserving privacy. While traditionally, the focus of cryptography has been on securing communication against eavesdropping by external adversaries, MPC shifts the paradigm by enabling privacy preservation among participants themselves within a conversation or collaboration. This capability opens up a wide array of applications in various domains such as finance, healthcare, and data analysis where multiple parties need to collaborate while keeping their individual data confidential. Protocols such as Yao's Garbled Circuits and Secure Function Evaluation (SFE) allow multiple parties to compute functions over their private inputs without revealing them to each other. These protocols ensure that each party learns only the output of the computation while keeping their inputs secret. Homomorphic encryption schemes enable computation on encrypted data, allowing parties to perform operations on ciphertexts without decrypting them. This approach ensures privacy while enabling collaborative computations. Zero-knowledge proofs provide a way for a party to prove the validity of a statement without revealing any information beyond the validity itself. This technique is valuable in MPC scenarios where participants need to authenticate themselves or prove certain properties of their inputs without disclosing sensitive information. Differential privacy techniques aim to maximize the accuracy of queries or computations on a dataset while minimizing the risk of revealing sensitive information about individual data points. It ensures that the presence or absence of a specific data point does not significantly affect the outcome of the computation, thereby preserving privacy. MPC techniques are increasingly being applied to collaborative machine learning scenarios where multiple parties wish to train a model on their combined data without sharing their raw data with each other. Secure aggregation and computation techniques allow parties to collaboratively train models while keeping their data private. Multiparty Computation (MPC) represents a transformative approach to privacy preservation, focusing not only on protecting against external threats but also ensuring confidentiality among collaborating parties. Recent methodologies have expanded the capabilities of MPC, making it applicable across various domains and enabling secure collaboration in scenarios where privacy is paramount.

Keywords: fascinating, eavesdropping, adversaries, parties, scenarios, paramount.

RULES OF RISK MANAGER IN INTEGRATED RISK MANAGEMENT SYSTEM (IRMS) IN IT INDUSTRY

Muhammad FAISAL (ORCID: 0000-0002-5797-766X)
Allama Iqbal Open University
Director (HRIMS), Ministry of Human Rights Commission, Pakistan
Email: dr.faisalshabbir88@gmail.com

Reema SHAHEEN (ORCID: 0000-0002-9454-9250)
Faculty of Computer Science and Information Technology, Universiti Malaysia Sarawak (UNIMAS) and Lecturer – Deanship of eLearning & IT, Jazan University

Munir AHMAD
National University of Science and Technology, Islamabad, Pakistan

ABSTRACT
Integrated risk management (IRM) is an approach that organizations use to manage risks across various domains comprehensively. In the IT field, where risks can have significant impacts on operations, data security, and overall business continuity, implementing IRM is crucial. Identify and document all potential risks associated with IT systems, including cybersecurity threats, data breaches, system failures, regulatory compliance issues, etc. Evaluate the likelihood and potential impact of each identified risk on IT operations, data integrity, confidentiality, availability, and compliance requirements. Prioritize risks based on their severity and potential impact on the organization. Develop and implement strategies to mitigate or reduce identified risks to an acceptable level. This may involve implementing security controls, redundancy measures, disaster recovery plans, staff training, and other risk mitigation techniques. Continuously monitor IT systems and processes for new risks or changes in existing risks. Implement controls to detect and respond to emerging threats promptly. Regularly review and update risk management policies and procedures to ensure their effectiveness in mitigating evolving risks. Establish clear communication channels for reporting risks and incidents within the organization. Provide regular updates to stakeholders, including senior management and relevant departments, on the status of IT risks and mitigation efforts. Ensure that IT risk management practices align with industry regulations, standards, and best practices. Establish governance structures to oversee and enforce compliance with risk management policies and procedures. Foster collaboration among IT teams, security professionals, compliance officers, and other relevant stakeholders to address cross-functional risks comprehensively. Integrate risk management processes with other business functions such as strategic planning, budgeting, and project management to ensure alignment with organizational objectives. Regularly review and assess the effectiveness of the IRMS, identifying areas for improvement. Implement lessons learned from past incidents or near misses to strengthen risk management practices and enhance organizational resilience. By adhering to these rules, risk managers can effectively implement an Integrated Risk Management System in the IT field, helping organizations proactively identify, assess, and mitigate risks to safeguard their assets and achieve their business objectives.
Keywords: comprehensively, crucial, failures, Prioritize, incidents.

MINERALS AND HEAVY METAL CONTENT IDENTIFICATION IN POMACE AND PEEL OF KINNOW NITIKA

Saini*
Department of Food Science and Technology, I.K. Gujral Punjab Technical University, Jalandhar – Kapurthala Highway, Punjab 144603, India

Barinderjit SINGH
Department of Food Science and Technology, I.K. Gujral Punjab Technical University, Jalandhar – Kapurthala Highway, Punjab 144603, India

ABSTRACT
Heavy metal pollution of the environment has increased in the modern era. It is crucial to research different kinds of pollution, particularly those that affect crops. Because metal traces are engaged in biological cycles and signal high toxicity, their detection is crucial. The current study's goal is to quantify the concentrations of mineral ions and heavy metals in kinnow fruit, a sample that was gathered from several locations in Punjab. Although heavy metals are naturally occurring elements of the earth's crust, human activity frequently releases greater concentrations of these elements into the environment. Metals that are essential for body growth and development include Fe, Cu, and Zn. Others, like Pb, Cd, etc., when breathed in, eaten, or absorbed, might have negative health impacts. As a result, people are becoming more aware of how harmful heavy metals may be. Determining the levels of heavy metals in kinnow peel, pomace, and the soil in which it is grown is the purpose of this study. XRF scanning was used to do an elemental analysis on the peel, pomace, and soil powders. Agricultural and food science fields have recently made extensive use of X-ray fluorescence techniques. Using XRF (X-ray fluorescence) methods, the amount of heavy metal pollution in the peel and pomace of kinnow fruit was determined.
Keywords: Kinnow; Minerals; Peel; Pomace; Heavy metals; XRF

PEROVSKITE-BASED MATERIALS FOR ENERGY APPLICATIONS

Tanweer ALAM*
University Department of Physics, V. K. S. University, Ara-802301 Bihar, India

Awadesh PRASAD
University Department of Physics, V. K. S. University, Ara-802301 Bihar, India
Email: tanweer802302@gmail.com

ABSTRACT
The significance of energy in contemporary society cannot be overstated. With the escalating constraints attributed to air pollutant emissions resulting from the excessive utilization of fossil fuels, the need for alternative energy sources has become increasingly pressing in recent years. Throughout history, diverse devices and systems have been devised to convert energy from natural sources into usable forms. Another critical consideration is energy storage, which involves capturing energy generated at one point in time and releasing it to provide power at a later stage, commonly referred to as energy storage. Addressing energy storage challenges is imperative in the quest for solutions to energy-related issues. Perovskite-type ceramic materials have emerged as promising candidates for various energy applications. This chapter presents a comprehensive literature review summarizing the advancements in energy applications of perovskite-type ceramic materials. Understanding the underlying structure-property relationships requires a thorough investigation of defect chemistry. This mini-review paper provides a concise overview of the existing literature and summarizes the progress in perovskite crystal structures, solid oxide fuel cells, electrocatalysts, photocatalysts, and transport properties associated with perovskite materials.
Keywords: Peovskite Oxides, Electrical Conductivity, Sensors

SIMULATION AND CONSTRUCTION OF MICROCONTROLLER BASED ELECTRONIC CIRCUIT WITH SMS REPORTING FACILITIES FOR IRRIGATION PLANT

Hamisu MUHAMMAD
Department of science laboratory technology, School of Science and Technology
Hussaini Adamu Federal Polytechnic Kazaure, Jigawa State
Email: abubakarharuna34y@gmail.com

ABSTRACT
Agriculture is the key to food security of every nation. Food security is a situation in which all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Irrigation is the act or process of causing water to flow over lands to nourish plants, or the watering of land by artificial means to foster plant growth. Irrigation in modern times is practiced in homes, offices and recreational centers. Over the years, the practice has moved away from the traditional watering mechanism using watering cans to sophisticated irrigation systems that are powered by electric water pumps. Properly designed and constructed water distribution structures in irrigation are ultimately targeted at sufficient food production. Irrigation ensures consistent food production and stabilizes agricultural production. It allows commercial production of food for local consumption and exports. It allows increased possibilities of crop diversification that favour high value crops and enhance attainment of food security. In this work, simulation and construction of a microcontroller based electronic circuit with SMS reporting facilities for irrigation plant has been achieved and in conclusion, the device was successful and base on the designed program, it works effectively. This device can be useful especially in the area of irrigation and in flowering gadding for monitoring the soil moisture. The device can also be effectively use in controlling the moisture of football filed for watering grass carpet as well as in factory were moisture is not required during operation (e.g. electronic industries). It is recommended that, further work should be done to advance this project in the area of collecting information of moisture in some electronic stores, big farm land and there also a need of improving the performance of the circuit so as to make more efficient and effective. Hence the followings improvements are needed. The project can be improved by the use a computer or Bluetooth for clause range to reduce a spending of recharge card. The project can be improved with an irrigation pump to operate automatic irrigation systems such as lawn sprinklers and drip irrigation systems.
Keywords: Automatic Irrigation, electronic circuit with SMS reporting facilities, moisture and content

GENETIC APPLICATION IN AGRICULTURE

Subhom GHOSH
1st Year B. Tech. Student, Department of Computer Science Engineering, Abacus Institute of Engineering and Management, Mogra, India 712148

Akash SANTRA
1st Year B. Tech. Student, Department of Electronics & Communications Engineering, Abacus Institute of Engineering and Management, Mogra, India712148

Atanu KOLEY
1st Year B. Tech. Student, Department of Computer Science Engineering, Abacus Institute of Engineering and Management, Mogra, India 712148

Dr. Monalisa HALDER
Assistant Professor, Department of Basic Sciences and Humanities, Abacus Institute of Engineering and Management, Mogra, India 712148
Email: monalisahldr18@gmail.com

ABSTRACT
Introduction: Climate change poses a severe threat to the future of the environment as it pertains to agriculture, biodiversity, human society and nearly every facet of our world. The United States, India and the other world face serious social challenges in the areas of food, environment, energy, and health. The new technologies are enabling the identification of key gene activity responses to the range of biotic and abiotic challenges experienced by plants. Genetic engineering played a significant role in modern agriculture, allowing for the direct manipulation of an organism genetic material to introduce specific traits or characteristics. The use of biotechnology in agriculture also raises concerns about potential impacts on ecosystems and human health the Indian government has been involved in discussions and debates about the potential benefits and risks of golden rice. Methodology: Here are some key methodologies employed in agricultural genetics: 1) Direct transfer of DNA: In microinjection process, the DNA fragment is dissolved in a solution. Then the solution is injected into the nucleus of the host cell with the help of micro projectiles. 2) By gene gun: DNA is coated around gold or tungsten particles biolistically with the help of gene gun and the DNA particles are sprayed onto the host cells with the help of micro projectiles. 3)Trans formation: The Ti plasmid of Agroibacterium tumefaciens is particularly helpful in gene transfer. 4) Bt crops: Bacillus thuringiencis or Bt cry IAc gene introduced into crops produces toxicity to insects. 5)Electroporation: A plant cell kept in a special container and a gene with it is given an electric shock for a moment with the help of an electrode, and the DNA enters the plant cell from the medium. Conclusion: As the population is increasing all over the world and people's demand on agriculture are constantly improving. The fact is that the crop fields are constantly disappearing. For this situation genetically modified organisms are really helpful. Bt brinjal, bt cotton has already high in demand. The vast benefits accrued to farmers, the environment, and consumers explain the widespread popularity of the technology in many regions of the world. The path toward a future sustainable

agriculture lies in harnessing the best of all agricultural technologies, including the use of genetically engineered seed, within the framework of ecological farming.

Keywords: ecological farming, climate change, DNA

PREDICTING WIND SPEED WITH THE ARIMA ALGORITHM

Seemant TIWARI
Southern Taiwan University of Science and Technology, Tainan City-71005, Taiwan
Department of Electrical Engineering
Email: da82b203@stust.edu.tw

ABSTRACT
Utilizing energy from renewable resources, like wind power, has emerged as a potent substitute to address this issue. However, precise prediction of wind speeds remains a highly difficult area of study due to the sporadic and unpredictable nature of wind energy. Accurate immediate prediction of wind speeds is becoming more and more necessary as a result of the large introduction of wind energy into the electrical grid. This aids transmission administrators in balancing the electrical systems with fewer backup capabilities. The ARIMA (Autoregressive Integrated Moving Average) approach to short-term forecasting of wind speeds is discussed in this study. The rows P, D, Q, and the duration of the past information interval determine the framework of the predictive model. Partial Auto-Correlation Function (PACF) along with Auto-Correlation Function (ACF) has been employed to derive the framework of variables P (Autoregressive component, AR) and Q (Moving Average component, MA), accordingly. The mean absolute percentage error (MAPE), mean absolute error (MAE), and root mean square error (RMSE) are used to calculate how accurate the predictive model's forecasts are. The findings show that the framework in use produces very good prediction precision. We suggest creating a hybrid model by combining the ARIMA approach with any more efficient technique, as determined by the computations that were carried out.
Keywords: ARIMA, Prediction, Wind Speed, Data

AVRUPA TARIMINA İLİŞKİN FARKLI ANLAYIŞLAR VE İLGİ ALANLARI

Sureyya YİĞİT (ORCID: 0000-0002-8025-5147)
Professor of Politics and International Relations, School of Politics and Diplomacy, New Vision University, Tbilisi, Georgia.
Email: syigit@newvision.ge

ÖZET
AB Komisyonu, periyodik yönergeler sunarak AB'nin Ortak Tarım Politikasını yenileme konusunda önemli adımlar attı. 2017 yılında, OTP'yi güçlendirme ve onun önemli zayıflıklarını ve eksikliklerini giderme potansiyeli taşıyan "Gıda ve Çiftçiliğin Geleceği" başlıklı bir rapor yayınladılar. Çeşitli dernekler, OTP'nin sosyal hedeflerle uyumlu hale getirilmesini ve bir kalite stratejisi izlenmesini önerdi. Bu, çoğu şirket için katma değeri artırmak ve sürdürülebilir ekonomik perspektifler yaratmak amacıyla gıda üretimine yönelik sosyal ve teknik yasal gerekliliklerin bilinçli bir şekilde uygulanması anlamına gelecekti. Piyasa ve ticaret politikasına yönelik teknik, hukuki ve finansman politikaları da dahil olmak üzere siyasi araçlar kullanılmalı ve buna göre yeniden tasarlanmalıydı. Bu kalite stratejisine hizmet etmek için OTP ve onun uygulanmasına yönelik çağrılar olmuştu. Finansman politikasıyla ilgili olarak, kamu fonlarının belirli sosyal hizmetleri ödüllendirmek için tam olarak kullanılması gerektiği ilkesine tutarlı bir şekilde bağlı kalınmalıydı. Ayrıca süt piyasasında 2014-2016'da olduğu gibi yıkıcı ve maliyetli krizlerin önlenmesi için kuralların da konulması gerekiyordu. Bu araştırma, OTP'nin sosyal hedeflerle uyumlu olmasını sağlamak ve sürdürülebilir ekonomik büyüme için kaliteli bir strateji izlemek üzere birlikte çalışmak üzere tarımsal zorluklara çözüm sunma konusunda başlıca Avrupalı paydaşların tartışmalarını vurgulayacaktır.
Anahtar Kelimeler: Ortak Tarım Politikası, Avrupa Birliği, Tarım Reformu, Avrupa Komisyonu, Sivil Toplum

DIFFERING UNDERSTANDINGS AND INTERESTS REGARDING EUROPEAN AGRICULTURE

ABSTRACT
The EU Commission has made strides in renewing the EU's Common Agricultural Policy by presenting periodic guidelines. In 2017, they released a communication titled "The Future of Food and Farming", which held the potential to strengthen the CAP and address its significant weaknesses and shortcomings. Various associations suggested aligning the CAP with social goals and pursuing a quality strategy. This would mean consciously implementing the social and technical legal requirements for food production to increase added value for most companies and create sustainable economic perspectives. The political instruments, including technical, legal, and funding policies for the market and trade policy, should be used and redesigned accordingly. There have been calls for the CAP and its implementation to serve this quality strategy. Regarding funding policy, one must consistently adhere to the principle that public funds must be used fully to reward specific social services. Moreover, one must also install rules to prevent devastating and expensive crises in the milk market, such as those of 2014-2016. This research will highlight the debates and discussions of the major European stakeholders in offering solutions to agricultural challenges, to work together to ensure that the CAP is aligned with social goals and pursue a quality strategy for sustainable economic growth.
Keywords: Common Agricultural Policy, European Union, Agricultural Reform, European Commission, Civil Society

SUCCESS OF MICRO, SMALL AND MEDIUM ENTERPRISES IN UTTARAKHAND

Assist. Prof. Deepali TOMAR
Head of Department of Economics, Himalayiya University, Dehradun, Uttarakhand, India **Email:** kittytomar52@gmail.com

ABSTRACT
The MSME sector act as a catalyst for the economic growth of the country. It involves large employment with lower capital cost and also helps in the industrialisation of rural and backward areas. The main aim of the paper is to examine the performance of the MSM sector in Uttarakhand in December 2023. Data was collected by using secondary sources from Industries department and other official websites, journals, etc. The study concluded that Uttarakhand has maximum number of micro enterprises followed by the small and medium enterprises. Dehradun and Haridwar districts recorded the highest number of UDYAM units as compared to other districts of Uttarakhand.
Keywords: MSME, UDYAM, Employment, Economic growth, Capital cost

APPLICATION OF DATA ENVELOPMENT ANALYSIS ON INTEGRATED CROP-LIVESTOCK ENTERPRISES IN KADUNA, NIGERIA

Sulaiman MUHAMMAD*
Department of Economics, Federal College of Education, Zaria-Nigeria
Email: smuhammad1981@gmail.com

Bello RILWAN
Department of Economics, Federal College of Education, Yola-Nigeria

Lawal Tanimu, AHMED
Department of Business Administration and Management, Federal Polytechnic Kaura Namoda, Nigeria

ABSTRACT
The study examines the best practice in integrated crop-livestock farming system in Kaduna state, Nigeria. Primary data were obtained through structured questionnaire and interview method. A multi-stage sampling procedure was used for the study where a random selection of 8 LGAs out of 23 was carried out, 48 villages purposively selected and 242 crop-livestock enterprises were randomly selected. Descriptive statistics and Data Envelopment Analysis (DEA) were used to achieve the objective of the study. Findings from the socio-economic characteristics of integrated crop-livestock farmers indicated that approximately 76% were male, with an average age of 43 years and each farmer had an average household size of 7 individuals. The DEA findings showed that the mean total efficiency, pure efficiency, and scale efficiency were 0.72, 0.89 and 0.81, respectively. Additionally, the results indicated that the enterprises could reduce the quantity of inputs such as farm size, labour, seed, fertilizer, manure, and agrochemicals by 4.8%, 15.4%, 20.8%, 10.50%, 26.7%, and 21.8%, respectively. Moreover, the results specified that 19.4%, 29.53%, and 51.1% of farmers operated at optimal, sub-optimal, and super-optimal scales, respectively. Tobit regression model used to determine factors influencing technical efficiency established that coefficients of age (0.0312), marital status (0.0021), household size (0.0810), education level (-0.1542), farming experience (0.1823), extension contact (-0.3711) and cooperative membership (-0.1105) were statistical significant variables at different level of probability. The research indicates the importance of collaboration between crop and animal scientists, extension agents, and agricultural economists. This is suggested to address the necessity for farmers to adopt integrated crop-livestock farming practices in order to attain the optimum level of efficiency.
Keywords: Crop-livestock, integration, farmers, efficiency, data envelope analysis (DEA).

SEQUENCE ANALYSIS AND AMINO ACIDS SUBSTITUTIONS OF ADIPONECTIN GENE IN SOME POULTRY SPECIES

Ewuola, Muslim KAYODE
Department of Animal Science, Faculty of Agriculture, University of Abuja, Federal Capital Territory, Abuja, Nigeria
Email: ewuolam@yahoo.com or ewuolamk@gmail.com

Usman, Achor MIRIAM
Department of Animal Science, Faculty of Agriculture, University of Abuja, Federal Capital Territory, Abuja, Nigeria

ABSTRACT
An essential gene that supports metabolic functions in farm animals, such as controlling metabolism and preserving insulin sensitivity, is the adiponectin (Adipoq) gene. There has not been much research done on the in-silico sequence variantions of the adipoq gene in poultry species. Therefore, this work was conducted to computationally classify precise mutations in the adipoq gene in particular poultry species and explore the molecular analysis variation. A total of eighteen (18) adipoq nucleotide sequences comprising chicken (4), turkey (4), guinea fowl (3), duck (3) and japanese quail (4) were downloaded from the DNA databank. Percentage identities were generated and functional analysis of nsSNP using *BLASTn* and *PROVEAN* were carried out. The percentage identities recorded 100% across all the species utilized and functional analysis showed five amino acid substitutions in each of the species of poultry (M21L, G94A, R50Q, MIdel, F13Y) in chicken, turkey (L8del, Y50R, W20C, V5M, M100del), guinea fowl (Q25D, G150A, A100del, M1E, R51delinsFCS), duck (K148G, Q2del, P96delinsRQ, M1R, G101F), and Japanese quail (G60V, M4del, H300G, H55del, V5delinsLSY) which were returned as deleterious or neutral. The information from nucleotide sequences showed the close relatedness of members of phasianidae family. Their deleterious nature implies their negative effects and neutrality obtained depicts beneficial impacts.
Keywords: Adiponectin locus, mutation, poultry species, NCBI, PROVEAN

UTILIZATION OF RECLAIMED SEWAGE WATER IN CONCRETE

Subhashish DEY
Civil Engineering Department, Gudlavalleru Engineering College, Gudlavalleru, Andhra Pradesh, India
Email: shubhashish.rs.civ13@itbhu.ac.in

ABSTRACT
These days the vast majority of the development ventures seem, by all accounts, to be answerable for the utilization of bountiful measure of crisp water. Without considering about different utilizations of water at the concrete industry, around 150 liters of water is required for 1m3 of concrete. In the accessible water just 3% is fresh water while the rest 97% is sea water which has high saltiness esteem. What's more, with the expanded urbanization the generation of sewage from the residential tenants has likewise been expanded. Very nearly 80% of thewater utilized for residential reason disseminates as civil emanating water. Treated waste water is acquired from treatment plant in the wake of treating metropolitan profluent water. It is fundamentally utilized for cultivating and in some circumstance for agrarian reason. Treated waste water is hard water; it chiefly contains sulfate and chloride content. So as to diminish the utilization of customary water being developed and to utilize the assistant treated sewage water in a ground-breaking way. It hopes to save million liters of waste water which may be deliberately orchestrate in the stream.
Keywords: Water, Concretes, Sewage, Civil Engineering, Treatments and Regenerations

INFLUENCES OF ADMIXTURES ON CHLORIDE RESISTANCE OF SELF COMPACTION CONCRETE

Subhashish DEY
Civil Engineering Department, Gudlavalleru engineering college, Gudlavalleru, Andhra Pradesh, India

ABSTRACT
The chloride resistance is the most important phenomenon of concrete structure durability; it is related to the penetration of chlorides. The strength of the steel is reduced due to the occurrence of chloride ions in concrete structures. This research investigates the effects of penetration of chloride ions and acid resistance on self- compacting concrete in different ages. Mineral admixtures like fly ash have been used to concrete mixed with cement replacement ratios of 0%, 5%, 10%, 15%, 20%, 25%, 30%, and copper slag is replaced with the fine aggregate ratio of 20%, 40%, 60%, 80%, 100% and also study the fresh properties like L-box, U-box, V-funnel and slump flow and mechanical properties are compressive strength, flexural strength, and split tensile strength of the self-compacting concrete. Durability properties of SCC assessed with rapid chloride penetrability test and acid resistance by using M40 grade concrete.
Keywords: Concrete structure, Chlorides, Minerals, Admixtures, Compressive strength, Flexibility, Durability and Self compacting concrete

DEPRESSION: DIABETES MELLITUS

Rampravesh KUMAR
Faculty Of Pharmacy, Bharath Institute of Higher Education and Research, Chennai

Dr. R. Devimohan
Faculty Of Pharmacy, Bharath Institute of Higher Education and Research, Chennai

ABSTRACT
Diabetes Mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia, resulting from either insufficient insulin production or ineffective utilization of insulin by the body. This abstract provides a comprehensive overview of diabetes mellitus, focusing on its pathogenesis, management strategies, and its impact on a global scale. The pathogenesis of diabetes mellitus involves a complex interplay of genetic, environmental, and lifestyle factors. Type 1 diabetes is caused by autoimmune destruction of insulin-producing beta cells in the pancreas, while type 2 diabetes is characterized by insulin resistance and impaired beta cell function. Other less common types include gestational diabetes and various monogenic forms. Effective management of diabetes requires a multidimensional approach. Lifestyle modifications, such as adopting a balanced diet, regular physical activity, and weight management, play a crucial role in preventing and managing the disease. Pharmacological interventions, including insulin and oral antidiabetic agents, are used in type 1 and type 2 diabetes management, respectively. Despite advances in treatment options, diabetes continues to impose a significant global burden. Its prevalence has been steadily rising, driven by factors such as urbanization, sedentary lifestyles, and increasing obesity rates. Uncontrolled diabetes can lead to a myriad of complications, including cardiovascular diseases, neuropathy, retinopathy, and nephropathy, thereby impacting both individual well-being and healthcare systems worldwide. Public health efforts aim to raise awareness, promote early diagnosis, and implement preventive measures to mitigate the escalating impact of diabetes.
Keywords: Diabetes Mellitus insulin

ASSESSMENT OF THE IMPACT OF RADIOACTIVE CAESIUM AND STRONTIUM ON MOROCCAN AGRICULTURE: SOIL ANALYSIS AND WHEAT GROWTH PATTERNS

Ayyoub AMMAR *
Laboratory of Virology, Microbiology, Quality and Biotechnology /Eco-toxicology and Biodiversity (LVMQB/EB), Faculty of Sciences and techniques Mohammedia, University Hassan II Casablanca, Morocco
Laboratory of Environment and Conservation of Natural Resources, National Institute of Agronomique research (INRA), Rabat, Morocco
National Center for Nuclear Energy, Science and Technology (CNESTEN), Rabat, Morocco
Email: ammarayyoub@hotmail.com

Zineb EL MOURIDI
Laboratory of Environment and Conservation of Natural Resources, National Institute of Agronomique research (INRA), Rabat, Morocco

Asmae NOUIRA
National Center for Nuclear Energy, Science and Technology (CNESTEN), Rabat, Morocco

Said BOUGHRIBIL
Laboratory of Virology, Microbiology, Quality and Biotechnology /Eco-toxicology and Biodiversity (LVMQB/EB), Faculty of Sciences and techniques Mohammedia, University Hassan II Casablanca, Morocco

ABSTRACT
Nuclear fallout from large-scale accidents poses significant challenges worldwide, particularly for the agricultural sector due to contamination of crops by radioactive fallout. While much is known about contamination factors in temperate regions, understanding remains limited in arid environments. This study combines two investigations of the effects of caesium and strontium on Moroccan agriculture. Soil samples from different agricultural regions were analyzed to understand the behavior of radiocesium and radiostrontium. Physicochemical analyses identified soil characteristics, and advanced spectroscopic techniques quantified soil constituents. The results revealed the prevalence of native strontium and cesium, necessitating tailored management strategies to mitigate potential contamination. In addition, the effects of varying strontium concentrations on the germination and growth patterns of two native wheat species, *Triticum durum* and *T. aestivum*, were investigated. Experiments showed that germination rates decreased with increasing strontium levels, particularly pronounced in *T. aestivum*. While low to moderate concentrations of strontium promoted stem development, higher concentrations proved toxic, inhibiting root growth in both species. These results underscore the complex relationship between radioactive elements and agriculture, and urge informed decision-making for sustainable practices and environmental stewardship.
Keywords: Agriculture, Radioactivity, Cesium, Strontium, Soil, Wheat, Germination, Growth Parameters.

KEDİ VE KÖPEKLERDE FLOROSKOPİNİN KULLANIM ALANLARI

Arş. Gör. Tolga Meriç DÜMBEK* (ORCID: 0000-0003-1734-3491)
Muğla Sıtkı Koçman University, Faculty of Milas Veterinary Medicine, Department of Surgery, Muğla-Türkiye
Email: tolgamericdumbek@mu.edu.tr

Doç. Dr. Zeynep BOZKAN ÜNAL (ORCID: 0000-0004-4233-6496)
Adnan Menderes University, Faculty of Veterinary Medicine, Department of Surgery, Aydın-Türkiye
Email: zbozkan@adu.edu.tr

ÖZET
Floroskopi, x ışınlarının kullanıldığı ve hastanın eş zamanlı olarak görüntülenmesini sağlayan görüntüleme sistemlerdir. Hastadan geçtikten sonra kalan ışınların ekran üzerine çarparak parıltı üretmesi sayesinde görüntü oluşturur. Floroskopinin radyografi sistemlerine göre avantajı x-ışını uyarımı boyunca anlık olarak görüntü alınabilmesidir. Bu özelliği sayesinde dinamik biyolojik süreçlerin değerlendirilmesine ve yönlendirici müdahalelere izin vermektedir. Floroskopi sistemlerinde, radyasyon dozunu makul miktarlarda tutmak için görüntü başına radyasyon miktarını oldukça düşük seviyelerdedir, bu radyografide kullanılan dozun yaklaşık %0,1'i kadarına eşdeğerdir. Floroskopi sistemlerinin başlıca bileşenleri; x-ışını jeneratörü, x-ışını tüpü, kolimatörler, filtreler, hasta masası ve pedleri, gridler, görüntü yoğunlaştırıcıları, optik bağlantı parçaları, televizyon sistemleri ve görüntülerin kayıt altına alınması için kullanılan aparatlardır. Modern floroskopi sistemlerinde bazı çalışma modları vardır, bunlar; sürekli floroskopi modu, değişken kare hızlı darbeli floroskopi modu, görüş alanı büyütme modu, geçici kare ortalama modu, son görüntü bekletme modu, yol haritalama modu ve C-kollu tomografi modudur. Floroskopi cihazları kardiyovasküler sistemde, damarların görüntülenmesi, intravasküler yabancı cisimlerin çıkartılması, arteriyel damarların embolizasyonu ve çeşitli kalp hastalıklarının tanı ve tedavisinde; Solunum sisteminde farenks, trakea ve akciğerdeki çeşitli hastalıkların tanı ve tedavisinde; Kas ve iskelet sisteminde, üç boyutlu analizlerde, minimal invaziv operasyonlarda ve ortopedik operasyonlarda; Üriner sistemde, üreter, idrar kesesi ve üretradaki hastalıkların tanı ve tedavisinde; Sinir sisteminde girişimsel prosedürlerde ve operasyonlar sırasında operasyon süresini kısaltmak ve operasyon başarısını arttırmak için; Sindirim sisteminde, özofagus, mide ve bağırsaklarda meydana gelen hastalıkların ve motalitelerin tanı ve tedavisinde kullanılabilir. Bu çalışma ile kedi ve köpeklerde floroskopinin kullanım alanları ile ilgili güncel çalışmaları bir araya getirmek amaçlanmıştır.
Anahtar Kelimeler: Anjiyografi, görüntüleme, radyasyon, skopi, x-ışını.

USES OF FLUOROSCOPY IN CATS AND DOGS

ABSTRACT
Fluoroscopy is an imaging system that uses x-rays and allows simultaneous visualization of the patient. After passing through the patient, the remaining rays hit the screen and produce a glow, creating an image. The advantage of fluoroscopy over radiography systems is that instantaneous images can be taken during x-ray stimulation. Thanks to this feature, it allows the evaluation of dynamic biological processes and guiding interventions. In fluoroscopy systems, the amount of radiation per image is very low to keep the radiation dose at reasonable levels, equivalent to approximately 0.1% of the dose used in radiography. The main components of fluoroscopy systems are the x-ray generator, x-ray tube, collimators, filters, patient tables and pads, grids, image intensifiers, optical fittings, television systems and apparatus for recording images. Modern fluoroscopy systems have several operating modes, including continuous fluoroscopy mode, variable frame rate pulsed fluoroscopy mode, field of view magnification mode, temporal frame averaging mode, final image hold mode, path mapping mode and C-arm tomography mode. Fluoroscopy devices are used in the cardiovascular system for visualization of vessels, removal of intravascular foreign bodies, embolization of arterial vessels and diagnosis and treatment of various heart diseases; in the respiratory system for diagnosis and treatment of various diseases in the pharynx, trachea and lung; in the musculoskeletal system for three-dimensional analyses, minimally invasive operations and orthopaedic operations; in the urinary system for the diagnosis and treatment of diseases in the ureter, urinary bladder and urethra; In the nervous system for interventional procedures and operations to shorten the operation time and increase the success of the operation; In the digestive system, in the diagnosis and treatment of diseases and motalities occurring in the oesophagus, stomach and intestines. The aim of this study was to bring together current studies on the use of fluoroscopy in cats and dogs.
Keywords: Angiography, imaging, radiation, scopy, x-ray.

HORMOPRIMING WITH CYTOKININS AND IMPACTS ON THE GERMINATION OF *Helianthus annuus L.*

Andrey POPATANASOV
Bulgarian Academy of Sciences, Sofia, Bulgaria
Email: and_atanasov@abv.bg

ABSTRACT
Helianthus annuus L. is introduced agriculture crop in Bulgaria with about a century long history. Soon after its introduction it widely and rapidly was accepted by the local farmers. As result countrywide it became the major oil producing agriculture species bringing Bulgaria to the position of world top producer. Alongside were initiated many research studies and breeding programs in order the useful traits of this crop to be improved and adapted to the local conditions. During these decades long efforts were developed and patented many sunflower cultivars. One of these cultivars is the cultivar Favorit, which became one of the main cultivars used for producing seeds for direct consumption in the country. Because of this high interest by the farmers it is grown in diverse local conditions and scenarios, some of them not the most optimal for the plant. It is known from other crops that pre-sowing treatments with some plant growth regulators can have beneficiary effects on the plant development under normal and stress conditions. Therefore this study was aimed to explore the effects of some cytokinin type plant growth regulators, on the early development and growth and on some important parameters for the farmers, since the stages of the early ontogenesis are among the most important ones for the long term survival, growth and yield for the crop. The results showed that there is improvement of the germination rate compared with the non-treated controls with all tested plant growth regulators. However, the results from the other parameters can have different trends depending on the application scenario of the used plant growth regulators.
Keywords: *Helianthus annuus,* cv. Favorit, hormopriming, cytokinin, phytohormone.

AGRICULTURE AS THE FOUNDATION OF NIGERIAN ECONOMIC ENTERPRISE

Ganya Adamu HAUNI (ORCID: 0000-0002-7173-2909)
Usmanu Danfodiyo University, Sokoto, (Nigeria). Faculty of Physical and Computing Sciences, Department of Statistics
Email: adamuganya@gmail.com

Dauda HAUWA (ORCID: 0000-0002-8319-1484)
Usmanu Danfodiyo University, Sokoto, (Nigeria). Faculty of Adult Education and Extension Services, Department of Adult Education
Email: hauwaganya@gmail.com

Ango MONICA (ORCID: 0000-0001-7860-8292)
Shehu Shagari University of Education Sokoto, (Nigeria). School of Vocational and Technical Education Department of Business Education
Email: monicaango@gmail.comj

Asabe IBRAHIM (ORCID: 0009-0007-3980-0725)
Federal University of Agriculture Department of Physics
Email: asabedauda@gmail.com

ABSTRACT

Agriculture is a sector of the Nigerian economy, accounting for up to 35% of total employment in 2020. According to the FAO.]Agriculture remains the foundation of the Nigerian economy, providing livelihoods for most Nigerians and generating millions of jobs. Along with crude oil, Nigeria relies on the agricultural products it exports to generate most of its national revenue. The agricultural sector in Nigeria comprises four sub-sectors: crop production, livestock, forestry, and fishing. Nigeria has a total agricultural area of 70.8 million hectares,[7] of which 34 million hectares are arable land, 6.5 million hectares are used for permanent crops, and 30.3 million hectares are meadows and pastures. Maize, cassava, guinea corn, and yam are the major crops farmed in Nigeria, with 70% of the households engaged in crop farming. In the south, 7.3% of the households practice fishing, while 69.3% of the households own or raise livestock in northwest Nigeria. In the third quarter of 2019, before the COVID-19 pandemic, the sector grew by 14.88% year-on-year. Crop production remains the largest part of the sector. During the third quarter of 2019, the agriculture sector contributed 29.25% to the overall real GDP.[10] Between January and March 2021, agriculture contributed 22.35% of the total gross domestic product. The sector is undergoing transformation through commercialization at the small, medium, and large enterprise levels.[16] However, there are several factors in the Nigerian agricultural sector that may prevent its growth, including a land tenure system that limits access to land, the country's level of irrigation development, limited adoption of research findings and technologies, costs of farm inputs, the amount of access to credit allowed by the management of specialized institutions established for the development of the agricultural sector, the manners of fertilizer procurement and distribution, storage facility

effectiveness, and the amount of access to markets. More recently, changes in average temperatures, rainfall, climate extremes, and the growing infestation of pests and related diseases precipitated by climate change pose a challenge to the integrity of the country's agriculture system. This is coupled with a dependence on rain-fed agriculture, which has made the sector vulnerable to seasonal conditions. These all contribute to agricultural productivity and post-harvest losses and waste in Nigeria. Illiteracy is also one of the several factors preventing the progress and development of agriculture in Nigeria. Research has proven that most of the farmers in Nigeria have not acquired formal education.

Keywords: Agriculture, Foundation, Nigerian Economy, Enterprise

EFFECTS OF CHITOSAN AND SILVER NANOPARTICLES ON TOMATO PLANT GROWTH UNDER HEAVY METAL STRESS CONDITIONS

Krupa-Małkiewicz MARCELINA (ORCID: 0000-0002-4333-9122)
Department of Plant Genetics, Breeding and Biotechnology, West Pomeranian University of Technology Szczecin, Szczecin 71-434, Poland
Email: mkrupa@zut.edu.p1

Ochmian IRENEUSZ (ORCID: 0000-0002-3606-1927)
Department of Horticulture, West Pomeranian University of Technology Szczecin, Słowackiego 17 Street, 71-434 Szczecin, Poland
Email: iochmian@zut.edu.pl

Agata JURKIEWICZ
Department of Plant Genetics, Breeding and Biotechnology, West Pomeranian University of Technology Szczecin, Szczecin 71-434, Poland

ABSTRACT
The study highlights the potential of chitosan and nanosilver in alleviating copper stress in tomato *in vitro* cultures. Tomato (*Solanum pimpinellifolium* L0566) explants were transferred on MS medium (control), MS with chitosan of molecular weight 3.33 kDa at concentration of 20 ppm, MS+6 mg l-1 nAg, MS+100 µl l-1 CuSO4 and combination of MS+100 µl l-1 CuSO4+20 ppm CH3.33 and MS+100 µl l-1 CuSO4+6 mg l-1 nAg. The research evaluated shoot and root length, number of new shoots per plant, and fresh mass. Results indicated that while copper or copper-nanosilver solutions inhibited growth traits, chitosan application stimulated growth, particularly in shoot production and fresh mass. Biochemical analyses revealed increased concentrations of proline, malondialdehyde, and total polyphenols in tomato explants under to copper stress. The addition of chitosan or nanosilver reduced these concentrations, indicating their potential role in mitigating heavy metal-induced stress. The mineral content analysis of tomato leaves showed that copper addition decreased most investigated mineral elements, while chitosan or nanosilver supplementation had minimal effects on individual elements compared to the control. Under heavy metal stress, chitosan and nanosilver positively influenced the elemental content of tomato leaves. Cluster analysis revealed distinct groups based on the influence of treatments on micro- and macroelements in tomato leaves, indicating differential responses to the growth conditions.
Keywords: tomato, chitosan, *in vitro*, nanoparticle, copper

SUBSTITUTING SUGAR WITH APPLE PUREE IN MUFFINS: IMPACT ON PHYSICAL AND TEXTURAL CHARACTERISTICS

Huțu DANA
Faculty of Food Engineering, Stefan cel Mare University of Suceava, Country Romania

Amariei SONIA
Faculty of Food Engineering, Stefan cel Mare University of Suceava, Country Romania

ABSTRACT
Concern for public health has led to increased attention to excessive sugar consumption and its impact on health. Sugar-rich baked goods have been the subject of extensive research into ways to reduce sugar content without compromising quality and taste. Various strategies have been applied to reduce the sugar content of baked goods, including the substitution of artificial sweeteners, the use of natural sweeteners, and adjusting recipes to reduce the proportion of sugar. Studies have shown that these strategies can be effective in reducing sugar intake and maintaining the quality of the final product. In addition, reduced sugar consumption in baked goods has been associated with health benefits such as reduced risk of obesity, diabetes and cardiovascular disease. However, reducing sugar content in baked goods is not without its challenges. Changes in traditional formulations can affect the taste, texture and appearance of finished products, and consumer acceptability can be influenced accordingly. In addition, there are concerns about the use of artificial sweeteners and their potential long-term health impact. The purpose of this research is to evaluate the impact of partial replacement of sugar with applesauce on the physical and textural characteristics of muffins. In this study, baking loss, height, volume, color and texture of muffins were investigated following partial/total replacement of sugar with applesauce. To achieve this goal, we conducted muffin preparation experiments using different percentages of sugar replacement with applesauce and compared the results obtained with the control sample. The results showed that the partial/total substitution of sugar with applesauce did not have a significant impact on the physical and textural characteristics of the muffins. Baking loss was generally higher for muffins in which applesauce was substituted for sugar. Also, muffin height and volume were not adversely affected by partial sugar substitution. The texture showed little differences compared to the control sample. These results suggest that partial replacement of sugar with applesauce in muffins may be an alternative to reduce sugar content and provide additional nutritional benefits. This approach could be of interest to the bakery industry and consumers interested in healthier and more nutritionally balanced options.
Keywords: apple puree, baking loss, color, height, muffins, sucrose, , texture, volume

ŞARBON (ANTRAKS) TANISINDA GÜNCEL YAKLAŞIMLAR

Ahu KAYALARLI ACARTÜRK (ORCID: 0009-0006-0294-1498)
Veterinary Control Institute, Bacteriological Diagnosis Laboratory, Samsun-Türkiye
Email: ahu.acarturk@taimorman.gov.tr

ÖZET

B. anthracis Gram pozitif, çomak şeklinde, oksijen varlığında hızlı bir şekilde spor oluşturan, genellikle endemik alanlardaki topraklarda bulunan zoonoz bir bakteridir. Çeşitli Bacillus türleri arasındaki genetik benzerliklerin yanı sıra hem spor formunda hem de vejetatif durumda bulunmasından dolayı, *B. anthracis*'in saptanması ve spesifik tanımlanmasının karmaşık teknikler ve/veya zahmetli yöntemler gerektirdiği kanıtlanmıştır. Etkenin biyoterörizm ajanı olarak kullanılma potansiyeli, mesleki maruziyet riskinin bulunması ve sporlarının çevrede kalıcılığı nedeniyle hızlı ve kesin tanı metotlarının geliştirilmesi kaçınılmaz olmuştur. Bunların yanı sıra enfeksiyonun tanısının çoğunlukla zor olması, hızlı yayılması ve yüksek mortaliteye sahip olmasından dolayı hastalığın hızlı ve kesin bir şekilde tanısının konması gerekmektedir. Moleküler araçlar, toprak, hayvan ve insan gibi farklı *B. anthracis* izolatları arasındaki çapraz bulaşmayı belirlemek amacıyla geniş çapta kullanılmaya başlamıştır. *B. anthracis*'in tespitinde kullanılan PCR, Real-Time PCR ve multipleks PCR) teknikleri de dahil olmak üzere çok çeşitli nükleik asit amplifikasyon tabanlı teknik mevcuttur. Mikrobiyal genom dizilimi -veya DNA parmakizi- infeksiyöz hastalık salgınlarını geriye dönük takip etme ve virülant veya multiresistant patojelerin global düzeyde izinin sürülmesi açısından oldukça önemlidir. Suşlar arasındaki genetik ilişkiyi ortaya koyabilecek yeni moleküler yöntemlere ihtiyaç duyulması sonucu çok sayıda lokustaki tekrarlayan gen bölgelerinin analizi (MLVA) yöntemi *B. anthracis* suşlarının genetik analizi konusunda ön plana çıkmıştır. *B. anthracis'*in genetik identifikasyonu için yapılan ilk çok lokuslu VNTR (Variable Number of Tandem Repeats) analizi 8 lokuslu MLVA çalışmaları olmuştur. Ancak MLVA-8 ile yapılan analizlerin ayrım gücünün yetersiz kaldığı kısa sürede anlaşılmış ve incelenen gen bölge sayısı 15'e, ardından 22'ye, sonrasında ise 25'e çıkartılmıştır. MLVA25 ile yapılan analizler sonucu *B. anthracis*'in bölgesel genotiplerini belirlemenin yanı sıra dünyadaki farklı genotiplerin tanımlanması da sağlanabilmiştir. Bu sayede saptanan genotiplerin daha önce saptanmış olanlar ile karşılaştırmaları yapılarak suşların coğrafik olarak dağılımları ve orijinleri hakkında bilgi almak mümkün olabilmektedir.

Anahtar Kelimeler: *B. anthracis*, Biyoterörizm, MLVA

CURRENT APPROACHES TO ANTHRAX DIAGNOSIS

ABSTRACT
B. anthracis is a Gram-positive,rod-shaped,zoonotic bacterium that quickly forms spores in the presence of oxygen,is generally found in soils in endemic areas.Due to the genetic similarities between various Bacillus species as well as its presence in both spore form and vegetative state,detection and specific identification of *B. anthracis* has proven to require complex techniques and/or laborious methods.Due to the potential as a bioterrorism agent,the risk of occupational exposure and the persistence of its spores in the environment,the development of rapid and accurate diagnostic methods has become inevitable.In addition,since the infection is often difficult to diagnose,spreads rapidly and has high mortality,the disease must be diagnosed quickly and precisely.Molecular tools have begun to be widely used to identify cross-contamination between different *B. anthracis* isolates such as soil,animal and human.A wide variety of nucleic acid amplification-based techniques are available for the detection of *B. anthracis*,including PCR,Real-Time PCR and multiplex PCR techniques.Microbial genome sequencing-or DNA fingerprinting-is very important for retrospectively tracking infectious disease outbreaks and tracing virulent or multiresistant pathogens at a global level.As a result of the need for new molecular methods that can reveal the genetic relationship between strains,MLVA method has come to the fore in the genetic analysis of *B. anthracis* strains.The first multi-locus VNTR analysis performed for the genetic identification of *B. anthracis* was the 8-locus MLVA study.However,it was soon realized that the discriminatory power of the analyzes performed with MLVA-8 was insufficient and the number of gene regions examined was increased to 15,22 and 25.As a result of the analyzes performed with MLVA25,in addition to determining the regional genotypes of *B. anthracis*,it was also possible to identify different genotypes in the world.In this way,it is possible to obtain information about the geographical distribution and origin of the strains by comparing the detected genotypes with those previously detected.
Keywords: *B. anthracis*, Bioterrorism, MLVA

HAMDANİ MELEZİ KOYUN (*Ovis Aries*) FETÜSLERİNDE KARACİĞERİN MORFOLOJİK ve HİSTOLOJİK YAPISININ İNCELENMESİ

Dr. Öğr. Üyesi Barış Can GÜZEL (ORCID: 0000-0002-2504-120X)
Siirt University, Faculty of Veterinary Medicine, Department of Anatomy, Siirt-Turkey
Email: bcguzel@hotmail.com

ÖZET

Karaciğer hem endokrin hem ekzokrin fonksiyonuna sahip vücuttaki en büyük bezdir. Bunun yanı sıra depolama, sentezleme gibi önemli görevleri vardır. Karaciğer diyaframın arkasında karın boşluğunun göğüs boşluğundaki kısmında median hattın sağ tarafında konumlanır. Boyut olarak türden türe, yaşa ve çevresel etkilere bağlı olarak değişkenlik gösterebilir. Fetal dönemde hemopoitic (kan yapıcı) bir organ olarak görev yaparken, olgun dönemde ise dalakta parçalanmış alyuvar artıklarını kandan temizler. Karaciğer gebelik döneminde yapısal değişiklikler gösterebilir ve bu değişikliklerin, açığa çıkarılması için detaylı çalışmalara ihtiyaç duyulmaktadır. Bu amaç doğrultusunda, gebeliğin son iki döneminde (2. ve 3. trimester) her grupta 7 erkek 7 dişi olacak şekilde toplam 28 adet Hamdani melezi fetüs karaciğeri kullanıldı. Fetüslerden, dikkatli bir diseksiyon ile karaciğer'in topografik konumu tespit edildi. Çıkarılan karaciğer dokusunun makroskobik ve morfometrik özellikleri belirlendi. Fötal ağırlık, karaciğer ağırlığı, sağ ve sol lop uzunluğu ve genişliği, lobus caudatus uzunluk ve genişliği gibi morfometrik parametreler belirlendi. Ayrıca toplanan karaciğer dokuları rutin histolojik prosedür ile takip edilerek Hemotoksilen & Eozin ve Masson Trichrome boyamaları ile mikroskobik düzeyde incelendi. Çalışma sonucunda 2. trimesterde ortalama CRL (crown-rump length) uzunluğu 15.68 ± 4.71 cm, ortalama fötal ağırlık 300.35 ± 260.39 g, ortalama karaciğer ağırlığı 19.72 ± 16.61 g, ortalama genişlik 4.25 ± 1.42 cm, ortalama yükseklik 4.43 ± 1.50cm olarak belirlenirken, 3.trimesterde bu ölçümler ortalama CRL uzunluğu 40.10 ± 4.16 cm, ortalama fötal ağırlık 2241.42 ± 541.32 g, ortalama karaciğer ağırlığı 59.68 ± 18.61 g, ortalama karaciğer genişliği 11.01 ± 1.34 cm, ortalama karaciğer yüksekliği 8.97 ± 1.54 cm olarak belirlendi. Histolojik incelemeyle 2. ve 3. trimesterde mikroskobik benzerlik ve farklılıklar belirlendi. Mikroskobik inceleme sonucunda karaciğer parankim yapısının, ikinci ve üçüncü trimester dönemlerinde gelişmeye devam ettiği izlendi. Elde edilen bilgiler anatomi ve histoloji literatürüne katkı sağlamasının yanı sıra, insan ve hayvan sağlığında yapılan, bilimsel araştırmalar için temel teşkil edecek niteliktedir.

Anahtar Kelimeler: Koyun fetus, Hamdani koyunu, karaciğer histolojisi, karaciğer morfometrisi

INVESTIGATION OF THE MORPHOLOGICAL AND HISTOLOGICAL STRUCTURE OF THE LIVER IN HAMDANI CROSSBREED SHEEP (*Ovis Aries*) FETUS

ABSTRACT

The liver is the largest gland in the body and has both endocrine and exocrine functions. In addition, it has important functions such as storage and synthesis. The liver is located behind the diaphragm, on the right side of the median line in the thoracic portion of the abdominal cavity. The liver may vary in size from species to species, depending on age and environmental influences. While it functions as a hemopoitic (blood-forming) organ in the fetal period, it cleans the fragmented red blood cell residues in the spleen from the blood in the mature period. The liver may show structural changes during pregnancy and detailed studies are needed to reveal these changes. For this purpose, 28 Hamdani crossbreed fetus livers, 7 males and 7 females in each group, were used in the last two periods of pregnancy (2. and 3. trimester). The topographic location of the liver was determined from the fetuses by careful dissection. Macroscopic and morphometric properties of the extracted liver tissue were determined. Morphometric parameters such as fetal weight, liver weight, right and left lobe length and width, lobus caudatus length and width were determined. In addition, the collected liver tissues were followed by a routine histological procedure and examined microscopically with Hematoxylin & Eosin and Masson Trichrome staining. As a result of the study, the average CRL (crown-rump length) length in the second trimester was determined as 15.68 ± 4.71 cm, the average fetal weight was 300.35 ± 260.39 g, the average liver weight was 19.72 ± 16.61 g, the average width was 4.25 ± 1.42 cm, and the average height was 4.43 ± 1.50cm. In the 3rd trimester, these measurements were determined as mean CRL length 40.10 ± 4.16 cm, mean fetal weight 2241.42 ± 541.32 g, mean liver weight 59.68 ± 18.61 g, mean total liver width 11.01 ± 1.34 cm, and mean total liver height 8.97 ± 1.54 cm. Microscopic similarities and differences were determined in the 2nd and 3rd trimesters by histological examination. As a result of microscopic examination, it was observed that the liver parenchymal structure continued to develop in the second and third trimester periods. In addition to contributing to the anatomy and histology literature, the information obtained will form the basis for scientific research in human and animal health.

Keywords: Hamdani sheep, liver histology, liver morphometry, sheep fetus

AFRICAN SWINE FLU EPIDEMIC IN ROMANIAN MEDIA

Marinache RAMONA (ORCID: 0000-0002-4072-8253)
University of Bucharest, Faculty of Letters, Department of Cultural Studies, Bucharest, Romania.
Email: ramona.marinache@gmail.com

Marinescu VALENTINA (ORCID: 0000-0002-9882-5902)
University of Bucharest, Faculty of Sociology and Social Work, Department of Sociology, Bucharest, Romania.
Email: vmarinescu9@yahoo.com

ABSTRACT
This presentation deals with both general and specific aspects pertaining to the manner in which Romanian media covered the African swine flu epidemic crisis in the interval between January 1st, 2014 and December 31st, 2018, after investigating a total of 450 texts. In Romania ASF was presented as a medical and scientific issue, but also as a political and legal matter. Unlike other studies data do not confirm the hypothesis which states that when confronting a public health crisis, mass-media selects and handles negative information infavour of the positive. At the same time, the way in which the epidemic was presented in Romanian media adheres to the distinction between "carriers" in the case of inter-human diseases and "carriers" in the case of epizootic diseases. This presentation delivers relevant aspects related to current changes in journalism. More specifically, the main media frames in covering epizootic diseases (economic repercussions, leadership, medical and scientific issues, political and legal matters) indicate a laid-back approach to the subject. At the same time, variations in the ties between text information and the formal properties of media coverage suggest the need for future development in the field of crisis communication concerning health risks, especially in the case of epizootics
Keywords: epizootic, mass media, African Swine Flu, crisis, public health.

AGRICULTURE IN ROMANIAN MEDIA

Marinescu VALENTINA (ORCID: 0000-0002-9882-5902)
University of Bucharest, Faculty of Sociology and Social Work, Department of Sociology, Bucharest, Romania.
Email: vmarinescu9@yahoo.com

Marinache RAMONA (ORCID: 0000-0002-4072-8253)
University of Bucharest, Faculty of Letters, Department of Cultural Studies, Bucharest, Romania.
Email: ramona.marinache@gmail.com

ABSTRACT
Agricultural issues are not typically analyzed in relation to populism, despite the fact that economic debate is at the center of populist discourse. Discourse is understood as the meanings given to phenomena (both social and physical) and the practices associated with those meanings. This paper will focus on two areas of agriculture in relation to populist discourse and ideology. First, we discuss the media coverage of african pigs pesta in 2017 and 2018 and examine whether this reconstruction of the topic have already set the basis of a populist discourse about agriculture for the Europarliamentary Elections from 2019. Second, we investigate the coverage of agriculture issues in media presentation of electoral campaign for the EU Parliament in 2019. Analysis of media coverage reveals distinctive meanings and metaphors concerning the role of agriculture in the general economy and in the conceptualisation of its nature along with elements of co-construction.
Keywords: agriculture, mass media, populism, media coverage, public issues.

INFLUENCE OF LEGUME/MAIZE CROPPING SYSTEMS AND RHIZOBIUM ON SOIL PHYSICAL PROPERTIES, GROWTH AND YIELD OF MAIZE (*Zea mays* L.)

Ewetola E. A.*
Department of Crop Production and Soil Science
Ladoke Akintola University of Technology, P.M.B.4000, Ogbomoso, Oyo State, Nigeria
Email: *eaewetola@lautech.edu.ng*

Ogunrinde J. O.
Department of Crop Production and Soil Science
Ladoke Akintola University of Technology, P.M.B.4000, Ogbomoso, Oyo State, Nigeria

Aborode M. A.
Department of Crop Production and Soil Science
Ladoke Akintola University of Technology, P.M.B.4000, Ogbomoso, Oyo State, Nigeria

Alabi D. A.
Department of Crop Production and Soil Science
Ladoke Akintola University of Technology, P.M.B.4000, Ogbomoso, Oyo State, Nigeria

ABSTRACT
Continuous cropping without additional input depletes the soil of essential nutrient demand of crop. However, intercropping always results in a more efficient utilization of growth resources among crops and more yield. Therefore, a study was conducted on the effect maize-legume cropping system and rhizobium on selected soil physical properties, growth and yield of maize at the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Treatments included sole maize, sole soybean, sole peuraria, soybean+rhizobium, maize+soybean, maize+soybean + rhizobium, maize + peuraria, and natural fallow (control) with three replications. Maize and soybean seeds were sown and data were collected on their growth and yield. Soil data were collected on soil temperature, bulk density, total porosity, and gravimetric moisture content. Soil bulk density decreased and total porosity increased under sole maize which was similar to the control. Gravimetric moisture content increased significantly under maize+peuraria by 11% compared to control. The highest soil temperature was observed in sole peuraria plots and the lowest was found in maize +soybean+ rhizobium (MZ+SB+RB) plots in comparison with the control. Maize leaf area was significantly higher on sole maize plot than (MZ+SB+RB) and MZ+SB by 64% and 65%, respectively. Similarly, sole maize recorded wider stem girth than (MZ+SB+RB) and MZ+SB. Soybean inoculated with rhizobium produced significantly wider stem girth and higher dry shoot weight than soybean without inoculation. It can be suggested that maize+peuraria will be a better cropping system for moisture conservation and soybean inoculation can improve soybean growth.
Keywords: Legume, Maize, Rhizobium, Physical properties

NEW BIOSTIMULANT (VOGOR STIMULANT) AS A PLANT GROW PROMOTER FOR PLANT GERMINATION ENHANCEMENT AND INCREASE THE YIELD OF FRIUT PRODUCTION

Kamran FAGHIHI
Faghihi Inductrial and Manufacturer Company (FIMACO) unit 207, Ferdousi Building, Ferdousi St., Shıraz-Iran.

Mehdi KHEIRANDISH
Faghihi Inductrial and Manufacturer Company (FIMACO) unit 207, Ferdousi Building, Ferdousi St., Shıraz-Iran.

Mohammad Kazem MOHAMMADI*
Faghihi Inductrial and Manufacturer Company (FIMACO) unit 207, Ferdousi Building, Ferdousi St., Shıraz-Iran.
Email: mkmohamadi@gmail.com , info@fimaco.org

ABSTRACT
Biostimulant is a material, which when applied in minute quantity promotes plant growth. Here, the word “minute” describes how the biostimulants are different from soil amendments and nutrients that perform a similar task but are applied in higher amounts. VIGOR STIMULATOR is a homogeneous powder mixture of Humic acid and Seaweed and is designed to support the growth of field crops, fruit and ornamental plants during the entire vegetation ranging from support for the formation of roots, growth, leaf area through the main preiods of growth until flowering and fruit growth. Nutrient uptake improvement: Fulvic acid creats an organic coating around Macro and Micronutrients which is similar to plant tissues and easily penetrate inside them Stimulates cell division and expansion: Ascophyllum nodosum extract is rich in active ingredientswith auxin- and cytokinin-like activit; as a result, it effectively stimulates cell division and expansion and promotes the proper hormone balance in plant tissues Photosynthetic activity enhancement: Humic acid stimulates the photosynthetic activity and augments the chlorophyll content and mesophyll cells. Besides its good chelating properties, humic acid flows well in various plant tissues and easily enters the roots, stems and leaves and transfers micronutrients from the plant surface to plant tissue. Therefore, it is a key element in many foliar fertilizer. Our organic stimulators contain natural elements. These contribute to a diverse soil life, healthier crops and better, tastier end products. They work quickly and effectively.
Keywords: Biostimulant, Plant growth, Germination, fruit production, Vigor stimulant

BIR KUZUDA KONJENITAL SKROTUM FITIĞI OLGUSU

Doç. Dr. Abdullah KARASU (ORCID: 0000-0001-9443-3867)
Van Yuzuncu Yil University, Faculty of Veterinary Medicine, Department of Surgery, Van -Türkiye
Email: abdullahkarasu@hotmail.com

Dr. Öğr. Üyesi Caner KAYIKCI* (ORCID: 0000-0001-7343-1045)
Van Yuzuncu Yil University, Faculty of Veterinary Medicine, Department of Surgery, Van -Türkiye
Email: caner5246@hotmail.com

ÖZET
Olgunun materyalini Van Yüzüncü Yıl Üniversitesi Veteriner Fakültesi Cerrahi Anabilim Dalı kliniğine getirilen 2 aylık erkek akkaraman ırkı bir kuzu oluşturdu. Anamnez bilgisinde, doğduktan birkaç gün sonra testislerinde bir şişkinlik fark etiklerini ve zamanla bu şişkinliğin arttığı bilgisi alındı. Klinik muayenede, beden ısısı, solunum ve nabız gibi diğer fiziksel muayene bulgularının normal olduğu belirlendi. Hayvan ayakta iken inspeksiyon ile yapılan muayenede skrotumun neredeyse yere değecek şekilde anormal derecede genişlediğini gözlemlendi. Skrotumun palpasyon ile muayenesinde testisler palpe edilemedi. Skrotal şişliğin fluktuan olduğu ve hafif bir ağrının varlığı tespit edildi. Hayvanın sırtüstü pozisyonda yatırılarak yapılan muayenesinde inguinal kanalın genişlediği, içeriğin kısmen red olduğu görüldü. Klinik muayene sonucu konjenital skrotum fıtığı tanısı konularak operasyona karar verildi. Sırtüstü pozisyonda operasyon masasına tespit edilen hastanın sedasyonunu takiben lokal anestezi eşliğinde herniorafi operasyonu gerçekleştirildi. İnguinal kanalın üzerinden paramedian ensizyonu takiben tunika vaginalise ulaşıldı. Fıtıklaşan yapılar reddedildikten sonra tunika vaginalis kendi ekseni etrafında burularak transfiksiyon ligatürü uygulandı. Ligatürün 1-2 cm altından kesilerek operasyon tamamlandı. Postoperatif 5 gün süre ile parenteral antibiyotik ve lokal antiseptik uygulandı. Operasyondan sonraki 10. gün yapılan muayenede herhangi bir komplikasyonun şekillenmediği, kuzunun genel durumunun iyi olduğu saptandı ve operasyon yarasındaki dikişler alındı. Nadir görülen konjenital skrotal fıtığın başarılı bir şekilde tedavi edilmesi ve olgunun klinik bulgular ile sağaltım sonuçlarının paylaşılmasının veteriner pratiğine katkı sağlayacağı kanısına varıldı.
Anahtar Kelimeler: Konjenital, Skrotum Fıtığı, Kuzu

A CASE OF CONGENITAL SCROTUM HERNIA IN A LAMB

ABSTRACT
The material of the case was a 2-month-old male Akkaraman lamb brought to the clinic of Van Yuzuncu Yıl University, Faculty of Veterinary Medicine, Department of Surgery. The anamnesis revealed that a few days after birth, a swelling was noticed in the testicles and this swelling increased over time. On clinical examination, other physical examination findings such as body temperature, respiration and pulse rate were found to be normal. The scrotum was observed to be abnormally enlarged almost touching the ground on inspection while the animal was standing. On palpation of the scrotum, testes could not be palpated. The scrotal swelling was fluctuant and there was mild pain. Examination of the animal in supine position showed that the inguinal canal was enlarged, and the contents were able to partially reducible. As a result of clinical examination, congenital scrotum hernia was diagnosed, and operation was decided. The patient was fixed on the operation table in dorsal recumbency and herniorrhaphy operation was performed under local anaesthesia following sedation. Following paramedian incision over the inguinal canal, tunica vaginalis was reached. After the herniated structures were rejected, the tunica vaginalis was twisted around its axis and transfixion ligature was applied. The operation was completed by cutting 1-2 cm below the ligature. Parenteral antibiotics and local antiseptics were applied for 5 days postoperatively. On the 10th day after the operation, no complication was observed, the lamb was in good general condition and the sutures in the operation wound were removed. It was concluded that successful treatment of a rare congenital scrotal hernia and sharing the clinical findings and treatment results of the case will contribute to veterinary practice.
Keywords: Congenital, Scrotal Hernia, Lamb

KOYUNLARDA SUBKLİNİK GEBELİK TOKSEMİSİNİN TANISI İÇİN KAN BHBA ÖLÇÜM CİHAZLARININ KARŞILAŞTIRILMASI: SAHA ÇALIŞMASI

Arş. Gör. Dr. Ali Osman TURGUT (ORCID: 0000-0001-6863-0939)
Siirt University, Faculty of Veterinary Medicine, Department of Animal Science, Siirt, Türkiye
Email: aosman.turgut@siirt.edu.tr

Arş. Gör. Dr. Davut KOCA (ORCID: 0000-0002-7962-6959)
Van Yuzuncu Yil University, Faculty of Veterinary Medicine, Department of Obstetrics and Gynecology, Van, Türkiye
Email: davutkoca@yyu.edu.tr

Arş. Gör. Ali ÜNVER (ORCID: 0000-0002-9683-7387)
Siirt University, Faculty of Veterinary Medicine, Department of Obstetrics and Gynecology, Siirt, Türkiye
Email: ali.unver@siirt.edu.tr

ÖZET
Gebelik toksemisi koyunlarda gebeliğin son trimesterinde ortaya çıkan ciddi bir hastalıktır. Ancak hastalık çoğu zamanda subklinik bir seyir izleyebilmektedir. Bu çalışmada ileri gebe koyunlarda subklinik gebelik toksemisinin tanısı için kan βHBA ölçüm cihazlarının karşılaştırılması amaçlanmıştır. Araştırmada Romanov (n=30) ve Hamdani melezi (n=20) koyunlardan toplam 50 adet kan örneği toplandı. Kan βHBA seviyeleri TaiDoc TD-4235 ve CentriVet βHBA ölçüm cihazları kullanılarak ölçüldü. Ölçüm cihazlarını karşılaştırmak için referans laboratuvar yöntemi olarak Randox βHBA (Ranbut) testi kullanıldı. Subklinik gebelik toksemisi teşhisi için βHBA eşik değeri 0,8 mmol/L olarak kabul edildi. İstatistiksel analizler Minitab 21 ve Jamovi yazılımı kullanılarak gerçekleştirilmiştir. Çalışmada Randox-TaiDoc TD-4235 ve Randox-CentriVet korelasyonu sırasıyla 0,822 ($p<0,001$) ve 0,728 ($p<0,001$) olarak bulunmuştur. Ranbut analizine göre 50 koyundan dokuzuna subklinik gebelik toksemisi tanısı konuldu. TaiDoc TD-4235 ve CentriVet ölçüm cihazlarının özgüllüğü (sağlıklı koyunların tespiti) ve duyarlılığı (subklinik gebelik toksemisi olan koyunların tespiti) sırasıyla %100, %77,8 ve %100, %66,7 olarak belirlendi. Elde edilen bulgular koyunlarda subklinik gebelik toksemisinin tanısı için TaiDoc ölçüm cihazının CentriVet ölçüm cihazına kıyasla Randox Ranbut testi ile korelasyonun daha iyi ve daha yüksek duyarlılıkta olduğunu ortaya koymaktadır.
Anahtar Kelimeler: Subklinik gebelik toksemisi, Randox, TaiDoc, Ölçüm cihazı, Koyun

COMPARISON OF BLOOD BHBA MEASUREMENT DEVICES FOR DIAGNOSIS OF SUBCLINICAL PREGNANCY TOXEMIA IN SHEEP: A FIELD STUDY

ABSTRACT

Pregnancy toxemia is a serious disease that occurs during last trimester of pregnancy in sheep. However, in most cases disease may have subclinical course. This study was aimed to comparison of blood βHBA measurement devices for diagnosis of subclinical pregnancy toxemia in late pregnant sheep. In the study, a total of 50 blood samples were collected from Romanov (n=30) and cross-bred Hamdani (n=20) sheep. Blood βHBA levels were measured using TaiDoc TD-4235 and CentriVet βHBA hand-held meter. Randox βHBA (Ranbut) assay was used as reference laboratory method to compare hand-held meters. βHBA value of 0.8 mmol/L was set as cut-off value for diagnosis of subclinical pregnancy toxemia. Statistical analyses were carried out using Minitab 21 and Jamovi software. In the study, correlation of Randox-TaiDoc TD-4235 and Randox-CentriVet were 0.822 ($p<0.001$) and 0.728 ($p<0.001$), respectively. Based on Ranbut assay, nine ewes of 50 were diagnosed as subclinical pregnancy toxemia. Specificity (detection of healthy ewes) and sensitivity (detection of ewes with subclinical pregnancy toxemia) for TaiDoc TD-4235 and CentriVet hand-held meters were 100%, 77.8% and 100%, 66.7%, respectively. Results indicates that TaiDoc hand-held meter show better correlation with Randox Ranbut assay and greater sensitivity compared to CentriVet hand-held meter for diagnosis of subclinical pregnancy toxemia in sheep.

Keywords: Subclinical pregnancy toxemia, Randox, TaiDoc, Hand-held meter, Sheep

HGC27 GASTRİK KANSER HÜCRELERİNDE KANABİNOİDLERİN MOLEKÜLER MEKANİZMASI VE ANTİKANSER ETKİSİ

Öğr. Gör. Kezban UÇAR ÇİFÇİ (ORCID: 0000-0002-4758-4141)
Yozgat Bozok University, Hemp Research Institute, Division of Basic Sciences and Health, Yozgat-Türkiye
Email: kezban.u.cifci@bozok.edu.tr

ÖZET
Mide kanseri dünya çapında en yaygın görülen 4. kanser türü olmasına rağmen kansere bağlı ölümlerde 2. sırada yer almaktadır. Erken evrede genellikle belirtisiz olması, özgün biyobelirtecinin bulunmaması ve rutin tarama protokollerinin olmaması nedeniyle hastaların çoğu ileri evrede tanı almaktadır ve ortalama 5 yıllık sağkalım oranlarına sahiptir. Cerrahi ve/veya kemoterapi uygulaması gibi güncel tedavi seçeneklerinin dışında yeni tedavi metodlarına ihtiyaç duyulmaktadır. Yaygın olarak esrar olarak bilinen Cannabaceae ailesinin bir üyesi olan Cannabis sativa, 5000 yıldan fazla bir süredir kullanılmaktadır ve dünyanın en eski ilaç ve tekstil lifi bitki kaynaklarından biridir. Kanabinoidler, son 20 yılda kanser de dahil olmak üzere diğer durumlar ve hastalıklar için değerlendirilmiştir. Kannabidiol (CBD), terapötik potansiyeli ve psikoaktif içeriğinin olmamasından dolayı son yıllarda çok fazla ilgi gören bir fitokanabinoiddir. Çalışmamızda kannabidiolün, insan HGC27 mide kanseri hücresinde antikanser etkisinin ve moleküler mekanizmasının araştırılmıştır. Kannabidiolün sitotoksik etkisi MTT analizi ile değerlendirildi ve IC50 değeri belirlendi. Çalışmanın devamındaki analizler için belirlenen hücrelere IC50 değerindeki kannabidiol konsantrasyonu uygulandı. Total RNA izolasyonu ve cDNA sentezi, flow sitometri ile apoptoz analizinde kontrol ve doz gruplarında tamamlanarak potansiyel kanser patogenezinde etkili olan genler RT-PCR ile çalışıldı. Çalışmanın sonucunda CBD'nin HGC27 hücre hattında 48 saat sonunda IC50 değeri 21.24 µM olarak belirlendi. Anjiyogenez, apoptoz, hücre döngüsü, DNA replikasyonu, DNA hasarı onarımı ile ilişkili genlerin ekspresyon seviyelerinin değiştiği gözlemlendi. Flow sitometri ile yapılan apoptoz analizinde CBD, mide kanseri hücrelerini kontrole kıyasla %28.4 apoptoza götürdü. Böylelikle çalışmamızda, kannabidiolün mide kanseri hücresinde antikanser etkisi ve moleküler mekanizması belirlendi.
Anahtar Kelimeler: Mide kanseri, kannabidiol, apoptoz, sinyal yolakları

MOLECULAR MECHANISM AND ANTICANCER EFFECT OF CANNABINOIDS IN HGC27 GASTRIC CANCER CELLS

ABSTRACT

Although gastric cancer is the fourth most common cancer worldwide, it is the second most deadly cancer. Since gastric cancers do not show symptoms at early stage, lack specific biomarkers and routine screening protocols, most patients are diagnosed at an advanced stage and have an average survival rate of 5 years. Novel treatment methods are in need in addition to current treatment options such as surgery and/or chemotherapy. Cannabis sativa, a member of the Cannabaceae family, widely known as cannabis, has been in use for over 5000 years and is one of the world's earliest plant sources of medicine and textile fiber. Cannabinoids have been assessed for diseases including cancer and other conditions in the last 20 years. Cannabidiol (CBD) is a phytocannabinoid that has gained much acclaim in recent years owing to its therapeutic potential and lack of psychoactive qualities. In our study, we examined the anticancer activity and molecular mechanism of cannabidiol in human HGC27 gastric cancer cells. The cytotoxic effect of cannabidiol was evaluated by MTT assay and IC50 value was identified. Cannabidiol concentration at IC50 value was administered to the cells for subsequent analysis. Total RNA isolation and cDNA synthesis, flow cytometry and apoptosis analysis were performed in control as well as dose groups and genes that are effective in potential cancer pathogenesis were studied by RT-PCR. In the study, the IC50 value of CBD in HGC27 cell line at the end of 48 hours was determined to be 21.24 µM. It was observed that the expression levels of genes related to angiogenesis, apoptosis, cell cycle, DNA replication and DNA damage repair had changed. In apoptosis analysis by flow cytometry, CBD induced 28.4% apoptosis in gastric cancer cells compared to control. Thus, in our study, the anticancer effect and molecular mechanism of cannabidiol in gastric cancer cells were determined.

Keywords: Gastric cancer, cannabidiol, apoptosis, signaling pathway

ANALYSIS OF CHANGE OF LAND COVER IN THE AREA OF THE MUNICIPALITY OF ILIDŽA

Edin HRELJA (ORCID: 0000-0002-2454-2141)
University of Sarajevo, Faculty of Science, Department of Geography, Sarajevo, Bosnia and Herzegovina.
Email: edinhrelja@pmf.unsa.ba

Amina SIVAC (ORCID: 0000-0002-7795-086X)
University of Sarajevo, Faculty of Science, Department of Geography, Sarajevo, Bosnia and Herzegovina.
Email: amina.sivac@pmf.unsa.ba

ABSTRACT
The subject of the research is the analysis of the change in land cover in the area of the municipality of Ilidža. In the period after 1995, throughout the entire Bosnia and Herzegovina, a visible spontaneous spatial planning contributed to significant changes in the land cover. The research aims to determine how many changes have taken place in the last few decades in the researched area when it comes to land cover. The analysis is based on topographic maps from 1980, Google Earth images, then Corina Land Cover images from 2000, 2006, 2012, and 2018. Research on the topic was conducted through several phases. The first part of the paper refers to determining the geographical location of the research area and defining all its components. The second part of the paper deals with a detailed analysis of all categories of land cover in the last twenty years. The third part of the paper involves a comparative analysis of quantitative and qualitative indicators of land cover in the municipality of Ilidža. The complete procedure of the analysis was performed using GIS, where the corresponding databases were created and a cartographic visualization for the investigated area was performed.
Keywords: Bosnia and Herzegovina, Ilidža, planning, space, land cover, change, GIS.

FACTORING IMPORTANCE OF GENDER PERSPECTIVES IN AGRARIAN REFORMS, WITH SPECIAL FOCUS ON NATIONAL MISSION ON SUSTAINABLE AGRICULTURE (NMSA) IN INDIA

Dr. Amna MIRZA
Jamia Millia Islamia University, Associate Professor (Sarojini Naidu Centre for Women's Studies), Noam Chomsky Complex, Jamia Nagar, New Delhi-1100251, India
Email: amirza@jmi.ac.in

Dr. Chayanika UNIYAL
University of Delhi, Department of History, Shyama Prasad Mukherji College, West Punjabi Bagh, Punjabi Bagh, Delhi, 110026, India
Email: dr.chayanika@gmail.com

ABSTRACT
Agriculture is backbone for the Indian economy. Any economic sector be it in primary or secondary side becomes important to understand with respect to dynamics of job creation, migration, livelihoods etc. From seasonal nature to impact of vagaries of nature, agricultural issues demand deep deliberations further. Social mobility, migration from rural to urban, vicious circle of poverty often work in strange manner putting more women in agrarian sphere. Feminization of Agriculture not only then raises question marks over patriarchal norms, overburdening and often unrecognised aspects of work attributed to women. Further, agriculture sector too is not static. From the rise of new challenges like climate change and concerns of sustainable development, there is always a fire need for new innovative ideas for agriculture. In India, agriculture too has been witnessing changes and policies too have been reflecting the same. With Bharatiya Prakritik Krishi Paddhati (BPKP) under Paramparagat Krishi Vikas Yojana (PKVY) to National Mission on Natural Farming which gives importance to women roles through self help groups. Women in natural farming through their various roles in production to post production have been playing an important role. The paper attempts to underline the benefits of an innovative approach in agriculture to cater better to needs of the future. It discusses the significance of social security, recognition of women's role and participation, mainstreaming gender in order to ensure a holistic outcome towards the processes of natural farming. It argues that a gender inclusive approach will be beneficial for good agrarian outputs, rational strategy to deal with common challenges of food security, climate change and sustainability.
Keywords: Agriculture, Natural Farming, Women Issues, Innovation, Feminization of Agriculture

THE IMPACT OF POLITICAL PRESSURE ON JUDICIAL INDEPENDENCE: A COMPARATIVE ANALYSIS OF INDIA AND THE UK

Dr. Rida ZULFIQAR
University of Szeged

ABSTRACT
The concept of judicial independence is very important for keeping the rule of law, democracy, and the protection of human rights. This paper aims to study how political pressure affects judicial independence, with a focus on India and the UK. For our study, we use a qualitative method. This includes looking at case studies, legal documents, times when politics interfered with the courts, and talking to or getting opinions from experts in law. In India, we see political pressure in several ways. For example, the government might change laws that affect how judges are chosen or speak against judges in public. This can make it hard for judges to make decisions freely. In the UK, there are systems meant to protect judges from such pressures. For instance, the Judicial Appointments Commission helps in choosing judges without political influence. However, even with these systems, there are still challenges that need attention. When we compare India and the UK, we notice both differences and similarities in how they keep their courts free from political pressure. Each country has its own way of dealing with this issue, influenced by its culture, laws, and history. Some methods work well in protecting judges, while others may not. From our study, we learn how important it is to keep the judiciary independent in democracies. Political pressures can threaten this independence, but there are ways to protect it. We suggest some ideas for making sure judges can work without fear of political interference. In conclusion, our paper shows how political pressure can challenge the independence of the judiciary in both India and the UK. It's crucial for democratic societies to keep an eye on this issue and take steps to protect the freedom of their courts. This way, judges can make fair decisions, which is important for everyone's rights and for democracy itself.
Keywords: UK, judicial independence, India

SURVEY ON THE DIAGNOSIS AND MANAGEMENT OF VIRAL HEMORRHAGIC DISEASE IN RABBITS BY FIELD VETERINARIANS IN EASTERN ALGERIA

Mouassa BOCHRA (ORCID: 0009-0007-3766-1274)
University Chadli benjdid, el Tarf, Algeria
Researche lab: Epidemiological surveillance, health, production, reproduction, experimentation, and cellular therapy of domestic and wild animals
Email: Mouassa2903@gmail.com / b.mouassa@univ-eltarf.dz

Lynda SAHRAOUI
Research Laboratory. Animal Health and Production. National Higher Veterinary School, Algiers, Algeria
Email: sahraoui@ensv.dz

S. Maziz BETTAHAR
Institute of Veterinary Sciences, Saad Dahleb University, Blida, Algeria

ABSTRACT
Viral Hemorrhagic Disease (VHD) in rabbits is highly infectious and often fatal, leading to significant economic impact. Additionally, diagnosis remains challenging without laboratory confirmation. In this context, we conducted a survey among field veterinarians to estimate the frequency of this disease and the methods used by practitioners in diagnosing and managing it. During the year 2020 and the current year, we contacted about twenty veterinarians in Eastern Algeria in the regions of Batna, Guelma, Bourdj Bou Arridj, Mila, Souk Ahras, and Skikda. The survey undertaken in this study revealed that almost all contacted veterinarians were knowledgeable about VHD. The diagnosis of the disease is based on clinical signs, lesion appearance, and mortality rates. However, a few practitioners (6%) were able to obtain laboratory confirmation. Half of the surveyed veterinarians recommend and practice vaccination. In contrast, others mention the lack and high cost of the vaccine, which does not encourage breeders to adopt this practice. In the rabbit farming sector, viral hemorrhagic disease should receive special attention from veterinary services and clinicians to implement a tailored program for its management.
Keywords: rabbit, VHD, diagnosis, veterinarian, Eastern Algeria.

ENHANCING URBAN PLANNING THROUGH 3D MAPPING OF TREES IN CONFLICT WITH ELECTRICAL INFRASTRUCTURE

Enrico GONÇALVES (ORCID: 0009-0004-6092-8481)
Federal Institute of Education, Science, and Technology of Southern Minas Gerais
Inconfidentes Campus
Department of Surveying and Cartography Engineering Inconfidentes, MG - Brazil
Email: enrico.goncalves@alunos.ifsuldeminas.edu.br

Prof. Dr. Fábio ALBARICI (ORCID: 0000-0003-4436-0561)
Federal Institute of Education, Science, and Technology of Southern Minas Gerais
Inconfidentes Campus
Department of Surveying and Cartography Engineering Inconfidentes, MG - Brazil
Email: fabio.albarici@ifsuldeminas.edu.br

ABSTRACT
Urban vegetation, comprised of trees of various sizes, often encounters conflicts with the electrical grid, requiring regular pruning to prevent power outage issues. Three-dimensional mapping of urban trees, conducted using technologies such as terrestrial laser scanning, allows for a detailed analysis of tree conditions in relation to the electrical infrastructure. This study revealed that half of the trees in a specific test area face conflicts with the electrical grid, necessitating pruning. Heights range from 3.5 to 10.5 meters, with an average of 6.83 meters and a standard deviation of 2.42 meters. This three-dimensional mapping is crucial for identifying trees in need of intervention. Additionally, a virtual tour has been developed to provide an immersive experience, accessible through the link: https://my.matterport.com/show/?m=wkn4JBBYuad.
Keywords: Urban vegetation, electrical infrastructure, 3D survey, urban planning.

INSIGHTS INTO THE ADOPTION OF GM CROPS IN INDIA AND PUBLIC PERCEPTION: A SURVEY

Eshika M.
Department of Biotechnology, Vels Institute of Science, Technology and Advanced Studies, Pallavaram, Chennai – 600117, Tamilnadu, India

Hemashree V.
Department of Biotechnology, Vels Institute of Science, Technology and Advanced Studies, Pallavaram, Chennai – 600117, Tamilnadu, India

Thenmozhi M.*
Department of Biotechnology, Vels Institute of Science, Technology and Advanced Studies, Pallavaram, Chennai – 600117, Tamilnadu, India
Email: drmthenmozhi@gmail.com

ABSTRACT
The rising global demand for food, driven by population growth, has pushed agriculture towards modern methods and technologies, including genetically modified plants, a breakthrough in biotechnology. The use of GM crops has skyrocketed in the past 25 years, with a figure of nearly 190 million GM crops being planted by farmers worldwide in 2023. India being a major agricultural centre despite the ongoing controversies is observing the change in the status of GM crops. While there is ongoing research and experimentation with transgenic technology across a range of crops, so far cotton remains the only commercially cultivated GM crop in India and other crops like mustard are undergoing trials and approvals. Despite this, according to a report published by the International Service for the Acquisition of Agri-biotech Applications (ISAAA), globally India is still the 5th largest area under cultivation of GM crops. The debate over GM crops in India centers on potential benefits like increased productivity and reduced pesticides versus concerns about their impact on human health and environmental safety. This survey aims to gather information and opinions about Genetically Modified (GM) crops from a diverse range of individuals. Understanding public acceptance of genetically modified (GM) foods is crucial for both industries and policymakers. It can guide innovation strategies, policy development, and implementation. Therefore, this survey aims to explore public perception and knowledge of GM crops, along with their attitudes towards regulations and use.
Keywords: GM crops, survey, nutritional value, public perception, environment, human health

EVALUATION OF THE ENERGY CONTENT AND THE QUALITATIVE CHARACTERISTICS OF RENEWABLE ENERGY RESOURCES FROM SOME AGRICULTURAL CROPS

Neacsu ANA (ORCID: 0000-0001-7731-1905)
Institute of Physical Chemistry "Ilie Murgulescu", Laboratory of Chemical Thermodynamics, Bucharest, Romania.
Email: anna_matache@yahoo.com

Gheorghe DANIELA (ORCID: 0000-0002-3835-7318)
Institute of Physical Chemistry "Ilie Murgulescu", Laboratory of Chemical Thermodynamics, Bucharest, Romania.
Email: gheorghedanny2@gmail.com

ABSTRACT
Biomass as a renewable energy resource is a useful tool of solving the social-economical problems of this millennium beginning society. Exploitation of agricultural biomass as a fuel offers considerable advantages in different domains as energy supply as far as the climate is involved. The suitability of a particular biomass as a potential feedstock for biofuels production depends on various characteristics such as moisture content, calorific value, fixed carbon, ash content, nitrogen and sulphur. Agro-industrial by-products are produced mainly after crop processing.The studied samples are coarse ground grist of sorghum seeds, rape seeds, soyabean, sunflower seeds, their mixture with coal and grape pomace, corn cob pellets with addition of sawdust, starch and waste rapeseed oil.Higher heating value (HHV), higher heating value of ash free sample (HHVf), fuel value index (FVI) and energy density were calculated after combustion experiments.The advantages of co-firing mainly relate to environmental benefits. Co-firing of biomass with fossil fuels provides means to reduce SO2 and CO2 emissions and it also may reduce NOx emissions. Significant differences were observed between the combustion heat of pellets from co-fired and non-cofired samples.
Keywords: biomass, energy content, agricultural crops, cofiring, calorific value.

BIOSECURITY MEASURE IN TREATMENT OF PASTURES TO PREVENT GASTROINTESTINAL HELMINTH INFECTIONS OF SMALL RUMINANTS

Dr. Ivan PAVLOVIC* (ORCID: 0000-0003-4751-6760)
Scientific Institute of Veterinary Medicine of Serbia, Belgrade, Serbia.
Email: dripavlovic58@gmail.com

Prof. Dr. Jovan BOJKOVSKI (ORCID: 0000-0001-7097-2559)
Faculty of Veterinary Medicine, University in Belgrade, Belgrade, Serbia
Email: bojkovski@vet.bg.ac.rs

Dr. Aleksandra TASIC (ORCID: 0000-0002-8361-5697)
Scientific Institute of Veterinary Medicine of Serbia, Belgrade, Serbia.
Email: alekstasic79@gmail.com

Dr. Marija PAVLOVIC (ORCID: 0000-0003-1709-0412**)**
Scientific Institute of Veterinary Medicine of Serbia, Belgrade, Serbia.
Email: majaspavlovic@gmail.com

Dr. Violeta CARO PETROVIC (ORCID: 0000-0002-6126-3846)
Institute for Animal Husbandry, Belgrade-Zemun, Serbia
Email: violycaro@yahoo.com

Dr. Nemanja ZDRAVKOVIC (ORCID: 0000-0002-3925-4409)
Scientific Institute of Veterinary Medicine of Serbia, Belgrade, Serbia.
Email: nemanja.zdravkovich@gmail.com

ABSTRACT

The grazing method of feeding allows small ruminants - goats and sheep, constant contact with transitional hosts and eggs and larval forms of parasites, so that there is no sheep that is not infected with at least one parasite species. Permanent pastures represent the greatest health risk for sheep and goats, especially if they have been used unplanned for many years. Uncultivated pastures with poor floristic composition cause nutritional imbalances, but cultivated pastures that are used improperly are also a place for constant infections, especially parasitic agents. The cultivation of pasture directly depends on the geological and pedological composition of the soil, hydrological conditions (standing, running water) and microclimatic conditions. The main goal of cultivation is to obtain a pasture that contains a minimum of infectious agents in the soil, which is maximally free from vectors and transitional hosts of certain diseases (molluscs, arthropods) and infectious forms of parasites. At the same time, the grass must be of optimal quality, density and nutritional value. Successful cultivation must be based on real data. This means that in addition to the floristic and pedological composition of the soil, parasitological control of the soil and grass must be done. Interventions on pastures can be a good prerequisite for controlling and preventing parasitic diseases. The solution can be sought in the form of grazing - it can be mixed and grazing, and also the limitation of the number of individuals in the pasture can be applied. Mixed grazing implies the grazing of different herbivores on one pasture, which certainly has a positive effect on the

reduction of parasitic infections. Cross-country grazing is a method of using pastures to move animals from one part of the pasture to another at certain time intervals and return to them only after a certain period of rest.

Keywords: small ruminants, control, gastroıntestınal helmınth, bıosecurıty measure

WISTAR ALBINO BiR RATTA HİDRONEFROZ OLGUSU

Doç. Dr. Turan YAMAN (ORCID: 0000-0001-8811-9775)
Van Yüzüncü Yıl University, Faculty of Veterinary Medicine, Department of Pathology, Van, Turkey
Email: turanyaman@yyu.edu.tr

ÖZET
Hidronefroz, genellikle alt idrar yollarında idrar akışının bozulması nedeniyle ortaya çıkan ve böbrek medüller dokusunun önemli kaybıyla karakterize obstrüktif bir üropati olarak tanımlanmıştır. Sunulan çalışmanın materyalini 3 aylık bir erkek wistar albino rat oluşturdu. Deneysel bir çalışma sonunda, klinik olarak normal görünen kontrol grubuna ait bir rata kan ve doku örnekleri alınması amacıyla ötenazi uygulandı. Bu esnada, sol böbreğin olduğu alanda böbrek şeklinde kistik bir oluşum görüldü. Bu oluşum şeffaf ve ince bir zar ile çevriliyidi ve idrara benzeyen bir sıvı ile doluydu. Sağ böbrek ise normale yakın görünümdeydi. Ancak sağ böbreğin kesit yüzü incelendiğinde renal pelvisin genişlemiş olduğu görüldü. Histopatolojik inceleme amacıyla alınan doku örnekleri %10'luk tamponlu formalinde tespit edildikten sonra parafin bloklara gömüldü. Mikrotomla 4µm'lik kesitler alınıdı daha sonra hematoksilen-eozin ile boyanarak ışık mikroskobunda incelendi. İnceleme sonucunda, sol taraftaki kistik yapının, hidronefrotik böbrek olduğu tespit edildi. Şiddetli hücre kaybı neticesinde böbrek dokusundan geriye sadece kortikal bölgede ince bir hücre tabakası kalmıştı. Bu tabakada parankim yer yer birkaç sıra hücreden oluşacak kadar incelmişti. Sağ böbrekte ise renal pelvis ve kalikslerin genişlediği görüldü. Ayrıca glomerüler ve tübüler hasar mevcuttu. Sonuç olarak, bir ratta iki taraflı hidronefroz olgusu tanımlandı. Hidronefrotik böbreğe sahip ratlarda klinik görünümün bazen normal olabileceği bildirilmiştir. Ayrıca bazı laboratuvar değerlerinin normale yakın tespit edilebileceği aktarılmıştır. Bundan dolayı bu vaka araştırmacıların dikkatine sunulmuştur.
Anahtar Kelimeler: Hidronefroz, histopatoloji, rat, böbrek

A CASE OF HYDRONEPHROSIS IN A WISTAR ALBINO RAT

Abstract
Hydronephrosis has been defined as an obstructive uropathy that usually occurs due to impaired urine flow in the lower urinary tract and is characterized by significant loss of renal medullary tissue. The material of the presented study was a 3-month-old male Wistar albino rat. At the end of an experimental study, a control rat that appeared to be clinically normal was euthanized to obtain blood and tissue samples. Meanwhile, a kidney-shaped cystic formation was observed in the area where the left kidney was located. This formation was surrounded by a transparent and thin membrane and was filled with a liquid similar to urine. The right kidney appeared to be close to normal. However, when the cross-section of the right kidney was examined, it was seen that the renal pelvis was enlarged. Tissue samples taken for histopathological examination were fixed in 10% buffered formalin and embedded in paraffin blocks. Using a microtome, 4-µm sections were cut, stained with hematoxylin-eosin, and examined under a light microscope. As a result of the examination, it was determined that the cystic structure on the left side was a hydronephrotic kidney. Due to result of severe cell loss, only a thin layer of cells remained in the cortical region of the kidney tissue. In this layer, the parenchyma was thin enough to consist of a few rows of cells. In the right kidney, the renal pelvis and calyces were enlarged. There was also glomerular and tubular damage. In conclusion, a case of bilateral hydronephrosis was described in a rat. It has been reported that the clinical appearance in rats with hydronephrotic kidneys may sometimes be normal. It has also been reported that some laboratory values may be close to normal. Therefore, the current case is brought to the attention of researchers.
Keywords: Hydronephrosis, histopathology, rat, kidney

CONTRIBUTION OF BACILLUS SPECIES TO ALLEVIATING DROUGHT STRESS

Elyoussfi CHAIMAE
University Abdelmalek Essaâdi , Faculty of Sciences and techniques of Al-Hoceima, Department of Biology ,Tetouan, Morocco
Email: c.elyoussfi1@uae.ac.ma

Hajar SOUJAA
University Abdelmalek Essaâdi , Faculty of Sciences and techniques of Al-Hoceima, Department of Biology ,Tetouan, Morocco
Email: h.souja@uae.ac.ma

Yahya EL HAMMOUDANI
University Abdelmalek Essaâdi , National School of Applied Sciences Al-Hoceima, Department of Environmental engineering ,Tetouan, Morocco
Email: y.elhammoudani@uae.ac.ma

Hassani Zerrouk MOHAMMED
University Abdelmalek Essaâdi , Faculty of Sciences and techniques of Al-Hoceima, Department of Biology ,Tetouan, Morocco
Email: m.hassani@uae.ac.ma

Nadira MOURABIT
University Abdelmalek Essaâdi , Faculty of Sciences and techniques of Al-Hoceima, Department of Biology ,Tetouan, Morocco
Email: nmourabit@uae.ac.ma

Saida AARAB
University Abdelmalek Essaâdi , Faculty of Sciences and techniques of Al-Hoceima, Department of Biology ,Tetouan, Morocco
Email: s.aarab@uae.ac.ma

ABSTRACT
The escalating challenges posed by drought stress on crop production necessitate innovative strategies for sustainable agriculture. In this context, the contribution of Bacillus species emerges as a promising avenue for alleviating the impacts of drought. As climate change intensifies, the urgency to develop resilient agricultural practices grows, and Plant Growth-Promoting Bacteria (PGPB), particularly Bacillus spp., gain prominence for their adaptive capabilities and production of valuable metabolites. This article explores the multifaceted role of Bacillus species in enhancing plant resilience to drought stress. Beyond their capacity to improve overall plant growth and yield, Bacillus species actively participate in mitigating drought stress by producing water-absorbing substances and enhancing water and nutrient uptake. The review also delves into the mechanisms employed by certain Bacillus species to confer resistance against plant pathogens, establishing them as essential biological agents in managing plant diseases.

This abstract underscores the potential of Bacillus species as valuable contributors to sustainable agriculture, focusing on their pivotal role in alleviating drought stress.
Keywords: Climate change, PGPB, Bacillus species

SUSTAINABILITY IN FASHION

Dr. Madan Lal REGAR (ORCID: 0000-0001-7821-4410)
Assistant Professor, Department of Fashion Design, National Institute of Fashion Technology Jodhpur, Jodhpur, India.
Email: madan.regar@nift.ac.in

ABSTRACT

Sustainability refers to the ability to continuously maintain a process over time. In business aspects, It refers to the prevention of depletion of resources, for their longer availability. It also consists of fulfilling the needs of current generations without compromising the needs of future generations, while ensuring a balance between economic growth, environmental care, and social well-being. This concept can be used to guide decisions on global and individual levels. There are 3 sub-concepts that fall under Sustainability. They are: economic, environmental, and social, also known as profits, planets, and people. Economic sustainability concentrates on conserving natural resources, both renewable and exhaustible inputs. Environment sustainability adds emphasis on life support systems, that must be maintained for economic production. Social sustainability focuses on the human effects of economic systems, to eradicate poverty and hunger. The three concepts above are its pillars. This practice is also actively carried out in the commercial sector. Corporate sustainability includes companies today setting sustainability goals like commitment to zero waste packaging or reduction of overall emissions. When they talk about Sustainability today, it is generally defined as,“meeting the needs of the present without comprising the ability of the future generations to meet their own needs .” Sustainable fashion is a way in which brands create clothing that not only reduces the impact on the environment but is also mindful of the people who work to produce the garments. Apparel brands have broken sustainability into four areas: Ethical, Slow, Circular and Conscious Fashion . The fashion industry is incredibly harmful to the planet. This industry is one of the world’s largest polluters, responsible for 20% of global industrial water pollution. Surprisingly, most of the clothes are made of plastic today, creating a disaster in the making. The goal of sustainable fashion is to create flourishing ecosystems and communities through its activity. This may include: increasing the value of local production and products; prolonging the lifecycle of materials; increasing the value of timeless garments; reducing the amount of waste; and reducing the harm to the environment as a result of production and consumption. Another goal is to educate people to practice environmentally friendly consumption by promoting the "green consumer". This finally proves that implementation of sustainability in fashion design can be achieved by identifying the perceptions, attitudes, and involvement of fashion design practitioners in sustainability. Both design and designer’s roles are the key to inspiring sustainable design practices as their role can contribute to sustainability by shaping design production practices and influencing consumption processes.

Keywords: Sustainability, Fashion, economic, environmental, social, and Industrialization

FIRST RECORD OF *ANGIOSTRONGYLUS VASORUM* IN ALGERIA

Noureddine MECHOUK*
Laboratory of Ecology of Terrestrial and Aquatics Systems (EcoSTAq), Department of Biology, Faculty of Science, Badji Mokhtar University. BP 12, 23200 Annaba, Algeria
Department of Parasitology and Parasitic Diseases, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Calea Mănăștur 3-5, 400372, Cluj Napoca, Romania
Email: noureddine.mechouk@usamvcluj.ro

Georgiana DEAK
Department of Parasitology and Parasitic Diseases, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Calea Mănăștur 3-5, 400372, Cluj Napoca, Romania
Email: **georgiana.deak@usamvcluj.ro**

Zihad BOUSLAMA
Laboratory of Ecology of Terrestrial and Aquatics Systems (EcoSTAq), Department of Biology, Faculty of Science, Badji Mokhtar University. BP 12, 23200 Annaba, Algeria
National Environmental Research Center, Sidi Amar Campus, BP N° 2024, 23005. Annaba, Algeria
Email: **zihadb@yahoo.fr**

Angela Monica IONICĂ
Clinical Hospital of Infectious Diseases of Cluj-Napoca, 23 Iuliu Moldovan, 400348, Cluj-Napoca, Romania

Corina Gina TOMA
Department of Veterinary Pathology, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Calea Mănăștur 3-5, 400372, Cluj-Napoca, Romania
Email: corina.toma@usamvcluj.ro

Andrei Daniel MIHALCA
Department of Parasitology and Parasitic Diseases, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Calea Mănăștur 3-5, 400372, Cluj Napoca, Romania
Email: amihalca@usamvcluj.ro

ABSTRACT
Introduction: *Angiostrongylus vasorum*, also known as the French heartworm, was first described in France in 1953 and is now endemic across Europe. In African, it was first reported in Uganda in 1972 and more recently, in a potential autochthonous case in a dog in Morocco, in 2022. In Europe, red foxes (*Vulpes vulpes*) and dogs are the main definitive hosts. In domestic dogs the infection can have a severe or even lethal outcome. Algeria hosts many wild carnivore species, including canids, which could act as hosts and reservoirs for parasites of veterinary importance. Considering these, the aim of this study was to evaluate the presence of *A. vasorum* in domestic and wild carnivores from Algeria.

Materials and Methods: In January-February 2022 road-killed and hunted carcasses of 26 wild and domestic carnivores were collected and examined by parasitological necropsy in region, Algeria. During necropsy, lung tissue samples were collected in formalin for histological examination. In addition, 33 faecal samples were tested using the modified Baermann's technique from domestic dogs. All detected parasites were morphologically identified and molecularly characterized. Results: Besides a single red fox with a coinfection with *Crenosoma vulpis* and *Eucoleus aerophilus*, no other lungworms were detected at necropsy, nor at larval concentration method. Histology of one of the African golden jackals (*Canis aureus*) showed numerous transverse and longitudinal sections of nematode larvae and eggs free in the alveolar spaces. The larvae were approximately 20-30 µm in width and 80-90 µm in length with a thin basophilic cuticle and numerous deep basophilic, internal nuclei. The eggs were round to ovoid, thin walled, of approximately 50-60 µm, and contained either a larva or a morula. Within these areas, the alveolar septae were expanded by a moderate number of inflammatory cells, composed mainly of macrophages, including binucleated and multinucleated macrophages, plasma cells, small lymphocytes, and few eosinophils. The BLAST analyses revealed 99.39-99.80% nucleotide identity to various *A. vasorum* isolates from dogs and foxes in Europe (e.g. GQ982858, GQ982791). Conclusion: To the best of our knowledge, this is the first report of *A. vasorum* infection in an African golden jackal, reporting a new host association, highlighting the importance of further studies to update the geographical distribution and its epidemiology across Algeria.

Keywords: *Angiostrongylus vasorum*, carnivores, jackal, Algeria.

ANTIOXIDANT BIO NANOCARRIER SYSTEM BASED ON *ACHILLEA MILLEFOLIUM* L. STANDARDIZED EXTRACT AND CHITOSAN POLYMER

Cornelia NICHITA (ORCID: 0000-0002-4928-4564)
University of Bucharest, Faculty of Physics, ICUB, CTT-3Nano-SAE Research Center, Bucharest, Romania
National Institute for Chemical – Pharmaceutical Research and Development, Pharmaceutical Biotechnologies, Bucharest, ROMANİA
Email: cornelia.nichita@unibuc.ro

ABSTRACT
Recent advances of smart nanocarriers composed of chitosan biopolymeric vesicles have led to improvement and efficiency of transport and controlled release of molecules of therapeutic interest of vegetable or synthetic origin in the microenvironment of diseased tissues of living systems, thus offering a wide range of for application in biotechnology and nanomedicine. In this sense, the aim of the present work was, in a first step, to obtain the *Achillea millefolium* L. standardized extract, by applying Soxhlet extraction technology, followed by vacuum concentration and purification, and in the second stage, the encapsulation of the extract, in chitosan nanoparticles obtained by ionic gelation method. The plant extract was characterized by UV-VIS spectrometric method by determining total phenolic contents (TPC) expressed as gallic acid equivalent/g, using the Folin-Ciocalteu reagent, and total flavonoid contents (TFC) expressed as rutin equivalent/g, using the aluminium chloride colorimetric assay. In addition, the encapsulation efficiency (EE%) was determined as well as the dimensional characteristics (hydrodynamic size) and stability of chitosan nanoparticles (zeta potential) by Dynamic Light Scattering (DLS) technique. The antioxidant effect of bio nano carrier system was evaluated in vitro non cellular assays, by chemiluminescence method in luminol-hydrogen peroxide system, by DPPH(2,2-diphenyl-1-picrylhydrazyl) and ABTS (2,2′-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) free radical scavenging assay. These investigations highlighted a synergistic effect generated by the matrix of chitosan nanoparticles with antioxidant effect as well as the contribution to the antioxidant effect of the standardized extract obtained from the Achillea millefolium L species.
Keywords: nanocarrier, antioxidant, chitosan nanoparticles

BİTKİSEL KATKILI YEMLERDE BAĞIRSAK FİZYOLOJİSİ, ET KALİTESİ VE MUCİN-2 GEN İFADESİ ÜZERİNE ETKİLER

Associate Prof. Dr. İsa COŞKUN* (ORCID: 0000-0001-5495-6006)
Kirsehir Ahi Evran University, Agricultural Faculty, Department of Animal Science Kirsehir Türkiye
Email: isa.coskun@ahievran.edu.tr

Assist Prof. Dr. Huseyin CAYAN (ORCID: 0000-0001-7731-2967)
Kirsehir Ahi Evran University, Agricultural Faculty, Department of Animal Science Kirsehir Türkiye
Email: huseyin.cayan@ahievran.edu.tr

Dr. Osman Tolga ÖZEL (ORCID: 0000-0002-5414-6975)
Central Fisheries Research Institute, Department of Aqauculture, Trabzon Türkiye
Email: osmantolgaozel@gmail.com

Emine DOĞAN (ORCID: 0000-0002-9572-6503)
Kirsehir Ahi Evran University, Çiçekdağı Vocational High School Directorate, laboratory and veterinary health. Kirsehir Türkiye
Email: emine.dogan@ahievran.edu.tr

Assist Prof. Dr. Emine BILGINOGLU (ORCID: 0000-0001-5974-327X)
Kirsehir Ahi Evran University, Agricultural Faculty, Department of Field Crops. Kirsehir Türkiye
Email: emine.bilginoglu@ahievran.edu.tr

ÖZET

Bu çalışma, rasyona %0,5 düzeyinde kekik, adaçayı, nane ve oregano tozu ilavesinin bıldırcınlarda besleme performansı üzerine etkilerini belirlenmek amacıyla yapılmıştır. Araştırmada canlı ağırlıkları standardize edilmiş 400 adet 1 günlük yaştaki bıldırcın civcivleri 4 tekerrürlü (20 civciv her tekerrür) 5 muamele grubuna tesadüfî dağıtılmışlardır. Muamele grupları T0: kontrol, T1: kekik, T2: adaçayı, T3: nane, T4: oregano olacak şekilde ayarlanmış olup deneme 35 gün sürdürülmüştür. Denemede civcivler 70-90-60 cm ebatlarında yer kafeslerinde 10 cm talaş altlık üzerinde yetiştirilmişlerdir. Yem ve su ad-libitum olarak verilmiştir. Deneme sonunda T1 ve T4 gruplarının canlı ağırlık artışları ve LAB kolonizasyonu T0, T2 ve T3 gruplarına göre istatistiki olarak yüksek bulunmuştur ($P<0,05$). T2 T3 ve T4 gruplarında MDA oluşumu T0 grubuna göre düşük, T1 grubunun MDA değeri de T0 grubuna göre sayısal olarak düşük bulunmuştur. Jejunumda villi boyutu T2 ve T4 gruplarında diğer gruplara göre oranla daha yüksek olduğu belirlenmiştir ($P<0,05$). İleumda ise T1 grubunun villi boyu diğer gruplara göre yüksek bulunmuştur ($P<0,05$). Jejunumda villi boyu/ kript derinliği oranı T1 ve T4 gruplarında T0 grubuna göre yüksek ($P<0,05$), ileumda ise T2 grubunun villi boyu/ kript derinliği oranı diğer gruplara göre düşmüştür. İleum musin-2 gen ekpresyonu T0 grubu ile kıyaslandığınında T2 T3 ve T4 gruplarında daha düşük ($P<0,05$), T1 grubu ile benzer olduğu belirlenmiştir. Bu araştırma çalışmasının sonuçları bıldırcın rasyonlarına kekik ve oregano tozu ilavesinin jejunum ve ileumda villi boyunu, sekumda LAB kolonizasyonunu arttırarak 35 günlük büyüme performansını arttırdığı, düşük dozda

fitobiyotik ilavesinin bıldırcınların göğüs etinde 3. günde MDA oluşumunu baskılayarak antioksidan etkili oldukları belirlenmiştir.
Anahtar Kelimeler: Tek mideli, büyüme, bağırsak, histomorfoloji, MDA

THE EFFECTS ON INTESTINAL PHYSIOLOGY, MEAT QUALITY AND MUCIN-2 GENE EXPRESSION IN QUAILS OF FEEDS WITH HERBAL ADDITIVE

ABSTRACT

The aim of this study is to determine the effects on the nutritional performance in quails by adding 0.5% thyme, sage, mint and oregano powder to ration. In the study, 400 1-day-old quail chicks, whose live weights were standardized, were randomly distributed to 5 treatment groups with 4 replicates (20 chicks per replicate). Groups T0: control, T1: thyme, T2: sage, T3: mint, T4: oregano. The trial continued for 35 days. In the experiment, chicks were raised in 70-90-60 cm sized ground cages on 10 cm wood shaving. Feed and water were provided ad-libitum. At the end of the experiment, live weight gains and LAB colonization of T1 and T4 groups were statistically higher than T0, T2 and T3 groups ($P<0.05$). MDA formation in the T2, T3 and T4 groups was lower than the T0 group, and the MDA value of the T1 group was numerically lower than the T0 group. The amount of villi in the jejunum was higher in T2 and T4 groups than in the other groups ($P<0.05$). In the ileum, the villi size of the T1 group was higher than the other groups ($P<0.05$). In the jejunum, the villi length/crypt depth ratio was higher in the T1 and T4 groups than in the T0 group ($P<0.05$). In the ileum, the villi length/crypt depth ratio of the T2 group decreased compared to the other groups. Ileum muc-2 gene expression was found to be lower in the T2, T3 and T4 groups compared to the T0 group ($P<0.05$), and was similar to the T1 group. The results of this research study determined that the addition of thyme and oregano powder to quail rations increased the 35-day growth performance by increasing the length of villi in the jejunum and ileum and LAB colonization in the cecum, and that the addition of low doses of phytobiotics had an antioxidant effect by suppressing the formation of MDA in the breast meat of quail on the 3rd day.

Keywords: Monogastric, growth, intestine, histomorphology, MDA

NOSEMA CERENEA

Münire TURHAN (ORCID: 0000-0003-3373-1400)
Bingöl Üniversitesi Gıda Tarım ve Hayvancılık Meslek Yüksek Okulu Bitkisel ve Hayvansal Üretim Bölümü Arıcılık Programı, / Arıcılık Araştırma ve Uygulama Merkezi Bingöl/Türkiye
Email: mturhan@bingol.edu.tr

ÖZET
Son yıllarda bal arıları (*Apis mellifera*) bilinmeyen bir şekilde kovanlarından kaybolmaktadır. Güçlü koloniler bir anda zayıflayıp ölmektedir. Arıların ortadan kaybolmasının altında yatan kesin etiyoloji bir sır olarak kalmıştır. Ancak aynı dönemde Asya arısı *Apis cerana'nın* bir *microsporidium'u* olan *Nosema ceranae'nin, A. mellifera'yı* kolonize ettiği görülmektedir. Artık tüm dünyada hem sağlıklı hem de zayıf bal arısı kolonilerinde sıklıkla tespit ediliyor. İlk kez, doğal *N. Ceranae* enfeksiyonunun arı kolonilerinin ani çöküşüne neden olabileceğini bilim insanları tarafından araştırılmıştır. *N. Ceranae* enfeksiyonu ile bal arısı kolonilerinin tarla koşullarında ölümü arasında doğrudan bir ilişki kurulmuş. Kraliçe enfekte arıların kaybını artık telafi edemeyecek duruma gelinceye kadar koloni zayıflığının belirtilerinin belirgin olmadığını gözlemlemişlerdir. Uzun asemptomatik kuluçka dönemi, koloni çökmesinden önce belirgin semptomların yokluğunu açıklayabilir Fakat, enfekte bir kolonin yakınındaki sağlıklı kolonilerin de enfekte olabileceğini ve *N.ceranae* enfeksiyonunun spesifik bir antibiyotik olan fumagillin ile kontrol edilebileceğini göstermektedir. Ayrıca *N.cerenae* mücadelesinde 120 mg fumagilin uygulamasının enfeksiyonu ortadan kaldırdığı kanıtlanmıştır ancak 6 ay sonra yeniden enfeksiyonu önleyemediği gözlenmiştir. Bu açıdan bakıldığında *N. cerenae* sporlarının *Nosema apisten* daha tehlikeli olduğu kovanlar için bu durumun korkutucu sonuçlar doğuracağı açıkça bellidir.
Anahtar Kelimeler: Nosema, Nosema apis, Nosema Cerenae, Apis mellifera, Bal Arısı Hastalıkları

NOSEMA CERENEA

ABSTRACT
In recent years, honeybees (Apis mellifera) have beenstrangely disappearing from their hives, and strongc olonies have suddenly become weak and died. The precise aetiology underlying the disappearance of the bees remains a mystery. However, during the same period,Nosema ceranae, a microsporidium of the Asian bee Apis cerana, seems to have colonized A.mellifera, and it's now frequently detected all over the world in both healthy and weak honeybee colonies.For first time, we show that natural N. Ceranae infection can cause the sudden collapse of bee colonies, establishing a direct correlation between N. Ceranae infection and the death of honeybee colonies under field conditions. Signs of colony weakness were not evident until the queen could no longer replace the loss of the infected bees. The long asymptomatic incubation period can explain the absence of evident symptoms prior to colony collapse. Furthermore, our results demonstrate that healthy colonies near to an infected one can also become infected, and that N.ceranae infection can be controlled with a specific antibiotic, fumagillin. Moreover, the administrationof 120 mg of fumagillin has proven to eliminate the infection, but it cannot avoid reinfection after6 months.
Keywords: Nosema, Nosema apis, Nosema Cerenae, Apis mellifera, Honey Bee Disease

TEK YÖNLÜ VARYANS ANALİZİNDE FARKLI ÇOKLU KARŞILAŞTIRMA TESTLERİNİN İSTATİSTİKSEL PERFORMANSININ KARŞILAŞTIRILMASI

Asst. Prof. Erman GÜLENDAĞ* (ORCID: 0000-0002-3335-7247)
Siirt University, Faculty of Veterinary Medicine, Department of Biostatistics, Siirt-Türkiye
Email: ermangulendag@yahoo.com.tr

ÖZET
Tek Yönlü Varyans Analizi (TYVA); tek faktörlü bağımsız bir değişkenin, nicel bir bağımlı değişken üzerinde etkisini ölçmeyi amaçlar. Bağımsız grup sayısının üç veya daha fazla olduğu durumlarda, gruplar arasındaki varyansları karşılaştırma yöntemi ile grup ortalamaları arasında anlamlı farklılık olup olmadığını belirler. TYVA'da yokluk hipotezi (H0) reddedildiğinde, başka bir deyişle grup ortalamaları arasında istatistiksel olarak anlamlı farklılığın bulunduğu durumlarda Çoklu Karşılaştırma Testleri (ÇKT) kullanılmaktadır. Ancak ÇKT'lerde birden çok karşılaştırma testinin uygulanması nedeniyle yanlış pozitiflik yani Tip I hata oranında (α) artış söz konusudur ve grup sayısına bağlı olarak yapılacak ÇKT miktarına göre artış göstermektedir. ÇKT olarak aşırı muhafazakar yöntemlerin seçilmesi durumunda α'daki artışın önüne geçilebilmektedir. Buna karşın bu yöntemler testin gücünü (1-β) düşürmekte ve ikili grup farklılıklarının istatistiksel olarak anlamlı bulunmasını güçleştirmektedir. Dolayısıyla yanlış negatiflik, Tip II hata (β) şekillenebilmektedir. Bu çalışma α seviyesinde oluşabilecek yükselişin önüne geçerken testin gücünü de koruyabilecek ÇKT yöntemlerini incelemektedir. Günümüzde kullanılabilecek ÇKT'nin sayısı 20'yi bulmaktadır. Ancak bunlardan 6 tanesi Ziraat ve Veteriner Bilimleri alanında daha yaygın olarak kullanılmaktadır. Bu çalışmada; Tukey, Duncan, Scheffe, LSD, Games-Howell Testleri ile Bonferroni düzeltmesinin özelliklerine değinilerek, hangi durumlarda uygulanmaları gerekliliği ve koşulları ele alınarak önerilerde bulunulmuştur. Çalışma sayesinde simüle edilen veri setleri üzerinde bahsi geçen testlere ait performansları karşılaştırılarak, Ziraat ve Veteriner Bilimleri alanlarında ÇKT'nin isabetli olarak seçilmesine katkı sağlanması amaçlanmıştır.
Anahtar Kelimeler: Varyans analizi, çoklu karşılaştırma testleri, Tip I hata, Tip II hata.

COMPARISON OF STATISTICAL PERFORMANCE OF DIFFERENT MULTIPLE COMPARISON TESTS IN ONE-WAY ANALYSIS OF VARIANCE

ABSTRACT

One-Way Analysis of Variance (ANOVA) aims to measure the effect of a single-factor independent variable on a quantitative dependent variable. When there are three or more independent groups, ANOVA compares the variances between the groups to see whether there is a significant difference between the group averages. Multiple Comparison Tests (MCT) are used when the null hypothesis (H0) is rejected in One-Way ANOVA, indicating a statistically significant difference between group means. However, the application of multiple comparison tests increases the risk of false positives, or Type I error rate (α), which rises as the number of tests performed due to number of groups involved. Choosing overly conservative methods as the MCT can prevent an increase in α, but this reduces the test's power (1-β) and makes it difficult to find statistically significant pairwise group differences. This study analyses MCT methods that can maintain the test's power while preventing an increase in α. Currently, there are up to 20 available MCTs. However, six of these statistical tests are widely used in Agricultural and Veterinary Sciences. This study discusses the characteristics of Tukey, Duncan, Scheffe, LSD, Games-Howell Tests, and Bonferroni correction, and explains the situations in which they are applied. The study aims to contribute to the accurate selection of the correct CCT in Agricultural and Veterinary Sciences by comparing the performance of the tests on simulated data sets.

Keywords: Analysis of variance, Multiple comparison tests, Type I error, Type II error.

BİYOİSTATİSTİK ALANINDA ARAŞTIRMACILAR TARAFINDAN YAYGIN OLARAK YAPILAN HATALAR VE BUNLARDAN KAÇINMA YOLLARI

Asst. Prof. Erman GÜLENDAĞ* (ORCID: 0000-0002-3335-7247)
Siirt University, Faculty of Veterinary Medicine, Department of Biostatistics, Siirt-Türkiye
Email: ermangulendag@yahoo.com.tr

ÖZET
Bilimsel araştırmaların önemli basamaklarından olan; deney deseninin belirlenmesi, örnekleme yönteminin ve örneklem büyüklüğünün seçilimi, verilerin analiz edilmesi ve özetlenmesi, uygun hipotez testlerinin yürütülmesi ve yorumlanması gibi birçok kısmında biyoistatistik hayati bir önem teşkil etmektedir. Tıp, eczacılık, diş hekimliği, veteriner hekimliği alanları başta olmak üzere klinik araştırmalar, epidemiyoloji, genetik bilimleri gibi alanlarda da biyoistatistik daha spesifik olarak kullanılmaktadır. Sağlık bilimlerinin her alanında kullanılan biyoistatistiğin önemi gittikçe artmış olup, bu önem sağlık bilimleri camiası tarafından bilinmektedir. Çünkü istatistiksel araçların eksik ya da yanlış olarak kullanılması durumunda, çalışmadan elde edilen sonuçların da doğru yorumlanabilmesi veya bilimsel olarak ispatlanabilir ve güvenilir çıkarımların yapılması mümkün değildir. Ancak bu önemi çok iyi bilinmesine rağmen, ne yazık ki araştırmacılar tarafında ciddi bir bilgi eksikliği mevcuttur. Bu yüzden yapılabilecek hataların sonuçları ise çalışmalar açısından oldukça kritik olabilmekte ve bilimsel verilerin güvenilirliği üzerinde ciddi etkilere sahip olabilmektedir. Bu çalışmada, bilimsel sonuçları daha sağlam hale getirme amacı ile bilimsel araştırmalarda yaygın olarak yapılan istatistiksel hataların bir listesi derlenmiştir. Çalışmanın amacına uygun deney deseni ve gruplarının belirlenmesi, örnekleme yöntemi ve örneklem büyüklüğü, doğru hipotez testi seçimi, varsayım kontrollerinin sağlanması, p değerinin yorumlanması, etki büyüklüğü kavramı, ilişki analizlerinde nedenselliğin önemi, grafiksel yöntemlerin doğru şekilde kullanılması gibi konular bilimsel araştırmalarda eksiklik noktasında sıklıkla karşımıza çıkmaktadır. Bu derlemede bilimsel araştırmacıların bu hataları ne şekilde saptayabilecekleri ve bunlardan nasıl kaçınabilecekleri konularında görüşlere yer verilmiştir. Bu çalışmanın hedefi, bilimsel araştırmalarda sıklıkla yapılan bu hataların tespiti ve çözümlenmesine yöneliktir.
Anahtar Kelimeler: İstatistiksel hatalar, verilerin yanlış yorumlanması, varsayım ihlalleri

COMMON MISTAKES MADE BY RESEARCHERS IN BIOSTATISTICS AND HOW TO AVOID THEM

ABSTRACT
Biostatistics plays a crucial role in various stages of scientific research, including experimental design, sampling method and size selection, data analysis and summarisation, and appropriate hypothesis testing. It is particularly relevant in the fields of medicine, pharmacy, dentistry, veterinary medicine, clinical research, epidemiology, and genetic sciences. The significance of biostatistics in the field of health sciences has increased and is acknowledged by the health sciences community. Incomplete or incorrect use of statistical tools can lead to incorrect interpretation of study results and unreliable inferences. However, despite the well-known importance of this issue, researchers often lack the necessary knowledge. As a result, mistakes can have serious consequences for the reliability of scientific data. This study compiles a list of common statistical errors in scientific research to improve the robustness of scientific results. In scientific research, common issues include determining the experimental design and suitable groups for the study, selecting the appropriate sampling method and sample size, choosing the correct hypothesis test, controlling for assumptions, interpreting the p-value, understanding the concept of effect size, considering causality in relationship analyses, and using graphical methods correctly. This review includes suggestions for scientific researchers on how to identify and avoid common errors in their study. The aim of this study is to address and overcome these common mistakes that are frequently made in scientific research.
Keywords: Statistical errors, misinterpretation of data, assumption violations.

GUT DYSBIOSIS IN DOGS WITH SPINAL CORD INJURY: IMPACT OF POLENOPLASMIN

Gheorghe GIURGIU (ORCID: 0000-0002-5449-2712)
Deniplant-Aide Sante Medical Center, Biomedicine, Bucharest, Romania
Email: deniplant@gmail.com

Prof. Dr. Manole COJOCARU (ORCID: 0000-0002-7192-7490)
Academy of Romanian Scientists
Titu Maiorescu University, Faculty of Medicine, Bucharest, Romania
Email: cojocaru.manole@gmail.com

ABSTRACT
Background Studies have demonstrated the presence of gut dysbiosis (alterations in gut bacterial homeostasis) secondary to spinal cord injury in dogs. The dysbiosis is thought to impair recovery by decreasing the production of short-chain fatty acids which play a role in suppressing inflammation within the central nervous system. Obiective Therefore, targeting gut dysbiosis could have significant therapeutic value in the management of spinal cord injury. The purpose of this study is to determine if gut dysbiosis occurs in dogs with spinal cord injury. Another area of potential intervention interest is in situations of spinal injury where there is an urgent need to generate new neurons. To arrive at these observations, the authors examined how Polenoplasmin and diet solve paralysis in dogs. Materials and methods The most common cause of spinal problems in dogs is trauma. We are currently assessing whether indoles can also stimulate formation of neurons in dogs with paralysis. Results We found that gut microbes that metabolize tryptophan- an essential amino acid-secrete small molecules called indoles, which stimulate the development of new brain cells in dogs, also demonstrated that the indole-mediated signals elicit key regulatory factors known to be important for the formation of new neurons. Conclusion This study is another intriguing piece of the puzzle highlighting the importance of lifestyle factors and diet. In conclusion, the link between the health of the microbiome and the health of the brain shows how microorganisms in the gut solve paralysis. Gut microbe secreted molecule linked to formation of new nerve cells in paralysed dogs.
Keywords: intestinal dysbiosis, indoles, paralysed dog, Polenoplasmin

A FRACTIONAL A-TRANSFORM FOR CONVERTING THIRD-ORDER FRACTIONAL DIFFERENTIAL EQUATION TO ORDINARY DIFFERENTIAL EQUATION

Khadiga MUSSA
Department of Mathematics, University of Tripoli, Tripoli, Libya

Ala Hasan AL-LAHAIBAT
Jabir Ibn Hayyan University for Medical and Pharmaceutical sciences, Faculty of Pharmacy

Shaymaa Y. ALKUFI
Department of Math., Faculty of Computer Science and Math., University of Kufa, Najaf, Iraq

Mohammed S. MECHEE*
Information Technology Research and Development Center (ITRDC), University of Kufa, Najaf, Iraq
Email: mohammeds.abed@uokufa.edu.iq

ABSTRACT
The fractional derivatives of real functions using the definition of α-fractional derivatives has been studied. It has been demonstrated that the characteristics of this definition are significant and appropriate for solving fractional differential equations and their applications. The objective of this paper is to use the α-transform to convert the third-order fractional differential equation (FDE) to an ordinary differential equation (ODE) of the same order and then, apply the α-fractional derivative properties of the real functions to find the solution of FDE. a new fractional α-transform has been built. Third-order FDE is transformed into ODE using the proposed α-transform. Furthermore, a third-order FDE can be solved numerically using the numerical techniques adapted to third-order FDEs. This study proposed the αtransform method for solving PDE problems. As a result, the executions demonstrate that the α-transform approach is the most accurate and most efficient.
Keywords: α-Fractional; α-Transform, Derivative; Third-order, FDEs; ODEs

TRANSFORMATIVE TECHNOLOGIES: UNLEASHING AI'S POTENTIAL FOR PRECISION BREEDING IN SHE-CAMELS

Brahmi ZAHIA (ORCID: 0009-0003-0812-3558)
Department of Veterinary Medicine, Institute of Agronomic and Veterinary Sciences, University of Souk-Ahras, Souk Ahras, Algeria, Laboratory of Animal Production, Biotechnology and Health (PABIOS), Souk Ahras, Algeria, Specialty: Zootechnie, Option: Animal Production and Biotechnology.
Email: z.brahmi@univ-soukahras.dz

Gherissi DJALLEL EDDINE (ORCID: 0000-0003-1615-1658)
Department of Veterinary Medicine, Institute of Agronomic and Veterinary Sciences, University of Souk-Ahras, Souk Ahras, Algeria, Laboratory of Animal Production, Biotechnology and Health (PABIOS), Souk Ahras, Algeria, Specialty: Zootechnie, Option: Animal Production and Biotechnology.
Email: d.gherissi@univ-soukahras.dz

ABSTRACT
Dromedary camels are renowned for their remarkable ability to thrive in challenging environments, underscored by distinctive physiological adaptations, particularly in their reproductive biology. In natural settings, these camels are often perceived to have relatively low reproductive efficiency, necessitating careful reproductive management for population sustainability and enhancement. Although hormonal protocols have conventionally played a significant role in optimizing fertility, their effectiveness has been limited by variations in individual responses and environmental factors. This study introduces a groundbreaking approach that harnesses artificial intelligence (AI) to advance hormonal protocols, aiming to improve reproductive outcomes in she camels. Through the integration of AI algorithms with extensive datasets encompassing physiological parameters, environmental influences, and individual reproductive histories, a pioneering predictive model has been developed. This model enables the provision of personalized hormonal protocol recommendations tailored to the unique characteristics of each she camel, optimizing the timing, dosage, and combination of hormonal treatments. The incorporation of AI in this context offers several advantages, including the capacity to adapt and refine protocols based on real-time data inputs, thereby mitigating the impact of environmental fluctuations and individual variability. Moreover, AI-driven protocols hold the promise of minimizing resource expenditure while maximizing reproductive success, ultimately contributing to the sustainability of she camel populations.
Keywords: Dromedary Camel, Artificial Intelligence, Algorithms, Hormonal Protocols

PHYSIO-BIOCHEMICAL RESPONSE OF SOME TRADITIONAL JOHA RICE VARIETY OF ASSAM UNDER HIGH TEMPERATURE CONDITION

Sharmistha Sarma KALITA (ORCID: 0009-0001-1759-3514)
Salbari College, Assistant Professor, Botany Department, Salbari (Assam, Pin-781318), India
Email: sarmakalita004@gmail.com

Bhaben TANTI* (ORCID: 0000-0002-7594-4562)
Gauhati University, Professor, Botany Department, Gauhati (Assam, Pin- 781014), India
Email: btanti@gauhati.ac.in

ABSTRACT
A traditional aromatic rice variety known for its unique flavor, aroma, and nutritional qualities, joha rice (Oryza sativa L.) is grown in northeastern India. A major challenge to rice farming in recent years has been heat stress brought on by climate change, which has an effect on rice quality and productivity. In order to lessen the negative impacts of extreme temperature on rice production, it can be helpful to understand adaption of rice plant in terms of their morphophysiological parameter and the biochemical pathways underlying Joha rice's tolerance to heat stress. In this work, morphophysiological adaption like shoot length, root length, shoot fresh weight, root fresh weight, shoot dry weight , root dry weight, chllorophyll, relative water content and biochemical defense mechanisms that Joha rice uses in the face of heat stress are examined, In-depth of biochemical examinations, such as enzymatic tests are catalase (CAT), superoxide dismutase (SOD), APX , GPX and Glutathione reductase And non- enzymatic Ascorbate and Glutathione test show that Joha rice triggers a number of defense mechanisms to lessen the harmful effects of heat stress. Furthermore, reducing oxidative damage to cellular components and scavenging reactive oxygen species (ROS) are two more benefits of enhancing antioxidant defense mechanisms, which include the actions of peroxidases and proline content. To increase the Joha rice variety's heat tolerance and productivity in areas where heat waves are common, it is imperative to comprehend the physio-biochemical reactions of this variety to elevated temperatures. This analysis may help alleviate the detrimental impacts of heat stress on rice farming and provide food security and sustainable agriculture in the face of climate change problems by providing clarity on these adaptive mechanisms and guiding breeding programs and agronomic methods accordingly. Understanding these biochemical defense mechanisms in Joha rice further gives opportunities biotechnological interventions to generate heat-tolerant varieties of rice, as well as insights into the molecular mechanisms underpinning rice's tolerance to heat stress.

Keyword: Joha Rice, Morpho-Physiology, Reactive Oxygen Species (ROS), Superoxide Dismutase (SOD), Catalase (CAT).

AGRO-INDUSTRIAL WASTE UTILIZATION AND CHARACTERIZATION: INSIGHTS FROM ANTIOXIDANTS AND PHENOLICS ANALYSIS

Ali IMRAN
Department of Food Science, Faculty of Life Science, Government College University, Faisalabad, Pakistan,
School of Agriculture, Food and Ecosystem Sciences, Faculty of Science, The University of Melbourne, Parkville, Victoria, Australia.

ABSTRACT
Agro-industrial waste encompasses the byproducts generated from agricultural and food processing activities. These residues, often considered discards, hold untapped potential for sustainable practices, offering opportunities for recycling and resource optimization. Utilizing the value in agro-industrial waste can contribute to environmental conservation and innovative solutions across industries. However, the extraction module and conditions are crucial factors influencing polyphenol extraction. The aim of this investigation was to understand the impact of different extraction modules on polyphenol concentration in various agro-industrial wastes. Specifically, seven types of agro-industrial waste were processed into powder, and extraction was conducted using conventional, ultrasonic, and microwave extraction systems. Results revealed that ultrasound extraction-based samples exhibited higher phenolics content and antioxidant activity compared to conventional methods. LC-ESI-QTOF-MS/MS screening demonstrated the presence of diverse compounds in different samples, highlighting the phenolic diversity in these materials. Most compounds belonged to flavonoids, lignans, phenolic acids, and other polyphenols. HPLC quantification revealed appreciable amounts of different phenolics in all samples. This study provides insights into the presence of valuable phytochemicals in agro-industrial waste that can be recovered and utilized for value addition.
Keywords: waste Valorisation: High input assays: Circular Economy: Extraction methods

ANALYSIS OF WATER SCARCITY EFFECTS ON FARMLAND VALUATION

Farhaoui MOHAMED*
ESSOR Lab, Sidi Mohamed Ben Abdellah University, Fez, Morocco
Email: farhaouimed@gmail.com

Slimani CHAHID
ESSOR Lab, Sidi Mohamed Ben Abdellah University, Fez, Morocco

ABSTRACT
Real estate valuation is an issue of particular concern. It depends on many factors such as economic social and physical factors. Water plays a key role in the development. Sustainable development needs to manage and preserve water resources to meet the population needs with the required quantity and the quality. However, the water quantity is decreasing due to climate change effects and population growth. The water scarcity causes big loses in the economy because it is the cornerstone of any production chain. Moreover, the water scarcity affects negatively the economy by diminishing the investment opportunities but also by decreasing, the real estate value considered as pillar of development programs. Water is the pillar of agriculture development and water scarcity affects negatively not only the agriculture policies but also the farmland values. Studies examining the impacts of water scarcity on farmland values are few. This paper seeks to fill that void by examining the effects of water scarcity on agricultural property values: ground water and surface water. Therefore, the water is an important factor, which affects the real estate value. In property appraisal, the water can be considered as a price-setting factor in market price of farmland. Then, it is so difficult for real estate appraiser to determine why agricultural property price differ and how much this difference can be attributed to particular distinguishing features such as water scarcity. To discuss this issue, the analytical method is used. Many appraisers' reports, research's findings and courts decisions related to real estate value influenced by water scarcity are analysed, discussed and compared to many studies findings.
Keywords: Appraiser, water scarcity, environment, farmland value, real estate appraisal.

EXPLORING EMPLOYEE TURNOVER INTENTION IN PRIVATE ORGANISATION IN MALASIA

Okeke Lordwilliams IKENNA
MBA Student, Faculty of Business, Hospitality, Accounting and Finance (FBHAF)
MAHSA University, Malaysia
Email: mbaf22086576@mahsastudent.edu.my

Dr. Rasheedul HAQUE* (ORCID: 0000-0001-8170-5413)
Associate Professor, Faculty of Business, Hospitality, Accounting and Finance (FBHAF)
MAHSA University, Malaysia
Email: rasheedul@mahsa.edu.my

DR. Abdul Rahman Bin S SENATHIRAJAH (ORCID: 0000-0001-6044-9051)
INTI International University, Malaysia,
Email: arahman.senathirajah@newinti.edu.my

Fakir Mohamed BIN OMAR DIN
MAHSA University, Malaysia
Email: mohamedfakir@mahsa.edu.my

ABSTRACT

Today, organizations run with various work groups of employees for their results, inventiveness, and outcomes. Even though this is a demonstrated technique, it is understandable that when individuals are united from different climate and encounters struggle will emerge there whenever. Struggle happens when individuals' principles, discernment, objectives concerning the result crash into one another. Struggle as an intrinsic wonder in people's life emerges as a day-by-day challenge in various organizations. Due to the struggle, employees might leave their current work for another organization. Job satisfaction is the satisfaction emerging from the fulfillment that people acquire from their positions. This satisfaction prompts people's more prominent job commitment and readiness to play out their undertakings. It brings about employee's work headway just as hierarchical responsibility. As indicated by the two-factor hypothesis created by Herzberg et al. (1959), there are two components related with employee satisfaction: motivation and hygiene factors. Motivation factors are work related elements, like acknowledgment, accomplishment, a chance of development, progression, obligation, and the actual work. Hygiene factors are known as extra-work factors. For example, pay, relationship with boss, relationship with subordinates, relationship with peers, management, organization strategy and organization, working conditions, status, employer stability, and components in close to home life. These components can well clarify a singular's conduct busy working and they are likewise connected with the work inspiration of people. The higher job satisfaction people have, the more probable they play out their errand eagerly. A few investigations discovered that job satisfaction hurts turnover expectation. This paper analyzed the relationship between Turnover Intention and Job Satisfaction, Job Stress, Work Engagement, Organizational Commitment. The review utilized the social trade hypothesis as its hypothetical supporting. Information was gathered through non-likelihood (advantageous inspecting) procedures of 350 clients of worker turnover expectation from

private sector. Measurable Bundle Sociology (SPSS) programming variant 2.0 was utilized to examine the information. The outcomes recognized Turnover Aim, Job Stress, Work Engagement, Organizational Commitment as significant driver and affected representative turnover intention. The outcomes have suggestions for relationship directors who use administration assessment and intuitive responsibility as a multidimensional development in anticipating employee turnover goal. The sampling method is a census, with the private sector employees serving as the unit of analysis. Using a five-point Likert scale, data were collected via questionnaires issued to employees of private sectors and evaluated. In the end, the study demonstrates that job satisfaction, job stress and work engagement are directly related to turnover intention, and that organizational commitment acts as a mediator between these factors. In addition to reporting the study's main findings, this paper elaborates on their significance and proposes avenues for similar research in the future. Excessive work engagement and underpay have been on the high especially for ladies. This has resulted to putting employees' jobs on the bleeding edge which made some resort to gambling and other side recreations to balance with the low salary from their respective jobs.

Keywords: Job Satisfaction, Job Stress, Work Engagement, Organizational Commitment, Turnover Intention, Private Sector.

DETECTION OF BACTERIAL LOADS ON THE SKIN OF FISHES HARVESTED FOR HUMAN CONSUMPTION IN RIVER HADEJIA, NORTHWEST NIGERIA

Adeniyi Olarewaju ADELEYE*
Department of Environmental Sciences, Federal University Dutse, Jigawa State, Dutse, Nigeria.
Email: adeniyi.adeleye@fud.edu.ng or adeniyiadeleye80@gmail.com

Hamzat ADAMU
Department of Environmental Sciences, Federal University Dutse, Jigawa State, Dutse, Nigeria.

Mohammed Bello YERIMA
Department of Microbiology, Sokoto State University, Sokoto, Sokoto State, Nigeria.

ABSTRACT
The disposal of waste into the water body and contamination through other channels, runoff fertilizers from farm application and other anthropogenic activities of man have been implicated in the availability of bacterial loads on the skin of fishes. The aim of this research was to assess the bacterial loads on the skin of fishes harvested for consumption from river Hadejia with a view to evaluating its possible human health risks. From each of the five (5) fish harvesting points (FHP); FHP1, FHP2, FHP3, FHP4 and FHP5 on the banks of river Hadejia, three (3) fishes were randomly sampled and kept in sterile plastic containers. The sampled fishes were subsequently transported to the laboratory for analysis. Standard microbiological methods were employed for assaying the bacteria on the skin of the sampled fishes. Bacterial isolates were identified via the cultural method, Gram staining and biochemical characterization tests. One way analysis of variance (ANOVA) was used to compare bacterial loads on the skin of the fishes sampled in the FHP at 95% confidence level. Results obtained indicate that there was an observed variation in the bacterial abundance across the FHP. Specifically, for the dilution factor 104 on nutrient agar plates, bacterial loads in FPH1 (1.4 x 106 CFU/mL), FHP2 (2.24 x 106 CFU/mL) and FHP3 (2.4 x 106 CFU/mL) were significantly ($p<0.05$) different from all the other FHP while the bacterial loads in FHP4 and FHP5 were not significantly ($p>0.05$) different from each other. Similar trend can be observed in the dilution factor (106) on Trypticase soy agar plates as the bacterial loads in FHP1 (9.6 x 107 CFU/mL), FHP2 (1.7 x 108 CFU/mL) and FPH3 (2.1 x 108 CFU/mL) were significantly ($p<0.05$) different from other FHP. The observation of both Gram-negative and Gram-positive bacteria in the Gram staining test indicates a diversity of bacterial types within the sampled fishes. *Bacillus subtilis, Klebsiella pneumoniae, Lactobacillus* spp., *Escherichia coli, Staphylococcus epidermidis* and *Staphylococcus aureus* were detected on the skin of the sampled fishes in the FHP. Based on the findings of this study, it is recommended that further research needs to be conducted to consider seasonal variations in the bacterial loads and incorporate this temporal aspect into the assessment. Again, there is a need to promote educational programmes on safe handling, cooking and consumption practices to minimize health risks on individuals that rely on the fishes from river Hadejia for consumption.
Keywords: Fish, Bacterial loads, Bacterial isolates, Fish harvesting points, River Hadejia

SURVIVAL TIME OF CANCER PATIENTS USING BURR DISTRIBUTION

Prof. Dr. P. PANDIYAN
Department of Statistics, Annamalai university, Annamalai Nagar, Cuddlaore Dist, Tamilnadu. India
Email: pandiyanau@gmail.com

G. SATHYAMURTHY
Research Scholar, Department of Statistics, Annamalai university, Annamalai Nagar, Cuddlaore Dist, Tamilnadu. India
Email: statsathya@gmail.com

Assist. Prof. Dr. G. Subash CHANDRABOSE
Department of Community Medicine, Aarupadai Veedu Medical College & Hospital, Puducherry, India
Email: subashstat@gmail.com

ABSTRACT
The three most common and serious cancers are stomach, lung, and oral cancers. Each has its own causes, symptoms, and characteristics. The oral cavity, which includes the lips, tongue, gums, and mouth lining, is the primary site of oral cancer. Tobacco and alcohol use, as well as HPV infection, are risk factors for the disease. Lung cancer begins in the tissues of the lungs and is mostly caused by tobacco use, though it can also develop as a result of genetics and environmental pollution exposure. The cells lining the stomach are the source of stomach cancer, sometimes referred to as gastric cancer. Helicobacter pylori infection, nutrition, and genetic susceptibility are some of the variables that might affect stomach cancer. In more advanced stages, metastasis the spread of cancer cells occurs often and is associated with worse prognoses and additional problems. The cells lining the stomach are the source of stomach cancer, sometimes referred to as gastric cancer. Helicobacter pylori infection, nutrition, and genetic susceptibility are some of the variables that might affect stomach cancer. In more advanced stages, metastasis the spread of cancer cells occurs often and is associated with worse prognoses and additional problems.
Keywords: HPV infection, statistical modelling, Epidemiology, Threshold, cancer.

ELABORATION AND CHARACTERIZATION OF BIOPOLYMER COMPOSITES FILMS BASED ON HYDROXYPROPYLE METHYLCELLULOSE HPMC REINFORCED WITH PECTIN

Mazouzi NOURDJIHANE
Functional Analysis Laboratory, Department of Process Engineering University of Saad dahlab Blida -1-, Algeria.
Email: mazouzi.nour.alg@gmail.com

K. BOUTEMAK
Functional Analysis Laboratory, Department of Process Engineering University of Saad dahlab Blida -1-, Algeria
Email: kboutemak@yahoo.fr

A. HADDAD
Laboratoire De Corrosion, Centre De Recherche En Technologie Industrielle, Alger, Algérie

ABSTRACT
Biopolymers have been studied as sustainable alternatives to synthetic plastics product; In this study, hydroxypropylmethylcellulose (HPMC)/pectin composites are reinforced with 0.5% magnesium nanooxides MgONPs, if not 0.5%, the aim of developing these materials is to optimize the engineering properties of biopolymer composite films, considering the following. what do we do In contrast to synthetic plastics of fossil origin. The films were prepared using the solution method. Next, we characterized the physical properties, biodegradability, and mechanical properties of the films, and the results showed that the nanocomposite films made from HPMC/pectin/MgO NPs solutions showed higher flexibility and plasticity of the nanocomposite films compared to HPMC / pectin. The films In other words, the use of strong HPMC/pectin nanocomposites and magnesium nanoparticles MgO NPs can be considered as an additional way to improve the properties of HPMC film.
Keywords: biopolymers, biodegradability, nanocomposite, hydroxypropyle methyl cellulose, pectin.

SÜT İNEKLERİNDE DOĞUM ANINDAKİ BUZAĞILAMA TİPİ VE METABOLİK DURUMA GÖRE POSTPARTUM HASTALIK RİSKİNİN TAHMİN EDİLMESİ

Dr. Öğr. Üyesi Tarık ŞAFAK (ORCID: 0000-0002-6178-4641)
Kastamonu University, Faculty of Veterinary Medicine, Department of Obstetrics and Gynecology, Kastamonu, Türkiye.
Email: tsafak@kastamonu.edu.tr

Efe DURUKAN (ORCID: 0009-0006-5603-042X)
Kastamonu University, Faculty of Veterinary Medicine, Department of Obstetrics and Gynecology, Kastamonu, Türkiye
Email: vetdrefedurukan@gmail.com

Dr. Öğr. Üyesi Öznur YILMAZ KOÇ* (ORCID: 0000-0003-0424-9471)
Siirt University, Faculty of Veterinary Medicine, Department of Obstetrics and Gynecology, Siirt, Türkiye
Email: oznur.yilmaz@siirt.edu.tr

Prof. Dr. Ali RİŞVANLI (ORCID: 0000-0001-5653-0025)
Kyrgyz-Turkish Manas University, Faculty of Veterinary Medicine, Department of Obstetrics and Gynecology, Bishkek, Kyrgyzstan
Email: ali.risvanli@manas.edu.kg

Prof. Dr. Metin BAYRAKTAR (ORCID: 0000-0001-7780-2982)
Fırat University, Faculty of Veterinary Medicine, Department of Zootechny, Elazığ, Türkiye
Email: mbayraktar@firat.edu.tr

ÖZET

Bu çalışmada, esterleşmemiş yağ asitleri (NEFA), β-hidroksibutirat (BHB), kalsiyum (Ca) ve buzağılama tipinin kan konsantrasyonlarının doğum sonrası hastalıkların gelişimine etkisi incelenmiştir Bu amaçla çalışmada 120 adet Holştayn ineği kullanıldı. Öncelikle bu inekler buzağılama tipine göre normal doğum (n=58) ve (n=62) olmak üzere iki alt gruba ayrıldı. İnekler doğum sonrası 15 gün boyunca takip edildi. Doğum sonrası dönemde gelişen hastalıklar kaydedildi. Daha sonra, retensiyo sekundinarum (RS) (n=19), metritisli (n=34), klinik mastitisli (n=20) ve hastalık şekillenmeyen (n=47) ineklerden doğum sırasında alınan kan örneklerinde NEFA, BHB ve Ca konsantrasyonları ölçüldü. Sonuçlarımız Ca'nın mastitis (P < .001, Odds oranı= 4.599), metritis (P= 0.009, Odds oranı: 0.085) ve RS (P < .001, Odds oranı=0.015) riski ile negatif ilişkili olma eğiliminde olduğunu göstermektedir. BHB, metritis riski (P= 0,002, Odds oranı= 42,069) ve RS (P < 0,001, Odds oranı= 96,498) ile pozitif olarak ilişkili olma eğilimindeydi. Diğer yandan buzağılama tipinin ve NEFA konsantrasyonunun bu hastalıkların gelişimi üzerine herhangi bir etkisi bulunmamıştır. Çalışmanın sonuçları, doğumdaki düşük Ca ve yüksek BHB konsantrasyonunun süt ineklerinin verim verimliliğini olumsuz yönde etkileyebileceğini gösterdi. Üstelik doğum sonrası hastalıklara yatkınlığın artmasına da sebep olabilmektedir.

Anahtar Kelimeler: İnek; güç doğum; mastitis; metritis; NEFA

PREDICTING THE RISK OF POSTPARTUM DISEASE IN DAIRY COWS ACCORDING TO METABOLIC STATUS AND CALVING TYPE AT PARTUTATION

ABSTRACT

The effects of blood concentrations of non-esterified fatty acids (NEFA), β-hydroxybutyrate (BHB), calcium (Ca), and calving type on the development of postpartum diseases were examined in this study. For this purpose, 120 Holstein cows were used in the study. First of all, these cows were divided into two subgroups according to the calving type: unassisted parturition (Vaginal delivery) (n = 58) and assisted parturition (Dystocia) (n = 62). Cows were followed for 15 days postpartum. Diseases that developed during the postpartum period were recorded. Then, NEFA, BHB and Ca concentrations were measured in blood samples collected at partutation from cows with retained fetal membranes (RFM) (n=19), metritis (n=34), clinical mastitis (n=20) and cows that did not develop the disease (n=47). Our results show that Ca tended to be negatively associated with the risk of mastitis (P < .001, Odds ratio= 4.599), metritis (P= 0.009, Odds ratio: 0.085), and RFM (P < .001, Odds ratio= 0.015). BHB tended to be positively associated with the risk of metritis (P= 0.002, Odds ratio= 42.069) and RFM (P < .001, Odds ratio= 96.498). On the other hand, calving type and NEFA concentration had no effect on the development of these diseases. The results of the study indicated that low Ca and high BHB concentration at partutation could negatively affect the productive efficiency of dairy cows. Moreover, it increases susceptibility to postpartum diseases.

Keywords: Cows; dystocia; mastitis; metritis; NEFA

KURŞUN UYGULANAN RATLARDA SODYUM TETRABORATIN ESER ELEMENTLER VE BAZI KAN PARAMETRELERİ ÜZERİNE ETKİSİ

Doç. Dr. H. Turan AKKOYUN (ORCID: 0000-0002-4547-8003)
Siirt Üniversitesi, Veteriner Fakültesi
Email: turanakkoyun@hotmail.com

ÖZET
Bor(B), Metalle ametal arası, yarı iletken özelliğe sahip Periyodik cetvelin 3A grubunda bulunan en hafif, element olarak bilinir. Bor elementinin oksijenle bağ yapma özelliği yüksektir ve bu bileşiklerinin genel adı borattır. Bor elementi proton verici olarak görev yapması hücre yapısı ve fonksiyonlarına etki etmesi gibi çeşitli nedenlerden dolayı canlı sistemler açısından bakıldığında son derece önemlidir. Sunulan çalışmada; kurşun ve sodyum tetraborat uygulanan ratlarda, kanda sodyum, potasyum, magnezyum, demir gibi element miktarları ve AST, ALT, LDH enzimleri ve glikoz gibi parametrelerinin değişimlerinin belirlenmesi amaçlandı. Çalışmada Wistar albino cinsi 200-300 gr ağırlığına sahip ratlar; Kontrol:izotonik serum(0.5mL,i.p), Kurşun(50 mg/kg/day/(i.p), Sodium tetraborat (4.0 mg/kg/day), Kurşun+ Sodium tetraborat(50 mg/kg/day/ kurşun (i.p)+ 4.0 mg/kg/day Sodium tetraborat) 4 gruba ayrıldı. Çalışma sonunda ratlardan kan örnekleri alınarak santrifüjlendi. Serum numuneleri ependorf tüplerine aktarılarak analizler için hazır hale getirildi. Analiz sonuçları değerlendirildiğinde; AST($p<0.05$), ALT($p<0.001$) ve LDH($p<0.001$) enzim aktivitelerinin kontrol grubuna oranla kurşun ve kurşun+sodyum tetraborat verilen grupta anlamlı olarak azaldığı belirlendi. Glikoz düzeyinin kontrol grubu ile kıyaslandığında kurşun($p<0.001$), kurşun+sodyum tetraborat($p<0.001$) grubunda anlamlı olarak arttığı görüldü. Sodyum ve kalsiyum düzeylerinin gruplar arasında anlamlı bir değişim göstermediği belirlenirken; Kontrol grubuyla kıyaslandığında potasyum($p<0,01$), magnezyum(0,001) ve demir($p<0,01$) içeriğinin kurşun uygulanan grupta ve benzer şekilde kurşun+sodyum tetraborat uygulanan grupta anlamlı azaldığı tesbit edildi.
Anahtar Kelimeler: Kurşun, Rat , Sodyum tetraborate

PROTECTIVE EFFECTS OF SODIUM TETRABORATE ON TRACE ELEMENTS AND SOME BLOOD PARAMETERS IN LEAD-APPLIED RATS

ABSTRACT

Boron (B) is known as the first and lightest element in the 3A group of the periodic table, with semiconductor properties between metal and nonmetal. The boron element has a high ability to bond with oxygen and the general name of these compounds is borate. Boron element is extremely important in terms of living systems for various reasons such as acting as a proton donor and affecting cell structure and functions. In the presented study; It was aimed to determine the amounts of elements such as sodium, potassium, magnesium and iron in the blood and the changes in parameters such as AST, ALT, LDH enzymes and glucose in rats administered lead and sodium tetraborate. In the study, Wistar albino rats weighing 200-300 g; Control: isotonic serum (0.5mL, i.p), Lead (50 mg/kg/day/ (i.p), Sodium tetraborate (4.0 mg/kg/day), Lead + Sodium tetraborate (50 mg/kg/day/ lead (i.p) + 4.0 mg/kg/day Sodium tetraborate) were divided into 4 groups. t the end of the study, blood samples were taken from the rats and centrifuged. Serum samples were transferred to Eppendorf tubes and made ready for analysis. When the analysis results are evaluated; It was determined that AST($p<0.05$), ALT($p<0.001$) and LDH($p<0.001$) enzyme activities decreased significantly in the lead and lead+sodium tetraborate group compared to the control group. It was observed that the glucose level increased significantly in the lead ($p<0.001$) and lead+sodium tetraborate ($p<0.001$) group when compared to the control group. While it was determined that sodium and calcium levels did not show a significant change between the groups; Compared to the control group, potassium ($p<0.01$), magnesium (0.001) and iron ($p<0.01$) contents were found to decrease significantly in the lead-treated group and similarly in the lead+sodium tetraborate-treated group.

Keywords: Lead, Rat, Sodiumtetraborate

SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL ACTIVITY OF Ni(II), Cu(II), Co(II) andMn(II) COMPLEXES OF 3,5-dichloro-2-hydroxybenzaldehyde BASED LIGAND

Saima TUFAIL
Department of Chemistry, Government College University Faisalabad, Faisalabad-38000, Pakistan

Bushra PARVEEN
Department of Chemistry, Government College University Faisalabad, Faisalabad-38000, Pakistan

Kashif ABBAS
Department of Chemistry, Government College University Faisalabad, Faisalabad-38000, Pakistan

Ameer Fawad ZAHOOR
Department of Chemistry, Government College University Faisalabad, Faisalabad-38000, Pakistan

ABSTRACT

The Schiff base 2-(((4-bromophenyl)imino)methyl)-4,5-dichlorophenol was prepared by reacting 4-bromoaniline with 3,5-dichloro-2-hydroxybenzaldehyde in a methanol solution underreflux. The complexes (**1-4**) were synthesized by treating Schiff base with MCL2; (M=Ni(II), Cu (II), Co(II) and Mn(II)) under reflux. All the complexes and ligandswere found to be non-electrolyte in nature. The structure of the Schiff base and its complexes were characterized by UV-Vis, FT-IR, and 1H NMR spectroscopy. This characterization revealed the presence of the azomethine group (HC=N) in the ligand and also provided evidence of the bonding of this azomethine nitrogen with the metal (II) atom. The -OH stretching vibration appeared in the FT-IR spectra of the ligand while disappear in the spectra of complexes and the appearance of new stretching vibrationsν(M-O) and ν(M-N) indicate that metal oxygen and metal nitrogen bondsare formed. The formation of bands indicates the coordination of M(II) occurs through this site thus 4-coordinated and6-coordinated geometry in the solid state is proposed. The synthesized complexes display intense bands in 200-500 nm, which may be assigned to π - π^*, n - π^* transition in the spectra. Intra ligand and charge transfer transitions observed in the spectra of metal complexes. The antibacterial activities of the synthesized Schiff base and its complexes were determined against different strains of bacteria *Bacillus subtiliius* and *Escherichia coli*. These complexes werefound to be more active towards the strains of bacteria as compared to the ligand.

Keywords: Schiff base, Transition metal complexes, Spectroscopic characterization, Antibacterial activity

OPTIMIZING *IN VITRO* REGENERATION PROTOCOLS OF TUNISIAN LOCAL PEARS (*Pyrus communis* L) AND FIGS (*Ficus carica* L)

Chokri BAYOUDH (ORCID: 0000-0002-7531-2979)
Research Laboratory "Production and Protection for a Sustainable Horticulture" (LR21AGR03), Regional Research Centre on Horticulture and Organic Agriculture (CRRHAB), B.P. 57, 4042 Chott-Mariem, IRESA-University of Sousse, Tunisia.
Email: chokribayoudh@gmail.com

Afifa MAJDOU
Regional Research Centre on Horticulture and Organic Agriculture (CRRHAB), B.P. 57, 4042 Chott-Mariem, IRESA-University of Sousse, Tunisia.
Email: afifamajdoub@yahoo.fr

Messaoud MARS
Research Laboratory "Agrobiodiversity and Ecotoxicology" (LR21AGR02), Higher Agronomic Institute (ISA), 4042 Chott-Mariem, IRESA-University of Sousse, Tunisia.
Email: mb.mars@yahoo.fr

ABSTRACT
Tunisian local pear cultivars are widely eradicated by fire blight disease and fig trees are threatened by the attack of Fig Mosaic Disease (FMD) viruses. For large-scale and fast production of the two crops, reliable protocols for rapid *in vitro* propagation was developed and optimized. Pears (*Pyrus communis* L) cv. "Arbi" is established from apical explants and figs (*Ficus carica* L.) from shoot-tips of three major local fig varieties Zidi (ZDI), Soltani (SNI), Bither Abiadh (BA) and one recalcitrant and rare caprifig Assafri (ASF). As results, successful initiation of pear cultures was achieved on MS basal medium supplemented with 0.25 mg L-1 BAP (Benzyle Amino Purine). The best initiation rates of fig shoot-tips was obtained on medium MS containing 0.2 mg L-1 BAP, 0.1 mg L-1 NAA (α-Naphthalene Acetic Acid) and 0.1 mg L-1 GA3 (Gibberellic acid). For the proliferation stage, optimal pear shoot multiplication rates were obtained on MS medium with only 1 mg L-1 BAP, but for figs the shoot multiplication and plantlet development were provided by MS medium with 0.5 mg L-1 BAP, 0.1 mg L-1 IBA and 0.1 mg L-1 GA3. Rooting and acclimatization success rates of pear vitroplants are optimal and need to be optimized. For fig vitroplants, *ex vitro* rooting was successfully performed on moist peat with success rate of 90%. The acclimatized fig vitroplants showed high establishment rates (98%) and rapid growth on substrate S1 composed by peat, and are with no morphological abnormalities.
Keywords: *in vitro*, shoot multiplication, *ex vitro* rooting, initiation rates, acclimatization

EVALUATION OF DIFFERENT TYPES OF BIOCHAR ON GROWTH PERFORMANCE AND BODY COMPOSITION OF *C. carpio* FINGERLINGS

Muhammad AMJAD*
Department of Zoology, Faculty of Life Sciences, Government College University, Faisalabad, 38000, Pakistan

Syed Makhdoom HUSSAIN
Department of Zoology, Faculty of Life Sciences, Government College University, Faisalabad, 38000, Pakistan
Email: mamjad5919@gmail.com

ABSTRACT
The study was aimed to find out how different types of biochar supplemented sunflower meal diets influence the growth and body composition of *C. carpio* fingerlings. Seven different diets were tested in the experiment. A sunflower meal-based diet was supplemented with 2% of various types of biochar (cotton stick, wheat straw, corn cob, house waste, grass waste, and green waste biochar). The control diet was without biochar. As a non-digestible marker, chromic oxide was added to the diets. Each day, at the 5 % of their live wet weight, fingerlings were fed. The maximum weight gain (272.37%), lowest FCR (1.23), highest SGR (1.88) were recorded in corn cob biochar supplemented sunflower meal based diet test diet. In case of body composition, corn cob biochar supplemented sunflower meal based diet indicated significant ($p<0.05$) improvements in crude protein (17.87%) and crude fat (6.27%). From these results, it was concluded that 2% corn cob biochar supplementation in sunflower meal based diet is optimum for improving growth performance and body composition of *C. carpio* fingerlings.
Keywords: *C. Carpio*, biochar, marker

EXTRACTION OF AROMATIC COMPOUNDS FROM NATURAL RESOURCES USING SUPERCRITICAL FLUID

Dr. Ghanshyam BARMAN (ORCID: 0000-0002-2611-0801)
C G P I T, UkaTarsadia University, India
Email: gbarmannitr@gmail.com

ABSTRACT
The extraction of aromatic compounds from natural resources using supercritical fluid is a process that utilizes a supercritical fluid, typically carbon dioxide (CO2), to extract aromatic compounds from plant materials. The supercritical fluid is a state where the fluid is neither a liquid nor a gas, but exhibits properties of both. In this method, the natural resource, such as flowers, herbs, or spices, is exposed to supercritical CO2, which acts as a solvent. The supercritical CO2 has unique properties that make it an effective solvent for extracting aromatic compounds. It has a low viscosity, high diffusivity, and can be easily removed after extraction. The extraction process involves pressurizing CO2 above its critical point, typically around 31 degrees Celsius and 74 atmospheres, to achieve the supercritical state. The supercritical CO2 is then passed through the natural resource, allowing it to dissolve and carry away the aromatic compounds. The extraction efficiency and selectivity can be enhanced by adjusting parameters such as temperature, pressure, and extraction time. After extraction, the supercritical CO2 can be easily separated from the extracted aromatic compounds by reducing the pressure, and the CO2 can be reused in subsequent extractions. The extracted aromatic compounds can be used in various industries, including the fragrance, flavor, and pharmaceutical industries. The supercritical fluid extraction (SFE) method using CO2 offers several advantages over conventional extraction techniques. It is a green and environmentally friendly process since CO2 is non-toxic, non-flammable, and readily available. It also allows for selective extraction of specific aromatic compounds, minimizing the extraction of unwanted compounds. Furthermore, SFE can offer higher extraction yields and maintain the quality of the extracted compounds, as it operates at lower temperatures compared to other methods. In summary, the extraction of aromatic compounds from natural resources using supercritical fluid, such as CO2, is an efficient and environmentally friendly method that offers selective extraction and high-quality yields.
Keywords: supercritical, extraction, aromatic, CO2, natural

BİR, İKİ VE DÖRT AYLIK BUZAĞILARDA MARBOFLOKSASİNİN KARŞILAŞTIRMALI FARMAKOKINETİĞİ

Doç. Dr. Orhan ÇORUM (ORCID: 0000-0003-3168-2510)
Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, University of Hatay Mustafa Kemal, Hatay, 31060, Turkiye.
Email: orhancorum46@hotmail.com

Prof. Dr. Murat YÜKSEL (ORCID: 0000-0001-6634-0559)
Department of Obstetrics and Gyneacology, Faculty of Veterinary Medicine, University of Hatay Mustafa Kemal, Hatay, 31060, Turkiye.
Email: murat.yuksel@mku.edu.tr

***Dr. Öğr. Üyesi Devran COŞKUN (ORCID: 0000-0003-1151-1861)**
Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, University of Siirt, Siirt, 56100, Turkiye.
Email: devrancoskun@gmail.com

Doç. Dr. Duygu DURNA ÇORUM (ORCID: 0000-0003-1567-991X)
Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, University of Hatay Mustafa Kemal, Hatay, 31060, Turkiye.
Email: ddurnacorum@gmail.com

Öğr. Gör. Şerafettin KARTAL (ORCID: 0000-0003-0935-2590)
Department of Veterinary Medicine, Samandag Vocational School, Hatay Mustafa Kemal University, Hatay, 31060, Turkiye.
Email: serafettin.kartal@mku.edu.tr

Doç. Dr. Mustafa CELLAT (ORCID: 0000-0003-2559-096X)
Department of Physiology, Faculty of Veterinary Medicine, University of Hatay Mustafa Kemal, Hatay, 31060, Turkiye.
Email: mcellat@mku.edu.tr

Prof. Dr. Kamil ÜNEY (ORCID: 0000-0002-8674-4873)
Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, University of Selcuk, Konya, 42031, Turkiye
Email: kuney@selcuk.edu.tr

ÖZET
Bu araştırmanın amacı bir, iki ve dört aylık yaştaki buzağılara damar içi yolla uygulanan marbofloksasinin farmakokinetiğini karşılaştırılmasıdır. Çalışma toplam 18 adet sağlıklı montafon ırkı buzağı üzerinde gerçekleştirildi. Buzağı yaşlarına göre bir aylık, iki aylık ve dört aylık olmak üzere 3 eşit gruba ayrıldı. Marbofloksasin tüm gruplara 10 mg/kg dozda damar içi yolla uygulandı. Kan örnekleri marbofloksasin uygulaması yapılmadan hemen önce (0. saat) ve uygulamasını takip eden 5., 15., 30 ve 45. dakikalar ile 1., 2., 4., 6., 8., 10., 12., 24., 48., 72 ve 96. saatlerde alındı. Marbofloksasinin plazma konsantrasyonu belirlenmesi için yüksek basınçlı sıvı kromatografisi kullanıldı. Farmakokinetik parametreler non-kompartmental analiz ile hesaplandı. Bir aylık, iki

aylık ve dört aylık buzağılarda marbofloksasin plazmadan sırası ile 72., 48. ve 24. saate kadar tespit edildi. Bir aylık buzağılarda marbofloksasinin eliminasyon yarı ömrü (t1/2ʎz), kararlı durum dağılım hacmi (Vdss), total klirens (ClT) ve eğri altında kalan alan (AUC0-∞) değerleri sırasıyla 10.62 saat, 1.03 L/kg, 0.08 L/h/kg ve 127.90 h*µg/mL olarak tespit edildi. Buzağıların yaşına paralel olarak eliminasyon yarı ömrü ve eğri altında kalan alan değerleri azaldığı ve klirensin arttığı belirlendi. Bir ve iki aylık buzağılar ile dört aylık buzağılarda karşılaştırıldığında, dört aylık buzağılarda Vdss'nin azaldığı belirlendi. Sonuç olarak buzağılarda yaşa bağlı olarak marbofloksasinin farmakokinetiğinin önemli oranda değiştiği belirlendi. Farmakokinetik değişime bağlı olarak klinik etkinliğinde değişebileceği göz önünde bulundurulduğunda farklı yaş buzağılarda marbofloksasinin farmakokinetik/farmakodinamik ilişkisinin ortaya konulmasına ihtiyaç vardır.

Anahtar Kelimeler: Buzağı, Farklı yaş, Farmakokinetik, Marbofloksasin, HPLC.

COMPARATIVE PHARMACOKINETICS OF MARBOFLOXACIN IN ONE-TWO- AND FOUR-MONTH-OLD CALVES

ABSTRACT

This study aimed to compare the pharmacokinetics of marbofloxacin in one-, two- and four-month old calves. The study was carried out on 18 healthy Montafon calves. The calves were divided into 3 equal groups according to their ages: one month old, two months old and four months old. Marbofloxacin was administered intravenously to all groups at a dose of 10 mg/kg. Blood samples were collected before drug administration (0 h) and at 5, 15, 30, and 45 min and 1, 2, 4, 6, 8, 10, 12, 24, 48, 72 and 96 h after marbofloxacin administration. Plasma concentrations of marbofloxacin were measured using high-performance liquid chromatography. Pharmacokinetic parameters were calculated by non-compartmental analysis. Marbofloxacin was measured from plasma until the 72, 48 and 24 h in one-, two- and four-month-old calves, respectively. The elimination half-life (t1/2ʎz), volume of distribution at steady state (Vdss), total clearance (ClT) and area under the concentration-versus time curve (AUC0-∞) values of marbofloxacin in one-month-old calves were 10.62 h, 1.03 L/kg, 0.08 L/h/kg and 127.90 h*µg/mL, respectively. It was determined that clearance increased while elimination half-life and area under the curve values decreased in parallel with the age of the calves. When one- and two-month-old calves were compared with four-month-old calves, it was determined that Vdss decreased in four-month-old calves. As a result, the pharmacokinetics of marbofloxacin changed significantly with age in calves. Since the clinical efficacy of marbofloxacin may vary depending on pharmacokinetic changes, there is a need to reveal the pharmacokinetic/pharmacodynamic relationship in calves of different ages.

Keywords: Calves, Different age, HPLC, Marbofloxacin, Pharmacokinetic.

YEM ENDÜSTRİSİ İÇİN MULTİVİTAMİNLERİN ÇİFT EMÜLSİYON ENKAPSÜLASYON YÖNTEMİYLE FORMÜLASYONU VE KARAKTERİZASYONU

Ece UYAR* (ORCID: 0000-0003-0480-3620)
Ege University, Faculty of Engineering, Department of Bioengineering, İzmir-Türkiye
Email: ece.uyar@coralinnovative.com

Dr. Mustafa AKIN (ORCID: 0000-0003-4268-6891)
Petro Yağ ve Kimyasalları San. Ve Tic. A.Ş., Kocaeli-Türkiye
Email: mustafa.akin@petroyag.com

Prof. Dr. Ayşe NALBANTSOY (ORCID: 0000-0002-3852-1974)
Ege University, Faculty of Engineering, Department of Bioengineering, İzmir-Türkiye
Email: analbantsoy@gmail.com

ÖZET
Kanatlı sektöründe artan talep ile birlikte kümes kapasitelerinin hızlı artışı, patojenler ve değişen çevre koşulları ile birlikte kanatlı yetiştiriciliğinde hayvanlar üzerindeki stresi de arttırmaktadır. Bu tehditleri kontrol altına alarak maliyetleri düşürmek ve verimi arttırmak için sektörde kullanılacak ekonomik yem katkılarına ihtiyaç duyulmaktadır. Bu amaçla uzun yıllardır yemlere eklenen vitamin katkı maddeleri, kanatlı sağlığını, kalitesini ve üretkenliğini artırmak için etkili bir araç olarak kullanılmaktadır. Sunulan bu çalışma ile kanatlı sektöründe ihtiyaç duyulan, yenilikçi bir teknoloji ile tasarlanarak enkapsüle edilen vitaminlerin; yem katkısı olarak verimliliği arttıracak şekilde daha dayanıklı, raf ömrü uzun ve biyoyararlanımı daha yüksek ürün olarak geliştirilme potansiyeli araştırılmıştır. Bu amaçla, ticari olarak geliştirilmiş mineral yağ bazlı CORALVAC AT 318 adjuvanı denemelerde kullanılmıştır. Yağda çözünen A, E ve K1 vitaminleri, yağ fazında; suda çözünen B12 ve C vitaminleri ise, su fazında W/O/W tipi emülsiyona eklenerek multivitamin enkapsülasyonları tasarlanmıştır. Formülasyonların enkapsülasyon stabilitesi ve verimliliği salınım denemeleri ile test edilmiştir. Formülasyonlar hızlandırılmış ve gerçek zamanlı stabilite denemelerine tabi tutulmuş ve sunuçta stabil bulunduğu ortaya konarak yağda ve suda çözünen vitaminlerin tek bir üründe formüle edilebileceği gösterilmiştir. Sonuç olarak, geliştirilen yeni formülasyon ile yeme veya içme suyuna eklenecek vitamin miktarı azaltılırken, verim ve biyoyararlanımda artış olacağı öngörülerek bunun saha çalışmaları ile desteklendikten sonra kanatlı sektörüne yeni bir teknolojik ürün olarak sunulabileceği ortaya konmuştur.
Anahtar Kelimeler: Vitaminler, Yem Katkı, Enkapsülasyon, Çift Katmanlı Emülsiyon

FORMULATION AND CHARACTERIZATION OF MULTIVITAMINS FOR THE FEED INDUSTRY BY DOUBLE EMULSION ENCAPSULATION METHOD

ABSTRACT

With the increasing demand in the poultry sector, coupled with the rapid expansion of poultry house capacities, stress on animals in poultry farming has also increased due to pathogens and changing environmental conditions. Economic feed additives are needed in the industry to control these threats, reduce costs, and increase productivity. For this purpose, vitamin additives added to feeds for many years have been effectively utilized as a tool to enhance poultry health, quality, and productivity. This study aims to investigate the potential development of vitamins, which are encapsulated with an innovative technology, designed to be more durable, have a longer shelf life, and higher bioavailability as feed additives to increase efficiency in the poultry sector. For this purpose, the commercially developed mineral oil-based adjuvant CORALVAC AT 318 was used in the trials. Fat-soluble A, E, and K1 vitamins were encapsulated in the oil phase, while water-soluble B12 and C vitamins were added to a W/O/W type emulsion to design multivitamin encapsulations. The encapsulation stability and efficiency of formulations were tested through release experiments. Formulations underwent accelerated and real-time stability tests, ultimately demonstrating stability, indicating that both fat-soluble and water-soluble vitamins can be formulated in a single product. Consequently, it is suggested that with the newly developed formulation, the amount of vitamins added to feed or drinking water can be reduced while increasing efficiency and bioavailability, potentially introducing a new technological product to the poultry sector after being supported by field studies.

Keywords: Vitamins, Feed Additives, Encapsulation, Double Emulsion

SUSTAINABILITY 2.0: HARNESSING THE POWER OF INNOVATION TO HEAL OUR PLANET

Nancy lilly MARIA C.S.
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: 1230510.it@rmkec.ac.in

Suganthi P (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
Embark on an odyssey through the kaleidoscopic realm of the environment, where the symphony of nature intertwines with the harmonies of cutting-edge technology to sculpt a future of boundless possibility. This abstract unveils the dynamic interplay between humanity and the natural world, weaving a tapestry of innovation, resilience, and transformative potential. At the heart of this narrative lies biodiversity, nature's magnum opus, adorned with the hues of genetic diversity and ecological intricacy. Yet, amidst the backdrop of escalating environmental challenges, the stage is set for a technological renaissance that promises to redefine our relationship with the Earth. Venture into the frontier of conservation technology, where drones soar through the skies, mapping ecosystems with unparalleled precision and guiding conservation efforts with surgical accuracy. Witness the rise of bioremediation techniques, where microbial marvels and nano-technological wonders collaborate to cleanse polluted waters and rejuvenate degraded landscapes. Peer through the looking glass of climate tech, where carbon capture innovations harness the power of nature to mitigate greenhouse gas emissions and forge a path towards climate neutrality. Journey alongside the pioneers of agro-tech, as vertical farms and aquaponics systems revolutionize food production, offering a glimpse into a future of sustainable abundance. Yet, innovation alone cannot bear the mantle of environmental stewardship. It is in the crucible of collective action and social innovation that the true alchemy of change unfolds. From block chain-powered conservation finance to citizen science initiatives leveraging the power of crowdsourcing, the abstract celebrates the catalytic role of human ingenuity in nurturing a thriving planet. As we stand at the precipice of a new era, let us embrace the convergence of nature and innovation as the catalyst for an eco-revolution. Through bold experimentation, audacious collaboration, and unwavering commitment, we illuminate the path towards a future where humanity and the environment dance in harmony, bound by a shared destiny of flourishing and resilience.

Keywords: Sustainability, innovation, environmental challenges, planetary healing, transformative, technology, renewable energy, sustainable development, ecological balance, biodiversity, climate change, resilience.

SUSTAINABILITY 2.0: AGRICULTURE BIOTECHNOLOGY

KAYALVIZHI V.
1R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: 1230139.it@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
Agricultural biotechnology has emerged as a pivotal tool in modern agriculture, offering solutions to global challenges such as food security, environmental sustainability, and climate change resilience. This abstract delves into the multifaceted applications of biotechnology in agriculture, focusing on its role in enhancing crop productivity and sustainability. Genetic engineering techniques have enabled the development of genetically modified (GM) crops with traits such as pest resistance, herbicide tolerance, and enhanced nutritional content. These traits not only improve yield potential but also reduce the reliance on chemical pesticides and fertilizers, thereby mitigating environmental impacts. Moreover, biotechnology facilitates the breeding of crops with enhanced resilience to biotic and abiotic stresses, including drought, salinity, and disease. Through molecular breeding techniques such as marker-assisted selection and genome editing, researchers can identify and introduce beneficial traits efficiently, accelerating the breeding process and reducing dependence on conventional breeding methods. Furthermore, agricultural biotechnology plays a vital role in sustainable farming practices by promoting precision agriculture and resource efficiency. Biotech-derived tools such as genetically engineered microbes for soil health improvement, biofertilizers, and biopesticides contribute to reducing the ecological footprint of agriculture while maintaining soil fertility and biodiversity. However, the adoption of agricultural biotechnology is not without challenges. Socioeconomic considerations, regulatory frameworks, and public acceptance pose significant barriers to the widespread implementation of biotechnological solutions in agriculture. Addressing these challenges requires interdisciplinary collaboration among scientists, policymakers, farmers, and consumers to ensure that biotechnology is deployed responsibly and ethically. In conclusion, agricultural biotechnology holds immense potential to revolutionize agriculture by increasing productivity, enhancing sustainability, and mitigating environmental impacts. However, realizing these benefits requires concerted efforts to overcome barriers and foster a supportive regulatory and socio-economic environment conducive to innovation and adoption.

Keywords: Genetic engineering, Crop improvement, Genetically modified organisms (GMOs), Molecular breeding, Transgenic crops, Public acceptance and perception, Socioeconomic considerations, Environmental impact assessment, Regulatory frameworks, Disease resistance, Marker-assisted selection, Precision agriculture, Sustainable farming practices

COMPREHENSIVE OVERVIEW OF ALL BRANCHES OF FOOD ENGINEERING: INNOVATIONS, CHALLENGES, AND FUTURE PROSPECTS

Parvatha SRINI K. P.
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: 1230184.it@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
This research provides an in-depth exploration of all branches of food engineering, offering a thorough understanding of the multidisciplinary facets shaping the modern food industry. Covering key domains such as food chemistry, food microbiology, food processing, and food safety, the study aims to unravel the intricate interplay of scientific principles and technological innovations within each branch. By examining the challenges, advancements, and future directions in these diverse areas, the research contributes to the broader knowledge base of food engineering. This comprehensive analysis is crucial for fostering innovation, ensuring food safety, and promoting sustainable practices in the ever-evolving field of food science and technology.
Keywords: Food Engineering, Food Science, Food Technology, Food Chemistry, Food Microbiology, Food Processing, Food Safety, Multidisciplinary Approaches, Food Quality, Innovations in Food Engineering, Challenges in Food Industry, Sustainable Food Production, Cross-disciplinary Integration, Future Trends in Food Engineering, Interconnected Food Sciences.

MATHEMATICAL MODELING FOR SUSTAINABLE WATER RESOURCES MANAGEMENT: A REVIEW OF METHODS AND APPLICATIONS

Poojitha N.
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
Recent technological progress has revolutionized landscape architecture, offering a suite of tools that enhance design precision and sustainability. Geographic Information Systems (GIS), Remote Sensing (RS), and Global Positioning Systems (GPS) provide landscape architects with invaluable data for informed decision-making, fostering sustainable design solutions. Building Information Modeling (BIM) and parametric design streamline processes and promote collaboration, driving innovation in landscape architecture. Virtual Reality (VR) and Augmented Reality (AR) technologies enable immersive experiences, facilitating stakeholder engagement and early design feedback. Drones and LIDAR technology improve site analysis, monitoring, and safety on construction sites, while digital fabrication and robotics push boundaries in material innovation. Addressing challenges such as data privacy and digital literacy is essential to fully harness the potential of these technologies. Through continuous research, education, and collaboration, landscape architecture can lead towards a more resilient, inclusive, and sustainable future."
Keywords: GIS, RS, GPS

ADVANCES IN PLANT PROTECTION

Priyajothi N.
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: 1230777.it@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
With the continuous rise in population growth, rapid urbanisation, and industry, agricultural land is deteriorating at an alarming rate. Increased crop output from limited land resources is required to feed today's massive populations, necessitating the constant application of high doses of inorganic fertilisers to agricultural soils. These could harm the health of the soil, making it more susceptible to pests and diseases. Traditional and environmentally beneficial agricultural methods are no longer used as a result of agricultural chemicalisation, which has a negative impact on the crop. Plant protection is critical for achieving agricultural output targets. Its goals include not simply eradicating dangerous organisms, but also predicting when they will emerge and how far they will spread, as well as preventing extremely dangerous infections. With recent improvements in plant protection, it has the potential to contribute to the greater goal of assuring the supply of safe and highquality pesticides to safeguard crop output from pests and diseases and meet food security requirements. Herein, we have detailed some of the plant protection chemicals, equipment, and current innovations that are beneficial to all food production systems. Plants are necessary for all life on Earth and serve as the foundation of our food chain. It is widely acknowledged that agricultural production must be significantly increased in the near future to meet the food and feed demands of a growing human population from a limited land resource. This necessitated the use of intensive farming systems, with inputs such as a narrow genetic base, high doses of fertilisers, pesticides, irrigation, monocropping, and so on, which resulted in the development of diseases and pests. The effect of changing global climate, particularly the sharp increase in CO2 concentration, has made plants more vulnerable to pathogens and pests. Because of the chemicalization of agriculture, age-old ecofriendly pest management practises such as sanitation, crop rotation, mixed cropping, adjusting planting date, fallowing, summer ploughing, green manuring, composting, and so on are no longer practised, negatively affecting crops.
Keywords: Plant virus, plant protection, pests, plant immunity agents, molecular mechanism, plant pesticides.

BİYOUYUMLU POLİMERLERİN ADJUVAN SISTEMLERİNDE İMMÜNOSTIMÜLATÖR ETKİSİNİN DEĞERLENDİRİLMESİ

Doç. Dr. Hülya Serap MOĞUL* (ORCID: 0000-0001-7556-9478)
Sağlık Bilimleri Unıversıty, Faculty of Hamidiye Health Science, Department of Biotechnology, İstanbul-Türkiye
Email: serap.mogul@coralinnovative.com

Dr. Öğr. Üyesi Altay SAVALAN (ORCID: 0000-0003-3925-9645)
Sağlık Bilimleri Unıversıty, Faculty of Hamidiye Health Science/ Pharmacy, Department of Biotechnology/ Pharmacy, İstanbul-Türkiye
Email: altay.savalan @sbu.edu.tr

ÖZET
Adjuvanlar, bir antijenin içsel immünojenikliğini artırabilen ve aynı zamanda modifiye edebilen bileşiklerdir. Bu nedenle, veteriner aşıların etkili ve kararlı immün tepkileri indüklemesine yardımcı olmak için gereklidirler. Geleneksel adjuvanlar bu özellikleri taşıyamadığından, adjuvan sistemi içinde kullanılabilecek ve hayvanlarda hem hücresel bağışıklığı hem de hümoral bağışıklığı uyaracak malzemelerin kullanımına başlanmıştır. Bu malzemelerden polimerler dikkat çekmektedir. Negatif yüklü hücre zarları ile pozitif yük ve iyonik etkileşimler nedeniyle kitosan ve türevleri, antijen sunan hücreler yoluyla üstün bir alıma neden olur. Hücresel immün yanıtı arttırmak ve aşının koruyuculuk süresini uzatmayı sağlamak amacıyla ürünün içerisine kitosan eklenmesiyle yeni yağ bazlı adjuvan sistemlerinin oluşturulmasını içermektedir. Bu kapsamda stabilite testlerini başarıyla tamamlayan W/O/W emülsiyon formülasyonların fizikokimyasal testleri gerçekleştirilmiştir. Kullanılacak olan polimerlerin tek başına ve adjuvan sistemi içindeki immünomodülatör etkisi *in vitro* olarak incelenmiştir. Sitotoksite testlerinde toksik etki göstermeyen dozlar belirlenmiştir. Adjuvan sistemlerinin makrofaj polarizasyonuna bakılmıştır ve immün yanıtların arttığı gözlemlenmiştir. Çalışma sonucunda, etkinliği kanıtlanmış formülasyonlar ile geliştirilmiş etki ve güvenliğe sahip yeni adjuvan sistemi oluşturulmuştur.
Anahtar Kelimeler: Adjuvan sistemleri, immünostimülant, kitosan ve türevleri

EVALUATION OF THE IMMUNOSTIMULATORY EFFECT OF BIOCOMPATIBLE POLYMERS IN ADJUVANT SYSTEMS

ABSTRACT

Adjuvants are compounds that can enhance and modify the intrinsic immunogenicity of an antigen. Therefore, they are essential for facilitating effective and stable immune responses induced by veterinary vaccines. Traditional adjuvants often fall short in carrying these properties, prompting the exploration of materials within the adjuvant system that can stimulate both cellular and humoral immunity in animals. Among these materials, polymers have garnered attention. Polymers, particularly chitosan and its derivatives, exhibit superior uptake through interactions with negatively charged cell membranes, positive charges, and ionic interactions. Incorporating chitosan into the product aims to boost the cellular immune response and extend the protective duration of the vaccine. In this context, stability tests were successfully conducted on W/O/W emulsion formulations, and their physicochemical tests were carried out. The immunomodulatory effects of the polymers, both individually and within the adjuvant system, were investigated *in vitro*. Non-toxic doses were determined through cytotoxicity assays. Macrophage polarization was assessed for adjuvant systems, revealing increased immune responses. As a result of this study, a new adjuvant system with proven efficacy, developed with enhanced effects and safety, has been established.

Keywords: Adjuvant systems, immunostimulant, chitosan and derivatives

BİR KEDİDE MEFENAMİK ASİT ZEHİRLENMESİ

Makbule GÖKCE (ORCID: 0009-0002-1417-3482)
Balıkesir Üniversitesi, Sağlık Bilimleri Enstitüsü, İç Hastalıkları Anabilim Dalı, Balıkesir, Türkiye
Email: makbule1742@gmail.com

Doç. Dr. Uğur AYDOĞDU (ORCID: 0000-0002-9828-9863)
Balıkesir Üniversitesi, Veteriner Fakültesi, İç Hastalıkları Anabilim Dalı, Balıkesir, Türkiye
Email: ugur.aydogdu@balikesir.edu.tr

ÖZET
Amaç: Fenamatların bir üyesi olan mefenamik asit, diğer NSAI ilaçlar gibi prostaglandin biyosentezini inhibe ederek analjezik, antipiretik ve antiinflamatuar özellik gösterir. Beşeri hekimlikte en sık postoperatif ağrı, dismenore, osteoartrit, baş ağrısı ve doğum sonrası ağrının tedavisinde kullanılmaktadır. Bu vaka sunumunda, bir kedide kazara mefenamik asit tüketimine bağlı gelişen nörotoksisitenin ve tedavisinin sunulması amaçlandı. Materyal ve Metod: Özel bir veteriner kliniğine 3 kg, tekir, dişi bir kedi mefenamik asit içeren ilaçtan (Ponstan forte 500 mg) 1.5 tablet yediği ve ilaç tüketimini takiben 40-45 dk sonra vücutta titremeler başladığı şikayetiyle başvurdu. Bulgular: Vücut sıcaklığı 38.4 °C olarak ölçüldü. Taşikardiye (>140 atım/dk) ek olarak, ataksi, kas seğirmesi, tremorlar ve sürekli olarak sol tarafına düşme eğilimi gösteriyordu. Bir defa kusma görüldü. Klinik ve anamnez bulgulara göre kediye mefenamik asit toksikasyonu tanısı konularak tedaviye alındı. Tedavide, oral adsorban olarak aktif kömür, antihistaminik, intravöz izotonik sodyum klorür ve oksijen uygulaması yapıldı. Tedavi sonrası 30 dk içerisinde klinik bulgularda azalma gözlenmeye başladı ve bir buçuk saat sonunda sinirsel bulgular tamamen normale döndü. Tartışma ve Sonuç: Mefenamik asit kaynaklı nörotoksisiteyle ilgili vaka raporları bildirilmiş ve bu raporlarda toksisitenin konvülsiyonlara ve/veya mental durum değişikliğine neden olabileceği gösterilmiştir. Bu olguda da benzer şekilde aşırı doz mefenamik asit tüketimine bağlı kedide nörotoksisiteyle ilgili sinirsel semptomlar gözlendi. Sonuç olarak, Mefenamik asidin kedilerde nörotoksisiteye neden olabileceği ve semptomatik ve destekleyici tedaviyle başarılı sonuçlar alınabileceği kanaatine varıldı.
Anahtar Kelimeler: Kedi, mefeneamik asit, zehirlenme

MEFENAMIC ACID INTOXICATION IN A CAT

ABSTRACT
Aim: Mefenamic acid, a member of the fenamates, shows analgesic, antipyretic and anti-inflammatory properties by inhibiting prostaglandin biosynthesis, like other NSAIDs. In human medicine, it is most commonly used in the treatment of postoperative pain, dysmenorrhea, osteoarthritis, headache and postpartum pain. In this case report, we aimed to present neurotoxicity and its treatment due to accidental consumption of mefenamic acid in a cat. Materials and Methods: A 3 kg, tabby, female cat applied to a private veterinary clinic with the complaint that she ate 1.5 tablets of a drug containing mefenamic acid (Ponstan forte 500 mg) and tremors started in her body 40-45 minutes after consuming the drug. Results: Body temperature was measured as 38.4 °C. In addition to tachycardia (>140 beats/min), he had ataxia, muscle crumps, tremors, and a tendency to constantly fall on his left side. Vomiting was observed once. According to clinical and anamnesis findings, the cat was diagnosed with mefenamic acid toxicity and was treated. In the treatment, activated charcoal, antihistamine, intravenous isotonic sodium chloride and oxygen were administered as oral adsorbents. After the treatment, clinical symptoms began to decrease within 30 minutes, and after one and a half hours, the neural findings completely returned to normal. Discussion and Conclusion: Case reports of mefenamic acid-induced neurotoxicity have been reported, and these reports have shown that toxicity may cause convulsions and/or mental status changes. Similarly, in this case, nervous symptoms related to neurotoxicity were observed in the cat due to excessive consumption of mefenamic acid. In conclusion, it was concluded that mefenamic acid may cause neurotoxicity in cats and successful results can be obtained with symptomatic and supportive treatment.
Keywords: Cat, mefeneamic acid, intoxication

NO-TILL INFLUENCE ON THE DYNAMICS OF CHERNOZEM PROPERTIES IN UKRAINE

Nataliia DIDENKO (ORCID: 0000-0002-0654-4231)
Institute of Water Problems and Land Reclamation, Department of Use Meliorated Land, Kyiv, Ukraine.
Email: 9449308nd@gmail.com

Anastasiia SARDAK (ORCID: 0000-0002-0540-9492)
Institute of Water Problems and Land Reclamation, Department of Use Meliorated Land, Kyiv, Ukraine.
Email: anastasiabilobrova1993@gmail.com

Serhii KOLOMIIETS (ORCID: 0000-0002-4329-4382)
Institute of Water Problems and Land Reclamation, Department of Irrigation, Kyiv, Ukraine.
Email: kss2006@ukr.net

ABSTRACT
A study was conducted at a farm in the Mykolaiv region of Ukraine to investigate changes in the agrophysical and biological parameters of chernozem. The farm has been successfully implementing no-till technologies since 2011 and has completely abandoned mechanical soil disturbance. Crops are grown in rotation under rainfed conditions, following cultivation practices similar to those in the Steppe zone of Ukraine. No-till technologies help to retain moisture in the soil and adapt plants to rainfed conditions. Fertilisers are only applied to winter wheat, with 100 kg/ha of superphosphate (P20) and 150 kg/ha of ammonium nitrate applied in spring as a top dressing (N50) or UAN-32. After twelve years of no-till on chernozem without irrigation, there is a significant improvement in the agrochemical parameters of soil fertility, particularly in the organic matter content, available forms of NPK, and acidity (pH). Experimental evidence confirms negative correlations between crop yields and total microbial biomass. This suggests that when crop production is suppressed due to various factors, microbiocenosis rapidly develops by utilizing available nutrients. This process represents an ecological buffering of the soil, depositing nutrients in the microbiome and preventing their removal from the root layer. This renews their availability after the death of microbes. The relevance of this research is confirmed by the results of other researchers and is of extreme importance in indicating soil processes.
Keywords: no-till, rainfed condition, microbiological paramemter, chernozem, Ukraine.

SUSTAINABLE STRATEGIES IN PLANT PROTECTION: INTEGRATING BIOLOGICAL, CULTURAL, AND CHEMICAL APPROACHES

Priyavarshini A.
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: 1230053.it@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
Plant protection is a vital aspect of agriculture and ecosystem management, aiming to safeguard plants from pests, diseases, and environmental stressors. This abstract presents an overview of the principles, methods, and challenges associated with plant protection. Effective plant protection strategies involve integrated pest management (IPM) approaches that incorporate biological, cultural, physical, and chemical control methods. IPM emphasizes sustainable practices to minimize the use of synthetic pesticides and mitigate their potential environmental and health impacts. Biological control involves utilizing natural predators, parasites, and pathogens to regulate pest populations, while cultural practices such as crop rotation and companion planting disrupt pest life cycles and enhance plant resilience. Physical barriers like nets and traps can provide additional protection against pests. However, despite advancements in plant protection techniques, challenges persist. Climate change introduces new pests and alters the distribution patterns of existing ones, complicating pest management efforts. Additionally, pesticide resistance in target organisms poses a significant threat to the efficacy of chemical control methods. Furthermore, the global trade of agricultural commodities facilitates the spread of invasive species, further exacerbating pest pressure. In conclusion, effective plant protection requires a multifaceted approach that integrates various control methods while considering ecological, economic, and social factors. Addressing emerging challenges through research, innovation, and international collaboration is essential to ensure sustainable agriculture and food security in the face of evolving pest pressures and environmental changes sytems.

Keywords: Plant protection, Integrated pest management (IPM), Biological control, Chemical control, Climate change, Pesticide resistance, Invasive species, Sustainable agriculture

IMPROVING ACCESS TO CLEAN WATER IN RURAL AREAS: INNOVATIVE SOLUTIONS FOR SUSTAINABLE DEVELOPMENT

P. Siddharth
R.M.K. Engineering College, Student, Department of Electronics and Communication Engineering, Chennai, India.
Email: 230681.ec@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
This abstract explores innovative solutions to improve access to clean water in rural areas, crucial for sustainable development. Rural communities often face challenges such as water scarcity, contamination, and inadequate infrastructure, perpetuating poverty and health issues. By examining decentralized treatment systems, rainwater harvesting, and community-led initiatives, this study identifies practical approaches to address these obstacles. Decentralized treatment systems, including bios and filters and solar-powered disinfection units, offer sustainable methods for purifying water at the household level. Rainwater harvesting and groundwater recharge techniques provide alternative clean water sources, reducing reliance on unreliable surface water supplies. Community-led efforts, such as water user associations and hygiene education programs, empower local residents to manage water resources sustainably.
Keywords: Clean water access, Sustainable development, Water scarcity, Rainwater harvesting, Technology integration

ADVANCEMENTS IN AGRICULTURAL PRACTICES: NURTURING SUSTAINABILITY AND RESILIENCE

K. Monika
R.M.K. Engineering College, Student, Mathematics, Chennai, India.
Email: 230090.it@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
The agricultural sector serves as the cornerstone of global food security, economic prosperity, and environmental sustainability. In recent years, the industry has witnessed a paradigm shift towards innovative techniques and technologies aimed at enhancing productivity while minimizing environmental impact. This presentation delves into the forefront of agricultural advancements, highlighting novel methodologies, sustainable practices, and cutting-edge technologies revolutionizing the way we cultivate crops and manage livestock. Key areas of focus include: 1. Precision Agriculture 2. Sustainable Farming Practices 3. Climate-Smart Agriculture 4. Digital Agriculture 5. Agri-Tech Innovations By leveraging these advancements, agriculture stands poised to address the evolving demands of a growing population, changing climate, and finite natural resources. This presentation underscores the critical role of innovation in shaping the future of agriculture, fostering resilience, sustainability, and prosperity for generations to come.
Keywords: agricultural sector, climate-smart agriculture

ENVIROMENTAL SUSTAINABILITY: AN ABSTRACT ON BIOSYSTEMS ENGINEERING

Sam Jones J.
R.M.K. Engineering College, Student, Department of Electronics and Communication Engineering, Chennai, India.
Email: 1230535.ec@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
Biosystems engineering, an interdisciplinary field at the intersection of biology, engineering, and computational sciences, plays a pivotal role in addressing pressing global challenges. In agriculture, biosystems engineers utilize precision farming techniques, including automation, sensor technologies, and data analytics, to optimize crop production while minimizing environmental impact. Sustainable farming practices such as hydroponics and vertical farming are also being developed to meet the increasing demands for food production. In the healthcare sector, biosystems engineering contributes to the development of advanced biomedical devices, such as microfluidics and biosensors, improving diagnostics and drug delivery systems. Additionally, biosystems engineers are actively engaged in the design of advanced imaging technologies and rehabilitation devices, enhancing patient care and rehabilitation processes. Environmental sustainability is a central focus, with biosystems engineers devising innovative solutions for waste management, pollution control, and renewable energy production. Bioreactors for wastewater treatment and biofiltration systems for air purification are among the key advancements in this domain. Furthermore, biosystems engineering drives progress in biotechnology, particularly in genetic engineering and synthetic biology, enabling sustainable production of biofuels, biomaterials, and biopharmaceuticals. Overall, biosystems engineering continues to evolve as a dynamic and indispensable field, integrating diverse disciplines to address complex global challenges and pave the way for a more sustainable future.
Keywords: Biosystems engineering, multidisciplinary, agriculture, healthcare, environmental sustainability, biotechnology

SOYBEAN YIELD AND NODULATION RESPONSE TO INOCULUMS AND NITROGEN RATES

Anjum NAEEM*
Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

Haroon Zaman KHAN
Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

Ahmad NAWAZ
Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

Asif IQBAL
Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

Farrukh SALEEM
Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

Muhammad Ashfaq WAHID
Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

Muhammad BILAL
Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

Ahmad ALI
Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

ABSTRACT

Extremes of soil pH and nutrient imbalance are major restrictions lowering the production of soybean especially when nitrogen source for growth is derived from symbiotic fixation. In Pakistan, productivity of soybean is being affected by low soil fertility and high soil pH results in poor nodulation. Use of proper inoculums and optimization of nitrogen rates may be an important management strategy to improve the response of soybean to form nodules and enhance productivity. Therefore, a field experiment was conducted at the Directorate of Farms, University of Agriculture Faisalabad in which two factors i.e. Factor A: Nitrogen rates:, N0 : 0 kg N ha1, N1: 30 kg N ha1, N2 : 60 kg N ha1 and N3 : 90 kg N ha-1 and Factor B: types of inoculation:, I0 : No inoculation, I1 : Inoculation with *Bradyrhizobium diazoefficiens*, I2 : Inoculation with *Bradyrhizobium japonicum* and I3 : Inoculation with *Bradyrhizobium diazoefficiens* and *Bradyrhizobium japonicum*, were studied by using Randomized complete block design (RCBD) under factorial arrangements. Agro-Physiological traits of soybean were recorded periodically and analyzed statistically. Fisher's analysis of variance was used to analyze the data and treatments means were compared by using LSD test at 5% level of significance. Results revealed that the individual effect of nitrogen was highly significant for plant height, number of pods per plant, seed yield, biological yield, seed oil contents and seed protein contents, whereas regarding the above mentioned parameters the individual effect of inoculum was seen non significant. However the interactive effect of both the factors was

seen non significant. It was concluded that factor N3 (90 kg N ha-1) is the better strategy to obtain good quality soybean with highest grain yield and biological yield under the agro ecological conditions of Faisalabad.
Keywords: Soybean, Nodulation, Inaculums, Nitrogen rates

BITTER MELON (MOMORDICA CHARANTIA): A HUB OF FUNCTIONAL BIOACTIVE COMPONENTS

Muhammad Bilal HUSSAIN
Department of Food Sciences, Government College University Faisalabad, Faisalabad, Pakistan

Marwa WAHEED
Department of Food Sciences, Government College University Faisalabad, Faisalabad, Pakistan

Farhan SAEED
Department of Food Sciences, Government College University Faisalabad, Faisalabad, Pakistan

Muhammad AFZAAL
Department of Food Sciences, Government College University Faisalabad, Faisalabad, Pakistan

Bushra NIAZ
Department of Food Sciences, Government College University Faisalabad, Faisalabad, Pakistan

ABSTRACT
Bitter melon offers numerous health benefits against several ailments for improving the quality of life. It is a nutrient dense plant-based food containing versatile bioactive compounds such as polypeptide, alkaloids, minerals and vitamins. Due to the presence of these bioactive compounds, it has the potential to counter many lifestyles related maladies including diabetes mellitus, cancer insurgence, kidney (stone), scabies, abdominal pain and fever. It is rich in p-insulin, which is quite helpful in lowering the blood glucose levels in diabetic patients. It also composed of steroidal saponins called charantin, which act alike peptides and certain alkaloids that efficiently regulate the sugar level in blood. Its therapeutic perspective in controlling the blood cholesterol level in body, protecting it from cardiovascular disorders have also been highlighted. Bitter melon seeds, leaves and fruit all aid in maintaining impaired antioxidant status and reduces fat accumulation. Additionally, remedial potential of its bioactive components and their utilization in value-added food products are also the highlights of this article.
Keywords: Bitter melon, Lifestyle related disorders, Diabetes mellitus, Cholesterol reduction, Cancer insurgence.

SUSTAINABILITY 2.0: BIOSYSYTEMS ENGINEERING ENVIRONMENT

Laksita M.
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: 1230702.it@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
Biosystems engineering plays a crucial role in addressing environmental challenges through interdisciplinary solutions that combine biological sciences with engineering principles. This abstract highlights recent advancements in biosystems engineering aimed at promoting environmental sustainability. Key areas of focus include waste management and resource recovery, where innovative bioremediation techniques are utilized to clean up soil and water pollution, while simultaneously generating valuable resources from organic waste streams. Additionally, biosystems engineers contribute to sustainable agriculture by developing precision farming technologies that optimize crop production while minimizing environmental impacts such as water usage and chemical. Renewable energy is another significant focus area, with biosystems engineers working on biofuel production and biorefinery technologies to harness the potential of biomass resources for clean energy generation. Furthermore, interdisciplinary collaboration and stakeholder engagement are emphasized to ensure the adoption of sustainable practices and the development of effective policies to address environmental challenges.
Keywords: Green Technologies, Environmental Sustainability, Waste Management, Resource Recovery, Bioremediation, Sustainable Agriculture, Precision Farming, Renewable Energy, Biofuel Production, Biorefinery Technologies, Interdisciplinary Collaboration, Stakeholder Engagement, Sustainable Practices, Policy Development, Green Technologies.

TURMERIC (*CURCUMA LONGA* L.): CHEMICAL COMPONENTS AND THEIR CLINICAL APPLICATIONS

Marwa WAHEED
Department of Food Sciences, Government College University Faisalabad, Faisalabad, Pakistan

Muhammad Bilal HUSSAIN
Department of Food Sciences, Government College University Faisalabad, Faisalabad, Pakistan

Farhan SAEED
Department of Food Sciences, Government College University Faisalabad, Faisalabad, Pakistan

Muhammad AFZAAL
Department of Food Sciences, Government College University Faisalabad, Faisalabad, Pakistan

Bushra NIAZ
Department of Food Sciences, Government College University Faisalabad, Faisalabad, Pakistan

ABSTRACT
Turmeric (*Curcuma longa* L.) is extensively used as a food colorant, spice and preservative in South-East Asia, India and China. It has been utilized in traditional medication for numerous illnesses counting hepatitis, diabetes, indigestion, hysteria, inflammation, hemorrhoids, skin disease, cough, hepatic disorders, anorexia, and sinusitis, etc. To date, lot of work has been accomplished to discover and prove biological activities and pharmacological applications of this golden spice and its extracts, both in animals and humans. Particularly, curcumin (diferuloylmethane), a distinctive component with key yellow bioactive turmeric feature, has been observed to possess many biological actions. Numerous ongoing studies are also significantly contributing to this gifted molecule that to the forefront of human therapeutics. Turmeric extracts and curcumin are regarded as safe and non-toxic promising compounds which has lot of potentially biological functions and these can be further explored in novel medical applications.
Keywords: Turmeric, Curcumin, Curcuminoids, Maladies, Clinical applications

AN OVERVIEW OF FOOD ENGINEERING BRANCHES: FROM CHEMISTRY TO PACKAGING

Mahalakshmi AVNK
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India
Email: 1230906.it@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
Food engineering encompasses various branches that focus on different aspects of food production, processing, and preservation. One key area is food chemistry, which delves into the composition, structure, and properties of food molecules. Understanding these elements helps in creating new food products, enhancing flavour, and improving nutritional value. Food microbiology is another vital branch, studying the role of microorganisms in food spoilage, fermentation, and foodborne illnesses. This knowledge aids in developing methods to prevent contamination and extend shelf life. Food process engineering involves designing and optimizing equipment and processes for food production, such as mixing, heating, and packaging, to ensure efficiency and safety. Food biotechnology explores the use of biological systems, such as enzymes and microorganisms, to enhance food quality, production, and sustainability. Meanwhile, food safety and quality assurance focus on implementing regulations and standards to ensure that food products meet safety and quality criteria throughout the supply chain. Finally, food packaging engineering involves designing packaging materials and systems that protect food from physical, chemical, and microbial damage, while also considering environmental sustainability. Overall, these branches of food engineering work together to innovate and improve the way we produce, process, and consume food.
Keywords: food engineering, branches, food chemistry, food microbiology, food process engineering, food biotechnology, food safety, quality assurance, food packaging engineering

EFFECTS OF FIPROFORCE AND *CALATROPIS PROCERA* EXTRACT ON GERMINATION RATES OF RICE (*Oryza sativa*) AND MACROINVERTEBRATES ABUNDANCE

Bate Garba BARDE*
Department of Environmental Sciences, Federal University Dutse, Jigawa State, Nigeria

Sam-Uket NWUYI OKORI
Department of Animal and Environmental Biology, Cross River University of Technology, Calabar, Nigeria

Yunana Bitrus DUHU
Department of Environmental Biology, University of Maiduguri, Borno State, Nigeria
Email: bategarba@yahoo.com

ABSTRACT
Chemical pesticides tend to reduce germination rates and are detrimental to non-target organisms due to their widespread toxicity. Germination rates and macroinvertebrates abundance in Fiproforce (a broad spectrum insecticide) and *Calatropis procera* extract treated rice fields were determined using standard methods with 14%, 9%, 5%, 1% and 0% concentrations of these substances. Analysis of variance was used to determine the differences among treatments while Student t–test was used to compute the differences between Fiproforce and *C. procera*. In the 1%, 5%, 9% and 14% Fiproforce treated seeds, germination rates were 65%, 80%, 70% and 55% respectively while it was 30%, 35%, 50% and 55% for the respective *C. procera* treatments with a significant difference ($P<0.05$) among them. Overall mean germination rates in the Fiproforce, *C. procera* and Control fields were 67.5%, 42.5% and 30% respectively which differed significantly ($P<0.05$). There were 11, 9, 5 and 4 macroinvertebrate species represented by 63, 33, 9 and 4 total individuals in the 1%, 5%, 9% and 14% Fiproforce treated fields respectively while *C. procera* treatments had 12, 12, 9 and 9 species represented by 99, 82, 46 and 37 individuals. Germination rates correlated positively with Fiproforce ($r = 0.2827$) and *C. procera* ($r = 0.9732$) while macroinvertebrates abundance correlated negatively with both Fiproforce ($r= –0.6015$) and *C. procera* ($r= –0.5799$). The results showed Fiproforce' detrimental effects on rice germination rates and macroinvertebrates with *C. procera* extract as a better alternative which should be harnessed while phasing out the chemical pesticides.
Keywords: Fiproforce, *Calatropis procera*, Germination rate, Macroinvertebrates, Stock solution.

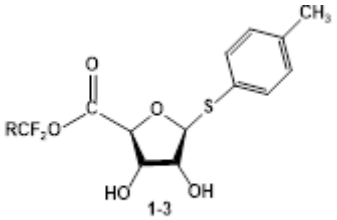
PREPARATION OF NEW ORGANOFLUORINE DERIVATIVES OF *β*-D-RIBOFURANOSIDE: SYNTHESIS, ACUTE TOXICITY AND INSECTICIDAL ACTIVITY

Valery V. BELAKHOV* (ORCID:0000-0003-1918-974X)
Technion – Israel Institute of Technology, Schulich Faculty of Chemistry, Haifa, Israel
Email: chvalery@technion.ac.il

Irina V. BOIKOVA (ORCID: 0000-0001-6268-7301)
All-Russian Institute of Plant Protection, Microbiological Plant Protection Laboratory, Saint Petersburg, Russia
Email: irina_boikova@mail.ru

ABSTRACT

Organofluorine insecticides are highly active against various insects, in particular, harmful arthropods; these are fast-acting agents effective at low use rates, which are rapidly metabolized in the body of vertebrates, do not accumulate in their tissues, and are characterized by widely ranging persistence. Moreover, organofluorine insecticides attract much interest because most of them readily break down in soil into substances that leave negligible quantities of toxic residues in the environment. Currently, over 420 organofluorine pesticides from various classes of fluorine-containing compounds are used in agriculture, of which about 50% are accounted for by insecticides. However, carbohydrates and, in particular, fluorinated monosaccharides, are completely lacking in the range of the chemical products used for agricultural crop protection. We have developed synthetic method for the preparation of new organofluorine derivatives of *β*-D-ribofuranoside (**1-3**).



1-3

R = F (**1**); C_2F_5 (**2**); (i-C_3F_7) (**3**)

Pharmacological studies have shown that the acute toxicity of LD50 of organofluorine derivatives of *β*-D-ribofuranoside **1-3** is 1250-1275 mg/kg (white mice, intraperitoneally), which allows it to be attributed to low-toxic compounds. In our experiments the insecticidal activity was analyzed using Vetch aphid *Megoura viciae* Buckt. as a test object. Treatment with 0.1% solution of organofluorine derivatives of *β*-D-ribofuranoside **1, 2** and **3** resulted in 98.3%, 93.5% and 95.0% vetch aphid mortality after 24 h, respectively. Biological studies indicated that organofluorine derivatives of *β*-D-ribofuranoside **1-3** may be considered as promising compounds for the creation of effective preparations on their basis for combating harmful arthropods that cause great damage to agricultural crops. The additional biological studies of compounds **1-3** will reveal their potential as polyfunctional plant protection products.

Keywords: organofluorine insecticides, ribose, insecticidal activity, toxicity.

NOISE APPROACH TO THE ANALYSIS OF THE QUALITATIVE COMPOSITION OF THE SOIL

Alexandrov V. S.
Kazan National Research Technical University named after A.N. Tupolev, REIMT department, Kazan
Email: bridgelin2@yandex.ru

ABSTRACT
Today the analysis of noise signals of various measuring devices finds the widest application from electronics to biology. Qualitative analysis of the composition of soil, water and ground using a new approach based on a comparative analysis of fluctuations will solve two classes of problems: economic (increasing the sowing of only high-quality feed and grain will reduce the costs of entrepreneurs, which will increase the supply of goods and consumer (consumers will be more satisfied with the quality of goods, which will increase the demand for goods). Compliance with the balance of supply and demand in the market ensures its stable functioning. With this approach, there is a problem of choosing a reference sample with which the test sowing will be compared. As this element, it is advisable to take a sample grown under ideal conditions. In addition, it is important to determine which biological parameters are subject to analysis, since the accuracy of their production will also affect the final result. The uniqueness of the proposed approach lies in the possibility of its application to solve a wide class of problems in various spheres of human activity with a high degree of accuracy.
Keywords: noise analysis method, compound feed, agricultural industry, technical condition.

GENETIC DIVERSITY OF BRASSICA INTEGRIFOLIA POPULATION

Pham Vu KHUONG DUY (ORCID: 0000-0001-6843-4540)
Can Tho University, College of Agriculture, Genetic and plant breeding Department, Can Tho City, Vietnam.
Email: pvkduy@ctu.edu.vn

Quan Thi AI LIEN (ORCID: 0009-0009-0166-9930)
Can Tho University, College of Agriculture, Genetic and plant breeding Department, Can Tho City, Vietnam.
Email: qtalien@ctu.edu.vn

ABSTRACT
Brassica integrifolia population of Can Giuoc district, Long An province has been affected by climate change and long-term cultivation, leading to morphological segregation and the appearance of many inappropriate phenotypes such as long leaf shape and low yields. The study aimed has selected some of the groups of B. integrifolia with desirable morphology such as gourd leaves (L/W < 2) and high seed yield. The study method was to collect 36 samples of B. integrifolia, record the coordinates and arrange an experiment according to a completely randomized design with 1 factor and 3 repetitions. Evaluated the difference means of 10 phenotype characteristics and 8 yield and yield component characteristics. Calculate genetic diversity coefficient such as genetic variability (GV), phenotypic variance (PV), phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h2) (%), genetic advance as percent of mean (GA) (%).Hierarchical cluster analysis through 10 phenotype characteristics and 8 yield and yield component characteristics of samples and drawn Dendrogram according to Ward (1963) method, Based on Euclid distance. The results recorded high heritability (h2> 80%) along with Genetic advance as percent of mean (GA<20%) in all characteristic excepted growth period and weight of 1000 seeds, showing that the traits are determined by genes and are not affected by environmental conditions. These accessions have a great proportion of genetic variability, which can be manipulated in future breeding programs to fully utilize their genetic potential. The samples of 31, 32, 10, 17, 13, 15, 6, 28, 34, 2, 33, 1, 35, 5, 14, and 30 were selected through dendrogram and belonging to group I had gourd leaves (L/W < 2) and the highest seed yield.
Keywords: Brassica, diversity, hierarchical clusters, dendrogram

IMMUNOTHERAPY

G. PREMANAND
Faculty of pharmacy, Bharath Institute of Higher Education And Resarch, Chennai, India
Email: gpremanand231@gmail.com

Dr. R. SARAVANAN
Faculty of pharmacy, Bharath Institute of Higher Education And Resarch, Chennai, India

ABSTRACT
Utilising the immune system's ability to combat cancer cells, immunotherapy is one method of cancer treatment. Immunotherapy teaches the immune system to identify and eliminate cancer cells, in contrast to conventional cancer treatments like chemotherapy and radiation therapy, which directly target cancer cells. Immunotherapy comes in a variety of forms, each of which focuses on a particular aspect of the immune system. The most popular forms of immunotherapy are cancer vaccines, CAR T-cell treatment, and checkpoint inhibitors. In order to target cancer cells, immune cells from a patient's body are modified in a lab as part of CAR T-cell therapy. The altered cells are then reintroduced into the body of the patient, where they can fight cancer cells. The immune system is prompted by cancer vaccines to identify and target cancer cells. Cancer cells or cancer cell components are used in the creation of some cancer vaccines, whereas materials that resemble cancer cells are used in others. To combat cancer cells, the immune system is prompted to do so by immunotherapy. Depending on the type of treatment being employed, immunotherapy targets various immune system components to accomplish this. Utilising the immune system's ability to combat cancer cells, immunotherapy is a promising new method of cancer treatment. Immunotherapy may provide a number of advantages, but there are also some concerns.
Keywords: Immunotherapy, Cancer cells, Immune system

INNOVATIVE METHODS TO AIM FOR THE MYCOLIC ACID BIOSYNTHESIS PATHWAY IN THE CREATION OF TUBERCULOSIS TREATMENTS

Pooja P.
Faculty of Pharmacy, Bharath Institute of Higher Education and Research, Tambaram, Chennai

Dr. R. Saravanan
Faculty of Pharmacy, Bharath Institute of Higher Education and Research, Tambaram, Chennai

Dr. R. Ivasan
Faculty of Pharmacy, Bharath Institute of Higher Education and Research, Tambaram, Chennai

ABSTRACT
Mycolic acids are the major lipid component of the unique mycobacterial cell wall responsible for the protection of the tuberculosis bacilli from many outside threats. Mycolic acids are synthesized in the cytoplasm and transported to the outer membrane as trehalose-containing glycolipids before being esterified to the arabinogalactan portion of the cell wall and outer membrane glycolipids. The large size of these unique fatty acids is a result of a huge metabolic investment that has been evolutionarily conserved, indicating the importance of these lipids to the mycobacterial cellular survival. There are many key enzymes involved in the mycolic acid biosynthetic pathway, including fatty acid synthesis (KasA, KasB, MabA, InhA, HadABC), mycolic acid modifying enzymes (SAM-dependent thioltransferases, aNAT), fatty acid activating and condensing enzymes (FadD32, Acc, Pks13), transporters (MmpL3) and transferees (Antigen 85A-C) all of which are excellent potential drug targets. Not surprisingly, in recent years many new compounds have been reported to inhibit specific portions of this pathway, discovered through both phenotypic screening and target enzyme screening. In this review, we analyze the new and emerging inhibitors of this pathway discovered in the post-genomic era of tuberculosis drug discovery, several of which show great promise as selective tuberculosis therapeutics.
Keywords: Tuberculosis, Antituberculosis agents, Mycolic acid, Fatty acid synthase, KasA, KasB, HadABC, InhA, FadD32, Pks13, MmpL3, Antigen 85

NON-ALKOLİK YAĞLI KARACİĞER HASTALIĞI (NAFLD) VE TEDAVİDE GÜNCEL YAKLAŞIM

Dr. Öğr. Üyesi Günsel KIRMAN (ORCID: 0000-0003-2497-7011)
Siirt Üniversitesi Veteriner Fakültesi Histoloji ve Embriyoloji Anabilim Dalı, Siirt
Email: gunsel.kirman@siirt.edu.tr

ÖZET
Bu derlemede, nonalkolik yağlı karaciğer hastalığı ve bu hastalığa güncel yaklaşımlar anlatılmaktadır. Hepatik steatoz (basit karaciğer yağlanması-NAFL), alkole bağlı olmayan karaciğer yağlanması hastalıklarının tetikleyicisi olarak kabul edilmekte ve hepatositlerde yüksek oranda mikro veya makroveziküler şekilde trigliserid damlacıklarının birikmesidir. Hepatik steatoz, oksidatif stres ve inflamasyon gibi sekonder etkenlerin eşlik ettiği durumlarda kronik karaciğer hastalıklarının terminal döneme kadar ulaşmasına neden olabilmektedir. Herhangi bir ikincil faktörün bulunmadığı patolojik durumlarda klinik belirtiler göstermemektedir. ABD Gıda ve İlaç Dairesi veya Avrupa İlaç Ajansı tarafından NAYKH için onaylanmış herhangi bir ilaç yoktur. NAYKH'nın tedavisinde iki temel amaç gözetilmektedir. Bunlardan ilki hastalığın ilerleme hızını düşürmek, ikincisi ise karaciğerde meydana gelebilecek herhangi bir hastalığı ya da nekrozu engellemektir. Özellikle egzersiz ve diyet uygulamaları insülin direncini düşürmesi nedeniyle önerilmektedir. Rastgele uygulanan antioksidanların veya hepatoprotektif ajanlar olan ursodeoksikolik asit veya metforminin histolojik açıdan iyileştirici bir etkisi olmamıştır. Peroksizom proliferatörünün aktive ettiği reseptör gamayı (PPARγ) tiazolidindionlar aktive ettikleri için insülin duyarlılığı üzerinde iyileştirici bir etkiye sahiptirler. Bu ilacın önemli bir yan etkisi kilo artışı olmasına rağmen, NAYKH hastalarını içeren pilot çalışmalarda umut vaat ettiği ortaya konulmuştur. İlk PPARγ agonisti olan troglitazon, hepatotoksik etkilerinden dolayı piyasadan kaldırılmıştır. Obezite ve diyabet insidansının artışıyla NAYKH arasında bir doğru orantı söz konusudur. NAYKH'lı hastaların az bir kısmı ve özellikle diyabetin eşlik ettiği hastalar, hepatosellüler karsinom, siroz gibi komplikasyonlar açısından predispozedirler. Güncel tedavide diyet uygulamaları, egzersiz ve metabolik hastalık riskine karşı kontrol sağlanması önerilmektedir. Son yıllarda fitoterapilerden de faydalanılmaktadır.
Anahtar Kelimeler: Alkolik olmayan yağlı karaciğer hastalığı, İlaçlar, Karaciğer, Tedavi

NON-ALCOHOLIC FATTY LIVER DISEASE (NAFLD) AND CURRENT APPROACH IN TREATMENT

ABSTRACT

In this review, nonalcoholic fatty liver disease and current approaches to this disease are described. Hepatic steatosis (simple fatty liver - NAFL) is considered to be the trigger of non-alcoholic fatty liver diseases and is the accumulation of highly micro or macrovesicular triglyceride droplets in hepatocytes. In cases accompanied by secondary factors such as hepatic steatosis, oxidative stress and inflammation, it may cause chronic liver diseases to reach the terminal stage. It does not show clinical symptoms in pathological cases where there are no secondary factors. There are no drugs approved for NAFLD by the US Food and Drug Administration or the European Medicines Agency. There are two main goals in the treatment of NAFLD. The first of these is to reduce the rate of progression of the disease, and the second is to prevent any disease or necrosis that may occur in the liver. Exercise and diet practices are especially recommended because they reduce insulin resistance. Randomly administered antioxidants or the hepatoprotective agents ursodeoxycholic acid or metformin had no histologically curative effect. Thiazolidinediones have an improving effect on insulin sensitivity because they activate peroxisome proliferator-activated receptor gamma (PPARγ). Although a significant side effect of this drug is weight gain, it has shown promise in pilot studies involving NAFLD patients. Troglitazone, the first PPARγ agonist, was removed from the market due to its hepatotoxic effects. There is a direct proportion between the increase in the incidence of obesity and diabetes and NAFLD. A small number of patients with NAFLD, and especially patients accompanied by diabetes, are predisposed to complications such as hepatocellular carcinoma and cirrhosis. In current treatment, diet practices, exercise and control against the risk of metabolic diseases are recommended. In recent years, phytotherapies have also been used.

Keywords: Non-alcoholic fatty liver disease, Drugs, Liver, Treatment

RECENT UPDATES IN CARBOHYDRATE METABOLISM

Tejasri
Vikas College of Pharmaceutical Sciences, Rayanigudem, Suryapet, Telangana, India.
Email: mothukuritejasree@gmail.com

Sahasra
Vikas College of Pharmaceutical Sciences, Rayanigudem, Suryapet, Telangana, India.
Email: sahasrasahasra28@gmail.com

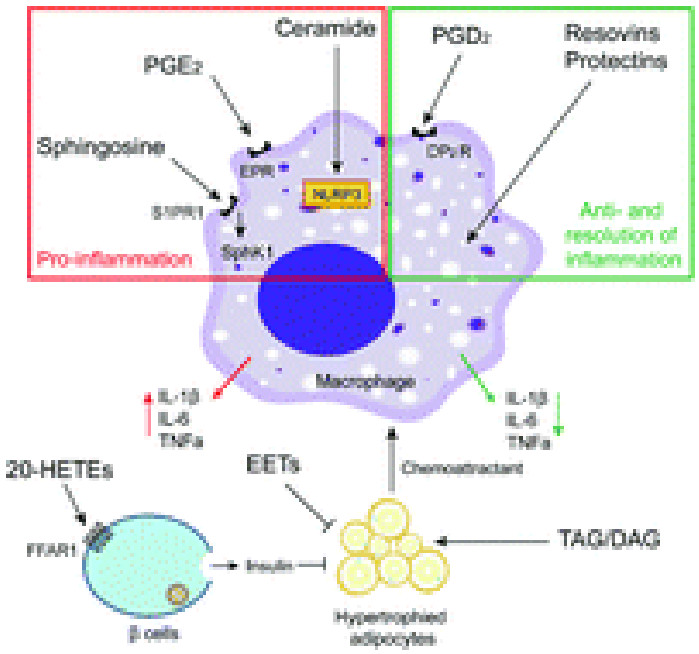
ABSTRACT
Carbohydrates are the most abundant macromolecules on our planet, in part because of the plant carbohydrates cellulose and starch, both composed of multiple conjugated glucose molecules. Cellulose is an important structural element of plant cell walls. Animals lack enzymes that can break down the cellulose into smaller glucose molecules, but they can break down starch into smaller glucose molecules. Animals also have glycogen, another carbohydrate composed of multiple conjugated glucose molecules. Many of us who exercise or play sports know that carbohydrates serve as a really good source of fuel during these strenuous endeavors. Unfortunately, most of us realize that overconsumption of carbohydrates can easily help us put on weight under nonexercise conditions. So, we know that carbohydrates can either be catabolized for energy (ATP) or used for anabolic functions, such as production of fatty acids. Carbohydrates are divided into three major groups based on their structures: (1) simple sugars (monosaccharides and disaccharides), such as glucose or sucrose (glucose and fructose); (2) complex carbohydrates, such as glycogen, starch, and cellulose, which are multiple conjugated glucose molecules; and (3) glycoconjugates, which are modified forms of glucose covalently attached to either proteins (glycoproteins) or lipids (glycolipids), which participate in important functions, such as immunity, and as components of cell membranes. This review covers all three groups and highlights their importance in maintaining physiological functions.
Keywords: glucose, fructose, glycoproteins

LIPID METABOLISM IN INFLAMMATION-RELATED DISEASES

Vikram BANDA
Vikas College of Pharmaceutical Sciences, rayanigudem, Suryapet, Telangana, India
Email: bandavikram760@gmail.com

Saikumar JARPULA
Vikas College of Pharmaceutical Sciences, rayanigudem, Suryapet, Telangana, India
Email: Saikumarjarpula2000@gmail.com

ABSTRACT
There are thousands of lipid species existing in cells, which belong to eight different categories. Lipids are the essential building blocks of cells. Recent studies have started to unveil the important functions of lipids in regulating cell metabolism. However, we are still at a very early stage in fully understanding the physiological and pathological functions of lipids. The application of lipidomics for studying lipid metabolism can provide a direct readout of the cellular status and broadens our understanding of the mechanisms that underpin metabolic disease states. This review provides an introduction to lipid metabolism and its role in modulating homeostasis and immunity. We also describe representative applications of lipidomics for studying lipid metabolism in inflammation-related diseases.



COMPARATIVE EFFECT OF MORINGA OLEIFERA SEED AND LEEF POWDER ON DIGESTIVE SYSTEM IN DUCKS (ANAS PLATYRHYNCHOS)

Razia KAUSAR
Department of Anatomy, Faculty of Veterinary Science, University of Agriculture, Faisalabad

Sana RIAZ
Department of Zoolgy, wildlife and Fisheries, Faculty of Sciences, University of Agriculture, Faislabad. Pakistan

Shah NAWAZ
Department of Zoolgy, wildlife and Fisheries, Faculty of Sciences, University of Agriculture, Faislabad. Pakistan

M. Abdullah
Department of Zoolgy, wildlife and Fisheries, Faculty of Sciences, University of Agriculture, Faislabad. Pakistan

Sarmad REHAN
Department of Zoolgy, wildlife and Fisheries, Faculty of Sciences, University of Agriculture, Faislabad. Pakistan

Umer SHARIF
Department of Zoolgy, wildlife and Fisheries, Faculty of Sciences, University of Agriculture, Faislabad. Pakistan
Email: razia.kausar@uaf.edu.pk

ABSTRACT
Moringa oleifera is a softwood tree with rapid growth and drought resistant tree. Their leaves and seeds used in poultry feed are favorable due to their nutrient rich contents. They are rich in vitamins, minerals, and amino acids. The study is planned to analyze the nutrient effect of *M.Oleifera* on the morphological and histological parameters of the digestive system of Pekin ducks. A total of 30 ducks, 3 weeks of age were purchased from bird market Faisalabad. All the ducks were divided randomly into 3 main groups G1, G2, and G3 consisting of 10 ducks, each with 5 males and 5 females. G1 were fed with basal diet (BD) and serve as control group. G2 were treated with *M. Oleifera* leaf powder (MOLP) with the dose rate 15 g/kg body weight, and G3 were treated with *M. Oleifera* seed powder (MOSP) with the dose rate 15 g/kg body weight. After 35 days all the ducks were slaughtered. All digestive organs were collected immediately after slaughtering the ducks. The weight of digestive organs was measured with the help of a weighing balance. The length and width of organs were measured with the measuring tape. All the layers (epithelium, lamina propria and lamina muscularis) were measured (µm) with the help of automated computer software Image J®. Overall mean values of gross digestive organs were found significantly ($p<0.05$) higher in male ducks than the female ducks. The mean values showed that the thickness of all layers of the digestive tract was significantly

($p<0.05$) more in males as compared to females of G1, G2 and G3. Therefore, it can be concluded that these findings can be extremely beneficial for strategic manipulation of feed and nutrition to enhance growth rate and diagnose pathological processes.
Keywords: Moringa leaf, moringa seeds, Gizzard, Histology,

UTILISATION OF INDIGENOUS MEDICINE AMONG RURAL DWELLERS IN OKE-OGUN AREA OF OYO STATE, NIGERIA

Adeleke OLUWASEUN ADERONKE
Department of Agricultural Extension and Rural Development, University of Ibadan, Nigeria
Email: arikegirl@gmail.com

ABSTRACT
Orthodox medicine is more expensive as compared to indigenous medicine that is readily available and cheap in most rural areas of developing countries which makes it the most preferred, especially in this harsh economy. This study examined utilisation of indigenous medicine among rural dwellers in Oke-ogun area of Oyo State, Nigeria. A multistage sampling procedure was used to select 113 respondents for this study. Data collected were analysed using frequencies, mean, percentages, chi-square and PPMC. Results of the study showed that mean age of respondents was 40.0±15.0years, 41.1% and 31.1% were married and engaged in farming, respectively. Indigenous medicine available among respondents were lemon grass, neem and bitter leaf which are used as herbs. Others are garlic, chili, onions and ginger that serves as spices. Treating diseases ($\bar{x}$ =0.98), cooking ($\bar{x}$ =0.58.0), achieve stable pregnancy ($\bar{x}$ =0.92) and fertility ($\bar{x}$ =0.95) were some of the benefits of indigenous medicine. Utilisation of indigenous medicine was low (51.8%). Perception of respondents towards utilisation of indigenous medicine was favourable (61.6%). Constraints to utilisation of indigenous medicine were poor quality control procedure ($\bar{x}$ = 0.91) and lack of accurate dosage ($\bar{x}$ = 0.86). There was a significant relationship between marital status ($\chi 2$ = 4.218, p= 0.040), constraints (r = 0.452, p= 0.000) and utilisation of indigenous medicine. Quality control, assessment of safety and regulation practices of indigenous medicine should be put in place so as to ensure safety and efficacy, since rural dwellers still patronise its use.
Keywords: Health, Indigenous, Medicine, Rural, Safety

TOWARDS SUSTAINABLE LIVESTOCK MANAGEMENT: STRATEGIES, CHALLENGES AND OPPORTUNITIES

Sai Krishna P. B.
R.M.K. Engineering College, Student, Department of Electronics and Communication Engineering, Chennai, India.
Email: 1230021.ec@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
Sustainable livestock management is essential for ensuring the long-term viability of agricultural systems while minimizing environmental impacts and safeguarding animal welfare.This abstract explores various strategies, challenges, and opportunities associated with sustainable livestock management. It begins by examining the importance of adopting sustainable practices to address environmental concerns such as greenhouse gas emissions, land degradation, and water pollution.The abstract then delves into the different strategies employed to promote sustainability, including improved animal husbandry techniques, efficient resource utilization, and adoption of technological innovations.Additionally, it highlights the challenges faced in implementing sustainable livestock management, such as economic constraints, policy barriers, and cultural resistance. Despite these challenges, the abstract emphasizes the numerous opportunities available for advancing sustainable practices, including public-private partnerships, consumer education, and research and development initiatives.Overall, this abstract underscores the importance of embracing abstract approaches to sustainable livestock management to ensure the resilience and prosperity of agricultural systems in the face of evolving environmental and societal pressures.
Keywords: Sustainable management, Agricultural viability, Environmental impacts, Animal welfare, Sustainable practices.

AN ABSTRACT ON APPLICATION OF MATHEMATICS IN ZOOTECHNICS

V. PAVITHRA
R.M.K. Engineering College, Student, Department of Electronics and Communication, Chennai, India.
Email: 1230364.ec@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
Zootechnics, the science of animal husbandry, encompasses various aspects of breeding, nutrition, management, and health to optimize animal production. This abstract explores the intersection of zootechnics with mathematics, highlighting its applications in enhancing animal productivity, welfare, and sustainability. Mathematics plays a crucial role in zootechnics by providing analytical tools and modeling techniques to understand and manipulate complex biological systems. Mathematical models are employed to predict animal growth, reproduction, and population dynamics, enabling breeders to optimize breeding strategies and manage resources efficiently. By utilizing algorithms and statistical analyses, breeders can assess breeding economics, formulate balanced feed rations, and optimize environmental conditions to maximize productivity while minimizing costs and environmental impacts. Furthermore, mathematical approaches facilitate precision livestock farming, where data analytics and sensor technologies are utilized to monitor animal health, behavior, and performance in real-time. Through mathematical modeling, breeders can identify factors influencing animal well-being and implement targeted interventions to improve overall health and welfare.In conclusion, mathematics serves as a cornerstone in modern zootechnics, providing invaluable tools for decision-making, optimization, and innovation in animal husbandry practices. By integrating mathematical principles with empirical data, zootechnicians can enhance productivity, sustainability, and animal welfare in the agricultural sector.
Keywords: zootechnics, animal productivity, breeding, population dynamics, livestock farming, optimization, zootechnicians, sustainability.

AN ABSTRACT ON APPLICATION OF MATHEMATICS IN PLANT PROTECTION

R. R. Sanjana
R.M.K. Engineering College, Student, Department of Electronics and Communication, Chennai, India.
Email: 1230364.ec@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
Embark on a journey exploring the intricate dance between mathematics and plant protection in agriculture. This presentation unveils the unsung heroism of numbers and equations as they become the shield for our crops. Beginning with an introduction that sets the stage, each slide delves into a unique facet of the synergy between math and nature."The Green Guardians" introduces the importance of protecting plants from threats, showcasing how mathematics plays a pivotal role in creating strategies for safeguarding crops. "Pest Census with Math" highlights the precision in understanding and controlling pest populations through mathematical models. "Precision Agriculture" demonstrates the efficiency gained in pesticide application through mathematical precision. "Weathering the Pest Storm" explores how mathematics predicts the impact of weather on pests, fostering proactive pest management. "Harmony in Numbers" delves into eco-friendly math, finding solutions that balance plant protection and environmental care. "Mathematics for Global Food Security" expands the narrative, illustrating how math is a global effort to feed the planet.
Keywords: Plant Protection, Agriculture, Pests, Diseases, Sustainable Practices, Global Food Security

HARVESTING HARMONY: CULTIVATING SUSTAINABILITY THROUGH AGROECOLOGY

Sanjani K.
R.M.K. Engineering College, Student, Department of Electronics and Communication, Chennai, India.
Email: 1230056.ec@rmkec.ac.in

Suganthi P. (ORCID: 0000-0002-8251-9660)
R.M.K. Engineering College, Faculty, Mathematics, Chennai, India.
Email: psi.sh@rmkec.ac.in

ABSTRACT
Imagine growing food that benefits both the environment and your community. That's the essence of agroecology, a growing movement that blends ecological principles with farming practices. It goes beyond just growing crops-it's about creating diverse ecosystems within farms. Think of a garden with a variety of plants, attracting helpful insects and birds. This is similar to agroecology, which encourages planting different crops together, using cover crops like clover, and creating habitats for beneficial creatures. This approach naturally reduces the need for pesticides and fertilizers, making it good for the environment and our health. But agroecology doesn't stop there. It also focuses on building healthy soil through composting and minimizing tillage. This not only improves soil fertility but also helps store carbon, a key player in climate change. Beyond environmental benefits, agroecology promotes fairer food systems. It supports small-scale farmers, who often face challenges with traditional methods, and encourages local food markets, ensuring communities have access to fresh, healthy, and ethically produced food. While agroecology may not be a magic solution, it offers a promising approach to tackling food security, environmental concerns, and social inequalities. By weaving together ecological and social considerations, agroecology has the potential to transform the way we grow food for a healthier and more sustainable future.
Keywords: Agroecology, Biodiversity, Composting, Minimizing tillage, Food security, Healthier food, Sustainable agriculture

DEVELOPING OF TRACEABILITY SYSTEMS FOR AGRICULTURE SUPPLY CHAIN: EVIDENCES FROM SHRIMP PRODUCTS IN MEKONG DELTA, VIETNAM

Nguyen Thi NGOC HOA (ORCID: 0009-0005-4864-4387)
Can Tho University, School of Economics, Faculty of Business Admisnistration, Can Tho city, Vietnam
Email: ntnhoa@ctu.edu.vn

Khuu Thi PHUONG DONG (ORCID: 0000-0003-2769-5167)
Can Tho University, School of Economics, Faculty of Finance and Banking, Can Tho city, Vietnam
Email: ktpdong@ctu.edu.vn

ABSTRACT
The aims of this study was to identify current situation and discuss alternatives for building traceability systems with the evidences from shrimp products in Mekong Delta, Vietnam. We investigated the primary data in Ca Mau provinces, from June to July 2019, which covered the whole supply chain of shrimp production such as farmers, collectors, distributors, processors and exporters. The comparison in products and information flows between separately groups of shrimp producers and stakeholders in terms of traceability were conducted to obtain the purposive study. We found that, shrimp processors was the main actors for traceability implementing procedures. The current systems supported for the traceability activities within shrimp stakeholders of supply chain. Based on the results, we suggested that, integration and synchronization in recording and keeping information between current systems and international food safety standards was a positive solution for developing of traceability towards food safety and human rights.
Keywords: traceability, supply chain, shrimp products, Vıetnam, Mekong Delta

FONKSİYONEL BİR BESİN KAYNAĞI OLAN YENİLEBİLİR YOSUNLARIN GASTRONOMİ ALANINDA KULLANIM OLANAKLARININ ARAŞTIRILMASI

Selma Lubabe ERDOĞAN (ORCID: 0000-0002-4248-001X)
Alanya University, Vocational School Hotel, Restaurant and Catering Services Department, Culinary Program, Alanya, Antalya, Turkey
Email: selmalubabe.erdogan@alanyauniversity.edu.tr

ÖZET

Dünya genelinde nüfusun hızlı bir şekilde artması ile paralel olarak besin ihtiyacının da artması ve gelecek yıllarda ortaya çıkabileceği düşünülen kıtlık tehlikesi, gıda tüketimini alışılmışın dışına çıkmaya yönlendirmektedir. Bilinen besinlere alternatif olacak şekilde çok sayıda yöntem ve ürün önerilmektedir. İnsanlar tarafından tüketimi tercih edilmeyen besinlerin gıda olarak tüketilebilir hale getirilmesi alternatif gıda kaynaklarının kullanım olanaklarını daha da kolaylaştırmaktadır. Zengin ve besleyici içerikleriyle dikkat çeken yenebilir yosunlar da günümüzde yaygın şekilde alternatif besin kaynağı olarak kullanılmaktadır. Yenebilir yosunlar çoğunlukla nemli bölgelerde, tatlı sularda ve denizlerde yetişen bitki türleri arasında yer almaktadır. Nori, kombu, agar agar, dulse, arame, hijiki vb. gibi yenebilir yosunların Kore ve Japon mutfaklarında sıklıkla kullanıldığı bilinmektedir. Yenebilir yosunlar yüksek besin değeri ve düşük kalorili olması sebebiyle sağlıklı gıdalar arasında yer aldığı görülmektedir. Bununla birlikte yenebilir yosunların vitamin, mineral, antioksidan ve protein bakımından da oldukça zengin bir içeriğe sahip olduğu söylenmektedir. Yenebilir yosunların kullanım şekilleri kültürden kültüre göre değişiklik gösterebilmektedir. Özellikle Asya ülkelerinin yosun tüketiminde ilk sıralarda yer aldığı görülse de Amerika ve Avrupa ülkelerinde de bazı yosun türlerinin tüketildiği bilinmektedir. Yosunların kullanım alanlarına bakıldığında, en yaygın tüketim şeklinin Japon mutfağına ait olan Sushi yapımında kullanıldığı görülmektedir. Ayrıca Japon Mutfağında yosunların peynir, reçel, çay, şarap, erişte ve çorba gibi birçok gıdanın üretiminde hammadde olarak kullanıldığı görülmüştür. Kore Mutfağına ait olan Miyeok-guk ise yosun ve deniz ürünleri ile hazırlanan bir çorbadır. Kore kültürüne göre bu çorba doğum yapan kadınlara enerji vermesi için hazırlanırken daha sonrasında doğum günlerinde içilen bir çorba olarak tüketilmeye başlanmıştır. Bununla birlikte yine Kore Mutfağının en sık tüketilen yiyeceklerinden olan Kimchi'nin yapımında da yosun kullanıldığı görülmektedir. Amerika ve Avrupa ülkelerine bakıldığında yosunlar özellikle sağlıklı beslenme eğilimleri sebebiyle smoothie yapımında, detoks içeceklerinde, çorbalarda ve salatalarda kullanılmaktadır. Yosun çeşitleri genellikle çorba, garnitür ve içecek olarak kullanılsa da Spirulina, Chlorella ve Astaxanthin gibi yosun türleri besin değerleri sebebiyle enerji barları veya gıda takviyeleri olarak da kullanılabilmektedirler. Bu çalışmanın amacı yenebilir yosunların ülkemizde kullanım alanlarını genişletmek ve gastronomi alanında yeni reçeteler geliştirerek literatüre katkı sağlamaktır.

Anahtar Kelimeler: yenebilir yosunlar, mikroalgler, gastronomi

INVESTIGATING THE POSSIBILITIES OF USING EDIBLE SEAWEEDS AS A FUNCTIONAL FOOD SOURCE IN GASTRONOMY

ABSTRACT

The rapid increase in the world's population, the parallel increase in the need for food and the threat of famine in the coming years are leading food consumption to go out of the ordinary. Numerous methods and products have been proposed as alternatives to conventional foods. Making foods that are not preferred by people to be consumed as food makes it easier to use alternative food sources. Edible seaweeds, which attract attention with their rich and nutritious content, are now widely used as alternative food sources. Edible seaweeds are among the plant species that grow mostly in humid regions, fresh waters and seas. Edible seaweeds such as nori, kombu, agar agar, dulse, arame, hijiki, etc. are frequently used in Korean and Japanese cuisines. It is seen that edible seaweeds are among the healthy foods due to their high nutritional value and low calorie content. However, edible seaweeds are said to have a very rich content in terms of vitamins, minerals, antioxidants and protein. The ways of using edible seaweeds may vary from culture to culture. Although it is seen that Asian countries are in the first place in seaweed consumption, it is known that some seaweed species are also consumed in American and European countries. When we look at the usage areas of seaweeds, it is seen that the most common form of consumption is used in making sushi, which belongs to Japanese cuisine. It has also been observed that seaweeds are used as raw materials in the production of many foods such as cheese, jam, tea, wine, noodles and soup in Japanese cuisine. Miyeok-guk, which belongs to Korean Cuisine, is a soup prepared with seaweed and seafood. According to Korean culture, this soup was prepared to energize women who gave birth, but later it started to be consumed as a soup drunk on birthdays. In addition, it is seen that seaweed is also used in the production of Kimchi, one of the most frequently consumed foods of Korean Cuisine. In America and Europe, seaweeds are used in smoothies, detox drinks, soups and salads, especially due to healthy eating trends. Although seaweed species are generally used in soups, side dishes and beverages, seaweed species such as Spirulina, Chlorella and Astaxanthin can also be used as energy bars or food supplements due to their nutritional value. The aim of this study is to expand the use of edible seaweeds in our country and to contribute to the literature by developing new recipes in the field of gastronomy.

Keywords: edible algae, microalgae, gastronomy

SÜPER GIDALARIN GASTRONOMİ ALANINDA KULLANIM OLANAKLARININ İNCELENMESİ

Selma Lubabe ERDOĞAN (ORCID: 0000-0002-4248-001X)
Alanya University, Vocational School Hotel, Restaurant and Catering Services Department, Culinary Program, Alanya, Antalya, Turkey
Email: selmalubabe.erdogan@alanyauniversity.edu.tr

ÖZET

Süper gıdalar, yüksek besin içeriğine sahip doğal besinlerdir. Vücudun görevlerini sağlıklı bir şekilde yerine getirebilmesinde büyük rol oynadıkları söylenmektedir. Bu gıdalar genellikle lifler, antioksidanlar, mineraller ve vitaminler gibi besin maddeleri bakımından zengin içeriğe sahiptirler. Sağlık bakımından önemli rol oynadıkları bilinen süper gıdalar içerdikleri antioksidanlar sayesinde hücre hasarını önleyebilmektedirler. Ayrıca, lif içeriğinin yüksek olması sebebiyle sindirim sistemini destekler ve tokluk hissini arttırması sebebiyle kalori yönetimine katkıda bulunurlar. Süper gıdaların çeşitliliği oldukça fazla olmakla birlikte, her bir gıdanın farklı sağlık faydaları ve besin değerlerinin olduğu bilinmektedir. Süper gıdalar olarak nitelendirilen başlıca besinler; yaban mersini, avokado, karabuğday, keten tohumu, kızılcık, nar, havuç, kefir, zencefil vb. şeklinde sıralanabilmektedir. Bu gıdaların gastronomi alanında da kullanımları oldukça yaygındır. Yaban mersini genellikle reçel, dondurma, kek ve kurabiye yapımında kullanılırken, vitaminler, mineraller, lifler ve sağlıklı yağlar bakımından oldukça zengin bir meyve olan avokado sandviç, salata ve meze yapımında sıklıkla kullanılmaktadır. Besleyici ve besin değeri zengin bir tahıl olarak kabul edilen karabuğday glütensiz olması sebebiyle popüler bir süper gıda olarak görülmektedir. Karabuğdayın Türk Mutfağında çeşitli yemeklerde kullanıldığı bilinmektedir. Pilav, salata, makarna ve keklerde yaygın olarak kullanılmaktadır. Bununla birlikte karabuğdayın un formunda da tatlı ve tuzlu ürünlerde kullanıldığı bilinmektedir. Keten tohumu içerdiği vitamin ve minerallerle süper gıda kaynağı olarak görülmektedir. Keten tohumu çoğunlukla yağ olarak veya öğütülerek kullanılmaktadır. Öğütülmüş keten tohumu, yoğurtlar, soğuk içecekler, fırınlanmış ürünler ve salatalar gibi birçok ürüne eklenerek kullanabilmektedirler. Kızılcık, sağlık açısından çeşitli faydaları bulunan bir süper gıda olarak kabul edilmektedir. Kızılcık meyvesinin en dikkat çekici özelliği yüksek miktarda antioksidan içermesidir. Kızılcık meyvesi genellikle sos ve reçel yapımı, kurutulmuş hali veya meyve suyu olarak tüketilmektedir. Genel anlamda süper gıdalar, sağlığa olan faydaları ve yüksek besin içerikleri sebebiyle dikkat çeken gıdalar olarak nitelendirilmektedir. Süper gıdalar her ne kadar dengeli beslenmenin birer parçası olsalar da tek başına tüketimlerinin bir soruna çözüm olmayacağı bildirilmiştir. Bu sebeple süper gıdalar sağlıklı yaşamın bir parçası olarak kullanılmalılardır. Bu çalışmada süper gıdaların gastronomi alanında yaygınlaşması ve kullanım alanlarının çeşitlendirilmesi amaçlanmaktadır.

Anahtar Kelimeler: süper gıdalar, gastronomi, ürün geliştirme

EXAMINATION OF THE POSSIBILITIES OF USING SUPERFOODS IN THE FIELD OF GASTRONOMY

ABSTRACT
Superfoods are natural foods with a high nutrient content. They are said to play a major role in the healthy functioning of the body. These foods are usually rich in nutrients such as fiber, antioxidants, minerals and vitamins. Superfoods, which are known to play an important role in health, can prevent cell damage thanks to the antioxidants they contain. They also support the digestive system due to their high fiber content and contribute to calorie management as they increase the feeling of satiety. Although the variety of superfoods is quite high, each food is known to have different health benefits and nutritional values. The main foods that are considered superfoods are blueberries, avocados, buckwheat, flaxseed, cranberries, pomegranates, carrots, kefir, ginger, etc. These foods are also widely used in gastronomy. Blueberries are often used to make jam, ice cream, cakes and cookies, while avocado, a fruit rich in vitamins, minerals, fiber and healthy fats, is often used in sandwiches, salads and appetizers. Considered a nutritious and nutrient-rich grain, buckwheat is considered a popular superfood because it is gluten-free. Buckwheat is known to be used in various dishes in Turkish Cuisine. It is widely used in rice, salads, pasta and cakes. However, buckwheat is also known to be used in flour form in sweet and savory products. Flaxseed is seen as a superfood source with its vitamins and minerals. Flaxseed is mostly used as oil or ground. Ground flaxseed can be added to many products such as yogurts, cold drinks, baked goods and salads. Cranberries are recognized as a superfood with various health benefits. The most remarkable feature of cranberry fruit is its high content of antioxidants. Cranberry fruit is usually consumed in sauce and jam making, dried form or as fruit juice. In general, superfoods are characterized as foods that attract attention due to their health benefits and high nutritional content. Although superfoods are part of a balanced diet, it has been reported that their consumption alone will not solve a problem. For this reason, superfoods should be used as part of a healthy life. In this study, it is aimed to popularize superfoods in the field of gastronomy and to diversify their usage areas.
Keywords: superfoods, gastronomy, product development

BIOFORTICATION OF MAIZE HERBAGE WITH NUTRIENTS AS AFFECTED BY FOLIAR SODIUM SELENATE APPLICATION

Aise DELIBORAN
Directorate of Olive Research Institute, Department of Plant Nutrient and Soil-Water Management, Izmir, Turkiye
Email: aise.deliboran@tarimorman.gov.tr/aisedeliboran@gmail.com

Yilmaz ISIK
Directorate of GAP Agricultural Research Institute, Sanliurfa, Turkiye

Hasan ASLAN
Directorate of GAP Agricultural Research Institute, Sanliurfa, Turkiye

Abdullah Suat NACAR
Directorate of GAP Agricultural Research Institute, Sanliurfa, Turkiye

Tuba Yasemin TEKGUL
Directorate of GAP Agricultural Research Institute, Sanliurfa, Turkiye

Hatice KARA
Directorate of GAP Agricultural Research Institute, Sanliurfa, Turkiye

Mustafa HARMANKAYA
Selcuk University, Agriculture Faculty, Department of Soil and Plant Nutrient, Konya, Turkiye

Sait GEZGIN
Selcuk University, Agriculture Faculty, Department of Soil and Plant Nutrient, Konya, Turkiye

ABSTRACT
Agronomic biofortification of field crops with micronutrients is at the forefront of strategies for healthy nutrition. Espicially, there is an increasing trend for biofortification of feed crops with Se, Zn, Fe to contribute to better nutrition of livestock. The aim of this study was investigate the effects of foliar selenate (Na2SeO4) application on the accumulation of nutrient compositions of maize herbage (*Zea mays* L. cvs. C 955 F1). Eight selenium levels (0-5-10-15-25-50-75-100 g Se ha-1) were used, and selenate was applied from foliar when the maize plant reached 50-70 cm in length. As a result of the study, a negative relationship was obtained between Se, N and Mo, and also, positive relationship between Se, Ca, Fe and Cu with foliar application of sodium selenate, statistically. While total N and Mo content in dry matter manifested a decreasing tendency, the total Ca, Fe and Cu in dry matter manifested an increasing tendency with the increase in Se concentration. Also, amounts of Zn and Mn slightly increased and amounts of B slightly decreased at the presence of 100 mg Se ha-1; however, the differences were not statistically significant. Selenate applications were found to be effective especially in terms of Ca, Fe, Cu, Zn and Mn biofortification of maize herbage for animal feeding.
Keywords: Biofortification, maize, selenium, nutrient uptake

CATALYZING SUSTAINABILITY: HARNESSING MICROBIAL FUEL CELLS FOR EFFICIENT WASTEWATER TREATMENT AND RENEWABLE ENERGY GENERATION

S. Elmazouzi*
Laboratory of Physical Chemistry of Materials, Faculty of Sciences Ben M'Sick, Hassan II University of Casablanca, Morocco
Email: siham.elmazouzi16@gmail.com

H. Mabraka
Laboratory of Spectroscopy, Molecular Modeling, Materials, Nanomaterials, Water and Environment, ENSAM, Mohammed V University in Rabat, Morocco

F. Allali
Laboratory of Spectroscopy, Molecular Modeling, Materials, Nanomaterials, Water and Environment, ENSAM, Mohammed V University in Rabat, Morocco

A. Zourif
Laboratory of Physical-Chemistry, Materials and Catalysis, Faculty of Sciences Ben M'Sick, Hassan II, University of Casablanca, Morocco

A. Salima
Laboratory of Physical Chemistry of Materials, Faculty of Sciences Ben M'Sick, Hassan II University of Casablanca, Morocco

I. Zerdani
Laboratory of Laboratory of Ecology and Environment, Faculty of Sciences Ben M'Sick, Hassan II University of Casablanca, Morocco

N. Touach
Laboratory of Spectroscopy, Molecular Modeling, Materials, Nanomaterials, Water and Environment, ENSAM, Mohammed V University in Rabat, Morocco

A. Benzaouak
Laboratory of Spectroscopy, Molecular Modeling, Materials, Nanomaterials, Water and Environment, ENSAM, Mohammed V University in Rabat, Morocco

Y. Naimi
Laboratory of Physical Chemistry of Materials, Faculty of Sciences Ben M'Sick, Hassan II University of Casablanca, Morocco

ABSTRACT
Microbial fuel cells (MFCs) represent an emerging approach for simultaneous wastewater treatment and renewable energy production. This study demonstrates the effectiveness of an innovative single-chamber, air-cathode MFC design fueled by garden compost leachate and textile industry wastewater. A peak power density of 110.08 mW/cm2 was achieved using compost leachate containing 2083 mg/L chemical oxygen demand (COD). The MFC generated 71.50 mW/cm2 peak power from textile wastewater with 1623 mg/L

COD. Notably, the system accomplished a substantial COD reduction of 88.67% for compost leachate and 81.45% for wastewater, along with the complete removal of heavy metals including zinc, cadmium, arsenic, and nickel. The air-cathode configuration omitting a proton exchange membrane simplified construction while facilitating excellent performance. The graphite was employed as a Cost-effective anode material, enriching an electroactive biofilm confirmed by SEM imaging, with rod-shaped bacteria visualized on the electrode surface. The results highlight the promise of innovative MFC designs for sustainable organic waste treatment coupled with renewable energy generation. This dual functionality provides both environmental and economic incentives for implementing microbial electrochemical technologies.
Keywords: Microbial Fuel Cells, Wastewater, heavy metals, chemical oxygen demand, Electricity

IDENTIFICATION OF AGROFORESTRY PLANT POTENTIAL IN KPH OF LAMPUNG PROVINCE

Frada Setia MONA
Department of Forestry, Faculty of Agriculture, University of Lampung
Email: setiamonafrada@gmail.com

Lutfi Nur LATIFAH
Department of Forestry, Faculty of Agriculture, University of Lampung
Email: lutfinurlatifah61@gmail.com

Lusiana BR PARDEDE
Department of Forestry, Faculty of Agriculture, University of Lampung
Email: lusianabrpardede@gmail.com

Prof. Dr. Ir. Christine WULANDARI
Department of Forestry, Faculty of Agriculture, University of Lampung
Email: christine.wulandari@fp.unila.ac.id

ABSTRACT
Agroforestry is a land management system that is offered to overcome problems arising from land use change to overcome various problems such as ecological, economic and social aspects. Ecological aspects are one of the basic aspects that need to be considered because they are related to sustainable land management, especially in soil and water conservation. Land management with agroforestry systems can be done by selecting MPTS plant species that can produce wood and non-timber and have prospective opportunities as plant species in critical land rehabilitation activities. Based on this, it is necessary to know the types of MPTS plants that have the potential to continue to be developed in Lampung Province. The purpose of this research is to determine the potential of MPTS plant species in Lampung Province with a case study in Kotaagung Utara FMU and Batu Serampok FMU. The data used in this research is secondary data. The types of MPTS plants found in KPH Kotaagung Utara are 27 species from 25 genus and 20 families. *Durio zibethinus* is the most dominant species with an INP of 46.5875, besides that there is *Pithecellobium lobatum* with an INP of 44.4850 and *Aluerites moluccana* with an INP of 26.7250. MPTS plant species found in KPH Batutegi are *Syzygium aromaticum* with an INP of 129.17, *Mangifera indica* with an INP of 46.51 and *Pithecellobium lobatum* with an INP of 34.7. Through the application of agroforestry patterns, it will contribute to supporting the acquisition of diverse and sustainable crops and maintaining forest sustainability.
Keywords: MPTS plant species, KPH, INP

FULL TEXT

ARI ÜRÜNLERİNİN SAĞLIK ÜZERİNE ETKİLERİ

Prof. Dr. Hakan İNCİ (ORCID: 0000-0002-9791-0435)
Bingol University, Faculty of Agriculture, Department of Animal Science, Bingöl-Türkiye
Email: hinci@bingol.edu.tr

ÖZET
Arıcılığın tarihçesi, insanoğlunun mağara hayatı yaşadığı on binlerce yıl öncesine kadar gitmektedir. Gerçek anlamda arıcılık, insanların ağaç kovuklarındaki arılara zarar vermeden içerisindeki balın bir kısmını arılara bırakıp geri kalan kısmını hasat etmeleriyle başlamıştır. Daha sonraları, arılara barınak olması amacıyla içi oyulmuş ağaç gövdeleri ve örme sepetler hazırlanmış ve bunların bir araya getirilmesiyle ilk arılıklar kurulmuştur. Arıların bitki döllenmesindeki öneminin anlaşılması ile birlikte bu alanda etkin bir şekilde kullanılmaya başlanmış ve tarımsal ürünlerin nicelik ve niteliğinde artışlar sağlanmıştır. Arı ürünlerinin insan beslenmesindeki fonksiyonel önemi de hızlı bir şekilde fark edilmiş ve bu ürünlere büyük talepler oluşmaya başlamıştır. Arıcılık, başlı başına bir tarımsal faaliyet ve hayvancılık üretim alanıdır. Arıcılıktan çok farklı şekillerde yararlanmak mümkündür. Herhangi bir tarım işletmesinde veya işletmenin bir bölümünde arıcılık yapılabileceği gibi, işletme dışında çiçeğin bol olduğu yörelerde, orman bölgelerin de de arılıklar kurmak mümkündür. Ayrıca, herhangi bir yer ve yöreye bağlı kalmaksızın yıl içerisinde bir kaç bölgeye göç ederek bol kazanç sağlayan göçer arıcılık sisteminden de yararlanmak mümkündür. Arıcılık faaliyetleri, bal, bal mumu, polen, propolis, arı sütü, arı zehiri gibi ekonomik değere sahip ürünlerden gelir elde edilmesine imkân sağlamaktadır. Zaman ilerledikçe arı ürünlerin gelir getirici özelliğinin yanı sıra sağlık açısından da önemli özelliklerinin olduğu keşfedilmeye başlanmıştır. Bu ürünler binlerce yıldır sağlığın korunması ve hastalıkların tedavisi için kullanılmıştır. Mısır ve Sümerliler gibi antik uygarlıklar hastalıklara karşı arı ürünleri kullanmışlardır. Son yıllarda hastalıkların ve özelliklede kanser vakalarının artışı tıbbı tedavilere ek olarak alternatif tedavi yöntemlerine yönelimi artmıştır. Arı ürünleri de alternatif tedavi seçeneklerinin en önemlileri arasında yer almaktadır. Ülkemizde de son yıllarda bu alanda çalışmalar başlatılarak, 2014 yılında yayınlanan geleneksel ve tamamlayıcı tıp uygulamaları yönetmeliğinin yayınlanmasıyla birlikte önemli çalışmalara imza atılmaya başlanmıştır. Bu çalışmada da arı ürünlerinin bazı özellikleri ve sağlık üzerine etkilerine ait bilgilerin derlenmesi amaçlanmıştır**.**
Anahtar Kelimeler: Arı, Arı Ürünleri, Sağlık

EFFECTS OF BEE PRODUCTS ON HEALTH

ABSTRACT

The history of beekeeping goes back tens of thousands of years when human beings lived in caves. Real beekeeping began when people left some of the honey in the tree holes for the bees and harvested the rest without harming the bees. Later, hollowed-out tree trunks and woven baskets were prepared to provide shelter for bees, and the first beekeepers were established by combining these. With the understanding of the importance of bees in plant pollination, they began to be used effectively in this field and an increase in the quantity and quality of agricultural products was achieved. The functional importance of bee products in human nutrition was quickly realized and great demands began to arise for these products. Beekeeping is an agricultural activity and livestock production area in itself. It is possible to benefit from beekeeping in many different ways. While beekeeping can be done in any agricultural enterprise or a part of the enterprise, it is also possible to establish apiaries outside the enterprise in regions where flowers are abundant, in forest regions. In addition, it is possible to benefit from the nomadic beekeeping system, which provides abundant income by migrating to several regions during the year without being tied to any place or region. It is possible to benefit. Beekeeping activities provide the opportunity to generate income from products with economic value such as honey, beeswax, pollen, propolis, royal jelly, and bee venom. As time progressed, it began to be discovered that bee products not only have income-generating properties but also have important health benefits. These products have been used for thousands of years to maintain health and treat diseases. Ancient civilizations such as Egypt and Sumerians used bee products against diseases. In recent years, the increase in diseases and especially cancer cases has led to an increased tendency towards alternative treatment methods in addition to medical treatments. Bee products are among the most important alternative treatment options. Studies in this field have been initiated in our country in recent years, and important studies have begun to be carried out with the publication of the regulation on traditional and complementary medicine practices published in 2014. In this study, it was aimed to compile information about some properties of bee products and their effects on health.

Keywords: Bee, Bee Products, Health

Giriş

Bal arılarının evrimsel süreçteki başarısı, yeryüzünde hemen hemen tüm yaşam alanlarına yayılabilmelerini ve uzun yıllar yaşayan türler olmalarını sağlamıştır. Ülkemizde arıcılık sektörü, tarımsal üretime olan katkısı ve elde edilen ürünlerin insan tüketimi ve sağlığındaki önemli yerinden dolayı geleneksel bir tarım faaliyeti olarak çok uzun yıllardan beri yapılmaktadır. Bal arısı (*Apis mellifera* L.), hayat döngüsü boyunca oluşturduğu değerli ve sağlıklı ürünler ile insanların yaşam kalitesi üzerine yapmış olduğu olumlu katkılardan dolayı ekosistemin en önemli canlılarından biri olmuştur. (Popova at al. 2007).

Bal arısı bütün çiçekli bitkilerde polinasyon sağlamasının yanı sıra ürettiği ürünler ile insanlar başta olmak üzere bütün canlılara başta beslenme ve sağlık olmak üzere koruma, temizlik, iyileştirici etki gibi etkiler bırakan canlıdır. Linnaeus tarafından adlandırılan Apis melliefera olarak adlandırılan bal arısının günümüzde 25 ten fazla kabul edilen alt türleri vardır. *Apis mellifera* syriaca, *Apis mellifera* anatoliaca, *Apis mellifera* meda, *Apis mellifera* carnica, *Apis mellifera* caucasica gibi alt türleri Türkiye'de bulunmaktadır. İnsanların bal arısını keşfedip bal ile tanışması M.Ö 7000'li yıllara dayanmaktadır. İnsanların doğadaki arıların yaptığı balı toplarken arı kolonilerini imha etmeden sadece balın bir bölümünü alıp kalanını bal arılarına bırakmaları ile arıcılık faaliyetleri doğal olarak başlamıştır. Zamanla artan bal ihtiyacından dolayı insanlar yeni teknikler geliştirerek arıcılık faaliyetlerini geliştirerek zamanla teknik arıcılığa geçiş yapmışlardır (Anonim 2021).

Arıcılıkta gelişen yeni teknikler ve değişen yaşam koşulları nedeniyle meydana gelen yetersiz beslenme, protein azlığı hastalıklarda artışlar gibi başlıca sorunların çözülmesi için yeni besin kaynakları konusunda çeşitli araştırmalar yapılmaktadır. Bu araştırmalar bal arılarnın sadece bal üretmediği bunun yanında propolis, arı ekmeği, arı sütü, arı zehri ve apilarnil gibi besin değeri yüksek ürünlerin olduğu keşfedilmiştir. Sağlık yönünden faydalı etkileri göz önüne alındığında, doğal olan ürünlerden, özellikle arı kovanı ürünleri, uzun zamandan beri insanların hatta bütün canlıların dikkatini çekmiştir (Margaoan et al. 2017).

Bal arısı ürünleri, propolis, bal, arı sütü, arı poleni, apilarnil, arı ekmeği ve ana arı larvası gibi birçok ürün üretilebilmektedir. Bu ürünlerin yeterli miktarda ve doğru zamanda

kullanımının, insan sağlığı üzerinde pozitif etkileri olduğu yapılmış bilimsel araştırmalarla ortaya koyulmuştur (Mateescu 2011; Topal vd. 2018; İlkaya ve İnci 2020).

Sonuç ve Öneriler

Tarih boyunca insanların sağlıklı ve dengeli beslenmelerinde önemli bir yeri olan arı ürünleri, birçok hastalığın iyileştirilmesinde ya da hastalık sürecinin yavaşlatılmasında kullanılmıştır. Bu medikal özellikleri bakımından tıp ve veteriner alanında alternatif veya destekleyici ürün olarak kullanılmaktadır. Arıcılık sektörünün en yaygın bilinen ve kullanılan ürünü baldır. Bal dışındaki propolis, polen, arı zehri, arı sütü ve bal mumu gibi birçok değerli arı ürünleri mevcuttur. Fakat bu değerli arı ürünlerinin üretimi ve aynı zamanda buna bağlı olarak tüketimi ülkemizde henüz istenilen düzeye ulaşamamıştır. Bu önemli arı ürünlerinden biri de propolistir. (Borba at al. 2015). Propolis; Apis mellifera tarafından çeşitli bitki kaynaklarından toplanan bir reçine karışımıdır. Fizikokimyasal özelliklerine ve coğrafi kaynaklarına göre 12 değişik türü bulunmakta olan propolis; tiamin, riboflavin, askorbik asit ve α-tokoferol gibi vitaminler ile bakır, kalsiyum, stronsitum gibi elementleri ve kafeik, sinamik ve miristik asit gibi bileşenleri de yapısında bulundurmaktadır (Aksoy ve ark. 2006; Mutlu ve ark, 2017). Arılar tarafından balmumu ile karıştırılan propolis, yabancı organizmaların yuvaya girişlerinin engellenmesi için yuvalarda bulunan çatlakların kapatılması ve yuva iç duvarlarının pürüzsüzleştirilmesi amacıyla kullanılmaktadır. Arılar tarafından belirtilen amaçlarla kullanılan propolis, insan sağlığı açısından da antimikrobiyal ve antikanserojen etkileri nedeniyle kullanılmaktadır. Yapılan çalışmalarda farklı propolis ekstraksiyonlarının kanserli hücre gelişimlerini engellediği, tümör hücrelerinin farklılaşmasını ve çoğalmasını azalttığı belirtilmiştir (Choudhari ve ark, 2013; Mutlu ve ark, 2017). Arı sütü işçi arılar tarafından üretilen bir besin maddesidir. Arı sütü temel yağ asitleri, amino asitler, mineral maddeler, kollajen, lesitin, A, B5, B6, C, D, E vitaminleri içerir. Farmakolojik olarak; yorgunluk giderici, kan damarlarını genişletici ve kan basıncını düşürücü, yangı giderici, tümör önleyici, antialerjik, antioksidatif, antibakteriyel ve bağışıklık sistemini uyarıcı, büyümeyi hızlandırıcı, hormon düzenleyici, cinsel gücü ve döl verimini arttırıcı olarak da kullanılmaktadır (Kamakura M, et al.2001).

Kaynaklar

Aksoy, Z., Dığrak, M., 2006. Bingöl yöresinde toplanan bal ve propolisin antimikrobiyal etkisi üzerinde in vitro araştırmalar. Fırat Üniversitesi Fen ve Mühendislik Bilimleri Dergisi 18(4): 471-478.

Anonim (2021a) https://www.ordutb.org.tr/wp-content/uploads/2020/10/Aricilik Raporu.pdf. (Erişim tarihi; 10.06.2021)

Borba, R. S., Klyczek, K. K., Mogen, K. L., & Spivak, M. 2015. Seasonal benefits of a natural propolis envelope to honey bee immunity and colony health. Journal of Experimental Biology, jeb-127324

Choudhari, M.K., Haghniaz, R., Rajwade, J.M., Paknikar K.M., 2013. Anticancer activity of Indian stingless bee propolis: an in vitro study. Evidence- Based Complementary and Alternative Medicine http://dx.doi.org/10.1155/2012/410406.

Fujii A, et al. Augmentation of wound healing by royal jelly in streptozotocin-diabetic rats. Jpn J Pharmacol 1990; 53: 331–337.

İlkaya M, İnci H, (2020) The effect of apıllarnıl (male bee larva) on human nutrıtıon, health sıte and medıcal treatment of some dıseases. New approaches and applıcatıons ın agrıculture. Iksad Publications 6: 121-135

Kamakura M, et al. Antifatigue effect of fresh royal jelly in mice. J Nutr Sci Vitaminol (Tokyo) 2001; 47: 394–401.

Kataoka M, et al. Analysis of antiallergic function of royal jelly. Natural Med. 2001; 55: 174– 180.

Mărgăoan R, Mărghıtaş LA, Dezmırean D S, Bobış O, Bonta V, Cătană C, Mureşan CI, Margin M G (2017) Comparative Study on Quality Parameters of Royal Jelly, Apilarnil and Queen Bee Larvae Triturate. Bulletin of the University of Agricultural Sciences & Veterinary Medicine Cluj-Napoca. Animal Science & Biotechnologies 74(1): 51-58

Mateescu C (2011) Apiterapia sau Cum Sa Folosim Produsele. Biomedical Analysis 30; 1403-1410

Matsui T et al.. Gastrointestinal enzyme production of bioactive peptides from royal jelly protein and their antihypertensive ability in SHR. J Nutr Biochem 2002; 13: 80–86.

Mutlu., C, Erbaş., M, Arslan., S, Tontul., A. (2017). Bal ve Diğer Arı Ürünlerinin Bazı Özellikleri ve İnsan Sağlığı Üzerine Etkileri. Akademik Gıda 15(1) (2017) 75-83

Popova, M. P., Bankova, V. S., Bogdanov, S., Tsvetkova, I., Naydenski, C., Marcazzan, G. L., & Sabatini, A. G. 2007. Chemical characteristics of poplar type propolis of different geographic origin. Apidologie, 38(3), 306-311.

Shimoda M. et al. Biochemical studies on vasodilative factor in royal jelly. Yakugaku Zasshi 1978; 98: 139–145

Tamura T, et al. Antitumor effect of royal jelly. Folia Pharmacol 1987; 89: 73–80.

Teles, F., da Silva, T.M., da Cruz-Júnior, F.P., Honorato, V.H., de Oliveira-Costa, H., Barbosa, A.P.F., de Oliveira, S.G., Porfírio, Z., Libório, A.B., Borges, R.L., 2015. Brazilian red Propolis attenuates hypertension and renal damage in 5/6 renal ablation model. PloS One 10(1), 10.1371/journal.pone.0116535.

Yaochun, C., Apiculture in China. Agricultural Publishing Housing No: 2, Nong Zhon Guan North Road, Chaoyang Distirct, Beijing, China,

1-157, 1993.

MİKROBİYOLOJİDE KULLANILAN NÜKLEİK ASİT AMPLİFİKASYON TEKNİKLERİ

Dr. Öğr. Üyesi Gokcenur SANİOGLU GOLEN (ORCID: 0000-0001-9950-330X)
Aksaray University, Faculty of Veterinary, Department of Microbiology, Aksaray-Türkiye
Email: gokcenursanioglu@aksaray.edu.tr

Dr. Öğr. Üyesi Kadir AKAR* (ORCID: 0000-0003-0894-7357)
Van Yuzuncu Yil University, Faculty of Veterinary, Department of Microbiology, Van-Türkiye
Email: kadirakar@yyu.edu.tr

ÖZET
Moleküler teşhis yöntemleri, moleküler biyoloji alanındaki yeniliklerin mikrobiyoloji alanında sunduğu en önemli faydalarından birisidir. Gelişen teknoloji yüksek duyarlılık ve özgüllük gösteren yeni teşhis metotlarının geliştirilmesine olanak sağlamıştır. Moleküler tekniklere her geçen gün bir yenisinin eklenmesi, farklı amaçlarla yürütülen bilimsel çalışmalara destek sağlamaktadır. Bu yöntemler, geleneksel yöntemler kullanarak bulunması ve belirlenmesi zor veya imkânsız olan enfeksiyöz ajanların tanımlanmasında oldukça önem arz etmiştir. Moleküler yöntemler, bakteri, virüs, mantar, protozoon ve parazit gibi hastalık etkenlerinin kesin tanısında, bu mikroorganizmaların sınıflandırılmasında kullanılmasının yanı sıra, mikrobiyal çalışmalarda ve genetik hastalıklarında, antimikrobiyal tedavinin yönlendirilmesinde, direnç genleri ve mutasyonların tespit edilmesinde ve epidemiyoloji alanında kullanılmaktadır. Amplifikasyon tekniklerinde; mikroorganizmaların tanımlanmasında kullanılan probların tersine, nükleik asit üzerindeki belirli bölgeler çoğaltılmaktadır. Belirlenebilir seviyelerin daha altındaki mevcut spesifik hedefleri seçici olarak amplifiye ederek, tanısal prob hibridizasyonunun en önemli limitasyonunun üstesinden gelme potansiyeli bulunmaktadır. Amplifikasyon teknikleri; nükleik asit dizisine yapışan işaretli probların oluşturduğu sinyallerin çoğaltıldığı sinyal amplifikasyonu ve belirli nükleik asit dizisine yapışan probların çoğaltıldığı prob amplifikasyon tekniklerini kapsar. Nükleik asit amplifikasyon teknikleri; sinyal amplifikasyona dayalı yöntemler ve nükleik asit amplifikasyon tekniklerine dayalı yöntemler olarak ikiye ayrılmaktadır. Sinyal amplifikasyona dayalı yöntemler, hedef dizilerin amplifikasyonu yerine üretilen sinyalin güçlendirilmesi esasına dayanır. Prob hibridizasyon yöntemlerinden daha duyarlı olsa da nükleik asit yöntemleri kadar duyarlı değildir. Nükleik asit amplifikasyon teknikleri Polimeraz zincir reaksiyonu, PZR tabanlı amplifikasyon teknikleri, nükleik asit sekans tabanlı amplifikasyon, transkripsiyon amaçlı amplifikasyon, nükleik asitlerin çoğaltılması için kullanılan yöntemlerdir. Moleküler biyoloji ve genetik alanında son yıllarda hızlı ve güvenilir bir teknik olması nedeniyle geniş bir kullanım alanına sahip olmuştur.
Anahtar Kelimeler: Mikrobiyoloji, PZR, Amplifikasyon Teknikleri, Teşhis

NUCLEIC ACID AMPLIFICATION TECHNIQUES USED IN MICROBIOLOGY

ABSTRACT
Molecular diagnostic methods are one of the most essential benefits of molecular biology and microbiology innovations. Developing technology has enabled the development of new diagnostic methods with high sensitivity and specificity. The addition of new molecular techniques every day provides support for scientific studies carried out for different purposes. These methods have been essential in identifying infectious agents that are difficult or impossible to find and identify using traditional methods. Molecular methods are used in the definitive diagnosis of disease agents such as bacteria, viruses, fungi, protozoa and parasites, in the classification of these microorganisms, in microbial studies and genetic diseases, in the guidance of antimicrobial therapy, in the detection of resistance genes and mutations and epidemiology. In amplification techniques, specific nucleic acid regions are amplified in contrast to the probes used to identify microorganisms. By selectively amplifying existing specific targets below detectable levels, they have the potential to overcome the most critical limitation of diagnostic probe hybridisation. Amplification techniques include signal amplification, where signals generated by labelled probes adhering to the nucleic acid sequence are amplified, and probe amplification, where probes adhering to specific nucleic acid sequences are amplified. Nucleic acid amplification techniques: They are divided into two: methods based on signal amplification and methods based on nucleic acid amplification techniques. Signal amplification-based methods strengthen the generated signal instead of amplifying the target sequences. Although it is more sensitive than probe hybridisation methods, it is less sensitive than nucleic acid methods. Nucleic acid amplification techniques Polymerase chain reaction, PCR-based amplification techniques, nucleic acid sequence-based amplification, and amplification for transcription purposes are the methods used to amplify nucleic acids. It has become widely used in molecular biology and genetics in recent years because it is a fast and reliable technique.
Keywords: Microbiology, PCR, Amplification Techniques, Diagnosis

Introduction

Numerical amplification of nucleic acids is among the most widely used methods in diagnosing pathogens, forensic medicine and genetic diseases. Amplification is obtained by enzymatic amplification of the materials used. Since amplification methods are quick, safe, sensitive and specific and are not affected by antibodies in the blood, the oldness of the materials, or the small number or inactivity of the agents in the body, they provide significant benefits in the identification of bacterial and viral agents whose isolation, production or identification is challenging. Although these techniques save time and personnel and minimise personnel errors and laboratory infections, they still require expensive, experienced and knowledgeable personnel, advanced equipment, pure chemicals, labelled probes, enzymes and specific primers (Anonymous 2021). Molecular diagnostic methods are used in the diagnosis of disease agents such as bacteria, viruses, fungi and protozoa, in the classification of microorganisms, in directing antimicrobial treatment and in the field of epidemiology. In recent years, increasing automation systems, conversion into easy software programs, and decreasing applications' costs have ensured their widespread use.

Nucleıc Acıd Amplıfıcatıon Technıques

Amplification techniques amplify specific nucleic acid regions, unlike probes used to identify microorganisms. The most crucial limitation of diagnostic probe hybridisation can be overcome by selectively amplifying specific targets below detectable levels. Amplification techniques include signal amplification, in which signals generated by labelled probes adhering to the nucleic acid sequence are amplified, and probe amplification techniques, in which probes adhering to a specific nucleic acid sequence are amplified (Arens 1993, Tang et al. 1997, Weile and Knabbe 2009).

Signal Amplification Based Methods

It is based on the principle of strengthening the generated signal instead of amplifying the target sequences. In principle, two probes are used. Although it is more sensitive than probe hybridization methods, it is not as sensitive as NAA methods. It can give positive results in the presence of the target molecule. It has two types of modifications (Arens 1993, Tang et al. 1997, Weile and Knabbe 2009).

Branched DNA (bDNA)

Multiple probes and signaling molecules are used to amplify the target DNA signal. It is

based on the principle that the probe sticks to the target and binds a large number of molecules on the branches it carries (Arens 1993).

Hybrid Capture System

It is a method of detecting chemiluminescent signals via antibody. DNA is hybridized with an RNA probe, allowing the nucleic acids to become free. DNA-RNA hybrid-specific labeled antibodies are measured with a chemiluminometer (Arens 1993, Tang et al. 1997, Weile and Knabbe 2009).

Nucleic Acid Amplification

Polymerase chain reaction, PCR-based amplification techniques, nucleic acid sequence-based amplification, amplification for transcription purposes are the methods used for the amplification of nucleic acids (Arens 1993, Tang et al. 1997, Weile and Knabbe 2009).

1. Target Amplification Methods

1.1. Polymerase chain reaction (PCR)

It has become widely used in the field of molecular biology and genetics in recent years because it is a fast technique (Edel 1998). This enzymatic reaction is based on the presence of polymerase enzyme and molecules suitable for synthesis in the environment, enabling the recognition and amplification of DNA and RNA sequences. Molecular diagnosis of diseases is mostly focused on nucleic acid. The nucleic acid must be isolated and is based on the use of restriction endonuclease enzyme, gel electrophoresis and nucleic acid hybridization techniques. Many new methods have been developed since the discovery of the PCR technique. Methods used when the DNA sequence to be replicated is known; Nested PCR, Real-Time PCR, Multiplex PCR, Quantitative PCR, Touch Down PCR, Solid Phase PCR, and Reverse Transcription PCR (Sevindik et al. 2013). The PCR technique basically consists of three stages. Oligonucleotide primers bind to complementary regions on single-stranded DNA molecules after the template DNA molecule is denatured at high temperatures. Specific binding of primers to target sequences occurs at low temperatures. The DNA polymerase enzyme enables the primer to extend from the 3' hydroxyl end in the presence of appropriate buffer and deoxyribonucleotide triphosphate (dNTP) containing four types of organic bases. Thus, a new DNA molecule complementary to the template DNA strand is synthesized. A PCR cycle consists of the stages of DNA becoming a single strand (denaturation), binding of the primer (annealing) and elongation. The basic principles of PCR are as follows (Fig 1)

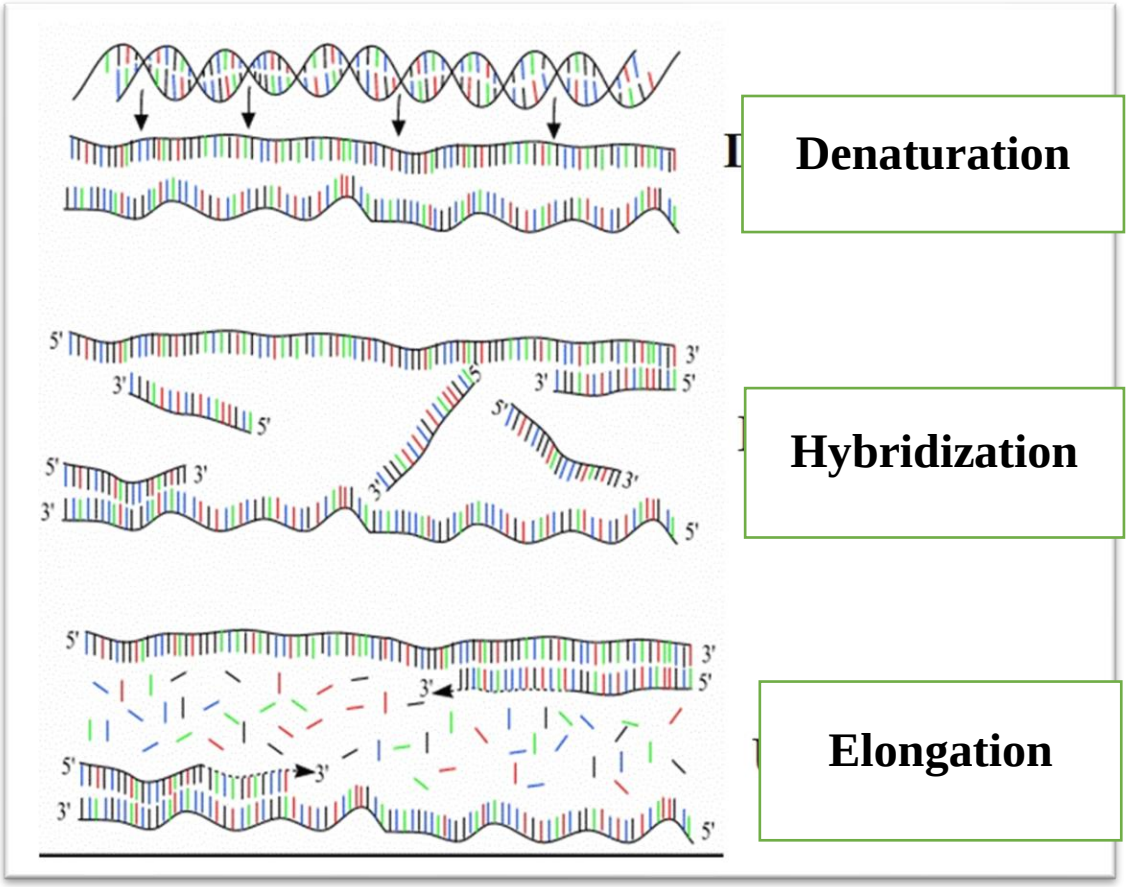


Figure 1. PCR reaction steps

Opening of the DNA Chain (Denaturation): The double-stranded DNA strands of the template DNA in the sample to be investigated are separated from each other with the help of high heat (15-60 seconds at 92-95 C). In some cases, preheating for 5-10 minutes may be necessary to separate the DNA strand (Watson et al. 1992, Hadidi et al. 1995).

Binding of Primers to the Separated DNA Chains (Annealing, hybridization): It is the process of reducing the reaction temperature to low temperatures (37-65 °C) and binding the synthetic oligonucleotide primers to the region corresponding to the specific base sequences of the separated DNA chains. This process takes place in 30-60 seconds, depending on the base length to be produced (Innis and Gelfand 1990).

Primer Elongation (Primer Extesion, elongation): Primers adhering to DNA chains are extended by the DNA polymerase enzyme (Taq DNA polymerase). Since Taq DNA polymerase works better at 72 C, all replication processes are generally carried out at this temperature (Erlich et al. 1991). The product obtained as a result of PCR is the total length of the DNA fragment targeted to be amplified and the two primers (Hadidi et al. 1995).

1.2. Multiplex PCR

To amplify the template DNA sequence, the amplification process is performed by adding more than one primer pair to the same reaction. Placing primers specific for different target regions on each microorganism or bacterial gene in the amplification tube can amplify many targets simultaneously.

1.3. Real-time PCR method

It is a recently widely used technique that can provide results in a short time by amplifying DNA or mRNA samples and simultaneously measuring the fluorescence signal that increases during amplification (Klein 2002).

1.4. Reverse Transcriptase PCR (RT-PCR) method

Unlike normal PCR, it is a fast and sensitive method in which gene expression analyses can be performed due to complementary DNA (cDNA) synthesis of RNA molecules isolated from microorganisms with the help of the reverse transcriptase enzyme isolated from retroviruses. First, complementary DNA is synthesized using RNA as a template, then the DNA-RNA strand is separated, and finally the double-stranded DNA sequence is replicated by using the separated DNA sequence as a template (Santagati et al. 1997).

To achieve appropriate RT-PCR results, it is necessary to carry out the processing steps carefully, work with appropriate enzymes, select the appropriate primer, use different buffers and additional agents, adjust the parameters well, and, most importantly, prepare samples of high quality and purity (Bustin 2002, Gibson et al. 1995).

1.5. Nested-PZR

It is a method developed to increase the specificity of the PCR technique. Nested PCR is a much more sensitive method compared to classical culture methods and other PCR applications, and this is due to the two-stage PCR application. Nested PCR applications will be used to diagnose and diagnose different diseases in the future and will provide reliable results.

Today, many protozoa, bacteria, viruses and many disease agents are diagnosed with this method (WHO 1997, Özkara et al. 1999). Studies have shown that the Nested PCR technique is effective in the diagnosis of Mycobacterium tuberculosis (Tzoanopoulos et al. 2001, Shukla et al. 2011), which causes tuberculosis, Coxiella burnetii (Ogawa et al. 2004), which causes Q fever, bacteria belonging to the Leptospira genus (Morshed et al. 1994, Nassi et al. 2003), which causes Spirochaete disease, and many pathogenic

microorganisms caused by bacteria, viruses and fungi in plants, animals and humans. (Chauhan 2009, Shen et al. 2012).

1.6. Touch Down PCR

Amplification of unwanted DNA sequences is achieved with the Touch Down PCR technique. In the first stage, it is aimed to specifically bind the primers to the target sequence by keeping the primer temperature above approximately 15 C in order to determine the optimal primer binding degree. It is then based on decreasing the temperature by 1-2 degrees to the Tm level during subsequent cycles. With this, amplicons specific to the target region are obtained (Karataş 2012, Persing 1993).

1.7. Solid Phase PCR

Solid Phase PCR is a type of polymerase chain reaction that uses DNA chip technology to produce surface-fixed DNA used in single nucleotide polymorphism and DNA sequence analyses. Replication is carried out by primers attached to the surface at the 5' end (Karataş 2012). This method can detect any bacteria or virus in water or air (Toranzos and Alvarez 1992).

1.8. Hot-Start PCR

In the classical PCR protocol, before the reaction starts, non-specific binding of the primers to some non-specific sequences may occur due to the effect of the polymerase enzyme at room temperature, as a result, many unwanted bands may be seen. In some cases, it is based on the principle of adding some PCR components (Polymerase enzyme, Nucleotides, Mg^{+2} or primers) after the first denaturation process and cooling the temperature to normal binding level after this stage, in order to eliminate negative situations such as primer oligomerization, primer loss, and non-specific amplifications. With these processes, clearer DNA bands are formed (Persing 1993).

1.9. İn Situ PCR

Another important step in PCR-related studies is the amplification of the target DNA of the microorganism in the infected cell detected on the slide and the demonstration of the result by "in situ" hybridization. Briefly; After the tissue or cells are placed on the slide, it is air dried and kept at 105°C for 30 seconds. It is processed with paraformaldehyde and phosphate buffered saline (2%) for one hour. Wash once with 3 x 0.1 M PBS (Phosphate buffer saline) and three times with 1 x 0.1 M PBS. After being treated with Proteinase K enzyme (5 µg/ml) at 55°C for two hours, Proteinase K is inactivated by

keeping it at 96°C for two minutes (Bagasra et al. 1993, Teo and Shaunak 1995).

The slide is washed with water and dried in air. Then amplification solution is added to the slide and covered with a plastic cap. The area around the plastic cover is fixed. The slide is placed on an automatic thermal cycler. After covering with aluminum foil, amplification is started. After amplification, the slide is kept in absolute ethyl alcohol for 3-5 minutes. Then, denaturation is ensured for 30 seconds at 92°C and washed with 2 x SSC (Sodium chloride + Sodium citrate) buffer. Following this, "in situ" hybridization is performed with specific probes and the amplification result is observed (Bagasra et al. 1993, Teo and Shaunak 1995).

The most important advantage of this method is that there is no contamination as the amplification occurs inside the cell.

1.10. RAPD (Randomly Amplified Polimorphic DNAs)

It first emerged in 1990 as a PCR-based technique using randomly selected primers (Williams ve ark 1990). The basic principle of the RAPD method is that a single 9-10 bp oligonucleotide randomly selected on the genomic DNA of the relevant species is randomly ligated at low binding temperature and amplified by PCR. The resulting amplification product is run in standard gel electrophoresis and the amplification products are observed and examined as bands. The results are evaluated by the presence or absence of bands (Williams et al. 1990).

Although RAPD is easy to use, it is difficult to diagnose dominant and heterozygous markers (Günel et al. 2009). The repeatability of the data obtained as a result of the studies may be low because it depends on all the variables involved in the reaction. For this reason, it is very important to optimize the method before engaging in other comparative analyses (Perandin et al. 2004, Levy et al. 1992).

In conclusion; Traditional microbiology methods may be disadvantageous due to the ability of the microorganism to reproduce, the sample losing its viability during shipment, the growth of competing microorganisms due to contamination, and the presence of pathogens that cannot be cultured or require high-cost biosecurity during culture. Molecular methods, on the other hand, can be used in the accurate detection of organisms that cannot be cultured for a long time or in a small number of organisms, the ability to screen a large number of samples, the use of techniques in epidemiological and clinical research, the detection of epidemic diseases, and the association of etiological agents by

comparing the sequences in their genomes. Today; Techniques such as PCR, Real Time PCR and sequencing are routinely used in many microbiology laboratories. In the future; The development of more user-friendly, easily applicable systems, increased automation, and the installation of these technologies in all laboratories and hospitals will make their use widespread.

References

Anonymous (2021). http://www.mikrobiyoloji.org

Arens M, 1993. Use of probes and amplification techniques for the diagnosis and prognosis of human immunodeficiency virus (HIV-1) infections. Diag Microbiol Infect Dis 16:165–72.

Bagasra O, Seshamman T, Pamerantz RJ, 1993. Polymerase chain reaction in situ, J Immunological Methods, 158, 131-45.

Bustin SA, 2002. Quantification of mRNA using real time revers transciription PCR, Journal of Molecular Endocrinology, 29, 23-39.

Bustin SA, Mueller R, 2005. Real-time reverse tarnscription PCR (qRT-PCR) and potential use in clinical diagnosis. Clin. Science, 109, 365-379

Chauhan HC, Kher HN, Chandel BS, Dadawala AI, Jain L, Agrawal SM and Bhadaniya A, 2009. Evaluation of Group specific Nested PCR for detection of Bluetongue virus Veterinary World, 2(5): 179-182.

Gibson UE, Heid CA, Williams PM, 1995. Anovel method for real time revers transcription PCR, Genome ress, 6. 995- 1001.

Günel T, Aydınlı K, 2009. Real-Time PCR and Applications Area Türk Bilimsel Derlemeler Dergisi 2(2): 43-45.

Hadidi AL, Podleskis EV, 1995. Polymerase chain reaction technology in plant pathology. In: Molecular Methods in Plant Pathology, pp.167-187. Eds. R. P. Singh, U. S. Singh. Boca Raton: CRS Press.

Innis MA and Gelfand D, 1990. Optimization of PCRs In Innis, M.A, Gelfand, D.H., Sninsky, J.J.and White T.J (eds.). PCR protocols A guide to methods and applications.Academic Press.3-12 pp.

Karataş M, 2012. Moleküler Biyoloji Nobel Akademik Yayıncılık. p. 289

Klein D 2002. Quantification using real-time PCR tecnology:İ Applications and limitations. Trends Mol. Med., 8: 257-260).

Levy L, Hadidi A and Garsey SM, 1992. Reverse transcription-polymerase chain reaction asays for the rapid detection of citrus viroids using multiplex primer sets. Proc. Int. Soc. Citriculture. 2:800.

Ogawa M, Setiyono A, Sato K, Cai Y, Shiga S, and Kishimoto T, 2004, Evaluation of PCR and nested PCR assays currently used for detection of Coxiella burnetii in Japan. Southeast Asian J Trop Med Public Health 35:852-855.

Perandin F, Manca N, Calderaro A, Piccolo G, Galati L, 2004. Development of a RealTime PCR Assay for Detection of Plasmodium falciparum, Plasmodium vivax, and Plasmodium ovale for Routine Clinical Diagnosis journal of clınıcal mıcrobıology, vol. 42, p. 1214–1219.

Persing DH, 1993. Target selection and of amplification reactions, American Society for Microbiology, Washington DC, 51-87.

Persing HD, 1991. Polymerase chain reaction: Trends to benches. J Clin Microbiol, 29: 1281-1285).

Santagati S, Garnier M, Carlo P, et al,1997. Quantitation of low abundance mRNAs in glial cells using different polymerase chain reaction (PCR)-based methods, Br Res Prot 217.

Sevindik E, Abacı TZ, 2013. Nested PCR and Applications Area Türk Bilimsel Derlemeler Dergisi.

Shen W, Xi P, Li M, Sun L, Zhang L and Jiang Z, 2012. Development of a sensitive nested-polymerase chain reaction (PCR) assay for the detection of Ustilago scitaminea. African Journal of Biotechnology.

Tang Y, Procop G W, Persing D, 1997. Molecular diagnostics of infectious diseases Clinical Chemistry 43:11 2021–2038

Toranzos AG, Alvarez JA,1992. Solid-phase polymerase chain reaction: applications for direct detection of enteric pathogens in waters. Canadian Journal of Microbiology, 38(5): 365-369, 10.1139/m92-062.

Tzoanopoulos D, Stakos D, Hatseras D, Ritis K, Kartalis G, 2001. Detection of Mycobacterium tuberculosis complex DNA in pericardial fluid, bone marrow and peripheral blood in a patient with pericardial tuberculosis. A case report Neth J Med. 59:177–80.

Watson JD, Gilman J, Witkowski M and Zoller M, 1992. The polymerase chain reaction In: Recombinant DNA. Second Edition. New York. 79-98.

Weile J, Knabbe C, 2009. Current applications and future trends of molecular diagnostics in clinical bacteriology, Anal Bioanal Chem (2009) 394:731–742 DOI 10.1007/s00216-009-2779-8.

Williams JGK, Kubelik AR, Livak KJ, Rafalski JA, Tingey SV, 1990. "DNA Polimorphism Amplified By Arbitrary Primers Are Useful As Genetic Markers", Nucleic Acids Research,Vol 18, 6531-6535.

HAYVAN BESLEMEDE NANOTEKNOLOJİK UYGULAMALARIN ETKİLERİ

Dr. Mazhar Burak CAN* (ORCID: 0000-0001-5248-1369)
Bayburt İl Tarım ve Orman Müdürlüğü, Hayvan Sağlığı Yetiştiriciliği ve Su Ürünleri Şube Müdürlüğü, Bayburt-Türkiye
Email: drmazharburakcan@gmail.com

Dr. Sümeyra CAN (ORCID: 0000-0002-2471-5786)
Sağlık Hizmetleri Meslek Yüksekokulu, Tıbbi Hizmetler ve Teknikler Bölümü, Bayburt Üniversitesi, Bayburt TR-69000
Email: sumeyrasacakli@bayburt.edu.tr

ÖZET
Nanoteknoloji hayvan besleme alanında çeşitli uygulamaları olan bir alandır. Yem kullanımını, besin dağıtımını ve hayvan sağlığını iyileştirme potansiyeli nedeniyle hayvan besleme alanında giderek daha fazla kullanılmaktadır. Ruminantlarda metan salınımını azaltmak ve rumen fermantasyonunu arttırmak için çinko oksit gibi nanopartiküller kullanılmıştır. Ek olarak nanominerallerin özellikle selenyum ve çinko nanopartiküllerinin geviş getiren hayvanların beslenmesindeki olası faydaları araştırılmıştır. Diğer yandan kümes hayvanlarında büyüme performansını ve sağlık sonuçlarını iyileştirmek için de nanopartiküller kullanılmıştır. Ancak nanoselenyum gibi nanomateryallerin hayvanlar üzerindeki potansiyel toksikolojik etkileri dikkate alınmalıdır. Nanominerallerin hayvan beslemede kullanımı eser minerallerin biyoyararlanımını iyileştirdiği, hayvanların genel sağlığına ve refahına katkıda bulunduğu ifade edilmektedir. Nanoteknoloji uygulamalar yan ürünlerin kullanımının ve diyet bileşenlerinin verimliliğinin artırılmasına katkıda bulunarak hayvan performansına fayda sağlayabilir. Aynı zamanda bu uygulamalar hayvanlarda hormon dozlarını azaltabilme ve hormon kinetiğini değiştirebilme özelliklerine sahip üreme sonuçlarını geliştirebilen nanoilaçların dağıtımını sağlayarak çiftlik hayvanlarının akıllı üreme yönetiminde çok önemli bir rol oynamaktadır. Alternatif yem kaynakları üzerine yapılan çalışmalarda zeytinyağı endüstrisi yan ürünlerinin hayvan beslemede kullanılabilirliği araştırılmış ve bu konuda yapılan araştırma sonuçlarına değinilmiştir. Benzer şekilde patates işleme endüstrisi yan ürünleri üzerine yapılan bir çalışmada yeşil patates ve filizlenmiş patateste bulunan solanin maddesinin hayvanlarda zehirlenmelere yol açtığı ve bu nedenle kullanım düzeyine dikkat edilmesi gerektiği vurgulanmıştır. Bu bilgiler ışığında nanoteknolojinin hayvan besleme alanında kullanımı ve alternatif yem kaynaklarının değerlendirilmesi konularında yapılan çalışmaların hayvan besleme alanında önemli bir potansiyele sahip olduğunu göstermektedir. Genel olarak hayvan besleme ve üretim sistemlerindeki nanoteknolojinin mevcut ve gelecekteki beklentileri; yem verimliliğini, hayvan sağlığını ve genel verimliliği artırmak için umut verici yollar sunmaktadır.

Anahtar Kelimeler: hayvan besleme, kanatlı, nanoteknoloji, ruminant, yem

EFFECTS OF NANOTECHNOLOGICAL APPLICATIONS IN ANIMAL NUTRITION

ABSTRACT
Nanotechnology is a field with various applications in animal nutrition. It is increasingly used in animal nutrition due to its potential to improve feed utilization, nutrient delivery and animal health. Nanoparticles such as zinc oxide have been used to reduce methane release and enhance rumen fermentation in ruminants. In addition, the possible benefits of nanominerals, especially selenium and zinc nanoparticles, in ruminant nutrition have been investigated. On the other hand, nanoparticles have also been used to improve growth performance and health outcomes in poultry. However, the potential toxicological effects of nanomaterials such as nanoselenium on animals should be considered. The use of nanominerals in animal nutrition is reported to improve the bioavailability of trace minerals and contribute to the overall health and welfare of animals. Nanotechnology applications may benefit animal performance by contributing to improved utilization of by-products and efficiency of dietary components. At the same time, these applications play a crucial role in the smart reproductive management of livestock by enabling the delivery of nano-drugs that can improve reproductive outcomes in animals with the ability to reduce hormone doses and alter hormone kinetics. In the studies on alternative feed resources, the usability of olive oil industry by-products in animal nutrition was investigated and the results of the research on this subject were mentioned. Similarly, in a study on by-products of potato processing industry, it was emphasized that the solanine substance found in green potatoes and sprouted potatoes causes poisoning in animals and therefore, the level of use should be considered. In the light of this information, studies on the use of nanotechnology in animal nutrition and the evaluation of alternative feed resources show that it has an important potential in the field of animal nutrition. In general, the current and future prospects of nanotechnology in animal nutrition and production systems offer promising ways to increase feed efficiency, animal health and overall productivity.
Keywords: animal nutrition, poultry, nanotechnology, ruminant, feed

Giriş

Nanoteknoloji en az bir boyutun nanometre ölçeğinde (metrenin milyarda biri) olduğu malzeme ve cihazların tasarımını, sentezini, karakterizasyonunu ve uygulamasını içeren çok disiplinli bir alandır (Lainović & Blažić, 2012). Diş hekimliği, tıp ve malzeme bilimi dâhil olmak üzere çeşitli sektörlerde yenilikçi uygulamalar için fırsatlar sunan atomik ve moleküler düzeydeki fenomenlerin incelenmesini kapsar (Manojlović, 2018). Nanobiyoteknoloji alanı tasarlanmış ultra küçük parçacıkların canlı hücreler, proteinler ve biyosistemler ile etkileşimine odaklanır ve çeşitli uygulamalar için bu etkileşimlerin anlaşılmasının önemini vurgulamaktadır (Faunce, 2009). Nanoteknoloji yalnızca bilimsel bir alan değil, aynı zamanda endüstrilerde devrim yaratma ve karmaşık toplumsal zorluklara çözüm bulma potansiyeline sahip teknolojik bir yeniliktir (Kagan vd., 2016). Nanoteknoloji başta hayvancılık, balıkçılık ve bitkisel üretim uygulamaları olmak üzere ticari yaşam bilimlerinde giderek artan uygulamalar bulan yeni ve gelecek vadeden bir araştırma ve teknoloji alanıdır. Son zamanlarda sürdürülebilir uygulamalara büyük önem verilmiş olsa da, hayvanların kâr amacıyla bütünsel yönetimi, yem yönetimi ve gelişmiş hayvan üretim metodolojileri, uzun vadeli sürdürülebilir ve ticari kazanımların anahtarıdır. Nanobilim ve bunun bu tür süreçlere uygulanması, hayvanların genel sağlığında ve atık yönetiminde gözle görülür derecede daha hızlı bir geri dönüş sağlayarak süreci büyük ölçüde istikrara kavuşturmaktadır. Yakın geçmişte, başka hiçbir yeni teknoloji kendisini bilimsel ve ticari uygulamalarla bu kadar hızlı bir şekilde etkili hayvansal üretim yollarına entegre edemedi. Ancak nanobilim yeniliklerine ilişkin etik, yasal ve politika çerçeveleri büyük ölçüde nanoteknolojinin sürdürülebilir hayvansal üretim uygulamalarındaki potansiyel faydalarına odaklanmıştır.

Nanoteknolojik Uygulamaların Hayvan Beslemede Kullanımı

Hayvancılık sektöründe nanoteknolojiyi ilerletmek ve hayvancılığın çeşitli yönlerini iyileştirmek amacıyla nanomateryallerin potansiyelinden yararlanmak çok önemlidir. Nanoteknoloji verimliliği, üretkenliği ve sürdürülebilirliği artırarak tarım, hayvancılık ve gıda endüstrilerini dönüştürme fırsatları sunmaktadır (Abdelnour ve ark., 2021). Nanoteknolojinin hayvancılık sektörüne entegrasyonu hayvan sağlığı, beslenme ve üretim yöntemlerinde ilerlemeyi teşvik etme ve böylece endüstrinin genel büyümesini destekleme potansiyeline bağlıdır (Hanafy, 2018). Tarımda özellikle de hayvancılıkta nanoteknolojik uygulamalara odaklanılarak sektördeki zorluklarla etkili bir şekilde

mücadele etmek için sürdürülebilir sistemler oluşturulabilir (Ahmad ve ark., 2022). Nanoteknolojinin hayvancılık sektöründeki gelişimine dâhil edilmesi çevresel sürdürülebilirliği korurken üretimi ve üretkenliği artırmak için sürdürülebilir bir büyüme çerçevesi gerektirir (Santoso ve Prasetiyono, 2018). Nanoteknoloji biyoyararlılığı artırmak, besin değerini artırmak ve hayvan sağlığını iyileştirmek için hayvan beslenmesinde kullanılabilir (Num ve Useh, 2013). Bu teknoloji yem alımından besin kullanımına kadar hayvan besleme senaryolarında geniş bir etkiye sahip olma potansiyeline sahiptir. Ayrıca nanoteknolojik hayvan sağlığı ve üretimi de kullanılmış olup, hastalık teşhisi, tedavisi, ilaç taşıma ve hayvansal ürünler değer katma gibi olanaklar sunmaktadır (Kobayashi ve ark., 2021).

Nanoteknoloji farklı hayvan türlerinin beslenme stratejilerinin oluşturulmasında çeşitli uygulamalarla önemli etkiler yaratabilir. Örneğin; nanopestisitler ve nanoyapılar gibi nanoteknolojik araçların kullanımı hassas tarım uygulamalarını destekleyebilir ve hayvancılık verimliliğini artırabilir (Vohra ve ark., 2016; Zaheer ve ark., 2022). Nanosensörler ve çinko oksit bazlı sensörler gibi nanomateryallerin ilerleyişi sayesinde hayvancılık sektöründe gelişmiş izleme ve yönetim uygulamalarına yol açmaktadır (Knoepfel ve ark., 2022). Nanoteknolojinin hayvan beslemedeki faydaları arasında selüloz nanofiberlerin daha fazla kullanıldığında yemlerin gözeneklerinin artırılması sonucunda hayvanların performanslarına olumlu katkı sağladığı ifade edilmiştir (Oliveira ve ark., 2021). Damızlık bıldırcınlarda nano selenyum (Se) kullanımının araştırıldığı bir çalışmada rasyonda 0.2 mg/kg oranında nano Se'nin verim ve canlı ağırlık parametrelerini olumsuz etkilememesine rağmen yumurta ağırlığı, kuluçka randımanı, döllülük oranı ve karaciğer üzerindeki olumsuz etkilerinden dolayı daha düşük düzeylerde kullanılabileceği ifade edilmiştir (Sevim ve ark., 2019). Tatlı ve ark. (2019) yaptıkları çalışmada damızlık bıldırcın rasyonlarında 46 mg/kg oranında kullanılmasının karaciğer, çıkım ve embriyonik ölüm oranı üzerine olumsuz etkileri olduğu, performans üzerine ise etkisinin olmadığı bildirilmiştir.

Nanoteknolojinin hayvancılık üretim sistemlerine entegrasyonu, çevresel etkilerin azaltılmasına, hayvan refahının iyileştirilmesine ve kaynak kullanımının optimize edilmesine yardımcı olmaktadır (Sere, 2020). Hayvancılıkta teşhis, tedavi ve beslenmede nanoteknolojinin potansiyelinin keşfedilmesiyle birlikte hastalık yönetimi ve hayvan refahı konularında önemli ilerlemeler kaydedilmiştir (Li ve ark., 2023). Aynı zamanda

nano ölçekli yem bileşenlerinin spesifik yüzey alanlarının genişlemesi sayesinde hayvan yemlerinde kullanıldığında biyoyararlılığın artması açısından çeşitli faydalar sağlamaktadır (Budak, 2018). Ek olarak kil minerallerinin sulu nanosüspansiyonlarının kanatlı performansını, karkas özelliklerini ve et kalitesini etkileyebileceği gösterilmiştir (Al-Beitawi, 2017). Bu tür nanomateryallerin hayvan beslenmesinde kullanılması hem yem kalitesini artırabilir hem de hayvan performansını olumlu yönde etkileyebilir. Nanoteknolojinin hayvancılıkta yem sektöründe uygulandığında çiftlik hayvanlarının beslenme verimliliğinin arttırılmasını, hayvan hastalıklarından kaynaklanan kayıpların azaltılmasını ve hayvan yan ürünleri ile atıklarının değerli ürünlere dönüştürülmesini sağlamaktadır (Sekhon, 2014).

Hayvan yemi endüstrisinde yenilikçiliği ve verimliliği teşvik eden bu teknoloji, hayvan refahını ve üretimini desteklemektedir. Ancak hayvan yemi uygulamalarında nanoteknolojinin kullanımıyla ilgili potansiyel riskleri ve etik kaygıları dikkate almak önemlidir.

SONUÇ

Hayvancılık sektörü, nanomateryallerin ve nanocihazların yenilikçi yeteneklerinden yararlanarak temel zorlukların üstesinden gelebilir ve üretim uygulamalarını optimize edebilir. Nanoteknolojinin hayvancılık sektörüne stratejik olarak dahil edilmesi sürdürülebilirliğin devamlılığı ve verimliliğin artırılması konusunda ümit vericidir. Araştırmacılar, hükümetler, tarım ve endüstri sektöründeki paydaşlar arasındaki işbirlikçi çabalar daha üretken bir gelecek için nanoteknolojide gelişim ve uygulamaları teşvik etmek için sorumluluk almaları hayati öneme sahiptir.

REFERANSLAR

Abdelnour, S., Alagawany, M., Hashem, N., Farag, M., Al-Ghamdi, E., Hassan, F., … & Attia, Y. (2021). Nanominerals: fabrication methods, benefits and hazards, and their applications in ruminants with special reference to selenium and zinc nanoparticles. Animals, 11(7), 1916. https://doi.org/10.3390/ani11071916

Ahmad, I., Mashwani, Z., Raja, N., Kazmi, A., Wahab, A., Ali, A., … & Rahimi, M. (2022). Comprehensive approaches of nanoparticles for growth performance and health benefits in poultry: an update on the current scenario. Biomed Research International, 2022, 1-13. https://doi.org/10.1155/2022/9539908

Al-Beitawi, N. (2017). Effect of an aqueous nanosuspension of clay minerals on the performance, carcass characteristics and internal organs of broilers. Nanotechnology Nanomedicine & Nanobiotechnology, 4(1), 1-5. https://doi.org/10.24966/ntmb-2044/100013

Budak, D. (2018). Nanotechnology in animal nutrition. Journal of Advances in Vetbio Science and Techniques, 3(3), 90-97. https://doi.org/10.31797/vetbio.494059

Faunce, T. (2009). Policy challenges of nanomedicine for australia's pbs. Australian Health Review, 33(2), 258. https://doi.org/10.1071/ah090258

Hanafy, M. (2018). Myconanotechnology in veterinary sector: status quo and future perspectives. International Journal of Veterinary Science and Medicine, 6(2), 270-273. https://doi.org/10.1016/j.ijvsm.2018.11.003

Kagan, C., Fernandez, L., Gogotsi, Y., Hammond, P., Hersam, M., Nel, A., … & Weiss, P. (2016). Nano day: celebrating the next decade of nanoscience and nanotechnology. Acs Nano, 10(10), 9093-9103. https://doi.org/10.1021/acsnano.6b06655i

Knoepfel, A., Liu, N., Hou, Y., Sujani, S., Reis, B., White, R., … & Priya, S. (2022). Development of tetrapod zinc oxide-based uv sensor for precision livestock farming and productivity. Biosensors, 12(10), 837. https://doi.org/10.3390/bios12100837

Kobayashi, R., Dhakal, S., & Nakazato, G. (2021). Editorial: the use of nanoparticles in the diagnosis and therapy of infectious disease in animals. Frontiers in Veterinary Science, 8. https://doi.org/10.3389/fvets.2021.829540

Lainović, T. and Blažić, L. (2012). Nanotechnology in dentistry: current state and future perspectives. Stomatoloski Glasnik Srbije, 59(1), 44-50. https://doi.org/10.2298/sgs1201044l.

Li, C., Wu, X., Pradhan, P., Liu, J., Li, Z., & Chen, G. (2023). The livestock sector can overshoot planetary boundaries and threaten paris agreement. https://doi.org/10.21203/rs.3.rs-2735132/v1

Manojlović, J. (2018). Introduction to nanotechnology and molecular self-assembly. Facta Universitatis Series Automatic Control and Robotics, 17(2), 105. https://doi.org/10.22190/fuacr1802105m

Num, S. and Useh, N. (2013). Nanotechnology applications in veterinary diagnostics and therapeutics. Sokoto Journal of Veterinary Sciences, 11(2). https://doi.org/10.4314/sokjvs.v11i2.2

Oliveira, G., Andrade, C., Sotomaior, C., & Costa, L. (2021). Advances in nanotechnology and the benefits of using cellulose nanofibers in animal nutrition. Veterinary World, 2843-2850. https://doi.org/10.14202/vetworld.2021.2843-2850

Santoso, B. and Prasetiyono, B. (2018). Planning of beef cattle development in district blora, central java, indonesia. E3s Web of Conferences, 31, 09022. https://doi.org/10.1051/e3sconf/20183109022

Sekhon, B. (2014). Nanotechnology in agri-food production: an overview. Nanotechnology Science and Applications, 31. https://doi.org/10.2147/nsa.s39406

Sere, C. (2020). Investing sustainably in african livestock development: opportunities and trade-offs. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3688901

Sevim, Ö., Tatli, O., Kuter, E., Karimiyan, E., Kaya, M., Karaarslan, S., ... & Cengiz, Ö. (2019). Nano selenyumun damızlık bıldırcınlarda verim, yumurta ve sperm kalitesi ile kuluçka parametreleri üzerine etkileri. Harran Üniversitesi Veteriner Fakültesi Dergisi, 8(1), 33-37.

Tatli, O., Sevim, Ö., Karaarslan, S., Kuter, E., Mehmet, K. A. Y. A., Khamseh, E. K., ... & Önol, A. G. (2019). Damızlık bıldırcın rasyonlarına katılan nano çinkonun performans, yumurta özellikleri, sperm kalitesi ve kuluçka parametreleri üzerine etkisi. Journal of the Institute of Science and Technology, 9(4), 2390-2397.

Vohra, A., Syal, P., & Madan, A. (2016). Probiotic yeasts in livestock sector. Animal Feed Science and Technology, 219, 31-47. https://doi.org/10.1016/j.anifeedsci.2016.05.019

Zaheer, T., Ali, M., Abbas, R., Atta, K., Amjad, I., Suleman, A., … & Aqib, A. (2022). Insights into nanopesticides for ticks: the superbugs of livestock. Oxidative Medicine and Cellular Longevity, 2022, 1-18. https://doi.org/10.1155/2022/7411481

DOĞAL ANTİOKSİDANLARIN YEM KATKI MADDESİ OLARAK KULLANIMI

Dr. Mazhar Burak CAN (ORCID: 0000-0001-5248-1369)
Bayburt İl Tarım ve Orman Müdürlüğü, Hayvan Sağlığı Yetiştiriciliği ve Su Ürünleri Şube Müdürlüğü, Bayburt-Türkiye
Email: drmazharburakcan@gmail.com

ÖZET
Hayvan yemlerindeki antioksidanlar doğal ve sentetik olarak kategorize edilmektedir. Doğal antioksidanlar potansiyel sağlık faydaları ve hayvansal ürünlerin kalitesini artırma yetenekleri nedeniyle hayvan beslemede dikkat çekmiştir. Birçok çalışma doğal antioksidanların hayvan yemlerindeki olumlu etkilerini vurgulamıştır. Gıda muhafazasında sentetik antioksidanların kullanımı yaygın bir uygulama olmuştur, ancak gözlemlenen toksik etkiler nedeniyle gıda sistemlerinde doğal antioksidanların kullanımına yönelik artan bir eğilim vardır. Bu değişim sentetik antioksidan bileşiklerin toksik ve mutajenik etkiler gösterebileceğinin anlaşılmasıyla da desteklenmekte ve doğal antioksidanların önemini daha da vurgulamaktadır. Diğer yandan lipid stabilitesini, etin duyusal özelliklerini ve et ürünlerinin işlevselliğini artırmakla ilişkilendirilmektedirler. Doğal antioksidanlar et ürünlerinin oksidatif stabilitesini ve besin değerini artırarak hayvan beslemede önemli bir rol oynamasının yanı sıra antioksidan savunma sistemini geliştirdiği, serbest radikallerin ve toksik ürünlerinin zararlı etkilerini önlediği bildirilmiştir. Aynı zamanda çeşitli bitkisel ve hayvansal kaynaklı ürünlerden elde edilen doğal antioksidanlar reaktif serbest radikallerle etkileşime girerek oksidatif hasarın zararlı etkilerini nötralize ettiği ifade edilmektedir. Doğal yem katkı maddeleri olarak fenolik bileşiklerin takviyesinin kümes hayvanları ve domuzlarda antioksidan, bağışıklık, antimikrobiyal ve genel üretim performansını iyileştirdiği bildirilmiştir. Hayvan diyetlerinin fenolik bileşiklerle zenginleştirilmesi antioksidan kapasitenin yanı sıra anti-enflamatuar ve antimikrobiyal aktivite de dahil olmak üzere bağırsak sağlığı üzerinde faydalı etkileri olduğu tespit edilmiştir. Buna ek olarak hayvanların sağlığını, genel performansını iyileştirebilir ve ısı stresi, kötü barınma koşulları ve hastalıklar gibi çevresel strese karşı dirençlerini artırabilirler. Bu bulgular hayvan beslemede doğal antioksidan yem katkı maddelerinin sadece hayvanların refahı için değil aynı zamanda hayvansal kaynaklı ürünlerin kalitesi ve güvenliği için de öneminin altını çizmektedir. Bununla birlikte antioksidanları diyetlerine dâhil ederken doğal antioksidanların potansiyel sınırlamalarını ve farklı hayvan türlerinin özel gereksinimlerini göz önünde bulundurmak önemlidir. Bu nedenle, hayvan beslenmesinde doğal antioksidanların kullanılmasının genel amacı, hayvan sağlığını optimize etmek, üretim performansını iyileştirmek ve insan tüketimine yönelik hayvansal ürünlerin kalitesini arttırmaktır.
Anahtar Kelimeler: antioksidan, doğal, sentetik, ruminant, kanatlı

USE OF NATURAL ANTIOXIDANTS AS FEED ADDITIVES

ABSTRACT

Antioxidants in animal feed are categorized as natural and synthetic. Natural antioxidants have attracted attention in animal nutrition due to their potential health benefits and ability to improve the quality of animal products. Many studies have emphasized the positive effects of natural antioxidants in animal feed. The use of synthetic antioxidants in food preservation has been a common practice, but there is an increasing trend towards the use of natural antioxidants in food systems due to observed toxic effects. This shift is supported by the understanding that synthetic antioxidant compounds may exhibit toxic and mutagenic effects, further emphasizing the importance of natural antioxidants. On the other hand, they are associated with improving lipid stability, sensory properties of meat and functionality of meat products. Natural antioxidants have been reported to play an important role in animal nutrition by increasing the oxidative stability and nutritional value of meat products, as well as improving the antioxidant defense system and preventing the harmful effects of free radicals and toxic products. At the same time, natural antioxidants from various plant and animal derived products are reported to neutralize the harmful effects of oxidative damage by interacting with reactive free radicals. Supplementation of phenolic compounds as natural feed additives has been reported to improve antioxidant, immune, antimicrobial and overall production performance in poultry and pigs. Enrichment of animal diets with phenolic compounds has been found to have beneficial effects on gut health, including antioxidant capacity as well as anti-inflammatory and antimicrobial activity. In addition, they can improve the health and overall performance of animals and increase their resistance to environmental stresses such as heat stress, poor housing conditions and diseases. These findings underline the importance of natural antioxidant feed additives in animal nutrition, not only for animal welfare but also for the quality and safety of products of animal origin. However, it is important to consider the potential limitations of natural antioxidants and the specific requirements of different animal species when incorporating antioxidants into their diets. Therefore, the overall aim of using natural antioxidants in animal nutrition is to optimize animal health, improve production performance and enhance the quality of animal products for human consumption.

Keywords: antioxidant, natural, synthetic, ruminant, poultry

Giriş

Doğal antioksidanların birçoğu bitkilerden elde edilmektedir. Fitokimyasal antioksidanlar hücrelere zarar veren serbest radikallerle etkileşime girme ve bunları nötralize etme yeteneğine sahip, bitkilerde bulunan doğal bileşiklerdir. Bu antioksidanlar aktivitelerine, kimyasal yapılarına ve özelliklerine göre farklı kategorilerde sınıflandırılabilir. Farmasötik, nutrasötik ve kozmetik gibi çeşitli alanlardaki potansiyel faydaları için kapsamlı bir şekilde araştırılmaktadır (Marino ve ark., 2022). Fitokimyasal antioksidanların, özellikle de flavonoidlerin, yüksek antioksidan aktiviteye sahip oldukları ve gıda ürünlerinde sentetik antioksidanların yerine doğal katkı maddeleri olarak kullanılabilecekleri gösterilmiştir.

Doğal antioksidanlar oksidasyonu engellemek, hayvan sağlığını ve verimliliğini artırmak için hayvan yemlerinde giderek daha fazla kullanılmaktadır. Bu antioksidanlar meyveler, sebzeler, bitki özleri, deniz makro ve mikroalgleri gibi çeşitli kaynaklardan elde edilebilir (Wang ve ark., 2022). Vitaminler, polifenoller ve antosiyaninler gibi bu antioksidanların sağlığa faydalı çeşitli etkileri olduğu ve kardiyovasküler hastalıklar, nörodejeneratif hastalıklar ve kanser dahil olmak üzere oksidatif stresle ilişkili hastalıkların önlenmesine yardımcı olabileceği gösterilmiştir (López-Pedrouso ve ark., 2022). Doğal antioksidanlar aynı zamanda gıda endüstrisinde yağların, proteinlerin ve hücresel DNA'nın bozulmasını önlemek için kullanıldığında kokuşmaya, istenmeyen koku ve tatlara neden olabilir.

Doğal Antioksidanların Yem Katkı Maddesi Olarak Kullanılması

Doğal antioksidanlar hayvan sağlığı, performansı ve hayvansal kaynaklı ürünlerin kalitesi üzerinde bildirilen faydalı etkileri nedeniyle hayvan beslemede potansiyel yem katkı maddeleri olarak büyük ilgi görmüştür. Sentetik antioksidanlara ilişkin güvenlik endişeleri ve sınırlamalar nedeniyle, yenilebilir kaynaklardan elde edilen doğal antioksidanların hayvan diyetlerine dahil edilmesine yönelik artan bir ilgi vardır (Shahidi ve Ambigaipalan, 2015). Yoğunlaştırılmış tanenler gibi doğal antioksidanların kullanımı, hayvanların antioksidan durumunu iyileştirmek ve hayvansal ürünlerin oksidatif stabilitesini artırmak için araştırılmış ve sentetik antioksidanlara kıyasla daha güvenli bir alternatif sağlamıştır (Soldado ve ark., 2021).

Hayvan yemlerinde doğal antioksidanların kullanımı sadece ürün kalitesini artırmayı amaçlamaz, aynı zamanda hayvan sağlığını ve performansını iyileştirmeye de uzanır. Bu antioksidanların hayvanların çevresel stres faktörlerine karşı direncini artırdığı ve genel

performansı geliştirdiği gösterilmiştir, bu da hayvancılıkta oksidatif stresi azaltmada potansiyel bir rol oynadığını göstermektedir (Michalak ve ark., 2022). Ayrıca, hayvan yemlerinde doğal antioksidanların uygulanması, oksidatif stresi azaltmak ve etin besin değerini artırmak için önemli bir beslenme müdahalesi olarak kabul edilmekte ve tüketicinin güvenli ve sağlıklı gıda seçeneklerine yönelik artan tercihiyle uyumludur (Tadesse ve ark., 2022). Yağların ekşimesini önlemede ve yem stabilitesini korumada etkili oldukları bulunmuştur; bu da balık büyümesi, yem kullanımı, bağışıklık sistemi ve hastalık direnci üzerinde olumsuz etkilere yol açabilir (Taşbozan ve Erbaş, 2023).

Doğal antioksidanlar aynı zamanda hayvan üremesinde, özellikle spermanın korunması amacıyla kullanılmış olup, çeşitli hayvan türlerinde umut verici sonuçlar elde edilmiştir (Castro ve ark., 2022). Çiftlik hayvanlarında, antioksidan olarak bitkisel yem katkı maddelerinin (PFA), ürün kalitesi, oksidatif stabilite ve raf ömrü üzerinde sentetik antioksidan vitaminlerle karşılaştırılabilir düzeyde olumlu etkileri olduğu gösterilmiştir (Tsiplakou ve ark., 2021). Kanatlı hayvan beslenmesinde PFA'nın oksidatif stresi azaltmada, verimliliği artırmada ve hayvan diyetlerindeki sentetik antioksidan vitaminlerin kısmen veya tamamen yerini almada etkili olduğu bulunmuştur (Righi ve ark., 2021).

Doğal antioksidanlar oksidatif stresin vücut üzerindeki zararlı etkilerini önlemede çok önemli bir rol oynar. Bu antioksidanlar hem endojen hem de eksojen olarak elde edilebilir; E vitamini (tokoferoller), C vitamini (askorbik asit) gibi doğal kaynaklar ile timol ve karvakrol gibi bitki kaynaklı bileşikler önemli antioksidan aktiviteler gösterir (Karatepe ve Ekerbiçer, 2017; Yıldız ve Turan, 2021). E vitamini ve biberiye esansiyel yağı gibi hayvan yemlerinde antioksidan kullanımının kanatlı hayvanlarda performans ve lipid oksidasyonunun önlenmesi üzerinde olumlu etkileri olduğu gösterilmiştir (Corino ve Rossi, 2021; Çimrin ve Demirel, 2016). Bu hayvan sağlığını ve ürün kalitesini iyileştirmek için antioksidanların yem katkı maddesi olarak kullanılma potansiyelini vurgulamaktadır. Birçok çalışma, doğal antioksidanların hayvan yemlerindeki olumlu etkilerini vurgulamıştır. Örneğin, Jiang & Xiong (2016) bitki özütlerinin etin oksidatif stabilitesindeki koruyucu rolünü gözden geçirmiş ve doğal antioksidanların hayvan beslenmesine dahil edilmesinin potansiyel faydalarını vurgulamıştır. Bernardi ve ark. (2016), doğal antioksidanlarla ilişkili sağlık ve güvenlik avantajlarını yansıtarak, kimyasal değişikliklerin etkisini azaltmak ve et ürünlerinde oksidatif stabiliteyi teşvik

etmek için doğal antioksidanların kullanımına doğru kaymanın altını çizmiştir. Bitkilerden ve deniz yosunlarından elde edilen fenolik bitkilerin hayvan yemlerinde antioksidan olarak kullanılmasının hayvan sağlığı, performansı ve strese dayanıklılık üzerinde olumlu kalıcılığa sahip olabileceği belirtilmektedir (Hashemi ve Davoodi, 2011). Bu doğal antioksidanların hayvan yemlerine eklenmesi, geleneksel antioksidanların (sentetik) gıda matrisinde doğal antioksidanlarla değiştirilmesinin gıda endüstrisi için ana güçsüzlük olduğu vurgulanmaktadır (Valenzuela-Grijalva ve ark., 2017) . Ayrıca, hayvan beslenmesinde doğal antioksidanların kullanımı, hayvan refahını artırmanın sıra yanı sıra davranışları streslere karşı direnci artırıcı genel performanslarını olumlu yönde artıracağı vurgulanmaktadır (Frengova ve Бешкова, 2008) . Bu sentez, doğal antioksidanların hayvan beslenmesinde hayvan sağlığını, performansının ve üretim sonuçlarının üzerinde potansiyel bulunduğunu vurgulamaktadır. Araştırmalar, bitkilerden ve deniz yosunlarından elde edilen fenolik resimlerin hayvan yemlerinde antioksidan olarak varlığının hayvan performansını artırabileceğini ve üretimin sonsuza kadar iyileşebileceğini göstermektedir. Çalışmalar, hayvan diyetlerine antioksidanların dahil edilmesinin, vücudun antioksidan savunma sisteminin gelişimini ve korunmasını destekleyebileceğini, serbest radikallerin ve bunların yan ürünlerinin zararlı etkilerine karşı koruma sağlayabileceğini göstermiştir (Surai ve ark., 2019). Narenciye atığı, özellikle kabukları, yüksek antioksidan kapasitesiyle tanınmaktadır ve bu, gıda endüstrisinde doğal bir antioksidan kaynağı olarak kullanıldığında potansiyel sağlık yararlarına işaret etmektedir (Elkhatim ve diğerleri, 2018) . Dahası, doğal antioksidanların hayvan yemine entegre edilmesi yalnızca oksidatif stabiliteyi arttırmakla kalmaz, aynı zamanda hayvansal ürünlerin duyusal özelliklerini ve besin değerini de artırır (Salami ve ark., 2016) . Doğal antioksidanların hayvan beslenmesinde kullanımı, sağlık açısından fayda sağlama, raf ömrünü uzatma ve et ürünlerinin besin profilini geliştirme yeteneklerinden dolayı ilgi görmektedir (Chouikhi ve ark., 2023) . Bu doğal antioksidanların güçlü antioksidan ve biyolojik özelliklere sahip olduğu bulunmuştur, bu da onları fonksiyonel gıda ve nutrasötik sektörlerinde değerli kılmaktadır (Souli ve diğerleri, 2018).

Sonuç

Genel olarak araştırmalar hayvan sağlığını iyileştirmek, ürün kalitesini artırmak ve tüketicilerin güvenli ve doğal gıda seçeneklerine yönelik taleplerini karşılamak için

hayvan yemlerine doğal antioksidanların dahil edilmesine doğru bir kayma olduğunu göstermektedir. Hayvan beslemede doğal antioksidanların kullanımı, hayvan refahını teşvik etmek, üretim sonuçlarını iyileştirmek ve hayvansal kaynaklı ürünlerin kalite ve güvenliğini sağlamak için umut verici bir yol sunmaktadır.

Referanslar

1. Bernardi, D. M., Bertol, T. M., Pflanzer, S. B., Sgarbieri, V. C., & Pollonio, M. A. R. (2016). ω-3 in meat products: benefits and effects on lipid oxidative stability. Journal of the Science of Food and Agriculture, 96(8), 2620-2634.
2. Castro, C. D. S., Cotrim, C. F. C., Santos, I. R. D., Santos, K. J. G. D., Paula, J. A. M. D., Caramori, S. S., ... & Borges, L. L. (2022). Application of natural antioxidants in animal reproduction. Ciência Animal Brasileira, 23.
3. Chouikhi, A., Ktari, N., Slima, S., Trabelsi, I., Bendali, F., & Salah, R. (2023). Effects of a novel lin seed polysaccharide on beef sausage properties. Polymers, 15(4), 1014.
4. Corino, C., & Rossi, R. (2021). Antioxidants in animal nutrition. Antioxidants, 10(12), 1877.
5. Çimrin, T., & Demirel, M. (2016). The effects of dietary rosemary (Rosmarinus officinalis L.) essential oil supplementation on laying hen performance, egg quality and oxidative stability of egg.
6. Elkhatim, K., Elagib, R., & Hassan, A. (2018). Content of phenolic compounds and vitamin c and antioxidant activity in wasted parts of sudanese citrus fruits. Food Science & Nutrition, 6(5), 1214-1219.
7. Jiang, J., & Xiong, Y. L. (2016). Natural antioxidants as food and feed additives to promote health benefits and quality of meat products: A review. Meat science, 120, 107-117.
8. Frengova, G. and Бешкова, Д. (2008). Carotenoids from rhodotorula and phaffia: yeasts of biotechnological importance. Journal of Industrial Microbiology & Biotechnology, 36(2), 163-180.
9. Hashemi, S. and Davoodi, H. (2011). Herbal plants and their derivatives as growth and health promoters in animal nutrition. Veterinary Research Communications, 35(3), 169-180.
10. Karatepe, T. U., & Ekerbiçer, H. Ç. (2017). Gıda katkı maddeleri. Sakarya Tıp Dergisi, 7(4), 164-167.
11. López-Pedrouso, M., Lorenzo, J. M., & Franco, D. (2022). Advances in natural antioxidants for food improvement. Antioxidants, 11(9), 1825.

12. Marino, A., Battaglini, M., Moles, N., & Ciofani, G. (2022). Natural antioxidant compounds as potential pharmaceutical tools against neurodegenerative diseases. ACS omega, 7(30), 25974-25990.
13. Michalak, I., Tiwari, R., Dhawan, M., Alagawany, M., Farag, M., Sharun, K., … & Dhama, K. (2022). Antioxidant effects of seaweeds and their active compounds on animal health and production – a review. Veterinary Quarterly, 42(1), 48-67.
14. Righi, F., Pitino, R., Manuelian, C. L., Simoni, M., Quarantelli, A., De Marchi, M., & Tsiplakou, E. (2021). Plant feed additives as natural alternatives to the use of synthetic antioxidant vitamins on poultry performances, health, and oxidative status: A review of the literature in the last 20 years. Antioxidants, 10(5), 659.
15. Salami, S., Guinguina, A., Agboola, J., Omede, A., Agbonlahor, E., & Tayyab, U. (2016). Review: in vivo and postmortem effects of feed antioxidants in livestock: a review of the implications on authorization of antioxidant feed additives. Animal, 10(8), 1375-1390.
16. Shahidi, F. and Ambigaipalan, P. (2015). Phenolics and polyphenolics in foods, beverages and spices: antioxidant activity and health effects – a review. Journal of Functional Foods, 18, 820-897.
17. Soldado, D., Bessa, R., & Jerónimo, E. (2021). Condensed tannins as antioxidants in ruminants—effectiveness and action mechanisms to improve animal antioxidant status and oxidative stability of products. Animals, 11(11), 3243.
18. Souli, I., Jemni, M., Rodríguez-Verástegui, L., Chaira, N., Artés, F., & Ferchichi, A. (2018). Phenolic composition profiling of tunisian 10 varieties of common dates (phoenix dactylifera l.) at tamar stage using lc-esi-ms and antioxidant activity. Journal of Food Biochemistry, 42(6), e12634.
19. Surai, P., Kochish, I., Фисинин, B., & Juniper, D. (2019). Revisiting oxidative stress and the use of organic selenium in dairy cow nutrition. Animals, 9(7), 462.
20. Tadesse, D., Retta, N., Girma, M., Ndiwa, N., Dessie, T., Hanotte, O., … & Maak, S. (2022). In vitro antioxidant activities of plant polyphenol extracts and their combined effect with flaxseed on raw and cooked breast muscle fatty acid content, lipid health indices and oxidative stability in slow-growing sasso chickens. Foods, 12(1), 115.

21. Taşbozan, O., & Erbaş, C. Antioxidant Additives in Fish Feeds. Black Sea Journal of Agriculture, 6(3), 321-325.
22. Tsiplakou, E., Pitino, R., Manuelian, C. L., Simoni, M., Mitsiopoulou, C., De Marchi, M., & Righi, F. (2021). Plant feed additives as natural alternatives to the use of synthetic antioxidant vitamins in livestock animal products yield, quality, and oxidative status: A review. Antioxidants, 10(5), 780.
23. Valenzuela-Grijalva, N., Pinelli-Saavedra, A., Muhlia-Almazán, A., Domínguez-Díaz, D., & González-Ríos, H. (2017). Dietary inclusion effects of phytochemicals as growth promoters in animal production. Journal of Animal Science and Technology, 59(1).
24. Yıldız, Ş., & Turan, S. (2021). Timokinon, Timol ve Karvakrolün Antioksidan Aktiviteleri ve Lipit Oksidasyonunu Önleme Kapasiteleri. Atatürk Üniversitesi Ziraat Fakültesi Dergisi, 52(1), 108-118.
25. Wang, J., Si, W., Du, Z., Zhang, J., & Xue, M. (2022). Antioxidants in Animal Feed. Antioxidants, 11(9), 1760.

TÜRKİYE'DE TARIMSAL EĞİTİM VE YAYIM FAALİYETLERİ ILE ÇİFTÇİ EĞİTİM VE YAYIM FAALİYETLERİNDE TARIM VE ORMAN BAKANLIĞININ ROLÜ

Ferit YILDIZ (ORCID: 0009-0002-0139-3398)
Van İl Tarım ve Orman Müdürlüğü, İskele Cd. No:224, 65040 Tuşba/Van-Türkiye
Email: feritydz65@hotmail.com

Dr. Öğr. Üyesi Serhat YILDIZ* (ORCID: 0000-0003-1063-4704)
Van Yüzüncü Yıl Üniversitesi, Gevaş MYO, Veterinerlik Bölümü, Gevaş/Van- Türkiye
Email: syildiz@yyu.edu.tr

ÖZET
Bilgi edinme, eskiden beri insanlığın vazgeçemediği tutkulardan biri olmuştur. Bilimde meydana gelen gelişmelerle birlikte teknolojik gelişmenin de ilerlemesiyle, birçok sektörde verim artışı meydana gelmiş, bu da ekonomik gelişmeyi beraberinde getirmiştir. Benzer bir şekilde tarım sektöründe de teknolojik gelişme, ekonomik gelişmeyi hızlandıran en önemli etmenlerden biri olmuştur. Bu gelişmelerin tarım sektörde faaliyet gösteren çiftçilere aktarılmasında, eğitim ve yayım faaliyetlerinin önemi büyüktür. Çiftçi eğitim ve yayım faaliyetleri ile çiftçilerin bilgi, beceri ve gelirlerinin artırılması mümkün olacak, böylece ürün kalitesi ve standartlarının yükseltilmesi sağlanarak, tarımsal üretimin verimli ve sürdürülebilir hale getirilmesi amaçlanmıştır. Bu faaliyetlerin tüm paydaşların katılımı, görüş ve önerilerinin alınması suretiyle, çiftçi ihtiyaçlarına hitap eden, uygulamaya dayalı, bölgesel farklıkları dikkate alacak şekilde ve yerinde, en uygun sürede yapılması gerekmektedir. Bu bağlamda ilgili kurum ve kuruluşlarla eğitim ve yayım konularında iş birliği protokolleri hazırlanarak hayata geçirilmesi önem arz etmektedir. Bu çalışmada genel olarak; Türkiye'de tarımsal eğitim ve yayım konuları ile birlikte bunların önemi, tarımsal eğitimi ve yayım faaliyetlerinin ilgili paydaşlara etkileri, bu faaliyetleri veren kurum ve kuruluşların durumları ve sektöre katkıları ile Tarım ve Orman Bakanlığının rolü üzerinde durulmuştur.
Anahtar Kelimeler: Çiftçi, Tarımsal eğitim ve yayım, Tarım ve Orman Bakanlığı

THE ROLE OF THE MINISTRY OF AGRICULTURE AND FORESTRY IN AGRICULTURAL TRAINING AND EXTENSION ACTIVITIES AND FARMER TRAINING AND EXTENSION ACTIVITIES IN TURKEY

ABSTRACT

Acquiring knowledge has been one of the passions that humanity has been unable to give up since ancient times. With the advancement of technological development along with the developments in science, productivity has increased in many sectors, which has brought about economic development. Similarly, technological development in the agricultural sector has been one of the most important factors accelerating economic development. Training and publication activities are of great importance in transferring these developments to farmers operating in the agricultural sector. It is aimed to increase the knowledge, skills and income of farmers through farmer training and extension activities, thus making agricultural production efficient and sustainable by increasing product quality and standards. These activities must be carried out in a manner that addresses farmer needs, is practice-based, takes into account regional differences, and is on-site and in the most appropriate time, with the participation of all stakeholders and taking their opinions and suggestions. In this context, it is important to prepare and implement cooperation protocols on training and publication with relevant institutions and organizations. In this study generally; Agricultural education and extension issues in Turkey, as well as their importance, the effects of agricultural education and extension activities on the relevant stakeholders, the status of the institutions and organizations providing these activities and their contributions to the sector, and the role of the Ministry of Agriculture and Forestry are emphasized.

Keywords: Farmer, Agricultural education and extension, Ministry of Agriculture and Forestry

1. Giriş

Bir ülkenin kalkınmasını sağlayan en önemli itici güçlerden biri insan faktörüdür. Tüm dünyada, insanlar için yapılan, eğitim ve eğitim yatırımlarının önemi iyice artmaya başlamış ve ülkelerin kalkınması ile arasındaki ilişki giderek netleşmiştir. Kişinin yaşamdaki yerini alabilmesi, yeteneklerinin ve ilgi alanlarının saptanması ve uygulamaların bu yönde yapılmasını, ancak doğru ve sistemli bir şekilde verilen eğitim sağlamaktadır. Eğitimin, işgücünün beceri ve üretkenlik kapasitesini arttırdığı, böylece milli gelirin artmasına katkıda bulunduğu bildirilmektedir. Kalkınmanın gerçekleştirilmesi için ihtiyaç duyulan insan gücünün yetiştirilmesi, geliştirilmesi ve fertlerin üretici haline getirilmesi hedeflendiğinde, bu hedeflere ulaşmanın aracının eğitim olduğu ifade edilmektedir. Ayrıca, yoksulluğun azaltılmasında, gıda güvenliğinin yükseltilmesinde, kırsal istihdamın arttırılmasında da gerekli olduğu bildirilmektedir. Ülkeler arasında görülen tarımsal verimlilik farklılıklarının ortaya çıkışında, eğitim düzeyinin önemli bir etken olduğu görülmektedir. Çiftçilerin eğitim seviyelerinin artmasına paralel olarak, çiftçilerin tarımsal etkinliklerinin ve modern tarım yöntemleri kullanan çiftçilerin sayısının arttığı saptanmıştır (Taş & Yenilmez, 2008; Kılıç & Kıymaz, 2014).

Tarımsal eğitim programları, hayat boyu öğrenme, mesleki eğitim gibi temel konuları ele alarak geliştirilmiş olması ve tarımsal üretimin sürdürülebilirliğinin sağlanması, tarım alanlarında kalifiye eleman ihtiyacının ve tarımsal hizmet kalitesinin arttırılması açısından önemli olduğu ifade edilmektedir. İşgücü verimliliği ile eğitim arasında da bir ilişkinin olduğu, ayrıca kırsaldaki işgücünde göç ile bir azalmanın meydana geldiği, bunun sonucunda da tarımsal işgücü verimliliğinde düşüşe yol açtığı bildirilmektedir. Kırsalda yeni iş olanakları sağlayacak tarımsal yatırımların desteklenmesi ile birlikte, kırsalda kalan işgücünün eğitim olanaklarının arttırılması ve meslek edindirmeye yönlendirilmesi ile tarımsal gelir artışı sağlanmış olacaktır (Kılıç & Kıymaz, 2014).

Türkiye'de çiftçi eğitimleri, genel olarak Tarım ve Orman Bakanlığının ve bu bakanlığa bağlı Tarım ve Orman il ve ilçe müdürlüklerinin sorumluluğu altında uygulanmaktadır. Ayrıca üniversitelere bağlı Ziraat ve Veteriner Fakülteleri ile bakanlığa bağlı araştırma enstitüleri, diğer bazı bakanlıklar ve kuruluşlar kısmi olarak çiftçi eğitimi yapmaktadır. Bazı durumlarda belediyelerin de, tarımsal eğitim ve yayım çalışmaları yaptıkları görülmektedir. Bunlara ilave olarak, Milli Eğitim Bakanlığı'na bağlı tarım meslek

liselerinde, tarımsal eğitimler verilmekte ve halk eğitim merkezlerinde de çiftçi eğitim kursları düzenlenmektedir. Bu kurumların tüm çabalarına rağmen, çiftçi eğitiminde yeterli başarının sağlanamadığı ve etkin çalışılamadığı, tarımsal faaliyetlerde yanlış uygulamaların yapıldığı bildirilmektedir. Sadece kırsal alanda değil, aynı zamanda şehir merkezinde ve merkeze çok yakın yerleşim yerlerinde bile, çok yanlış uygulamaların yapıldığı görülmektedir. Türkiye'de tarım sektörünün gelişmesi ve rekabet edilebilirliğin arttırılması açısından, çiftçi eğitim faaliyetlerinin etkin bir şekilde uygulanmasının oldukça önemli olduğu ifade edilmektedir. AB'ye uyum sürecinde, özellikle tarım alanında, tarımsal gelişmeyi hızlandıracak çiftçi eğitimi faaliyetlerinin, etkin bir şekilde yapılmasına yönelik her türlü çalışma desteklenmelidir (Sezgin ve ark., 2008; Yıldız ve ark., 2019).

Türkiye'de kırsal alanda yaşayan insanların birçoğu, eğitim ve gelir seviyesinin düşüklüğü, sınırlı arazi kaynakları ile geçimini tarımdan sağlamaya çalışmaktadırlar. Tarımda sınırlı üretim kaynaklarının maksimum düzeyde değerlendirilmesi sayesinde, bu insanların yaşam standartlarının yükseltilmesi, daha iyi bir hayat düzeyinin yakalanması açısından önemlidir. Bu noktadan konuya yaklaşıldığında ülkemizde çiftçi eğitim ve yayım faaliyetleri ile bu faaliyetlerle ilgili birimlerin yaklaşımları, özellikle Tarım ve Orman Bakanlığı'nın bu konudaki rolü başta olmak üzere, ülkemizde çiftçilerin tarımsal konularda bilgi düzeylerinin ortaya konulması ve bu alandaki eğitim sorunlarının saptanarak çözüm yöntemlerinin geliştirilmesi ve önerilerde bulunulması amacıyla bu çalışma yapılmıştır.

2. Tarımsal Eğitimin Önemi

Sanayileşmiş toplumlarda eğitim, bir yandan toplumsal anlamda bireylerin çeşitli rol ve beceriler kazanmasını, diğer yandan da yeniden üretimi teşvik etmektedir. Toplumsal yaşamın gereklerine uygun, ekonomik ihtiyaçlar doğrultusunda eğitilmiş insana duyulan gereksinim, eğitime verilen önemi artırmaktadır. Genel olarak toplumların gelişmişlik düzeyi, eğitilmiş insan potansiyeline bağlı olarak değerlendirilebilmekte ve eğitim, çağdaş toplumların seviyesine ulaşmada en önemli araçlardan biri olarak kabul görmektedir. Bundan dolayı eğitim, uzun zamandan beri Türkiye'de üzerinde en fazla tartışılan konuların başında gelmektedir. Günümüzde bilgilenme sürecini, yalnızca okullarla sınırlı düşünmeyip, tüm yaşamı kapsayacak biçimde ele alınması gerekmektedir. Eğitim kurumları yalnızca okul sistemini kapsamakla kalmayıp aynı

zamanda, toplumdaki diğer kurumlarla da ilişki içinde olmalıdır. Gelişmiş ülkelerde yaşanan yapısal dönüşümün temelini eğitim, bilim ve teknolojideki ilerlemelerin oluşturduğu unutulmamalıdır (İçli, 2001; Pıçak, 2009).

Kırsal alanlar, insanların yaşamasını sağlayan kaynakların bulunduğu ve üretildiği yerler olmasının yanında, geleneksel yapının korunduğu, örf, adet ve geleneklerin devam ettiği yerler olarak karşımıza çıkmaktadır. Bu alanlarda yapılan gelişigüzel, bölgeye ve kültürüne aykırı yatırım ve projelerle birlikte, kırsal alanlarda yapılan bazı işlemler neticesinde, çeşitli sorunlar meydana gelmektedir. Kırsal kesimdeki yaşam kalitesi, kentlerle karşılaştırılmayacak kadar düşük seviyededir. Ülke nüfusunun kırsal ve kent arasında daha dengeli dağılmasının sağlanmasıyla, kırsal nüfusun refah seviyesinin asgari ülke ortalaması seviyesinde korunmasıyla olacaktır. Bunun için kilit önemdeki temel altyapı ve hizmetlerin sunulması, mali ve teknik kapasitelerinin güçlendirilmesi gerekmektedir. Kırsal yerleşimlerin temel altyapı gereksinimlerine ilave olarak, temel kamusal hizmetler, mahalli müşterek nitelikli gündelik hizmetler ve kırsal ekonominin temelini oluşturan tarımsal hizmetlerin de iyileştirilmesi önem arz etmektedir (Anonim, 2021).

Tarımsal konularda yapılan tüm çalışmalar, parasal harcamalar, zaman ve emeklerin amacı, tarım kesiminin kalkınmasına ve ülke ekonomisinin gelişmesine katkı sağlamaktır. Tarım eğitimi ve yayımı, yetiştiriciler ve bilimsel araştırma kurumları ile bağlantı sağlamaktadır. Teknolojik yeniliklerin üreticiler tarafından kullanılmasının sağlanması ve oluşan problemlerin de zamanında araştırma kuruluşlarına iletilmesiyle, çözüm odaklı çalışılmaktadır. Eski zamanlardan beri tarım alanında yaşanan gelişmeler, teknolojik yeniliklerin çiftçiler tarafından benimsenmesi sayesinde olmuştur. Birim alandan ve birim hayvandan alınan verimin artmasıyla, toplam üretimin de arttığı görülmüştür. Bunun daha da ileriye taşınması, ülke koşullarına ve ihtiyaçlarına uygun etkili bir yayım ve eğitimi sisteminin kurulması ile sağlanmış olacaktır (Küçükçongar ve ark 2015; Özçatalbaş ve ark., 2015). Bravo-Ureta & Pinheiro (1993) yaptıkları bir çalışmada, farklı saha araştırmalarına dayanarak, çeşitli değişkenlerin kullanıldığı, çiftlik bazında yapılan, etkinlik değerlendirmelerinde, çiftçilerin eğitimi ve tecrübesi ile yayım hizmetlerine ulaşımı gibi etkenlerin önemli olduğu ve bu değişkenlerin teknik etkinliğe anlamlı şekilde olumlu katkı sağladığı bildirilmektedir.

Kırsal kalkınmada en önemli faktörlerden birisi olan, kırsal nüfusun gelişmesinde en önemli araçlardan biri eğitimdir. İnsanların bireysel yetenekleri beşeri sermaye; dayanışma ve işbirliği içinde olmaları ise sosyal sermaye olarak nitelendirilmektedir. İnsan kaynaklarının geliştirilmesi de beşeri ve sosyal sermaye gibi eğitim yoluyla olmaktadır. Almanya ile Türkiye'nin her konudaki gelişmişlik farkı, her iki ülke insanlarının eğitimleri arasındaki farktan kaynaklanmış olduğu, eğitim düzeyinin gelişmişlik üzerine etkisine örnek olarak verilebilir. Bu durum ülke çiftçilerinin eğitime olan ihtiyacının ne kadar fazla olduğunu açıkça göstermektedir. Tarımsal eğitim ve yayımın amacı, çiftçilerin yeni bilgi ve becerilerini arttırarak, daha iyi yaşam seviyesine ulaştırmaktır. Ayrıca, yetişkinlere verilecek eğitim, bir mesleğin öğretilmesinin yanında, bireyin toplumsallaşmasına yönelik diğer eğitim gereksinimlerini de kapsamaktadır (Celep,1995; Yurttaş, 2006).

3. Türkiye'de Tarımsal Eğitim ve Öğretim Kurumlarının Mevcut Durumları

Tarım sektöründe ekonomik gelişmeyi destekleyen en önemli etmenlerden biri teknolojik gelişmedir. Ayrıca, eğitim ve öğretimin önemini, gelişmiş ülkelerin tarım alanında ulaştıkları bilgi düzeyini ve birikimlerini, diğer gelişmemiş ülkeleri bağımlı hale getirecek şekilde kullanmaları, daha da arttırmaktadır. Kırsal kesimde yaşayan nüfusun, yaşadığı yerlerde tutulması, her şeyden önce yaşam düzeylerinin iyi bir duruma getirilmesi gerekmektedir. Bunun için, tarımsal eğitim ve öğretim faaliyetleri yeterli imkanlarla ve etkin bir şekilde uygulanmalıdır. Bu alanda belirlenen projelerin gerekli şekilde uygulanabilmesini ve kalkınma planlarında belirlenen, tarımsal hedeflerin yakalanabilmesini sağlayacak nitelikli insan gücünün gerekliliği tartışılmaz bir gerçektir. Ayrıca, akademik düzeyde çalışma yapabilecek düzeyde insan gücü yetiştirmesinde de tarımsal eğitim ve öğretim politikalarının önemi bulunmaktadır. Temelde tarımsal eğitim ve öğretimi; ilkokuldan sonra başlayıp üniversiteye kadar süren eğitim ve öğretim ile yetişkinlerin eğitimi olmak üzere iki grupta incelemek mümkündür. Geçmişten günümüze kadar tarımsal eğitim ve öğretimle ilgili birçok çalışma yapılmıştır. Bunlar sırasıyla incelendiğinde; ilkokul sonrası tarımsal öğretim kurumları olan, Teknik Ziraat Ortaokulları ve Teknik Bahçıvanlık Okulları, ilkokula dayalı olarak öğretim yapmış ve bu okullar amaçlanan yararları sağlamadığı gerekçesiyle kapatılmıştır. Benzer bir şekilde, ortaokul sonrası tarımsal öğretim kurumlarından olan Bölge Ziraat Okulları, Tarım Meslek Lisesi ve Ev Ekonomisi Meslek Liseleri ile Veteriner Sağlık Meslek Lisesi ve

Laborant Meslek Liseleri gibi okullar günümüze kadar değişikliklere uğrasa da, hizmet vermişlerdir (Demirtaş & Gürler, 1994).

İstanbul Ayamama Çiftliği'nde, 1846 yılında Ziraat Mektebi'nin açılması, Türkiye'de tarımsal eğitim ve öğretimin başlangıcı olarak kabul edilmektedir. Bunu, 1891 yılında Bursa'da ve 1893 yılında İstanbul Halkalı'da açılan Yüksek Ziraat Mektepleri izlemiştir. Cumhuriyetten sonra ise Ziraat Meslek Liseleri ve Ev Ekonomisi Meslek Liseleri açılmış, 1928 yılında Halkalı Yüksek Ziraat Mektebi ile birlikte, birçok ziraat okulu kapatılmıştır (Sönmez & Öztaş, 2000).

Tarımsal alandaki yükseköğretim kurumlarından olan Ziraat Fakülteleri, Türkiye'nin ihtiyacı olan Ziraat Mühendislerinin yetiştirilmesi için kurulmuştur. Ayrıca, başta Veteriner Fakültesi olmak üzere, Orman Fakültesi ve Gıda Mühendisliği Fakültesi de tarımın farklı alanlarıyla ilgili eğitim-öğretim ve araştırma yapmak için kurulmuşlardır. Bunların yanında tarımsal konularda çalışabilecek ve teknik eleman yetiştirmek üzere kurulan Meslek Yüksek Okulları da diğer yükseköğretim kurumlan arasında yer almaktadır (Demirtaş & Gürler, 1994). İlk olarak, 1930 yılında Ankara Ziraat Yüksek Okulu'nun açılması ile Fakülte seviyesinde eğitim-öğretime başlanmış, sonraki yıllarda Ziraat ve Ev Ekonomisi Meslek liselerinden mezun olan teknisyenler ile Ziraat Yüksek Okulu'ndan mezun olan ziraat mühendisleri, tarımsal gelişmenin teknik mimarları olarak kabul edilmektedir. 1933 yılında, Ankara Ziraat Yüksek Okulu, Ankara Ziraat Enstitüsü olarak ve bu enstitünün adı 1948 yılında Ankara Üniversitesi Ziraat Fakültesi olarak değiştirilmiştir. Daha sonraki yıllarda, çeşitli üniversitelerde tarımla ilgili birçok fakülte açılarak bu alanda birçok ilerleme kaydedilmiştir (Sönmez & Öztaş, 2000).

Türkiye'de tarımsal eğitim ve öğretim kurumlarının faaliyetlerine ilave olarak özellikle yetişkin eğitimine katkı sağlayan, başta Tarım ve Orman Bakanlığına bağlı birimler, bazı illerde faaliyet gösteren Yaygın Eğitim Kurumları (Tarımsal Mekanizasyon Eğitim Merkezleri, Çiftçi Eğitim Merkezleri ve Değişik Araştırma Merkezleri, El Sanatları Eğitim Merkezleri, Dericilik Araştırma Eğitim Enstitüsü, Ders Araç ve Gereçleri Makina Eğitim Merkezi Müdürlüğü, Tarım ve Orman Bakanlığı İl Müdürlüğü Çiftçi Eğitim ve Yayım Şube Müdürlükleri), tarafından çeşitli demonstrasyonlar, tarla günleri ve kurslar düzenlenmektedir. Bunların yanında ortak paydaşlarla yapılan toplantı, seminer ve paneller ile birlikte, doğrudan çiftçi eğitimi ile birlikte yasal yetkiler çerçevesinde birçok eğitim-öğretim faaliyetlerini de yürütmektedirler (Demirtaş & Gürler, 1994). Bunlara

ilave olarak, Halk Eğitim Merkezleri, bir kamu kurumu olarak, yetişkin eğitimi ve yaşam boyu öğrenme uygulamalarını yerine getiren kurumlardan biridir. Milli Eğitim Bakanlığına bağlı olarak kurulmuş olan kurumda, genel, mesleki ve teknik ile okuma-yazma olmak üzere üç temel kategoride kurslar verilmektedir. Yetişkinlerin eğitimleri, yaşam boyu öğrenmeye bağlı şekilde, yetişkinlerin bilgi ve becerilerini sürekli yenilemeleri sağlanmaktadır. Halk Eğitimi Merkezlerinden talep edilen ve bölgenin şartları dikkate alınarak gerekli kurslar planlanmaktadır. Merkezlerde çiftçilerin tarımsal konularda kendilerini geliştirebilmeleri açısından çeşitli kurslar düzenlenmektedir (Kaya, 2015). Bunların yanında, 2016 yılında hizmete başlayan ve DAP Bölge Kalkınma İdaresi tarafından desteklenen, Van Yüzüncü Yıl Üniversitesi, Atatürk Üniversitesi ve Fırat Üniversiteleri bünyesinde faaliyet gösteren, çiftçi eğitim merkezlerinde de tarımsal konularda çiftçilere ve çiftçilik yapmak isteyenlere eğitimler verilmektedir (Yıldız ve ark., 2019).

4. Tarım ve Orman Bakanlığı'nın Çiftçi Eğitimine Yönelik Çalışmaları

Kırsalda yaşayan işgücünün tarımsal gelir artışının sağlanması için, kırsalda yeni işlerin ve tarımsal girişimlerin desteklenmesi yanında, meslek edindirmeye yönlendirecek eğitim olanaklarından daha fazla faydalandırılması gerekmektedir (Kılıç & Kıymaz, 2014). Bu girişimleri desteklemek için, Tarım ve Orman Bakanlığı'nın görevleri ve yetkileri arasında yer alan; eğitim faaliyetini yapma veya yaptırma, çiftçi eğitimi, tarımsal yayım ve danışmanlık hizmetlerini yürütme gibi faaliyetlerden yararlanılmaktadır. Bu yetki ve sorumluluk, 30474 sayılı Resmi Gazete'de yayınlanan 1 No'lu Cumhurbaşkanlığı Kararnamesi ile düzenlenmiştir. Bakanlığın organizasyon yapısı içerisinde eğitim faaliyetlerinde bulunmak üzere, Eğitim Yayım ve Yayınlar Dairesi Başkanlığı ile taşra birimlerinde Eğitim Merkezi Müdürlükleri bulunmaktadır. Bu birimler Bakanlığın görev alanına giren konularda hem hizmet içi hem de çiftçilerle ilgili her türlü eğitim faaliyetini yapmak veya yaptırmakla yükümlüdürler. Bakanlığın yüklendiği amaçlar doğrultusunda, sunulan eğitim-yayım ve danışmanlık faaliyetleri sonucunda, çiftçilerin bilgi düzeylerinde artma meydana gelecek ve böylece, kaliteli üretim ve birim alandan daha fazla verim alınması sağlanmış olacaktır. Ayrıca tarımsal yeniliklerin yaygınlaştırılması çalışmaları ile çiftçi, araştırmacı ve yayımcı arasında işbirliği sağlanarak, yeniliklerin çiftçiye ulaşması ve çiftçi problemlerinin çözümü yoluna gidilmesi planlanmaktadır (Anonim, 2022).

Tarım ve Orman Bakanlığı, çiftçi eğitimi ve yayım faaliyetleriyle ilgili yürüttüğü birçok çalışmada, çiftçilerin karşılaştıkları sorunların çözümüne yardımcı olacak yeteneklerin kazandırılmasını amaçlayan, tarımsal eğitim ve yayım faaliyetlerinin tamamını kapsamaktadır. Tarım ve Orman Bakanlığı, İl Yayım Programı çerçevesinde yapılan çiftçi eğitimi ve yayım faaliyetleri kapsamında, tüm paydaşlarla bir araya gelerek, illerde yaşanan tarımsal sorunların nedenleri ortaya konulmakta, analiz sonuçlarına göre eğitim ve yayım faaliyetleri planlanıp, il yayım programları oluşturmaktadır. Bu yayım programları kapsamında çiftçiler için, inceleme gezileri, teşvik müsabakaları, sergiler, konferanslar, paneller, kurslar, toplantılar, demonstrasyonlar ve tarla günleri düzenlenmektedir. Yapılan çalışmaların çiftçilere ulaşması için, kitle yayım materyalleri üretilmektedir (Anonim, 2023).

Türkiye'de 2021 yılında gerçekleşen il eğitim ve yayım faaliyetleri içerisinde düzenlenen 25.913 faaliyete (çiftçi inceleme gezileri, teşvik müsabakaları, sergiler, konferanslar, paneller ve diğer benzeri faaliyetler) toplam 365.234 kişi; 1.224 çiftçi kursuna toplam 308.027 kişi; 36.548 çiftçi toplantılarına toplam 791.994 kişi; 1.757 demonstrasyonlara toplam 20.752 kişi; 319 tarla günlerine toplam 14.862 kişi katılmıştır. Tarımsal yeniliklerin yaygınlaştırılması ve benimsetilmesi amacıyla, 2012-2021 yılları arasında, 42 araştırma enstitüsü ve 76 il müdürlüğünün iş birliği ile 167 proje hazırlanıp yürütülmüştür. Tarımsal yeniliklerin yaygınlaştırılması yayım projeleri kapsamında 1002 faaliyete (açılış tanıtım toplantısı, demonstrasyon, tarla günü, çiftçi toplantısı, inceleme gezisi, işletme ziyareti, fuar, hizmet içi eğitimler, kapanış değerlendirme toplantıları, basılı ve görüntülü yayınlar) katılan 5344 çiftçiye, 18.755 adet basılı ve görüntülü yayın dağıtılmıştır. Yine, enstitü uzmanları, il yayım personelleri, üniversiteler ve ilgili sektör paydaşlarının bir araya gelmesiyle, toplamda 2048 katılımcıya ulaşan bölge grup toplantıları düzenlenmiştir (Anonim, 2023).

Bakanlığa ait, 2018 yılından itibaren tarımsal yayım projeleri kapsamında, üretim miktar ve kalitesinde artışın hedeflendiği, iller için önemli tarımsal konularda projeler hazırlanmaya ve uygulanmaya başlanmıştır. Bunun için, 2018-2021 yılları arasında, araştırma enstitüleri ve il müdürlükleri iş birliği ile toplam 45 adet Tarımsal Yayım Projesi kapsamında, çeşitli faaliyetler yürütülmüştür. Bu projelerde, 392 yayım faaliyetine 1959 kişi katılmış, 6609 adet çeşitli basılı ve görüntülü yayın çiftçilerle paylaşılmıştır. Çiftçilere hazırlanan iki farklı uygulamalı modüler eğitim programı ile 26

ilde 73 eğitim gerçekleştirilmiş, 1.329 çiftçiye sertifika verilmiştir. Bu kapsamda, ilgili kurum ve kuruluşlara inceleme gezileri düzenlenerek, 554 çiftçi konu uzmanları tarafından bilgilendirilmiştir. Bu eğitimlerle ilgili 9.586 adet yayım materyalleri çoğaltılarak çiftçilere dağıtılmıştır (Anonim, 2023).

Süt arzında yer alan çiftçiler ve diğer üretim sürecinde yer alan kişilere yönelik başta Bakanlık Stratejik Planı doğrultusunda ve gıda güvenilirliği kapsamında olmak üzere eğitimler verilmiştir. Millî Eğitim Bakanlığı iş birliği ile hazırlanan 2021 yılında, süt ve sağım hijyeni konulu çiftçi eğitimlerinde 62 eğitime, 1049 katılım gerçekleşmiştir (Anonim, 2023).

Tarım ve Orman Bakanlığına bağlı Eğitim ve Yayın Dairesi Başkanlığı ile Türkiye İş Kurumu Genel Müdürlüğü ve Türkiye Ziraat Odaları Birliği arasında oluşturulan protokol 2013 yılından itibaren uygulanmaktadır. Temelde kırsal göçün önlenmesi amaçlanan projede, çiftçilik yapan kişiler bu eğitimlere dahil edilmiş, eğitimlerde Millî Eğitim Bakanlığı, modüler eğitim paketleri kullanılmıştır. 2021 yılında yapılan 519 kursa 11.997 kursiyer katılmış ve katılım belgesi verilmiştir. Sürü Yönetimi Projesi kapsamında ise, 2021 yılında yapılan 159 kursa katılan 4.033 kursiyere katılım belgesi verilmiştir (Anonim, 2023).

Tarım ve Orman İl Müdürlükleri, kooperatif yöneticileri ve ortakları olan çiftçilere, kooperatifçilik ve bunlarla ilgili konu ve diğer mevzuat ile ilgili tarımsal konularda eğitimler verilmektedir. Kooperatifçilik yayım faaliyetleri ile 2021 yılında yapılan 170 faaliyete 4.563 kişi, düzenlenen 3 adet çiftçi kursuna 54 kişi ve 310 adet çiftçi toplantısına 10.238 kişi katılmıştır. Gerçekleştirilen bu faaliyetlerle tarımsal amaçlı kooperatifçilik konusunda ilerleme kaydedilmiş ve eğitim verilen çiftçilerin bilinçlenmelerine katkı sağlanmıştır. Bakanlık çiftçi eğitimi ve yayım faaliyetlerini yapmak amacıyla, çeşitli kurum ve kuruluşlarla birçok alanda işbirliği protokolleri imzalamıştır (Anonim, 2023).

Bakanlık tarafından, "Kırsalda Kadın ve Aile Hizmetleri" adı altında, başta tarımsal ve sosyal konularda eğitim ve yayım hizmetleri ile birlikte, kadınların ve ailenin desteklenmesine yönelik birçok çalışma yürütülmüştür. Bunlardan bazıları;

- 2003 yılından bugüne kadar kırsalda, 203 bin faaliyetle 2,3 milyon kadın çiftçiye, farklı tarımsal ve sosyal konularda eğitimler verilmiştir.

- 2004 yılından bugüne kadar kooperatif bulunan yerlerde, 11.000'in üzerinde toplantıda 74.000'in üzerinde kadın çiftçiye, kooperatifçilik konularında eğitimler verilmiştir.
- 2000 yılından itibaren yürütülen, "Kadın Çiftçiler Tarımsal Yayım Projesi" çalışmaların ana çatısını oluşturmaktadır. Bugüne kadar illerde proje kapsamında, kadın çiftçilere tarımsal eğitimler verilmektedir.

Bu programlarla yürütülen eğitimler kapsamında bu güne kadar yaklaşık 8.500 kadın çiftçi eğitim almıştır. Kadın ve aileye yönelik faaliyetler kapsamında, diğer kurum ve kuruluşlarla yürütülen daha birçok çalışma bulunmaktadır (Anonim, 2023).

Sever (2020), tarafından Tarım ve Orman Bakanlığından bir yetkiliyle yapılan bir söyleşide, Bakanlık Eğitim ve Yayın Dairesi Başkanlığının bilginin çiftçilere ve yetiştiricilere yüz yüze ya da uzaktan aktarıldığı bildirilmiştir. Başkanlık tarafından, bakanlığın 2019-2023 Stratejik Planı hedeflerine uygun olarak, çiftçilere bilgi ulaştırmada aracılık ederek, önemli bir misyon gerçekleştirilmiştir. Tarımsal eğitimler, Milli Eğitim Bakanlığı ile iş birliği yapılarak, çiftçi eğitim kursları şeklinde, yayım faaliyetleri ise daha çok projelerle uygulanmıştır. Tüm bu eğitim ve yayım faaliyetleri ile yılda ortalama 1,5 milyon kişiye tarımsal konularla ilgili eğitim ve yayım çalışması uygulanmıştır. Çocuklara yönelik olarak "Hayatın merkezinde tarım, tarımın merkezinde çocuk" ilkesinden yola çıkarak, 2010 yılında, Lider Çocuk Tarım Kampı Projesi, hayata geçirilmiştir. Bu proje, 2014 yılından itibaren Eğitim ve Yayın Dairesi Başkanlığı Koordinasyonunda, 81 İl Müdürlüğünde de uygulanmaya başlanmıştır. Bakanlığa ait "Tarım Bülteni" ve "Türk Tarım Orman Dergisi" isminde iki adet süreli yayını da bulunmaktadır. Ayrıca "Web Tarım TV" adında internetten yayın yapan bir televizyon kanalı da vardır. Bu platformlar üzerinden, bakanlığın yaptığı birçok çalışma yayınlanmaktadır. Bugüne kadar tarım, orman, su, gıda vb. çeşitli konularda 1000'in üzerinde eğitim filmi çekilmiştir. Bu filmler çeşitli kanallar üzerinden yayınlanmaktadır. Bu konuda tarım ve orman bakanlığının ayrıca Tarım TV'nin çiftçilerin eğitimi için birçok programı ve eğitimleri bulunmaktadır. Tarım TV'de yayınlanan çiftçi programlarına örnek olarak;

- Tarım Orman gündemi,
- Tarım gündem,
- Tarım özel,

- Başak ve Kozalak,
- IPARD programları,
- Tarımda kadın eli,
- İllerden gelenler,
- Tarım reçetesi,
- Yaşayan pazarlar, verilebilir.

Tarım ve Orman Bakanlığı'nda verilen çiftçi eğitimleri, Tarım Akademisi adı altında çiftçilere web üzerinden çeşitli eğitimler de sunmaktadır. Bunlardan bazıları;

- Hayvansal üretim (Büyükbaş, Küçükbaş, kanatlı ve arıcılık vb.),
- Bitkisel üretim (Meyve ve sebze yetiştiriciliği, Hububat ve yem bitkileri yetiştiriciliği, Çayır ve mera yönetimi vb),
- Toprak, gübreleme ve sulama,
- Gıda, beslenme ve tüketici bilinci,
- Tarımsal finans ve pazarlama,
- Su ürünleri,
- Tarımsal çevre ve sürdürülebilirlik,
- Tarım teknolojileri ve tarımsal yapılar,
- Doğa ve orman,
- Tarımda iş sağlığı ve iş güvenliği,
- Zirai mücadele.

5. Sonuç ve Öneriler

- Yapılan değerlendirmelerde, Türkiye'de çiftçilere yönelik tarımsal eğitim ve yayım hizmetlerinin, çiftçilerin modern tarımsal üretimi gerçekleştirebilecek düzeye çıkarılması gerektiği,
- Tarım ve Orman Bakanlığı, üniversiteler, Milli Eğitim Bakanlığı ve diğer bazı kurumların tüm çabalarına rağmen çiftçilere yönelik verilen, hem teorik hem de uygulama eğitimlerinin, tüm çiftçiler göz önüne alındığında, yetersiz kaldığı,
- Bu süreç de göstermektedir ki, Türkiye'de çiftçilerin tarımsal açıdan kendi kendilerine yeterli olma kabiliyetlerinin geliştirilmesini destekleyen oturmuş ve sürekliliği olan düzenlemelerin geliştirilesi gerektiği,

- Türkiye'de tarımsal eğitim ve yayım çalışmalarını etkin bir şekilde uygulanabilmesi açısından, uyum içinde çalışan bir organizasyonun kurulması gerektiği,
- Farklı zamanlarda değişik uygulamalar hakim olsa da, tarımın gelişme doğrultusu ve üreticilerin ihtiyaçlarının esas alınması ve uzun dönemde istikrarlı ve birbirini destekleyen bir yapının kurulası gerektiği,
- Mevcut yapının çok yönlü, farklı disiplinleri de kapsayacak şekilde ele alınarak, ilgili bakanlıklar ve kuruluşların işbirliğiyle iyileştirilebileceği ve bu şekilde eğitim ve yayımın hedeflerine uygun sonuçların alınabilmesinin mümkün olacağı tespit edilmiştir.
- Tarımsal eğitim ve yayım faaliyetlerinin geliştirilmesi, düzenlenmesi ve sürdürülebilir hale getirilmesi sayesinde, çiftçilerin daha iyi yetişebilmesine olanak tanınmış olacaktır.

Tarım sektöründe tarımsal eğitime ve yayıma olan ihtiyaç gelecekte daha da artacağı tahmin edilmektedir. Dünya ve ülkemizin birçok yerinde tarım sektörünün, yaşanan değişimlere ayak uydurması ve gelişmesi beklenmektedir. Bu bağlamda;

- Sınırlı tarım arazisi varlığı ve yetersiz kaynaklar ile tarımsal üretimin ve kalitenin artırılabilmesi adına, çiftçilerin alanlarında uzmanlaşmış olmaları ve daha verimli tarımsal faaliyet ortaya koymaları,
- Son yıllarda tarımsal eğitim ve yayım çalışmalarında, üreticilerin gereksinim duyduğu eğitim ve yayım ihtiyaçlarının daha gerçekçi bir şekilde belirlendiği, bunun da izlenecek tarımsal eğitim ve yayım programlarında etkinliği artıracağı,
- Özellikle eğitim ve yayım çalışmalarında farklı kurumlarla birlikte, sivil toplum örgütlerinin de görev almasının ve bölgesel planlamaların yapılmasının, merkezi planlamaya göre daha başarılı sonuçlar sağlayacağı beklenmektedir.

Teşekkür ve Bilgi Notu

Bu çalışma, Zir. Müh. Ferit YILDIZ'ın aynı isimli Yüksek Lisans seminerinden özetlenmiştir.

Kaynakça

Anonim, (2021). Ulusal Kırsal Kalkınma Stratejisi (2021 - 2023). https:// www.tarimorman.gov.tr/Duyuru/1372/Ulusal-Kirsal-Kalkinma-Stratejisi-_2021-2023_-Yayimlanmistir Erişim Tarihi: 01.06.2023

Anonim, (2022). 2019-2023 Stratejik Plan (Güncellenmiş Versiyon) Tarım ve Orman Bakanlığı. https://www.tarimorman.gov.tr/SGB/Duyuru/100/Bakanligimiz-2019-2023-Stratejik-Plani-_guncellenmis-Versiyon_-_2022_-Yayimlanmistir Erişim Tarihi: 01.06.2023

Anonim, (2023). 2021 Yılı Çiftçi Eğitim ve Yayım Faaliyetleri Raporu. https://www.tarimorman.gov.tr/Konular/Egitim-Ve-Yayim/Ciftci-Egitimi-Calismalari. Erişim Tarihi: 19.09.2023

Bravo-Ureta, B. E. & Pinheiro, A. (1993). Efficiency analysis of developing country agriculture: a review of the frontier function literature, Agricultural and Resource Economics Review 22 (1), http://purl.umn.edu/31643 Erişim Tarihi: 01.08.2014

Case, L. & Whitaker, K. (1998). What are the goals and purposes of agricultural education?, *The Agricultural Education Magazine,* 71(3), http://www.cals.ncsu.edu/agexed/leap/aee500 /case.htm Erişim Tarihi: 30.07.2014

Celep, C. (1995). Halk Eğitimi. Pegem Yayın No:22. 2.Baskı. ISBN: 975-7251-14-3.Ankara. 134s.

Demirtaş, M. & Gürler, A. Z. (1994). Türkiye'de Tarımsal Eğitim ve Öğretimin Gelişimi, Sorunları ve Çözüm Önerileri. file:///C:/Users/AU%C3%87M/Downloads/483-489%20(1).pdf Erişim Tarihi: 01.06.2023

İçli, G. (2001). Eğitim, İstihdam ve Teknoloji. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi,* 2001, 9, 65-71

Kaya, H. E. (2015). Türkiye'de Halk Eğitimi Merkezleri. International Journal of Science Culture and Sport (IntJSCS). Special Issue 3. 268-277. Doi: 10.14486/IJSCS289

Kılıç, Y. & Kıymaz, T. (2014). Tarımda Eğitim ve İşgücü Verimliliği İlişkisi: Bölgesel Farklılıklar. *Tarım Ekonomisi Dergisi*; 20(1): 53-64

Küçükçongar, M., Kan, M., Özdemir, F., Demirtaş, M. N., Okur, O. (2015). KOP Bölgesinde Tarımsal Eğitim ve Yayım İhtiyaç Analizi- chrome-extension:// efaidnbmnnnibpcajpcglclefindmkaj/http://www.kop.gov.tr/upload/dokumanlar/20.pdf). Erişim Tarihi: 19.02.2024

Lindley, W. I., Van Crowder, L., Doron, N. (1996). Education in agriculture: links with development in Africa, Agricultural Extension and Education Service (SDRE) FAO Research, Extension and Training Division. http://www.fao.org/sd/exdirect/exan0008.htm Erişim Tarihi: 30.07.2014

Özçatalbaş, O., Budak, D. B., BOZ, İ., Demiryürek, K., Boyacı, M., Karaturhan, B. (2015). Türkiye'de Tarımsal Eğitim ve Yayım İlişkisi. Türkiye IX. Tarım Ekonomisi Kongresi, Şanlıurfa.

Pıçak, M. (2009). Eğitim Düzeyi Açısından Türkiye İşgücü Yapısındaki Değişimler. *Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi Dergisi,* 13, 166-182

Sever, C. Y. (2020). Bilgiyi çiftçiye aktarmada önemli bir misyonumuz var. Söyleşi. http://www.turktarim.gov.tr/Haber/523/bilgiyi-ciftciye-aktarmada-onemli-bir-misyonumuz-var- Erişim Tarihi: 01.09.2023

Sezgin, A., Yurttaş, Z. & Yavuz, F. (2008). Erzurum İlinde Uygulanan Hayvancılığa Yönelik Çiftçi Eğitimi Projelerinin Karşılaştırmalı Analizi. *Tarım Ekonomisi Dergisi;* 14(2): 75-85

Sönmez, K. & Öztaş, T. (2000). Türkiye'de Tarımsal Öğretim ve Sorunları. *Atatürk Üniv. Ziraat Fak. Derg.* 31. Özel Sayı, 5-8.

Taş, U. & Yenilmez, F. (2008). Türkiye'de Eğitimin Kalkınma Üzerindeki Rolü ve Eğitim Yatırımlarının Geri Dönüş Oranı. Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi, 9(1); 155-186

Than, M. K. (2011). A Study of Literature Reviews on Farmer Education and Farm Efficiency Yangon University of Distance Education Research Journal, 3(1), http://www.yude.edu.mm/demos/Journals/V3N1-15eco.pdf Erişim Tarihi: 30.07.2014

TÜİK (2019). Gelir ve Yaşam Koşulları Araştırması. https://data.tuik.gov.tr/Bulten/Index?p=Income-and-Living-Conditions-Survey-2019-33820 Erişim Tarihi: 28.09.2023

TÜİK, (2021). İşgücü İstatistikleri. https://data.tuik.gov.tr/Bulten/Index?p=Isgucu-Istatistikleri-Aralik-2021-45642#:~:text=%C4%B0stihdam%20edilenlerin%20say%C4%B1s%C4%B1%202021%20y%C4%B1l%C4%B1,ile%20%47%2C0%20oldu. Erişim Tarihi: 28.09.2023

Yıldız, S., Akkol, S., Deniz, S. (2019). Van Yüzüncü Yıl Üniversitesi DAP Çiftçi Eğitim Merkezi'nde Eğitim Alan Kursiyerlerin Tarımsal Okuryazarlık Kapasitelerinin Değerlendirilmesi. *YYÜ Fen Bilimleri Enstitüsü Dergisi*, Cilt 24, Sayı 2, 133-141

Yurttaş, Z. (2000). Tarımsal Yayım ve Haberleşme, Atatürk Üniversitesi Ziraat Fakültesi Yayınları No:67, Erzurum, 105s.

THE USE OF ROBOTS IN POULTRY PRODUCTION

Bratislav PEŠIĆ (ORCID: 0000-0002-5356-1499)
Toplicka Academy, Department of Agricultural and Food Studies in Prokuplje, Serbia
Email: batta.pesic@gmail.com

Nikola STOLIC
Toplicka Academy, Department of Agricultural and Food Studies in Prokuplje, Serbia
Email: nikola.stolic@gmail.com

Nebojsa ZLATKOVIĆ
Toplicka Academy, Department of Agricultural and Food Studies in Prokuplje, Serbia
Email: nebojsa.zlatkovic79@gmail.com

Aleksandra JEVTIC
Toplicka Academy, Department of Agricultural and Food Studies in Prokuplje, Serbia
Email: aleksandrajevtic76@gmail.com

ABSTRACT
Robots are playing increasingly important roles in poultry farms. Improving production efficiency increases food safety, improves animal health and well-being, and contributes to better working conditions and well-being on farms. The basic functions of these robots, depending on the model, are either for cleaning and disinfection of poultry facilities or for turning over and aerating the mat. But these robots are also modular allowing users to transform them into several different versions with the ability to perform different tasks. Beyond their core functions, robots are equipped to collect, analyze and store data—from sensors, cameras and other systems—that can improve record-keeping and traceability on farms. They continuously measure ambient factors, such as temperature, air humidity, carbon dioxide and ammonia, warning the farmer about potential problems in a timely manner. The greatest importance of the use of robots in poultry farming is reflected in the control of the health condition of poultry, especially where new epidemics of bird flu, frequent zoonotic diseases, the development of drug-resistant organisms, etc. are constantly breaking out. whereby robots act quickly and effectively during disease outbreaks. By reducing human contact with birds, eliminating human error and performing tasks more efficiently, robots become an invaluable instrument in this ongoing battle.
Keywords: robots, poultry, farm, welfare

Introduction

Historically speaking, the use of machines and robots in agriculture does not represent a completely new idea and solution to the high demand for agricultural goods. The modern revolution in agriculture began in 1752, and the main reason for its emergence was the replacement of manual work with machine work. More precisely, the modern agricultural revolution began when large numbers of people began to lose their jobs and move out of rural areas in search of manufacturing jobs. The first machine used in agriculture was called Eli Witney's cotton-gyn and it had the ability to isolate seeds from cotton bolls and process an extraordinary 22-23 kilograms of cotton fiber in a single day, equivalent to hundreds of manual labor hours. Eli Witney's cotton-gyn is the first machine that opened up the possibility of applying modern machines and robots in agriculture [10]. Robotics in general, including robotics in agriculture, began its development in the 20th century and is experiencing rapid modernization along with other technology today. Although it currently brings a strong inflow of capital to the European market, which is measured in billions of euros annually, digitization is taking place more slowly than expected. Such a pace cost too much: it is estimated that for this reason Europe was losing 600 billion euros on an annual basis. One of the sectors in which this is, unfortunately, particularly true, is agriculture at a time when it is facing historical challenges [1]. In just one century, the world's population grew from one to seven billion people. In order to provide enough food for all the inhabitants of our planet, by 2050, the production of food and raw materials will have to be increased by 70%. There are almost no new arable areas. In the second half of the last century, due to the widespread use of mechanization and agrochemistry, as well as methods of genetic engineering, the yield per arable hectare increased several times. However, with the growing population and the demands placed on not only the quantity but also the quality of food, this is not enough. The only solution to the challenges facing society is to try to raise animals and crops in a smart and precise way. The IT sector is currently mature enough to make agricultural production more efficient.

Agriculture is one of the oldest industrial branches, and industrial revolutions and the development of techniques and technology caused by them have always had a huge impact on its development and progress. The main benefits of the digital transformation of agriculture are sustainability, knowledge and efficiency [2]. The digital transformation

of agriculture makes it significantly easier for farmers to overcome the three main challenges that arise during a single production cycle. The first challenge arises during the planning of agricultural production and involves providing adequate input data on soil quality and actual crop needs. Digitization of this part of the process facilitates the planning itself and enables the optimal and precise calculation of all the necessary input data for the season. Farmers face another challenge during the growing and maturing phase, which is related to making decisions about protection measures, watering and promoting crop growth. Digitization in this part of the process enables data-based decision-making and enables the achievement of economic and environmental sustainability through optimal use of pesticides, fertilizers and water [3]. The third challenge appears during the sale of agricultural products. As in the case of the previous ones, overcoming this challenge is facilitated by the digitization of a more accurate digital platform for sales and customer management that allows to adequately connect customers and farmers, which gives farmers a significant opportunity to better manage their sales, to better understand the needs of customers and to achieve adequate prices for their products [4]. The main difference between agricultural production and other economic branches is that success in agriculture is significantly determined by climatic conditions and soil quality. Climatic conditions are very difficult to predict, and even more difficult to prevent, which is why the role of robots, which are increasingly used in agriculture and animal husbandry, is more important.

Digitization of livestock production

Considering their degree of efficiency and autonomy, robots are increasingly considered and used as a valuable tool in the cultivation of agricultural land in modern agriculture. The most common name for these robots is agribot or agbot. In the simplest terms, agribots help farmers increase the efficiency of crop production and reduce the need for the physical involvement of seasonal workers and workers in general [5].

Also, there is the possibility of connecting agribots with wireless sensor networks and drones, which enables the collection of a huge amount of information or data such as physiological parameters, determining the presence of diseases in plants, yield estimation and the like. It is reasonable to assume that in the next generations, service jobs will animals, processing, sowing, harvesting and many other agricultural works taken over completely by agribots. Technological development in the design and production of

agricultural machinery was aimed at making it rational, cheap, energy-saving and environmentally friendly. Despite this, it was not available as an investment for the majority of our agricultural producers. Over time, mechanization in agriculture and its unprofessional or incorrect application began to condition and reflect on the product, in terms of poor quality, and above all in growth, carrying capacity and quality. As a response to such phenomena, and as one of the possible solutions, is the application of robots and digitization of equipment.

Like all other economic activities, agriculture today faces the problems of price competitiveness at the global level, which creates constant pressure to reduce operating costs. Price is the main thing that determines the position of farmers in the competitive market, and for this reason, all farmers strive to reduce their operating costs. By introducing robots in agriculture, difficulties such as the lack of physical workers can be overcome because the jobs are often extremely demanding. Since agribots perform work precisely and are programmed to efficiently perform tasks that are time and energy demanding for physical workers, their use is an effective solution.

There are several different types of agribots, where new technical solutions are constantly being developed, but in practical application, the mentioned 7 models have been singled out, which perform the following functions: 1) Precision agriculture. Robots in precision agriculture use modern technology such as sensors, satellite monitoring, remote reading, drones, GIS software, etc. [9]. These robots help in monitoring metabolic processes, such as photosynthesis activity and all other biological aspects; 2) Pollution monitoring. The function of these machines is to calculate emissions of pollutants as well as greenhouse gases (carbon dioxide, methane and nitrogen oxides) to help farmers reduce their negative impact on the environment; 3) Farming of domestic animals. This technology is intended for keeping domestic animals on huge ranches. These agribots also play an active role in monitoring animals, checking their health and availability of grazing space; 4) Weed control. Agribots designed to control weeds can navigate autonomously and spray herbicides at targeted points to avoid or eliminate weeds, which reduces crop exposure to heavy herbicides and helps prevent the growth of herbicide-resistant weeds; 5) Milking cows: Robots can completely replace human activity and successfully milk cows several times a day; 6) Harvesting fruits: Harvesting is a difficult task even for agricultural robots. However, the robots are equipped with an advanced monitoring system, due to which

they can identify the fruits and harvest them without harming the plant; 7) Sowing and planting: This is the most developed application at the moment. Agribots with advanced three-dimensional monitoring systems are now able to plant and sow crops, enabling successful plant growth and development.

Agribots can also be programmed so that with the sensors they have, they can precisely position and move through the rows of plants. By doing so, they collect information that they automatically send to farmers in the form of reports with information that improves seed cultivation, such as the state of growth, the presence of parasites, and the like.

As already mentioned, the use of robots and machines in agriculture enables automation and easier maintenance of production, which is why it is believed that robots will completely replace the ordinary farmer in the future, but not without the factor of human control. Namely, there is no possibility of complete automation of the farm, so the need for farmers, farm managers and agronomists will not disappear. In the simplest terms, it is not possible to exclude the human factor when making decisions, but on the other hand, some agricultural tasks are better adapted and left to machines [6].

The use of robots in poultry production

Robots are playing a bigger and more important role in poultry farms. By improving production efficiency, they increase food safety, improve the health and well-being of animals, and contribute to better working conditions and well-being on farms. The basic functions of these robots, depending on the model, are either for cleaning and disinfection of poultry facilities or for turning over and aerating the mat. But these robots are also modular allowing users to transform them into several different versions with the ability to perform different tasks. In addition to their basic functions, robots are equipped to collect, analyze and store data - sensors, cameras and other systems - that can improve record keeping and traceability on farms [7]. They continuously measure ambient factors, such as temperature, humidity air, carbon dioxide and ammonia, timely warn the farmer about potential problems. The greatest importance of the use of robots in poultry farming is reflected in the control of the health status of poultry, especially where new epidemics of bird flu, frequent zoonotic diseases, the development of drug-resistant organisms, etc. are constantly breaking out. whereby robots act quickly and effectively during disease outbreaks [8]. By reducing human contact with birds, eliminating human error, and

performing tasks more efficiently, robots are becoming an invaluable instrument in this ongoing battle.

Conclusion

During the twentieth century, a revolution took place in agriculture, with the massive development of the agricultural machinery and tools industry. The focus was on the development of mechanics and elements outside buildings, while at the end of the twentieth and in the twenty-first century, the focus shifted to the development of equipment inside buildings, by introducing smart technologies into the process of modernizing agricultural production. Today, almost all the world's manufacturers of agricultural machinery and equipment have smart agricultural devices in their product line, and air conditioning, computer, GPS guidance and the like have become standard supporting equipment in the production process. In this text, we looked at non-standard, smart machines, which with their appearance and specifications seem as if they arrived from the distant future, but in fact are widely used on farms and fields around the world. It is important to note that this solution is currently not economically profitable in all countries of the world, as well as that there are shortcomings and doubts when it comes to the introduction of robotics in agriculture. For example, this kind of implementation of robotics is an expensive process and significantly increases the complexity of the farm, which creates the risk of even greater damage in the case of inadequate and unprofessional staff. For this reason, farm employees must have adequate knowledge in the field of technology.

Since the introduction of robotics in agriculture replaces a certain percentage of human labor and the need for hiring physical workers with machines, it is considered that the above is not ethically correct because with the introduction of robotics, farmers massively lose their jobs due to the cessation of the need for their engagement, which is a problem for poor agricultural countries .

Overall, it can be concluded that robotics in agriculture has a wide range of potential that is worth exploiting, but that it will never completely replace the human hand. It is undeniable that this type of technology will spread over time to the whole world and it is in our hands to make smart use of its possibilities.

References

1. Barras, K., Brito, L. (2017). Introduction to the Internet of Things, in Hassan, Q.F. (ed.), Internet of Things: Challenges, Advances, and Applications, CRC Press, Boca Raton.
2. Digital World. Digitization of agriculture in Serbia [Internet]. White City; Digital world; 2019 [cited 2022-12-12]. Available at: https://digitalnisvet.rs/-digitalizacija-poljoprivrede-u-srbiji/
3. IEC (2014). Internet of Things - Wireless Sensor Networks, White paper, Geneva
4. Ristić, Z., Džafić, G., Jevremović, M., Damnjano-vić, A. (2020). New technologies - challenges for companies and sustainable economic development, Ecologica 27(99), 401-406.
5. Radić, V., Radić, N. (2021). Application of unmanned aerial vehicles in environmental monitoring, Ecologica 28(104), 426-434.
6. Shepherd M, Turner JA, Small B, Wheeler, D. Priorities for science to overcome hurdles thwarting the full promise of the 'digital agriculture' revolution. Journal of the Science of Food and Agriculture, Vol 100, Iss 14, pp. 5083 – 5092, 2018.
7. Weltzien C. Digital agriculture – or why agriculture 4.0 still offers only modest returns. Landtechnik 71 (2), pp. 66–68, 2016.
8. https://www.frontiersin.org/articles/10.3389/fpls.2022.1064219/full
9. https://www.agrifarming.in/agricultural-robots-advantages-automation-history-future#Agricultural_Robots
10. https://www.automate.org/blogs/robotics-in-agriculture-types-and-applications

KÜÇÜK ÖLÇEKLİ AİLE İŞLETMESİ YAPISINDAKİ AKKARAMAN KOYUN SÜRÜLERİNDE BAZI VERİM ÖZELLİKLERİ

Başak ÖZTEN (ORCID: 0009-0001-0396-2278)
Yozgat Bozok Üniversitesi, Lisansüstü Eğitim Enstitüsü, Yozgat, Türkiye
Email: basaknozten@gmail.com

Dr. Öğr. Üyesi Hacer TÜFEKCİ* (ORCID: 0000-0003-2272-4088)
Yozgat Bozok Üniversitesi, Ziraat Fakültesi, Zootekni Bölümü, Yozgat-Türkiye
Email: hacer.tufekci@bozok.edu.tr

ÖZET
Türkiye'de koyun yetiştiriciliği önemli sosyal ve kültürel rolleri de olan özel bir yere sahiptir. Aynı zamanda koyunlardan elde edilen ürünler ekonomik bir üretim kolu özelliğindedir. Koyun, verimsiz meraların, kısa boylu bitkilerin, anız alanlarının ve bitkisel üretime uygun olmayan arazilerin, et ve süt gibi gıda maddelerine, yapağı ve deri gibi yaşam malzemelerine dönüştürebilme yeteneği yüksek olan çiftlik hayvanlarındandır. Ülkemizde, özellikle yerli ırkların hastalıklara karşı dirençli olması, bakım ve beslemesinin kolay olması da koyunun tercih edilme nedenleri arasındadır. Türkiye'de koyun yetiştiriciliğinde üretim sistemleri, yetiştiriciliğin yapıldığı bölgenin coğrafi şartları, sosyo-ekonomik yapısı, koyun yetiştiricilerinin bilgisi ve tarımsal altyapıya bağlı olarak değişmektedir. Bu çalışma küçük ölçekli aile işletmesi yapısındaki Akkaraman koyun sürülerinde bazı verim özelliklerini incelemek amacıyla yapılmıştır. Koyunların döl verim özelliklerinin belirlenmesi amacıyla doğum, tekiz doğum, ikiz doğum, bir doğumdaki kuzu sayısı ve kuzuların büyüme özelliklerinin belirlenmesi için doğum ağırlığı ve sütten kesin dönemi canlı ağırlığına ait veriler kullanılmıştır. Koyunlara ait döl verim özelliklerinden kuzulama oranı %94.8; tek doğum oranı %79.5; ikiz doğum oranı %25.5 ve doğuran koyun başına düşen kuzu sayısı 1.20 olarak hesaplanmıştır.
Anahtar Kelimeler: Akkaraman, döl verimi, koyun, kuzu

SOME PRODUCTIVITY CHARACTERISTICS OF AKKARAMAN SHEEP FLOCKS IN THE SMALLHOLDER FAMILY FARM STRUCTURE

ABSTRACT

Sheep breeding in Türkiye has a special place with important social and cultural roles. At the same time, products obtained from sheep are an economical production line. Sheep are farm animals with a high ability to transform infertile pastures, short plants, stubble areas and lands not suitable for plant production into foodstuffs such as meat and milk, and living materials such as fleece and leather. In our country, the fact that especially local breeds are resistant to diseases and that they are easy to care for and feed are among the reasons why sheep are preferred. Production systems in sheep breeding in Türkiye vary depending on the geographical conditions, socio-economic structure, knowledge of sheep breeders and agricultural infrastructure of the region where the breeding takes place. This study was carried out to examine some productivity characteristics of Akkaraman sheep flocks, which are smallholder family farm. In order to determine the fertility characteristics of the sheep, data on birth weight and live weight at the final weaning period were used to determine the birth, singleton birth, twin birth, the number of lambs in one birth and the growth characteristics of the lambs. According to the fertility characteristics of the sheep, the lambing rate is 94.8%; single birth rate 79.5%; The twin birth rate was calculated as 25.5% and the number of lambs per ewe was calculated as 1.20.

Keywords: Akkaraman, reproduction, sheep, lamb

Giriş

Yüzyıllardan bu yana Anadolu'da koyun, son derece zahmetsiz bir şekilde yetiştirilmesi nedeni ile özellikle kırsal alanlarda yaşayan halk tarafından büyük oranda benimsenmiştir. Ülkemiz koyun yetiştiriciliğine uygun bir coğrafyaya ve kültürel geçmişe sahiptir. Ancak geçtiğimiz dönemlerde birçok nedenden dolayı kırsal alanlarda yürütülen koyunculuk eski niteliğini yitirmiş ve koyun sayısı da hızlı bir şekilde gerilemeye başlamıştır. Buna ek olarak yerli gen kaynaklarından bir uzaklaşma meydana gelmiş ve aslında son derece başarılı olarak yetiştirilebilecek yerli koyunlar, yerini hızlı bir şekilde yabancı gen kaynaklarına bırakmıştır. Ülkemizde son yıllarda, hayvancılık konusunda yoğun olarak verilen teşvik ve destekler ile pazarda koyun eti ve sütüne olan talebin yeteri kadar karşılanamaması, bu ürünlerin pazar fiyatlarını artırmış dolayısı ile günümüzde koyun yetiştiriciliği cazip bir hale gelmiştir (Darcan, 2014). Türkiye koyun yetiştiriciliği bakımından dünyanın sayılı ülkelerinden biridir (Bingöl ve Aygün, 2013).

Küçükbaş hayvan üretimi dünya çapında önemli bir sosyo-ekonomik ve çevresel role sahiptir (Simões ve ark., 2021). Küçükbaş hayvanlarda ekstansif üretim sistemleri dünyanın birçok farklı yerinde yürütülmektedir ve genellikle hayvan başına ve yüzey alanı başına düşük verimlilik ile karakterize edilen, mahsul üretimi için uygun olmayan esasen marjinal alanlar kullanılır. Bu üretim kolu yerel sosyo-ekonomik faaliyetleri olumlu yönde etkiler, kırsal toplulukların korunmasında, ekosistemlerde ve kuzu eti veya peynir gibi benzersiz, değerli gıdaların üretiminde önemli bir rol oynamaktadır (de Rancourt ve ark., 2006; Bertolozzi-Caredio ve ark., 2021; Teixeira ve ark., 2020). Bununla birlikte, bu tür sistemler, esas olarak çok az işgücü mevcudiyeti olduğu ve geleneksel olarak düşük üretkenliğe ve genellikle zayıf ekonomik uygulanabilirliğe sahip oldukları için önemli bir baskı altındadır (Bertolozzi-Caredio ve ark., 2021; Wishart, 2019).

Koyunculukta en önemli kazanç kuzu üretiminden sağlanmaktadır (Snowder, 2002; Süß ve ark., 2004). Döl verimi, sürü büyüklüğünün devamı hayvansal besin maddelerinin temini, ayıklama ve seleksiyonun etkili bir şekilde yapılması yönlerinden önem taşımaktadır. Döl verimi; hayvan yetiştirme terimi olup, bir gebelik döneminde anaç dişilerden elde edilen yavru sayısı veya oranı olarak ifade edilmektedir. Döl verimine; genotip, canlı ağırlık, damızlıkta kullanma yaşı gibi faktörler ile bakım ve beslenme, sıcaklık, gün uzunluğu gibi çevresel birçok faktör etkilidir. Koyunlarda döl verimi

açısından önemli olan konu, genelde koç altı koyun ya da doğuran koyun başına elde edilen kuzu sayısı ile bir koyundan damızlık sürecinde elde edilecek toplam kuzu sayısıdır (Kaymakçı 2006).

Materyal ve Metod

Araştırmanın hayvan materyalini, Çorum ili merkeze bağlı üç farklı işletmede bulunan 175 baş Akkaraman koyunu ve 200 baş Akkaraman kuzuları oluşturmuştur. Araştırma 2022 yılında yapılmış olup, çalışma süresince koyunların döl verim özelliklerinin belirlenmesi amacıyla doğum, tekiz doğum, ikiz doğum, bir doğumdaki kuzu sayısı kayıtları tutulmuştur. Ayrıca kuzuların büyüme özelliklerinin belirlenmesi amacıyla doğum ağırlığı ve sütten kesim ağırlığı alınmıştır. Döl verim özelliklerine ait veriler Kaymakçı (2006)'nın bildirdiği yöntemlere göre hesaplanmıştır. İşletmelerde meraya dayalı olarak yetiştiricilik yapılmakta olup, bakım besleme koşullarına herhangi bir müdahale yapılmamıştır. Sürülerde koç katımı 15 Eylül-15 Ekim tarihleri arasında serbest sıfat yöntemi ile yapılmıştır. Kuzulamalar Şubat-Mart aylarında gerçekleşmiştir ve doğan kuzuların, ilk 24 saat içinde doğum ağırlıkları, doğum tarihi, doğum şekli ve cinsiyetleri kaydedilmiştir. Elde edilen veriler SPSS İstatistik Paket Programı kullanılarak analiz edilmiştir (SPSS, 2016).

Bulgular ve Tartışma

Çalışmada elde edilen Akkaraman koyun sürülerinde bazı döl verim özellikleri Tablo 1'de sunulmuştur. Çalışma süresince kuzulama oranı %94.8, tek doğum oranı %79.5, ikiz doğum oranı %20.5 ve bir doğumda ortalama kuzu sayısı 1.20 olarak bulunmuştur.

Tablo 1. Akkaraman koyun sürülerinde bazı döl verim özellikleri

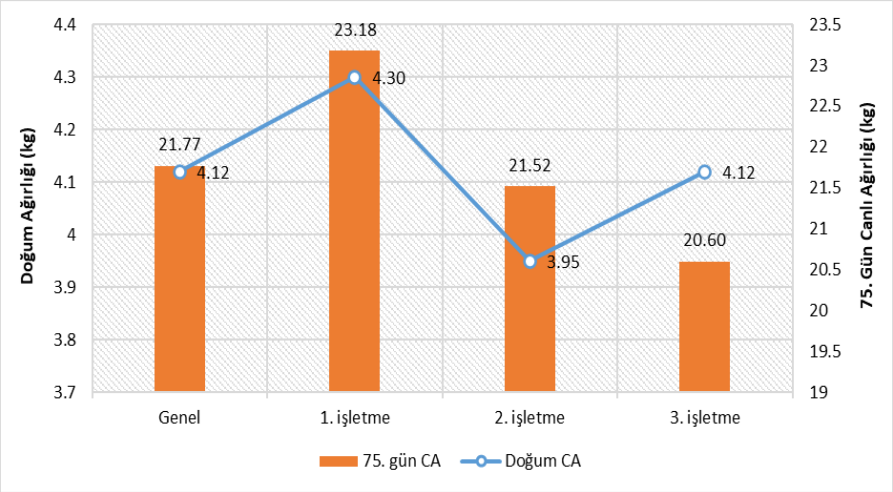
İşletme	Koç Altı Koyun Sayısı	Doğuran Koyun Sayısı	Tek Doğuran Koyun Sayısı	İkiz Doğuran Koyun Sayısı	Toplam Doğan Kuzu Sayısı	Kuzulama Oranı %	Tek Doğum Oranı %	İkiz Doğum Oranı %	Bir Doğumda Ortalama Kuzu Sayısı
1.	51	48	38	10	58	94.1	79.2	20.8	1.21
2.	60	58	46	12	70	96.6	79.3	20.7	1.20
3.	64	60	48	12	72	93.7	80.0	20.0	1.20
Genel	175	166	132	34	200	94.8	79.5	20.5	1.20

Tablo 2'de işletme, doğum tipi, cinsiyetin doğum ve sütten kesim canlı ağırlığa etkisi verilmiştir. Elde edilen sonuçlar incelendiğinde doğum ağırlığı ve 75. gün canlı ağırlığı üzerine işletme, doğum tipi ve cinsiyetin etkisi istatistiki olarak önemli (P<0.001) bulunmuştur. Çalışmada kuzulara ait ortalama doğum ağırlığı 4,12 kg, 75. gün canlı ağırlığı 21,77 kg olarak bulunmuştur (Şekil 1).

Tablo 2. İşletme, doğum tipi, cinsiyetin doğum ve sütten kesim canlı ağırlığa etkisi

Faktörler	**n**	**Doğum** $\bar{x} \pm SD$	**n**	**75. gün** $\bar{x} \pm SD$
Genel	200	4.12±0.13	191	21.77±0.12
İşletme				
1. işletme	58	4.30±0.12[a]	56	23.18±0.22[a]
2. işletme	70	3.95±0.10[b]	67	21.52±0.19[b]
3. işletme	72	4.12±0.22[b]	68	20.60±0.11[c]
p		<0.001		<0.001
Doğum Tipi				
Tek	132	4.25±0.32	130	23.01±0.15
İkiz	68	3.90±0.52	60	21.78±0.30
p		<0.001		<0.001
Cinsiyet				
Dişi	84	4.01±0.11	80	22.10±0.18
Erkek	82	4.20±0.44	77	22.96±0.21
p		<0.001		<0.001

a,b: Farklı harflerle gösterilen aynı sütundaki değerler istatistiki farklılığı göstermektedir.



Şekil 1. Kuzulara ait doğum ve 75. gün canlı ağırlıklar

Koyunların ekstansif koşullarında yetiştirilmesi ile sınırlı sayılabilecek üreme performansı kayıtlarının tutulamaması başarı şansını olumsuz yönde etkileyen temel etmenler arasında sayılabilir (Sezenler ve ark., 2013). Üreme, küçük ya da aile tipi hayvancılık işletmelerinde sürdürülebilir üretimin esasını oluşturur ve bu nedenle üreticilerin her yetiştirme döneminde koyun sürülerindeki üreme potansiyelini saptamaları önemlidir. Koyun yetiştiriciliğinde kuzu gelirleri, döl verim düzeyi ile birlikte büyütülen yavruların oranı ve canlı ağırlıklarına da bağlıdır (Koyuncu ve Akgün, 2018). Çalışmada elde edilen döl verimi özelliklerinden kuzulama oranı, Tüfekci (2023), Özmen ve ark. (2015) ve Akçapınar ve ark. (2000)'nın elde ettiği değerler ile (sırasıyla %95.8, %94.5 ve %94.0) benzerlik göstermektedir. Çalışmada elde edilen ikiz doğum oranı Tüfekci (2023) ve Ceyhan ve ark. (2019)'nın elde ettiği değer ile (%21.8, %20.8) benzer, doğuran koyun başına düşen kuzu sayısı (1.12) ise yüksek bulunmuştur. Literatürde yetiştirici koşullarında Akkaraman ırkının döl verim özelliklerini belirlemeye yönelik yapılmış birçok çalışma mevcuttur. Sonuçlarda meydana gelen farklılıklar bakım, besleme, canlı ağırlık, yaş, kondisyon, koçun etkisi, doğum mevsimi ve bölge farklılıkları gibi döl verimi üzerinde etkili olan faktörlerden kaynaklanmış olabilir. Çalışmada elde edilen doğum ağırlığı değerleri Türkmen ve Çak (2021) ve Noyan ve Ceyhan (2021)'ın yaptığı çalışma değerleri ile (4.29 kg ve 4.07 kg) benzer bulunmuştur.

Sonuç

Sonuç olarak; Çorum ilinde küçük ölçekli aile işletmesi yapısındaki Akkaraman koyun sürülerinde gerek döl verimi gerekse kuzularda büyüme özelliklerine ait elde edilen veriler literatür bulgularıyla benzerlik göstermektedir. Bu durum ülkemizde oldukça geniş bir yetiştirme alanı mevcut olan Akkaraman koyun ırkının, Çorum ilinde de halk tarafından yaygın olarak yetiştiriciliğinin yapılması için mevcut şartlara sahip olduğunu ortaya koymaktadır.

Kaynaklar

Akçapınar, H., Özbeyaz, C., Ünal, N., Avcı, M. (2000). Kuzu eti üretimine uygun ana ve baba hatlarının geliştirilmesinde Akkaraman, Sakız ve Kıvırcık koyun ırklarından yararlanma imkanları I. Akkaraman koyunlarda döl verimi, Akkaraman, Sakız x Akkaraman F1 ve Kıvırcık x Akkaraman F1 kuzularda yaşama gücü ve büyüme. Turkish Journal of Veterinary and Animal Sciences, 24(1), 71-80.

Bertolozzi-Caredio, D., Garrido, A., Soriano, B., Bardaji, I. (2021). Implications of alternative farm management patterns to promote resilience in extensive sheep farming. A Spanish case study. J. Rural Stud., 86, 633-644.

Bingöl, E ve Aygün, T. (2013). Hakkari'de Yetiştirilen Karakaş Koyunlarında Bazı Döl Verimi Özellikleri. Iğdır Univ. J. Inst. Sci. and Tech. 3(2), 113-118.

Ceyhan, A., Şekeroğlu, A., Duman, M. (2019). Some reproductive traits and lambs growth performance of Akkaraman sheep raised in Niğde Province. Turkish Journal of Agriculture Food Science and Technology, 7(10), 1509-1514.

Darcan, N. (2014). Koyun Yetiştiriciliği. Akademisyen Kitap Evi, ISBN: 9786054649617, ss:48, 2014.

de Rancourt, M., Fois, N., Lavín, M.P., Tchakérian, E., Vallerand, F. (2006). Mediterranean sheep and goats production: An uncertain future. Small Rumin. Res., 62, 167-179.

Kaymakçı, M. (2006). İleri Koyun Yetiştiriciliği. Meta Basım Matbaacılık Hizmetleri, ISBN 978-605-85998-1-9, Bornova-İzmir.

Koyuncu, M ve Akgün, H. (2018). Ekstansif yetiştirme koşullarındaki Kıvırcık koyunlarında bazı döl verimi özellikleri, Journal of Animal Production, 59(1), 33-40.

Noyan, M ve Ceyhan, A. (2021). Yarı entansif koşullarda yetiştirilen Akkaraman ırkı kuzuların büyüme performansı. Journal of Agriculture, Food, Environment and Animal Sciences, 2(2), 147-162.

Özmen, Ö., Kul, S., Gök, T. (2015). Elazığ ilinde halk elinde yetiştirilen Akkaraman ırkı koyun ve kuzulara ait bazı verim özellikleri. Fırat Üniversitesi Veteriner Fakültesi Dergisi, 29(2), 81-85.

Sezenler, T., Soysal, D., Yıldırır, M., Yüksel, M.A., Ceyhan, A., Yaman, Y., Erdoğan, İ., Karadağ, O. (2013). Karacabey Merinos koyunların kuzu verimi ve kuzularda

büyüme performansı üzerine bazı çevre faktörlerinin etkisi. Tekirdağ Üniv. Ziraat Fak. Derg., 10 (1), 40-47.

Simões, J., Abecia, J. A., Cannas, A., Delgadillo, J. A., Lacasta, D., Voigt, K., and Chemineau, P. (2021). Managing sheep and goats for sustainable high yield production. Animal, 15, 100293.

Snowder, G.D. (2002). Composite trait selection for improving lamb production. Sheep Goat Res. 17, 42-49.

SPSS, (2016). IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.

Süß, R., Siersleben, K., Rösler, H.-J., Dörin, L., (2004). Analysis of The Economic Situation of Sheep Farms in Saxony-Anhalt. Archiv für Tierzucht 47, 135-141.

Teixeira, A., Silva, S., Guedes, C., Rodrigues, S. (2020). Sheep and goat meat processed products quality: A Review. Foods, 9, 960.

Tüfekci, H. (2023). Yetiştirici koşullarında Akkaraman ırkı koyunlarda döl verimi ile kuzularda büyüme ve yaşama gücü özelliklerinin belirlenmesi. Akademik Ziraat Dergisi, 12(1), 139-144.

Türkmen, C ve Çak, B. (2021). Çaldıran'da yetiştirilen Akkaraman koyunlarının bazı verim özelliklerinin araştırılması. Van Sağlık Bilimleri Dergisi, 14(1), 63-73.

Wishart, H.M. (2019). Precision Livestock Farming: Potential Application for Sheep Systems in Harsh Environments. Ph.D. Thesis, The University of Edinburgh, Edinburgh, UK.

KOYUN VE KEÇİLERDE SÜT VERİMİ VE KALİTE ÖZELLİKLERİ İLE İLİŞKİLİ ADAY GENLER

Hatice BARIŞIK* (ORCID: 0009-0007-3441-8834)
Selçuk Üniversitesi Ziraat Fakültesi Zootekni Bölümü, TR-42075 Konya – Türkiye
Email: htc.barisik@gmail.com

Dr. Ögr. Üyesi Fatma İLHAN (ORCID:0000-0002-9248-2056)
Selçuk Üniversitesi Ziraat Fakültesi Zootekni Bölümü, TR-42075 Konya – Türkiye
Email: fatmailhan@selcuk.edu.tr

ÖZET

Hayvancılıkta süt üretimi ve kalitesi ıslah çalışmaları ile artırılabilir. Kantitatif bir özellik olan süt verimi geleneksel ıslah yöntemleri ile sınırlı düzeyde artırılabilmektedir. Moleküler markerlerin kullanılmasıyla geleneksel ıslah metotlarıyla aşılamayan bazı sınırlamaların da önüne geçilebilir. Moleküler yöntemleri uygulamak amacıyla hayvancılıkta farklı genler üzerinde çalışılmaktadır. Koyun ve keçilerde hem süt verimi hem de süt kalitesini etkileyen birçok gen belirlenmiştir. Süt proteini ve yağı ekonomik açıdan önem arz ettiği için en yaygın çalışılan kalite özellikleridir. Süt proteini için kazein genleri (α s1 Kazein, s2 Kazein, Kazein ve κ Kazein), serum protein genleri (α laktoalbumin, β laktoglobulin); süt yağı için ise Asetil-CoA karboksilaz Alfa (ACACA), Stearoil-CoA Desatüraz (SCD), AsilCoA-diasilgliserol-asiltransferaz1 (DGAT1) genleri yaygın olarak çalışılan genlerdir. Süt verimi için çoğunlukla çalışılan genler ise Büyüme hormonu salgılama faktörü-1 (POU1F1; PIT1), Prolaktin (PRL) ve Büyüme hormonu (Somatotropin, GH). Bu çalışmada bu gen bölgeleri için koyun ve keçilerde yapılan çalışmalar özetlenmeye çalışılmıştır.

Anahtar Kelimeler: Koyun, Keçi, Moleküler marker, Süt, Süt proteini, Süt yağı

CANDIDATE GENES ASSOCIATED WITH MILK YIELD AND QUALITY TRAITS IN SHEEP AND GOATS

ABSTRACT
Milk production and quality in animal husbandry can be increased through breeding efforts. Milk yield, a quantitative trait, can be moderately increased through traditional breeding methods. By utilizing molecular markers, some limitations that cannot be overcome with traditional breeding methods can be addressed. The study involves working on different genes in animal husbandry to apply molecular methods. Many genes influencing both milk yield and quality have been identified in sheep and goats. Milk protein and fat are the most commonly studied quality traits due to their economic importance. For milk protein, the commonly studied genes include the casein genes (α s1 casein, s2 casein, casein, and κ casein), serum protein genes (α-lactalbumin, β-lactoglobulin); for milk fat, commonly studied genes include Acetyl-CoA carboxylase Alpha (ACACA), Stearoyl-CoA Desaturase (SCD), and AcylCoA-diacylglycerol-acyltransferase1 (DGAT1). Genes commonly studied for milk yield include Growth hormone releasing factor-1 (POU1F1; PIT1), Prolactin (PRL), and Growth hormone (Somatotropin, GH). In this study, efforts have been made to summarize the research conducted on these gene regions in sheep and goats.
Keywords: Sheep, Goat, Molacular marker, Milk, Milk protein, Milk fat

Giriş

Süt, yeni doğan canlıların tüm beslenme gereksinimlerinin yanı sıra bazı savunma ve diğer fizyolojik gereksinimleri karşılamak üzere üretilen, memelilerin karakteristik salgısıdır. Mükemmel bir vitamin ve mineral kaynağıdır. Kemik sağlığında önemli bir role sahiptir. Süt; lipit, protein, amino asit, vitamin ve mineral kaynağı olmasının yanında immunoglobulinler, hormonlar, büyüme faktörleri, sitokinler, nükleotitler, peptitler, enzimler ve diğer biyoaktif peptitleri de yapısında barındırır (Haug ve ark., 2007).

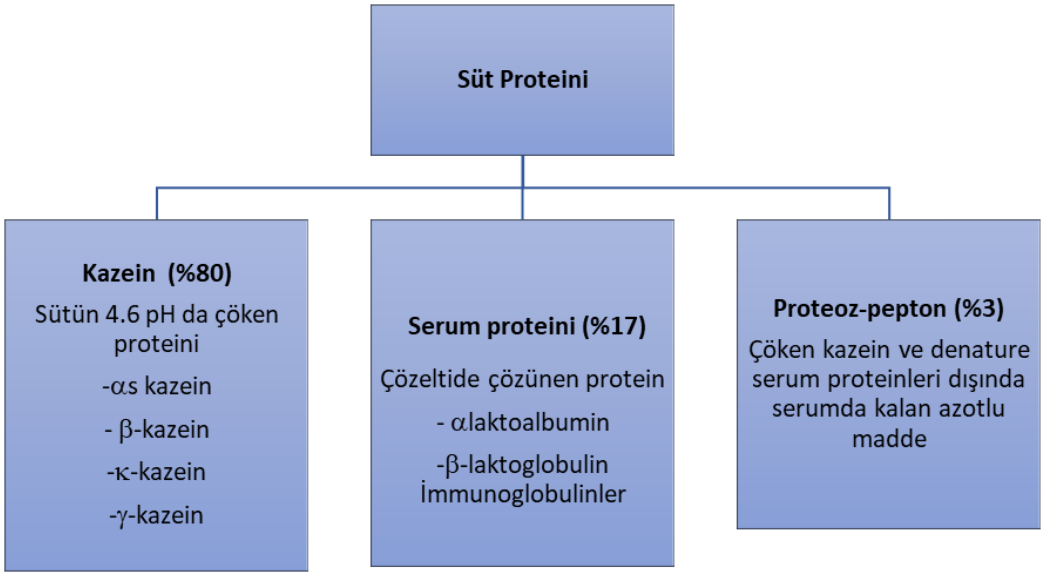
Tablo 1. Koyun ve keçi sütü bileşimi ((Moatsou ve Sakkas, 2019) .

Özellik (%)	Koyun sütü	Keçi sütü
Yağsız Kuru madde	12	8.9
Protein	6.2	3.4
Yağ	7.4	3.8
Laktoz	6.2	4.1

Bu özellikler ırk, laktasyon periyodu, çevresel faktörler ve hayvanın sağlık durumu gibi çeşitli faktörlerden etkilenebilmektedir. Fakat ortalama olarak koyun ve keçi sütlerinin bilşimi tablo1 de verilmiştir. Hayvancılıkta süt üretimi ve kalitesi ıslah çalışmaları ile artırılabilir. Kantitatif bir özellik olan süt verimi geleneksel ıslah yöntemleri ile sınırlı düzeyde artırılabilmektedir. Moleküler markerlerin kullanılmasıyla geleneksel ıslah metotlarıyla aşılamayan bazı sınırlamaların da önüne geçilebilir. Bu sunumda koyun ve keçilerde süt verim ve kalite özellikleri ile ilişkili genler özetlenmeye çalışılmıştır.

Süt Proteinleri

Esansiyel aminoasitler bakımından zengin olan süt proteinlerinin önemi yapılan araştırmalarla daha iyi anlaşılmaktadır. Süt proteinlerinin beslenmenin yanı sıra bağışıklık açısından önemli olduğu ve biyoaktif peptitler açısından diğer protein kaynaklarına göre daha önemli bir kaynak olduğu birçok araştırmacı tarafından bildirilmiştir (Regester ve ark., 1996; McIntosh ve ark., 1998; Filiz ve ark., 2010; Sharma, 2019). Süt proteinleri kazeinler, serum proteini ve proteoz-pepton olmak üzere üç ana gruptan oluşmaktadır. Süt proteinleri ve sütteki oranlarının dağılımı şekil 1'de özetlenmiştir.

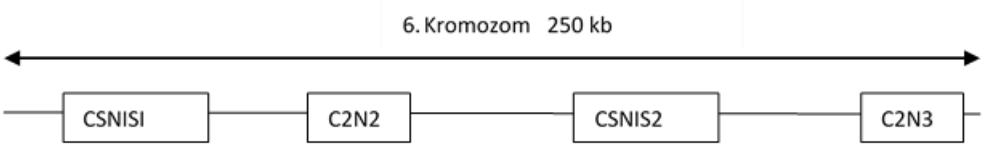


Şekil 1. Süt proteinleri dağılımı

Kazein Genleri

Sütün esas proteini olarak bilinen kazeinler, sütün asit ile reaksiyonundan sonra çökmeyen kısımdır ve süt proteinlerinin %80 ini oluştururlar. Kazeinler sütün kalitesini ve peynir randımanı üzerine etkisi olan önemli bir süt proteini ailesidir.

Kazeinler koyun ve keçi genomunda 6. kromozomdadır ve 250 kb uzunluğundadır ve kromozom üzerindeki yerleşimi, ekzon sayısı ve kodlanan aminoasit sayısı şekil 2 de gösterilmiştir.



Kazeinler	αsI	β	αs2	κ
Ekzonlar	19	9	18	5
Aminoasit	214	209	208	171

Şekil 2. Kazein genlerinin kromozom üzerinde yerleşimi

Koyun ve keçilerde araştırılan kazein genleri ve elde edilen varyantlar Tablo 2 de verilmiştir.

Tablo 2. Koyun ve keçilerde kazein gen varyantları (Moioli ve ark., 2007) .

Kazein	**Gen**	**Varyantlar**	
		Koyunlarda	Keçilerde
α s1 Kazein	CSN1S1	A,B,C,D,E,F,H,I	A,B1,B2,B3,B4, C,D,E,F,G,01,02,H,I,L,M,N
α s2 Kazein	CSN1S2	A,B,C,D,E,F,G	A,B,C,D,E,F,0
β Kazein	CSN2	A,B,C,X,Y	A,B,C,01,02,03
κ Kazein	CSN3	Monomorfik	A,B,B1,B2,C,C1,D,E,F,G,H,L,M

Koyun ve keçilerde kazein genlerinden en fazla α-s1 kazein geni çalışılmıştır. Diğer kazein genleri ile ilgili sınırlı sayıda çalışma vardır bu bölümde yapılan çalışmalar özetlenmiştir.

α-s1 Kazein (CSN1S1): Bulgaristan yerli 5 koyun ırkında yapılan bir PCR-RFLP çalışmasında α-s1 kazein gen bölgesi çalışılmış ve bu gen bölgesi için 3 genotip (AA, AC, CC) belirlenmiştir. Bu genotiplerin süt özellikleri ile ilişkisinin araştırıldığı çalışmada AC genotipine sahip hayvanların sütlerinin daha fazla protein ve yağ içerdiği, AA genotipine sahip hayvanların sütlerinin ise daha fazla laktoz içerdiği tespit edilmiştir (Gencheva ve Georgieva, 2019; Gencheva ve ark., 2020). Serra da Estrela ırkı koyunlarda CSN1S1 lokusunda yapılan bir düğer çalışmada CC genotipine sahip hayvanların diğer α-s1 kazein genotiplerine göre daha fazla süt verdiği belirlenmiştir (Ramos ve ark., 2009). Polonya merinosunda süt proteinleri ve bunların verime etkilerini araştırmak amacıyla yapılan çalışmada kazein geninin αS_1-kazein genotipinin D alleli daha düşük yağ ve protein seviyesi ile, C alleli en yüksek süt verimi, protein ve yağ seviyesi ile ilişkili bulunmuştur (Mroczkowski ve ark., 2004).

Brezilya'nın kuzey doğusunda üretilen Alpine ve Saanen keçi ırklarına ait sütlerin kazein kompozisyonunda αs1-kazein olmadığı bildirilmektedir. Bu ırklara ait sütlerin hipoalerjik protein kaynakları açısından potansiyele sahip olduğu düşünülmektedir(Costa ve ark., 2014). Sarda ırkı keçilerde A ve B allellerinin CSN1S1 BB ve AB genotipleri yüksek protein ve yağ miktarı ile ilişkili bulunmuştur (Vacca ve ark., 2014). Kazein gen polimorfizminin Sarda keçilerinden elde edilen sütün mayalanma özellikleri üzerindeki etkisi araştırılmış ve CSN1S1 in F aleli taşıyan keçiler daha düşük yağ içeriğine sahip olduğu bulunmuştur. En yüksek protein konsantrasyonunun CSN1S1 AB genotipli keçilerin sütlerinde olduğu tespit edilmiştir (Pazzola ve ark., 2014).

α-s2 Kazein (CSN1S2): α-s2-kazein miktarı sütün alerjenik özellikleri ile ilişkili olduğu belirlenmiştir. Varyantlar A, B, C, E ve F daha yüksek bir alerjenik etki göstermiştir. Sarda keçilerinde CSN1S2 AC genotipinin yüksek yağ ve protein içeriği ile ilişkili olduğu tespit edilmiştir (Vacca ve ark., 2014).

β-kazein (CSN2): Merinos ırkı koyunlarda CSN2 geninin ekzon 7 de polimorfik olduğu (aleller A ve G) ve (Genotipleri AA, AG, GG) GG genotipini taşıyan koyunlar yüksek süt üretim ile ilişkili olduğu bulunmuştur(Corral ve ark., 2010). Sarda keçilerinde CSN2 AA genotipine sahip hayvanlarının sütlerinde daha fazla protein içerdiği tespit edilmiştir (Vacca ve ark., 2014)

Kappa kazein (CSN3): Kappa-Kazein proteini süt misellerinin kararlılığına ve formasyonuna izin vererek bunların şekillerini ve görevini düzenlemektedir ve bu nedenle sütün kalitesini belirleyen en önemli proteinlerden birini temsil etmektedir. CSN3 B alleline sahip keçilerde sütteki toplam kazein ve protein miktarının daha yüksek olduğu belirlenmiştir (Caravaca ve ark., 2009).

Serum Proteinleri

Sütte bulunan proteinlerin yaklaşık, % 20'sini serum proteinleri oluşturmaktadır. Serum proteinleri globüler yapıda olup, β-laktoglobulin, α-laktalbümin, serum albümini, immünoglobulinleri içermektedir. Doğal formlarında suda çözünür halde bulunurlar. Serum proteinleri biyolojik değeri en yüksek olan protein grubudur. Serum proteinlerinin besinsel ve fonksiyonel özellikleri bu proteinlerin yapısal nitelikleri ile ilişkilidir (Smithers, 2008).

Alfa-laktalbumin (LALBA): Meme bezinden salgılanıp sütün sentezlenmesinde önemli bir rol oynayan süt proteinidir. Isıl işlemlere karşı en dirençli serum proteini olduğu bilinmektedir. 80°C'nin altındaki sıcaklıklarda, α-laktalbuminin ısıl işlemlere duyarlılığının en fazla koyun sütünde olduğu ve sırasıyla inek ve keçi sütlerinde azaldığı saptanmıştır. LALBA geni koyunlarda çok az çalışılmıştır ve koyunlarda 3. kromozom üzerinde bulunmaktadır (Jain ve ark., 2009; Öner ve ark., 2012; Ağaoğlu ve ark., 2014). Koyun ırklarında çoğunlukla A varyantı bulunmaktadır. Merinoslarda yapılan bir çalışmada A alleline sahip koyunların sütlerinin yağ ve protein bakımından daha zengin olduğu belirlenmiştir.

Bu gen keçilerde 5. kromozom üzerinde bulunmaktadır. Bu gen 123 aminoasidi kodlayan, 75 ile 329 nükleotide kadar değişen uzunlukta 4 ekzon bölgesinden oluşmaktadır (Vilotte

ve ark., 1991). Saanen keçilerinde LALBA gen polimorfizmi incelenmiş, polimorfizmin verim özellikleriyle ilişkilendirilip hayvan ıslahı çalışmalarında kullanılabileceği ön görülmüştür (Öner ve ark., 2012). Murciano-Granadina ve Malaguena keçilerinde yapılan bir çalışmada LALBA gen polimorfizmi incelenmiş ve bu keçilerde LALBA varyasyonu ile sütteki laktoz yüzdesi arasında önemli bir ilişki bulunmamıştır (Zidi ve ark., 2014).

β -Laktaglobulin (β -LG): Süt proteinlerinden biridir ve sütün teknolojik özellikleri üzerinde önemli bir işlevi vardır(peynir yapma). Globüler yapısı nedeniyle, midede bulunan proteolitik enzimlere ve asitliğe karşı dayanıklılık göstermektedir (Papiz ve ark., 1986).Koyun ve keçi sütlerindeki β-laktoglobulinin, inek sütüne kıyasla, ısıl işlemlere karşı daha fazla duyarlı olduğu bulunmuştur. (Dumitraşcu ve ark., 2013).

β-LG proteininin biyolojik fonksiyonları henüz tam olarak bilinmemekle birlikte, meme salgı bezlerinde fosfat metabolizmasında yer aldığı ve ayrıca bağırsakta retinol ile yağ asitlerinin taşınmasında görev yaptığı düşünülmektedir (Rachagani ve ark., 2006).

β-LG geni koyunlarda 3, keçilerde 11. kromozom üzerindedir. β-LG, sütü artırmaya yönelik seleksiyon ve ıslah programları için aday gen olarak kullanılabilmektedir. Portekiz koyunlarından 3 ırk da yapılan çalışmada β-Laktoglobulin genotip AA, Serra da Estrela ve Merinos koyunlarında daha düşük süt verimi ile ilişkilendirilmiştir (Ramos ve ark., 2009). Koyunlarda β-LGB lokusunda A ve B olmak üzere iki allelin varlığı belirlenmiş, daha sonra A alleli'nin bir alt varyantı olan C alleli de tespit edilmiştir. A ve B alelleri arasındaki tek fark genin nükleotid diziliminde 1617. sırada yer alan nükleotidinde oluşan nokta mutasyonudur (Öner ve ark., 2012).

BLG gen bölgesi için koyunlarda yapılan birçok çalışmada süt verimi ile ilişkisi olmadığı tespit edilmiştir (Pietrola ve ark., 2000; Staiger, 2009; Aranguren-Mendez ve ark., 2011). Diğer birkaç çalışmada ise A alleline sahip koyunların daha fazla süt verdiği tespit edilmiştir (Giaccone ve ark., 2000; Nudda ve ark., 2003). Süt kalitesi açısından ise A alleline sahip hayvanların sütlerinin yağ ve protein bakımından diğer allellere sahip hayvanların sütlerine göre daha zengin olduğu tespit edilmiştir (Martínez Hens ve ark., 1993; Dario ve ark., 2008; Ramos ve ark., 2009; Corral ve ark., 2010).

Süt Yağı

Sütün yağlı kısmıdır. Süt yağı esas olarak her biri üç yağ asidi içeren trigliseridlerden oluşur. Süt trigliseridleri miristik asit, palmitik asit, stearik asit, palmitoleik asit, oleik asit, linoleik asit, alfa linolenik asit yağ asitleri içerir.

Asetil-CoA karboksilaz Alfa (ACACA): Hayvan dokularında yağ asidi sentezinin düzenlenmesinde belirleyici enzimdir.

Koyunlar'da 11. keçilerde 19. kromozomda bulunan ACACA geni koyunlarda 58, keçilerde 60 ekzona sahiptir (Matar ve ark., 2023). Koyunlarda ACACA geni ile yapılan çalışmalar sonucunda sütteki yağ asit profili ve sütteki toplam yağ miktarı ile ilişkili olduğu belirlenmiştir (García-Fernández ve ark., 2010; Moioli ve ark., 2013). Alpin keçilerinde yapılan bir çalışmada ACACA allellerinin süt verimi ile ilişkili olduğu bulunmuştur(Crepaldi ve ark., 2012).

Stearoil-CoA Desatüraz (SCD): Tekli doymamış yağ asitlerinin hücresel biyosentezinde anahtar bir enzimdir.

SCD geninin 5 varyantı olduğu belirlenmiştir. Koyunlarda 22., keçilerde 26. kromozomda bulunan SCD geni 7 ekzondan oluşmaktadır. Koyun ve keçilerde yapılan çalışmalarda SCD geninin yağ asidi kompozisyonu ile ilişkili olduğu belirlenmiştir (Tudisco ve ark., 2012). Yağlı kuyruklu ve ince kuyruklu İran koyun ırklarında yapılan bir çalışma sonucunda SCD geni allellerinin konjuge linoleik asit ve süt yağı oranı ile ilişkili olduğu belirlenmiştir (Aali (Aali ve ark., 2014).

AsilCoA-diasilgliserol-asiltransferaz1 (DGAT1): Adipositlerde trigliseritlerin sentezini kontrol etmede anahtar enzim olduğu düşünülmektedir (Dervishi ve ark., 2015). DGAT1 geni koyunlarda 9., keçilerde 14. kromozomda bulunmakta; koyunlarda 17, keçilerde 18 ekzondan oluşmaktadır

Triaçilgliserol sentezinde temel bir rol oynadığından, DGAT1 genindeki mevcut SNP'ler süt koyunlarında süt yağı içeriğindeki değişimi kısmen açıklamada önemli bilgiler sağlamaktadır. 8 farklı koyun ırkında yapılan bir çalışmada DGAT1 geninin yağ asiti kompozisyonu ve laktoz miktarı ile ilişkili olduğu belirlenmiştir (Dervishi ve ark., 2015).

Süt Verimi ile İlişkili Diğer Genler

Sütteki protein ve yağ içeriği ile genler dışında süt verimi ve kalitesi ile ilişkili çok fazla gen üzerinde çalışılmıştır. Bu genlerden en çok çalışılanlar; POU1F1, PRL, GH

Büyüme hormonu salgılama faktörü-1 (POU1F1; PIT1): Büyüme, üreme, süt verimi ve süt bileşenleri ile ilişkili önemli bir aday gendir. POU1F1 geni 1. kromozomu üzerinde yer alır. Keçi ve koyunlarda 6 ekzondan oluşur (Feng ve ark., 2012). Sakız ırkı koyunlarda yapılan bir araştırmada POU1F1 allellerinin süt verimi, sütteki yağ ve laktoz miktarı ile ilişkili olduğunu tespit etmişlerdir (Ozmen ve ark., 2014). Saanen ırkı

keçilerde TC ve CC genotiplerinin laktasyon süt verimi ve doğumda oğlak sayısının TT genotipinden yüksek olduğu gözlenmiştir (Işık ve Bilgen, 2019).

Prolaktin (PRL): PRL memelilerde hipofiz bezinden salgılanan ve laktasyonun başlatılması ve sürdürülmesinde önemli rol oynayan bir hormondur. PRL geni koyunlarda 20. keçilerde 23. kromozomda yer alır, 5 ekzondan oluşmaktadır. İki varyantı belirlenmiştir; PRLA, PRLB

Serra da Estrela ırkında, prolaktin genotip AA taşıyan koyunlar, düşük süt verimi ile önemli ölçüde ilişkili olduğu, ancak prolaktin genotiplerinin süt verimi üzerindeki bu etkisi Merinos'ta tespit edilmemiştir. Prolaktin genotipleri ayrıca Serra da Estrela ırkında süt yağı ve protein içerikleri ile önemli ölçüde ilişkili olduğu bulunmuştur(Ramos ve ark., 2009).

Merinoslar ve Portekiz koyun ırklarında yapılan çalışmalarda PRL BB genotipine sahip koyunların sütlerini yağ oranlarının daha yüksek olduğu tespit edilmiştir (Ramos ve ark., 2009; Padilla ve ark., 2018).

Kısa Kuyruklu Han koyunlarında PRLR geni ekzon 10 ve intron 1 için üç primer çiftinin üç genotipi (AA, AB ve BB) belirlenmiş, PRLR geninin Kısa Kuyruklu Han koyunları için ya çoklu doğumu etkileyen major bir gen ya da bu gibi genlerle yakın bağlantılı bir gen olduğu bildirilmiştir (Chu ve ark., 2009) ve ark.).

Büyüme hormonu (Somatotropin, GH): Memelilerde doğum sonrası büyüme ve metabolizmanın ana düzenleyicisidir. Ön Hipofiz bezinde üretilmektedir. Büyüme hormonu; büyüme hızını, vücut kompozisyonunu, Vücut sağlığı, Süt verimini ve bu işlemlerde görev alan birkaç genin ekspresyonunu düzenlemektedir. GH geni koyunda 11., keçilerde 19. kromozomda lokalize olmuştur ve 5 ekzona sahiptir.

Sarda koyunlarında GH geni için yapılan bir sekans çalışması sonucunda elde edilen genotiplerin sütteki laktoz ve yağ oranı ile ilişkili olduğu belirlenmiştir (Dettori ve ark., 2020). GH1 geninin Serrada Estrela koyun ırkında daha düşük süt verimi ile ilişkili bir gen olduğu tespit edilmiştir (do Rosário Marques ve ark., 2006).

Keçilerde GH geninin, süt verimi ve protein yüzdesi ile önemli ilişkisi bulunmuştur (Dettori ve ark., 2013). Ayrıca bazı ırklarda doğuran keçi başına doğan oğlak sayısı ve süper ovulasyon üzerine de etkili olduğu bildirilmiştir(Zhang ve ark., 2011).

Sonuç

Hayvancılıkta birçok ekonomik verim özelliği ile ilişkili olduğu düşünülen çok sayıda gen çalışılmıştır. Süt verimi de ekonomik verim özelliklerden birisi olarak önem arz etmektedir. Süt verimi birçok faktör tarafından (Irk, yaş, laktasyon sırası, bakım besleme vb) etkilendiğinden genlerin etkisi tam olarak görülemeyebilir. Bu nedenle geniş örneklerde ve gelişmiş tekniklerle yapılacak araştırmalar süt verimi ile ilişkili majör genleri daha net belirlemeyi sağlayacak ve daha ekonomik bir üretim yapmaya yardımcı olacaktır.

Kaynaklar

Aali, M., Shahrbabak, M. M., Shahrbabak, H. M. ve Sadeghi, M., 2014, Identifying novel SNPs and allelic sequences of the stearoyl-Coa desaturase gene (SCD) in fat-tailed and thin-tailed sheep breeds, *Biochemical genetics*, 52, 153-158.

Ağaoğlu, Ö. K., Saatci, M., Elmaz, Ö., Çolak, M., Kocamüftüoğlu, M. ve Zeytünlü, E., 2014, Mva I PCR-RFLP identifies single nucleotide polymorphism of the alpha-lactalbumin gene in some goat breeds reared in Turkey, *Turkish Journal of Veterinary & Animal Sciences*, 38 (3), 225-229.

Aranguren-Mendez, J. A., Portillo, M. G., Yañez, L., Rincon, X., Contreras, G. ve Ontiveros, Y. V., 2011, Caracterización genética del ganado criollo limonero a través de genes de interés productivo, *Actas Iberoamericanas de Conservación Animal-AICA*, 1 (1).

Caravaca, F., Carrizosa, J., Urrutia, B., Baena, F., Jordana, J., Amills, M., Badaoui, B., Sánchez, A., Angiolillo, A. ve Serradilla, J., 2009, Effect of αS1-casein (CSN1S1) and κ-casein (CSN3) genotypes on milk composition in Murciano-Granadina goats, *Journal of Dairy Science*, 92 (6), 2960-2964.

Chu, M., Wang, X., Jin, M., Di, R., Chen, H., Zhu, G., Fang, L., Ma, Y. ve Li, K., 2009, DNA polymorphism of 5′ flanking region of prolactin gene and its association with litter size in sheep, *Journal of animal breeding and genetics*, 126 (1), 63-68.

Corral, J., Padilla, J. ve Izquierdo, M., 2010, Associations between milk protein genetic polymorphisms and milk production traits in Merino sheep breed, *Livestock Science*, 129 (1-3), 73-79.

Costa, W. K. A. d., Souza, E. L. d., Beltrao-Filho, E. M., Vasconcelos, G. K. V., Santi-Gadelha, T., de Almeida Gadelha, C. A., Franco, O. L., Queiroga, R. d. C. R. d. E. ve Magnani, M., 2014, Comparative protein composition analysis of goat milk produced by the Alpine and Saanen breeds in northeastern Brazil and related antibacterial activities, *PLoS One*, 9 (3), e93361.

Crepaldi, P., Milanesi, E., Coizet, B., Nicoloso, L., Fresi, P., Murru, S., Steri, R. ve Macciotta, N., 2012, Associations between candidate gene polymorphisms and milk production traits in Alpine goats farmed in Italy, *Journal of Animal Science*, 90 (Suppl. 3), 686-686.

Dario, C., Carnicella, D., Dario, M. ve Bufano, G., 2008, Genetic polymorphism of β-lactoglobulin gene and effect on milk composition in Leccese sheep, *Small Ruminant Research*, 74 (1-3), 270-273.

Dervishi, E., Serrano, M., Joy, M., Sarto, P., Somera, A., González-Calvo, L., Berzal-Herranz, B., Molino, F., Martinez-Royo, A. ve Calvo, J., 2015, Structural characterisation of the acyl CoA: diacylglycerol acyltransferase 1 (DGAT1) gene and association studies with milk traits in Assaf sheep breed, *Small Ruminant Research*, 131, 78-84.

Dettori, M. L., Rocchigiani, A. M., Luridiana, S., Mura, M. C., Carcangiu, V., Pazzola, M. ve Vacca, G. M., 2013, Growth hormone gene variability and its effects on milk traits in primiparous Sarda goats, *Journal of Dairy Research*, 80 (3), 255-262.

Dettori, M. L., Pazzola, M., Petretto, E. ve Vacca, G. M., 2020, Association analysis between SPP1, POFUT1 and PRLR gene variation and milk yield, composition and coagulation traits in Sarda sheep, *Animals*, 10 (7), 1216.

do Rosário Marques, M., Santos, I. C., Carolino, N., Belo, C. C., Renaville, R. ve Cravador, A., 2006, Effects of genetic polymorphisms at the growth hormone gene on milk yield in Serra da Estrela sheep, *Journal of Dairy Research*, 73 (4), 394-405.

Dumitraşcu, L., Moschopoulou, E., Aprodu, I., Stanciu, S., Râpeanu, G. ve Stănciuc, N., 2013, Assessing the heat induced changes in major cow and non-cow whey proteins conformation on kinetic and thermodynamic basis, *Small Ruminant Research*, 111 (1-3), 129-138.

Feng, T., Chu, M., Cao, G., Tang, Q., Di, R., Fang, L. ve Li, N., 2012, Polymorphisms of caprine POU1F1 gene and their association with litter size in Jining Grey goats, *Molecular biology reports*, 39, 4029-4038.

Filiz, G., Güzel, M., Öncül, N., YILDIRIM, Z. ve YILDIRIM, M., 2010, Süt serum proteinleri ve türevlerinin biyolojik ve fizyolojik aktiviteleri, *Akademik Gıda*, 8 (1), 23-31.

García-Fernández, M., Sánchez, J., Gutiérrez-Gil, B., García-Gámez, E. ve Arranz, J., 2010, Association between acetyl-CoA carboxylase α (ACACA) SNPs and milk fatty acid profile in Spanish Churra sheep, *Proceedings of the 9th World Congress*

on Genetics Applied to Livestock Production, Dept. Produccion Animal, Universidad de Leon, Leon, Spain, 1-6.

Gencheva, D. ve Georgieva, S., 2019, Genetic diversity and population structure of Bulgarian autochthonous sheep breeds based on nucleotide variation in Alpha S1-casein gene, *Bulgarian Journal of Agricultural Science*, 25 (3), 95-102.

Gencheva, D., Veleva, P., NAIDENOVA, N. ve Pamukova, D., 2020, Genetic polymorphism of alpha S1-casein in Bulgarian sheep breeds and its effect on milk composition, *Turkish Journal of Veterinary & Animal Sciences*, 44 (4), 860-870.

Giaccone, P., Di Stasio, L., Macciota, N. P., Portolona, B., Todaro, M. ve Cappio-Borlino, A., 2000, Effect of β-lactoglobulin polymorphism on milk-related traits of dairy ewes analysed by a repeated measures design, *Journal of Dairy Research*, 67 (3), 443-448.

Haug, A., Høstmark, A. T. ve Harstad, O. M., 2007, Bovine milk in human nutrition–a review, *Lipids in health and disease*, 6 (1), 1-16.

Işık, R. ve Bilgen, G., 2019, Associations between genetic variants of the POU1F1 gene and production traits in Saanen goats, *Archives animal breeding*, 62 (1), 249-255.

Jain, A., Gour, D., Bisen, P., Dubey, P., Sharma, D., Joshi, B. ve Kumar, D., 2009, Single nucleotide polymorphism (SNP) in alpha-lactalbumin gene of Indian Jamunapari breed of Capra hircus, *Small Ruminant Research*, 82 (2-3), 156-160.

Martínez Hens, J., Garzón Sigler, A., Méndez Medina, D., Aparicio Ruíz, F. ve Vera y Vega, A., 1993, Effect of β-lactoglobulin genetic variants on the pH, total casein concentration and yield of curd in Manchega ewes.

Matar, A. M., Alharthi, A. S., Ayadi, M., Al-Garadi, M. A. ve Aljummah, R. S., 2023, Identification of Genetic Polymorphisms of PI, PIII, and Exon 53 in the Acetyl-CoA Carboxylase-α (ACACα) Gene and Their Association with Milk Composition Traits of Najdi Sheep, *Animals*, 13 (8), 1317.

McIntosh, G. H., Royle, P. J., Le Leu, R. K., Regester, G. O., Johnson, M. A., Grinsted, R. L., Kenward, R. S. ve Smithers, G. W., 1998, Whey proteins as functional food ingredients?, *International Dairy Journal*, 8 (5-6), 425-434.

Moatsou, G. ve Sakkas, L., 2019, Sheep milk components: Focus on nutritional advantages and biofunctional potential, *Small Ruminant Research*, 180, 86-99.

Moioli, B., D'Andrea, M. ve Pilla, F., 2007, Candidate genes affecting sheep and goat milk quality, *Small Ruminant Research*, 68 (1-2), 179-192.

Moioli, B., Scatà, M., De Matteis, G., Annicchiarico, G., Catillo, G. ve Napolitano, F., 2013, The ACACA gene is a potential candidate gene for fat content in sheep milk, *Animal Genetics*, 44 (5), 601-603.

Mroczkowski, S., Korman, K., Erhardt, G., Piwczynski, D. ve Borys, B., 2004, Sheep milk protein polymorphism and its effect on milk performance of Polish Merino, *Archiv fur Tierzucht*, 47 (6; SPI), 114-121.

Nudda, A., Feligini, M., Battacone, G., Macciotta, N. P. P. ve Pulina, G., 2003, Effects of lactation stage, parity, β-lactoglobulin genotype and milk SCC on whey protein composition in Sarda dairy ewes, *Italian Journal of Animal Science*, 2 (1), 29-39.

Ozmen, O., Kul, S. ve Unal, E. O., 2014, Polymorphism of sheep POU1F1 gene exon 6 and 3'UTR region and their association with milk production traits, *Iranian journal of veterinary research*, 15 (4), 331.

Öner, Y., Şahin, Ş. ve Elmacı, C., 2012, Gökçeada, Saanen ve Kıl Keçisi Irklarının LALBA/MvaI Polimorfizmi Bakımından İncelenmesi, *Hayvansal Üretim*, 53 (1).

Padilla, P., Izquierdo, M., Martínez-Trancón, M., Parejo, J. C., Rabasco, A., Salazar, J. ve Padilla, J. Á., 2018, Polymorphisms of α-lactoalbumin, β-lactoglobulin and prolactin genes are highly associated with milk composition traits in Spanish Merino sheep, *Livestock Science*, 217, 26-29.

Papiz, M., Sawyer, L., Eliopoulos, E., North, A., Findlay, J., Sivaprasadarao, R., Jones, T., Newcomer, M. ve Kraulis, P., 1986, The structure of β-lactoglobulin and its similarity to plasma retinol-binding protein, *Nature*, 324 (6095), 383-385.

Pazzola, M., Dettori, M. L., Pira, E., Noce, A., Paschino, P. ve Vacca, G. M., 2014, Effect of polymorphisms at the casein gene cluster on milk renneting properties of the Sarda goat, *Small Ruminant Research*, 117 (2-3), 124-130.

Pietrola, E., Carta, A., Fraghi, A., Piredda, G. ve Pilla, F., 2000, Effect of β-lactoglobulin locus on milk yield in Sarda ewes, *Zootecnica e Nutrizione Animale*, 26 (3), 131-135.

Rachagani, S., Gupta, I. D., Gupta, N. ve Gupta, S., 2006, Genotyping of β-Lactoglobulin gene by PCR-RFLP in Sahiwal and Tharparkar cattle breeds, *BMC genetics*, 7, 1-4.

Ramos, A., Matos, C., Russo-Almeida, P., Bettencourt, C., Matos, J., Martins, A., Pinheiro, C. ve Rangel-Figueiredo, T., 2009, Candidate genes for milk production traits in Portuguese dairy sheep, *Small Ruminant Research*, 82 (2-3), 117-121.

Regester, G., McIntosh, G., Lee, V. ve Smithers, G., 1996, Whey proteins as nutritional and functional food ingredients, *Food Australia*, 48, 123-127.

Sharma, R., 2019, Whey proteins in functional foods, In: Whey proteins, Eds: Elsevier, p. 637-663.

Smithers, G. W., 2008, Whey and whey proteins—From 'gutter-to-gold', *International Dairy Journal*, 18 (7), 695-704.

Staiger, E. A., 2009, Genetic markers for increased milk production in sheep, Oklahoma State University, p.

Tudisco, R., Calabrò, S., Cutrignelli, M. I., Moniello, G., Grossi, M., Gonzalez, O., Piccolo, V. ve Infascelli, F., 2012, Influence of organic systems on Stearoyl-CoA desaturase gene expression in goat milk, *Small Ruminant Research*, 106, S37-S42.

Vacca, G. M., Dettori, M. L., Piras, G., Manca, F., Paschino, P. ve Pazzola, M., 2014, Goat casein genotypes are associated with milk production traits in the Sarda breed, *Animal Genetics*, 45 (5), 723-731.

Vilotte, J. L., Soulier, S., Printz, C. ve Mercier, J., 1991, Sequence of the goat α-lactalbumin-encoding gene: comparison with the bovine gene and evidence of related sequences in the goat genome, *Gene*, 98 (2), 271-276.

Zhang, C., Liu, Y., Huang, K., Zeng, W., Xu, D., Wen, Q. ve Yang, L., 2011, The association of two single nucleotide polymorphisms (SNPs) in growth hormone (GH) gene with litter size and superovulation response in goat-breeds, *Genetics and Molecular Biology*, 34, 49-55.

Zidi, A., Amills, M., Jordana, J., Carrizosa, J., Urrutia, B. ve Serradilla, J., 2014, Murciano-Granadina goats.

ANTIBACTERIAL EFFECTS OF SOME HERBAL EXTRACTS AGAINST PLANT PATHOGENIC *STREPTOMYCES SPP.*

Seray DÖNMEZ (ORCID: 0000-0002-3662-075X)
Niğde Ömer Halisdemir University, Department of Plant Production and Technologies, Niğde - Turkey, Niğde- Turkey
Email: srydnmz06@gmail.com

Research. Asst. Nida ÜNLÜ* (ORCID: 0000-0002-0740-4425)
Niğde Ömer Halisdemir University, Department of Plant Production and Technologies, Niğde - Turkey, Niğde- Turkey
Email: n.unlu33@gmail.com

Assoc. Prof. Eminur ELÇİ (ORCID: 0000-0002-6434-6321)
Niğde Ömer Halisdemir University, Department of Plant Production and Technologies, Niğde - Turkey, Niğde- Turkey
Email: eminur@gmail.com

ABSTRACT
Potato common scab is one of the most common diseases of potato, worldwide. There are some pesticides available for disease but due to their side effects on human health and other living organisms, there is a need for more sustainable alternative ways. Using plant extracts may offer an alternative way to harmful pesticides. In this study, we aimed to: determine to antibacterial activity of plant extract of sandalwood (*Santalum album*), black locust (*Robinia pseudoacacia*), laurel (*Laurus nobilis*), clove (*Syzygium aromaticum*) and commercial thyme (*Thymus vulgaris* L.) and tea tree (*Melaleuca alternifolia*) essential oils using the disc diffusion method against *Streptomyces* spp. As a result of this study; 6% thyme oil and 15% sandalwood extract were shown highest antibacterial activity *in vitro* and *in vivo* tests. In future prospects; thyme oil and sandalwood extract may be proposed as a potential biochemical against potato common scab.
Keywords: Potato, plant extract, essential oil, *Streptomyces* spp., eco-friendly disease control

INTRODUCTION

Potato (*Solanum tuberosum* L.) is in the Solanaceae family. The origin of the potato plant is Andes Mountains in South America., Also *Solanum tuberosum* L. is an annual cultivated plant. Recently, it is known that the potato plant contains around two hundred species and more than four thousand varieties. (Abed & Demirhan, 2018) The most important potato producing countries in the world are China, India, Ukraine, Russia and the USA. (FAO, 2022). The amount of potato production in Turkey is 5,2 billion tons in 2022. (TUIK,2022) In our country, potato farming is generally grown in provinces such as Niğde, Nevşehir, İzmir, Bolu, Afyon, Konya, and Erzurum. (Dumanoğlu et al., 2021). Diseases and pests are made serious problems in areas where potato cultivation is carried out. In addition to biotic factors (bacteria, fungi, viruses, viroids, phytoplasmas), abiotic factors (frost, hail, wind, drought) also have a negative impact on potato production in terms of quality and product loss. (Ünlü and Elçi, 2022). Potatoes are very sensitive to diseases, pests, quality problems and due to the inadequacy of genetic resistance against diseases, pests and abiotic stress, there is a loss of approximately 22% in world potato production (Czajkowski et al., 2011). Due to these problems, potato production decreases, and a less profitable production can be realized due to variable market prices, quality and yield. Latent infected tubers are the most important source of inoculum because potatoes reproduce vegetatively (Helias et al, 2000; De Boer, 2002). Therefore, the problems of certification systems that will minimize distributions must be resolved (Öztürk & Polat, 2017). Thus, while certification systems are partially effective, they only work in advanced disease symptoms (Czajkowski et al., 2011). Among the most important potato bacterial disease agents; Potato brown disease is agents caused by *Pectobacterium atrosepticum, P. carotovorum* subsp. *brasilinse, P. carotovorum* subsp. *carotovorum and P. parmentieri,* Bacterial ring rot disease agent; *Clavibacter michiganensis* subsp. *sepedonicus.* Potato common scab (PCS) caused by *Streptomyces* spp. is one of the most important bacterial disease on potato (Wanner, 2006). Henrici and Waksman proposed the *Streptomyces Genus* (1943). Based on its morphological characteristics and subsequently cell wall chemistry, it was classified as a member of the family *Streptomycetaceae,* order *Actinomycetales* within the class *Actinobacteria* (Anderson and Wellington 2001). *Streptomyces* species are filamentous and cell-walled bacteria. This genus produces a substrate mycelium with vegetative hyphae 0.5 to 2.0 µm in diameter.

Streptomyces is a large group of filamentous Gram-postive bacteria that are saprophytic pathogens that develop in areas where tuber plants are grown (Lerat et al., 2009). Both mycelium colonies and spores have a complex life cycle. Exospores, which form the substrate mycelium, are a form that germinates under proper conditions to form hyphae (Yaxley, 2009). PCS is caused by many different *Streptomyces* species (*Streptomyces stelliscabiei, Streptomyces caviscabies, Streptomyces luridiscabiei, Streptomyces turgidiscabies, Streptomyces europaeiscabiei, Streptomyces puniciscabiei, Streptomyces niveiscabiei,* and *Streptomyces bottropensis*), especially *Streptomyces scabiei*, in potato can cause disease in its tubers (Henao et al., 2022; Yuan et al., 2020). The species that cause common scab on potatoes in North America are *S. europaeiscabiei, S. stelliscabiei, S. acidiscabiei, S. scabiei and Streptomyces sp*. and *IdahoX* (Clarke et al., 2019; Wanner, 2009). In addition, *S. acidiscabies, S. scabiei* and *S. turgidiscabies,* these three species have been found in S. America, Asia and Europe (Hudec et al., 2021). *Streptomyces acidiscabies* has been reported in Japan, China, South Korea, England, and North America (Braun et al., 2017). *S. europaeiscabiei* and *S. stelliscabiei* have also been reported among the causative species in France (Wanner, 2006; Hudec et al., 2021). An identified *S. turgidiscabies* isolate has been found in South Korea, China, Sweden, England, North America, Japan and Finland. (Wanner, 2006; Braun et al., 2017). The most common symptoms of potato common scab disease are lesions on the surface of potato tubers that can be seen during harvest (Han et al., 2008). General symptoms of the disease may include raised lesions or pitted lesions. The lesions are especially brown and mushroom looking. The frequency and severity of PCS symptoms vary by region and year. The symptom depends on various factors such as potato variety, environment and pathogen density. Streptomyces, the pathogen of the plant, causes symptoms in parts such as stolon, stems and tubers. But roots are excluded. It does not affect the health of infected plants as long as the upper parts of the soil and the crusty stem part in the lower part of the soil do not prevent the transfer of nutrients between the shoots and the root (Dees and Wanner, 2012). Phytotoxin is the primary pathogen determinant. One function of phytotoxin is to synthesize thaxtomin. The exact target of thaxtomin is unknown, but it can be said that it inhibits cellulose biosynthesis (Braun et al., 2017). In 1989, two phytotoxins associated with common PCS were characterized and isolated. These pathogenic species were named “thaxtomins” after the success of the United States

scientist R. Thaxter, who identified them as organisms of PCS (King and Calhoun, 2009). The predominant phytotoxin is considered thaxtomin-A. Another 10 compounds were also characterized and isolated. It was predicted that more findings would be found regarding the effect of thaxtomins in the process. These findings will be important in the coming years to modify genotypes to increase resistance to PCS (King et al., 2001).

To used clean and certified seeds is the main management method of PCS disease. If the soil has infected by PCS, disease-resistant potato varieties should be preferred. Infected and suspicious tubers should be removed and not used as seed. In heavily contaminated soils, crop rotation should be applied with plants such as wheat and barley. Instead of farm manure, green manures should be used along with chemical fertilizers for a few years. (Ministry of Agriculture and Forestry, 2024). To suppress common scab, cultivation methods such as soil pH control (Waterer, 2002) irrigation (Wilson et al. 2001) and rotation (Larkin et al. 2010) have been proposed. Chemical management, including the application of sulfur and bactericides are complicated and environmentally problematic (Dees and Wanner 2012). Biological control is another alternative method. Although it was not pathogenic in different studies, *Streptomyces* spp. one of the biological methods in China is the prevention of widespread scabies caused by *S. scabiei* by using *Streptomyces* strains isolated from soils where the disease is suppressed. It was reported that the study also has positive results in laboratory, greenhouse and field conditions. (Lin et al., 2018; Karagöz, 2013). The future of the agriculture system will cope with the request for significant changes: new trends and solutions to decrease environmental impact. So, increasing interest has been devoted to the research of natural products in food safety and environmental protection. In the search for alternatives to the use of chemical products, aromatic plant extracts and especially essential oils in the use of natural substances is one of the alternative methods. Using herbal biochemical such as essential oils (EO) and extracts is an ecofriendly method to manage plant diseases, pests, and weeds without seriously effecting crop yields (Catani et al., 2022). Their quality and quantity of these compounds depend on plant species, pathogen emergence, harvest time, environmental growing conditions, extraction method and bio pesticide properties are generally broad and targeted against a variety of plant pathogens. Also, they have biodegradable properties and prevent very important damage to the environment (Steglińska et al., 2022). The aim of this study was to evaluate the antibacterial activity

of thyme (*Thymus vulgaris*) and tea tree (*Melaleuca alternifolia*) essentials oils and also plant extract of sandalwood (*Santalum album*), black locust (*Robinia pseudoacacia*, laurel (*Laurus nobilis*) and clove (*Syzygium aromaticum*) against potato commons scab disease caused by *Streptomyces* spp.

MATERIAL AND METHODS

Bacterial isolate and herbal extracts

Potato common scab isolates *Streptomyces* spp. and plant extracts of sandalwood (*Santalum album*), black locust (*Robinia pseudoacacia)*, laurel (*Laurus nobilis*) and clove (*Syzygium aromaticum*) were obtained from the culture collection of the bacteriology laboratory of Niğde Ömer Halisdemir University, Faculty of Agricultural Sciences and Technologies, Department of Plant Production and Technologies, Türkiye. Commercial thyme (*Thymus vulgaris L.*) and tea tree (*Melaleuca alternifolia*) oils were purchased from market.

Used mediums

In the study, Nutrient Agar (NA) (2.0 g K2HPO4, 0.5 g KH2PO4, 2.5 g Glucose, 1000 ml distilled water) was used. Yeast Extract-Malt Extract (YME) agar (Yeast extract 4.0 g, Malt extract 10.0 g, Dextrose 4.0 g, Agar 20.0 g , distilled water 1.0 l) Water Agar (WA) 1.5% (w/v) agar was added to 1 L dH2O .

In vitro antimicrobial effect of herbal extracts

In vitro, antibacterial activity of the plant extract of sandalwood, black locust, laurel and clove was evaluated by disc diffusion methods with the determination of inhibition zones. The tested bacteria, *Streptomyces* sp. isolate were cultured on Yeast Malt Extract (YME) agar medium for two weeks. It was used 10 µl from each extracts and oils. Then the suspension was prepared with a concentration of 10^{8} cfu/ml bacteria. In vitro, antibacterial activity was estimated using formula:

(ZD-DD)/ID×100

ZD: Inhibition zone diameter

DD: Dics diameter

The most effective amount of herbal extracts

Different doses were used to determine the effective amount of the most effective essential oil determined by the disk diffusion method. Herbal extract has diluted by 10 % dimethyl sulfoxide (DMS) solution. It was used 1%, 2%, 4%, 5%, 6% from thyme and

1%, 2%, 4%, 5%, 6%, 18%, 36% and 72% from tea tree oils. 5%, 10%, 15% dilution series used for sandalwood extracts. The studies were conducted in triplicate. The most effective amount of essential oil determined was applied to radish seeds.

***In vivo* antimicrobial effect of herbal extracts**

Tubes containing water agar were inoculated by water (negative control), pathogen bacteria (positive control), essential oils and extracts. Radish seeds were disinfected by 0.5% sodium hypochlorite and 0.1% Tween 20 for 3 min and then passed through sterile distilled water three times. *In vivo* antimicrobial effect of herbal extracts against Streptomyces sp. Was evaluated in six different treatments. 1) only water (negative control), 2) only pathogen bacteria (positive control), 3) only 6 % thyme oil, 4) 6 % thyme oil/pathogen bacteria, 5) only 15% sandalwood extract, 6) 15% sandalwood extract/ pathogen bacteria.

Data analysis

Obtained all data were replicated three times and analysis of variance (ANOVA) was done by using SPSS software. The mean values were compared with Duncan multiple range test at a probability of 5% ($P<0.05$).

RESULTS AND DISCUSSION

***In vitro* antibacterial effects of herbal extracts**

Sandalwood, black locust, laurel, clove plant extracts and thyme and tea tree essantial oils were tested for their antibacterial activity against plant pathogenic *Streptomyces* isolate. According to the analysis; two oils showed antibacterial effect (100 %) and sandalwood extract showed a higher antibacterial effect (23.33-18.50 %) as compared with the other plant extracts (Figure 1).

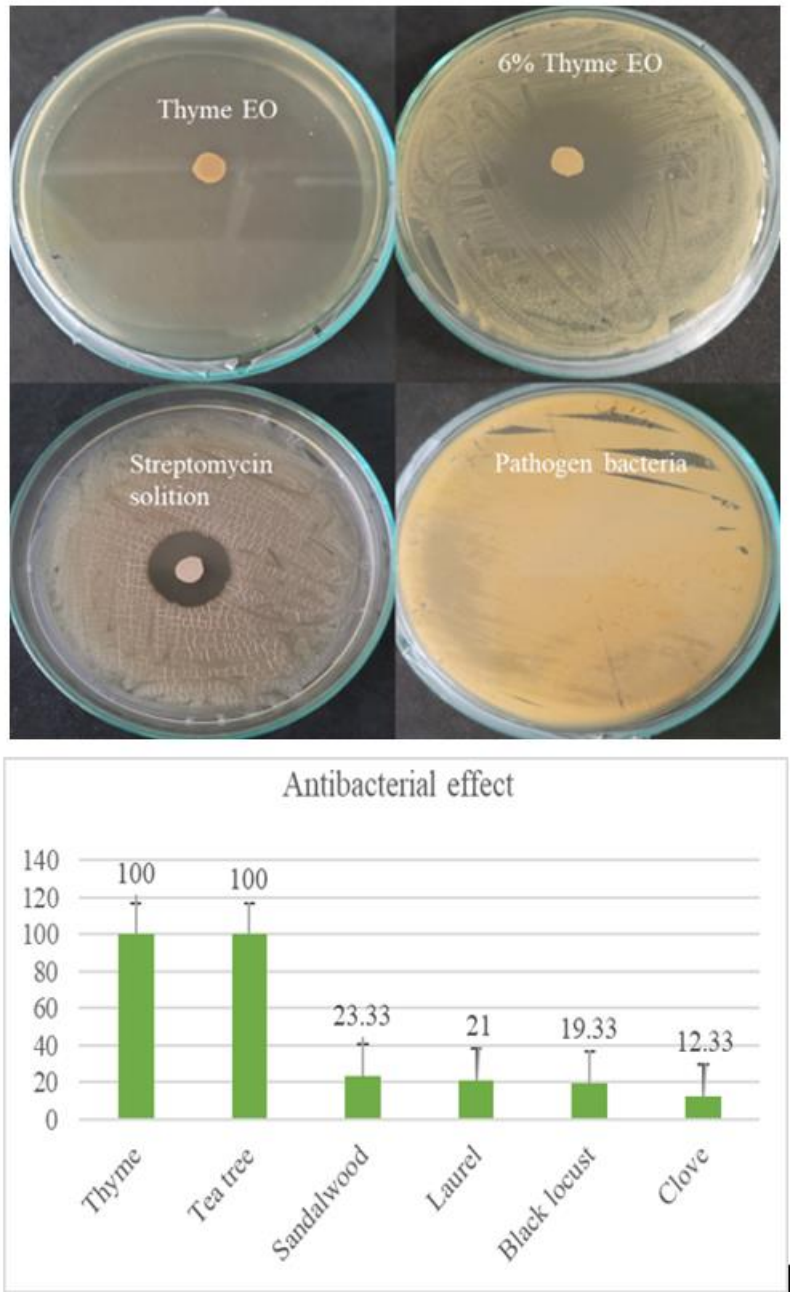


Figure 1. *In vitro* antibacterial effects of herbal extracts

The most effective amount of herbal extracts

According to the analysis; 6% dilution of thyme (21.66 mm zone) 72% tea tree (12.33 mm zone) oils and 15% sandalwood (13.66 mm zone) extract showed a higher antibacterial effect as compared with the other dose of herbal extract (Figure 2).

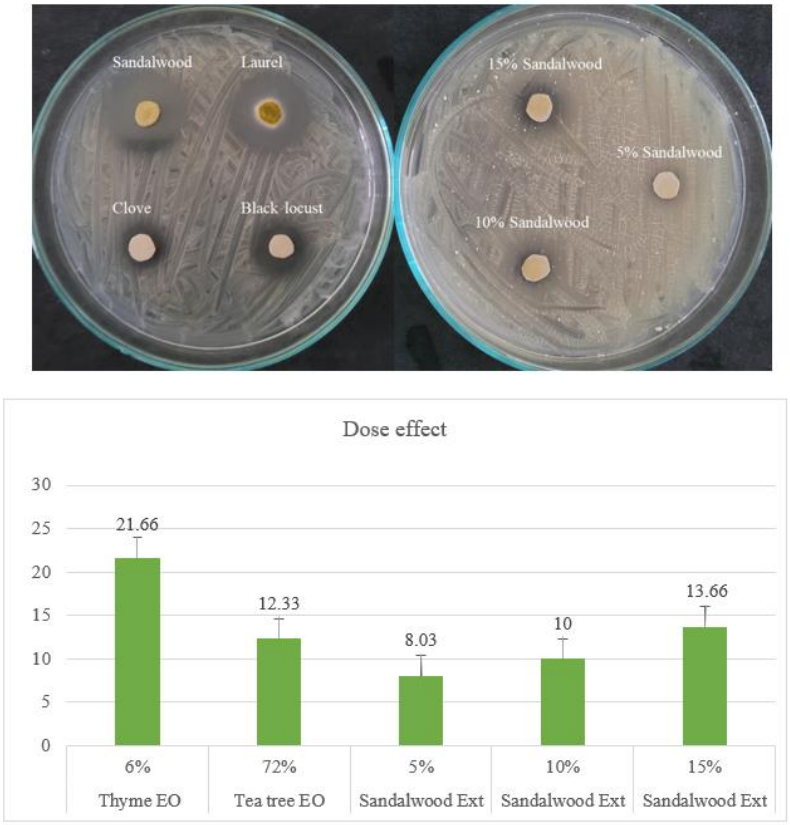


Figure 2. *In vitro* antibacterial effects of herbal extracts of different doses

Prieto et al. (2019), used essential oil of thyme, suico, oregano and mint plants on *Streptomyces scabie*. They found the antimicrobial effect of plants compound by using the disc diffusion method. It was found effective to use all essential oil (EO) against *S. scabiei*, but thyme and suico EO were the most successful. Canadian goldenrod (*Solidago canadensis*) was used Paré et al. (2017), against *Streptomyces scabie*. As a result of the study, it was found that *S. canadensis* significantly reduced the scab severity. Steglińska et al. (2022); tested the 22 plant water extracts, 22 water-glycol extracts, and 3 subcritical carbon dioxide extracts using the agar diffusion method against 10 potato phytopathogens including *Streptomyces scabiei.* As a result of the study, it was found the most effective extract and method was garlic water extract. (Prieto et al., 2020) In this study, the antibacterial fight of peppermint, thyme and suico oils and plant extracts against common scabies was tested. The microdilution method was used to analyze the antibacterial identity of essential oils. 31 bacterial isolates were detected. Thyme essential oil consists heavily of thymol. All essential oils tested were effective against *S. scabiei*, with these oils being the most successful with an inhibitor mixture of 0.068 g·l−1 and 0.147 g·l−1

and a minimum antibacterial mixture of 0.137. Prieto et al. (2022) *T. vulgaris* and *T. minuta* oils are known for their antibacterial fight against common scabies bacteria in potatoes. In this study, the efficiency effect and antibacterial properties of encapsulated oils against the common scabies pest were tested. It has been observed that *T. minuta* and *T. vulgaris* oils reduce tuber yield. It did not have any effect on photosynthesis and plant development when applied to potatoes. It has been observed that microencapsulation of these oils preserves this bacterial activity and is beneficial for potato common scab.

***In vivo* antibacterial effects of herbal extracts**

According to the results of the radish seedling test, there is no germination was observed in diluted 72% tea tree and in tubes in which diluted 72% tea tree and pathogen were added, and it had a phytotoxic effect on the seed. In diluted 6% thyme oil, no germination was observed in 9 seeds and 6 healthy plants were formed. In the tubes containing diluted 6% thyme and pathogen, 6 seeds did not germinate and 9 seeds germinated healthily. In diluted 15% sandalwood extract, 1 germination was not observed, 2 weak plants were formed and 12 healthy plants were formed. In diluted 15% sandalwood extract and pathogenic tubes, germination was not observed in 7 seeds, 1 weak plant and 6 healthy plants were formed (Figure 3).

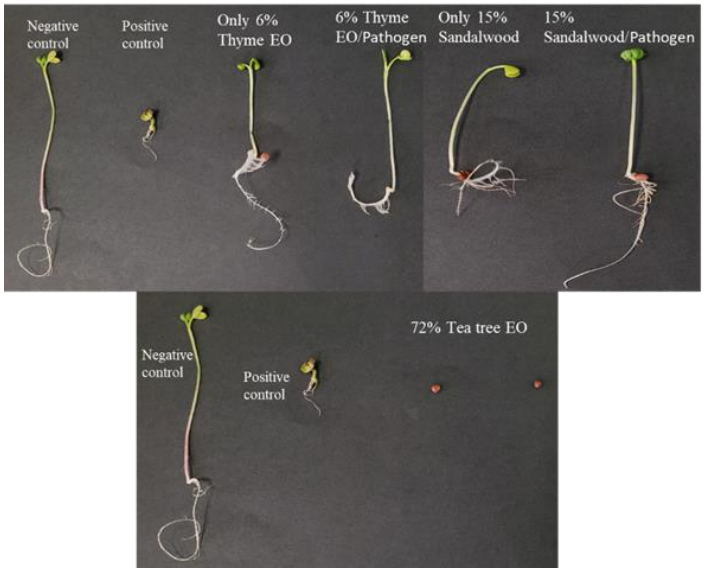


Figure 3. *In vivo* the antibacterial effect of herbal extract against *Streptomyces* sp.

Conclusion and Recommendations

Potato common scab is an important soil-borne disease, which occurs in most potato growing areas of the world. In this study, we evaluated the antibacterial activity of plant extracts and essential oils against potato common scab disease.

- Four plant extracts such as sandalwood (*Santalum album*), black locust (*Robinia pseudoacacia*, laurel (*Laurus nobilis*) and clove (*Syzygium aromaticum*) and two commercial essential oils such as thyme (*Thymus vulgaris L.*) and tea tree (*Melaleuca alternifolia*), furthermore *Streptomyces* sp. as a pathogen were used in the current study.
- Antibacterial activity of herbal extracts against bacterial isolate tested by disc-diffusion method.
- 6% thyme EO and 15% sandalwood extract showed highest inhibition zones than other extracts against bacterial isolate *in vitro* and *in vivo* tests and it was proposed as a potential biopesticide against potato common scab.

As a result of this study, plant extract of thyme EO and sandalwood extract has highest antibacterial effect on potato common scab. In summary, the tested plant extracts especially herbal extracts seem to be promising tools for the control of potato common scab. Future research needs to confirm these findings through the application of the studied plant extracts in field experiments.

REFERENCES

Abed, M. M., & Demirhan, B. (2018). Patates bitkisine (*Solanum tuberosum* L.) genel bir bakış. *International Journal of Life Sciences and Biotechnology*, *1*(1), 1-9.

Anderson, A. S., & Wellington, E. M. (2001). The taxonomy of *Streptomyces* and related genera. *International journal of systematic and evolutionary microbiology*, *51*(3), 797-814. https://doi.org/10.1099/00207713-51-3-797

Food and Agriculture Organization (2022). Food and Agriculture Organization of the United Nations, Rome, Italy Web. Access Address (06.02.2024): http://www.fao.org/faostat/en/#data/QC

Braun, S., Gevens, A., Charkowski, A., Allen, C., & Jansky, S. (2017). Potato common scab: A review of the causal pathogens, management practices, varietal resistance screening methods, and host resistance. *American Journal of Potato Research, 94*, 283-296.

Catani, L., Grassi, E., di Montanara, A. C., Guidi, L., Sandulli, R., Manachini, B., & Semprucci, F. (2022). Essential oils and their applications in agriculture and agricultural products: *A literature analysis through VOS viewer. Biocatalysis and Agricultural Biotechnology,* 102502. https://doi.org/10.1016/j.bcab.2022.102502

Clarke, C. R., Kramer, C. G., Kotha, R. R., Wanner, L. A., Luthria, D. L., & Kramer, M. (2019). Cultivar resistance to common scab disease of potato is dependent on the pathogen species. *Phytopathology, 109*(9), 1544-1554. https://doi.org/10.1094/PHYTO-09-18-0368-R

Czajkowski, R., Perombelon, M. C., van Veen, J. A., & van der Wolf, J. M. (2011). Control of blackleg and tuber soft rot of potato caused by *Pectobacterium* and *Dickeya* species: a review. *Plant pathology, 60*(6), 999-1013. https://doi.org/10.1111/j.1365-3059.2011.02470.x

De Boer, S. H. (2002). Relative incidence of *Erwinia carotovora subsp. atroseptica* in stolon end and peridermal tissue of potato tubers in Canada. *Plant disease, 86*(9), 960-964. https://doi.org/10.1094/PDIS.2002.86.9.960

Dees, M. W., & Wanner, L. A. (2012). In search of better management of potato common scab. *Potato research, 55*, 249-268.

Dumanoğlu, Z., & Öztürk, G. (2021). Patates (*Solanum tuberosum* L.) Tarımı ve Önemi. *MAS Journal of Applied Sciences*, *6*(Özel Sayı), 1307-1315. https://doi.org/10.52520/masjaps.166

Han, L., Dutilleul, P., Prasher, S. O., Beaulieu, C., & Smith, D. L. (2008). Assessment of common scab-inducing pathogen effects on potato underground organs via computed tomography scanning. *Phytopathology, 98*(10), 1118-1125. https://doi.org/10.1094/PHYTO-98-10-1118

Hélias, V., Andrivon, D. & Jouan, B. 2000. Development of symptoms caused by *Erwinia carotovora ssp. atroseptica* under field conditions and their effects on the yield of individual potato plants. *Plant Pathology 49*: 23 – 32. https://doi.org/10.1046/j.1365-3059.2000.00430.x

Henao, L., Guevara, M., Restrepo, S., & Husserl, J. (2022). Genotypic and phenotypic characterization of *Streptomyces* species associated with potato crops in the central part of Colombia. *Plant Pathology, 71*(3), 750-761. https://doi.org/10.1111/ppa.13485

Hudec, C., Novinscak, A., & Filion, M. (2021). Diversity and virulence of *Streptomyces* spp. causing potato common scab in Prince Edward Island, Canada. *Phytopathology*®, *111*(4), 617-626. https://doi.org/10.1094/PHYTO-08-20-0339-R

Karagöz, K. (2013). Erzurum ili patates tarlalarından izole edilen bitki patojeni *Streptomyces* türlerinin tanısı ve karakterizosyonu. *Fen Bilimleri Enstitüsü, Doktora Tezi, s129.*

King, R. R., & Calhoun, L. A. (2009). The thaxtomin phytotoxins: sources, synthesis, biosynthesis, biotransformation and biological activity. *Phytochemistry, 70*(7), 833-841. https://doi.org/10.1016/j.phytochem.2009.04.013

King, R. R., Lawrence, C. H., & Gray, J. A. (2001). Herbicidal properties of the thaxtomin group of phytotoxins. *Journal of Agricultural and Food Chemistry, 49*(5), 2298-2301. https://doi.org/10.1021/jf0012998

Lerat, S., Simao-Beaunoir, A. M., & Beaulieu, C. (2009). Genetic and physiological determinants of *Streptomyces scabies* pathogenicity. *Molecular plant pathology, 10*(5), 579-585. https://doi.org/10.1111/j.1364-3703.2009.00561.x

Lin, C., Tsai, C. H., Chen, P. Y., Wu, C. Y., Chang, Y. L., Yang, Y. L., & Chen, Y. L. (2018). Biological control of potato common scab by *Bacillus amyloliquefaciens* Ba01. *PLoS One, 13*(4), e0196520. https://doi.org/10.1371/journal.pone.0196520

Öztürk, E., & Polat, T. (2017). Tohumluk patates yetiştiriciliği ve önemi. *Alinteri Journal of Agriculture Science*, *32*(1), 99-104. https://doi.org/10.28955/alinterizbd.285638

Prieto, M. C., Camacho, N. M., Inocenti, F. D., Mignolli, F., Lucini, E., Palma, S., & Asensio, C. M. (2023). Microencapsulation of *Thymus vulgaris* and *Tagetes minuta* essential oils: Volatile release behavior, antibacterial activity and effect on potato yield. *Journal of the Saudi Society of Agricultural Sciences, 22*(3), 195-204. https://doi.org/10.1016/j.jssas.2022.10.003

Prieto, M. C., Lapaz, M. I., Lucini, E. I., Pianzzola, M. J., Grosso, N. R., & Asensio, C. M. (2020). Thyme and suico essential oils: promising natural tools for potato common scab control. *Plant Biology, 22*(1), 81-89. https://doi.org/10.1111/plb.13048

Republic of Turkey Ministry of Agriculture and Forestry (2023). Patates Adi Uyuz Hastalığı. Access Address (15.02.2024) https://kayseri.tarimorman.gov.tr/Belgeler/SOL%20MEN%C3%9C%20BELGELER%C4%B0/Z%C4%B0RAA%C4%B0%20M%C3%9CCADELE/Sebze%20Hastal%C4%B1klar%C4%B1/patates_adi_uyuz_hastaligi.pdf

Steglińska, A., Bekhter, A., Wawrzyniak, P., Kunicka-Styczyńska, A., Jastrząbek, K., Fidler, M., & Gutarowska, B. (2022). Antimicrobial Activities of Plant Extracts against *Solanum tuberosum* L.Phytopathogens. *Molecules*, *27*(5), 1579. https://doi.org/10.3390/molecules27051579

Turkish Statistical Institute (TUIK). (2022) Turkey's crop production statistics. Access Address (06.02.2024). https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr

Ünlü, N., & Elçi, E. (2022). Niğde ilinde yetiştirilen patateslerdeki adi uyuz hastalık etmeni *Streptomyces* türlerinin belirlenmesi. *Mustafa Kemal Üniversitesi Tarım Bilimleri Dergisi*, *27*(3), 402-412. https://doi.org/10.37908/mkutbd.1092635

Wanner, L. A. (2006). A survey of genetic variation in *Streptomyces* isolates causing potato common scab in the United States. *Phytopathology, 96*(12), 1363-1371. https://doi.org/10.1094/PHYTO-96-1363

Wanner, L. A. (2009). A patchwork of *Streptomyces* species isolated from potato common scab lesions in North America. *American Journal of Potato Research, 86*, 247-264.

Yuan, J., Bizimungu, B., De Koeyer, D., Rosyara, U., Wen, Z., & Lagüe, M. (2020). Genome-wide association study of resistance to potato common scab. *Potato Research, 63,* 253-266.

THE CAUSAL AGENT OF BLACK ROT ON CABBAGE

Tuğba EROĞLU (ORCID: 0009-0000-9441-4914)
Niğde Ömer Halisdemir University, Faculty of Agricultural Sciences and Technologies, Department of Plant Production and Technologies, Niğde-Türkiye
Email: tugba.eroglu2017@gmail.com

Rsch. Asst. Nida ÜNLÜ* (ORCID: 0000-0002-0740-4425)
Niğde Ömer Halisdemir University, Faculty of Agricultural Sciences and Technologies, Department of Plant Production and Technologies, Niğde-Türkiye
Email: n.unlu33@gmail.com

Assoc. Prof. Eminur ELÇİ (ORCID: 0000-0002-6434-6321)
Niğde Ömer Halisdemir University, Faculty of Agricultural Sciences and Technologies, Department of Plant Production and Technologies, Niğde-Türkiye
Email: eminur@gmail.com

ABSTRACT
Black rot disease is a widespread bacterial disease which causes serious economic losses in whitehead cabbage (*Brassica oleraceae* var. *capitata* f. *alba*) production in Türkiye, as well as all over the world. Chlorotic yellow V-shaped lesions and black veins on the leaf edges are the most typical symptoms of this disease. In this study, it was aimed to conduct observations, isolations and 3 different pathogenicity tests for the preliminary identification of this disease in Niğde province, which is an important white cabbage producer in Türkiye. In this direction, 7 isolates were obtained as a result of isolation from infected leaf samples, and pathogenicity tests were carried out *in vitro* on potato disc and *in vivo* on tobacco and whitehead cabbage plants. As a result of these tests, all of the isolates gave positive results and are thought to be *Xanthomonas campestris* pv. *campestris*, the causative agent of black rot disease.
Keywords: Cabbage, bacterial disease, black rot, *Xanthomonas spp.*

Introduction

White head cabbage (*Brassica oleraceae* var. *capitata* f. *alba*), which belongs to the *Brassicaceae* (formerly *Cruciferae*) family, is a biennial vegetable whose leaves are eaten, and its homeland is known as the Baltic Sea coasts and Northern European countries (Al-Shehbaz et al., 2006). Since it is not a soil-selective vegetable, it is produced all over Türkiye. Although it is produced all year round in European countries, it is mostly produced in winter in Türkiye (Balkaya et al., 2016). Cabbage is an economically important vegetable produced in more than 90 countries around the world and its cultivation is increasing in the world and in Türkiye (Šamec et al., 2017). When the data averages of the world cabbage production amounts for the years 2016 and 2020 are examined, the highest production was realized in China with approximately 38 million tons. China's share in the world's total cabbage production is approximately 41%. China is followed by India with 16.44% and Russia with 3.06%. Türkiye's share in the world's total cabbage production is approximately 1% (FAO, 2020). And in 2022, a total of 597,910 tons of white cabbage is produced in Türkiye. The provinces with the most cultivation are; Samsun (228.271 tons), Niğde (131.205 tons), Bursa (27.008 tons), Afyonkarahisar (24.278 tons), Antalya (23.134 tons), Mersin (21.267 tons) are listed (TUIK 2024). Niğde, with Kaynarca Village of Bor District, is one of the province with the highest production in Türkiye and contributes significantly to agricultural output. However, diseases and pests that occur during its cultivation have a negative impact on production. Among these, bacterial black rot disease caused by the vascular pathogen *Xanthomonas campestris* pv. *campestris* (Pammel) Dowson (Xcc) which is a gram negative, obligate aerobic, rod shaped bacterium with yellows pigmented colonies in culture can be seen in all brassica plants and can cause crop losses of more than 90% (Alvarez et al., 1994). Some surveys and identification studies have been carried out for the Xcc at different times in Türkiye so far. In relation to this, Xcc causing black rot was identified for the first time in Türkiye in the Mediterranean region in 2004-2006 by Mirik et al., (2008) in white cabbage, brussels sprouts and broccoli. 20 isolates obtained were identified as Xcc by the fatty acid methyl ester (FAME) analyze and Elisa. Aksoy (2007) conducted surveys on cabbage growing areas in 10 different regions of Samsun between 2003 and 2004 and determined 10 isolates as Xcc by hypersensitivity, pathogenicity and biochemical tests. With the disease severity of 41.6%, Kuşçular Village was detected as

the area with the highest disease rate. In addition, this study is the first study for the determination of Xcc in the Bafra Plain. Öztürk & Soylu (2021), on the other hand, reported the presence of Xcc for the first time in Niğde and identified 15 bacterial isolates obtained as a result of surveys they carried out in 27 fields in 2019 as *Xanthomonas campestris* pv. *campestris* by morphological, physiological, pathogenicity and molecular tests. Dervis et al., (2021) identified all 50 bacterial isolates obtained as a result of their surveys in 300 fields across Niğde in 2017-2018 as *Xanthomonas campestris* pv. *campestris* by fatty acid methyl ester (FAME) analysis and showed that Xcc were the most common bacterial disease in white cabbage production areas in Niğde. And lastly, Erken (2022) carried out studies to determine the prevalence, incidence and severity of black rot disease agent in Samsun, Amasya, Çorum and Tokat provinces, and physiological, biochemical, molecular identification of Xcc isolates, determination of races and whole genome sequence analysis. Of the 330 isolates, 307 were identified as Xcc and 211 were identified as race 4. The primary inoculum sources of cabbage black rot disease are contaminated seeds, diseased weeds, plant residues and bacteria survive there. In the spread of *Xanthomonas campestris* pv. *campestris* in the production area, irrigation water, rain, agricultural equipment is extremely important. The most important symptom in the white head cabbage plant is dark veined and chlorotic yellow V-shaped lesions on the leaf margin. Leaves are infected by stomata, or usually by hydatids, and the typical V-shaped symptoms enlarge towards the center of the leaf. As a result of the movement of bacteria between the veins, the vascular system begins to darken and reaches the stem and infects other leaves. Thus, the entire plant becomes infected. Eventually, the plant begins to rot. Factors such as rain, suitable humidity and temperature facilitate the movement of bacteria. In such favorable conditions, symptoms are more severe (Cook et al., 1952; Schaad, 1982; Walker, 1953).

Black rot caused by *Xanthomonas campestris* pv. *campestris* is still a considerable problem in the white head cabbage growing areas today and is an arduous disease to manage. One of the best control methods is to use pathogen-free, clean seeds (Williams, 1980). Cultural practices such as the use of resistant varieties, crop rotation, sanitation, and physical and chemical treatment of seeds are among the other control methods (Franken, 1992; Kocks & Zadoks, 1996; Taylor et al., 2002). Unfortunately, today, an effective and economical control method for this disease has not been fully developed.

Materials and Methods

Reference bacterial isolate

Positive control were obtained from the culture collection of the bacteriology laboratory of Niğde Ömer Halisdemir University, Faculty of Agricultural Sciences and Technologies, Department of Plant Production and Technologies, Türkiye.

Collection of infected plants samples

As a result of six different field studies in Kaynarca village of Bor district of Niğde Province, suspicious cabbage samples with black rot disease symptoms were collected and transferred to the laboratory environment.

Isolation of disease-causing bacteria

After surface sterilization of the diseased leaf materials, small pieces taken from the main vein, whose vascular bundles turned black, were crushed in a mortar and 0.9% NaCl solution was added to them to enable the bacteria to pass into the water. 30 minutes later, bacteria were planted on NA medium with the help of a loop by line sowing method and incubated at ±26°C. At the end of 3 days, the developing colonies with single yellow colony morphology compatible with the diagnostic criteria of *Xanthomonas campestris* pv. *campestris* were purified on a different media. Purified isolates were developed in LB (Luria Bertani) broth medium at 150 rpm at 28°C for 24 hours in a shaking incubator, then mixed with 50% glycerin at a ratio of 50% and stored at -20°C for pathogenisity studies.

Tobacco hypersensitivity (HR) test

For the pathogenicity tests of the 8 isolates obtained, suspensions of bacterial cultures grown in NA for 24-48 hours at ±26°C were prepared with sterile pure water. Then, after 1 cm wounds were made on tobacco (*Nicotiana glutinosa*) leaves with the help of a sterile needle, bacterial suspensions were injected between the vessels of the tobacco plant with the help of a sterile syringe. Reference bacterial isolate as positive control and sterile pure water as negative control were used. The isolates that produced necrosis were evaluated as HR positive (+), and those that did not form were evaluated as HR negative (–).The experiment was carried out in 3 replications (Fig. 1).

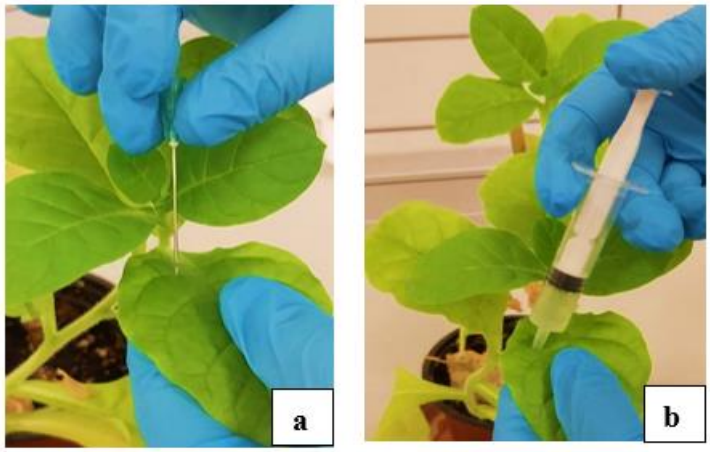


Figure 1. Creating wounds (a), and inoculation of bacterial isolates to tobacco leaves (b).

Potato disc test

After surface sterilization in %3 sodium hypochlorite, disease-free potatoes (Solanum tuberosum) tubers were peeled and sliced approximately in 1 cm thickness and placed in petri dishes. Bacterial cultures grown in NA for 24-48 hours at ±26°C were injected into the middle part of the potato slices with a sterile toothpick. Reference bacterial isolate as positive control and sterile pure water as negative control were used and they were incubated at ±26°C. The experiment was carried out in 3 replications. After 24-72 hours, they were checked whether there is softening and they were evaluated as positive in case of formation of soft rot (Fig. 2).

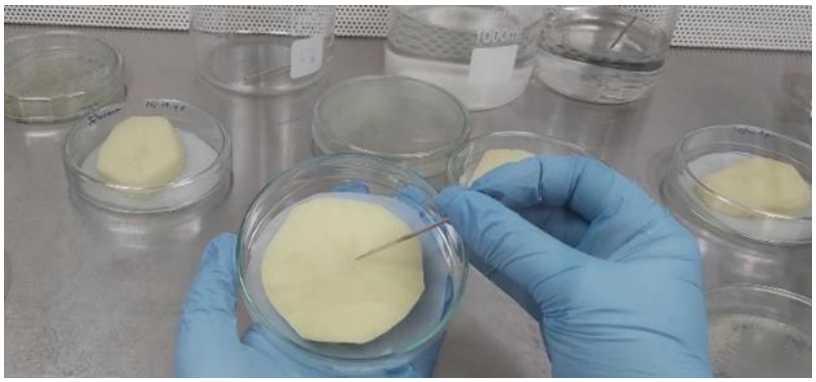


Figure 2. Inoculation of bacterial isolates on potato slices.

Cabbage seedling test

Suspensions of bacterial cultures grown in NA at ±26°C for 24-48 hours were prepared with sterile pure water, and inoculation was carried out by pricking the leaf stems of 4-6 week old cabbage plants with a sterile needle dipped in the bacterial suspension.

Reference bacterial isolate was used as a positive control and sterile pure water was used as a negative control. For each isolate, 3 plants were used, 3 leaves were selected per plant, and each petiole was inoculated from 5 different places. After 3-4 weeks, it was observed whether symptoms specific to Xcc occurred. Seeds of native Kaynarca cultivar were used in the experiment (Fig. 3).

Figure 3. Inoculation of bacterial isolates to cabbage seedling.

Findings and Discussion

Collection of infected white head cabbage plants

As a result of the field observations conducted in Kaynarca Village of Bor district of Niğde province, plant samples showing symptoms such as yellow lesions on the leaves of mature plants starting from the leaf margins and progressing inwards in a V shape, blackening of the veins of infected leaves, and rotting of the plant veins were collected from six fields (Fig. 4).

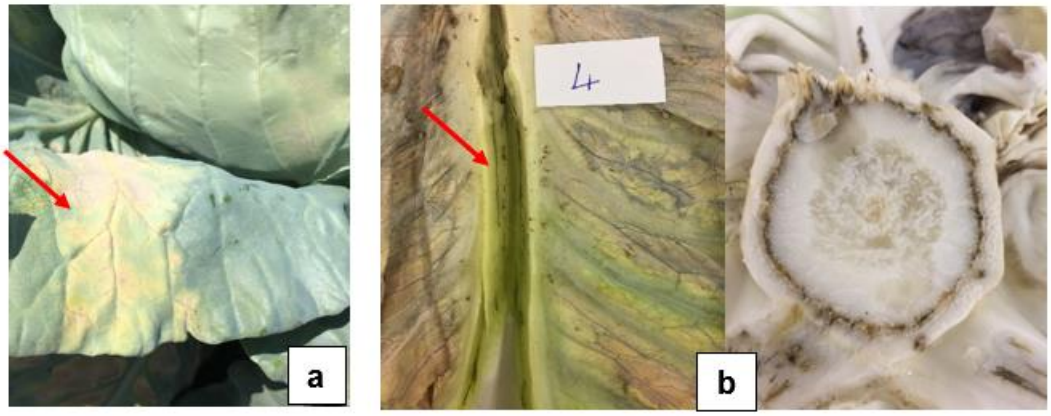


Figure 4. Yellow lesions growing in a V shape (a), blackening of the vein (b).

Figure 5. View of the infected white head cabbage plant vein under the microscope.

Isolation of black rot agent in cabbage

During the purification process, colonies with single yellow color, shiny appearance, convex, mucoid and smooth edges were selected (Fig. 6).

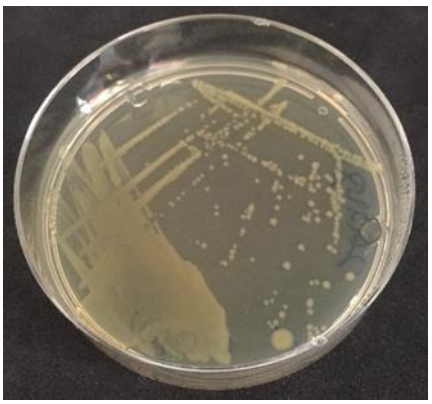


Figure 6. Yellow colonies growing on NA media.

Tobacco hypersensitivity (HR) test

Within one week-10 days after inoculation of 7 isolates, necrosis formation was observed in the inoculation areas of tobacco plant and it was understood that 7 isolates were pathogenic. Although reference isolate showed necrosis, no symptoms were observed in the area where sterile pure water was inoculated as negative control (Fig. 7).

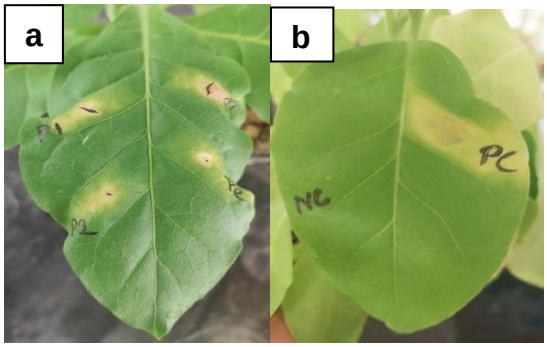


Figure 7. Symptoms caused by bacterial isolates on tobacco plant (a), negative and positive controls.

Potato disc test

Each of these seven isolates, like the reference isolate, was observed to damage the tissues and cause soft rot in potato slices. As a negative control, soft rot was not observed in potato slices inoculated with sterile pure water (Fig. 8).

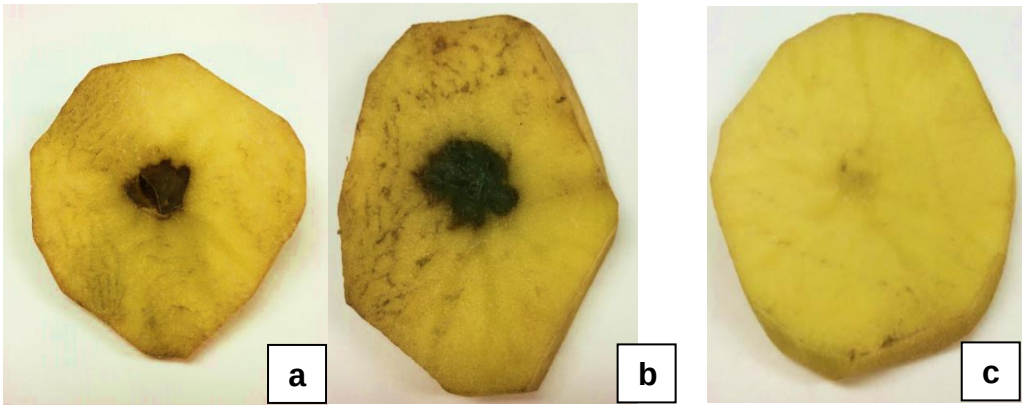


Figure 8. Soft rot caused by bacterial isolates on potato slice (a), positive control (b), and negative control (c).

Cabbage seedling test

After a 3-4 week incubation period, cabbage plants inoculated with 7 bacterial isolates showed the same typical symptoms of black rot disease as the reference isolate, such as black veins and chlorotic V-shaped lesions starting from the leaf edges and progressing inward. In the negative control, no symptoms wee observed (Fig. 9).

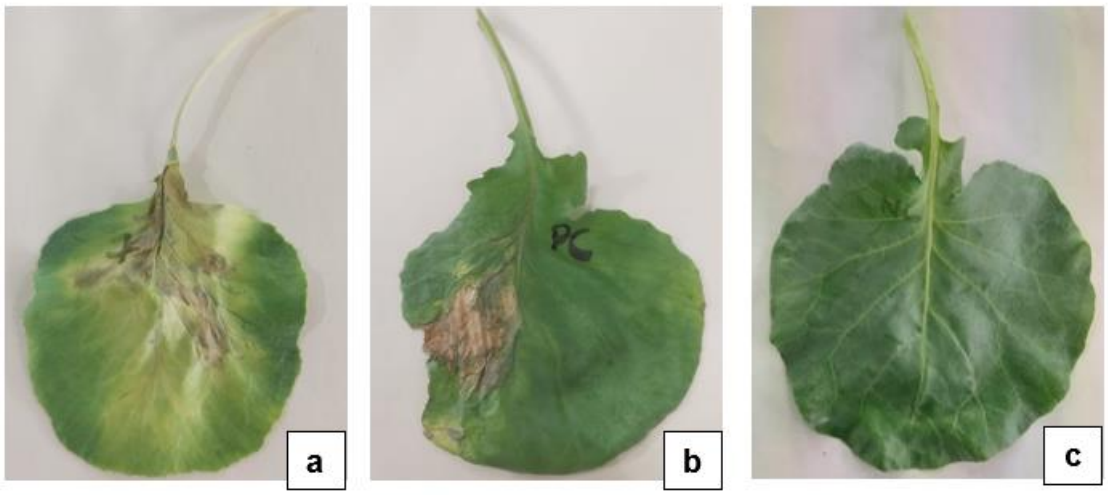


Figure 9. Symptoms caused by bacterial isolates on cabbage seedling (a), positive control (b), and negative control (c).

Conclusion and Recommendations

Within the scope of the study, observations were done on the fields where white cabbage is grown in Kaynarca village of Bor district of Niğde province and isolations were carried out of infected plants. Seven isolates were obtained by looking at their colony development, and all of them were found to be pathogenic as a result of tobacco hypersensitivity, potato disk and cabbage seedling pathonenisity tests. Among the vegetables belonging to the *Brassicae* family, whitehead cabbage plants, which are one of the most damaging hosts of Xcc, showed typical black rot disease symptoms such as black veins and chlorotic V-shaped lesions that started at the leaf edges and progressed inwards.

In this study, the black rot disease agent *Xanthomonas campestris* pv. *campestris,* which causes significant crop losses in white head cabbage plant in terms of vegetable cultivation, was identified and its existence was investigated in Kaynarca village of Bor district of Niğde province, which is an important cabbage production area in Türkiye. Since it is one of the most devastating diseases among white cabbage and other crops belonging to the *Brassicaceae* family and can cause serious losses in production areas, it is of great importance to identify regional races of the bacteria and control the disease.

Thanks and Information Note

The current research partly produced by the Master Thesis of Tuğba EROĞLU which is carrying out at Niğde Ömer Halisdemir University Niğde, Türkiye.

References

Aksoy, H. (2007). Samsun ili bafra ilçesi'nde beyaz baş lahana alanlarinda siyah damar çürüklük etmeni *Xanthomonas campestris* pv. *campestris* [(Pammel 1895) Dowson 1939]'nin belirlenmesi. *Anadolu Tarım Bilimleri Dergisi*, *22*(3), pp. 297-300.

Al-Shehbaz, I. A., Beilstein M. A. & Kellogg E. A. (2006). Systematics and phylogeny of the *Brassicaceae* (Cruciferae): an overview. *Plant Syst Evol*, pp. 259:89-120.

Alvarez, A. M., Benedict, A. A., Mizumoto, C. Y., Hunter, J. E., & Gabriel, D. W. (1994). Serological, pathological, and genetic diversity among isolates of *Xanthomonas campestris* infecting crucifers. *Phytopathology*, 84(12), pp. 1449-1457.

Balkaya, A., Sarıbaş, Ş. & Özgen, T. (2016). Türkiye'de kışlık sebze türlerinin tarımsal üretimdeki yeri ve önemi. *Journal of TURKTOB*, *5*(20), pp. 8-12.

Cook, A. A., Walker, J. C. & Larson, R. H. (1952). Studies on the disease cycle of black rot of crucifers. *Phytopathology*, 42, pp. 162-167.

Dervis, S., Serçe, Ç.U. & Bozkurt, A. (2021). Survey on disease problems of cabbage (Brassica oleracea var. capitata) in Niğde, Turkey. *In book: Bitki Korumada Son Gelişmeler*, pp. 45-62.

Food and Agriculture Organization of the United Nations. FAO. (2020). "FAOSTAT-Production-Crops-Cabbage". Access Address (12.02.2024):
http://www.fao.org/faostat/en/#data/QC

Franken, A. (1992). Application of polyclonal and monoclonal antibodies for the detection of *Xanthomonas campestris* pv. *campestris* in crucifer seeds using immunofluorescence microscopy. *Neth. J. Plant Pathol*, 98, pp. 95-106.

Kocks, C. G. & Zadoks, J. C. (1996). Cabbage refuse piles as sources of inoculum for black rot epidemics. *Plant Dis.* 80, pp. 789-792.

Mirik, M., Selcuk, F., Aysan, Y. & Sahin, F. (2008). First outbreak of bacterial black rot on cabbage, broccoli, and brussels sprouts caused by *Xanthomonas campestris* pv. *campestris* in the Mediterranean Region of Turkey. *Plant Disease*, *92*(1), pp. 176-176.

Šamec, D., Pavlović, I. & Salopek-Sondi, B. (2017). White cabbage (*Brassica oleracea* var. *capitata* f. *alba*): botanical, phytochemical and pharmacological overview. *Phytochemistry reviews*, *16*(1), pp. 117-135.

Öztürk, M. & Soylu, S. (2021). Identification of *Xanthomonas campestris* pv. *campestris* Isolates causing black rot disease on cabbage in Niğde province of Turkey. *Book of Proceedings of the XII International Scientific Agricultural Symposium "Agrosym 2021"*, pp. 647.

Singh, D., Raghavendra, B. T., Rathaur, P. S., Singh, H., Raghuwanshi, R. & Singh, R. P. (2014). Detection of black rot disease causing pathogen *Xanthomonas campestris* pv. *campestris* by bio-PCR from seeds and plant parts of cole crops. *Seed Science and Technology*, *42*(1), pp. 36-46.

Taylor, J. D., Conway, J., Roberts, S. J., Astley, D. & Vicente, J. G. (2002). Sources and origin of resistance to *Xanthomonas campestris* pv. *campestris* in *Brassica* genomes. *Phytopathology*, 92, pp. 105-111.

Turkish Statistical Institute (TUIK). (2024). Crop Production Statistics. Access Address (12.02.2024): (https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr)

Williams, P. H. (1980). Black rot: a continuing threat to world crucifers. *Plant Dis.* 64, pp. 736-742.

FOSFOROZ ASİTE KARŞI *PHYTOPHTHORA* × *CAMBIVORA* VE *PHYTOPHTHORA CINNAMOMI* İZOLATLARININ HASSASIYETININ *ABCA1* GEN İFADE SEVİYESİNDE BELİRLENMESİ

Öğr. Gör. Dr. Deniz ÇAKAR* (ORCID: 0000-0002-6269-404X)
Çankırı Karatekin Üniversitesi, Merkezi Araştırma Laboratuvarı Uygulama ve Araştırma Merkezi, Çankırı, Türkiye
Email: denizzcakarr86@gmail.com

Dr. Öğr. Üyesi Ebru DERELLİ TÜFEKÇİ (ORCID: 0000-0003-1097-8574)
Çankırı Karatekin Üniversitesi, Gıda ve Tarım Meslek Yüksekokulu, Bitkisel ve Hayvansal Üretim Bölümü, Çankırı, Türkiye
Email: ebru.derelli@gmail.com

Prof. Dr. Seçil AKILLI ŞİMŞEK (ORCID: 0000-0002-5055-1391)
Çankırı Karatekin Üniversitesi, Fen Fakültesi, Biyoloji Bölümü, Çankırı, Türkiye
Email: secilakilli@gmail.com

ÖZET
Phytophthora türleri tek ve çok yıllık bitkilerde kök, kök boğazı ve yaprak yanıklığı oluşturarak ani ölümlere yol açan önemli bir patojen olup, birçok orman ve meyve ağacını da enfekte etmektedir. *Phytophthora* hastalıklarının kontrolü ve mücadelesinde çeşitli yöntemler araştırılmıştır. Bu uygulamalar içerisinde Fosforoz asit [Phosphorous acid (PA)] en etkili ve en çok kullanılan kimyasallardan biri olarak yerini almaktadır. Yapılan bu çalışmada *P.* × *cambivora* ve *P. cinnamomi* izolatlarına karşı Fosforoz asitin duyarlılığını belirlemek amacıyla, 17.5, 35, 85 µg mL^{-1} konsantrasyonlarında hazırlanan kimyasal ilaç besi ortamlarına eklenmiş, kontrol petrilerinde ise steril su kullanılmıştır. Etken maddenin, fungusun miselyal gelişimi üzerine etkilerini belirlemek için, miselyal büyümeyi engelleme yüzdeleri (%) hesaplanmıştır. Çalışma üç tekerrürlü ve deneyler iki tekrarlı olacak şekilde yapılmıştır. Patojenlerin, kimyasal ilaca karşı dirençlerini gen ifade seviyesinde belirlemek amacıyla, kemoterapötik ajanlara karşı çoklu ilaç direncinde rol oynayan ATP-bağlayıcı kaset (ABC) membran taşıyıcıları *ABCA1* geni ifade seviyesinde belirlenmiştir. Elde edilen sonuçlara göre, ABC taşıyıcıları, ATP kaynaklı akış mekanizmaları ile bitki savunma bileşiklerine ve fungisitlere karşı koruma sağlayabilir.
Anahtar Kelimeler: *Pyhtophthora*, Fosforoz asit, Miselyal gelişim, ABC taşıyıcıları

THE DETERMINATION OF SENSITIVITY OF *PHYTOPHTHORA* × *CAMBIVORA* AND *PHYTOPHTHORA CINNAMOMI* ISOLATES TO PHOSPHOROUS ACID BY ASSESSING *ABCA1* GENE EXPRESSION LEVELS

ABSTRACT

Phytophthora species are significant pathogens that cause root, collar rots and leaf blight, leading to sudden death in both annual and perennial plants, infecting numerous forest and fruit trees. Various methods have been researched for the control and management of *Phytophthora* diseases. Among these approaches, Phosphorous acid (PA) stands out as one of the most effective and widely used chemicals. In this study, the sensitivity of *P.* × *cambivora* and *P. cinnamomi* isolates to phosphorous acid was determined by adding the chemical to nutrient media at concentrations of 17.5, 35, and 85 µg mL^{-1}, while sterile water was used in control petri dishes. The percentages of inhibition of mycelial growth were calculated to determine the effects of the active substance on fungal mycelial development. The study was conducted with three replicates, and experiments were carried out in duplicate. To determine the pathogens' resistance to the chemical treatment at the gene expression level, ATP-binding cassette (ABC) membrane transporters, particularly the *ABCA1* gene, involved in multidrug resistance to chemotherapeutic agents, were assessed. According to the results obtained, ABC transporters may provide protection against plant defense compounds and fungicides through ATP-dependent transport mechanisms.

Keywords: *Pyhtophthora*, Phosphorous acid, Mycelial growth, ABC transporters

Introduction

Phytophthora, derived from the Greek words phytón (plant) and phthorá (destruction), is a name given to signify "plant destroyer". It is a genus known as a harmful agent to plants within the class Oomycetes (water molds). There are over 100 species of *Phytophthora*, particularly causing root rot, affecting numerous plant species. *Phytophthora* species are recognized globally as significant pathogens causing severe wilting and death in forest and fruit trees. This phenomenon has been addressed in various studies (Carneiro-Carvalho et al., 2017; Akıllı Şimşek et al., 2019).

Despite the limited number of species-specific races or varieties within *Phytophthora* species, they often infect multiple hosts (Hansen, 2015). Among *Phytophthora* species, *P. cinnamomi* Rands and a newly identified species, *P. ramorum* Werres, De Cock, & Man in't Veld, have the highest number of hosts.

One of the primary forest trees affected by *P. cinnamomi*, leading to root rot, is the species of *Castanea* spp. (Vannini and Vettraino, 2001; Fernandes et al., 2021). In Turkey, it has been observed that chestnut (*Castanea sativa* Mill.), which is an important forest tree in terms of its fruit, wood, and even flowering, is affected by root rot and wilting (Akıllı Şimşek et al., 2019).

Studies conducted worldwide have reported the presence of 10 *Phytophthora* species in chestnut trees. These include *P.* × *cambivora* (Petri) Buisman, *P. cinnamomi*, *P. cactorum* (Lebert & Cohn) J. Schröt., *P. cryptogea* Pethybr. & Laff., *P. gonapodyides* Pethybr. & Laff., *P. megasperma* Drechsler, *P. nicotianae* Breda de Haan, *P. plurivora* T. Jung & T.I. Burgess, *P. pseudosyringae* T. Jung & Delatour, and *P. syringae* (Kleb.) Kleb. (Prospero et al., 2012). Four of these mentioned species have been identified in chestnut fields in Turkey. According to their occurrence frequency, these species are *P. cinnamomi*, *P. cambivora*, *P. plurivora*, and *P. cryptogea*. The most aggressive *Phytophthora* species are reported to be *P.* × *cambivora* and *P. cinnamomi* (Akıllı et al., 2012). *Phytophthora* × *cambivora* is one of the common species known as the causal agent of ink disease (Day 1938; Vannini & Vettraino, 2001). This species particularly affects chestnut and beech trees in the Fagaceae family (Belisario et al., 2006; Jung et al., 2005). *Phytophthora cinnamomi*, on the other hand, can be described as a species that predominantly causes root deaths.

Various control methods have been tested in combating *Phytophthora* diseases. One of the most effective and widely used practices among these is the application of phosphorous acid. This product, phosphorous acid, possesses fungicidal properties against oomycetes such as *Phytophthora* spp. (Banko and Hong, 2004). Additionally, phosphorous acid is registered by the Environmental Protection Agency (EPA) for use in controlling *Phytophthora* root rot (Anonymous, 2023).

Several studies *in vivo* have demonstrated the effectiveness of phosphorous acid (PA) against *Phytophthora* species (Daniel & Guest, 2005). In a study conducted in Turkey, Çakar et al. (2023) reported that when chestnut seedlings were treated with phosphorous acid during the leafing period and subsequently inoculated with *P. × cambivora* and *P. cinnamomi*, the treatment exhibited high efficacy and prevented disease progression.

ATP-Binding Cassette (ABC) transporters are membrane proteins. They are mainly responsible for transporting substances across the cell membrane using the energy generated by ATP hydrolysis. ABC proteins, which are reported to be located in the membranes of cells and organelles, are mainly responsible for the exchange of substances within the cell and with the external environment. However, they have also been found to be involved in many other metabolic events such as regulation of nucleic acids and chromosome structure, signal transduction, protein release and drug resistance (Higgins and Linton, 2003). The first member of an ABC transporter subfamily recognized to have a role in multidrug resistance (MDR) is the name of several of these subfamilies. ABC transporters with different topologies have been reported in n *Saccharomyces cerevisiae* (Decottignies and Goffeau, 1997). Tolerance to various hazardous chemicals is conferred to *S. cerevisiae* through transporters within the pleiotropic drug resistance (PDR) network. When one or more network members are disrupted, this manifests as increased sensitivity. Plant secondary metabolites can be exported through a wide variety of chemicals transported by ABC transporters present in *S. cerevisiae* (Kolaczkowski et al. 1998). Therefore, by providing protection against plant defense chemicals or limiting the suicidal consequences of fungal toxins, ABC transporters of plant pathogens may be important players in pathogenesis. Laboratory investigations have shown that ABC transporters have roles in virulence or toxicant efflux in plant pathogenic fungi (Urban et al., 1999). The aim of this study was to determine the effectiveness of phosphorous acid on pathogens developed *in vitro* in various doses of phosphorous acid-containing media,

following a study reporting the inhibition of pathogen development by phosphorous acid in chestnut seedlings against *P. × cambivora* and *P. cinnamomi* (Çakar et al., 2023). Additionally, this study sought to investigate the role of minor genes in the sensitivity of *P. cinnamomi* and *P. × cambivora* to phosphorous acid, as well as to examine the function and molecular structure of ABC transporters. The study identified the *ABCA1* gene family within the transporter superfamily and conducted expression profiling of isolates with high and low sensitivity to fungicides in order to elucidate the potential involvement of ABC transporters in the response to phosphorous acid.

Materials and Methods

***In vitro* test of *Phytophthora* × *cambivora* and *Phytophthora cinnamomi* using phosphorous acid**

The four isolates of *Phytophthora*; *P. × cambivora* (IstKs06, IstKs02) and *P. cinnamomi* (Simav07, Simav03) obtained from root rot in chestnut used for *in vitro* test selected four obtained from "Turkish Scientific and Technical Research Association and with the project no: 111O494". Using phosphorous acid, *P. × cambivora* and *P. cinnamomi* is tested *in vitro*. Two isolates of *P. × cambivora* and two isolates of *P. cinnamomi* were initially incubated on Carrot Rind Agar (HRA) at 22°C for four days. Subsequently, doses of phosphoric acid at 17.5, 35, and 85 µg mL^{-1} (Hua et al., 2022) were added to Potato Dextrose Agar (PDA) medium, allowed to cool to 60°C after autoclaving, and mycelial pieces of *Phytophthora* isolates with a diameter of 7 mm were inoculated into the prepared medium. Sterile water was used in control petri dishes. After third and sixth days of incubation, two perpendicular colony mycelial growth was calculated. The mycelial growth diameter (MGD), expressed in mm, was calculated using the following equation (Owaid et al., 2018). Two perpendicular colony diameters were measured per plate.

$$MGD\ (mm) = (D1 + D2)\ /2$$

D1= Colony diameter 1, and D2=Colony diameter 2

The percentages of inhibition in the growth of pathogens by the medication were calculated using the following formula.

$$\text{Mycelial growth inhibition (\%)} = \frac{dc - dt}{dc} \times 100(\%)$$

dc = average diameter of fungal colony in non-poisoned PDA (control), and dt= average diameter of fungal colony in poisoned PDA (Shakeel et al., 2021).

Determination of The Expression Levels of *ABCA1*Gene

Total RNA isolation

For the isolation of total RNA, *P.* × *cambivora* and *P. cinnamomi* isolates were grown on Potato Dextrose Agar at 20 °C for 6 days, including both treated and control petri dishes. Approximately 50 mg of mycelium was scraped from the agar surface and then treated with liquid nitrogen. RNA extraction was carried out using RNA Extracol (Eurx Ltd, Gdańsk, Poland) following the manufacturer's instructions.

Complementary DNA (cDNA) synthesis

The first strands cDNA synthesis kit (Eurx Ltd, Gdańsk, Poland) was employed to synthesize cDNA from 1 µg total RNA. Reverse transcription was carried out in 20 µL of reaction mixture containing 1 µg total RNA, 4 µl 5× cDNA Buffer, 1 µL mix RT (reverse transcriptase), 1 µL oligo (dT), 1 µL random hexamers, 12 µL nuclease-free water. The thermal cycling conditions of the reaction for cDNA were 10 min at 20 °C, 40 min at 50 °C, 5 min at 85 °C, and finally, 10 min at 4 °C.

Real-Time Quantitative Reverse Transcription Polymerase Chain Reaction (qRT-PCR)

In the qRT-PCR study, actin used as the housekeeping gene, and the primers were designed using the Primer3 v4.1.0 tool (Table 1). qRT-PCR reactions were conducted following the manufacturer's instructions using SYBRTM Green PCR Master Mix in the CFX ConnectTM Real-Time PCR Detection System. Each 25 µL qRT-PCR experiment consisted of 12.5 µL of 2 × real-time PCR Mix (SYBR Green I), 0.5 µL of primer, and appropriately diluted cDNA as a template. The qRT-PCR settings were programmed as follows: initial denaturation at 95 °C for 20 seconds, followed by 40 cycles of denaturation at 95 °C for 30 seconds, annealing at 54 °C for 20 seconds, and extension at 72 °C for 10 seconds. Each sample underwent three technical and biological replicates in each qRT-PCR experiment. The data were analyzed using the $2^{-\Delta\Delta CT}$ technique, and statistical analysis was performed using one-way ANOVA (Livak and Schmittgen, 2001).

Table 1. Primers sequences used for qRT-PCR experiment

Gene regions	Primers	Primer sequences (5'-3')	Product size (bp)
β-actin (housekeeping)	*β-actin*F *β-actin*R	TGAGCAAGGAGATTACAGCATTGG CATACTCTGCCTTCGCAATCCAC	150
ABCA1	*ABCA1*F *ABCA1*R	GTTGCGGTTCGTGATCTCTC GAACCTCGATCTGTTGCGTC	175

Results

Mycelial Growth

In media containing phosphorous acid, the mycelial growth of *P.* × *cambivora* and *P. cinnamomi* isolates varied. Different results were obtained when evaluating the assessment of three different drug doses on four isolates. In *P.* × *cambivora* isolates, varying doses led to different colony growth among isolates. It was observed that as the dose of phosphorous acid increased for *P.* × *cambivora* isolates, mycelial growth decreased (Table 2). The percentage of inhibition of mycelial growth by phosphorous acid was highest for *P.* × *cambivora* isolate at a dose of 85µg mL^{-1} on the 3rd day of measurements (Table 3). For *P. cinnamomi* isolates, increasing doses did not parallelly inhibit mycelial growth. The percentage of inhibition of mycelial growth by the drug was highest for isolate IstKs02 at a dose of 35µg mL^{-1} on the 3rd day of measurements (Table 2, 3). All measurements for the mycelial growth of isolates were taken on the 3rd and 6th days, and the averages were calculated in millimeter (Table 1, Figure 1).

Table 2. Mean mycelial growth (mm) obtained in third and sixth after treated fungicide

Isolate name	Phosphorous acid concentration							
	Measuring the average size of fungal colony diameter (mm)							
	3th day				6th day			
	17.5 (µg mL^{-1})	35 (µg mL^{-1})	85 (µg mL^{-1})	C*	17.5 (µg mL^{-1})	35 (µg mL^{-1})	85 (µg mL^{-1})	C
IstKs06	19.1	15.9	22.2	17.5	44.1	33.9	27.0	34.5
IstKs02	19.7	16.7	19.4	23.0	36.0	34.8	34.0	40.0
Simav07	9.3	9.2	8.2	11.4	19.5	14.5	17.7	19.0
Simav03	15.7	14.0	13.2	14.0	28.5	27.2	25.0	29.5

Table 3. Percentages of inhibition of mycelial growth using fungicide on third and sixth days

Isolate name	Percentages of inhibition of mycelial growth (%)					
	3th day			6th day		
	17.5 (µg mL^{-1})	35 (µg mL^{-1})	85 (µg mL^{-1})	17.5 (µg mL^{-1})	35 (µg mL^{-1})	85 (µg mL^{-1})
IstKs06	-	9.1%	-	-	1.7%	21.7%
IstKs02	14.3%	27.3%	15.6%	10.0%	13.0%	15.0%
Simav07	18.4%	19.2%	28.0%	-	23.6%	6.84%
Simav03	-	-	5.7%	3.3%	7.7%	15.2%

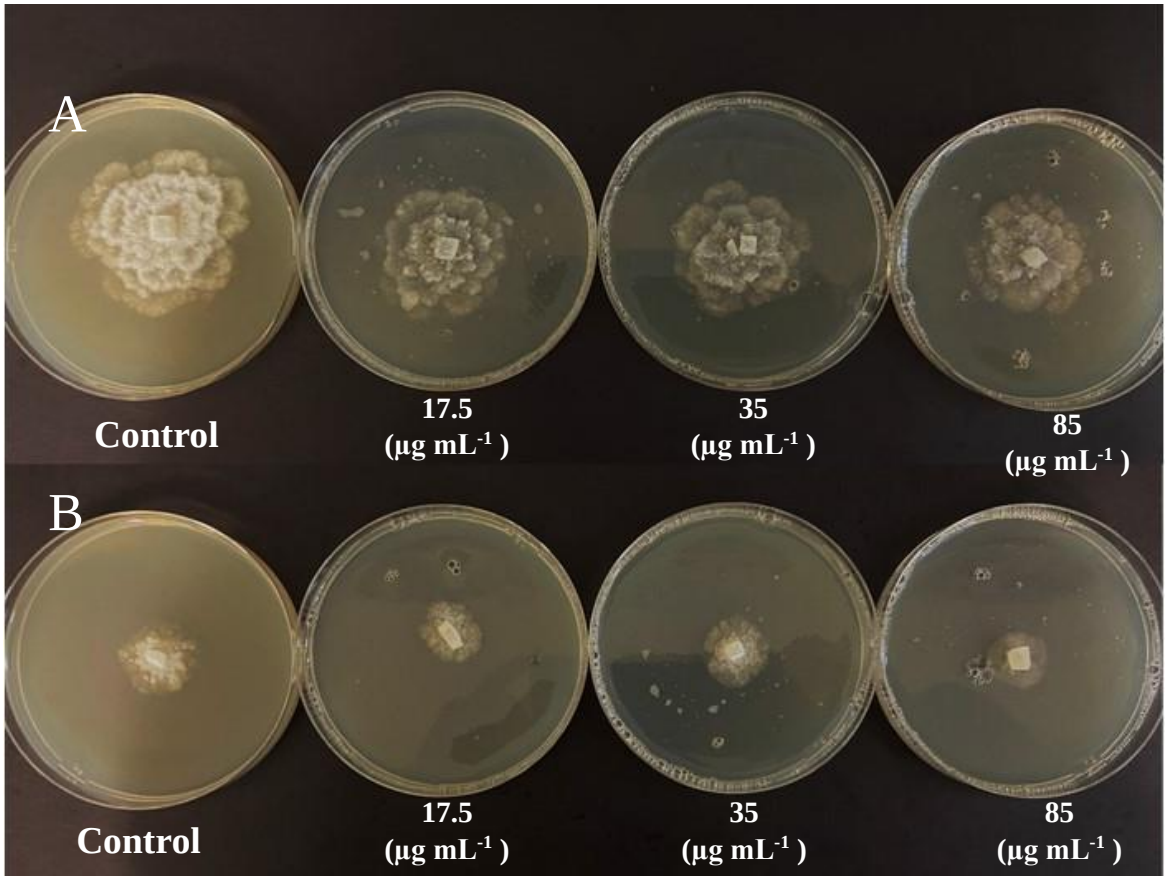


Figure 1. *Phytophthora* türlerinin farklı dozlarda potato dextrose agar besi yerinde altıncı günde miselyal büyümesi; A) *Phytophthora cinnamomi*, B) *Phytophthora* × *cambivora*

ABCA1 Gene Expression Levels

In media containing phosphorous acid, the expression levels of the *ABCA1* gene in *P.* × *cambivora* and *P. cinnamomi* isolates were determined using qRT-PCR analysis. The results showed that the *ABCA1* gene exhibited varying expression levels in response to three distinct concentrations of phosphorous acid treatment in both *P. cinnamomi* and *P.* × *cambivora* isolates. Following phosphorous acid treatment, the expression of the *ABCA1* gene was observed at 17.5 µg mL^{-1} concentration in isolate IstKs06 and at 85 µg mL^{-1} concentration in isolate IstKs02. The highest expression of the *ABCA1* gene was detected in isolate Simav07 at a concentration of 17.5µg mL^{-1} and in isolate Simav03 at a concentration of 35 µg mL^{-1} (Figure 2).

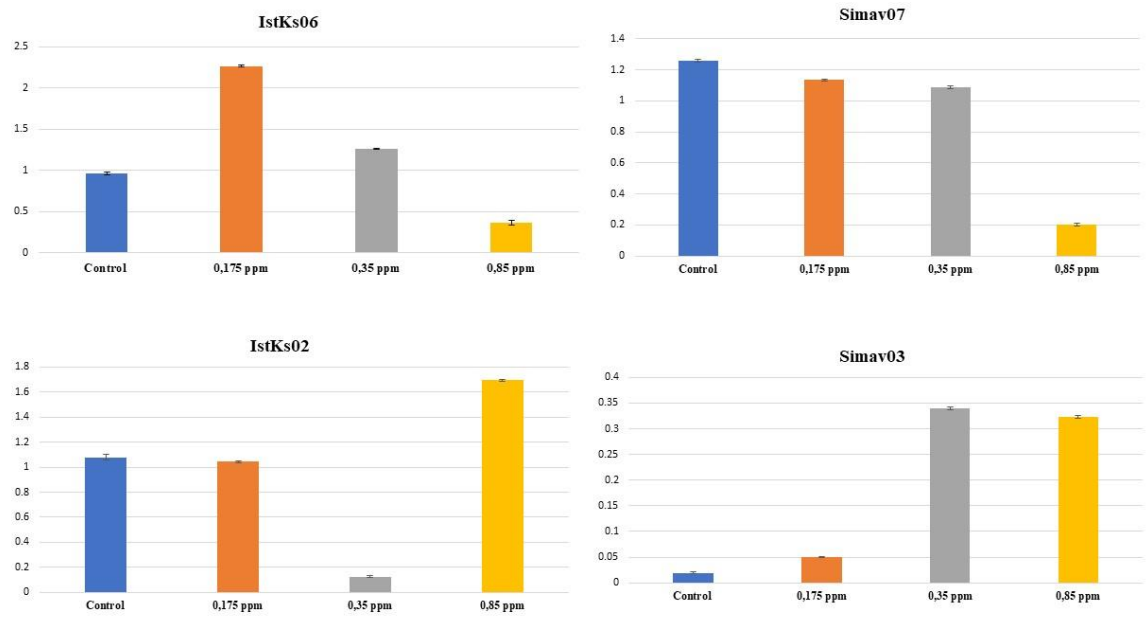


Figure 2. Effect of phosphorous acid treatment on *ABCA1* gene expression in *Phytophthora* × *cambivora* and *Phytophthora cinnamomi* isolates

Discussion and Conclusion

Phosphorous acid is a chemical frequently applied in the control of Phytophthora root rot in chestnuts. Two *Phytophthora* species, *P.* × *cambivora* and *P. cinnamomi*, are commonly associated with dieback in chestnut trees in Turkey (Akıllı Şimşek et al., 2019). In this study, the effects of phosphorous acid on mycelial growth *in vitro* against two *Phytophthora* species associated with dieback in chestnut trees were evaluated. It was found that the drug, prepared in different doses, increasingly inhibited mycelial growth of *P.* × *cambivora* isolates. However, for *P. cinnamomi*, it was determined that it was not equally effective at increasing doses. In *in vivo* studies conducted in Turkey, it was reported that after the application of phosphorous acid to chestnut seedlings via foliar spraying, followed by pathogen inoculation assessments, no disease formation was observed (Çakar et al., 2023). However, in this study, it was found that direct application of phosphorous acid to pathogens *in vitro* did not completely inhibit the mycelial growth of *Phytophthora* species. Products containing phosphorous acid are known to be systemic, transported through both xylem and phloem vessels in plants (Quimette & Coffey, 1989). They act as plant activators, operating in a complex mode of action, rather than directly impacting pathogens (Guest and Grant, 1991).

In the study by Hua et al. (2022), various chemical agents containing phosphorous acid were compared *in vitro* for their effects on mycelial growth against the causative agent of *Phytophthora* blight in peppers, *Phytophthora capsici* Leonian. They reported that the chemical agent Nutri-Phite was the most effective in inhibiting mycelial growth of the pathogen. Additionally, the study determined that the chemical agents also affected sporangium formation and zoospore germination. In our study, we conducted *in vitro* experiments with a single chemical agent and three different doses against two different pathogens, *P. × cambivora* and *P. cinnamomi*. Evaluating the effects of the drug on mycelial growth provides valuable insights into the efficacy of the treatment against these pathogens. Testing different chemicals and increasing the dose range would be beneficial for obtaining more detailed data on the extent to which the pathogens are affected.

According to the results obtained, it was observed that the expression level of the *ABCA1* gene was lowest in the isolates treated with phosphorous acid at concentrations where the inhibition of mycelial growth was highest compared to the control. This suggests that as the concentration of phosphorous acid increases, more of it enters the cells, potentially leading to damage to cell structure and functions under extreme stress conditions. Furthermore, the sensitivity of isolates to high doses of the drug and the suppression of the *ABCA1* gene expression may be correlated.

In this study, the effects of phosphorous acid at three different doses, namely 17.5, 35, and 85 $\mu g\ mL^{-1}$, were evaluated on mycelial growth. It was found that at the applied doses, the drug inhibited mycelial growth to a low extent compared to the control. Consequently, the chemical agent exhibited a low antifungal effect in *in vitro* studies. Future studies should consider evaluating the phytotoxic effect of the drug in more detail, taking into account zoospore formation, to better understand its potential impact.

Acknowledgments

We would like to thank the "Turkish Scientific and Technical Research Association of project (No: 111O494)" and the project team for the *Phytophthora × cambivora* and *Phytophthora cinnamomi* isolates used in the study.

References

Akıllı Şimşek, S., Katırcıoğlu, Y. Z., Ulubaş Serçe, Ç., Çakar, D., Rigling, D. & Maden, S. (2019). *Phytophthora* species associated with dieback of sweet chestnut in Western Turkey. *The Journal of Pathology, 49*(4), 1-11.

Akıllı, S., Ulubaş Serçe, Ç., Katırcıoğlu, Y. Z. & Maden, S. (2012). Involvement of *Phytophthora* spp. in chestnut decline in the Black Sea region of Turkey. *The Journal of Pathology, 42*(5), 377-386.

Anonymous, (2024). ‘’*Phytophthora* and Phosphonats by jo Grant, Farm Advisor, San Joaquin County’’,cebutte.ucanr.edu/files/152930.pdf.

Banko, T. J. & Hong, C. X. (2004). Evaluation of nutrient phosphite for the control of *Phytophthora* shoot blight on annual vinca. *Journal of Environmental Horticulture, 22*(1), 41-44.

Belisario, A., Maccaroni, M., & Vettorazzo, M. (2006). First report of *Phytophthora cambivora* causing bleeding cankers and dieback on beech (*Fagus sylvatica*) in Italy. *Plant Disease, 90*(10), 1362-1362.

Carneiro Carvalho, A., Pereira, C., Marques, T., Martinsa, L., Anjosa, R., Pintoa, T., Lousadaa, J. & Gomes Laranjoa, J. (2017). Potential of silicon fertilization in the resistance of chestnut plants to ink disease (*Phytophthora cinnamomi*). *International Journal of Environment, Agriculture and Biotechnology, 2*(5), 2740-2753.

Çakar, D., Akıllı Şimşek, S. & Maden, S. (2023). Effectiveness of foliage applications of phosphorous acid and potassium silicate on collar rots caused by *Phytophthora*× *cambivora* and *P. cinnamomi* on chestnut saplings. *Journal of Plant Diseases and Protection, 130*(2), 263-270.

Daniel, R. & Guest, D. (2005). Defence responses induced by potassium phosphonate in *Phytophthora palmivora*-challenged Arabidopsis thaliana. *Physiological and Molecular Plant Pathology, 67*(3-5), 194-201.

Day, W. R. (1938). Root-rot of Sweet Chestnut and Beech caused by species of *Phytophthora*: I. Cause and symptoms of disease: its relation to soil conditions. *Forestry, 12*, 101-116.

Decottignies, A. & Goffeau, A. (1997). Complete inventory of the yeast ABC proteins. *Nature Genetics, 15*, 137-145.

Fernandes, P., Machado, H., Silva, M. D. C. & Costa, R. L. (2021). A histopathological study reveals new insights into responses of chestnut (*Castanea* spp.) to root infection by *Phytophthora cinnamomi*. *Phytopathology*, *111*(2), 345-355.

Guest, D. & Grant, B. (1991). The complex action of phosphonates as antifungal agents. *Biological Reviews*, *66*, 159-187.

Hansen, E. M. (2015). *Phytophthora* species emerging as pathogens of forest trees. *Current Forestry Reports*, *1*, 16-24.

Higgins, C. F. & Linton, K. J. (2003). The ATP switch model for ABC transporters. *Nature Structural Molecular Biology*, *11*, 918-926.

Hua, G. K. H., Ji, P., Culbreath, A. K., & Ali, M. E. (2022). Comparative Study of Phosphorous-Acid-Containing Products for Managing Phytophthora Blight of Bell Pepper. *Agronomy*, *12*(6), 1293.

Jung, T., Hudler, G. W., Jensen-Tracy, S. L., Griffiths, H. M., Fleischmann, F. & Osswald, W. (2005). Involvement of *Phytophthora* species in the decline of European beech in Europe and the USA. *Mycologist*, *19*, 159-166

Kolaczkowski, M., Kolaczowska, A., Luczynski, J., Witek, S. & Goffeau, A. (1998). *In vivo* characterization of the drug resistance profile of the major ABC transporters and other components of the yeast pleiotropic drug resistance network. *Microbial Drug Resistance*, *4*, 143-158.

Livak K. J. & Schmittgen T. D. (2001). Analysis of relative gene expression data using real-time quantitative PCR and the $2^{-\Delta\Delta CT}$ method, *Methods*, *25*(4), 402-408.

Owaid, M. N., Jaloot, A. S. & Ahmed, D. M. (2018). Influence of *Ficus carica* and *Olea europaea* leaves extracts on the mycelial growth of mushrooms *in vitro*. *Acta Ecologica Sinica*, *39*(1), 36-41.

Prospero, S., Vannini, A. & Vettraino, A. M. (2012). *Phytophthora* on *Castanea sativa* Mill. (Sweet chestnut). *JKI Data Sheets - Plant Diseases and Diagnosis*, *6*, 14.

Quimette, D. G. & Coffey, M. D. (1989). Comparative fungal activity of four phosphonate compounds against isolates of nine *Phytophthora* species. *Phytopathology*, *79*, 761-767.

Shakeel, Q., Bajwa, R. T., Iftikhar, Y., Mubeen, M., Luqman, M., Ashraf, W. & Rashid, I. (2021). Effective management of ginger soft rot caused by *Penicillium digitatum* through plant extracts. *Sarhad Journal of Agriculture, 37*(3), 714-721.

Urban, M., Bhargava, T. & Hamer, J. E. (1999). An ATP-driven effluxpump is a novel pathogenicity factor in rice blast disease. *The EMBO Journal*, *18*, 512-521.

Vannini, A. & Vettraino, A. M. (2001). Ink disease in chestnuts: impact on the European chestnut. *Forest Snow Landscabe Research*, *76*(3), 345-350.

Vettraino, A. M., Natili, G., Anselmi, N. & Vannini, A. (2001). Recovery and pathogenicity of *Phytophthora* species associated with a resurgence of ink disease in *Castanea sativa* in Italy. *Plant Pathology*, *50*(1), 90-96.

ACCOUNTING POLICY IN THE FUNCTION OF MAKING DECISIONS ON THE BASIS OF FINANCIAL STATEMENTS IN THE COMPANY

Jelena LUTOVAC
Megatrend University in Belgrade. Maršala Tolbuhina 8, 11000 Beograd, Serbia
Email: jelena.vitomir1@gmail.com, slobodan.popovic49@gmail.com

ABSTRACT
Accounting policy in the function of making decisions based on financial reports in the company is of great importance for the formation of important management decisions by the company's top management. Accounting policy in the function of making valid business decisions can help in real decision-making and making valid business decisions in companies because the security of business reporting (financial) in numerous and heterogeneous legal entities and companies is essentially increased. The accounting policy is adopted and approved first by the financial management and then by the top management of the company. The essence is to fundamentally increase the security of the entire business in any company. This is of great importance for the business of small, underdeveloped economies, those that want to join large international organizations, etc.
Keywords: accounting policy, internal audit, laws and professional standards

1. INTRODUCTION

The top management of the company tries to establish and implement a realistic accounting policy with the aim of enabling valid business decision-making in heterogeneous companies [1-6].

Accounting policy represents a set of special principles, bases, agreements, rules and practices applied by companies, especially when compiling and presenting financial reports in all reporting periods that are imposed on top management.

Financial reporting is one of the most important reporting in the company and it refers to the reporting of the management body in the company, then the reporting of the state authorities, the reporting of the majority owners, shareholders, etc. relevant users of financial reports [7-11].

There are numerous examples of the implementation of accounting policies, and in this study the authors highlight only some of the important ones, such as:

- assessment of fixed assets,
- managing the policy of intangible investments in the company,
- valuation of investment real estate in the company,
- the choice of methods of calculating ascending stocks in the company,
- the chosen method in connection with the estimated method as well as the participation in the capital of related legal entities, which relate to the essential operations of the company,
- determining the recording of interest expenses and other borrowing costs,
- consolidation of joint, controlled legal entities and others.

Implementation of the accounting policy in companies is of great importance, because in this way the comparability and security of financial reports delivered by the accounting sector of the company to the users of financial reporting can be safely implemented [12-14].

2. IMPLEMENTATION OF INTERNAL AUDIT IN COMPANIES

Internal audit can be devoted to real business, which will be directed towards:

- independence in the work of internal auditors in relation to the entity in which the work of the requested audit is performed;
- the wide scope of work of internal audit in companies,

- the ability of internal auditors to ensure that the results reached by the auditors are such that they can become available to all interested parties in the company that essentially ordered the internal audit of a certain area.

3. INTERNAL AUDIT JOBS

Internal auditors should consider heterogeneous requirements in their work, such as:

- analysis of the effectiveness (effectiveness) of the internal control system;
- the audit also deals with aspects of correctness, as well as the structure that ensures economy, efficiency and effectiveness (effectiveness) in companies;
- considering the legality/correctness of transactions;
- analytical approach to work, where the starting point should be an overview of the auditee's characteristics, responsibilities and problems it faces, and the auditee's administration and organization;
- an active approach, through which audit work, where possible, is characterized by a constructive attitude that ensures changes, which can be seen in the maintenance of constructive and adequate relations with officials, but also in the timing and approach applied in reporting on audit findings.

The general flow of the implementation and existence of the internal audit, which is connected with the work of the accounting department in the company, was presented by the authors in the form of a representation in figure number 1.

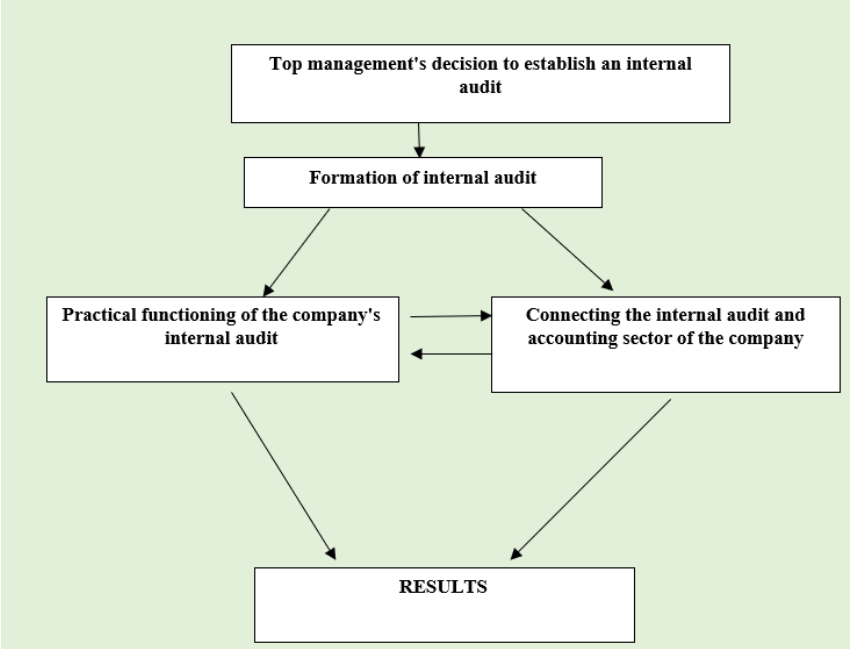


Figure 1: internal audit implementation flow

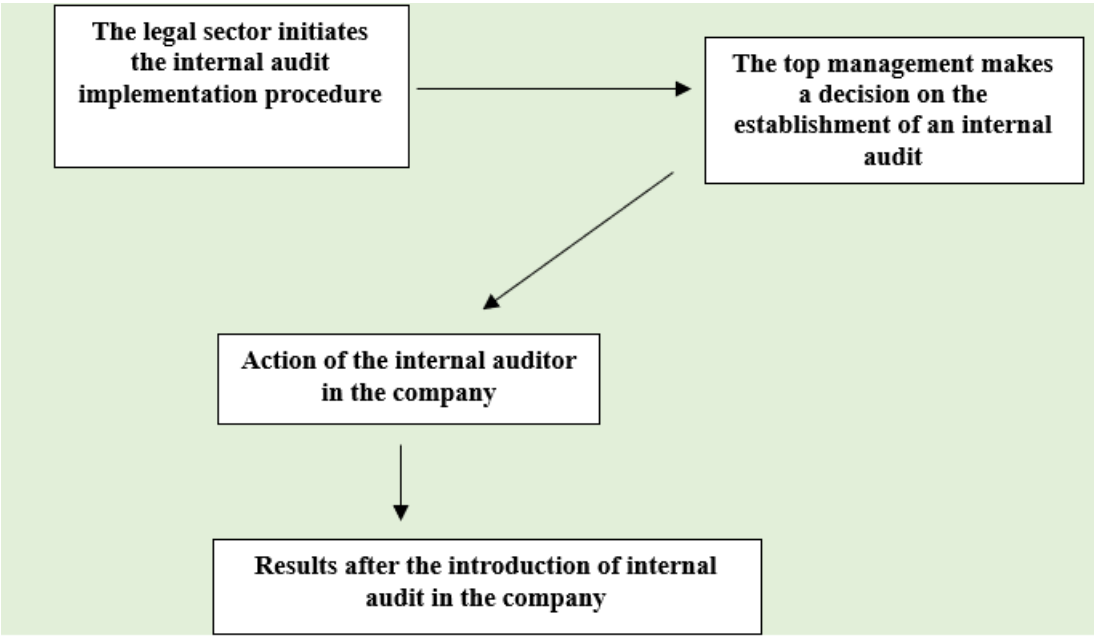


Figure 2: initiatives for the operation of internal audit in the company.

CONCLUSION

The accounting policy is adopted by top management. With her work, it is possible to improve the work of a large percentage of companies. The implementation of internal audit with the real work of the accounting sector in companies is of increasing importance for the real financial reporting of all those interested in the company. Internal audit should be seen as part of the activity of increasing the security of operations of a large number of companies. In addition, a large number of state authorities, but also more widely, ask companies, mainly public companies, to improve the work of financial reporting in companies in order to improve the work of reporting by state authorities.

LITERATURE

1. Barker, R., McGeachin, A. (2013): Why is there inconsistency in accounting for liabilities in IFRS? An analysis of recognition, measurement, estimation and conservatism. Accounting and Business Research. 43(6): 579-604.

2. Chen, R. (2019): Internal Control Audit Fee and Internal Control Audit Quality—Evidence from Integrated Audits, Open Journal of Business and Management, 7, pp. 292-311.

3. Popović, D., Vitomir, J., Jokić, M., Arnautović, I., Vrhovac, D., Barović, N., Vujinović, K., Popović, S. (2020): Implementation of internal audit in companies intending to operate on the principles of green economy in the Republic of Serbia, Agriculture & Forestry, Vol. 66Issue 2: 93-98.

4. Popović, S. (2014). Socio-ekonomski faktori ograničenja razvoja agrara, Feljton, Novi Sad.

5. Popović, S., Majstorović, A., Grublješić Ž. (2015). Valuation of facilities in use and application of international accounting standards, Actual problems of economics, 3(165): 379-387.

6. Popović, S., Novaković, S., Đuranović, D., Mijić, R., Grublješić, Ž, Aničić, J., Majstorović, A. (2017): Application of international accounting standard-16 in a public company with predominantly agricultural activities. Economic Research-Ekonomska Istraživanja, 30(1): 1850–1864.

7. Popović, S., Đuranović, D., Laban, B., Ivić, M., Jovin, S., Nastić, S., Grublješić, Ž., Popović, V. (2018). Impact of different light intensity on the production of the plant narcissus l. and its financial effects, Economics of Agriculture, 4: 1359-1370.

8. Radović, M., Vitomir, J., Laban B., Jovin, S., Nastić S., Popović, V., Popović, S. (2019). Management of joint-stock companies and farms by using fair value of agricultural equipment in financial statements on the example of IMT 533 tractor. Economics of Agriculture, 66 (1): 35-50.

9. Vitomir, J., Tomaš-Miskin, Laban, B. (2019): Management of business results in medium-sized agricultural enterprises and individual farms in relation to the movement of the height of wages, Economics of Agriculture, 66(3):811-822.

10. Vitomir, J., Tomaš-Miskin, S., Ivić, M., Popović, S. (2020): Implementation of the Tender by the Municipal Service Administration from the Aspect of Management in

the Municipalities of the Republic of Serbia, Lex Localis – Journal of Local Self-Government, 8(3), 469 – 486.

11. Majstorović, A. & Popović, S. (2015). Revizija poslovanja poljoprivrednog preduzeća, Računovodstvo, 1: 77-85.

12. Tamas-Miškin, S., Vitomir, J., Dragosavac, M., Medan, N., Radaković, M., Vitomir, G., Davidov, T. & Popović, S. (2022). The significance of archiving documentation and assessment quality of archiving financial documentation given by top managers, Economics of Agriculture, Year 69, No. 4, 2022, (pp. 949-1252),

13. Popović, S., Vitomir, J., Tomaš-Miskin, S., Davidov, T., Nastić., S., Popović, V., Popović, D., Vitomir, G. (2021). The importance of a realistically determined amount of tax on property rights relating to the ownership of agricultural land in the Republic of Serbia adopted by tax authorities of local selfgovernment units, Ekonomika poljoprivrede, Economics of agriculture, Vol.LXVIII, 4: 1029-1042.

14. Popović, D., Vitomir, J., Tomaš-Miskin, S., Davidov, T., Popović, S., Jovanović, M., Aćimić-Remiković, M., Jovanović, S. (2021). Implementation of internal control with reference to the application of it in companies operating on the principles of the green economy. Agriculture & Forestry, Vol. 67 Issue 2: 261-269.

BASIC OBSERVATION OF FINANCIAL REPORTING AND MANAGEMENT OF HETEROGENEOUS COMPANIES IN THE REPUBLIC OF SERBIA

Jelena LUTOVAC
Megatrend University in Belgrade. Maršala Tolbuhina 8, 11000 Beograd, Serbia
Email: jelena.vitomir1@gmail.com, slobodan.popovic49@gmail.com

ABSTRACT
The basic observation of financial reporting and management of heterogeneous companies in the Republic of Serbia is of great importance both for successful business operations and for successful decision-making by decision-makers. The framework for compiling and presenting the adopted financial statements should include all legally prescribed elements, i.e. parts, in order to realistically, truthfully and accurately present the actual operations of the legal entity in the financial statements. They are intended for a wide audience, i.e. a wide range of all users of such reports in the specific time for which they are compiled. Essentially, it should be emphasized that financial reports are drawn up continuously and represent the basis for valid business decision-making in a certain time period of observation.
Keywords: financial reporting, regulation, reporting model.

1. INTRODUCTION

Observing the broadest framework that is important and that regulates the basis for compiling financial statements means determining the broadest framework that affects financial reporting in a certain period of time, which is often identified with the legal framework of financial reporting of numerous legal entities [1-9]. The observation made in this way can be from the macro-economic level of observing numerous heterogeneous influences on the operations of a large number of heterogeneous companies that, as a rule, want to operate positively in a certain economy and in a long-term way of acting [10-15].

1. EFFECTS OF COMPILED FINANCIAL STATEMENTS

The most common components of the framework within which impacts can be manifested through real financial reporting are:

- Legal regulations in the field of accounting and auditing.
- Professional regulation in the field of accounting and auditing.
- Internal accounting regulations.

Legal regulations in the field of accounting and auditing. which fundamentally implies the application of adopted laws and by-laws, which primarily relate to the essence of financial reporting in the national economy.

At the same time, the reporting observed in this way also includes numerous regulations that are adopted that regulate the issues of financial reporting in the national economy.

Professional regulation in the field of accounting and auditing means the adoption of key financial documents by representative and recognized professional accounting organizations within the legal and economic system of the nation state.

Internal accounting regulation, which implies the adoption of internal general acts adopted by top management in companies (ethical code of conduct for internal auditors and other documents) that are essential for the optimal, essential functioning of a large number of heterogeneous legal entities.

The flow of decision-making on financial reporting issues is given in the continuation of the study.

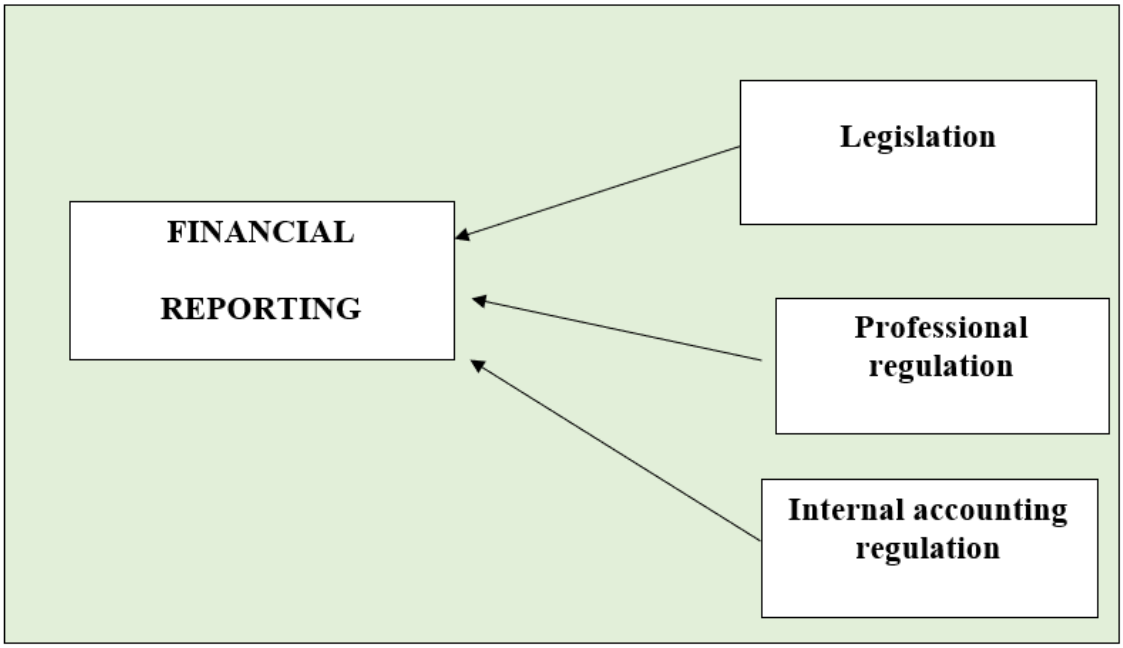


Figure number 1: decision-making flow in financial statements

In addition to the prominent importance of financial reporting, the authors point out that in numerous works, the importance of the formation of control forms, primarily internal control and internal audit in companies managed by top management, is emphasized.

3. BASIC SET OF FINANCIAL REPORTS

The coverage of the basic set of financial statements includes the observation and formation of the main set of financial statements.

Most often, top management opts for the creation of a set of financial reports, namely:

- Balance Sheet;
- Profit and loss;
- Statement of cash flows;
- Report on changes in capital;
- Report on other results;
- Notes accompanying descriptive financial reporting.

3. IMPORTANCE OF FORMATION OF FINANCIAL STATEMENTS IN THE FRAMEWORK OF THE REGULAR BUSINESS OF THE COMPANY

Financial statements should show how business changes affect the financial structure, business performance and changes in cash flows in companies. Financial reports are a

"mirror" of the company's operations, because they show operations by segments, sectors, lower organizational units, etc.

The goal of compiling financial reports is to provide information on the financial position, performance and changes in the financial position of companies, which are necessary for top management to make valid business decisions.

There are internal and external users of financial statements

The most common financial reports are:

- Balance sheet, which is an essential financial report that shows the values of the company's assets, liabilities and capital on a specific day in monetary units.
- The income statement represents financial statements in which all income, expenses and financial results of the company are shown in a certain period of time in monetary units of measure.
- The report on cash flows (cash flows) shows the inflows and outflows of cash and cash equivalents in the company during the reporting period for which the financial reporting is prepared.

4. CONCLUSION

In this paper, the author emphasized the importance of observing financial reporting and management in heterogeneous companies in the Republic of Serbia. At the same time, he pointed out that realistic observation of financial reporting is of great importance both for successful business and for successful decision-making by decision-makers in a large number of heterogeneous legal entities. Such observation is of great importance in establishing realistic, fair and essential financial reporting. At the same time, such an observation of financial reporting is the essence of making improved decisions made by top management within the framework of their regular operations of numerous legal heterogeneous entities, which is of great importance for small economies, such as the Republic of Serbia.

REFERENCES

[1] Bakmaz, O., Dragosavac, M., Jestrović, V., Radaković, M., Davidov, T., Bjelica, B, Brakus, A., Popović, D., (2023). Management of plant production (narcissus l.) Through the application of non-standard growing methods in order to increase the financial value of production, Economics of Agriculture, Year 70, No. 2.

[2] Popović, S., Laban, B., Vukasović, D., Ivić., M., Popović, V. (2018). Internal and external audit as a factor in improving the management of the Agricultural enterprise, Poljoprivredna tehnika, 4: 8–12.

[3] Popović, S. (2015). Implementacija heterogenih rizika u radu interne revizije, Revizor 69: 7-19.

[4] Bjelica, B., Bakmaz, O., Mijić, R., Popović, S. & Popović, V. (2017). The implementation of heterogeneous risk to the company's operations and transition countries respecting the behavior of agricultural enterprises in the republic of Serbia. Annals of the „Constantin Brâncuşi" University of Târgu Jiu, Economy Series, 3/2017, 207-213, ISSN 2344 – 3685/ISSN-L 1844 –7007.

[5] Radović, M., Vitomir, J., Laban, B., Jovin, S., Nastić, S., Popović, V. & Popović S. (2019). Management of joint stock companies and farms by using fair value of agricultural equipment in financial statements on the example of IMT 533 Tractor, Economics of Agriculture, 1: 35-50.

[6] Popović, S. (2014). Socio-ekonomski faktori ograničenja razvoja agrara, monografija, Fimek, Novi Sad.

[7] Popović, S., Novaković, S., Đuranović, D., Mijić, R., Grublješić, Ž, Aničić, J. & Majstorović, A. (2017). Application of international accounting standard-16 in a public company with predominantly agricultural activities, Economic Research-Ekonomska Istraživanja, 30(1):1850–1864.

[8] Popović, S., Tošković, J., Majstorović, A., Brkanlić, S. & Katić, A. (2015). The importance of continuous audit of financial statements of the company of countries joining the EU, Annals of the „Constantin Brâncuşi" University of Târgu Jiu, Economy Series, Special Issue, 241-246.

[9] Radović, M., Vitomir, J. & Popović, S. (2021). Impact of internal control in enterprises founded by local self-government units: the case of Republic of Serbia, Inzinerine Ekonomika-Engineering Economics, 32(1): 82–90.

[10] Ivaniš., M. & Popović., S. (2013). Altmanov Z-Score model analize, Ekonomija-teorija i praksa br.2, Fakultet za ekonomiju i inženjerski menadžment, Univerzitet Privredna akademija u Novom Sadu, 47-62.

[11] Arnautović, I., Davidov, T., Nastić, S. & Popović, S. (2022). Značaj donošenja racionalne poslovne odluke top menadžmenta u poljoprivrednim preduzećima u Republici Srbiji, Poljoprivredna tehnika, 1-8.

[12] Majstorović, A. & Popović, S. (2015). Revizija poslovanja poljoprivrednog preduzeća, Računovodstvo, 1: 77-85.

[13] Tamas-Miškin, S., Vitomir, J., Dragosavac, M., Medan, N., Radaković, M., Vitomir, G., Davidov, T. & Popović, S. (2022). The significance of archiving documentation and assessment quality of archiving financial documentation given by top managers, Economics of Agriculture, Year 69, No. 4, 2022, (pp. 949-1252),

[14] Popović, S., Vitomir, J., Tomaš-Miskin, S., Davidov, T., Nastić., S., Popović, V., Popović, D., Vitomir, G. (2021). The importance of a realistically determined amount of tax on property rights relating to the ownership of agricultural land in the Republic of Serbia adopted by tax authorities of local selfgovernment units, Ekonomika poljoprivrede, Economics of agriculture, Vol.LXVIII, 4: 1029-1042.

[15] Popović, D., Vitomir, J., Tomaš-Miskin, S., Davidov, T., Popović, S., Jovanović, M., Aćimić-Remiković, M., Jovanović, S. (2021). Implementation of internal control with reference to the application of it in companies operating on the principles of the green economy. Agriculture & Forestry, Vol. 67 Issue 2: 261-269.

ADOPTION OF A REALISTIC FINANCIAL REPORTING MODEL IN HETEROGENEOUS COMPANIES IN SMALL ECONOMIES LIKE THE REPUBLIC OF SERBIA

Jelena LUTOVAC
Megatrend University in Belgrade. Maršala Tolbuhina 8, 11000 Beograd, Serbia
Email: jelena.vitomir1@gmail.com, slobodan.popovic49@gmail.com

ABSTRACT
The adoption of a realistic model of financial reporting in heterogeneous companies in small economies like the Republic of Serbia does not represent a generally accepted model, but a unique model adapted to the operations of a national economy. At the same time, in such a business and observing the generally accepted business model that focuses on financial reporting, the goal is basically to improve the profit, that is, the success of the business of numerous heterogeneous legal entities and companies. In the long term, such a business system aims to observe the positive effects of the model, which represents the basis of decision-making and which is based on the realistic compilation of financial reports in the company's business for a certain time period of observation.
Keywords: financial reporting, regulation, reporting model.

1. INTRODUCTION

The adoption of a realistic model of financial reporting in heterogeneous companies in small economies like the Republic of Serbia does not represent a generally accepted model, but should be viewed as a unique system of action in order to optimize business results [1-5].

It should be emphasized that there is no single reporting model that will solve the problems of general and financial management, but a model adapted to the operations of a national economy should be created [6-10].

The goals of management understood in this way can be achieved:

- By bringing unique management solutions
- By adopting unique legal solutions
- By making possible applicable solutions that will be applied in a large number of cases.

2. DEVELOPMENT OF REAL FINANCIAL REPORTING MODELS IN COMPANIES

Creating a model of realistic financial reporting in companies is a special task that the top management gives to the professional services in the company to create it and which is constantly adapted to the newly created business situation in the business.

The goal is to increase the improvement of the overall results in the company's work if the top management finds a realistic approach in order to realistically reduce the business risk for the company in which it performs a management function.

3. PRESENTATION OF A POSSIBLE MODEL RELATED TO FINANCIAL REPORTING AND BUSINESS RISK ASSESSMENT

Presentation of a possible model related to financial reporting and business risk assessment is given by the author in Figure 1.

NUMBER OF FINANCIAL STATEMENTS	ASSESSED RISK	RISK INTERVAL	NOMINALLY EXPRESSED RISK		
			MODEL A	MODEL B	MODEL C
	6	1-10	170	175	173
	4	1-10	114	117	111
	3	1-10	87	86	80
	2	1-10	57	54	60

The main goal of management by the top management can essentially be defined as the need to reduce the risk to the business of any company.

Risk reduction observed in this way refers to the observation of all places that are key to the management's operations, as well as in relation to possible identified risks to the company's operations.

5. CONCLUSION

In this paper, the authors emphasized the importance of establishing a realistic model that will improve the making of valid decisions by top management in the operations of numerous heterogeneous companies.

The goal of establishing such a model, which is basically based on financial reporting, is to improve the operational decisions made by the top management within its regular business. In addition, the top management of the company should find a realistic approach in order to realistically reduce the business risk for the company in which it performs a management function.

The paper presents three possible models that encompass possible business risk in relation to the number of financial reports that are essentially submitted to top management.

LITERATURE

1. Vitomir, J., Tomaš-Miskin, S. i Popović. S. (2021): Značaj evidencije poljoprivredne opreme u upotrebi premafer vrednosti sa stanovišta upravljanja u malim i srednjim preduzećima u tranzicionoj državi, - primer Republike Srbije, Poljoprivredna tehnika, str. 1-6.

2. Radović, M., Vitomir, J. i Popović, S. (2021): Kretanje dokumentacije u sklopurevizijskog izveštavanjatop menadžmenta poljoprivrednog preduzećA, Poljoprivredna tehnika, str. 47-53.

3. Popović, D., Vitomir, J., Jokić, M., Arnautović, I., Vrhovac, D., Barović, N., Vujinović, K., Popović, S. (2020): Implementation of internal audit in companies intending to operate on the principles of green economy in the Republic of Serbia, Agriculture & Forestry, Vol. 66Issue 2: 93-98.

4. Popović, D., Vitomir, J., Jokić, M., Arnautović, I., Vrhovac, D., Barović, N., Vujinović, K. & Popović, S. (2020): implementation of internal audit in companies intending to operate on the principles of green economy in the Republic of Serbia, Agriculture &Forestry, Vol. 66Issue 2: 93-98.

5. Milanović, T., Popović, V., Vučković, S., Rakaščan, N., Popović, S., Petković, Z. (2020): Analysis of soybean production and biogas yield to improve eco-marketing and circular economy, Economics of Agriculture, 67/1: 141-156.

6. Jokić, M., Laban, B., Arnautović, I., Popović, D. i Popović, S. (2020): Making business decisions in industrial companies in the transition country, by the case of the Republic of Serbia, Annals of the „Constantin Brâncuşi" University of Târgu Jiu, Economy Series, Issue 2/2020, pp. 4-11.

7. Vitomir, J., Tomaš-Miskin, S., Ivić, M., Popović, S. (2020): Implementation of the Tender by the Municipal Service Administration from the Aspect of Management in the Municipalities of the Republic of Serbia, Lex Localis – Journal of Local Self-Government, 8(3), 469 – 486.

8. Milanović, T., Popović, V., Vučković, S., Rakaščan, N., Popović, S., Petković, Z. (2020): Analysis of soybean production and biogas yield to improve eco-marketing and circular economy, Economics of Agriculture, 67/1: 141-156.

9. Popović, S., Vitomir, J., Tomaš-Miskin, S., Davidov, T., Nastić., S., Popović, V., Popović, D., Vitomir, G. (2021). The importance of a realistically determined amount of

tax on property rights relating to the ownership of agricultural land in the Republic of Serbia adopted by tax authorities of local selfgovernment units, Ekonomika poljoprivrede, Economics of agriculture, Vol.LXVIII, 4: 1029-1042.

10. Popović, D., Vitomir, J., Tomaš-Miskin, S., Davidov, T., Popović, S., Jovanović, M., Aćimić-Remiković, M., Jovanović, S. (2021). Implementation of internal control with reference to the application of it in companies operating on the principles of the green economy. Agriculture & Forestry, Vol. 67 Issue 2: 261-269.

ORIGANUM SPP'DEN ELDE EDİLEN UÇUCU YAĞIN ELMADA SİYAH ÇÜRÜKLÜK HASTALIĞINA KARŞI ANTİFUNGAL AKTİVİTESİ

Keziban Sinem TULUKOĞLU KUNT* (ORCID: 0000-0001-7443-9022)
Niğde Ömer Halisdemir University, Faculty of Agricultural Science and Technologies, Department of Plant Production and Technologies, Niğde-Türkiye
Email: ksinemtulukoglu@gmail.com

Gazal ARSLANSOY (ORCID: 0009-0001-9027-6611)
Niğde Ömer Halisdemir University, Faculty of Agricultural Science and Technologies, Department of Plant Production and Technologies, Niğde-Türkiye
Email: arslansoy.gazal@outlook.com

İlayda ARUK (ORCID: 0009-0000-4320-0748)
Niğde Ömer Halisdemir University, Faculty of Agricultural Science and Technologies, Department of Plant Production and Technologies, Niğde-Türkiye
Email: arukilayda8@gmail.com

Doç. Dr. Mustafa ÖZDEN (ORCID: 0000-0001-5275-1250)
Niğde Ömer Halisdemir University, Faculty of Agricultural Science and Technologies, Department of Plant Production and Technologies, Niğde-Türkiye
Email: mozden@ohu.edu.tr

ÖZET

Alternaria alternata, elma meyvelerinde hasat sonrası çürümeye neden olan yaygın bir fungal hastalık etmenidir. Depo hastalıkları ile mücadelede yaygın olarak sentetik fungisitler kullanılmaktadır. Ancak fungisitlere karşı patojen direnç gelişimi ve tüketicilerin güvenli gıda için talebinin artması, hasat sonrası çürüklük etmeni ile mücadelede doğal bileşiklerin kullanımı gibi alternatif mücadele yöntemlerine ilginin artmasına neden olmuştur. Nitekim, uçucu yağların (UY) ve özelinde *Origanum* spp. türlerinden elde edilen uçucu yağların, hasat sonrası hastalık etmenleri mücadelede ümitverici doğal bileşik adayları olduğu bilinmektedir. Bu çalışmada, *O. vulgare, O. onites* ve *O. syriacum* farklı kekik uçucu yağlarının ve konsatrasyonlarının (5%, 10%, 15%, 20%, 25% ve 30%), *A. alternata*'ya karşı antifungal aktivitesi *in vitro* buhar teması (VT) ve doğrudan temas (DT) deneyleri kullanılarak test edilmiştir. VT deneyi neticesinde, en yüksek miselyum inhibasyon oranı (MİO, %) *O. vulgare*'nin %20 konsantrasyonu (%83.90) ve *O. onites* ve *O. syriacum* uçucu yağlarından ise, sırasıyla %30 (%79.81-77.43) ve %25 (%81.06-76.75) konsantrasyonlarından elde edilmiştir. DT deneyi sonucunda ise, konsantrasyona bağlı olmaksızın tüm kekik uçucu yağları, *A. alternata* miselyum gelişimini engellediği tespit edilmiştir. *İn vivo* denemeler için minimum kekik uçucu yağ konsantrasyonu, DT deneme sonuçları dikkate alınarak, *O. vulgare* ve *O. onites* için %15, O. *syriacum* için %10 olarak belirlenmiştir. Bu konsantrasyonların lezyon engelleme oranları ise, patojenle inoküle edilmiş elma meyveleri yüzeyine püskürtülerek test edilmiştir. Deneme neticesinde, uçucu yağların lezyon gelişimini engellediği, ancak patojene karşı etkinliklerinin değiştiği saptanmıştır. Bu çalışma, elmada hasat sonrası siyah çürüklük etmeni ile mücadelede alternatif bir yöntem olarak *Origanum* spp türlerinden elde edilen uçucu yağların kullanım potansiyelini göstermektedir.

Anahtar Kelimeler: Hasat sonrası, elma, *Alternaria* spp., antifungal aktivite

ANTIFUNGAL ACTIVITY OF ESSENTIAL OIL FROM *ORIGANUM* SPP. AGAINST BLACK ROT DISEASE OF APPLE

ABSTRACT

Alternaria alternata is a ubiquitous fungal pathogen that cause postharvest rot in apples. The development of resistance to synthetic fungicides and growing consumer demand for natural alternatives has led to increased interest in essential oils (EOs). including EOs derived from *Origanum* spp., as a promising antifungal candidate for postharvest loss control. In the present study, the antifungal activity of *O. vulgare*, *O. onites*, and *O. syriacum* against *A. alternata* was tested at different concentrations (5%, 10%, 15%, 20%, 25%, and 30%) with vapor contact (VC) and direct contact (DC) assay in *in vitro*. In VC assay, the fumigation activity of EOs, showed that the 20% concentration of *O. vulgare*, and 30% and 25% concentrations of *O. onites* and *O. syriacum* showed high mycelium inhibition rates (MIR, %), 83.90%, 79.81-77.43%, and 81.06-76.75%, respectively. However, all EOs were able to inhibit mycelium growth of *A. alternata* at the highest rate in a concentration-independent manner in DC assay. The minimum EOs concentrations for *in vivo* assay were determined 10% for *O. vulgare*, *O. onites* and *O. syriacum* based on *in vitro* DC assay. These concentrations were tested by spraying on apple fruit artificially inoculated by the pathogen. The results showed that the studied EOs inhibited fungal growth but their effectiveness against the pathogen varied. The present study showed the perspective of using EOs derived from *Origanum* spp. against black rot disease as an alternative antifungal agent for postharvest preservation of apples. However, further studies need to be done to improve application.

Keywords: Postharvest, apple, *Alternaria* spp., antifungal activity.

1. Introduction

According to Food and Agriculture Organization of United Nations (FAO), around 29-45% of fresh fruits and vegetables are loss and waste each year around the world, depending on development level of the countries (FAO, 2019). The main reason for loss is postharvest diseases caused by fungal infection at the storage level and they are the reason for major economic loss and have become a major global concern. Furthermore, it is estimated that these loss amounts yearly 1 billion USD in waste due to wrong harvesting practices, lack of handling facilities, and poor disease management practices from field to storage (PostHarvest, 2022).

Apple (*Malus domestica* L.) is one of the most cultivated temperate zone fruits in the world, and its annual production is over 87 million metric tons (FAO, 2022). Moreover, they can be stored for 6 to 12 months under cold storage and controlled atmosphere storage, respectively which makes them sufficiently available at the market all year around (Naets et al., 2020). However, apple fruits are susceptible to several fungal infections during long-term postharvest storage. These diseases cause fruit rots and decay, which decreases the quality and quantity of apple fruit (Sutton et al., 2014). Among these diseases, black rot caused by *Alternaria alternata* is considered one of the major postharvest diseases of apple fruits (Jurick et al., 2014; Pavicich et al., 2020). *A. alternata* is saprophytic and pathogenic fungus which can cause postharvest rots and fruit decay. This fungus follows two pathways to cause rot in apples: as a wound pathogen via wounds that occur at the harvest and as an infection pathogen infecting the blossom and remaining at the latent phase, but subsequently shows symptoms in apples at storage (Troncoso-Rojas and Tiznado-Hernández, 2014). Therefore, it is important to develop and improve suitable and sustainable disease management strategies to keep quality and prolong the storage time of apple fruit.

The most effective method to control postharvest diseases of fruit has been considered the application of synthetic fungicides. However, the emergence of resistant fungus strains against synthetic fungicides and increasing public concerns over the health and environmental hazards due to excessive usage of fungicides have led to the development of alternative, sustainable and safe postharvest disease management methods. Nowadays, there has been a growing interest in using essential oils (EOs) derived from plants as a promising natural substitute for controlling postharvest diseases (Sivakumar and

Bautista-Baños, 2014). Different EOs (e.g. thyme, oregano, mustard, lemongrass, clove) have been widely studied and found that they have strong antimicrobial activity on postharvest diseases (Prakash et al., 2015). The main mechanisms behind their antimicrobial activity are the direct inhibition of the mycelium growth of the pathogen and the effect on spore germination by disturbing the cellular metabolism of the pathogen (Tzortzakis, 2007; Yan et al., 2021). *Origanum* spp. is a broadly studied essential oil that possesses antimicrobial active compounds such as carvacrol and thymol. These compounds can disrupt microbial cell membranes, interfere with metabolic processes, and induce oxidative stress within the pathogens (Marrelli et al., 2018). Therefore, the usage of *Origanum* spp has gained interest in controlling major postharvest decay in fruits against several pathogens, including *Rhizopus. stolonifer* and *Aspergillus niger* (dos Santos et al., 2012); *Penicillium expansum* (Frankova et al., 2016); *Botrytis cinerea* (Kahramanoğlu et al., 2021; Zhao et al., 2021). The aim of this study was to determine the efficacy of Oregano EOs derived from *O. vulgare*, *O. onites*, and *O. syriacum* against postharvest black rot disease on apple both in *in vitro* and in *in vivo* assay.

2. Materials and Methods

2.1. Essential Oil, pathogen source and apple fruits

The essential oils (EO) derived from *O. vulgare* L., *O. onites* L., and *O. syriacum* plants were kindly supplied from Plant Protection Department, Hatay Mustafa Kemal University. EOs are kept in a clean glass pharmaceutical bottle at 4°C until they used for experiments. *A. alternata* isolate was obtained from the culture collection of Plant Production and Technologies Department, Agricultural Science and Technologies Faculty, Niğde Ömer Halisdemir University and used as a pathogen source. The pathogen was isolated from apple fruit and the pathogen stored on filter paper pieces at -25°C. For *in vivo* biocontrol assay, *Malus domestica* var. "Starking Delicious" apple fruits were harvested from Research and Application Center of Agricultural Science and Technologies Faculty, Niğde Ömer Halisdemir University and kept at cold storage (0°C±1, %95 Relative humidity) until they were used.

2.2. *In vitro* antifungal activity of essential oils on mycelium growth

2.2.1. Vapor contact assay

Antifungal activities of the essential oils of *O. vulgare* L., *O. onites* L., and *O. syriacum* L. on *A. alternata* were tested with the filter disk method, as suggested by previous studies

with slight modifications (Zhao et al., 2021; Soylu et al., 2010). Glass petri dishes (Ø, 90mm) were filled with 20ml of sterilized Potato Dextrose Agar (PDA, 39 g/L, VWR, Radnor, Pennsylvania, USA) and 6 mm diameter agar plugs from 7 days old culture of *A. alternata* were placed in center of solidified PDA. EOs suspensions were prepared at different concentrations (5%, 10%, 15%, 20%, 25% and 30%) using of 1:2 (v/v) of Ethanol (70%) and Tween-20 (0.05%) solution. The EO suspensions were pipetted onto sterile filter paper disks (Ø, 10 mm) and the disks were placed in the center of petri dish lids. The lids were placed on the PDA with pathogen directly after EOs treatments, sealed with parafilm, and incubated in the dark at 22± 1°C for 7 days. Petri dishes were treated with an Ethanol-Tween-20 solution considered as a control. Each concentration was tested in 5 petri dishes. Mycelium diameter was measured in two different directions after 7 days helping with a ruler, and antifungal activity was expressed as Mycelium Inhibition Rate (MIR, %), and was determined by following formula:

Mycelium Inhibition Rate (MIR, %) = ((C-T)/ C) * 100)

where C is the average diameter (mm) and T is the diameters (mm) of fungal mycelia in the control and the treatment, respectively.

2.2.2. Direct contact assay

In direct contact assay, the antifungal activity of EOs was determined by the mycelium inhibition rate as explained above. 20 ml of PDA was poured in petri dishes with 90 mm diameter and left under laminar hood for solidification. 100 µl of the prepared EOs application suspension, as described above, dropped in the media, and spread onto the media by sterile spreader. After the EOs application, agar plugs were placed in center of the petri dish from 7 days old pathogen culture, sealed with parafilm, and incubated in the dark at 22± 1°C for 7 days. Plates with Ethanol-Tween-20 solution were considered as a control. In the end of incubation period, mycelium radial growth was measured in two different directions and the antifungal activity was expressed as a MIR (%). Each EOs concentration was tested in 5 petri dishes and each petri dish referred as a replicate.

2.3. *In vivo* antifungal activity of essential oils on lesion growth

Apple fruits of cv. “Starking Delicious” were subjected to surface sterilization before application of the most effective concentration of each EOs determining by *in vitro* assay. The fruits were dipped in 2% NaOCl for 3 min, washed with distilled water, and then

placed on filter paper for drying under room conditions for almost 1h. The experiment had 5 fruits with three replications and the fruits were placed in plastic boxes with vials. Artificial fungal inoculation was performed at room temperature by puncturing with a sterilized tip to each fruit at one point, and spore suspension ($1x10^5$ spore/ml) inoculated onto artificial wounds. Spore suspension was prepared from 7 days old pathogen culture. 10 ml 0.05% Tween-20 solution was added to the culture plate, spores were disturbed with a sterile loop from mycelium, and the suspension passed through two layers of sterilized gauze to prevent hyphae in the final spore suspension. The suspension concentration was justified by helping with the hemocytometer.

To determine biocontrol activity of EOs, 15% *O. vulgare*, 15% *O. onites*, and 10% *O. syriacum* were sprayed into the artificial wounds and then left under room conditions. After 1h of EOs application, 20 µl spore suspension was inoculated into the wounds, and the plastic boxes were closed with plastic bags. All treatment batches were incubated in the dark at 25±1°C for 7 days. Lesion diameters were measured with a ruler and the Lesion Inhibition Rate (LIR, %) was determined by the following formula:

Lesion Inhibition Rate (MIR, %) = ((C-T)/ C) * 100)

where C is the average diameter (mm) and T is the diameter (mm) of the decay lesion in the control and the treatment, respectively.

2.3. Statistical analysis

All experiments were set up based on a completely randomized design. The inhibition rate data were subjected to angular transformation before statistical analysis. SPSS Version 25.0 (SPSS Inc., USA, 2017) was used for statistical analysis. Analysis of variance (ANOVA) was used to determine the statistical differences between the sample means, and multiple comparisons of the means were conducted using Tukey's test ($p < 0.05$). All data were expressed as mean ± SD.

3. Finding and Discussion

3.1. Direct vapor assay *in vitro*

The *in vitro* VC assays, the fumigation activity of *Origanum* spp. EOs against *A. alternata* at different concentrations are shown in Figure 1. Different concentrations of the EOs showed to have different impacts on mycelial radial growth. The highest concentrations of Oregano EOs (from 20% to 30%) were observed that prevent the mycelium growth of *A. alternata* in a EOs species independent manner and the inhibition rate was not

significantly different among these concentrations ($p > 0.05$). At 30%, the inhibitory effect of *Origanum* spp. was varied from 68.14% to 81.06%, however, the highest inhibition rate (83.90%) was observed at 20% concentration of *O. vulgare* EO to the mycelial growth of *A. alternata*. The results in this study are also similar with those of Frankova et al. (2021), who found that EO of *O. vulgare* at higher concentration inhibited the growth of *A. alternata*. Others also report that *Origanum* spp. showed inhibitory effect on *Botrytis cinerea* at highest concentrations (Zhao et al., 2021; Kahramanoğlu et. al, 2022).

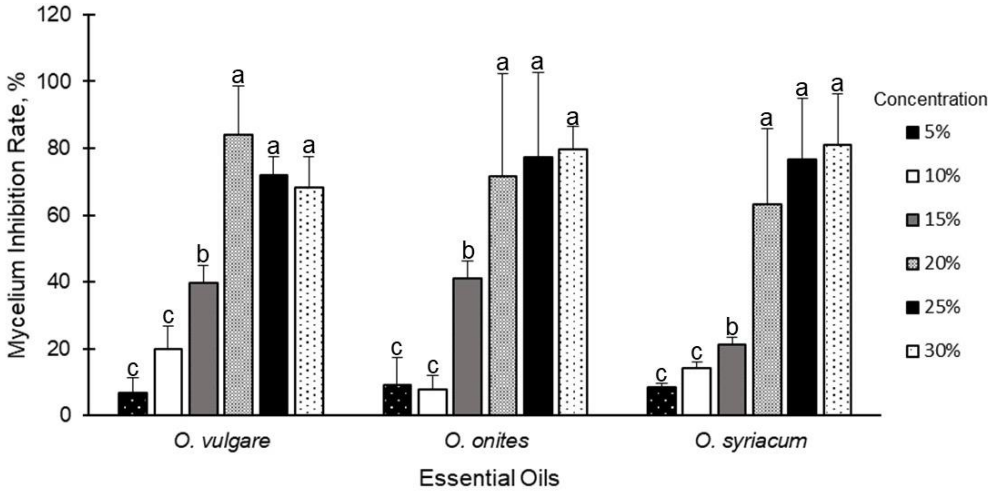


Figure 1. Direct vapor assay. *In vitro* antifungal activities of the essential oils (EOs) of *Origanum* spp. against mycelial growth of *Alternaria alternata* after 7 days incubation at 22 ± 1°C. Different letters on the bars represent significant difference according to Tukey's test ($p<0.05$).

3.2. Direct contact assay *in vitro*

The *in vitro* antifungal activities of *Origanum* spp. EOs DC by assay against *A. alternata* at different concentrations are shown in Figure 2. In DC assay, all concentration of Oregano EOs showed the higher inhibition on the mycelium growth of *A. alternata* compared to the result of VC assay. Moreover, EOs derived from *O. vulgare*, *O. onites* and *O. syriacum* stopped the mycelium growth of the pathogen from the concentrations of 15% to 30%. To explain the difference in antifungal activity between the *in vitro* assay, it is possible that mycelia of the pathogen faced direct exposure to compounds released by EOs in the contacted on the PDA surface, whereas in a VC assay, the mycelia only exposure to the compounds indirectly in the closed environment. Consequently, the

inhibitory effect on mycelial growth of *A. alternata* in DC assays was more effective than that in VC assays. In contrast with our result, Zhao et al (2021) report that *O. vulgare* showed the greater inhibition on mycelium growth of *B. cinerea* in VC assay compare to DC assays.

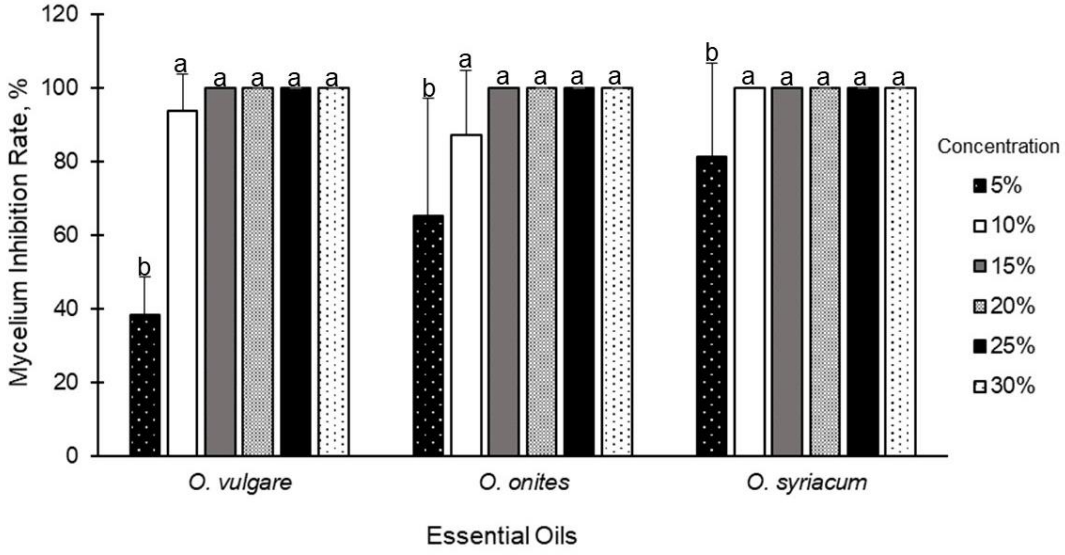


Figure 2. Direct contact assay. *In vitro* antifungal activities of the essential oils (EOs) of *Origanum* spp. against mycelial growth of *Alternaria alternata* after 7 days incubation at 22 ± 1°C. Different letters on the bars represent significant differences according to Tukey's test ($p<0.05$).

3.3. *In vivo* antifungal activity of essential oils

The *in vivo* application concentrations of EOs from *O. vulgare*, *O. onites*, and *O. syriacum* were determined as 15% and 10% based on in vitro antifungal activity results, respectively. The impacts of spray contact of the EOs the decay lesion of apple fruits infected by *A. alternata* are presented in Figure 3. The statistical analysis revealed that all the EOs have a significantly inhibitory impact on lesion inhibition, and the highest lesion inhibition rate (36.34%) was observed in the EO treatment derived from *O. syriacum*. However, none of the EOs showed total disease inhibition on the artificially infected apple fruits. Many studies shows that EOs of *Origanum* spp. can inhibit postharvest disease under *in vivo* conditions (Tzortzakis, 2007; Zhao et al, 2021; Kahramanoğlu et al., 2022). But there are limited studies on *in vivo* efficacy of oregano EOs against postharvest black rot diseases of apple fruit.

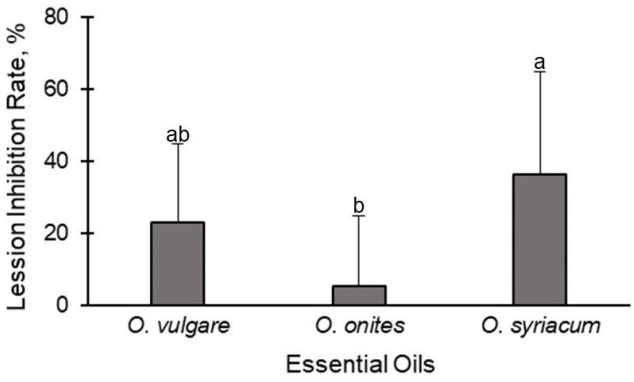


Figure 3. *In vivo* antifungal activities of the essential oils (EOs) at concentrations of 15% of *O. vulgare* and *O. onites*, and 10% of *O. syriacum* on lesion inhibition after 7 days incubation at 25 ± 1°C. Different letters on the bars represent significant difference according to Tukey's test ($p<0.05$).

4. Conclusion and Recommendations

The present study showed that EOs derived from *Origanum* spp. have concentrations dependent effect on the inhibition of mycelium growth of *A. alternata* in *in vitro*. Although their high potential with antifungal activity in *in vitro*, the lesion inhibition of EOs by spraying showed less inhibition rate than that in *in vitro*. Therefore, the application of EOs derived from *Origanum* spp. needs to be detailed research in order to reveal possible application solution in the field condition as an alternative to the synthetic fungicides.

References

Dos Santos, N.S.T., Aguiar, A.J.A.A., De Oliveira, C.E.V., De Sales, C.V., De Melo, S., Da Silva, R.S., Stamford, T.C.M. and De Souza, E.L. (2012). Efficacy of the application of a coating composed of chitosan and Origanum vulgare L. essential oil to control Rhizopus stolonifer and Aspergillus niger in grapes (*Vitis labrusca* L.). Food microbiology, 32(2), pp.345-353.

Food and Agriculture Organization of United Nations (2019). The state of food and agriculture. (https://www.fao.org/3/ca6030en/ca6030en.pdf) Accesed 03 August 2023.

Food and Agriculture Organization of United Nations (2022). Food and agriculture data. (https://www.fao.org/faostat/en/#home) Accesed 03 August 2023.

Frankova, A., Smid, J., Bernardos, A., Finkousova, A., Marsik, P., Novotny, D., Legarová, V., Pulkrabek, J. and Kloucek, P. (2016). The antifungal activity of essential oils in combination with warm air flow against postharvest phytopathogenic fungi in apples. Food Control, 68, pp.62-68.

Jurick, W.M., Kou, L.P., Gaskins, V.L. and Luo, Y.G. (2014). First report of Alternaria alternata causing postharvest decay on apple fruit during cold storage in Pennsylvania. Plant disease, 98(5), pp.690-690.

Kahramanoğlu, İ., Panfilova, O., Kesimci, T.G., Bozhüyük, A.U., Gürbüz, R. and Alptekin, H., 2022. Control of postharvest gray mold at strawberry fruits caused by Botrytis cinerea and improving fruit storability through Origanum onites L. and Ziziphora clinopodioides L. volatile essential oils. Agronomy, 12(2), p.389.

Marrelli, M., Statti, G.A. and Conforti, F. (2018). Origanum spp.: An update of their chemical and biological profiles. Phytochemistry reviews, 17, pp.873-888.

Naets, M., Bossuyt, L., De Coninck, B., Keulemans, W. and Geeraerd, A. (2020). Exploratory study on postharvest pathogens of 'Nicoter'apple in Flanders (Belgium). Scientia Horticulturae, 260, p.108872.

Pavicich, M.A., Cárdenas, P., Pose, G.N., Pinto, V.F. and Patriarca, A. (2020). From field to process: How storage selects toxigenic *Alternaria* spp. causing mouldy core in Red Delicious apples. International journal of food microbiology, 322, p.108575.

PostHarvest (2021). The top food loss and waste statistics of 2021. (https://www.postharvest.com/blog/top-food-waste-statistics-of-2021/) Accesed 03 August 2023.

Prakash, B., Kedia, A., Mishra, P. K., Dubey, N. K. (2015). Plant essential oils as food preservatives to control moulds, mycotoxin contamination and oxidative deterioration of agri-food commodities–Potentials and challenges. Food control, 47, 381-391.

Sivakumar, D. and Bautista-Baños, S., 2014. A review on the use of essential oils for postharvest decay control and maintenance of fruit quality during storage. Crop protection, 64, pp.27-37.

Soylu, E.M., Kurt, Ş. and Soylu, S. (2010). In vitro and in vivo antifungal activities of the essential oils of various plants against tomato grey mould disease agent *Botrytis cinerea*. International journal of food microbiology, 143(3), pp.183-189.

Sutton, T. B., Aldwinckle, H. S., Agnello, A. M., & Walgenbach, J. F. (Eds.). (2014). Compendium of apple and pear diseases and pests. The American Phytopathological Society.

Troncoso-Rojas, R. and Tiznado-Hernández, M.E. (2014). *Alternaria alternata* (black rot, black spot) in Postharvest decay (pp. 147-187). Academic Press.

Tzortzakis, N.G., 2007. Maintaining postharvest quality of fresh produce with volatile compounds. Innovative food science & emerging technologies, 8(1), pp.111-116.

Yan, J., Wu, H., Chen, K., Feng, J. and Zhang, Y. (2021). Antifungal activities and mode of action of *Cymbopogon citratus*, *Thymus vulgraris*, and *Origanum heracleoticum* essential oil vapors against Botrytis cinerea and their potential application to control postharvest strawberry gray mold. Foods, 10(10), p.2451.

Zhao, Y., Yang, Y.H., Ye, M., Wang, K.B., Fan, L.M. and Su, F.W. (2021). Chemical composition and antifungal activity of essential oil from *Origanum vulgare* against *Botrytis cinerea*. Food chemistry, 365, p.130506.

MORİNGA BİTKİSİNİN PROTEİN KAYNAĞI VE YEM KATKI MADDESİ OLARAK KANATLI BESLEMEDE KULLANIMI

Simge SELVİ (ORCID: 0000-0003-4455-3339)
Ege Üniversitesi, Ziraat Fakültesi, Zootekni Bölümü, İzmir-Türkiye
Email: ssimgee98@gmail.com

Hatice BASMACIOĞLU-MALAYOĞLU (ORCID: 0000-0002-4026-5631)
Ege Üniversitesi, Ziraat Fakültesi, Zootekni Bölümü, İzmir-Türkiye
Email: hatice.basmacioglu@ege.edu.tr

ÖZET
Dünyada kanatlı sektöründe çok hızlı bir büyüme görülmektedir. Ancak bu hızlı büyüme başta yem hammadde temini olmak üzere bazı sorunları da beraberinde getirmiştir. Kanatlı rasyonlarında kullanılan soya küspesinin temininin zor ve fiyatının yüksek olması, hayvansal kökenli yem kaynaklarının kullanımına getirilen sınırlamalar ve ek aminoasit yemlerinin pahalı olması alternatif protein kaynakları arayışına neden olmuştur. Bununla birlikte kümes hayvanlarının verimliliğini ve bağışıklığını artırmanın yanı sıra hem hayvan sağlığını hem de ekonomik et ve yumurta üretimini artırmak amacıyla büyütme faktörü olarak kullanımı yasaklanmış olan antibiyotiklere alternatif olabilecek yem katkı maddeleri kullanımına gidilmiştir. Son yıllarda tüketicilerin sağlıklı beslenme için doğal ürünleri tercih etmeleri de sektörü alternatif doğal yem katkı maddeleri kullanımına yöneltmiştir. Bu bağlamda, anavatanı Kuzey Hindistan olan Moringa bitkisinin yüksek protein içeriği, immün sistemi üzerinde pozitif etki oluşturması, antioksidan, antienflamatuar, antimikrobiyal etki göstermesi nedeniyle kanatlı beslemede kullanımına dikkat çekilmiştir. Moringa bitkisinin en iyi bilinen türü *Moringa oleifera Lamarck*'tır. Mucize ağaç olarak da adlandırılan bu bitkinin kuraklığa dayanıklı olması ve farklı iklim türlerine uyum sağlayabilmesi sürdürülebilir hayvan besleme açısından kullanımını daha da önemli kılmaktadır. Moringa bitkisi ile yapılan kanatlı besleme çalışmaları ile bitkinin yaprak kısmının rasyonlarda alternatif protein kaynağı ve yem katkı maddesi olarak belirli düzeylerde kullanıldığında hayvan sağlığı ve performansı üzerinde olumlu etkileri olduğu ortaya konmuştur.
Anahtar Kelimeler: Kanatlı besleme; *Moringa oleifera*, protein kaynağı, yem katkı maddesi

THE USE OF MORINGA PLANT IN POULTRY NUTRITION AS A PROTEIN SOURCE AND FEED ADDITIVE

ABSTRACT

There is a very rapid growth in the poultry industry in the world. However, this rapid growth has brought with it some problems, especially the supply of feed raw materials. The difficulty in obtaining and high price of soybean meal used in poultry rations, the restrictions on the use of animal feed sources and the expensiveness of supplementary amino acid feeds have led to the search for alternative protein sources. In addition to increasing the productivity and immunity of poultry, feed additives have been used as alternatives to antibiotics, which are banned as growth factors, in order to increase both animal health and economic meat and egg production. In recent years, consumers' preference for natural products for healthy nutrition has led the industry to use alternative natural feed additives. In this context, attention has been drawn to the use of the Moringa plant, whose homeland is Northern India, in poultry feeding due to its high protein content, positive effect on the immune system, antioxidant, anti-inflammatory and antimicrobial effects. The best known species of moringa plant is *Moringa oleifera Lamarck*. The fact that this plant, also called the miracle tree, is drought resistant and can adapt to different climate types has made its use even more important in terms of sustainable animal nutrition. Poultry feeding studies conducted with the Moringa plant have revealed that the leaf part of the plant has positive effects on animal health and performance when used at certain levels as an alternative protein source and feed additive in rations.

Keywords: Poultry nutrition, *Moringa oleifera,* protein source; feed additive

1. Giriş

Kanatlı eti ve yumurta üretimi her ne kadar tüm dünyada gittikçe artış göstermekle birlikte üretim giderlerinin önemli bir kısmını oluşturan yemin temini ve maliyeti ile ilgili sorunları da beraberinde getirmiştir. Nitekim kanatlı rasyonlarında önemli bir yere sahip protein kaynağı soya küspesinin teminin zor ve pahalı olması, hayvansal kaynaklı yemlerin kullanımındaki kısıtlamalar, aminoasit ek yemlerin yüksek fiyatları alternatif protein kaynakları arayışına neden olmuştur. Bununla birlikte büyütme faktörü olarak kullanılan antibiyotiklerin yasaklanması ve tüketicilerin doğal ürünlere olan talebi alternatif doğal yem katkı maddeleri kullanımını ön plana çıkarmıştır.

Alternatif proteince zengin olan kaynakların araştırılarak bulunmasıyla hayvan beslemede protein açığının giderilmesi, sürdürülebilir kaliteli yem hammadde tedariki ve kanatlı sektöründeki yüksek maliyetlerin düşürülmesi hedeflenmektedir (İpçak ve ark., 2018). Antibiyotiklere alternatif olarak kullanılabilecek doğal yem katkı maddelerinin geliştirilmesine yönelik yapılan çalışmalarla da hayvanların beslenmesinde sağlık, performans ve üretim kalitesi konularına eğilim artmıştır.

Moringa bitkisinin yüksek protein içeriği yanında immün sistem üzerinde pozitif etki oluşturması, antioksidan, antienflamatuar ve antimikrobiyal etkileri kanatlı beslemede kullanımına dikkat çekmiştir.

Bu derlemede, yüksek protein ve biyoaktif madde içeriğine sahip Moringa bitkisinin anavatanı ve botanik özellikleri, kimyasal kompozisyonu hakkında bilgi verilecek ve kanatlı beslemede kullanımı ile ilgili yapılan çalışmalar sunulacaktır.

2. Moringa Bitkisinin Anavatanı ve Botanik Özellikleri

Bitkiler âleminde Moringaceae familyasına ait olan 14 adet farklı tür bulunmaktadır. Bu farklı türler içerisinde en değerlisi, en fazla yetiştirileni ve bilineni *Moringa oleifera Lamarck*'tır (Mersin & İşcan, 2022). Kuzey Hindistan, Pakistan ve Nepal'e özgü olan Moringa bitkisinin, Güney Asya'nın tamamında, Güneydoğu Asya'nın birçok ülkesinde, Arap Yarımadası'nda, Afrika'da, Orta Amerika'da, Karayipler'de ve Güney Amerika'da yetiştiriciliği yapılmaktadır (Parrotta, 2014). Türkiye'de ise yetiştiriciliğinin yaygın olarak yapıldığı yer Gaziantep'in Nur Dağı ilçesidir.

Moringa bitkisi çeşitli beslenme, farmakolojik ve endüstriyel uygulamaları nedeniyle sosyoekonomik öneme sahip olan bir bitkidir. "Mucize ağaç" olarak da adlandırılmaktadır (Kasola et al., 2010). Bu şekilde adlandırılmasının nedeni ise bitkinin

tohumundan köküne, sapına kadar her kısmından faydalanılabilmesi ile neredeyse bütün kısımlarının farklı ve önemli değerlere sahip olmasıdır. Moringa bitkisi yaprakları 20-50 cm genişliğinde olan, yüksekliği ise 5-12 m'ye varabilen ve hızlı büyüme yeteneğine sahip olan bir ağaçtır (Şekil 1)

Şekil 1. Moringa Bitkisi

Bitki ilk yıl 4 m'ye kadar büyüyebilmektedir. Herhangi bir don vs. gibi kötü hava koşulları ile karşılaşmazsa, sıcak iklimlerde ağacın 6-15 metre arası uzayabildiği görülmüştür. Tropik, subtropik ve yarı kurak iklimlerde yetişebilmekte olan bir türdür. Farklı iklim koşullarına kolay bir şekilde uyum sağlayabilmektedir. Bitkinin, herhangi bir toprak tercihi bulunmamaktadır. Genel olarak kuru kumlu topraklarda iyi yetişebilmekle birlikte, en fakir topraklarda dahi yetişebilme kabiliyeti bulunmaktadır (Ruiz-Hernández et al., 2022).

3. Moringa Bitkisinin Besin Madde ve Fitokimyasal İçeriği

Moringa bitkisinin besin madde içeriği bitkinin kısımlarına göre farklılık gösterir. Bitkinin kısımlarına göre (sırasıyla tohum, çiçek, kabuk, yaprak, sap ve tüm bitki) kuru madde içeriği 892.5 ile 950.0 g/kg, ham kül içeriği 34.8 ile 138.9 g/kg, protein içeriği 71.2 ile 391.7 g/kg, ham yağ içeriği 20.0 ile 388.0 g/kg, ham selüloz içeriği 48.0 ile 490.0 g/kg arasında değişim göstermektedir. Yaprak ve tüm bitkinin sindirilebilirliği %79.05 ve %76.09 olmakla birlikte kabuk ve sap kısımlarının sindirilebilirliği ise %43.07 ve %52.17 olarak bildirilmiştir (Mabruk et al., 2010).

Tablo 1. Moringa Bitkisinin farklı kısımlarına göre besin madde içeriği (g/kg) ve sindirilebilirliği (%)

Bitki Kısımları	Kuru Madde	Ham Kül	Ham Protein	Ham Yağ	Ham Selüloz	Sindirilebilirlik
Tohum	950.0	34.8	391.7	388.0	48.0	-
Çiçek	892.5	112.1	314.8	68.0	170.0	-
Kabuk	940.0	97.1	71.2	20.0	490.0	43.07
Yaprak	930.0	138.9	267.9	64.0	210.0	79.05
Sap	940.0	101.1	112.3	32.0	430.0	52.17
Tüm Bitki	914.0	123.7	200.0	24.0	270.0	76.09

(Mabruk et al., 2010)

Moringa bitkisinin yaprakları kalsiyum, potasyum, çinko, magnezyum, demir ve bakır gibi mineraller bakımından zengindir. Vitamin A (beta-karoten), vitamin B (folik asit, piridoksin ve nikotinik asit), vitamin C, D ve E gibi vitaminler de Moringa bitkisinde yüksek düzeylerde bulunmaktadır. Moringa bitkisi, kolin, lösin, β-sitosterol, kaempferol, kuersetin gibi önemli besleyici maddeler bakımından zengin olmakla beraber yapısında fazla miktarda lutein, zeaksantin, glutatyonda içermektedir (Gıdık, 2018). Bitkinin mineral madde içeriği çok çeşitli olup özellikle kalsiyum ve potasyum mineralleri açısından oldukça zengin bir içeriğe sahip olduğu görülmektedir (Tablo 2).

Tablo 2. Moringa yaprağının mineral madde içeriği (mg/100g)

Mineral madde	**Minimum-maksimum**	**Ortalama**
Kalsiyum (Ca)	2787-3307	3039
Potasyum (K)	2672-4892	3346
Demir (Fe)	14.11-16.57	14.72
Magnezyum (Mg)	553-1566	658.77
Sodyum (Na)	14.78-17.76	16.55

(Mulyaningsih & Yusuf, 2018)

Moringa oleifera yaprakları tanenler, steroller, terpenoidler, flavonoidler, saponinler, alkaloidler ve indirgeyici şeker gibi fitokimyasallar, glukozinolatlar, izotiyosiyanatlar, glikozitler ve gliserol gibi antikanseröz ajanları içermektedir (Gopalakrishnan et al., 2016). Taşımakta olduğu biyoaktif maddelerin (flavonoidler, polifenoller, tanenler, saponinler, karotenoitler, alkoloidler) antioksidan ve antienflamatuar etkileri bildirilmiştir (Mbikay, 2012, Boztaş ve ark., 2019). Moringa yaprağında bulunan bazı fitokimyasallar ve % değerleri Tablo 3 de verilmiştir.

Tablo 3. Moringa yaprağında bulunan bazı fitokimyasallar ve oranları

Fitokimyasallar	**%**
Alkoloidler	1.24
Flavonoidler	4.90
Saponinler	0.69
Siyanogenik glikozidler	0.25
Tanenler (polifenoller)	0.03

(Alikwe & Omotosho, 2013)

Tablo 3 de verilmiş olan fitokimyasallar hayvanlar tarafından fazla tüketildiğinde toksik etki oluşturabilir (Alikwe & Omotosho, 2013). Bu durum hayvanların sağlığını, verimini, yemden yararlanmayı, vücut fonksiyonlarını ve büyümesini negatif etkiler. Ancak fitokimyasalların toksik etki düzeyinin altındaki düzeylerde alınmaları durumunda antimikrobiyal, antioksidan aktivite ve immun sistemi iyileştirici özellikleri görülür. Bu özellikteki fitokimyasalları içeren Moringa bitkisi ile ilgili çok sayıda in vitro ve in vivo çalışmalar yapılmıştır. *Moringa oliefera* bitkisinin antimikrobiyal ve antioksidan etkisinin belirlenmesi amacıyla yapılan in vitro bir çalışmada (Moyo et al., 2012) aseton ile ekstraksiyon işlemi yapılan *Moringa oleifera* yaprak ekstraktının *Escherichia coli, Enterobacter cloace, Proteus vulgaris, Staphylococcus aureus* ve *Micrococcus kristinae'ye* karşı antibakteriyel aktivite gösterdiği, *Streptococcus faecalis, Bacillus pumilus, Klebsiela pneumonia, Bacillus cereus* ve *Pseudomonas aeruginosa* üzerinde ise engelleyici etki göstermediği saptanmıştır. Oladeji et al. (2019) tarafından yapılan başka bir çalışmada ise kloroform, etil asetat ve etanol kullanılarak ekstrakte edilen Moringa yaprak ekstraktlarında steroidler, saponinler, tanenler, flavonoidler, terpernoidler gibi

bazı önemli biyoaktif bileşikler tespit edilmiş olup etanol ekstraktının, kloroform ve etil asetat ekstraktlarıyla karşılaştırıldığında en yüksek antimikrobiyal aktiviteyi gösterdiği belirlenmiştir. Ayrıca bitkinin *Pseudomonas aeruginosa, Trichoderma* sp, *Aspergillus flavus, Bacillus cereus, Streptococcus pneumoniae, Candida* gibi bazı patojenler üzerinde yüksek antimikrobiyal etkileri olduğu saptanmıştır.

Gómez-Martínez et al. (2020) tarafından yapılan çalışmada yüksek miktarda toplam fenolik bileşik, flavonoid ve terpen içeren *Moringa oleifera* yaprağının yüksek antioksidan aktivite potansiyeline sahip olduğu ortaya konmuştur. Olaoye et al. (2021), 21 farklı bölgeden toplanan *Moringa oleifera* yapraklarının antioksidan aktivitesinin yıllık yağış, minimum sıcaklık ve maksimum sıcaklık gibi çevresel parametrelerin ve bitkinin yetiştiği toprak yapısına göre değiştiğini bildirmişlerdir. Moringa yaprağının antioksidan aktivite ile ilgili yapılmış bir başka çalışmada, yaprağın metanolik, sulu ve etil asetat ekstraktlarının yüksek antioksidan aktiviteye sahip olduğu ve bitkinin yapraklarının kaempferol, gallik asit, vanilik asit, kumarik asit ve kuersetin gibi fenolik ve flavonoid içeriğine sahip olduğu tespit edilmiştir (Saleem et al., 2020).Sonuç olarak, yapılan in vitro çalışmalarla *Moringa oleifera* bitkisinin önemli bir antioksidan ve antimikrobiyal etken madde içeriğe sahip olduğu ve çevresel parametrelerin bu içerikleri önemli düzeyde etkilediği ortaya konmuştur.

4. Moringa Bitkisinin Besin Değerinin Biyoteknolojik Yöntemlerle İyileştirilmesi-Katı Kültür Fermantasyonu

Kanatlı beslemede alternatif protein kaynağı olarak Moringa bitkisinin biyoteknolojik yöntemlerle protein içeriğinin artırılması ve içermiş olduğu anti-besleme faktörlerinin en az düzeye indirebilmesi mümkündür. Bu kısıtlayıcı faktörleri ortadan kaldırabilmek amacıyla susuz veya suyun az olduğu katı ortamlarda gerçekleşen katı kültür fermantasyonu, düşük maliyetli ve hızlı olması nedeniyle tercih edilmektedir. Katı kültür fermantasyonunda uygun mikroorganizmaların ve substratın seçimi, fermantasyon koşullarının optimizasyonu, ürünün izolasyonu ve saflaştırılması oldukça önemlidir (Bhargava et al., 2008). Fermantasyonda sıklıkla kullanılmakta olan 2 farklı kültür vardır. Bunlar; bakteri kültürleri ve fungus kültürleridir. Bakteri kültürlerinden *Enterecoccus faecium, Lactobacillus plantarum, Lactobacillus fermentum* ve *Bacillus subtilus* kullanılmaktadır. Fungus kültürlerinden ise *Aspergillus oryzae, Sacchoramyces cerevisia* ve *Aspergillus niger* kullanılmaktadır (Quiroz et al., 2014; Altop ve ark., 2016;). Fermente

edilmiş olan yemlerin hayvanlarda bağırsak florasını olumlu olarak etkilediği ve böylece performans da iyileşme sağlandığı bildirilmiştir (Sugiharto & Samir, 2019).

Tablo 4 de Moringa bitkisine uygulanan katı kültür fermantasyonu ile ilgili yapılan bazı çalışmalar ve sonuçları verilmiştir. Tablo 4 incelendiğinde genel olarak katı kültür fermantasyonunun Moringa bitkisinin besin madde içeriği üzerinde olumlu etkileri olduğu ve içerisindeki bazı anti-besleme faktörleri azaltarak yem hammaddesinin besin değerini iyileştirdiği görülmektedir. Yapılan bu çalışmalar, gelecekte Moringa yaprağı üzerine yapılacak olan çalışmaların geliştirilmesi için bir temel oluşturmaktadır.

Tablo 4. Moringa yaprağına uygulanan katı kültür fermantasyonu ile ilgili bazı çalışmalar

Mikroorganizma	**Bulgular**	**Referans**
Bacillus pumilus	-Moringa yaprağına uygulanan mikrobiyal fermantasyon yoluyla besin değerinde iyileşmeler saptanmıştır.	Zhang et al. (2017)
Aspergillus niger	-Fermente edilen yaprakların protein içeriği ve sindirilebilirliğinde artış saptanmıştır. -Flavonoidler ve γ-aminobutirik asit içeriği gibi bazı fonksiyonel bileşenlerin miktarlarında fermente edilmemiş yapraklara kıyasla önemli düzeyde artış saptanmıştır.	Wang et al. (2018)
Aspergillus niger, Candida utilis, Bacillus subtilis	-Ham protein içeriğinde artış, fitik asit ve tanen içeriğinde azalma saptanmıştır.	Shi et al. (2020)
Rhizopus oligosporus, Aspergillus oryzae, Neurospora intermedia	-*Rhizopus* ve *Aspergillus* ile yapılan çalışmada artan antioksidan potansiyeline rağmen fermantasyon sonrasında toplam serbest fenolik içeriğinde iyileşme saptanmamıştır. Fermantasyon süresinin uzaması serbest fenolik içeriğinde ciddi bir düşüşe neden olmuştur. *Neurospora intermedia* ile yapılan fermantasyon yaprağın protein içeriğini artırmıştır.	Starzyńska-Janiszewska et al. (2022)

5. Etlik Piliçlerde ve Yumurtacı Tavuklarda *Moringa* Kullanımı

Kanatlı sektöründe üretim maliyetlerindeki artışın temel nedenleri konvansiyonel yemlerin (mısır ve soya küspesi gibi) fiyatlarındaki artış, hayvansal kaynaklı yem hammaddelerinin kullanımındaki sınırlamalar, proteince zengin bazı yem hammaddelerinin talep rekabeti nedeni ile pahalı ve temininin zor olmasıdır. Günümüzde artan endüstri standartları ve tüketici bilincinin yanı sıra hayvansal kaynaklı sağlıklı gıda ürünlerine olan talebin artmasıyla birlikte doğal olan alternatif yem hammaddeleri ve yem katkı maddeleri arayışına gidilmiştir. Moringa bitkisinin de antioksidan, antienflamatuar, antimikrobiyal etki göstermesi, zengin bir besin içeriğe sahip ve kuraklığa dayanıklı bir bitki olması nedeniyle son zamanlarda sürdürülebilir kanatlı beslemede alternatif protein kaynağı ve doğal yem katkı maddesi olarak kullanımına dikkat çekilmiştir.

Tablo 5 de etlik piliç ve yumurta tavuğu karma yemlerinde Moringa bitkisinin kullanımı ile ilgili bazı çalışmalar ve elde edilmiş olan bulgular verilmiştir.

Tablo 5. Etlik piliç ve yumurta tavuğu karma yemlerinde Moringa bitkisinin kullanımı ile ilgili bazı çalışmalar

Tür	Kullanım düzeyi	Bulgular	Referans
Etlik piliç	Soya küspesi yerine %0-%25-%50-%75-%100 *Moringa oleifera* yaprağı ilavesi	-Kullanılan bütün oranlarda yem tüketiminde önemli bir farklılık saptanmamıştır. - %25 ilavesinin yemden yararlanmayı iyileştirdiği dolayısıyla karma yemde %25 *Moringa oleifera* yaprağının kullanılabileceği ortaya konmuştur.	Gadzirayi et al. (2012)
Yumurtacı tavuk	Soya küspesi yerine %0-%5 ve %10 *Moringa oleifera* yaprağı ilavesi	-%5 ilavesi (%0 ve %10 ilavelere göre) yumurta verimini artırmış ve yemden yararlanmayı iyileştirmiştir. -En kötü yemden yararlanma ve yumurta verimi %10 ilavede saptanmıştır. -Yumurtanın ağırlığını arttırdığı belirlenmiştir.	Kana et al. (2015)
Etlik piliç	%2.5 ve %4 *Moringa oleifera* yaprağı ilavesi	-%2.5 ilave performansı olumsuz yönde etkilemediği ancak %4 ilavesinin yem tüketimi, canlı ağırlık artışı ve yemden yararlanmayı olumsuz etkilediği saptanmıştır.	Abasse et al. (2017)
Etlik piliç	%0, %0.5, %1 ve %5 *Moringa oleifera* yaprağı ilavesi	-%1'e kadar ilave, büyüme performansı üzerinde olumlu etkilere yol açmış, daha yüksek bir canlı ağırlık artışı saptanmıştır. -Patojen bakterilerde azalmaya ve faydalı bakteri popülasyonlarında artışa neden olmuştur. -Beyaz kan hücresi ve lenfosit sayısında, karın yağında ve kan kolesterol seviyelerinde azalma saptanmıştır. -İlave %5'e yükseldikçe yem tüketimi azalmıştır. - Ca ve P düzeylerini artmış ancak glikoz, kolesterol, trigliserit azalmıştır.	Hafsa et al. (2019)

Yumurtacı tavuk	%0-%2-%4-%6 *Moringa oleifera* yaprağı ilavesi.	-Moringa yaprağı ilavesinin yumurta verimini, yumurta ağırlığını, yem tüketimini, kabuk kalınlığını, yumurta kabuğundaki Mg ve Ca içeriğini önemli düzeyde artırdığı saptanmıştır. Yeme %2-6 Moringa yaprağı ilavesi yumurta sarısı kolesterol içeriğini önemli düzeyde düşürmüş, yumurta sarı rengi ile yumurta sarısındaki β-karoten, Mg ve Ca içeriğini arttırmıştır.	Bidura et al. (2020)
Yumurtacı tavuk	%0-%0.5-%1-%1.5 *Moringa oleifera* yaprağı ilavesi	-Moringa yaprağı yumurta ağırlığı üzerinde etkili olmazken yumurta sarı rengi ve yumurta kırılma mukavemetini arttırmıştır. -Bu çalışma ile yumurta tavuğu yemine %1.5 *Moringa* oleifera yaprağı ilavesinin yumurta kalitesini ve yağ asidi profilini iyileştirdiği ve yumurta sarısı kolesterol içeriğini düşürdüğü ortaya konmuştur.	Sharmin et al. (2021)
Yumurtacı tavuk	Soya küspesi yerine %0-%5-%10 ve %15 *Moringa oleifera* yaprağı ilavesi	-Soya küspesi yerine %10 *Moringa oleifera* yaprağı kullanımı yumurta verimini, yem tüketimini ve yumurta ağırlığını artırmış, yemden yararlanmayı iyileştirmiştir.	Umesh et al. (2022)
Etlik piliç	Kolza tohumu küspesi yerine %1-%3-%5-%7 ve %9 *Moringa oleifera* yaprağı ilavesi	-*Moringa oleifera* yaprağının piliçlerin büyüme performansını ve karkas özelliklerini iyileştirdiği belirlenmiştir. -Büyüme performansı ve karkas özellikleri açısından farklı oranlar değerlendirilmiş, erken ve geç dönem için %5 kullanım dozu önerilmiştir. -Bu çalışma ile Moringa yaprağının protein kaynağı yemlerin yerine kullanım potansiyeli ortaya konmuştur.	Zhang et al. (2023)
Etlik piliç	Balık unu yerine %10 Moringa yaprağı ile %5 Moringa yaprağı+%5 *Sauropus androgynus* yaprağı ilavesi	-%10 Moringa yaprağı ile %5 Moringa yaprağı+%5 *Sauropus androgynus* yaprağı unu uygulanmasının etlik piliçlerde performansı azalttığı ve yem maliyetini arttırma eğiliminde olduğu tespit edilmiştir.	Dillak et al., 2023
Etlik piliç	%0-%0.25-%0.50- %0.75 Moringa yaprağı ilavesi	-*Moringa oleifera* yaprağı canlı ağırlık artışını artırmış ve yemden yararlanmayı iyileştirmiştir. -%0.5 ve %0.75 Moringa yaprağı ilavesi karkas randımanını kontrol grubuna kıyasla önemli düzeyde artırmıştır. -Moringa yaprağı ilavesi kan hemoglobin düzeylerinde artışa neden olmuştur. -Bu çalışmada Moringa yaprağının büyümeyi teşvik edici olarak %0.75 oranında kullanılabileceği, piliçlerin büyüme performansı ile sağlığını iyileşme ve buna bağlı olarak da üretim maliyetinde düşüş görülebileceği ortaya konmuştur.	Kairalla et al. (2023)
Etlik piliç	*Moringa oleifera* yaprağı ekstraktı ve peynir altı suyu ile kombinasyonu (%0- katkısız, %1 *Moringa oleifera* yaprak ekstraktı ve %0.5 *Moringa oleifera* yaprağı ekstraktı+ %0.5 peynir altı suyu protein tozu ilavesi)	-*Moringa oleifera* yaprağı ekstraktının canlı ağırlığını, canlı ağırlık artışını ve yemden yararlanmayı olumsuz etkilediği, yaprak ekstraktının peynir altı suyu protein tozu ile kullanımının büyüme performansı, karkas ve et kalitesi üzerinde olumlu etkiye neden olmadığı belirlenmiştir.	Ma'rifah et al. (2023)

Yapılan çalışmalar sonucunda kanatlı yemlerine Moringa yaprağı ilave düzeyinin önemli olduğu, Moringa bitkisi yaprağının belirli düzeylerde kullanımı ile etlik piliçlerin ve yumurtacı tavukların sağlığı, performansı ve ürün kalitesi üzerinde olumlu etkilerinin olduğu ortaya konmuştur.

7. Sonuç ve Öneriler

Bu derlemede; dünyada kullanımı ve yetiştiriciliği gün geçtikçe artmakta olan Moringa bitkisinin genel özellikleri ve kanatlı sektöründe alternatif protein kaynağı ve yem katkı maddesi olarak kullanımı ele alınmıştır. Yapılan çalışmalarda yemlere protein kaynağı ve yem katkı maddesi olarak ilave edilen bu bitkinin hayvanların sindirim sistemi, kan parametreleri, antioksidan etkinlikleri, büyüme performansları, karkas özellikleri ve yumurta verimleri üzerinde olumlu etkiler meydana getirdiği görülmüştür. Katı kültür fermantasyonu uygulamasının sonucunda da bitkinin besin değerinin arttırılarak içeriğindeki protein düzeyini yükseltip, anti-besinsel faktörleri en az düzeye indirerek yem hammaddesinden maksimum düzeyde fayda sağlandığı saptanmıştır. Ayrıca yapılan çalışmalar sonucunda, *Moringa* bitkisinin konvansiyonel protein kaynaklarının yerine tamamen ikame olabileceği görülmektedir. Bu durum Moringa bitkisine kolay ulaşabilen işletmelerde ekonomik açıdan önemli bir kazanç sağlamaktadır. Bu nedenle Moringa'nın kanatlı rasyonlarında farklı düzeylerde alternatif bir ürün olarak kullanımının mümkün olacağı söylenebilir. Kanatlı hayvanlar üzerinde yapılan besleme çalışmalarında da kullanımı yaygınlaşmaya başlamış olup bu konudaki araştırmalar devam etmektedir. Moringa bitkisinin Türkiye'de ekonomik hale getirilebilmesi ve kullanım alanının genişletilebilmesi için gerekli ıslah çalışmalarının yapılması önerilmektedir.

Kaynaklar

Abasse, T., Maigachi, I., Habba, W. & Diallo, D. (2017). "Effet de la supplémentation de la farine des feuilles de Moringa oleifera (Lam.) dans la production des poulets de chair au Niger". International Journal of Biological and Chemical Sciences, 11(2), p.722–729. DOI:10.4314/ijbcs.v11i2.15

Alikwe, P. C. N. & Omotosho M. S. (2013). An evaluation of the proximate and phytochemical composition of Moringa oleifera leaf meal as potential feedstuff for non ruminant livestock. Agrosearch, 13(1), p.17-27. DOI:10.4314/agrosh.v13i1.2

Alshelmani, M. I., Loh, T. C., Foo, H. L., Sazili, A. Q. & Lau, W. H. (2016). Effect of feeding different levels of palm kernel cake fermented by Paenibacilluspolymyxa ATCC 842 on nutrient digestibility, intestinal morphology, and gut microflora in broiler chickens. Animal Feed Science and Technology, 216: p.216-224. https://doi.org/10.1016/j.anifeedsci.2016.03.019

Altop, A., Güngör, E. & Erener, G. (2016). Katı kültür fermantasyonu uygulanan yem hammaddelerinin kanatlı beslemede kullanılabilirliği. Ulusal Kümes Hayvanları Kongresi, p.181-196.

https://www.bingol.edu.tr/documents/ULUSAL%20K%C3%9CMES%20HAYVANLARI%20KONGRES--2016.pdf

Bhargava, S., Sanjrani, M.A. & Javed, S. (2008). Solid-state fermentation: an overview. Chemical and Biochemical Engineering Quarterly, 22(1), p. 49-70. https://www.researchgate.net/publication/27205523_Solid-State_Fermentation_An_Overview

Boztaş, G., Özer, S. M. & Bayram, E. (2019). Mucize Bitki Moringa oleifera L. Türkiye 13. Ulusal I. Uluslararası Tarla Bitkileri Kongresi, https://www.researchgate.net/profile/Guelsuem-Boztas/publication/342046340

Bidura, I. G. N. G., Partama, I. B. G., Utami, I. A. P., Candrawati, D. P. M. A., Puspani, E., Suasta, I. M., Warmadewi, D. A., Okarini, I. A., Wibawa, A. A. P., Nuriyasa, I. M. & Siti, N. W. (2020). Effect of Moringa oleifera leaf powder in diets on laying hens performance, β-carotene, cholesterol, and minerals contents in egg yolk. IOP Conference Series: Materials Science and Engineering, 823, p.1-11. DOI:10.1088/1757-899X/823/1/012006

Dillak, S. Y. F. G., Suryatni, N. P. F., Enawati, L. S. & Telupere, F. M. S. (2023). The Use of Moringa Leaf Meal [Moringa Oleifera, Lam] and "Katuk" Leaf Meal [Saurapus Androgynus] to Reduce The Volume of Fish Meal in Broiler Feed Formula. International Journal of Scientific Advances, 4(2), p.151-154. DOI: 10.51542/ijscia.v4i2.1

Faydaoğlu, E. & Sürücüoğlu, M. S. (2013). Tıbbi ve aromatik bitkilerin antimikrobiyal, antioksidan aktiviteleri ve kullanım olanakları. Fen Bilimleri Enstitüsü Dergisi, 6(2), p.233-265. https://dergipark.org.tr/tr/download/article-file/68449

Gadzirayi, C. T., Masamha, B., Mupangwa, J. F. & Washaya, S. (2012). "Performance of broiler chickens fed on mature Moringa oleifera leaf meal as a protein supplement to soyabean meal". International Journal of Poultry Sciences, 11(1), p.5–10. DOI:10.3923/ijps.2012.5.10

Gıdık, B. (2018). Antikanserojenik antidiyabetik ve antioksidan bir etkiye sahip mucizevi bitki Moringa oleifera bitkisinin incelenmesi. Bayburt Üniversitesi, Uygulamalı Bilimler Fakültesi, p.1-8. https://www.researchgate.net/publication/328512817

Gómez-Martínez, M., Ascacio-Valdés, J. A., Flores-Gallegos, A. C., González-Domínguez, J., Gómez-Martínez, S., Aguilar, C. N., Morlett-Chávez, J. A. & Rodríguez-Herrera, R. (2020). Location and tissue effects on phytochemical composition and in vitro antioxidant activity of Moringa oleifera. Industrial Crops & Products 151. DOI:10.1016/j.indcrop.2020.112439

Gopalakrishnan, L., Doriya, K. & Santhosh Kumar, D. (2016). Moringa Oleifera: A review on nutritive ımportance and Its medicinal. Food Science and Human Wellness Application, 5(2), p.49-56. https://doi.org/10.1016/j.fshw.2016.04.001

Hafsa, S.H.A., Ibrahim, S.A., Eid, Y. Z. & Hassan, A.A. (2019). Effect of dietary Moringa oleifera leaves on the performance, ileal microbiota and antioxidative status of broiler chickens. Journal of Animal Physiology and Animal Nutrition, 104(2), p. 1-10. DOI: 10.1111/jpn.13281

İpçak, H. H., Özüretmen, S., Alçiçek, A. & Özelçam, H. (2018). Alternatif protein kaynaklarının hayvan beslemede kullanım olanakları. Journal of Animal Production, 59 (1), p.51-58. https://doi.org/10.29185/hayuretim.343285

Kairalla, M. A., Alshelmani, M. I. & Imdakim, M. M. (2023). Effect of diet supplemented with different levels of Moringa powder on growth performance, carcass

characteristics, meat quality, hematological parameters, serum lipids, and economic efficiency of broiler chickens. Archives of Razi Institute, 78(5), p.1647-1656. DOI:10.22092/ARI.2023.78.5.1421

Kana, J. R., Tiambo, C. K., Juliano, R. S., Lisita, F., Soultan, M. Y., Hervé, M. K. & Alexis, T. (2015). "Effects of substituting soybean with Moringa oleifera meal in diets on laying and eggs quality characteristics of KABIR chickens". Journal and Animal Research and Nutrition, 1(1:4), p.1–6. DOI:10.21767/2572-5459.100004

Kasola, J. N., Bimenya, G. S., Ojok, L., Ochieng, J. & Ogwal-Okeng, J. W. (2010). Phytochemicals and uses of Moringa oleifera leaves in Ugandan rural communities. Journal of Medicinal Plants Research, 4(9), p.753-757. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=0b93db1902bb44982284b0035e1c0ced141e2c5c

Mabruk, A. A., Talib, H. N., Mohamed, M. A. & Alawad, A. H. (2010). A note on the potential use of moringa oleifera tree as animal feed, Hillat Kuku. Journal Veterinary Medicine and Animal Production, 1(2), 184-188. https://www.researchgate.net/publication/316449004

Ma'rifah, B., Agusetyaningsih, I., Sarjana, T., Kismiati, S. & Sugiharto, S. (2023). Effect of Moringa oleifera leaves extract, whey protein, and their combination on growth, carcass and meat quality of broiler chickens. Tropical Animal Science Journal, 46(3), p.313-320. https://doi.org/10.5398/tasj.2023.46.3.313

Mbikay, M. (2012). Therapeutic potential of Moringa oleifera leaves in chronic hyperglycemia and dyslipidemia: A review. Front Pharmacol, 3(24), p.1-12. doi: 10.3389/fphar.2012.00024

Mersin, B. & İşcan, G. S. (2022). Moringa oleifera'nın etkinlik ve güvenliği. Ankara Eczacılık Fakültesi Dergisi, 46(2), p.487-504. Doi: 10.33483/jfpau.1021227

Moyo, B., Masika, P. J. & Muchenje, V. (2012). Antimicrobial activities of Moringa oleifera lam leaf extracts. African Journal of Biotechnology, 11(11), p.2797-2802. DOI: 10.5897/AJB10.686

Mulyaningsih, T. R. & Yusuf, S. (2018). Determination of minerals content in leaves of moringa oleifera by neutron activation analysis. Penentuan Kandungan Mineral Dalam Kelor Dengan Analisis Aktivasi Neutron, 21(1), p. 11- 16. DOI:10.17146/gnd.2018.21.1.3683

Oladeji, O. S., Odelade, K. A. & Oloke, J. K. (2019). Phytochemical screening and antimicrobial investigation of Moringa oleifera leaf extracts. African Journal of Science, Technology, Innovation and Development, 12(1), p.1-6. DOI:10.1080/20421338.2019.1589082

Olaoye, A. B., Ologunde, C. A., Molehin, O. R. & Nwankwo, I. (2021). Comparative antioxidant analysis of Moringa oleifera leaf extracts from South Western States in Nigeria. Future Journal of Pharmaceutical Sciences, 7(1), p.3-15. DOI:10.1186/s43094-021-00204-8

Paguia, H. M., Paguia, R. Q., Balba, C. & Flores, R. C. (2014). Utilization and evaluation of Moringa oleifera l. as poultry feeds. APCBEE Procedia, 8, p.343-347. https://doi.org/10.1016/j.apcbee.2014.03.051

Parrotta, J. A. (2004). Moringa oleifera Lam. Enzyklopädie der Holzgewächse: Handbuch und Atlas der Dendrologie, p.1-8. DOI:10.1002/9783527678518.ehg2005015

Quiroz, R. D. C., Roussos, S., Herna´ndez, D., Rodrı´guez, R., Castillo, F. & Aguilar, C.N. (2014). Challenges and opportunities of the bio-pesticides production by solid-state fermentation: filamentous fungi as a model. Informa Healthcare, 35(3), p. 1-8. DOI:10.3109/07388551.2013.857292

Ruiz-Hernández, R., Hernández-Rodríguez, M., Cruz Monterrosa, R.G. & Díaz-Ramírez, M. (2022). Moringa oleifera Lam.: A revıew of envıronmental and management factors that ınfluence the nutrıtıonal content of leaves. Tropical and Subtropical Agroecosystems, 21(1), p. 1-15. DOI:10.56369/tsaes.4053

Saleem, A., Saleem, M. & Akhtar, M. F. (2020). Antioxidant, anti-inflammatory and antiarthritic potential of Moringa oleifera Lam: An ethnomedicinal plant of Moringaceae family. South African Journal of Botany, 128, p.246-256. https://doi.org/10.1016/j.sajb.2019.11.023

Sharmin. F., Sarker, M. S. K., Sarker, N. R. & Faruque, S. (2021). Dietary effect of Moringa oleifera on native laying hens' egg quality, cholesterol and fatty-acid profile. Italıan Journal Of Anımal Scıence, 20(1), p.1544–1553. https://doi.org/10.1080/1828051X.2021.1987846

Shi, H., Yang, E., Li, Yun. & Chen, X. (2020). Effect of solid-state fermentation on nutritional quality of leaf flour of the drumstick tree (Moringa oliefera Lam.). Research Square, p. 1-16. DOI:10.21203/rs.3.rs-102471/v1

Starzyńska-Janiszewska, A., Stodolak, B., Fernández-Fernández, C. & Mickowska, B. (2022). Phenolic profile, antioxidant activity and amino acid composition of Moringa leaves fermented with edible fungal strains. Foods, 11(23), p. 3762. DOI:10.3390/foods11233762

Sugiharto, S. & Samir, R. (2019). Recent advances in fermented feeds towards improved broiler chicken performance, gastrointestinal tract microecology and immune responses: A review. Animal Nutrition, 5(1), p.1-10. DOI:10.1016/j.aninu.2018.11.001

Umesh, B.U., Bhushan, B., Manegar, G. A., Ashok, M., Satheesha, G. M., Venkatesha, M. M. & Nataraju, O. R. (2022). Effect of replacing Moringa olifera leaf meal for soybean Meal on the production performance of commercial laying hens. The Pharma Innovation Journal, 11(3), p.562-565. https://www.thepharmajournal.com/archives/2022/vol11issue3/PartH/11-3-113-678.pdf

Wang, J., Cao, F., Zhu, Z., Zhang, X.,Sheng, Q. & Qin, W. (2018). Improvement of quality and digestibility of Moringa oleifera leaves feed via solid-state fermentation by Aspergillus Niger. International Journal of Chemical Reactor Engineering, 16 (12), p.1-14. https://doi.org/10.1515/ijcre-2018-0094

Zhang, H., Huang, L., Hu, S., Qin, X. & Wang, X. (2023). *Moringa oleifera* leaf powder as new source of protein-based feedstuff ımproves growth performance and cecal microbial diversity of broiler chicken. National Library of Medicine, 13(6). DOI: 10.3390/ani13061104

Zhang, M., Huang, Y., Zhao, H., Wang, T., Xie, C., Zhang, D., Wang, X. & Sheng, J. (2017). Solid-state fermentation of Moringa oleifera leaf meal using Bacillus pumilus CICC 10440. Journal of Chemical Technology & Biotechnology, 92, p. 2083–2089. DOI 10.1002/jctb.5203

TARIMDA TEKNİK ETKİNLİK ÜZERİNE YAYINLANMIŞ MAKALELERİN BİBLİYOMETRİK ANALİZİ: ULAKBİM ÖRNEĞİ (2003-2023)

Doç. Dr. Görkem ÖZTÜRK (ORCID: 0000-0003-3767-0537)
Siirt University, Faculty of Agriculture, Department of Agricultural Economics, Siirt-Türkiye
Email: gorkem.ozturk@siirt.edu.tr

Dr. Öğr. Üyesi Belma DOĞAN ÖZ* (ORCID: 0000-0003-1766-0016)
Siirt University, Faculty of Agriculture, Department of Agricultural Economics, Siirt-Türkiye
Email: belma.doganoz@siirt.edu.tr

ÖZET
Etkinlik ölçümleri işletmeler arası karşılaştırmaya olanak tanıması, etkin olmayan işletme veya üretim faaliyetlerinde aksayan unsurları saptayarak, birtakım önlemler alınmasına olanak sağlaması açısından önemlidir. Bu çalışma Ulusal Akademik Ağ ve Bilgi Merkezi (ULAKBİM) tarafından taranan dergilerde tarım alanında "teknik etkinlik" konulu yayımlanmış makalelerin bibliyometrik analiz ile incelenmesini amaçlamaktadır. Çalışma 2003- 2023 yılları arasında ULAKBİM veri tabanında yayımlanmış araştırma makalelerini kapsamaktadır. ULAKBİM Keşif web sitesinde, Google Akademik ve Dergipark veri tabanlarında başlık, anahtar kelime, özet ve konu içerisinde "Teknik Etkinlik" ifadesi geçen makaleler taranmıştır. Kullanılacak olan makalelerin belirlenmesinin ardından yazar sayısı, yazarların bulunduğu kurumlar, yazarların unvanları, sayfa sayısı, yayınladığı yıl, yayın dili, dergi ismi, anahtar kelimeler, örnekleme yöntemi, örnek hacmi, analiz yöntemi, atıf sayısı parametreleri incelenmiştir. Elde edilen verilere ait tanımlayıcı istatistikler ortaya konmuştur. Çalışma kapsamında 70 makaleye ulaşılmıştır. Elde edilen sonuçlara göre; araştırma makalelerinde daha çok veri zarflama analizi (VZA) yönteminin kullanıldığı belirlenmiştir.
Anahtar Kelimeler: bibliyometrik analiz, teknik etkinlik, tarım

BIBLIOMETRIC ANALYSIS OF PUBLISHED ARTICLES ON TECHNICAL EFFICIENCY IN AGRICULTURE: THE CASE OF ULAKBIM (2003-2023)

ABSTRACT

Efficiency measurements are important because they facilitate comparisons between farms and enable the detection of inefficient components within farm operations or production activities. This study aims to examine articles on 'technical efficiency' in agriculture published in journals scanned by the National Academic Network and Information Center (ULAKBIM) using bibliometric analysis. The study includes research articles published in the ULAKBIM database between 2003 and 2023. Articles containing the phrase "Technical Efficiency" in the title, keyword, abstract and subject were scanned on the ULAKBIM Discover website, Google Scholar and Dergipark databases. After selecting the articles to be included, we examined the number of authors, institutions of authors, authors' titles, number of pages, publication year, language of the study, journal name, keywords, sampling method, sample volume, analysis method, and citation count parameters. Descriptive statistics of the data obtained were presented. Within the scope of the study, 70 articles were reached. According to the results, it has been determined that the data envelopment analysis (DEA) method is mostly used in research articles.

Keywords: bibliometric analysis, technical efficiency, agriculture

1.Giriş

Tarım sektörü, bireylerin yaşamlarını sürdürebilmeleri için gerekli olan besin maddelerini üretmesinin yanında istihdam, dış ticaret ve tarım dışı sektörlere sağlamış olduğu hammadde katkılardan dolayı hem toplum sağlığı hem de ülke ekonomisi üzerinde önemli etkiye sahip olan bir sektördür (Yazıcı, 2021). Günümüzde sahip olunan sınırlı doğal kaynaklarla hızla artan nüfusun gıda ihtiyacını karşılamak giderek güçleşmektedir. Bu sebeple, bütün ulusların tarım sektörüne tahsis ettikleri kaynakları verimli ve etkin kullanması gerekmektedir. Kaynakların verimli ve etkin kullanımı, hali hazırda tarım sektörünün mutlak ve nispi olarak büyük pay aldığından gelişmekte olan ülkeler için daha büyük önem taşımaktadır (Hazneci ve Ceyhan 2017).

Kaynakların verimli ve etkin kullanımı Türkiye'de politika yapıcıların gündeminde olan önemli bir konudur. Artan verimlilik, akılcı ve çağdaş bir yönetim altında kalkınmayı hızlandırmakta, gittikçe daha ileri boyutlara ulaştırmaktadır (Özden ve Armağan, 2005). Tarım işletmelerinin üretimde etkinliği sağlayabilmesi için hem üretim sürecinde kullandıkları üretim faktörlerini teknik olarak iyi değerlendirmeleri, hem de tarım ürünleri ve girdi piyasalarında meydana gelen değişikliklere uyum sağlayacak esnek bir yapıya kavuşmaları gerekmektedir. Bu sebeple karar alıcılar ve uygulayıcı kuruluşlar, tarım ürünleri üretimini gerçekleştiren tarım işletmelerinin sahip oldukları kaynakları verimli ve etkin kullanmasını sağlamak için büyük çaba sarf etmektedirler (Hazneci ve Ceyhan 2017). Türkiye gibi tarımın önemli bir sektör olduğu ülkelerde, etkinlik çalışmaları, üretim girdilerini arttırmaya ve teknolojiyi iyileştirmeye gerek kalmadan mevcut kaynakların optimum şekilde kullanılmasına olanak sağladığı için çok büyük önem taşımaktadır. Tarımda kaynakların etkin kullanımının sağlanması, tarımsal gelirin artmasına ve sektörün daha rekabet edebilir duruma getirilmesine olanak sağlamaktadır (Aydın ve Aktürk, 2021).

Genellikle bir üretim sınırının belirlenmesine dayanan etkinlik ölçümü yaklaşımlarında parametrik ve parametrik olmayan teknikler olmak üzere iki farklı metodoloji kullanılmaktadır. Tarımsal performansın değerlendirilmesi, etkin bir tarımsal üretimin sağlanabilmesi ve ileriye dönük tarım politikaları geliştirilebilmesi adına parametrik olmayan etkinlik değerlendirme yöntemlerinden Veri Zarflama Analizine çok sık başvurulmaktadır (Menten ve ark., 2020). Türkiye'de farklı tarımsal ürünlerin teknik analizi üzerine bugüne kadar çok sayıda araştırma yapıldığı görülmektedir (Abay et al.,

2004; Artukoğlu et al., 2010; Gündüz et al., 2011; Engindeniz ve Öztürk Coşar, 2013; Başaran ve Engindeniz, 2015; Öztürk ve Engindeniz 2018; Karakayacı, 2019; Kaya ve Gürcan 2021; Özden ve ark., 2021; Şahin ve Külekçi 2022; Adanacıoğlu ve ark., 2023, Sarıözkan ve ark., 2023). Yayınlanan çalışma sayısının artması, yapılan bu çalışmaları bir araya getirme ihtiyacını ortaya çıkarmakta ve bibliyometrik analizlere tabi tutulmasının önünü açmaktadır.

Bibliyometrik analiz yöntemi, belirli bir bilimsel araştırma konusundaki nitel ve nicel değişiklikleri belirlemek, daha önce konuyla ilgili yapılmış yayınların profilini oluşturmak ve bir disiplin içerisindeki eğilimleri ortaya koymak için yapılan istatiksel yöntemlerin uygulamasından oluşur (De Bakker vd. 2005). Bu analiz ile, tarımsal etkinlik konusunda yapılan çalışmaların mevcut durumunun ne olduğu ve gelecekte nasıl şekilleneceği doğrultusunda rehberlik edebileceği düşünülmektedir.

Bu çalışmanın amacı 2003- 2023 yılları arasında çalışmanın yayınlandığı yıl Ulusal Akademik Ağ ve Bilgi Merkezi (ULAKBİM) tarafından taranan dergilerde tarım alanında "teknik etkinlik" konulu yayımlanmış makalelerin bibliyometrik analiz ile incelenmesidir. Çalışma kapsamında ULAKBİM Keşif web sitesinde, Google Akademik ve Dergipark veri tabanlarında başlık, anahtar kelime, özet ve konu içerisinde "Teknik Etkinlik" ifadesi geçen makaleler taranmıştır. Çalışma kapsamında 70 makaleye ulaşılmıştır. Kullanılacak olan makalelerin belirlenmesinin ardından yazar sayısı, yazarların bulunduğu kurumlar, yazarların unvanları, sayfa sayısı, yayınladığı yıl, yayın dili, dergi ismi, anahtar kelimeler, örnekleme yöntemi, örnek hacmi, analiz yöntemi, atıf sayısı parametreleri incelenmiştir. Elde edilen verilere ait tanımlayıcı istatistikler ortaya konmuştur.

2. Araştırma Bulguları

İncelenen makalelerin yayınlanma yılına göre dağılımları incelendiğinde, konu ile ilgili en fazla 2020 yılında 8 adet makale yayınlandığı belirlenmiştir. Yine son yıllarda makale sayılarının artış gösterdiği görülmektedir. 2003-2003 ve 2009 yıllarında ise konu ile ilgili makaleye rastlanmamıştır (Tablo 1).

Makalelerin yazar sayıları incelendiğinde, sıkılıkla, 1,2 veya 3 isimli yapıldıkları belirlenmiştir. 2 yazar tarafından hazırlanana çalışmalar ilk sırada yer almış olup, %47,14'ü yani neredeyse incelenen çalışmaların yarısını oluşturmaktadır. 3 isimli olarak

hazırlanan makale oranı %24,29'ken, tek isimli olarak yapılan çalışmaların oranı %15,71 olarak belirlenmiştir. En fazla 6 isimli çalışmaya rastlanmıştır (Tablo 2).

Tablo 1. Makalelerin Yayın Yıllarına Göre Dağılımları

Yayın Yılı	Frekans	Yüzde
2005	1	1.43
2006	2	2.86
2007	1	1.43
2008	1	1.43
2010	1	1.43
2011	3	4.29
2012	6	8.57
2013	3	4.29
2014	3	4.29
2015	4	5.71
2016	7	10.00
2017	4	5.71
2018	4	5.71
2019	5	7.14
2020	8	11.43
2021	6	8.57
2022	6	8.57
2023	5	7.14
Toplam	70	100.00

Tablo 2. Makalelerin yazar sayısı dağılımı

Yazar Sayısı	Frekans	Yüzde
1	11	15.71
2	33	47.14
3	17	24.29
4	4	5.71
5	3	4.29
6	2	2.86
Toplam	70	100.00

Makalelerin yayın dili dağılımı incelendiğinde, %77,14'ünün Türkçe, %22,86'sının İngilizce olarak yayınlandığı belirlenmiştir (Tablo 3).

Tablo 3. Makalelerin yayın dili dağılımı

Yayın Dil	Frekans	Yüzde
Türkçe	54	77.14
İngilizce	16	22.86
Toplam	70	100.00

İncelenen makalelerin sayfa sayısı dağılımı tablo 4'de verilmiştir. Yayınlanan çalışmaların %57,14 oranla en çok 1-10 sayfa aralığında olduğu, 11-20- sayfa arasında olan çalışmaların oranı %37,14 olurken, 21 sayfa ve üzeri olan çalışmaların oranı %5,72 olarak belirlenmiştir.

Tablo 4. Makalelerin sayfa sayısının dağılımı

Sayfa sayısı	Frekans	Yüzde
1-10	40	57.14
11-20	26	37.14
21+	4	5.72
Toplam	70	100.00

Konu ile ilgili Toplam 34 dergide makale bulunduğu belirlenmiştir. Makalelerin yayınlandığı dergilerin dağılımına bakıldığında ise, 9 makale ile en çok Tarım Ekonomisi Dergisinde yayın yapıldığı belirlenmiştir. Türk Tarım ve Doğa Bilimleri Dergisi, Ankara Üniversitesi Veteriner Fakültesi Dergisi, Ege Üniversitesi Ziraat Fakültesi Dergisi ile Türk Tarım, Gıda, Bilim ve Teknolojileri dergileri konu ile ilgili yayın sayısı fazla olan dergilerdir (Tablo 5).

Tablo 5. Makalelerin yayınlandığı dergilerin dağılımı

Dergi adı	Frekans	Yüzde
Akademik Araştırmalar ve Çalışmalar Dergisi	1	1.43
Anadolu Tarım Bilimleri Dergisi	3	4.29
Anadolu Üniversitesi Sosyal Bilimler Dergisi	1	1.43
Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi	1	1.43
Ankara Üniversitesi Veteriner Fakültesi Dergisi	4	5.71
Atatürk Üniversitesi Ziraat Fakültesi Dergisi	1	1.43
Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi	3	4.29
Dokuz Eylül Üniversitesi Sosyal bilimler dergisi	1	1.43
Ege Akademik Bakış	2	2.86
Ege Üniversitesi Ziraat Fakültesi Dergisi	4	5.71
Erciyes Üniversitesi Veteriner Fakültesi Dergisi	1	1.43
Gazi Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi	1	1.43
Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi	3	4.29
Hacettepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi	1	1.43
Harran Üniversitesi Ziraat Fakültesi Dergisi	1	1.43
Hayvansal Üretim	1	1.43
Iğdır Üniversitesi Fen Bilimleri Enstitüsü Dergisi	2	2.86
Kafkas Üniversitesi Veteriner Fakültesi Dergisi	2	2.86
KSÜ Doğa Bilimleri Dergisi	1	1.43
Mediterranean Agricultural Science	1	1.43
Selçuk Tarım ve Gıda Bilimleri Dergisi	1	1.43
Sosyoekonomi	1	1.43
Tarım Bilimleri Dergisi	2	2.86
Tarım Ekonomisi Araştırmaları Dergisi	2	2.86
Tarım Ekonomisi Dergisi	9	12.86
Tekirdağ Ziraat Fakültesi Dergisi	2	2.86
Turkish Journal of Agriculture and Forestry	1	1.43
Türk Tarım – Gıda Bilim ve Teknoloji Dergisi	4	5.71
Türk Tarım ve Doğa Bilimleri Dergisi	5	7.14
Uludağ Arıcılık Dergisi	1	1.43
Uluslararası Tarım ve Yaban Hayatı Bilimleri Dergisi	1	1.43
Üçüncü Sektör Sosyal Ekonomi	1	1.43
Verimlilik dergisi	3	4.29
Yüzüncü Yıl Üniversitesi Tarım Bilimleri Dergisi	2	2.86

Konu ile ilgili Toplam 40 üniversiteden akademisyenin makalesinin bulunduğu belirlenmiştir. %17,37'lik oran ile yazarların en fazla Ege üniversitesinden olduğu ortaya

çıkmıştır. İkinci sırada Selçuk üniversitesi ve üçüncü sırada Adnan menderes üniversitesi yer almıştır (Tablo 6).

Tablo 6. Makalelerin yazarlarının kurumlarının dağılımı

Kurum adı	Frekans	Yüzde
Ege Üniversitesi	29	17.37
Siirt Üniversitesi	2	1.20
Recep Tayyip Erdoğan Üniversitesi	4	2.40
Selçuk Üniversitesi	13	7.78
Akdeniz Üniversitesi	6	3.59
Kafkas Üniversitesi	4	2.40
Ankara Üniversitesi	6	3.59
Atatürk Toprak. Su ve Tarımsal Meteoroloji Araştırma	10	5.99
Adnan Menderes Üniversitesi	12	7.19
Çanakkale 18 Mart Üniversitesi	6	3.59
Yakın Doğu Üniversitesi	1	0.60
Gümüşhane Üniversitesi	1	0.60
TÜBİTAK	1	0.60
Çukurova Üniversitesi	4	2.40
Osmaniye Korkut Ata Üniversitesi	1	0.60
Namık Kemal Üniversitesi	3	1.80
Mersin Üniversitesi	1	0.60
Isparta Uygulamalı Bilimler Üniversitesi	2	1.20
Malatya Turgut Özal Üniversitesi	3	1.80
Ondokuz Mayıs Üniversitesi	10	5.99
Orman ve Su İşleri Bakanlığı	1	0.60
Doğu Akdeniz Geçit Kuşağı Tarımsal Araştırma Enstitüsü	3	1.80
Gaziosmanpaşa Üniversitesi	2	1.20
Karadeniz Teknik Üniversitesi	1	0.60
Hacettepe Üniversitesi	7	4.19
Biga İlçe Tarım ve Orman Müdürlüğü	1	0.60
Atatürk Üniversitesi	9	5.39
Nevşehir Üniversitesi	1	0.60
Uşak Üniversitesi	1	0.60
Hakkari Üniversitesi	1	0.60
Fırat Üniversitesi	3	1.80
Süleyman Demirel Üniversitesi	3	1.80
Erciyes Üniversitesi	3	1.80
Gazi Üniversitesi	2	1.20
Pamukkale Üniversitesi	2	1.20
Hatay Mustafa Kemal Üniversitesi	1	0.60
İstanbul Üniversitesi	1	0.60
Yıldız Teknik Üniversitesi	1	0.60
İstanbul Damızlık Yetiş. Birliği	2	1.20
Muş Alparslan Üniversitesi	3	1.80

İncelenen makalelerde en çok kullanılan kelimenin veri zarflama analizi (46) olduğu belirlenmiştir. Sık kullanılan diğer anahtar kelimeler ise etkinlik (29), teknik etkinlik (17), etkinlik analizi (8) olmuştur.

İncelenen çalışmalarda kullanılan örnekleme dağılımları incelendiğinde, en sık başvurulan örnekle yönteminin %52,86 oran ile olasılıklı örnekleme yöntemi olduğu belirlenmiştir (Tablo 7).

Tablo 7. Örneklem Yöntemlerinin Dağılımı

Örnekleme Yöntemi	Frekans	Yüzde
Tam sayım	8	11.43
Yok	16	22.86
Olasılıklı Örnekleme	37	52.86
Olasılık Dışı Örnekleme	9	12.86
Toplam	70	100.00

İncelenen çalışmaların örnek hacmi dağılımları incelendiğinde %31,43 oranıyla, en fazla 51- 100 aralığında örneklemi bulunan çalışma olduğu belirlenmiştir (Tablo 8). İncelenen makalelerin 14 tanesinde panel veriler kullanılmıştır.

Tablo 8. Örnek hacmi dağılımı

Örnek hacmi	Frekans	Yüzde
1-50	18	25.71
51-100	22	31.43
101+	16	22.86
Yok	14	20.00
Toplam	70	100.00

Çalışmaların atıf sayıları dağılımları incelendiğinde %70 oranıyla, en fazla 0- 10 aralığında atıf alan çalışma olduğu ortaya çıkmıştır. Çalışmaların %14,29'u 11-20 aralığında atıf alırken, %15,71'i 21 ve üzeri atıf almıştır (Tablo 9).

Tablo 9. Atıf Sayısı Dağılımı

Atıf Sayısı	Frekans	Yüzde
0-10	49	70.00
11-20	10	14.29
21+	11	15.71
Toplam	70	100.00

Çalışmalarda kullanılan analiz yöntemlerinin dağılımı incelendiğinde %78,21 oran ile en fazla veri zarflama analizinden yararlanıldığı belirlenmiştir. Bunu %10,26 oran ile skolostik sınır analizi, %6,41 oran ile malmquist analizi izlemektedir (Tablo 10).

Tablo 10. Analiz Yöntemleri Dağılımı

Analiz Yöntemleri	**Frekans**	**Yüzde**
Veri zarflama analizi	61	78.21
Stokastik sınır analizi	8	10.26
Malmquist toplam faktör verimliliği	5	6.41
Bulanık Veri Zarflama	1	1.28
Olasılıklı Sınır Analizi	1	1.28
Stokastik kar fonksiyonu yaklaşımı	1	1.28
Meta sınır yaklaşımı	1	1.28
TOPLAM	78	100.00

3. Sonuç

Bu araştırmada 2003- 2023 yılları arasında ULAKBİM veri tabanında yayımlanmış tarım alanında "teknik etkinlik" konulu makaleler incelenmiştir. İnceleme sonucunda 70 adet makaleye ulaşılmıştır ve bibliyometrik analiz yapılmıştır. Yapılan inceleme sonucunda konu ile ilgili yayınlanan makale sayılarının son yıllarda artış gösterdiği belirlenmiştir. Çalışmaların sıklıkla 2 yazar tarafından kaleme alındığı, yayınların daha çok Türkçe olduğu, en fazla yayının Tarım Ekonomisi dergisinde olduğu ve en çok Ege Üniversitesi'nde yer alan araştırmacılar tarafından yapıldığı, en sık kullanılan analiz yönteminin veri zarflama analizi olduğu sonuçlarına ulaşılmıştır. Bu çalışmanın teknik etkinlik üzerinde çalışan veya çalışacak olan araştırmacılara önemli bir referans kaynağı olacağı düşünülmektedir.

Kaynaklar

Abay, C., Miran, B. and Günden, C. (2004). An analysis of input use efficiency in tobacco production with respect to sustainability: the case study of Turkey, Journal of Sustainable Agriculture, 24(3):123-143.

Adanacıoğlu, H., Saner, G., Engindeniz, S., Güler, D., Şengül, Z. (2023). The efficiency of water buffalo farms in semi-intensive feeding system: A case study from Balıkesir, Türkiye. Ege Üniversitesi Ziraat Fakültesi Dergisi, 60(2), 205-219. https://doi.org/10.20289/zfdergi.1247238

Artukoğlu, M., Olgun A., and Adanacıoğlu, H. (2010). The efficiency analysis of organic and conventional olive farms :case of Turkey, Agricultural Economics, 56(2):89-96.

Aydın, B., Aktürk, D. (2021). Kiraz Üretiminde Karşılaştırmalı Etkinlik Analizi: Çanakkale İli Örneği. Türk Tarım ve Doğa Bilimleri Dergisi, 8(4), 1073-1083. https://doi.org/10.30910/turkjans.954030

Başaran, C., Engindeniz, S. (2015). Sivri biber üretiminde girdi kullanım etkinliğinin analizi: İzmir örneği. *Tarım Ekonomisi Dergisi*, *21*(1 ve 2), 77-84.

De Bakker, F. G., Groenewegen, P., Den Hond, F. (2005). A Bibliometric Analysis of 30 Years of Research and Theory on Corporate Social Responsibility and Corporate Social Performance. Business & Society, 44(3), 283-317.

Engindeniz, S., Öztürk Coşar, G. (2013). İzmirde domates üretiminin ekonomik ve teknik etkinlik analizi. *Journal of Ege University Faculty of Agriculture (Turkey)*, *50*(1).

Gündüz O, Ceyhan V., Esengun K. (2011). Measuring the technical and economic efficiencies of the dry apricot farms in Turkey. Journal of Food Agriculture & Environment 9(1): 319-324

Hazneci K., Ceyhan V. (2017). TR83 Bölgesinde buğday tohumluğu üretiminde teknik etkinlik ve etkinliği belirleyen faktörler, Anadolu Tarım Bilimleri Dergisi, 32, 181-188 doi: 10.7161/omuanajas.289038

Karakayacı, Z. (2019). Determination of the Efficiency of Resource Utilization of Agricultural Enterprises in Urban Sprawl; in Case of Konya Province. Yuzuncu Yıl University Journal of Agricultural Sciences, 29(3), 450-457. https://doi.org/10.29133/yyutbd.562194

Kaya, U., GÜRCAN, İ. (2021). An evaluation of the efficiency of beekeeping enterprises in Hatay province with data envelopment analysis. *Ankara Universitesi Veteriner Fakultesi Dergisi, 68*(3).

Menten, C., Çekiç, B., Atıcı, K. B. (2020). Türkiye Tarım Sektöründe Ürünler Bazında Etkinlik Değerlendirmesi. Verimlilik Dergisi (1), 117-141.

Özden, A., Armağan, G. (2005). Aydın ili tarım işletmelerinde bitkisel üretim faaliyetlerinin verimliliklerinin belirlenmesi. Tarım Ekonomisi Dergisi, 11(1 ve 2), 111-121.

Özden, A., Armağan, G., Özer, O. O., & Çinar, G. (2021). Determining the effective factors on technical efficiency and quality efficiency in fig processing businesses.

Öztürk, G., Engindeniz, S. (2018). Muğla'da örtüaltı domates üretiminde girdi kullanım etkinliğinin analizi. *Tarım Ekonomisi Dergisi, 24*(2), 175-183.

Sarıözkan, S., Akçay, A., Küçükoflaz, M., Güngör, G., et al. (2023). Kayseri İli Yumurta Tavukçuluğu İşletmelerinde Verimlilik ve Karlılık Analizleri. Erciyes Üniversitesi Veteriner Fakültesi Dergisi, 20(1), 47-56. https://doi.org/10.32707/ercivet.1259622

Şahin, K., & Külekçi, M. (2022). Örtü Altı Domates Üretiminde Enerji Kullanımı ve Sera Gazı Emisyonunun Girdi Optimizasyonu Yaklaşımı ile Azaltılması: Antalya İli Örneği. Journal of the Institute of Science and Technology, 12(3), 1808-1819. https://doi.org/10.21597/jist.1111255

Yazıcı, A. (2021). Tarım Sektörünün Türkiye Ekonomisi Gelişimine Katkısı 1980-2018 Döneminin Analizi, Nevşehir Hacı Bektaş Veli Üniversitesi Sosyal Bilimler Enstitüsü İktisat Anabilim Dalı, Yüksek Lisans Tezi, 130s.

ÇİLEK ÜRETİMİNDE GİRDİ KULLANIMI VE BRÜT KAR ANALİZİ (BATMAN İLİ ÖRNEĞİ)

Müslüm RÜZGAR (ORCID: 0000-0001-7150-0721)
Siirt Üniversitesi Fen Bilimleri Enstitüsü Biyosistem Anabilin Dalı-Siirt

Prof. Dr. Mehmet Fırat BARAN* (ORCID: 0000-0002-7657-1227)
Siirt Üniversitesi Ziraat Fakültesi Biyosistem Mühendisliği Bölümü-Siirt
Email: firat.baran@siirt.edu.tr

ÖZET
Bu çalışmada, Batman ili çilek üretiminde girdi kullanımı brüt kar analizinin belirlenmesi amaçlanmıştır. Çalışmanın ana materyalini Batman ili ve Sason ilçesinde çilek üretimi yapan 189 üreticiden anket yöntemiyle elde edilen veriler oluşturmuştur. Araştırma alanında toplam çilek bahçesi üretim alanı 150 ha ve ortalama çilek üretim alanı alan 0,79 ha olarak hesaplanmıştır. Gayri safi üretim değeri 313.194,15TL/ha, değişken masraflar 73.245,88 TL/ha ve brüt kâr 239.948,27 TL/ha olarak bulunmuştur. Enerji kullanım etkinliği 1'den yüksek olduğu için girdilerin etkin kullanıldığını söylemek mümkündür ancak daha etkin girdi kullanımıyla bu oranın artması sağlanabilir.
Anahtar Kelimeler: Brüt kâr, girdi kullanımı, çilek üretimi, Batman

INPUT USAGE AND GROSS PROFIT ANALYSIS IN STRAWBERRY PRODUCTION (BATMAN PROVINCE EXAMPLE)

ABSTRACT
In this study, it was aimed to determine the gross profit analysis of input use in strawberry production in Batman province. The main material of the study was the data obtained from 189 producers of strawberry production in Batman province and Sason district by questionnaire method. In the research area, the total strawberry garden area was 150 ha and the average strawberry production area was calculated as 0.79 ha. Gross production value was found to be 313.194,15 TL/ha, variable costs 73.245,88 TL/ha and gross profit 239.948,27 TL/ha. Since energy utilisation efficiency is higher than 1, it is possible to say that inputs are used efficiently, but this ratio can be increased by using more efficient inputs.
Keywords: Gross profit, input use, strawberry production, Batman

Giriş

Tarımsal üretimin temel amacı, tarım işletmelerinin kendi koşul ve imkânlarına göre toprak, iklim, su, bitki ve insan gücü kaynaklarının en verimli ve en uyumlu bir şekilde kullanılmasını sağlamak suretiyle işletmenin üretim miktarını, verimliliğini arttırmak ve çiftçinin harcanabilir gelir düzeyini yükselterek tarım işletmelerini güçlendirmek ve ulusal gelire katkılarını arttırmaktır. Her üretim faaliyetinde, üretim faktörlerinin en uygun fiyat ile temin edilmesi ve optimum düzeyde kullanımı, hem verimi arttırıcı, hem de maliyetleri düşürücü yönde etki yapmaktadır. Üreticiler gerek işletme sermayelerindeki yetersizlikler ve gerekse teknik bilgi eksikliği nedeniyle tarımsal üretim faktörlerini optimum düzeyde kullanamamakta ve bu durum ürün verimini ve dolayısıyla çiftçi gelirini olumsuz etkilemektedir (Gündoğmuş, 1997).

Tarım sektörünün diğer sektörlere sermaye ve işgücü transfer etmesi, hammadde ve ürün ihtiyacını karşılaması açısından ekonomik kalkınmaya önemli katkıları vardır. Günümüzde küresel ısınmanın giderek artması ve su kaynaklarının giderek azalması tarım sektörünün önemini daha da arttırmaktadır. Uluslararası rekabet ve gıda alanında kendi kendine yeten ülkeler arasında olabilmek için tarım sektörünün etkinliğinin ve verimliliğinin arttırılması gerektiği ortaya çıkmaktadır (Avcı ve Kaya, 2008). Artan nüfusun gıda talebinin karşılanabilmesi, çiftçilerin yaşam standartlarının arttırılabilmesi, tarımın daha etkin hale getirilebilmesi ve tarımsal kalkınmanın sağlanabilmesi bakımından yeni teknolojilerin adaptasyonu ile birlikte üretim faktörlerinin verimli ve etkin kullanılması büyük önem taşımaktadır.

Dünya çapında en sevilen ve en çok tüketilen meyvelerden biri olan çilek, aynı zamanda en çok ticareti yapılan meyve çeşididir. Kendine has aroması ve kokusuyla hem yetişkinler hem de çocuklar tarafından beğeni ile tüketilen meyve, Türkiye'de Akdeniz ve Ege Bölgesi'nde yaygın olarak yetiştirilir.

Hassas ve bakım isteyen bir meyve çeşidi olan çileğin taze olarak tüketilmesi ve buzdolabında saklanması önerilir. Ana vatanı Amerika olan çilek, dünya genelinde yıllık 5 milyon tonluk üretimi ile en çok yetiştirilen meyvelerden biridir (Anonim 2023a).

Çileğin özellikle son yıllarda dünyada ve ülkemizde giderek önem kazanmasında en büyük etken değişik iklim ve toprak koşullarında ekonomik olarak yetiştirilmesi olmuştur. Ayrıca çilek, pazarda taze meyvenin az olduğu dönemlerde olgunlaşması nedeniyle iyi bir pazar avantajı sağlar. Taze olarak tüketilmesinin yanında işlenerek

tüketilebilen, vitamince zengin bir meyvedir. Ülkemizde çilek üretimi 1970'li yıllarda başlamış olup 1975 yılında üretim 16.000 ton iken 2007 yılında 250.000, 2019/20 üretim sezonunda 487 bin ton, 2020/2021 döneminde 547 bin tona ulaşmıştır (Anonim 2023b). Türkiye çilek üretiminin %45.54'ünü Marmara, %30.39 Akdeniz, %13.71'ini Ege Bölgesi karşılamaktadır. Akdeniz Bölgesinin erkenci çilek yetiştiriciliği bakımından ayrı bir önemi vardır.

Sakinleştirici etkiye sahiptir, stresi azaltır. Diş etlerini güçlendirir, ağız kokusunu giderir. Romatizma ve karaciğer rahatsızlıklarına iyi gelir. Etkili bir antioksidan olması sebebiyle bağışıklık sistemini güçlendirir.

Çilek C vitamini ve manganez açısından oldukça zengin bir meyvedir. Genellikle çiğ ve taze olarak tüketilen bu meyve aynı zamanda reçel ve tatlılarda da kullanılır. Yüzde 91'i sudan oluşan çileğin bir porsiyonunda (100 gr) 32 kalori, 2 gr lif bulunur. Folat (B9 vitamini) ve potasyum açısından zengin olmasının yanı sıra kalp sağlığı ve kan şekeri kontrolü için de oldukça önemli olan bu yaz meyvesinin vücuda birçok faydası bulunmaktadır (Anonim 2023 c). Çileğin büyük bir kısmı sudan oluşur, bu nedenle içerdiği karbonhidrat miktarı oldukça düşüktür. 100 gramında 8 gram karbonhidrat bulunur. İçeriğindeki karbonhidratlar esas olarak liflerden ve basit şekerlerden oluşur. Diyet lifleri ile bağırsaklardaki yararlı bakterileri besleyerek sindirim sağlığının iyileşmesine yardımcı olur. Aynı zamanda glisemik indeksi düşük olan çilek kan şekeri üzerinde büyük değişikliklere neden olmaz. Farklı vitamin ve mineralleri içeren çilek, C vitamini, manganez, folat (B9 vitamini) ve potasyum açısından zengindir. C vitamini sayesinde bağışıklık sistemi ve cilt sağlığını korur. Özellikle hamilelik döneminde ve ileri yaşlarda vücut için oldukça önemli bir vitamin olan B9 vitamini ile büyüme ve hücre fonksiyonlarına destek olur. Bunlar dışında demir, bakır, magnezyum, fosfor, B6, K ve E vitaminlerini de bulundurur. Genellikle meyvelerin dış katmanlarında bulunan antioksidanlar çileğin etli kısmında da bulunur. Bu kırmızı meyvede 25'ten fazla antioksidan vardır. Bu antioksidanlar özellikle kalp sağlığının korunmasında önemli rol oynar. Araştırmalara göre çileğin kalp sağlığının korunmasında önemli rolü var. Orta yaşlı kişilerde kalp hastalığı riskini ölçen bir araştırmaya göre, meyveler iyi huylu kolesterol olarak da bilinen HDL kolesterol seviyesini düşürerek, kan basıncı ve kan trombositlerinin işlevini iyileştirebilir. Aynı zamanda kandaki antioksidan seviyesini artırmaya, stresi ve inflamasyonu azaltmaya ve trigliseridi iyileştirmeye yardımcı olur.

Yapılan çalışmalarda LDL kolesterol düzeyini de düşürdüğü tespit edilen çilek, kalp damar sağlığı ve kanserden korunmada da antioksidanlar sayesinde ilk sıralarda gelen bir meyvedir (Anonim 2023c).

Çilek (Fragaria), gülgiller (Rosaceae) familyası içinde yer alan bir bitki cinsi ve bu cins içinde yer alan türlerin meyvelerinin ortak adıdır (Anonim 2023d). 2020 yılında Mersin 188 bin ton çilek üretimi ile birinci sırada yer alırken, Aydın 68 bin ton ile ikinci, Konya ise 51 bin ton ile üçüncü sırada yer almaktadır. 2020 yılında bir önceki yıla oranla üretim miktarı Mersin'de %11,6 oranında, Aydın'da %0,4 oranında, Konya'da ise %17,2 oranında artmıştır. TÜİK Bitkisel Üretim birinci tahminine göre 2020 yılında 546 bin ton çilek üretiminin %18,2 oranında artarak 2021 yılında 646 bin ton olacağı tahmin edilmektedir.

Bu çalışmada, Batman ili Sason ilçesinde çilek üretiminde uygulanan işlemler ve kullanılan girdiler incelenmiştir. Kullanılan girdilerin ve elde edilen çıktıların kullanımı ve brüt kar analizi yapılmıştır. Çalışma sonucunda belirlenen bulgu ve etkinlik göstergelerine bağlı olarak, mevcut üretimin iyileştirilmesine yönelik çözüm önerileri verilmiştir.

Materyal ve Metot

Materyal

Araştırmanın ana materyalini Batman il ve ilçelerine çilek üretimi yapan üreticilerden anket yöntemiyle elde edilecek veriler oluşturacaktır. Bunların dışında, İl ve İlçe Tarım ve Orman Müdürlüklerinden çeşitli veriler elde edilecektir. Ayrıca konuyla ilgili olarak Türkiye'de ve diğer ülkelerde daha önce yapılan araştırmalardan elde edilen bilgilerden de yararlanılacaktır. Araştırmanın ana materyalini Batman ilinde çilek üretiminin yoğun olarak yapıldığı Merkez ve ilçelerindeki üreticilerden anket yöntemiyle elde edilecek veriler oluşturmuştur. Bunların dışında, İl Tarım ve Orman Müdürlüğü kayıtları, Çevre, Şehircilik ve İklim Değişikliği İl Müdürlüğü kayıtları, Türkiye İstatistik Kurumu (TÜİK), Birleşmiş Milletler Tarım ve Gıda Örgütü (FAO) istatistiki verilerden yararlanılmıştır. Ayrıca konuyla ilgili olarak Türkiye'de ve diğer ülkelerde daha önce yapılan araştırmalardan elde edilen bilgilerden de yararlanılmıştır.

Batman ilinin coğrafi yapısı

Batman, Dicle havzasında, batı-doğu doğrultusunda il topraklarından geçen Dicle nehri ile Batman çayı kenarındaki verimli ovalardan oluşan düz bir alan üzerine yerleşiktir.

Coğrafik olarak kuzey ve kuzeydoğusu sarp, yüksek ve dağlık olup, güney tarafı ise engebeli yapıya sahiptir. Doğusunda Siirt, batısında Diyarbakır, Kuzeyinde Bitlis ve Muş, güneyinde ise Mardin illeri ile çevrili, 41° 10' ve 41° 40' doğu boylamları ile 38° 40' ve 37° 50' kuzey enlemleri arasında yer almakta olan ilin denizden yüksekliği 540-560 m arasında değişmektedir (Aydın, 2019). İl Nüfusu: 620.278'dur. Bu nüfusun %84,27'i şehirlerde yaşamaktadır İlde km²'ye 139 kişi düşmektedir. (Bu sayı merkez ilçede 722'dır.İlin yüzölçümü 4.477 km²'dir. İl merkezinin denizden yüksekliği: 570 m.'dir.

2020 yılında TÜİK verilerine göre merkez ilçeyle beraber 6 İlçe, 11 belediye, bu belediyelerde 136 mahalle ve ayrıca 283 köyü vardır.

1990 yılına kadar Siirt iline bağlı olan Batman, 16 Mayıs 1990 tarih ve 3647 sayılı kanunla Beşiri, Kozluk ve Sason ilçeleri Siirt'ten, Hasankeyf ve Gercüş ilçeleri Mardin'den alınıp Merkez'e bağlanarak Türkiye'nin 72. ili olmuştur.

Tarım Alanlarının Yapısal Özellikleri

İl yüzölçümü 470.600 ha olup ilin tarım arazisi toplamı, 972.281 da'dır. İl yüzölçümünün % 20,6'sı tarımsal faaliyetlerde, %8,6 mera arazisi,%14,6 orman arazisi,%56 tarıma elverişsiz arazilerden oluşmaktadır (Anonim 2019) . Batman ili arazilerinin niteliklerine göre mevcut dağılımı Tablo 1'de verilmiştir. Kullanılan 972281 da alanın %82.80'i kuru, geri kalan %17.20'sin de ise sulu tarım yapılmaktadır. Kayıtlı çiftçi sayısı 7889 kişidir (Baran, 2019)

Tablo 1. Batman ilinde arazi kullanım durumu

Arazi kullanımı	**Alan (ha)**	**%**
Tarımsal alan	972.281	20,66
Ormanlık alan	690.840	14,68
Çayır-Mera	405.925	8,63
Tarım dışı alan	2.636,954	56,03
Toplam	4.706.000	100,00

Meyve Üretimi

Batman ilinde, yıllık 1667.93 ton meyve üretimi yapılmaktadır. Üretimi yapılan en önemli meyve türleri üzüm, nar, elma, ceviz, badem ve armuttur. Ağırlıklı olarak Golden Delicious, Starking, Amasya ve Granny Smith elma çeşitlerinin üretimi 1331 da alanda,

yıllık 424.924 ton olarak gerçekleşmektedir. Yılda 195.18 ton armut, 246.82 ton nar, 3.62 ton üzüm, 272.862 ton ceviz ve 515.7 ton da badem üretimi yapılmaktadır (Baran 2019).

Metot

Örnekleme aşamasında kullanılan metot

Anket çalışması Batman ilinde çilek üretiminin yoğun olduğu Sason ilçesi ve köylerindeki tarımsal işletmelerde yürütülmüştür. Tarım ve Orman İl Müdürlüğü'nden Çiftçi Kayıt Sistemine kayıtlı çilek üretimi yapan toplam üretici sayılarına ilişkin bilgiler elde edilmiştir. Çiftçi Kayıt Sistemine kayıtlı çilek üretimi yapan toplam üretici sayısının 189 olduğu saptanmıştır. Ana kitle sayısının az olması nedeniyle tam sayım yöntemi kullanılmış olup 189 üretici ile anket çalışması gerçekleştirilmiştir.

Verilerin toplanması aşamasında kullanılan metot

Araştırma verileri belirlenen ilçelerdeki üreticilerle yüz yüze görüşmek suretiyle anket yapılarak toplanmıştır. Anket, çilek üretiminde uygulanan işlemler, tarımsal mekanizasyon uygulamalarının işlem sayıları ve süreleri, kullanılan ekipmanlar, her bir üretim faaliyetinde kullanılan işgücü miktarı, diğer tarımsal girdilerin miktar ve bedelleri, ürün verimi, satış fiyatı, ekim alanı gibi verileri kapsamaktadır.

Ekonomik analiz

Ekonomik analiz kapsamında çilek üretiminden elde edilen verim, brüt üretim değeri, yapılan değişken masraflar ve brüt kâr belirlenmiştir. Değişken masraflar; işgücü, çeki gücü, gübre, zirai mücadele masrafları, elektrik ve su ücretleri, pazarlama ve taşıma masraflarının yanında değişken masraflar faizinden oluşmaktadır. Döner sermaye faizinin hesaplanmasında T.C. Ziraat Bankasının bitkisel üretim kredilerine uyguladığı faiz oranı dikkate alınmıştır. Gayrisafi üretim değerini hesaplanmasında, çiftçi eline geçen ürünün satış fiyatı dikkate alınmıştır. Brüt kar, gayrisafi üretim değerinden değişken masraflar çıkarılarak hesaplanmıştır (Kıral ve ark., 1999).

Brüt kar: Gayrisafi üretim değeri- Değişken masraflar (1)

BULGULAR VE TARTIŞMA

Batman ilinde, 189 adet çilek üreticisi ile yapılan anketlerden elde edilen veriler, yöntem bölümünde verilen sıralama esas alınarak ilgili eşitliklerin kullanılmasıyla değerlendirilmiştir. Elde edilen bulgular ilerleyen bölümlerde verilmiştir.

Çilek Üretiminde Girdi Kullanımı

Çilek üretimi ile ilgili istatistiki bilgiler Tablo 2'de verilmiştir. Araştırma alanında 189 üreticinin toplam çilek bahçesi alanı 1500 da ve ortalama çilek üretim alanı 7.93 da olarak hesaplanmıştır.

Tablo 2. Çilek üretimi ile ilgili istatistikler

Çilek üretim verileri	**Ortalama**
İşletme sayısı (adet)	392
Anket yapılan üretici sayısı	189
Toplam çilek üretim alanı (da)	1500

Çilek üretiminde uygulanan tarımsal işlemlere ait bilgiler Tablo 3'te verilmiştir. Çilek üretim işlemleri, toprak işleme, sulama, gübreleme, ilaçlama ve hasat işlemlerinden oluşmaktadır. Toprak işleme uygulamaları Kasım ve Haziran ayları arasında ortalama 3 defa yapılmış ve traktör, kazayağı, tırmık ve sed pulluğu kullanılmıştır. Sulama için damla sulama sistemi kurulu olan tarlalarda yağışın olmadığı günlerde her gün bitki ihtiyacına göre sulama (34 kez) yapılmaktadır. Sulama pompa ve insan iş gücünden yararlanılmıştır. Gübreleme uygulamaları Eylül ve Temmuz ayları arasında ortalama gün aşırı 3 kez yapılmış ve insan işgücü ve gübreleme makinesi kullanılmıştır. İlaçlama işlemleri Ocak ve Temmuz ayları arasında ortalama 3 kez yapılmış ve işlemlerde pülverizatör ve insan işgücü kullanılmıştır. Hasat işlemleri ürün Pazar satışına uygun hale gelince hafta da 3 kez yapılmaktadır. Çilekte hasat dekara 4 kişi Ocak ve Temmuz aylarında olgunluğa erişen üründe 3 gün ara ile 15 kez insan işgücü kullanılarak yapılmış ve taşımada traktör kullanılmıştır.

Tablo 3 Çilek üretiminde tarımsal işlemler ve kullanılan ekipmanlar

Tarımsal işlem	**Kullanılan ekipman**	**İşlem sayısı**	**İşlem dönemi**
Toprak İşleme	Çizel, Kazayağı, Ark Pulluğu,	3	Kasım-Haziran
Malç Naylonu	İnsan işgücü	1	Kasım
Sulama	İnsan işgücü, pompa	34	Mart-Eylül
Gübreleme	İnsan işgücü, Gübreleme makinesi	3	Eylül-Temmuz
İlaçlama	İnsan işgücü, Pülverizatör	3	Eylül-Temmuz
Hasat peryodu	İnsan işgücü, traktör	15	Ocak - Temmuz

Çilek üretiminde tarımsal işlemlere göre kullanılan girdiler ve miktarları Tablo 4'te verilmiştir. Toprak işleme, içerisinde insan işgücü girdi değeri ortalama 14,91 h/ha, çeki

gücü girdi değeri ortalama 14,91 h/ha hesaplanmıştır. Toprak işleme, 1. sürüm, 2. sürüm ve set oluşturma tarımsal uygulamalarından oluşmakta olup, bu faaliyetler esnasında harcanan yakıt miktarı 82,60 l/ha olarak belirlenmiştir. Gübreleme girdileri içerisinde insan işgücü, çeki gücü, azot, fosfor, potasyum, kükürt, çiftlik gübresi ve yakıt yer almaktadır. Gübreleme işleminde insan işgücü girdi değeri ortalama 22,07 h/ha, çeki gücü değeri 11,37 h/ha, azot miktarı 184,19 kg/ha, fosfor miktarı 220,92 kg/ha, potasyum miktarı 93,56 kg/ha, kükürt miktarı 113,56 kg/ha, çiftlik gübresi 8.089,54 kg/ha ve harcanan yakıt miktarı 42,13 kg/ha olarak bulunmuştur. İlaçlama işlemlerinde insan işgücü kullanımı 19,38 h/ha, çeki gücü kullanımı 10,30 h/ha, İnsektisit kullanımı 30,34 kg/ha, fungusit kullanımı 24,63 kg/ha ve yakıt kullanımı 50,52 l/ha olarak belirlenmiştir. Sulama işlemleri içerisinde insan işgücü, su ve elektrik girdileri yer almakta olup, insan işgücü girdi değeri 553,33 h/ha, sulama suyu miktarı m^3/ha ve harcanan elektrik 576,80 kWh/ha olarak bulunmuştur. Malç naylonu döşeme e işlemleri çoğunlukla insan işgücü ile yapılmakta olup insan işgücü girdi değeri 87,89 h/ha olarak hesaplanmıştır. Hasat-taşıma işlemleri insan işgücü kullanımı 409,95 h/ha olarak bulunmuştur.

Tablo 4. Çilek üretiminde tarımsal işlemlere göre kullanılan girdi miktarları

Girdi	**Birim**	**Ortalama (birim/ha)**
Toprak İşleme		
İnsan işgücü	h/ha	14,91
Çeki gücü	h/ha	14,91
Yakıt	l/ha	82,60
Gübreleme		
İnsan işgücü	h/ha	22,07
Çeki gücü	h/ha	11,37
Azot (N)	kg/ha	184,19
Fosfor (P_2O_5)	kg/ha	220,92
Potasyum (K_2O)	kg/ha	93,56
Kükürt (S)	kg/ha	113,56
Çiftlik gübresi	kg/ha	8.089,54
Yakıt	l/ha	42,13
İlaçlama		
İnsan işgücü	h/ha	19,38
Çeki gücü	h/ha	13,30
İnsektisit	kg/ha	30,34
Fungusit	kg/ha	24,63
Yakıt	l/ha	50,52
Sulama		
İnsan işgücü	h/ha	553,33
Sulama suyu	m^3/ha	630,94
Elektrik	kWh/ha	576,80
Malç Naylonu Döşeme		
İnsan işgücü	h/ha	87,89
Hasat		
İnsan işgücü	h/ha	409,95

Brüt Kâr Analizi

İncelenen işletmelerde çilek üretim faaliyetine ilişkin değişken masraflar Tablo 5'te verilmiştir. Değişken masraflar 73.245,88 TL/ha olarak bulunmuş olup, masraflar içinde %36,71 ile gübre masrafları ilk sırada yer almaktadır. Bunu %29,83 ile işgücü masrafları, %13,58 ile ilaç masrafları, %7,41 ile döner sermaye faizi, %5,22 ile çeki gücü masrafları, %4,13 ile su masrafları, %1,71 ile pazarlama masrafları ve %1,42 ile elektrik masrafları izlemektedir. Gayri safi üretim değeri 313.194,15 TL/ha ve brüt kâr 239.948,27TL/ha olarak bulunmuştur.

Çanakçı (2010) araştırmasında nar üretiminde değişken masraflar içinde en yüksek payı alan girdilerin işgücü ve gübre masrafları olduğunu belirlemiştir. Özalp ve Yılmaz (2013) Antalya ilinde nar üretimi üzerine yaptıkları araştırmada gübre ve işgücü masraflarının değişken masraflar içinde en yüksek payı alan girdiler olduğunu belirlemişlerdir. Troujeni ve ark. (2018) araştırmalarında nar üretiminde değişken masraflar içinde en yüksek payı işgücü masraflarının aldığını bulmuşlardır. Araştırma sonucunda elde edilen bulgular Çanakçı (2010), Özalp ve Yılmaz (2013) ve Troujeni ve ark. (2018) literatürleriyle benzerlik göstermektedir.

Tablo 5. Çilek üretiminde değişken masraflar ve brüt kâr

Masraf kalemleri	**TL/ha**	**%**
İşgücü Masrafları	21.850,60	29,83
Çeki Gücü Masrafları	3.822,48	5,22
Gübre	26.884,98	36,71
İlaç	9.945,45	13,58
Su	3.028,51	4,13
Elektrik	1.038,24	1,42
Pazarlama	1.250,00	1,71
Döner Sermaye Faizi	5.425,62	7,41
Değişken Masraflar	73.245,88	100,00
Verim (kg/ha)	36.846,37	
Satış Fiyatı (TL/kg)	8,50	
Gayri Safi Üretim Değeri (TL/ha)	313.194,15	
Brüt Kâr (TL/ha)	239.948,27	

SONUÇ VE ÖNERİLER

Yapılan çalışma kapsamında Batman ili Sason ilçe ve köylerinde üretimi yapan 189 üretici ile yapılan anketler ile elde edilen veriler değerlendirilerek çilek üretiminde girdi

kullanımı belirlenmiş, enerji analizi yapılmış ve brüt kar analizi hesaplanmıştır. Araştırmada elde edilen sonuçlar özetlenmiş ve maddeler halinde aşağıda verilmiştir.

- Ortalama çilek verimi 36.846,37 kg/ha olarak bulunmuştur.
- Çilek üretim işlemleri, toprak işleme, sulama, gübreleme, ilaçlama, malç plastik örtü ve hasat işlemlerinden oluşmaktadır.
- Araştırma alanında incelenen işletmelerde bir hektar çilek bahçesinde 1.092,53 saat işgücü kullanılmıştır. Çilek üretiminde harcanan işgücünün %50,65'i sulamada, %37,52'si hasatta, %6,21'i malç naylonu döşeme, %2,48'i gübrelemede, %1,77'si ilaçlamada, %1,36'sı toprak işlemede kullanılmıştır.
- Bir hektar çilek bahçesinde ortalama traktör kullanımı 43,30 saat olarak bulunmuştur. Çilek üretiminde harcanan çeki gücünün %41,36'sı toprak işlemede, %28,56'sı gübrelemede, %30,71'i ilaçlamada kullanılmıştır.
- Bir hektar çilek tarlasında ortalama 175,25 l mazot kullanıldığı tespit edilmiştir.
- Bir hektar çilek tarlasında ortalama 8.089,54 kg çiftlik gübresi kullanıldığı tespit edilmiştir.
- İşletmeler ortalaması olarak bir hektar çilek tarlasında 184,19 kg azot, 220,92 kg fosfor, 93,56 kg potasyum, 113,82 kg kükürt uygulaması yapılmıştır.
- Bir hektar çilek tarlasında ortalama 30,34 kg/ha insektisit, 24,63 kg/ha fungusit kullanılmıştır.
- Gayri safi üretim değeri 313.194,15 TL/ha, değişken masraflar 73.245,88 TL/ha ve brüt kâr 239.948,27 TL/ha olarak bulunmuştur.

Öneriler

Çalışmada elde edilen bulgular doğrultusunda aşağıda yer alan önerilerde bulunmak mümkündür.

- Enerji kullanım etkinliği 1'den yüksek olduğu için girdilerin etkin kullanıldığını söylemek mümkündür ancak daha etkin girdi kullanımıyla bu oranın artması sağlanabilir. Bölgede çilek üretiminde yüksek verime sahip çilek çeşitlerinin yaygınlaştırılması, enerji kullanım etkinliğinin artmasına katkı sağlayacaktır.
- Gübre uygulamaları en fazla çevre kirleticiler oldukları için, toprak analizleri iyi yapılmalı, gübre uygulamalarını (özellikle azotlu gübre) azaltıcı önlemler alınmalıdır. Ayrıca yenilenebilir enerji kaynaklarının artırılabilmesi için kimyasal

gübre kullanım oranının azaltılması ve çiftlik gübresi veya organik gübre kullanımının arttırılması sağlanmalıdır.

- Kaynakların korunumu ve fosil yakıtların doğrudan veya dolaylı kullanımıyla ortaya çıkan çevresel sorunların etkin bir şekilde önlenebilmesi açısından yenilenebilir enerji kaynaklarının tarımda kullanımını yaygınlaştırmak önemlidir. Dünya genelinde önemli bir pazar haline gelen organik tarımsal üretim ile araştırma bölgesinde çilek üretiminde fosil kaynaklı yakıtların tarımsal amaçlı olarak kullanımı azaltılabilir.
- Yenilenemeyen enerji kaynaklarının neden olduğu etkiler ve çevre ile uyumlu sürdürülebilir tarım konularında çiftçilerin bilinçlendirilmesi önemlidir.
- Hasat kurallarına uyulması, erken ya da geç hasattan kaçınılması oldukça önemlidir. Ayrıca taşıma sırasında soğuk zincirin bozulmamasına ve ambalajlamanın dikkatli yapılmasına dikkat edilmelidir.

Not: Bu çalışmadaki veriler Müslüm Rüzgar'ın Yüksek Lisans Tezinden derlenmiştir.

KAYNAKLAR

Anonim,2019. Batman il Tarım ve orman Müdürlüğü, https://batman.tarimorman.gov.tr/Menu/14/Brifing-Ve-Yayimlar, [Ziyaret tarihi: 20.11.2019].

Anonim, 2023a. Çilek, https://www.azizozkan.com/2023/07/cilek-kullemesi-sphaerotheca-macularis.html , [Ziyaret tarihi: 02.03.2023].

Anonim, 2023b Çilek Yetiştiriciliği.Erişim linki: https://tarfin.com/blog/cilek-yetistiriciligi-nasil-yapilir [Ziyaret tarihi: 20.02.2023].

Anonim, 2023c. Hazine Tarım, Erişim linki: https://www.hazinetarim.com/blog/cilek-lezzetin-yani-sira-sagliga-da-iyi-gelen-meyve [Ziyaret tarihi: 20.04.2023].

Anonim, 2023d. Çilek, İletişim linki: https://tr.wikipedia.org/wiki/%C3%87ilek, [Ziyaret tarihi: 18.04.2023].

Avcı, M.A., Kaya, A., 2008. Geçiş ekonomileri ve Türk tarım sektöründe etkinlik ve toplam faktör verimliliği analizi (1992-2004), *Ege Akademik Bakış*, 8 (2), 843-860.

Aydın, Y. 2019. Batman İli Toprak ve Su Kaynaklarının Tarımsal Açıdan Değerlendirilmesi . Yuzuncu Yıl University Journal of Agricultural Sciences , 29 (1) , 178-186 . https://doi.org/10.29133/yyutbd.511801

Baran M.F.,2019. Batman İlinin Tarımsal Yapısı Ve Mekanizasyon Durumu. Ispec International Conference on Agriculture and Rural Development-III-Van-TURKEY (Tam Metin Bildiri/Sözlü Sunum)(Yayın No:5662549)

Çanakçı, M., 2010. Energy use pattern and economic analyses of pomegranate cultivation in Turkey, *African Journal of Agricultural Research*, 5 (7), 491-499. https://doi.org/10.5897/AJAR10.039.

Gündoğmuş, E., 1997. İç Anadolu Bölgesi Tarım İşletmelerinde Şeker Pancarı Üretiminin Simülasyon Yöntemiyle Fonksiyonel Analizi, Doktora Tezi, *Ankara Üniversitesi Fen Bilimleri Enstitüsü*, Ankara.

Kıral, T., Kasnakoğlu, H., Tatlıdil, F.F., Fidan, H., Gündoğmuş, E., 1999. Tarımsal Ürünler İçin Maliyet Hesaplama Metodolojisi ve Veri Tabanı Rehberi. Proje Raporu 1999-13, Yayın No:37, Ankara.

Özalp, A., Yılmaz, İ., 2013. Antalya ili nar üretiminde girdi kullanımı, kârlılık ve verimlilik analizi, *Akdeniz Üniversitesi Ziraat Fakültesi Dergisi*, 26 (1), 19-26.

Troujeni, M.E., Khojastehpour, M., Vahedi, A., Emadi, B., 2018. Sensitivity analysis of energy inputs and economic evaluation of pomegranate production in Iran, *Information Processing in Agriculture*, 5 (1), 114-123. https://doi.org/10.1016/j.inpa.2017.10.002

TÜİK, 2022a. Bitkisel Üretim İstatistikleri. http://biruni.tuik.gov.tr/medas/?kn=92&locale=tr [Ziyaret Tarihi: 10 Mart 2023].

EVALUATION ON BASE LINE SURVEY OF NEWLY DEVELOPED PEARL MILLET VARIETIES SUPER-SOSAT UNDER NATURAL FIELD CONDITIONS IN NORTH EAST NIGERIA

Usman ABDULLAHI
Head of Agric Extension Programme, Department of Agric Economic and Extension, Lake Chad Research Institute, Maiduguri Borno State.
Email: usmanmiringa@gmail.com

Abba GAMBO
Agric Extensipon Officer, Department of Agric Economic and Extension, Lake Chad Research Institute, Maiduguri Borno State.

Fatima ABUBAKAR
Head of Product Development Programme, Department of Agric Economic and Extension, Lake Chad Research Institute, Maiduguri Borno State.
Email: fatidupli@yahoo.com

ABSTRACT
Pearl millet [Pennisetum glaucum] varieties – SOSAT (newly released by Lake Chad Research Institute Maiduguri in Nigeria) and SUPER-SOSAT (has being released in 2022) were evaluated under natural infestation in 80 farmers' fields in five states of North East Nigeria during 2023 for reactions to downy mildew [Sclerospora graminicola (Sacc.) J. Schrot.], parasitic weed Striga hermonthica and pearl millet stem borer [Coniesta ignefusalis Hampson]. The objectives of the survey were to assess the effects of these biotic constraints on the new varieties to prioritize areas for future improvement in order to enhance adoption process. Our study reveals that SUPER-SOSAT appears to be resistant to downy mildew not only in on-station experiments but also in farmers' field conditions. This variety could serve as potential source parent for transfer of downy mildew resistance genes to elite materials or as a resistant check in downy mildew screening experiments. However, SOSAT seems to be susceptible to S. hermonthica in the two test environments. Babura, Ajiwa and Kamba were endemic to S. hermonthica on pearl millet. These locations could be useful as hot sports for screening pearl millet lines for resistance studies under natural infestations. SUPER-SOSAT appears to tolerate these diseases while local cultivars are highly susceptible to downy mildew but tolerant to Striga and stem borer. Incidence of pearl millet stem borer was lower than expected; this could probably be due to adoption by farmers of early sowing practices and burning of millet stem before the commencement of rains in most locations. More information is needed on the reactions of SOSAT to downy mildew in order to fully ascertain the stability of the resistance over time and space. Also the performance of SOSAT under artificial infestation of Striga should be further investigated. Intercropping systems was the dominant practices and two and three crop mixtures were prevalent in all the states surveyed.
Keywords: base line survey of newly developed pearl millet varieties super-sosat under natural field conditions and inter - cropping system.

Introduction

Pearl millet [Pennisetum glaucum (L.) R. Br.] is an important food crop widely grown in sudanian and sahelian regions of Nigeria where it is second to sorghum in importance. Nigeria is the largest producer of pearl millet in Africa with over 40 percent of the regional output (The world Sorghum and Millet economies, 2016). Downy mildew [Sclerospora graminicola (Sacc.) J. Schrot.], S. hermonthica and stem borer [Iconiesta ignefusalis Hampson (Lepidoptera: Pyralidae)] are widespread pests and diseases of pearl millet in Nigeria (Ajayi et al., 2017) Yield losses of up to 50 percent from downy mildew have been reported in Western Africa (Singh et al., 2013). Downy mildew occurs in all millet growing areas of Nigeria. The magnitude of loss depends on millet cultivar and management practices.

Many methods have been suggested for the control of downy mildew but no single method has provided effective control measure. However an integration of host plant resistance, seed treatment, crop rotation and crop management practices would be required for effective control of the disease. S. hermonthica [Del. Benth.] is a major constraint to millet production in the sahel where yield losses of up to 65 percent have been reported. (Werder and Manzo, 2012). Infection in farmers' fields is more severe in low fertility soils. King (2012) noted that less is known about Striga on millet than on maize and sorghum. Resistance to Striga has not been found in millet (Werder and manzo, 2012). Ajayi et al (2017) reported 100 percent yield losses from stem borer. The millet stem borer is the most widespread and most damaging insect pest in Nigeria. Total crop loss occurs under severe infestation especially near villages where millet stems have been used for fencing or building (Dike and Ajayi, 2017). Various millet types and varieties exhibit different levels of susceptibility to the stem borer but no resistant varieties are as yet available (Ajayi, 2015b). The destruction of infested millet stems before the beginning of the rainy season is a very important control measures (Harris, 2002).

There are three types of pearl millet grown in Nigeria. The early maturing type called 'gero' is the most widespread. Maiwa and dauro are late maturing and areas under cultivation are limited. Farmers in Nigeria grow different types and varieties of millet. These varieties react variously to biological stresses depending on ecology and pests and disease pressure (Ajayi et al., 2017). The national mean yield of millet under peasant

farming conditions is below 1000 kg/ha-1. (The World Sorghum and Millet Economies, 2016). Improved varieties yields above 2000 kg/ha-1. Many factors are responsible for this low yield such as use of unimproved varieties, pests and diseases and abiotic factors. One major solution to the low yield is the use of improved varieties which combines high yield, adaptation to local environment and resistance to major pests and diseases. Some improved varieties may be high yielding but susceptible to diseases and may therefore reduce adoption rate. A survey was carried out to monitor the reaction of SOSAT-C88 (a newly released millet variety in Nigeria) that is SUPER-SOSAT (released in 2022) to downy mildew, S. hermonthica and stem borer. The purpose of this survey was to assess the effects of these biotic constrains on the new varieties and prioritize areas for future improvement in order to facilitate adoption process.

Materials and Methods

A survey of pests and diseases was conducted on farmers' fields between 30 August and 11 September 2023 in Adamawa, Bauchi, Borno, Gombe and Yobe States while survey was carried out between 11 -20 September, 2023. The gero millet was at the hard dough stage while maiwa was at the vegetative stage in all the states at the time of survey. Survey routes included Fufure and Gurore, Gongolon, and Dubai Bajoga and Daho, Kari and Jalan, Nguru and Yunusari and covered a distance of about 2000 km. These routes covered all the major millet-growing belts in Nigeria.

Fields were sampled from pearl millet based on-farm trial meant to identify the adaptation zones of these new varieties in five states. Sixteen farmers were selected per state. Each farmer grew three varieties consisting of two improved varieties (SOSAT-C88 and SUPER-SOSAT) and a local variety (check). Plot size was made up of 400m2 per treatment. The farmers were instructed to follow their usual practice in planting. Experimental design was randomized block design with each farmer serving as a replicate. Rainfall was normal in Adamawa, Bauchi, Gombe and southern part of Borno, states while rains came late and ceased early in some part of Yobe and Northern parts of Borno states. A total of 80 farmer's fields were surveyed.

Incidence of these pest and diseases were recorded following a 1-6 damage rating (DR) scale where 1 = no symptom; 2 = 1-5%; 3 = 6-10%; 4 = 11-20%; 5 = 21-40% and 6 = > 40% infected plants. Fifty randomly selected stands were examined per farm and the proportion of stands showing symptoms of infections for downy mildew and

stem borer and proportion of stands showing symptoms of attack and Striga plants was expressed as a percentage. Additional information were obtained from the farmers on type and variety of millet grown in their farms, cropping systems practiced, date of sowing, expected date of harvest, use of seed dressing chemical before planting and the most destructive millet diseases and pests. Observation was also made from on-station trials involving SOSAT-C88, SUPER-SOSAT and local checks.

Results and Discussion

Gero millet was sown sole and in various combinations with sorghum, groundnut, cowpea, cotton, soybean, seseme, bambara nut. Intercropping of millet with any of these crops in various row arrangements was generally practiced. One row of millet to one row of legume is very common in most parts of Borno, Bauchi and in drier part of Gombe states. Seseme is an important component of intercrop in drier part of Yobe state. Two or more rows of millet to one or more rows of maiwa, sorghum and legumes were frequently observed in fields in Adamawa and Gombe states. Planting millet sole or relay with early or late cowpea is commonly practiced in wetter part of Borno state and in all parts of Adamawa state. Two crops mixture are most common in Bauchi, Gombe and Adamawa states while three crops mixtures are very common in Bauchi and Borno states.

This observation confirm the report by Andrews and Kassam (2006); Harwood and Price (2006); Okigbo and Greenland (2006), that intercropping is a predominant system and widely practiced among farmers in Asia and Africa, because of its higher total yield and greater returns than sole cropping. Norman (2004) also noted that in West Africa, insect-susceptible grain legumes such as cowpea, were generally intercropped with cereals. The growth period of millet, cowpea, sorgum, and groundnut are 90 – 130 days, 60 – 120 days, 100 – 160 days and 90 – 140 days respectively. Millet was sown between May and July depending on the type of millet and rainfall pattern. Gero was normally harvested between August and September while maiwa was harvested in November. The most dominant local millet is Nangere and. Weyin Bejimi is more preferred because it withstands wind-causing lodging. Borno is predominant in Bauchi and parts of Gombe state. Ex-Bornu is the only improved variety adopted by about 35 percent of the farmers. SE 2124 was introduced but not well accepted by farmers because of low yield and susceptibility to downy mildew. Figure 1 shows that downy mildew incidence was prevalent in all the locations except in kari where the incidence was low. kari falls within

Sahel zone with annual rainfall of 400-600 mm. Highest incidence was recorded in Gongolon, Dubai and Goni-kachallari, these locations falls within sudan ecologies. Striga incidence was low in all the locations except Fufure and Gurore where the severity was more than 40%. These locations are endemic for S. hermonthica on pearl millet and could be used as hot sports to screen pearl millet lines for striga resistance under natural infestations. Apart from Bajoga, Funakaye, and Doho that recorded slightly higher incidence of stem borer, all other locations recorded very low damages. Pearl millet was sown late in Maiduguri, Nguru, Gaidam and Gashuwa locations owing to late establishment of rains that resulted in high incidence of stem borer. Pande et al, (2017) and Ajayi et al, (2017) reported that early sowing ameliorates incidence of major pearl millet diseases while late sown millet are more vulnerable to attack irrespective of the millet variety.

Table 1 reveals that SOSAT-C88 was least infested with downy mildew with mean percentage damage of 2 while SUPER-SOSAT and local varieties exhibited 14 and 25 mean percent damage rating respectively, showing that SUPER-SOSAT could be regarded as tolerant while local cultivars was susceptible to downy mildew than improved varieties.

State	Location	Ecology
Adamawa -	Fufure	Sudan
	Gurore	Sudan
Borno –	Gongolong	Sahel
	Dubai	Sahel
Bauchi –	Kari	Sudan
	Jalan	Sudan
Gombe –	Bajoga	Sudan
	Daho	Sahel
Yobe –	Nguru	Sudan-sahel
	Yunusari	Sudan-sahel

Total Farmers Surveyed

Mean & Damage

& Dowmy mildew			& Sriger			&Stemborer			Number of Field Surveyed
S-C88	S-Sosat	L-V	S-C88	S-Sosat	L-V	S-C88	S-Sosat	L-V	N of F-V
3	14	23	50	15	10	0	20	22	6
1	11	25	0	0	0	0	15	12	6
0	12	19	0	0	0	0	0	0	4
0	3	14	0	0	0	0	0	0	4
1	10	15	0	0	0	0	0	0	5
3	24	25	0	0	0	0	0	0	8
3	11	32	45	25	15	0	0	0	8
0	0	0	0	0	0	0	0	0	3
0	30	47	30	5	10	2	10	15	2
0	0	0	0	0	0	0	5	14	7
–	–	–	–	–	–	–	–	–	–
2	14	25	31	15	12	2	13	16	57

KEY

S-C88 is SOSAT-C88

S-Sosat is SUPER-SOSAT

L-V is LOCAL-VARIETY

N of F-S is NUMBER of FIELD SURVEYED

On-station data also in Table 2 shows that SOSAT-C88 recorded lowest incidence of downy mildew in comparison with other varieties. SOSAT-C88 appears to be resistant to downy mildew. SOSAT-C88 recorded highest incidence of Striga with mean percentage damage of 31, SUPER-SOSAT and local varieties recorded 15 and 12 mean damages respectively. On-station data show that SOSAT-C88 possess highest mean Striga plants in comparison with other varieties. This investigation has shown that SUPER-SOSAT and local varieties seem tolerant to Striga while SOSAT-C88 is susceptible. This observation is in support of King (2012) who noted that local cultivars of pearl millet show some tolerance to Striga. Striga equally devastated SOSAT-C88 in agronomy trial plots in Maiduguri (Bibinu, Pers. Comm.., November, 2010). Stem borer damage was lowest in SOSAT-C88 but highest in local cultivars. However, incidence of stem borer was generally lower than expected, this could probably be due to adoption of early sowing practices and burning of millet stalk by all the farmers before the commencement of the cropping season. SUPER-SOAT appears to be

tolerant to these diseases. This variety is high yielding and early maturing (70 days) and highly preferred by farmers in drier parts of the states where drought is always a common phenomenon. SOSAT-C88 is a medium maturing variety (85-90 days) with a superior yield advantage over Ex-Bornu a popular millet variety.

Most farmers interviewed indicated that downy mildew was one of the most important diseases militating against millet production. None of the farmers dress their seeds before planting because of high cost and scarcity of seed dressing chemicals. This survey has provided evidence that SOSAT-C88 is resistant to downy mildew not only in on-station environment but also in farmer's field conditions. This variety could be a potential source parent for the transfer of downy mildew resistance genes to elite varieties. However, more information is needed on the reactions of SOSAT-C88 to downy mildew in order to ascertain the stability of the resistance over time and space. SUPER-SOSAT appears to tolerate these diseases while local cultivars were susceptible to downy mildew but tolerates Striga and stem borer. Field monitoring of promising materials should be a routine exercise. Performance of SOSAT- C88 under artificial infestation of Striga should be further investigated.

Table 2: On-station data on downy mildew and Striga hermonthica incidence on pearl millet varieties and hybrids in Bagauda.

Entry	Downy mildew (%)	Striga count/plot
SOSAT-C88	2	3.8
ExBornu	4	0.8
SUPER-SOSAT	4	0.8
SE 2124	7	1.5
Gwagwa	10	1.5
DMR 65	15	0.9
80A-5 x LCIC 9702	14	0.9
20A-2 x DMR 15	15	0
75A-6 x ZATIB	18	0
Farmers' Local	24	2.3
Standard Error	0.8	0.26
Mean	9	0.37
CV (%)	93	123

References

Ajayi, O.; Owonubi, J.J.; Uyovbisere, E.O. and Zarafi, A.B. (2017). Climatic, edaphic and biological factors limiting millet yield in Nigeria. Paper presented at the pre-season Nationally coordinated Research project on pearl millet, Maiduguri, Nigeria, 21-24 April, 2017.

Ajayi, O. (2005b). The effects of planting dates and varieties on stem borer infestationmand damage of pearl millet. Nigerian Journal of Entomology 6: 71-77.

Andrews, D.J. and Kassam, A.H. (2006). The importance of multiple-cropping in increasing world food supplies. In Multiple-cropping. Papendick, R.K.; Sanchez, P.A.; Triplett, G.B. (eds.), Madison, Wisconsin, USA: American Society of Agronomy, 1-10. Dike,

M.C. and Ajayi, O. (2017). Survey of pearl millet stem borer, Coniesta ignefusalis in Nigeria. In: IAR 2017 Cropping Scheme Meeting. Report on Cereals Research Programme, 24-28 February, 2017. Institute for Agricultural Research, Samaru, Ahmadu Bello University, PMB 1044, Zaria, Nigeria, 54- 56.

Harris, K.M. (2002). Lepidopterous stem borer of cereals in Nigeria. Bulletin of Entomological Research 53: 139 – 171.

Harwood, R.R. and Price, E.C. (2006). Multiple cropping in tropical Asia. In: Multiple cropping. Papendick, R.K.; Sanchez, P.A.; Triplett, G.B. (eds.), Madison, Wisconsin, USA: American Society of Agronomy, 11-40.

King, S.B. (2012). World review of pearl millet diseases. Knowledge and future research needs. In: Sorghum and millets diseases: a second world review. W.A.J. de Milliano,

R.A. Fredericksen, and G.D. Bergston (eds.). ICRISAT, India. Norma, D.W. (2014). Crop mixture under indigenous conditions in the northern part of Nigeria. Samaru Research Bulletin, 205, 130 – 144.

Okigbo, B.N. and Greeland, D.J. (2006). Intercropping Systems in Tropical Africa. In: Multiple cropping. Papendick, R.I.; Sanchez, P.A.; Triplett, G.B. (eds.). Madison, Wisconsin, USA: American Society of Agronomy, 63-101.

Pande, S.; Gupta, S.C.; Ogungbile, A.O. and Ezeaku, I.E. (2017). Incidence of pearl millet diseases in relation to time of sowing in Niger and Nigeria. International Sorghum and Millets Newsletter 38: 121- 122.

Singh, S.D.; King, S.B. and Werder, J. (2003). Downy mildew disease of pearl millet. Information Bulletin No. 37. Patancheru 502 324, AP, India: International Crops Research Institute for the Semi-Arid Tropics, 17.

The World Sorghum and Millet Economies – Facts, trends and outlook (2016). Patancheru 502 324, AP, India: International Crops Research Institute for the Semi-Arid Tropics and Food and Agriculture Organisation of the United Nations. Vialledelle Termedi caracalla, 00100 Rome, Italy, 33.

Werder, J. and Manzo, S.K. (2012). Pearl millet diseases in West Africa. In: Sorghum and millets diseases: a second world review, W.A.J. de Milliano, R.A. Fredericksen and G.D. Bergston (eds.). ICRISAT, India.

KISITLI SULAMA UYGULAMALARININ İKİNCİ ÜRÜN MISIRIN MORFOLOJİK PARAMETRELERİ ÜZERİNDEKİ ETKİSİ

Mehmet FİDAN (ORCID: 0000-0003-3060-8335)
Siirt University, Faculty of Agriculture Department of Biosystem Engineering, Siirt-Türkiye, Siirt- Türkiye
Email: fidan_mehmet@tarimorman.gov.tr

Prof. Dr. Ali Beyhan UÇAK* (ORCID: 0000-0003-4344-2848)
Siirt University, Faculty of Agriculture Department of Biosystem Engineering, Siirt-Türkiye, Siirt- Türkiye
Email: abucak@siirt.edu.tr

Prof. Dr. Cafer GENÇOĞLAN (ORCID: 0000-0002-4559-4354)
Kahramanmaraş Sütçü İmam University, Faculty of Agriculture Department of, Department of Biosystem Engineering, Kahramanmaraş-Türkiye, Kahramanmaraş-Türkiye
Email: firatpala@siirt.edu.tr

ÖZET
Mardin ili merkez Küçük köyünde çiftçi koşullarında 2022 yılı ikinci ürün mısır bitkisinin yetişme sezonu boyunca yürütülen bu çalışmada, damla sulama yöntemi ile uygulanan farklı sulama düzeylerinin ikinci ürün mısırın morfolojik parametreler üzerine etkilerinin belirlenmesi amacıyla yapılmıştır. Araştırma tesadüf bloklarında bölünmüş parseller deneme deseninde üç yinelemeli olarak yürütülmüştür. Denemede üç adet mısır çeşidi (Fito portbou, Dekalp 6664 ve Agromar1506) bitki materyalini oluşturmuştur. En yüksek tane verimi I100 sulama konusundan elde edilirken, en düşük tane verimi I_{75} sulama konusundan belirlenmiştir. Yapılan bu çalışmanın sonuçlarına göre Mardin ilinde ikinci ürün mısır bitkisinde tam sulama (I_{100}) uygulamasının yapılması, gereksinim duyduğu sudan daha az veya daha fazla sulama uygulamasının yapılması ise verimde bir artışa sebep olmadığından dolayı önerilmemektedir.
Anahtar Kelimeler: Mısır bitkisi, kısıtlı sulama, damla sulama
*Bu bildiri Mehmet Fidan'ın yüksek lisans tezinin bir kısmından alıntı içermektedir.

EFFECT OF RESTRICTED IRRIGATION PRACTICES ON MORPHOLOGICAL PARAMETERS OF SECOND CROPS CORN

ABSTRACT
This study, which was carried out during the growing season of the second crop corn plant in 2022 under farmer conditions in the Küçük village of central Mardin province, was carried out to determine the effects of different irrigation levels applied with the drip irrigation method on the morphological parameters of the second crop corn. The research was conducted in a split-plot trial design in randomized blocks with three replications. Three corn varieties (Fito portbou, Dekalp 6664 and Agromar1506) constituted the plant material in the experiment. While the highest grain yield was obtained from the I100 irrigation plot, the lowest grain yield was determined from the I75 irrigation plot. According to the results of this study, it is not recommended to apply full irrigation (I100) to the second crop corn plant in Mardin province, or to apply less or more water than the water required, as it does not cause an increase in yield.
Keywords: Corn plant, restricted irrigation, drip irrigation

Introduction

Doğa insanoğlunun doğuşu ile birlikte kullandığı ortamdır. Kullanılan doğanın daha yararlı hale getirilmesini insanoğlu sağlamaktadır. Bu yararlanma öncelikle tabiatın kuralları gereği dünyamızdaki mevcut kaynakların tespiti ile başlar. Önemlilik arz eden kaynakların tespit edilmesiyle, bu kaynakların daha uzun süre nasıl korunabileceği ve verimliliğinin artırılabilmesi için ne gibi yöntemlerin geliştirilmesi çalışmaları başlar. Üzerinde yaşanan dünya için önemlilik arz eden kaynaklardan biri sudur, diğeri de üzerinde yetiştirilen bitkilerdir. Su, yenilenebilir bir kaynak olmasına rağmen aynı zamanda sınırlı olan temel bir ihtiyaç maddesidir. Nüfus artışı ve sanayide görülen gelişme, su kullanımında sektörler arasında rekabete yol açmaktadır. Sektörler arasında su kullanımında en büyük payı tarım sektörü almaktadır (Çakmak, 2002).

Mısır bitkisi, dünyada stratejik öneme sahip önemli bitkilerden biridir (Panda ve ark., 2004). Dünya'da tahıl ekilişinde buğday ve çeltikten sonra üçüncü, üretimde ise buğdaydan sonra ikinci sırada yer alan mısır, insan gıdası ve hayvan yemi olarak değerlendirilmesinin yanı sıra endüstride ham madde olaraktan kullanılmaktadır (Süzer, 2003). Ülkemizde mısır hemen hemen her bölgede yetiştirilmektedir. Bölgenin iklim, sıcaklık ve su varlıklarına göre taze yeşil yem, silaj, taze koçan, birinci ve ikinci dane ürünü olarak tarımı yapılmaktadır.

Uluslararası Hububat Konseyi (IGC) verileri göre dünyada 2022-2023 yılında mısır üretimi 1.184 milyar ton, mısır tüketimi ise 1,200 milyar tondur.(Anonim, 2023). Dünya genelinde temel tarım ürünleri arasında yer alan mısır, hayvan yeminden, mısır şurubuna, enerji kaynaklarından temel gıdalarda kullanımına kadar çok geniş kullanım alanına sahiptir. Ülkemizde üretilen tahıllar içinde buğday ve arpadan sonra en çok ekimi yapılan bitki mısırdır. Mısır, insan beslenmesinde hem de hayvan yemi olarak kullanılmaktadır. Ülkemizde çalışan nüfusun yaklaşık %50 si tarımla uğraşmaktadır. Ülkemizde en çok tüketilen besin maddesi ekmektir. Ekmek yapımın en çok buğday kullanılmasının yanı sıra özellikle Karadeniz bölgesinde mısır ekmeği yapılmaktadır. Mısır bitkisin iki türlü yararlanır. Bunlar otsu kısmı ve tanelerde yararlanılır. Otsu gövdesi hayvan yemi olarak kullanılır. Mısır tanesinden elde edilen glikoz, nişasta ve mısır bazlı yağ da sanayide ham madde açısında büyük önem arz etmektedir. Ülkemizde 1950'lerde mısır üretimi Marmara ve Karadeniz bölgelerinde yapılmakta iken 1980'den sonra Akdeniz ve Ege

bölgelerinde de mısır ekimi yaygınlaşmıştır. 2000 yıllarında sonra ise Güneydoğu Anadolu bölgesinde mısır üretiminde önemli miktarda artış sağlanmıştır (Anonim, 2023). Ülkemizde 2022 yılı itibarıyla mısır ekiliş alanı 911.885 ha olup, dekar ortalama verim 932 kg/dekar ve toplam üretimi miktarı ise 8.500.000 ton olarak gerçekleşmiştir. Güneydoğu Anadolu bölgesinde mısır ekiliş alan 227.057,8 ha olup, dekara ortalama verim 792 kg/dekar ve toplam üretim miktarı ise 1.798.952 ton olarak gerçekleşmiştir. Mardin ilinde mısır ekiliş alanı 67.319,3 ha olup, dekara ortalama verim 845 kg/dekar ve üretimi miktarı ise 568.580 ton olarak gerçekleşmiştir (Anonim, 2023b).

Materials and Methods

Bu araştırma Mardin ili merkeze bağlı Küçük köyünde, 2022 yılında çiftçi koşullarında, tesadüf bloklarında bölünmüş parseller deneme deseninde 3 yinelemeli olarak, 3 orta geçici özelliklere sahip 2.ürün mısır genotipleri kullanılarak yürütülmüştür. Araştırmada, bitki materyali olarak Fito portbou, Agromar 1506 ve Dekalp6664 gibi farklı olum grubundaki mısır genotipleri kullanılmıştır.

Mardin ilinin iklimi üzerinde kuzeydeki yüksek dağlar etkili olmaktadır. Bölgede kış döneminde oluşan yüksek basınç alanı, kış aylarının soğuk geçmesine yol açar. Bir yandan güneydeki çöl ikliminin etkisi altında bulunması, bir yandan kuzeydeki yüksek dağların serin hava kütlelerinin bölgeye girişini engellemesi nedeniyle ilin genelinde yazlar çok sıcak geçerken karasal iklimin tipik özelliği görülür. Ancak Derik, Nusaybin ve Savur ilçelerinde pamuk, fındık ve zeytin gibi ürünlerin yetişmesi mikroklima özelliğinin yörede hüküm sürerken Akdeniz iklimi ile karasal iklimin ortak özelliklerine sahiptir (Anonim, 2023a). İl genelinde karasal iklim özellikleri görülmektedir. Kış ayları soğuk geçmektedir. Yaz aylarında güneyden gelen çöl iklimi etkisi altında olduğu için kurak geçer. İlde ölçülen en yüksek sıcaklık 42,5 °C'dir (Anonim, 2023a). Bir başka deyişle ortalama sıcaklık 29.8 °C, ortalama en yüksek sıcaklık 35 °C, ortalama en düşük sıcaklık 0.6 °C ve ortalama güneşlenme süresi Temmuz ayında 12.4 saat olarak bildirilmiştir (Anonim, 2023a).

3.2 Araştırma alanının konumu

Bu araştırmanın yürütüldüğü arazinin elektriksel iletkenliği düşük olup tuzluluk sorunu bulunmamaktadır. Kireç oranının bitki yetiştiriciliği açısından sorun oluşturmadığı, fosfor içeriği düşük, potasyum içeriğinin yüksek ve organik madde oranının orta derecede bulunduğu killi bünyeli toprak yapısına sahiptir. Deneme alanının rakımı 894 metredir.

Mardin ilinin GPS koordinatları ise 37,9319 enlem, 41,9354 boylamlarında yer almaktadır.

Findings and Discussion

Verim ve Verim Bileşenleri

Araştırmadan elde edilen üç mısır genotipine ait varyans analiz sonuçları ve ortalama değerlere ait tablolar aşağıda ayrı başlıklar halinde verilmiştir. Verim kg/da cinsinden verilmiştir.

Farklı sulama konuları ve mısır genotiplerinden elde edilen verim değerlerine ait varyans analiz sonuçları Tablo 5.1.1'de verilmiştir. Yapılan varyans analizi sonuçlarına göre sulama konusu ve genotipler arasındaki farklılıklar istatistiksel olarak %1 ($p \leq 0.01$) önem seviyesinde önemli bulunmuştur. Konulara ilişkin oluşan LSD testi gruplamaları ise Tablo 5.1.2, 5.1.3 ve 5.1.4'de verilmiştir.

Tablo 5.1.1 Verim değerlerine ait varyans analiz tablosu

Varyasyon Kaynağı	Serbestlik Derecesi	Kareler Toplamı	Kareler Ortalaması	F Değeri	P Değeri
Tekerrür	2	36921,4	18460,7	3,4671	0,1338
Sulama konusu	2	339810	169905	31,9102	0,0035**
Sulama konusuxTek&Random	4	21297,9	5324,48	2,1321	0,1394
Genotip	2	650921	325460	130,3232	<.0001**
GenotipxSulama konusu	4	18615,7	4653,93	1,8636	0,1817
Hata	12	29968,0	2497,3		
Genel toplam	26	1097534,1			

** : % 1 seviyesinde önemli * : % 5 seviyesinde önemli

Tablo 5.1.2 Sulama konularının verim değerlerine ait ortalama değerler tablosu

Sulama Konuları	Verim (LSD)
I100	1479,44 a
I125	1239,11 b
I75	1104,00 c
ORTALAMA	1274,185
CV (%)	9,92
P DEĞERİ	0,0035
LSD	51,32**

*Aynı sütunda aynı harf ile gösterilen ortalamalar arasındaki fark $P \leq 0.01$ değerleri içerisinde istatistiksel olarak önemlidir

Tablo 5.1.3 Genotiplerin verim değerlerine ait ortalama değerler tablosu ve LSD grupları

Genotip	Verim
DEKALP 6664	1417,22 a
AGROMAR 1506	1262,11 b
FİTO PORTBOU	1143,22 c
ORTALAMA	1274,185
CV (%)	9,92
P DEĞERİ	0,0001
LSD	95,50**

*Aynı sütunda aynı harf ile gösterilen ortalamalar arasındaki fark P<0.01 düzeyinde istatistiksel olarak önemlidir

Tablo 5.1.4 Genotipxsulama konusunun verim değerlerine ait ortalamalar tablosu

Genotip*Sulama Konusu İnteraksiyonu	Verim
I100,AGROMAR 1506	1443,6667
I100,DEKALP 6664	1670,3333
I100,FİTO PORTBOU	1324,3333
I125,AGROMAR 1506	1253,3333
I125,DEKALP 6664	1340,6667
I125,FİTO PORTBOU	1123,3333
I75,AGROMAR 1506	1089,3333
I75,DEKALP 6664	1240,6667
I75,FİTO PORTBOU	982,0000
ORTALAMA	1274,185
CV (%)	9,92
P DEĞERİ	0,1817
LSD	ÖD

*Aynı sütunda aynı harf ile gösterilen ortalamalar arasındaki fark P<0.05 düzeyinde istatistiksel olarak önemlidir. ÖD; Önemli değil

Tablo 5.1.1'de verim değerlerine ilişkin varyans analiz tablosunda sulama konusu ve genotip varyasyon kaynakları % 1 seviyesinde önemli iken sulama konuları x genotip interaksiyonu ise istatistiksel olarak önemsiz bulunmuştur.

Tablo 5.1.2 incelendiğinde sulama konularının verim değerlerinin 1104-1479,44 kg/da arasında değiştiği görülmüştür. Araştırma sonuçlarına göre verim değerleri bakımından sulama konularının arasındaki farklılıklar % 1 seviyesinde önemli

bulunmuştur. Verim değerlerine baktığımızda I_{100} sulama konusu 1479,44 kg/da ile a grubunda (1. grup) yer alırken, I_{75} sulama konusu 1104 kg/da ile c grubunda yer almıştır. I_{125} sulama konusu ise 1239,11 kg/da verim değeriyle b grubunda yani 2. grupta yer almıştır.

Tablo 5.1.3 incelendiğinde genotipler arasındaki verim değerlerinin 1143,22-1417,22 kg/da arasında değiştiği belirlenmiştir. Araştırma sonuçlarına göre verim bakımından genotipler arasındaki farklılıklar % 1 seviyesinde önemli bulunmuştur. Araştırma sonuçlarına göre verim değerlerine baktığımızda 1417,22 kg/da değeri ile DEKALP 6664 çeşidi a grubunda yer almıştır. AGROMAR 1506 çeşidi ise 1262,11 kg/da verim değeriyle b grubunda yer alırken FİTO PORTBOU çeşidi 1143,22 kg/da değeriyle en düşük verim değerini göstermiş ve istatistiki olarak c grubunda yer almıştır.

Tablo 5.1.4 incelendiğinde genotipxsulama konusu arasındaki verim değerlerinin 982,00-1670,33 kg/da arasında değiştiği belirlenmiştir. Verim bakımından genotipxsulama konusu arasındaki farklılıklar istatistiksel olarak önemli bulunmamıştır. En yüksek verim değeri; DEKALP 6664*I100 interaksiyonunda 1670,33 kg/da bulunurken; en düşük verim değeri ise FİTO PORTBOU*I75 interaksiyonunda 982,00 kg/da olarak tespit edilmiştir.

Conclusion and Recommendations

Sonuç olarak ikinci ürün mısır bitkisinde en yüksek tane verimine ulaşmak için her 8 günde bir 0-90 cm toprak profilinde kaybedilen suyun %100'ünün sulama suyu olarak uygulandığı I_{100} sulama tercih edilebilir. Elde edilen bulgular neticesinde; Mardin koşullarında ikinci ürün mısır yetiştiriciliğinde denemede kullanılan genotipleri dikkate alınarak kısıntılı sulama uygulanmaması gerektiği söylenebilir. Yarı kurak iklime sahip Mardin koşullarında ikinci ürün mısır kısıntılı sulama uygulamalarının dikkatli planlanması gerektiği vurgulanmış olup verim ve verim bileşenleri üzerinde etkili olacağı söylenebilir.

Yapılan bu çalışmanın sonuçlarına göre Mardin ilinde ikinci ürün mısırda kısıntılı sulama yapılması önerilmemekte veya kısıntı yapma zorunluluğu olduğu takdirde bunun erken vejetatif gelişme döneminde (döllenme öncesinde) maksimum %25 oranında yapılması önerilmektedir. Bir başka deyişle su kaynağı yetersiz olan böylesi yörelerde maksimum %25 düzeyinde su kısıntısı yapılması söylenebilir. Öte yandan mısır çeşitleri ise özellikle erken vejetatif dönemde yabancı ot ile rekabete girmekte zorlanmakta buda

verimde önemli oranlarda düşüşlere sebep olmaktadır. Kısaca yabancı otlardan ari bir mısır tarlası elde edilmek isteniyorsa uygun mısır çeşitlerinin yetiştiriciliğinin yapılması önerilmektedir.

Thanks and Information Note

Bu tez çalışmasının tüm süreci boyunca bana sürekli yol gösteren ve yardımlarını esirgemeyen, sonsuz desteğini sunan danışman hocalarım Sayın Doç. Dr. Ali Beyhan UÇAK'a ve Sayın Doç. Dr. Fırat BARAN'a en içten teşekkürlerimi ve saygılarımı sunarım.

References

Anonim, 2023a. Mardin Valiliği İklim Verileri. http://www.mardin.gov.tr/iklimi. [Ziyaret Tarihi:24.11.2023].

Anonim, 2023b. Türkiye İstatistik Kurumu. https://www.tuik.gov.tr/ [Ziyaret Tarihi:24.11.2023].

Çakmak, B., 2002. Kızılırmak Havzası Sulama Birliklerinde Sulama Sistem Performansının Değerlendirilmesi. KSÜ Fen ve Mühendislik Dergisi 5(2) 2002.

Panda, R.K., Behera, S.K. and Kashyap, P.S. 2004. Effective Management of Irrigation Water for Maize Under Stressed Conditions. Agricultural Water Management, 66: 181-203.

Süzer, S., 2003, Mısır Tarımı, Trakya Tarımsal Araştırma Enstitüsü, Edirne.

AYÇİÇEĞİ BİTKİSİNDE KISITLI SULAMA UYGULAMALARININ YABANCI OT POPÜLASYONU ÜZERİNE ETKİSİ

Ruken KONUK (ORCID: 0000-0003-3060-8335)
Siirt University, Faculty of Agriculture Department of Biosystem Engineering, Siirt-Türkiye, Siirt- Türkiye
Email: konukruken@gmail.com

Prof. Dr. Ali Beyhan UÇAK* (ORCID: 0000-0003-4344-2848)
Siirt University, Faculty of Agriculture Department of Biosystem Engineering, Siirt-Türkiye, Siirt- Türkiye
Email: abucak@siirt.edu.tr

Doç. Dr. Fırat PALA (ORCID: 0000-0002-4394-8841)
Siirt University, Faculty of Agriculture Department of, Department of Plant Production, Siirt-Türkiye, Siirt- Türkiye
Email: firatpala@siirt.edu.tr

ÖZET
Bu araştırma Siirt Üniversitesi, Ziraat Fakültesi deneme arazisinde 2022 yılı ikinci ürün ayçiçeği bitkisinin yetişme sezonu boyunca yürütülmüştür. Damla sulama yöntemi ile uygulanan kısıntılı sulama altında ikinci ürün ayçiçeği bitkisinin su-verim ilişkilerini incelemek amacıyla uygulanmıştır. Araştırma üç tekerrürlü olarak tesadüf blokları bölünmüş parseller deneme deseninde yürütülmüştür. Denemede 1 çeşit clearfield ayçiçeği(Ç1=P64LP130) ile 2 çeşit tescilli ayçiçeği çeşidi (Ç2=P64LL134 ve Ç3=P63MM54) kullanılmıştır. Araştırmada farklı sulama düzeyleri, yedi günde bir 90 cm'lik toprak profilinde tüketilen suyun %100'ünün (I_{100}, kontrol konusu) uygulandığı tam sulama ve tam sulamanın %70'inin (I_{70}) ve %35'inin (I_{35}) uygulandığı kısıntılı sulama konularından oluşturulmuştur. Clearfield olmayan ayçiçeği çeşitleri özellikle erken vejetatif dönemde yabancı ot ile rekabete girmekte zorlanmakta bu da verimde %40-50'lere varan önemli oranlarda düşüşlere sebep olmaktadır.
Anahtar Kelimeler: Clearfield ayçiçeği, sulama, yabancı ot
*Bu bildiri Ruken Konuk'un yüksek lisans tezinin bir kısmından alıntı içermektedir

EFFECT OF LIMITED IRRIGATION PRACTICES ON WEED POPULATION IN CLEARFIELD SUNFLOWER PLANT

ABSTRACT
This research was carried out in the trial land of Siirt University, Faculty of Agriculture, during the growing season of the second crop sunflower plant in 2022. It was applied to examine the water-yield relations of the second crop sunflower plant under restricted irrigation applied with the drip irrigation method. The research was conducted in a randomized block split-plot trial design with three replications. In the experiment, 1 type of clearfield sunflower (Ç1 = P64LP130) and 2 registered sunflower varieties (Ç2 = P64LL134 and Ç3 = P63MM54) were used. In the study, different irrigation levels were used: full irrigation, where 100% of the water consumed in a 90 cm soil profile (I100, control subject) was applied every seven days, and limited irrigation, where 70% (I70) and 35% (I35) of full irrigation were applied. It was created from the topics. Non-Clearfield sunflower varieties have difficulty in competing with weeds, especially in the early vegetative period, which causes significant decreases in yield, up to 40-50%.
Keywords: Clearfield sunflower, irrigation

Introduction

Ülkemizde insan beslenmesinde çoğunlukla ayçiçeği yağının tercih edilmesi ve artan yağ açığımız nedeniyle en önemli yağ bitkilerinden birisi ayçiçeğidir. Hemen her şeyin mekanize olması, düşük işgücü kullanımı, geniş alanlarda ekim potansiyeline sahip olmasına rağmen, ayçiçeği ekim alanlarında istenen artış sağlanamamıştır. Bunun en önemli nedenlerinden birisi; ülkemizin hemen her bölgesinde ayçiçeği kuru ziraat şeklinde (yağışa bağlı olarak sulanmadan) üretildiğinden, gelişme dönemindeki kuraklıkların tane verimini olumsuz yönde etkilemesiyle üretiminin yıllar bazında değişiklik göstermesidir. Tarımsal anlamda iklim değişikliğinin en ciddi sonucu olan su stresi veya kuraklık konusunda alınabilecek önlemlerden biride ülkemizde önemli bir ekim alanına sahip olan ayçiçeğinin, su stresi koşullarında yetiştirilebilecek yeni clearfield ayçiçeği çeşitlerinin su stresine olası tepkilerinin belirlenmesi ve su stresinin yabancı ot popülasyonu üzerine etkilerinin saptanması sürdürülebilir tarımın devamlılığı açısından büyük önem arz etmektedir (Anonim, 2022).

Türkiye sahip olduğu toprak ve su kaynakları ile çok değişik iklim koşulları yönünden dünyada tarımsal potansiyeli yüksek olan sayılı ülkeler arasında bulunmaktadır. Ülkemizde işlenen arazi 28,5 milyon hektardır. Yapılan etütlere göre, mevcut su potansiyeli ile teknik ve ekonomik olarak sulanabilecek arazi miktarı 8,5 milyon hektar olarak hesaplanmıştır. Sulanan alan ise 6,7 milyon ha'dır (Anonim, 2021). Moutonnet ve Heng (2002), yaptıkları çalışmada Akdeniz ülkeleri için suyun kısıntılı bir kaynak olduğunu, kişi başına gerekli toplam su miktarının ise yaklaşık 1700 m3/kişi/yıl olduğunu bildirmişlerdir. Ancak, çoğu Batı Asya ülkelerinde bu rakam 500 m3/kişi/yıl'dan daha azdır. Bu durum gelecekte artan nüfus için çok olumsuz bir durumdur. Tarım %70 kullanım oranı ile suyu en fazla tüketen sektördür. Ülkemizin nüfusu yaklaşık olarak 82 milyona ulaşmış bulunmaktadır. Hâlbuki tarım arazilerini daha fazla arttırma olanağı bulunmamaktadır. Bu durumda artan nüfusumuzun beslenmesi, sanayimize hammadde sağlaması ve dış ödemeler dengesinde katkıda bulunması için tarımsal üretimin arttırılması gerekmektedir. Bu husus ülke çapında iyi bir üretim planlaması ve günün modern tekniklerinin uygulanmasıyla sağlanabilir. Günümüzde bitkilerin sulanmasında yüzey sulama yöntemleri yetersiz kalmakta ve uygulanan sulama suyunun yalnızca 1/3'ü bitkiler tarafından terleme (transpirasyon) yoluyla kullanılmaktadır. Bu nedenle, sulama yöntemlerinin geliştirilmesine şiddetle ihtiyaç duyulmaktadır. Bu bağlamda, Türkiye'nin

de dâhil olduğu Akdeniz ülkelerinde yapılan çalışmaların sonucuna göre; damla sulamanın, ortalama %42 su tasarrufu sağladığı, fertigasyonun geleneksel gübrelemeye göre verimi %42 arttırdığı, sulama suyu kullanma etkinliği ise %79 oranında daha yüksek olduğu belirtilmiştir. Özellikle yağmurlama ve damla sulama sistemlerine uygun sulama programları hazırlayıp, bu programları sulama otomasyonu ile birlikte uygulayarak su kullanım etkinliği daha da arttırılabilir. Plastik sanayinin hızla gelişimi, sulama sistemi ve donanımındaki gelişmeler, basınçlı sulama sistemi kullanımının artmasında itici bir güç oluşturmuştur. Bunun sonucu olarak son yıllarda birçok bitkinin sulanmasında yağmurlama ve damla sulama uygulamaları başlamıştır. Ülkemizde de bu konudaki araştırma çalışmaları yakın geçmişten (son 20-25 yıl) beri yapılmaktadır. Ayrıca, yüzey sulamadan damla sulama sistemlerine geçişte %30-60 arasında değişen oranda bir su tasarrufu sağlanabilmektedir (Anonim, 2003). Bitkilerin sulanması amacıyla, sulama programlarının oluşturulmasında son zamanlarda sulama otomasyonu kullanılmaya başlanmıştır. Sulama otomasyonu sulama programı ile birlikte kullanıldığında, daha hassas olmakta, su ve gübre kullanım etkinliğini arttırmakta, işçilik ve enerji giderlerini azaltmakta, verimi ve kaliteyi arttırmakta, insan hatasını en aza indirmekte, sık ve düşük hacimli sulama yapma imkânı sağlamaktadır.

Materials and Methods

Bu araştırma, 2021-2022 yılında Siirt Üniversitesi Ziraat Fakültesi araştırma ve deneme alanında doğal tarla koşullarında, tesadüf bloklarında bölünmüş parseller deneme deseninde 3 tekerrürlü olarak yürütülmüştür. Araştırmada, bitki materyali olarak clearfield özelliklerine sahip ayçiçeği genotipleri kullanılmıştır.

Bölge yaz mevsiminde çoğunlukla Basra alçak basınç merkezine yerleşmiş olan kuru ve sıcak tropikal hava kütlelerinin etkisi altında kalmaktadır. Gündüz en yüksek hava sıcaklığı 40 ˚C'nin üzerine çıkabilmektedir. Basra alçak basınç merkezinin Anadolu'ya doğru genişlemesi ile oluşan ve "samyeli" olarak adlandırılan kuru ve sıcak rüzgârlar hem buharlaşmayı artırmakta ve hem de toz fırtınalarına neden olmaktadır. Ayrıca bölge Arabistan ve Suriye çöllerinden gelen tozlu havanın etkisi altında da kalmaktadır. Kış mevsiminde bölge, Orta Akdeniz'den gelen cephelerin etkisi altına girmektedir. Yağışlara neden olan bu cephe faaliyetleri Nisan ayına kadar devam etmektedir (Atalay ve Mortan, 2003). Benzer koşulların hakim olduğu inceleme alanında 1970-2013 yılları arasındaki dönemde yapılan ölçüm sonuçlarına göre yıllık ortalama

hava sıcaklığı değeri 16,1 ºC olarak tespit edilmiştir. Kış aylarında ülkemiz ve çevresini etkileyen planeter faktörlerin etkisiyle sahada en düşük düzeye inen ortalama sıcaklık değerleri Mart ayından itibaren hızlı bir yükselme eğilimine girerek Mayıs ve Haziran aylarında 25 ºC'nin üzerine çıkmaktadır. İnceleme alanında yaz döneminde (Haziran, Temmuz, Ağustos) ortalama sıcaklıkların 26 ºC'nin, kış döneminde ise (Aralık, Ocak, Şubat) 2,7 ºC'nin altına düşmediği görülmektedir. En düşük (2,7 ˚C) ve en yüksek (30,5 ˚C) aylık ortalama hava sıcaklığı değerleri sırasıyla Ocak ve Temmuz aylarında gerçekleşmekte olup, bu değerler arasında 27,8 ˚C düzeyinde bir sıcaklık farkı bulunmaktadır (Ayberk, 2013).

Findings and Discussion

Verim ve Verim Bileşenleri

Araştırmadan elde edilen üç ayçiçeği genotipine ait varyans analiz sonuçları ve ortalama değerlere ait tablolar aşağıda ayrı başlıklar halinde verilmiştir.

1.1.1. Verim (kg/da)

Farklı sulama konuları ve ayçiçeği genotiplerinden elde edilen verim değerlerine ait varyans analiz sonuçları Tablo 4.1'de verilmiştir. Yapılan varyans analizi sonuçlarına göre sulama konusu ve genotipler arasındaki farklar istatistiksel olarak %1 ($p \leq 0.01$) önem seviyesinde önemli bulunmuştur. Konulara ilişkin oluşan LSD testi gruplamaları ise Tablo 4.2, 4.3 ve 4.4'de verilmiştir.

Tablo 4.1. Verim değerlerine ait varyans analiz tablosu

Varyasyon Kaynağı	Serbestlik Derecesi	Kareler Toplamı	Kareler Ortalaması	F değeri	P Değeri
Tekerrür	2	497,45	248,725	12,5894	0,1880
Sulama konusu	2	171494	85747	4340,153	<.0001**
Sulama konusuxTek&Random	4	79,0267	19,7567	0,1875	
Genotip	2	1792,08	896,039	8,5035	0,0050**
GenotipxSulama konusu	4	103,274	25,8185	0,2450	0,9072
Hata	12	1264,48	105,4		
Genel toplam	26	175230,30			

** : % 1 seviyesinde önemli * : % 5 seviyesinde önemli

Tablo 4.2. Sulama konularının verim değerlerine ait ortalama değerler tablosu (LSD)

Sulama Konuları	Verim
I_{100}	307,22 A
I_{70}	257,56 B
I_{35}	118,89 C
ORTALAMA	227,89
CV (%)	4,50
LSD (0,01)	5,817

*Aynı sütunda aynı harf ile gösterilen ortalamalar arasındaki fark P<0.01 değerleri içerisinde istatistiksel olarak önemlidir

Tablo 4.3. Genotiplerin verim değerlerine ait ortalama değerler tablosu ve LSD grupları

Genotip	Verim
P64LP130	237,06 A
P63MM54	229,34 A
P64LL134	217,26 B
ORTALAMA	227,89
CV (%)	4,50
LSD (0,01)	10,54

*Aynı sütunda aynı harf ile gösterilen ortalamalar arasındaki fark P<0.01 düzeyinde istatistiksel olarak önemlidir

Tablo 4.4. Genotipxsulama konusunun verim değerlerine ait ortalamalar tablosu

Genotip*Sulama Konusu İnteraksiyonu	Verim
P63MM54,35	117,67
P63MM54,70	260,00
P63MM54,100	310,33
P64LL134,35	111,13
P64LL134,70	247,33
P64LL134,100	293,33
P64LP130,35	127,85
P64LP130,70	265,33
P64LP130,100	318,00
ORTALAMA	227,89
CV (%)	4,50
LSD	ÖD

*Aynı sütunda aynı harf ile gösterilen ortalamalar arasındaki fark P<0.05 düzeyinde istatistiksel olarak önemlidir

Tablo 4.1'de verim değerlerine ilişkin varyans analiz tablosunda sulama konusu ve genotip varyasyon kaynakları % 1 seviyesinde önemli iken sulama konuları x genotip interaksiyonu ise istatistiksel olarak önemsiz bulunmuştur.

Tablo 4.2 incelendiğinde sulama konularının verim değerlerinin 118,89-307,22 kg/da arasında değiştiği görülmüştür. Araştırma sonuçlarına göre verim değerleri bakımından sulama konularının arasındaki farklılıklar % 1 seviyesinde önemli bulunmuştur. Verim değerlerine baktığımızda I_{100} sulama konusu 307,22 kg/da ile a grubunda yer alırken I_{35} sulama konusu 118,89 kg/da ile c grubunda yer almıştır. I_{70} sulama konusu ise bu 2 sulama konusu arasında yer almış olup, b grubunda 2. grupta bulunmaktadır.

Tablo 4.3 incelendiğinde genotipler arasındaki verim değerleri 217,26-237,06kg/da arasında değiştiği gözlemlenmiştir. Araştırma sonuçlarına göre verim bakımından genotipler arasındaki farklılıklar % 1 seviyesinde önemli bulunmuştur. Araştırma sonuçlarına göre verim değerlerine baktığımızda 237,06 kg/da değeri ile P64LP130 ve 229,34 kg/da değeri ile de P63MM54 en yüksek değerleri ile a grubunda yer alırken; en düşük değer 217,26 kg/da ise P64LL134 çeşidinde b grubunda yer almıştır.

Tablo 4.4 incelendiğinde genotipxsulama konusu arasındaki verim değerlerinin 111,13-318 kg/da arasında değiştiği belirlenmiştir. Verim bakımından genotipxsulama konusu arasındaki farklılıklar istatistiksel olarak önemli bulunmamıştır. En yüksek verim değeri; P64LP130*100 interaksiyonunda 318 kg/da bulunurken; en düşük verim değeri ise P64LL134*35 interaksiyonunda 111,13 kg/da olarak tespit edilmiştir.

Conclusion and Recommendations

Yapılan bu çalışmanın sonuçlarına göre Siirt'te ayçiçeğinde kısıntılı sulama yapılması önerilmemekte veya kısıntı yapma zorunluluğu olduğu takdirde bunun erken vejetatif gelişme döneminde (çiçeklenme öncesinde) maksimum %30 oranında yapılması önerilmektedir. Bir başka deyişle su kaynağı yetersiz olan böylesi yörelerde maksimum %30 düzeyinde su kısıntısı yapılması söylenebilir. Öte yandan clearfield olmayan ayçiçeği çeşitleri ise özellikle erken vejetatif dönemde yabancı ot ile rekabete girmekte zorlanmakta buda verimde %40-50'lere varan önemli oranlarda düşüşlere sebep olmaktadır. Kısaca yabancı otlardan ari bir ayçiçeği tarlası elde edilmek isteniyorsa clearfield ayçiçeği çeşitlerinin yetiştiriciliğinin yapılması önerilmektedir.

Thanks and Information Note

Bu tez çalışmasının tüm süreci boyunca bana sürekli yol gösteren ve yardımlarını esirgemeyen, sonsuz desteğini sunan danışman hocalarım Sayın Doç. Dr. Ali Beyhan UÇAK'a ve Sayın Doç. Dr. Fırat PALA'ya en içten teşekkürlerimi ve saygılarımı sunarım.

References

Anonim, 2021. Devlet Su İşleri Faaliyet Raporları, Devlet Su İşleri Genel Müdürlüğü,https://www.dsi.gov.tr/ [Ziyaret Tarihi:10.08.2023].

Anonim, 2022. Türkiye'nin Ayçiçeği Yağı İhtiyacı, Türkiye İstatistik Kurumu, https://www.tuik.gov.tr/ [Ziyaret Tarihi:01.06.2023].

Anonim, 2003. Improving Irrigation Technology, Agriculture Department Food and Agriculture Organization of the United, FAO https://www.faostat.org. [Ziyaret Tarihi: 12.04.2023].

Atalay, İ., Mortan, K., 2003. Resimli ve Haritalı Türkiye Bölgesel Coğrafyası(Genişletilmiş 2. Baskı), İnkılap Yayınları, İstanbul, 32-34.

Ayberk, C., 2013. Siirt Merkez İlçesinin Coğrafi Etüdü, Yüksek Lisans Tezi, *19 Mayıs Üniversitesi Sosyal Bilimler Enstitüsü Coğrafya Anabilim Dalı*, Samsun, 11.

THE IMPORTANT ROLE OF AGROFORESTRY IN INCREASING COMMUNITY INCOME IN SUPPORTING THE RESILIENCE OF SUSTAINABLE AGRICULTURAL SYSTEMS IN SUMBER AGUNG VILLAGE, KEMILING DISTRICT, LAMPUNG PROVINCE

Raden AJI
Department of Forestry, Faculty of Agriculture, University of Lampung Jl. Prof. Dr. Sumantri Brojonegoro No 1, Bandar Lampung, Indonesia

Christine WULANDARI
Department of Forestry, Faculty of Agriculture, University of Lampung Jl. Prof. Dr. Sumantri Brojonegoro No 1, Bandar Lampung, Indonesia

Zeda ERDIAN
Department of Forestry, Faculty of Agriculture, University of Lampung Jl. Prof. Dr. Sumantri Brojonegoro No 1, Bandar Lampung, Indonesia

Achmad HARIS
Department of Forestry, Faculty of Agriculture, University of Lampung Jl. Prof. Dr. Sumantri Brojonegoro No 1, Bandar Lampung, Indonesia

Imam Fahrur ROZI
Department of Forestry, Faculty of Agriculture, University of Lampung Jl. Prof. Dr. Sumantri Brojonegoro No 1, Bandar Lampung, Indonesia

ABSTRACT
Agroforestry is an integrated land use system that has social, economic, and ecological aspects. Agroforestry has an important role in increasing community income through diversification of income sources, increased land productivity, and long-term benefits. Agroforestry also plays a role in supporting sustainable agricultural systems, which can increase agricultural land productivity, maintain environmental sustainability, and provide economic benefits for farmers. In the climate change era and the need for sustainable agriculture, agroforestry is a promising and effective solution to addressing poverty and improving community welfare. Thus, it is important to conduct this research to provide a better understanding and information on the important role of agroforestry for community income and support for sustainable agricultural systems. This study aims to determine the important role of agroforestry in community income and supporting sustainable agricultural systems in Sumber Agung Village. This research uses a qualitative method through a descriptive approach, which is research that intends to describe a phenomenon from a literature study. The data collection methods use observation and interviews as a means of obtaining primary data, as well as literature studies to obtain secondary data. The results showed that the average income of agroforestry farmers reached IDR. 127,931,871 with a total contribution of 98.47% to total income which was also supported by plant diversity of 531,030 plants.
Keywords: Agroforestry, Income, Agriculture, Sustainability

INTRODUCTION

Forests with natural conservation areas which have the aim of collecting natural and artificial wild plants and animals in Lampung Province are found in the Great Forest Park (Tahura), which is used for research, science, education, cultivation, tourism, and recreation purposes (Susanti *et al*., 2021). Tahura WAR is expected to function as a water catchment area and support development, agriculture, animal husbandry, plantations, and irrigation (Sukra *et al*., 2021). Sumber Agung sub-district, located in Kemiling District, Bandar Lampung City, which borders Tahura WAR, has Gapoktan, namely the Forest Management and Conservation Group (KPPH). In Sumber Agung, there are MPTS (*Multi-Purpose Trees Species*) plants such as rubber (*Hevea brasiliensis*), Durian (*Durio zibethinus*).), candlenut (*Aleurites moluccana*), cocoa (*Theobroma cacao*), banana (*Musa Sp*), petai (*Parkia speciosa*), clove (*Eugenia aromatica*), melinjo (*Gnetum gnemon*), bamboo (*Bambusa sp*), coffee (*Coffea robusta*), pepper (*Piper nigrum*), cempaka (*Michelia champaca*), and sugar palm (*Arenga pinnata*) which are grown using an agroforestry system. (Syofiandi *et al*., 2016).

Agroforestry is an integrated land use system that combines agricultural and forestry activities, which has social, economic, and ecological aspects that aim to maintain and increase yields in a productive, economical, and sustainable manner by using management and land use practices that are appropriate to the conditions of a land (Tjatjo, 2015). Agroforestry not only aims to increase plant productivity but also pays attention to the welfare of local communities and environmental conservation. Implementing a community-based management system, agroforestry can create sustainable economic opportunities for communities through the results of sustainable forest management. So agroforestry not only provides economic benefits but also improves social welfare and maintains the ecological sustainability of the surrounding environment (Indra *et al*., 2017).

According to Umiyati (2015), agroforestry has an important role in increasing people's income through diversifying income sources, increasing land productivity, and providing long-term benefits. The planting pattern uses agroforestry with the application of a diversification pattern to convey information about the stages of farming activities (agroforestry) and its feasibility analysis (economic valuation) with various parameters that are easy to understand, both for land owners and groups that manage other land with

income and expenditure in a double cropping pattern /agroforestry (*mixed cropping/multiple cropping*) (Andayani, 2020).

In an era of climate change and the need for sustainable agriculture, agroforestry is a promising and effective solution to overcoming the problem of poverty and improving community welfare. Agroforestry can be a solution, therefore this research is important to carry out and provide a better understanding and information about the important role of agroforestry for people's income and can support a sustainable agricultural system. This research aims to determine the influence and important role of agroforestry on community income and supporting a sustainable agricultural system in Sumber Agung Village, Kemiling District, Lampung.

RESEARCH METHODOLOGY

The research was carried out in January 2024 in Sumber Agung Village, Kemiling District, Bandar Lampung City, Lampung Province, where the research objects used were farmers and traders of agroforestry commodities in Sumber Agung Village. The research was conducted using qualitative methods through a descriptive approach, namely research that aims to describe a phenomenon from literature studies with the concept of a systematic review, which aims to collect evidence to answer predetermined research questions (Pollock *et al*., 2018). This involves identifying all primary research relevant to the specified review question, critical appraisal of that research, and synthesis of the findings. The tools and materials used in this research were a list of questions or questionnaires and a list of field books (tally sheets), stationery, calculating equipment, computers, and cameras.

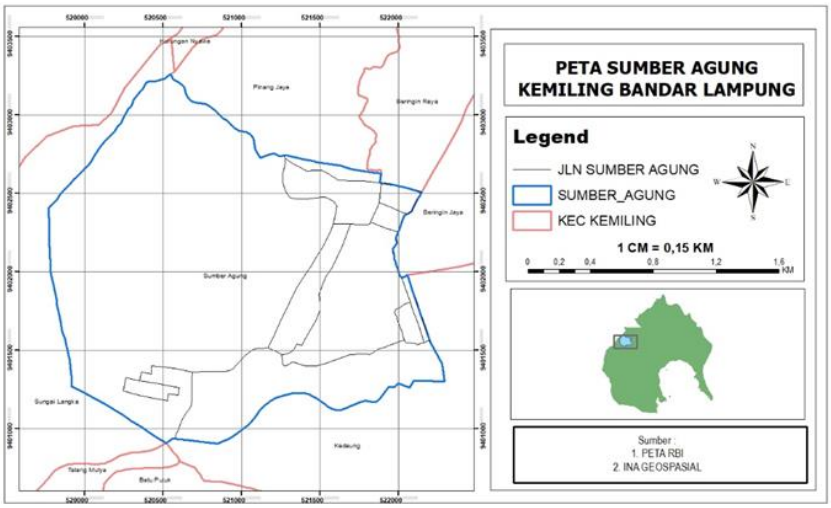


Figure 1. Research Locations

The types of agroforestry plants in Sumber Agung Village are very diverse, ranging from forestry plants to agricultural plants cultivated by the community itself. Data collection on agroforestry plant species in Sumber Agung Village was carried out using the vegetation analysis method. Vegetation analysis is a way of studying the arrangement and composition of vegetation in terms of the form (structure) of vegetation from plant communities (Sari *et al*., 2019). Through vegetation analysis, we can find out what plants have the potential to increase people's income. After that, interviews were conducted with farmers who work on agricultural land. An interview is a face-to-face interpersonal situation where one person (interviewer) asks one interviewee several questions designed to obtain answers related to the research problem. An interview is an interaction between at least two people; one party plays a role in a process, and the other party influences the other's response (Edi, 2016).

DISCUSSION

A. Diversity of Agroforestry Plant Types

The diversity of agroforestry plant types is an important aspect of sustainable agricultural practices. According to research conducted by Nurjanah *et al.* (2019), agroforestry combines trees, shrubs, and annual plants in one system, creating diverse patterns of diversity within agricultural land. This diversity provides various benefits, including increasing land productivity, ecosystem balance, and food security. The diversity of agroforestry plant types also has an important role in environmental conservation. According to research by Prasetyo *et al*. (2020), agroforestry can reduce soil erosion, improve soil quality, and provide habitat for various species of flora and fauna. The biodiversity produced by agroforestry helps maintain ecosystem balance and maintains the sustainability of natural resources. Agroforestry has become a source of increasing attention in the field of sustainable agriculture. The combination of trees, shrubs, and annuals in one system creates a diversity of plant species that provide a variety of economic, environmental, and social benefits. As can be seen in Table 1, the diversity of plant types in Sumber Agung Village is as follows.

Table 1. Diversity of Plant Types

No	Plant Type	Latin name	Already in Production (Trees)	Not Production Yet (Trees)	Amount (Trees)
High Header					
1.	Durian	*Durio zibethinus*	5.111	7.900	13.011
2.	Petai	*Parkia speciosa*	1.051	5.961	7.012
3.	Melinjo	*Gnetum gnemon*	3.200	2.649	5.849
4.	Avocado	*Persea gratissima*	3.759	2.434	6.193
5.	Nutmeg	*Myristica fragrans*	-	96	96
6.	Candlenut	*Aleurites moluccana*	1.990	168	1.158
7.	Cempaka	*Michelia champaca*	205	616	821
8.	Betel nut	*Areca catechu*	997	1.941	2.938
9.	Cinnamon	*Cinnamomum verum*	112	95	207
10.	Rubber	*Hevea brasiliensis*	23.896	68.388	92.284
11.	Bamboo	*Bambusa sp*	694	10	704
12.	Clove	*Eugenia aromatica*	322	1.048	1.370
13.	Sugar palm	*Arenga pinnata*	261	27	283
14.	Coconut	*Cocos nucifera*	867	39	906
15.	Fruits		441	329	770
Middle Header					
1.	Coffee	*Coffea robusta*		22.383	163.433
2.	Cocoa	*Theobroma cacao*		34.788	189.885
Low Header					
1.	Banana	*Musa sp*		1.861	43.785
2.	Vanilla	*Vanilla planifolia*		-	162
3.	Pepper	*Piper nigrum*		-	163
Amount					**531.030**

Source: Secondary data (Gapoktan, 2011)

The results presented in Table 1 show that through vegetation analysis, the diversity of plant types in Sumber Agung Village is known, with the highest ranking being durian.

(*Durio zibethinus*), petai (*Parkia speciosa*), melinjo (*Gnetum gnemon*), avocado (*Persea gratissima*), nutmeg (*Myristica fragrans*), candlenut (*Aleurites moluccana*), cempaka (*Michelia champaca*), betel nut (*Areca catechu*), Cinnamon (*Cinnamomum verum*), Rubber (*Hevea brasiliensis*), bamboo (*Bambusa sp.*), clove (*Eugenia aromatica*), sugar palm (*Arenga pinnata*), coconut (*Cocos nucifera*), and various other fruits. The plant that has the highest production is rubber, with a total production of 23,896 stems out of a total of 92,284 stems, and the lowest production is cinnamon, with a total production of 112 stems for a total of 207 stems, while nutmeg out of a total of 96 plants has not yet produced. This is because the nutmeg plants have not yet reached production age. Research from Latumahina *et al*. (2020) shows that nutmeg plants cannot be produced yet because they have not yet reached production age; the optimal peak production age of nutmeg plants is ten years old. The nutmeg plant is also a plant that often experiences problems in the production process because the nutmeg plant is susceptible to disease attacks, which result in a decrease in the quality of the fruit.

The middle-tier plants obtained were coffee (Coffea robusta), with a total production of 141,050 stems (per plant), and Cocoa (Theobroma cacao), with 155,097 stems, and the low-tier crops were banana (Musa sp.), vanilla (Vanilla planifolia), and pepper (Piper nigrum). This was discovered through interviews with local farmers. It was stated that rubber plants contribute more to the economy of the surrounding community with the highest production volume. This is because rubber plants are very adaptable to various agro-climatic conditions. Rubber plants have quite good abilities in creating a stable environment, so they are suitable to replace productive wet tropical forest vegetation (Achmad *et al*., 2016).

B. Contribution of Agroforestry to Community Income

Income is the farmer's total income, which has been reduced by production costs for agroforestry businesses. Agroforestry income is the sum of income from plantations, fisheries, and agriculture. Non-agroforestry income is the total sum of income from trade, civil servants, labor, and services. Data on the income of respondents from agroforestry communities is presented in Table 2. Research conducted by Sumarno *et al.* (2019) found that agroforestry increased farmers' overall income compared to monoculture practices. The combination of various types of crops in one field allows farmers to get more stable and varied yields throughout the year. Various types of agroforestry plants can also

provide more value-added results, such as wood, fruit, and medicinal plants, which can increase farmers' income in the long term. The following can be seen in Table 2 regarding the contribution of agroforestry to community income in Sumber Agung Village.

Table 2. Contribution of Agroforestry to Community Income

Source of Income	Farmers' income (IDR/Year)	Average Income (IDR/HH/Year)	Contribution to total income (%)
Agroforestry	IDR.5.245.206.700	IDR.127.931.871	98.47%
Plantation	IDR.4.228.716.700	IDR.103.139.432	79.38%
Agriculture	IDR.764.340.000	IDR 18.642.439	14.35%
Farm	IDR.252.150.000	IDR.6.150.000	4.73%
Non Agroforestry	IDR.81.700.000	IDR.1.992.683	1.53%
Civil servants	IDR.36.000.000	IDR.878.049	0.68%
Merchant	IDR.13.200.000	IDR.321.951	0.25%
Laborers	IDR.32.500.000	IDR.792.683	0.61%
Amount	**IDR.5.326.906.700**	**IDR.129.924.554**	**100.00%**

Source: Secondary data (Research result, 2016)

The table above shows the contribution of agroforestry to community income, namely, the sources of income, farmer income, average income, and contribution to total income. Farmers' income generated from Agroforestry consists of Plantations, Agriculture, and Livestock with a total amount of IDR. 5,245,206,700 per year with an average income per family of IDR. 127,931,871 per year, of which this income contributed 98.47%. It can also be seen that farmers' income from non-agroforestry products is from civil servants with an income of IDR. 36,000,000 per year in average income per family IDR. 878,049 per year with a contribution of 0.68% and income from traders with a total income of IDR. 13,200,000 per year and an average per family of IDR. 321,951 per year with a contribution of 0.25%, and Labor Income with a total IDR. 32,500,000 per year, and the average income per family is IDR. 792,683 per year, with a contribution of 0.61%. From this data, the total income from Agroforestry and Non-Agroforestry products was obtained as much as IDR 5,326,906,700 with an average annual income of IDR 129,924,554.

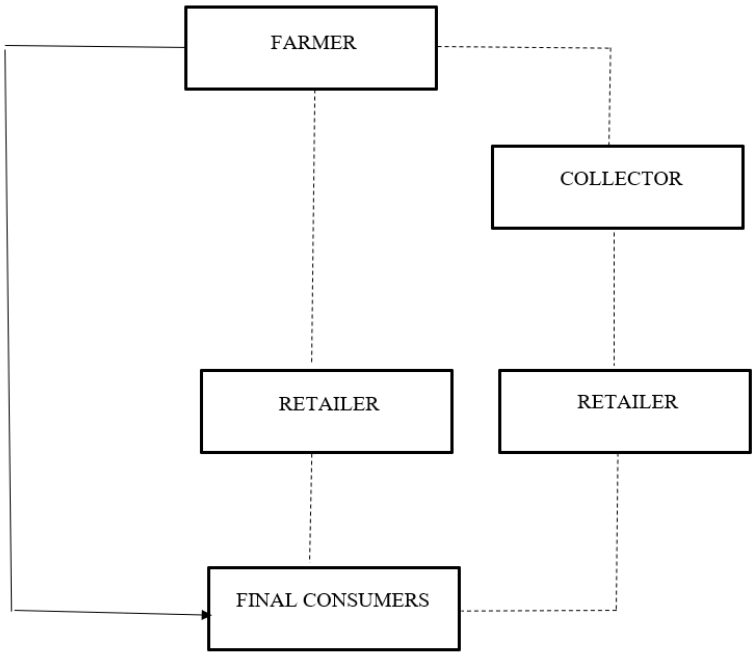
Agroforestry is one of the land management systems that might be offered to overcome the problems that arise due to the land use change mentioned above and, at the same time,

to overcome the food problem. Through the agroforestry system, the community has a wider way to improve the economy by utilizing available land. The ultimate goal of the agroforestry program is to improve the welfare of farmers, especially those living around forests, namely by increasing active community participation in improving and maintaining the environment. This goal can be achieved by optimizing positive interactions between the various constituent components (trees, agricultural plants, livestock/animals) or the interaction between these components and their environment. This is proven by the production of chocolate and coffee plants, which have the highest total production (Suryani *et al*., 2012).

C. Contribution of Agroforestry in Supporting Sustainable Agricultural Systems

Based on its constituent components, the agroforestry system implemented in Sumber Agung Village is agrisilviculture, namely land management that combines forestry components with agriculture. The concept of sustainable agriculture is the integration of three main goals, namely, environmental health, economic profit, and socio-economic justice. Sustainable agriculture is the management and conservation of natural resources that is technology-oriented to ensure human needs now and in the future. Sustainable agriculture is the management and conservation of natural resources that is technology-oriented to ensure human needs now and in the future (Indrianti, 2018).

D. Agroforestry Crop Marketing System in Sumber Agung Village



It can be seen from the sequence above that the marketing institutions in Sumber Agung, which consist of collectors and retailers, carry out exchange, physical, and facility functions. The exchange function carried out by collectors and retailers is proven by the purchase of durian from farmers. Collectors and retailers buy durian from farmers to provide durian for sale. This is in line with research by Annisa *et al*. (2018), which explains that marketing institutions will buy products from farmers and then resell them on the market.

CONCLUSION

By conducting research on the influence of agroforestry planting patterns, we can find out the importance of a sustainable land management system in Sumber Agung Village, Kemiling District, Bandarlampung City, Lampung. Using qualitative methods with a descriptive approach, various aspects related to agroforestry exploration include the diversity of plant types and the contribution of plants on agroforestry land to community income, as well as supporting sustainable agricultural systems that influence the marketing system.

BIBLIOGRAPHY

Achmad, S. R., Aji, Y. B. S. 2016. Pertumbuhan Tanaman Karet Belum Menghasilkan di Lahan Pesisir Pantai Dan Upaya Pengelolaan Lahannya (Studi Kasus: Kebun Balong, Jawa Tengah). *Warta Perkaretan*. 35(1): 11-24.

Andayani, W. 2020 *Ilmu Ekonomi Kehutanan Kontekstual: 70 Tahun Prof Dr Dudung Darusman.* Ipb Press. Bogor

Edi, F. R. S. 2016. *Teori Wawancara Psikodignostik*. Leutikaprio. Yogyakarta.

Indra Gumay Febryano, F., Safe'i, R., & Irwan Sukri Banuwa, I. (2017). Performa Pengelolaan Agroforestri di Wilayah Kesatuan Pengelolaan Hutan Lindung Rajabasa. *Jurnal Hutan Tropis*, 5(2), 127-133.

Indrianti, M. A. 2018. Implementasi Sistem Agroforestri Sebagai Solusi Pertanian Berkelanjutan di Gorontalo. *Prosiding*. Universitas Ichsan Gorontalo. Gorontalo.

Latumahina, F., Mardiatmoko, G., Tjoa, M. 2020. Penggunaan Biopestisida Nabati Dari Bahan Dasar Toga Untuk Pengendalian Hama Rayap Pada Pembibitan Pala Dan Cengkeh Milik Kelompok Tani Spirit di Desa Liliboi. *Jurnal Karya Abdi Masyarakat*. 4(2): 288-298.

Pollock, A., Berge, E. 2018. How To Do A Systematic Review. *International Journal Of Stroke*. 13(2): 138-156.

Prasetya, A. Y. Qurniati, R. Herwanti, S. 2020. Saluran Dan Margin Pemasaran Durian Hasil Agroforestri di Desa Sidodadi. *Jurnal Belantara* 3(1) : 32-40.

Sari, D. N., Wijaya, F., Mardana, M. A., Hidayat, M. 2019. Analisis Vegetasi Tumbuhan Dengan Metode Transek (*Line Transect)* dikawasan Hutan Deudap Pulo Aceh Kabupaten Aceh Besar. *In Prosiding Seminar Nasional Biotik*. Aceh Besar.

Sukra, P., Indriyanto, I., & Asmarahman, C. (2021). Asosiasi Liana Dengan Tumbuhan Penopangnya di Blok Koleksi Taman Hutan Raya Wan Abdul Rachman, Provinsi Lampung. *Jurnal Rimba Lestari*, *1*(1), 1-11.

Suryani, E., Dariah, A. 2012. Peningkatan Produktivitas Tanah Melalui Sistem Agroforestri. *Jurnal Sumberdaya Lahan*. 6(2): 101-109.

Susanti, Y., Wulandari, C., Kaskoyo, H., Safe'i, R., & Yuwono, S. B. (2021). Persepsi Masyarakat Terhadap Pengelolaan Agroforestri di Tahura Wan Abdul Rachman, Bandarampung. *Jurnal Hutan Tropis*, *9*(2), 472-487.

Syofiandi, R. R., Hilmanto, R., & Herwanti, S. (2016). Analisis Pendapatan Dan Kesejahteraan Petani Agroforestri di Kelurahan Sumber Agung Kecamatan Kemiling Kota Bandar Lampung. *Jurnal Sylva Lestari*, 4(2), 17-26.

Syofiandi, R. R., Hilmanto, R., Herwanti, S. 2016. Analisis Pendapatan Dan Kesejahteraan Petani Agroforestri di Kelurahan Sumber Agung Kecamatan Kemiling Kota Bandar Lampung. *Jurnal Sylva Lestari*. 4(2): 17-26.

jatjo, N. T. (2015). Karakteristik Pola Agroforestri Masyarakat di Sekitar Hutan Desa Namo Kecamatan Kulawi Kabupaten Sigi. *JSTT*, *4*(3).

Umiyati, R. (2015). Diversifikasi Hasil Kegiatan Agroforestri Bagi Ketahanan Pangan di Kecamatan Sigaluh, Kabupaten Banjarnegara. *Jurnal Ilmiah Teknosains*, *1*(1/November).

KURAKLIK ALTINDA BUĞDAY BİTKİSİNE POTASYUM UYGULAMALARININ FİZYOLOJİK ÖZELLİKLERİ ÜZERİNE ETKİSİ

Arş. Gör. Dr. Ali SARIOĞLU* (ORCID: 0000-0001-6269-4990)
Harran University, Faculty of Agriculturel, Department of Soil Science and Plant Nutrition, Şanlıurfa-Türkiye
Email: asarioglu@harran.edu.tr

Arş. Gör. Sabri AKIN (ORCID: 0000-0002-9196-3157)
Harran University, Faculty of Agriculturel, Department of Agricultural Structures and Irrigation, Şanlıurfa- Türkiye
Email: sabriakin@harran.edu.tr

ÖZET
Kuraklık, buğday bitkisinin gelişimi üzerinde olumsuz etkiler bırakarak verim kaybına ve fizyolojik streslere neden olabilmektedir. Kuraklık, tarımsal verimlilik üzerinde önemli bir zorluk oluşturduğundan bitki fizyolojisi üzerindeki etkilerinin daha iyi anlaşılması ve etkili önlemler geliştirilmesi gerekmektedir. Bu çalışma, saksı ortamında yetiştirilen buğday bitkisinin su stresine karşı potasyum (P) uygulamalarının fizyolojik yanıtlarını belirlemeyi amaçlamaktadır. Araştırma tesadüf parsellerinde bölünmüş parseller deneme desenine göre 3 tekerrürlü olarak yürütülmüş. Çalışmada, ana konular sulama seviyeleri (%50 ve %100), alt konular ise potasyum uygulamaları (P1: 1 g P, P1: 2 g P ve P3: 4 g P) olmuştur. Araştırmada, spad, termal görüntüler, Fv/Fm değerleri, yaprak oransal içeriği, H_2O_2, MDA, POD, CAT ve APX enzim aktiviteleri analizleri yapılmıştır. Sonuçlar, su stresi altında bitki morfolojisi ve fizyolojisi üzerinde belirgin etkilerin olduğunu göstermektedir. Ancak, K uygulamalarının bu etkileri azalttığı ve bitkinin stres toleransını artırdığı gözlemlenmiştir. Özellikle, P3 uygulamasının antioksidan enzim aktivitelerini artırarak bitkiyi su stresine karşı daha dirençli hale getirdiği belirlenmiştir. Bu bulgular, tarımsal uygulamalarda su stresine karşı buğday bitkisinin K uygulamalarının etkinliğini anlamak için önemli bir katkı sağlamaktadır.
Anahtar Kelimeler: Kuraklık, Buğday, Potasyum, kısıntılı sulama, Enzim

THE EFFECT OF POTASSIUM APPLICATIONS ON PHYSIOLOGICAL CHARACTERISTICS OF WHEAT PLANT UNDER DROUGHT CONDITIONS

ABSTRACT

Drought can have negative effects on the development of wheat plants, leading to yield losses and physiological stresses. Since drought poses a significant challenge to agricultural productivity, it is necessary to better understand its effects on plant physiology and develop effective measures. This study aims to determine the physiological responses of wheat plants grown in pot conditions to potassium (P) applications against water stress. The research was conducted in a randomized complete block design with three replications. The main plots were irrigation levels (50% and 100%), and the subplots were potassium applications (P1: 1 g P, P2: 2 g P, and P3: 4 g P). In the study, analyses such as SPAD, thermal images, Fv/Fm values, leaf relative water content, H_2O_2, MDA, POD, CAT, and APX enzyme activities were performed. The results indicate significant effects on plant morphology and physiology under water stress. However, potassium applications were observed to mitigate these effects and increase the plant's stress tolerance. Particularly, the P3 application was found to enhance antioxidant enzyme activities, making the plant more resilient to water stress. These findings provide valuable insights into the effectiveness of potassium applications for wheat plants under water stress in agricultural practices.

Keywords: Drought, Wheat, Potassium, Deficit Irrigation, Enzyme

Introduction

Wheat (Triticum aestivum) is one of the world's leading food crops, serving as a primary source of calories and protein for a significant portion of the global population. However, its production is severely threatened by drought stress, which is becoming more frequent and severe due to climate change. Drought stress leads to a series of morphological, physiological, and biochemical changes in plants, reducing growth and yield (Farooq et al., 2009).

Moreover, drought stress significantly increases the production of reactive oxygen species (ROS) such as superoxide radicals, hydrogen peroxide, and hydroxyl radicals in plants. These ROS can cause oxidative damage to lipids, proteins, and nucleic acids, leading to cellular damage and impaired plant growth (Gill et al., 2010). To mitigate oxidative stress, plants have developed an intricate antioxidant defense system, including enzymatic antioxidants like ascorbat peroxidase (APX), catalase (CAT), and peroxidase (POD), as well as non-enzymatic antioxidants such as ascorbate and glutathione (Miller et al., 2010). The application of potassium under drought conditions may enhance the antioxidant defense mechanism in wheat, thereby reducing oxidative damage and improving plant resilience to stress (Szepesi et al., 2009). This potential enhancement of the antioxidant system by potassium supplementation underlines the importance of our study, as it could offer a viable strategy to mitigate the adverse effects of drought stress on wheat and other crops.

Potassium (K) is an essential macronutrient for plant growth and development, playing a pivotal role in water uptake, enzyme activation, photosynthesis, and stress response (Römheld and Kirkby, 2010). Despite its importance, the specific effects of potassium on wheat plants under drought conditions are not fully understood. Potassium's role in enhancing drought resistance involves regulating stomatal opening, osmotic adjustment, and activation of stress-response enzymes (Wang and Huang, 2010).

Recent studies have shown that potassium application can improve crop yield under drought stress by enhancing the physiological and biochemical processes of plants (Pei et al., 2010). However, the mechanism by which potassium mediates these improvements in wheat, particularly under drought stress, remains to be fully elucidated. This study aims to investigate the effect of potassium applications on the physiological characteristics of

wheat plants under drought conditions, with a focus on growth parameters, yield, water use efficiency, and stress biomarkers.

Understanding the role of potassium in mitigating drought stress in wheat is crucial for developing sustainable agricultural practices. This research could provide valuable insights for farmers and policymakers, leading to improved crop management strategies that enhance resilience to drought conditions, thereby contributing to food security and agricultural sustainability (Shao et al., 2008).

Materials and Methods

This study was conducted under controlled conditions in a glass greenhouse. Five-liter capacity pots were used, with 3 kg of soil added to each pot. Planting was carried out with 20-30 seeds of the Edessa wheat variety in each pot. The experimental treatments consisted of five different applications: control (Full irrigation: 100% irrigation water), water stress (WS: 50% irrigation water), WS+P1 (1g potassium), WS+P2 (2g potassium), and WS+P3 (4g potassium), totaling 15 pots with three replicates each. In pots where potassium application was applied, potassium sulfate fertilizer was administered after seed germination. The measurements were obtained as preliminary results before the completion of the trial.

Irrigation water application

The available water holding capacity (AWC) of the soil in the pot was determined for growing the wheat plant under controlled conditions. The calculated AWC values of the 50% and 100% levels (Full Irrigation) have been used for providing water at those levels. After the commencement of scheduled irrigations, pots were weighed in each period, which followed two days, and watered to reach 50% and 100% of AWC. These applications were continued through the experimental period.

Thermal Camera Images

Thermal images have been obtained using the FLIR T540 model thermal camera. The FLIR T540 model thermal camera possesses a resolution of 464 × 348, a pixel size of 640 × 480, an accuracy of ±2%, a sensitivity of 0.5 °C at 37 °C, a spectral range of 7.5-14 µm, a field of view of 25° x 19°/0.4 m, and temperature detection capabilities ranging from -20 to 650 °C. Due to the potential impact of height on canopy temperature (Thomson et al., 2012), images have been taken from a distance of 1 m for standardization. The obtained thermal images will be analyzed with FLIR Tools software. Measurements have

been conducted by inputting the relative humidity and air temperature values. The measurements were carried out between the hours of 12:00-14:00.

SPAD Values

Chlorophyll content in wheat plants was assessed with a portable SPAD meter, which is designed for rapid in-field measurement of leaf chlorophyll levels.

Findings and Discussion

Determination of Maximal Quantum Yield (Fv/Fm)

Fv/Fm was determined using a photosynthesis yield analyzer post a 30-minute dark adaptation of the plants.

Electrolyte leakage (EL)

Electrolyte leakage (EL) was analyzed for all treatments by Dionisio-Sese and Tobita, (1998). 0.2 g fresh leaf sample was weighed and inserted in a test tube including distilled water (10 mL). It was left out of the two-h incubation and the electrical conductivity (EC1) was measured. Then the test tubes with samples were autoclaved at 121^{o}C for 20 min and EC2 was read when the temperature dropped to 25 ^{o}C. %EL was determined as a percentage of the values derived from the formula: (EC1/EC2X100).

Determination of Plant Water Content

We calculated leaf relative water content (RWC) following the method by Yamasaki an Dillenburg (1999). Fresh weight (FW) of the leaves was determined by immediately excising them and weighing. The leaves were then immersed in distilled water for 24 h to determine turgid weight (TW). Afterward, the leaves were oven-dried at 65 $^{\circ}$C to obtain the constant dry weight (DW). RWC was calculated using the equation proposed by Yamasaki and Dillenburg (1999).

Hydrogen Peroxide (H_2O_2)

H_2O_2 levels were assessed using a modified Loreto and Velikova (2001) method. Plant tissue (0.5 g) was homogenized in 5 ml of 1% TCA, centrifuged, and the supernatant was reacted with potassium iodide. Absorbance at 390 nm was recorded and quantified against a standard curve.

Antioxidant Enzyme Activities

Antioxidant enzymes were extracted from 0.5 g of leaf tissue ground in liquid nitrogen and homogenized in 5 ml of cold 0.1 M KH2PO4 buffer with 1% PVP and 1 mM EDTA.

The homogenate was centrifuged and the supernatant was used to assay enzyme activities as per Angelini and colleagues' protocols.

Catalase (CAT) Activity

CAT activity was determined following Kraus and Fletcher (1994), by mixing enzyme extract with the reaction mixture and reading the absorbance at 240 nm at 25 °C for 1 minute.

Peroxidase (POD) Activity

POD activity was measured based on the Chance and Maehly (1955) method. The reaction mixture containing enzyme extract was monitored at 470 nm over 5 minutes.

Ascorbate Peroxidase (APX) Activity

APX activity was assayed as per Nakano and Asada (1981). The enzyme extract was combined with the reaction mixture and absorbance changes at 290 nm were recorded for 3 minutes.

Analysis of Data Using Statistical Tools

Statistical analysis of each variable was conducted using the SPSS 21 software, applying ANOVA to determine the significance of the data. Duncan's Multiple Range test was utilized at a $P \leq 0.05$ significance level to differentiate between the means of the treatments.

Conclusion and Recommendations

Thermal Camera Images

Thermal camera images of this study are given in Figure 1. The rise in wheat temperature under water stress conditions to 21.1, compared to the control temperature of 19.8, confirmed the expected increase in leaf temperature due to the reduction in transpiration as a stress response. The implementation of potassium supplementation led to a sequential decrease in wheat temperatures with WS+P1, WS+P2, and WS+P3 treatments, registering temperatures of 20.9, 20.6, and 20.4, respectively. These results align with the hypothesis that potassium may ameliorate the effects of water stress by enhancing the plant's water retention and transpirational cooling, as evidenced by the gradual decrease in thermal readings with increased potassium application.

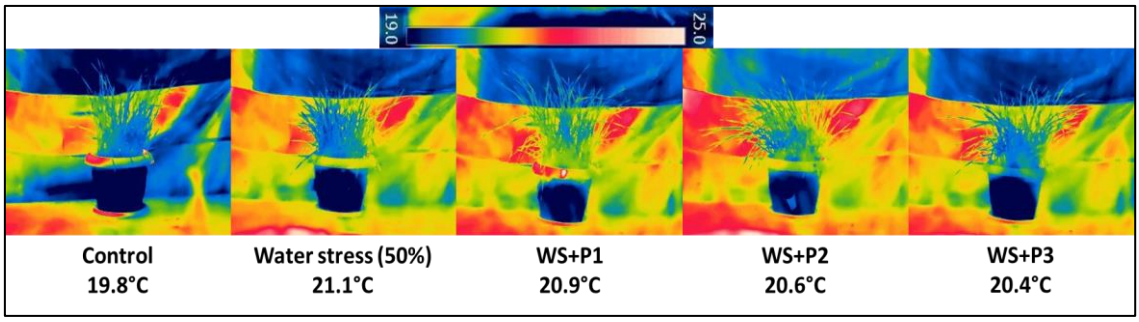


Figure 1: Wheat plant thermal camera images) (Mean ± S.E.); Different alphabets on bars exhibit significant difference between means within each variable. Control: treatment with water alone (100%); WS: water stress(50%) P1: 1g potassium (2.2g K_2SO_4); P2: 2g potassium (4.4g K_2SO_4); P3: 3g potassium (8.8g K_2SO_4)

The application of thermal imaging in detecting water stress is corroborated by studies such as Balota et al. (2007), which demonstrated the capacity of thermal imagery to effectively distinguish between water-stressed and non-stressed wheat plants. This technique's sensitivity to physiological changes in plants underlines its potential as a valuable tool for precision agriculture practices. Further, the thermal imaging approach aligns with the findings of Blum et al. (1982), who utilized this technology for the selection of drought-resistant wheat genotypes, illustrating the method's utility in identifying variations in water use efficiency and potential yield under stress conditions.
In conclusion, the thermal imagery analysis conducted in this research provides critical insights into the water-related stress responses of wheat plants, underscoring the utility of thermal imaging in monitoring plant health. Such non-invasive techniques are imperative for the development of sustainable agricultural practices, enabling the optimization of irrigation strategies to improve water use efficiency and ensure crop productivity under varying environmental conditions.

SPAD and Fv/Fm Values

SPAD measurement was made with a SPAD device in order to obtain information about the leaf chlorophyll content of the wheat plant before harvest. wheat plant SPAD results are given in Figure 2A. Among the treatments, water stress (WS) reduced plant SPAD content by 21.3% compared to the control. Potassium application to reduce the effect of stress caused increases in SPAD contents in the plant. P1 application to the WS application reduced the negative effect of stress by 7.5%, P2 application reduced the

negative effect of stress by 14%, and P3 application reduced the negative effect of stress by 17.7%. When the results are examined; It is seen that potassium applications to plants under stress increase the SPAD value and it is found to be statistically significant (P≤0.05).

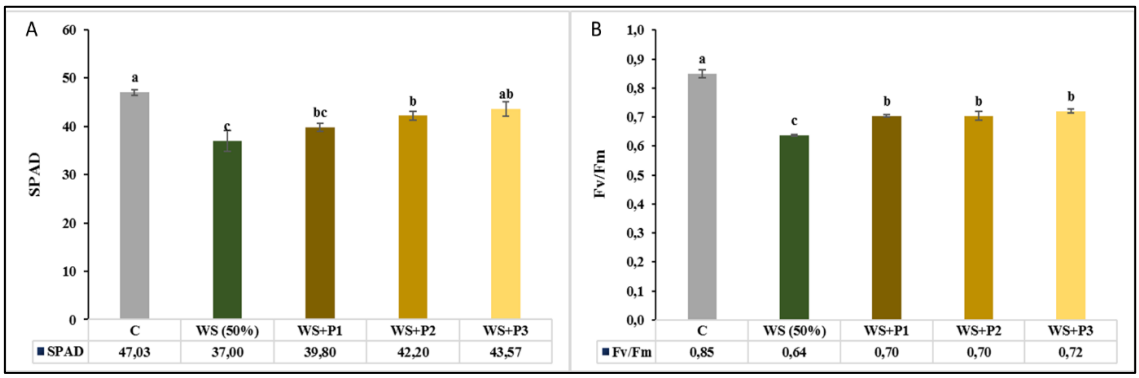


Figure 2: SPAD meter (A) and Chlorophyll fluorescence parameters [Fv/Fm] (B) (Mean ± S.E.); Different alphabets on bars exhibit significant difference between means within each variable. Control: treatment with water alone (100%); WS: water stress(50%) P1: 1g potassium (2.2g K_2SO_4); P2: 2g potassium (4.4g K_2SO_4); P3: 3g potassium (8.8g K_2SO_4)

In parallel, the maximal quantum efficiency of PSII (Fv/Fm) was measured, as shown in Figure B. The control plants exhibited an Fv/Fm value of 0.85, indicating optimal photosynthetic efficiency. Under water stress, Fv/Fm decreased to 0.64, a reduction of 24.7%, suggesting significant stress impact on the photosynthetic apparatus. However, potassium treatments ameliorated this stress effect: WS+P1 increased Fv/Fm by 9.37%, WS+P2 and WS+P3 treatments each enhanced Fv/Fm by 14.08% and 16.18%, respectively, compared to the WS condition. These results imply that potassium plays a crucial role in sustaining photosynthetic performance under water deficit conditions.

The decline in SPAD values and Fv/Fm ratios under water stress, as observed in the wheat study, reflects the deleterious impact of drought on chlorophyll content and photosynthetic efficiency, consistent with the findings of Morales et al. (2002), who reported similar reductions in leaf chlorophyll and PSII efficiency under water deficit. Potassium's mitigation of these effects, evident in the incremental improvements in both SPAD and Fv/Fm with potassium treatments, aligns with the work of Cakmak (2005),

highlighting the essential role of potassium in maintaining chlorophyll stability and protecting the photosynthetic apparatus during stress.

Electrolyte leakage and Leaf Relative Water Content

Water stress, electrolyte leak (%EL) values in wheat plants are given in Figure 3A. Compared to the control, water stress increased the %EL value to 130.71%; This indicates cell membrane damage due to dehydration and stress. Potassium applications reduced EL% to varying degrees: 16.52% from P1, 26.53% from P2, and 30.51% from P3. This demonstrates the effectiveness of potassium in increasing cell membrane stability and reducing stress-induced damage.

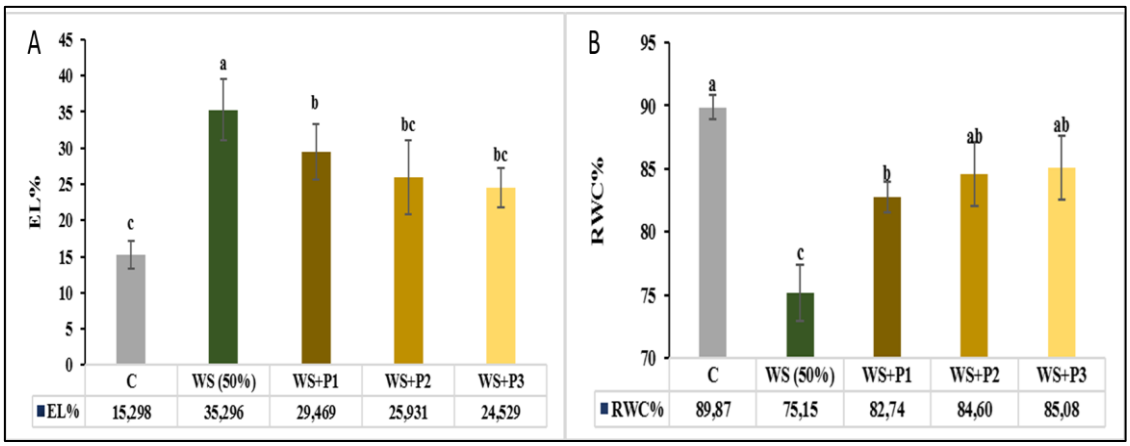


Figure 3: Electrolyte leakage [EL; (A)] and Leaf relative water content [RWC; (B)], (Mean ± S.E.); Different alphabets on bars exhibit significant difference between means within each variable. Control: treatment with water alone (100%); WS: water stress (50%) P1: 1g potassium (2.2g K_2SO_4); P2: 2g potassium (4.4g K_2SO_4); P3: 3g potassium (8.8g K_2SO_4)

The findings obtained as a result of measurements made to obtain information about pre-harvest leaf water content (%RWC) in wheat plants show plant stress responses and the effects of potassium applications against these stresses. Water stress (%WS) application reduced the %RWC value of wheat plant by 16.33% compared to the control. Potassium (P) applications made to reduce the negative effects of stress provided improvements in the %RWC values in the plant. P1 application to WS application provided a 10.13% improvement in %RWC. P2 application rate is 12.57%; P3 application provided an improvement of 13.06%. When these results are examined; It is seen that potassium

applications to stressed wheat plants increase the %RWC value and these improvements are found to be statistically significant (P≤0.05).

H_2O_2 and MDA values

Water stress, H_2O_2 values in wheat plants are given in Figure 4A. Water stress escalated H_2O_2 levels by approximately 69.22% (from 11.99 to 20.29), signifying an increase in oxidative stress. Potassium applications systematically reduced this stress impact, with P1 decreasing H_2O_2 levels by 15.51%, P2 by 26.89%, and P3 by the most significant reduction of 30.01% relative to WS conditions. This indicates potassium's critical role in oxidative stress mitigation.

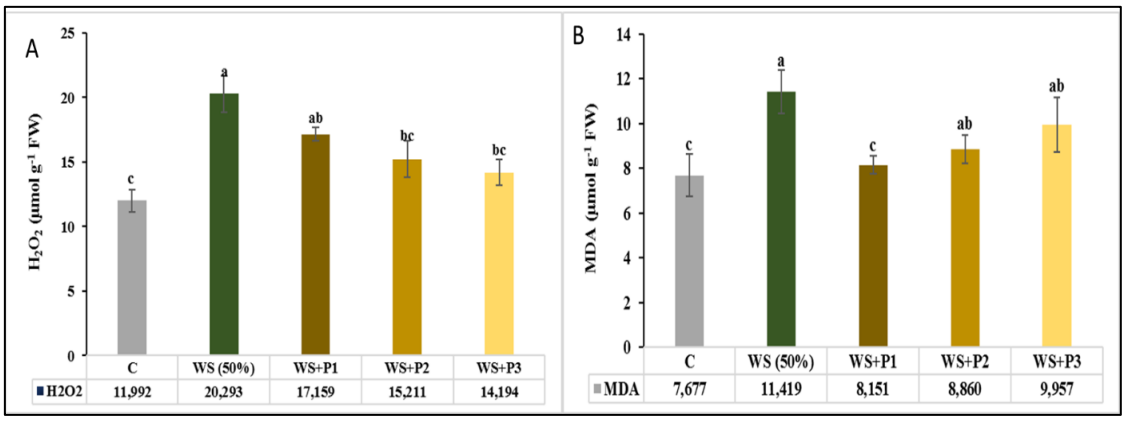


Figure 4: Hydrogen peroxide [H_2O_2; (A)] and malondialdehyde [MDA; (B)], (Mean ± S.E.); Different alphabets on bars exhibit significant difference between means within each variable. Control: treatment with water alone (100%); WS: water stress(50%) P1: 1g potassium (2.2g K_2SO_4); P2: 2g potassium (4.4g K_2SO_4); P3: 3g potassium (8.8g K_2SO_4)

MDA, an indicator of lipid peroxidation, increased by 48.76% under WS (from 7.67 to 11.41). Potassium treatments effectively countered this, with P1 reducing the MDA increase to 5.89%, P2 to 15.53%, and P3 showing a decrease of 29.36% from the stress condition, illustrating potassium's protective role against cellular damage.

Water stress (WS) is known to induce oxidative stress in plants, leading to increased electrolyte leakage (%EL), hydrogen peroxide (H_2O_2) accumulation, and malondialdehyde (MDA) levels, which are indicative of lipid peroxidation. Our findings reveal that WS significantly elevates %EL, H_2O_2, and MDA in wheat plants,

corroborating with numerous studies that have documented similar stress responses in various plant species.

For instance, a study by Sharma et al. (2012) reported that WS conditions led to an increase in %EL and MDA in wheat, reflecting membrane damage and lipid peroxidation, which are common indicators of oxidative stress in plants. Similarly, Farooq et al. (2009) observed an increase in H_2O_2 levels under drought conditions in rice, underscoring the role of reactive oxygen species (ROS) in stress responses.

Potassium (K) supplementation has been shown to mitigate the adverse effects of WS by enhancing plant water retention, improving antioxidant defense mechanisms, and reducing oxidative damage. In our study, K treatments systematically reduced %EL, H_2O_2, and MDA levels in wheat plants under WS, suggesting an improvement in water status, oxidative stress mitigation, and protection against lipid peroxidation. These findings are in line with those of Cakmak (2005), who demonstrated that K plays a crucial role in activating antioxidant enzymes, thus reducing ROS accumulation and lipid peroxidation in stressed plants.

Additionally, Wang et al. (2013) found that K supplementation improved drought tolerance in maize by reducing %EL and MDA levels, further supporting our observations. The reduction in H_2O_2 levels following K treatments may be attributed to the enhanced activity of antioxidative enzymes such as superoxide dismutase (SOD), catalase (CAT), and peroxidase (POD), as reported by Rizwan et al. (2016) in their study on K's role in mitigating salt stress in cotton.

Antioxidant Analysis Results

APX activity increased by 59.50% in response to WS (from 10.47 to 16.70), reflecting an enhanced antioxidative response (Figure 5A). Potassium's application moderated this increase, with P1 bringing it down to 24.93%, P2 to 18.91%, and P3 by 11.36% from WS levels, highlighting potassium's efficacy in regulating antioxidative enzyme activities under stress.

POD activity, indicative of antioxidative defense, was up by 60.35% under WS (from 12.46 to 19.99) (Figure 5B). Potassium treatments led to a moderated increase of 40.37% (P1), 33.96% (P2), and 29.46% (P3) relative to WS, showing potassium's role in fine-tuning the plant's antioxidative responses to stress.

CAT activity, essential for detoxifying excess H_2O_2, increased by 94.88% under WS (from 2.54 to 4.95) (Figure 5C). Potassium treatments tempered this increase to 44.49% (P1), 26.38% (P2), and 25.59% (P3) compared to WS, demonstrating potassium's effectiveness in maintaining balanced antioxidative defense mechanisms.

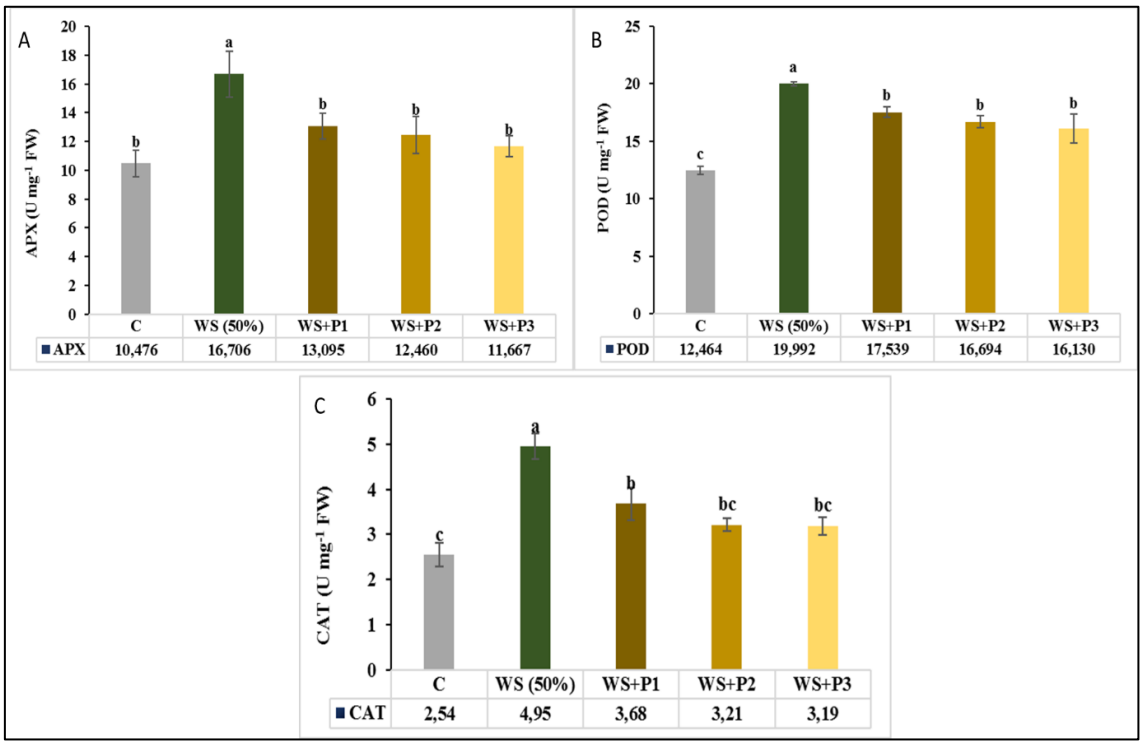


Figure 5: Activities of askorbat peroksidaz (APX) (A), peroxidase (POD)(B) and catalase (CAT)(C) values (Mean ± S.E.); Different alphabets on bars exhibit significant difference between means within each variable. Control: treatment with water alone (100%); WS: water stress(50%) P1: 1g potassium (2.2g K_2SO_4); P2: 2g potassium (4.4g K_2SO_4); P3: 3g potassium (8.8g K_2SO_4)

The antioxidative defense mechanisms of wheat plants, particularly through the activities of Ascorbate Peroxidase (APX), Peroxidase (POD), and Catalase (CAT), play a pivotal role in mitigating the oxidative stress induced by water stress (WS). Our study delineates the significant modulation of these antioxidative enzymes in response to WS and subsequent alleviation through potassium (K) supplementation, offering insights into potassium's integral role in enhancing plant stress tolerance.

Under WS, we observed a substantial increase in APX activity, indicative of an intensified ascorbate-glutathione cycle to detoxify the excess hydrogen peroxide (H_2O_2) generated. This response aligns with the plant's adaptive strategy to mitigate oxidative damage, as

supported by Gill and Tuteja (2010), who highlighted the universal upregulation of APX in stressed plants. Potassium's ability to modulate APX activity underscores its contribution to maintaining redox homeostasis, affirming findings from Hasanuzzaman et al. (2018), which showed improved antioxidative defense with K supplementation in abiotically stressed plants.

Similarly, the upregulation of POD activity under WS underscores an enhanced defense mechanism against oxidative stress, aiding in H_2O_2 scavenging and reinforcing cell wall integrity through lignin polymerization. The reduction in POD activity with K treatments reflects a mitigation of oxidative stress, thus reducing the demand for H2O2 scavenging. This is consistent with Anjum et al. (2011), who documented POD's role in the antioxidative defense under various stress conditions, and Szalai et al. (2009), who demonstrated K's efficacy in optimizing antioxidative enzyme responses.

Moreover, the observed increase in CAT activity highlights its crucial function in the rapid detoxification of H_2O_2, preventing its accumulation and the consequent oxidative damage. The moderation of CAT activity by K treatments suggests an effective reduction in oxidative stress levels, highlighting K's role in oxidative stress mitigation. This finding aligns with Ahmad et al. (2016), which illustrated that K supplementation under salt stress improved CAT activity, emphasizing K's beneficial effects in managing ROS and enhancing plant stress tolerance.

Collectively, our findings reveal the dynamic interplay between water stress and potassium supplementation in modulating the activities of key antioxidative enzymes in wheat plants. By enhancing the antioxidative defense mechanisms, potassium supplementation emerges as a crucial strategy for improving plant resilience against abiotic stresses, offering promising avenues for agricultural practices aimed at sustaining crop productivity under adverse environmental conditions.

References

Ahmad, P., Abdel Latef, A. A., Hashem, A., Abd_Allah, E. F., Gucel, S., & Tran, L. S. P. (2016). Nitric oxide mitigates salt stress by regulating levels of osmolytes and antioxidant enzymes in chickpea. Frontiers in Plant Science, 7, 347.

Ahmad, P., Abdel Latef, A. A., Hashem, A., Abd_Allah, E. F., Gucel, S., & Tran, L. S. P. (2016). Nitric oxide mitigates salt stress by regulating levels of osmolytes and antioxidant enzymes in chickpea. Frontiers in Plant Science, 7, 347.

Anjum, N. A., Umar, S., & Chan, M. T. (2011). Ascorbate-Glutathione Pathway and Stress Tolerance in Plants. Springer.

Anjum, N. A., Umar, S., & Chan, M. T. (2011). Ascorbate-Glutathione Pathway and Stress Tolerance in Plants. Springer.

Cakmak, I. (2005). The role of potassium in alleviating detrimental effects of abiotic stresses in plants. Journal of Plant Nutrition and Soil Science, 168(4), 521-530.

Cakmak, I. (2005). The role of potassium in alleviating detrimental effects of abiotic stresses in plants. Journal of Plant Nutrition and Soil Science, 168(4), 521-530.

Farooq, M., Wahid, A., Kobayashi, N., Fujita, D., & Basra, S. M. A. (2009). Plant drought stress: effects, mechanisms and management. Agronomy for Sustainable Development, 29(1), 185-212.

Gill, S. S., & Tuteja, N. (2010). Reactive oxygen species and antioxidant machinery in abiotic stress tolerance in crop plants. Plant Physiology and Biochemistry, 48(12), 909-930.

Gill, S. S., & Tuteja, N. (2010). Reactive oxygen species and antioxidant machinery in abiotic stress tolerance in crop plants. Plant Physiology and Biochemistry, 48(12), 909-930.

Hasanuzzaman, M., Bhuyan, M. H. M. B., Nahar, K., Hossain, M. S., Mahmud, J. A., Hossen, M. S., Masud, A. A. C., Fujita, M., & Fotopoulos, V. (2018). Potassium: A vital regulator of plant responses and tolerance to abiotic stresses. Agronomy, 8(3), 31.

Hasanuzzaman, M., Bhuyan, M. H. M. B., Nahar, K., Hossain, M. S., Mahmud, J. A., Hossen, M. S., Masud, A. A. C., Fujita, M., & Fotopoulos, V. (2018). Potassium: A vital regulator of plant responses and tolerance to abiotic stresses. Agronomy, 8(3), 31.

Rizwan, M., Ali, S., Ibrahim, M., Farid, M., Adrees, M., Bharwana, S. A., Zia-ur-Rehman, M., Qayyum, M. F., & Abbas, F. (2016). Mechanisms of silicon-mediated alleviation of drought and salt stress in plants: a review. Environmental Science and Pollution Research, 23(20), 12348-12368.

Rizwan, M., Ali, S., Ibrahim, M., Farid, M., Adrees, M., Bharwana, S. A., Zia-ur-Rehman, M., Qayyum, M. F., & Abbas, F. (2016). Mechanisms of silicon-mediated alleviation of drought and salt stress in plants: a review. Environmental Science and Pollution Research, 23(20), 12348-12368.

Sharma, P., Jha, A. B., Dubey, R. S., & Pessarakli, M. (2012). Reactive oxygen species, oxidative damage, and antioxidative defense mechanism in plants under stressful conditions. Journal of Botany, 2012.

Sharma, P., Jha, A. B., Dubey, R. S., & Pessarakli, M. (2012). Reactive oxygen species, oxidative damage, and antioxidative defense mechanism in plants under stressful conditions. Journal of Botany, 2012.

Szalai, G., Kellos, T., Galiba, G., & Kocsy, G. (2009). Glutathione as an antioxidant and regulatory molecule in plants under abiotic stress conditions. Journal of Plant Growth Regulation, 28(1), 66-80.

Szalai, G., Kellos, T., Galiba, G., & Kocsy, G. (2009). Glutathione as an antioxidant and regulatory molecule in plants under abiotic stress conditions. Journal of Plant Growth Regulation, 28(1), 66-80.

Thomson, S. J., Ouellet-Plamondon, C. M., DeFauw, S. L., Huang, Y., Fisher, D. K., & English, P. J. (2012). Potential and challenges in use of thermal imaging for humid region irrigation system management. Journal of Agricultural Science, 4(4), 103-116.

Wang, Y., Wu, W. H., & Meng, Q. W. (2013). Enhanced drought tolerance of maize plants by potassium-mediated stress-signaling pathways. Crop Science, 53(1), 131-139.

Wang, Y., Wu, W. H., & Meng, Q. W. (2013). Enhanced drought tolerance of maize plants by potassium-mediated stress-signaling pathways. Crop Science, 53(1), 131-139.

BAZI ABSORBENT MADDELERİN IN VITRO KOŞULLARDA NAR (*Punica granatum* L.) BİTKİSİNDE ORTAYA ÇIKAN KARARMA ORANLARI ÜZERİNE ETKİLERİ

Safiye KAÇKIN (ORCID: 0009-0008-1787-304X)
Harran University, Faculty of Agriculture, Department of Horticulture, Şanlıurfa-Türkiye
Email: safiyekackin@gmail.com

Arş. Gör. Heydem EKİNCİ* (ORCID: 0000-0002-1828-7367.)
Harran University, Faculty of Agriculture, Department of Horticulture, Şanlıurfa-Türkiye
Email: heydemekinci@harran.edu.tr

Zir. Müh. Necla ŞAŞKIN (ORCID: 0000-0003-3828-0522)
Harran University, Faculty of Agriculture, Department of Horticulture, Şanlıurfa-Türkiye
Email: neclasaskinn@gmail.com

Prof. Dr. Bekir Erol AK (ORCID: 0000-0001-6938-942X)
Harran University, Faculty of Agriculture, Department of Horticulture, Şanlıurfa-Türkiye
Email: beak@harran.edu.tr

ÖZET

Kültür ortamına transfer edilen bazı türlerin yapılarında bulunan fenolik maddelerden dolayı kültür ortamlarında kararmalar meydana gelmektedir. Nar yapısında fenolik bileşikler bulunduran bir türdür. Bu nedenle besi ortamına transferi yapıldıktan sonra fenolik maddenin neden olduğu kararmalar meydana gelmekte ve gelişimi engellemektedir. Bu çalışma besi ortamında fenolik maddenin neden olduğu kararmaları önlemek amacıyla yapılmıştır. Çalışmada kararmayı önlemek için kültür ortamına sürgün aşamasında 0, 50, 100 mg L^{-1} aktif karbon, 0, 50, 100 mg L^{-1} askorbik asit ve 0, 10, 20 mg L^{-1} polivinilpirolidon (PVP) ilave edilmiştir. Sürgünler tek gözlü olacak şekilde hazırlanmıştır. Yüzey sterilizasyonu için %70 etil alkolde 1 dakika, %5 sodyum hipokloritte 7 dakika boyunca steril kabinde işlem gerçekleştirilmiştir. Sterilizasyonun ardından mikro çelikler %3.0 sükroz, 0.2 mg L^{-1} GA_3 ve 1.0 mg L^{-1} BAP ve bakteriyel kontaminasyonu önlemek için 1.0 ml L^{-1} PPM (Plant Preservative Mixture), % 0.7 gr agar ile katılaştırılmış MS (Murashige and Skoog) besi ortamı içeren kavanozlara transfer edilmiştir. Gözler sürdükten sonra 1.0 mg L^{-1} IBA ve 0.1 mg L^{-1} NAA içeren MS ortamına aktarılmıştır. Kültürler 25±2°C'de, 16/8 saatlik fotoperiyotta, 3000 lüks ışık şiddetinde inkübe edilmiştir. Çalışmada patlama oranı (%), sürme oranı (%), köklenme oranı (%), kök sayısı (adet/bitkicik) ve kök uzunluğu (cm) incelenmiştir. İncelenen parametreler istatistiksel olarak önemli bulunmuştur. Patlama oranı 37.50 ile en yüksek T1, sürme oranı 29.16 ile Kontrol ve T1, köklenme oranı 37.50 ile en yüksek T2, kök sayısı 4.66 (adet/bitkicik) ile en yüksek T2 ve kök uzunluğu 1.71cm ile en yüksek T2 uygulamasından elde edilmiştir. Kullanılan absorbent maddelerden en iyi sonuçlar 50 ve 100 mg L^{-1} askorbik asit uygulamalarında belirlenmiştir.

Anahtar Kelimeler: Aktif karbon, askorbik asit, fenolik, *in vitro*, *Punica granatum* L., PVP

EFFECTS OF SOME ABSORBENT SUBSTANCES ON THE BROWNING RATES OF POMEGRANATE (*Punica granatum* L.) PLANT UNDER *IN VITRO* CONDITIONS

ABSTRACT

Browning occurs in the culture media due to the phenolic substances found in the structures of some species transferred to the culture environment. Pomegranate is a species that contains phenolics compounds in its structure. For this reason, after it is transferred to the nutrient medium, browning caused by the phenolic substance occurs and prevents development. This study was carried out to prevent darkening caused by phenolic substances in the growing medium. In the study, to prevent browning, 0, 50, 100 mg L^{-1} activated carbon, 0, 50, 100 mg L^{-1} ascorbic acid, and 0, 10, 20 mg L^{-1} polyvinylpyrrolidone (PVP) were added to the culture medium in shoot stage. Shoots were prepared as single nodular cuttings. For surface sterilization, they were kept in a sterile cabinet for 1 min in 70% ethyl alcohol and then 7 min in 5.0% sodium hypochlorite solution. After surface sterilization, the cuttings were treated with 3.0% sucrose, 0.2 mg L^{-1} GA_3 and 1.0 mg L^{-1} BAP and 1.0 mg L^{-1} PPM (Plant Preservative Mixture) to prevent bacterial contamination of explants and they were transferred to jars containing MS (Murashige and Skoog) medium solidified with 0.7% agar. After emergence of the nodes, shoots were transferred to MS rooting medium containing 1.0 mg L^{-1} IBA and 0.1 mg L^{-1} NAA. The cultures were incubated at 25±2°C under 16/8 hour's photoperiod with a light intensity of 3000 lux. In the study, bud break rate (%), shooting rate (%), rooting rate (%), number of roots (pieces/plantlet) and root length (cm) were examined. The examined parameters were found to be statistically significant. The highest bud break rate was obtained from T1 application with 37.50, the highest shooting rate from control and T1 with 29.16, the highest rooting rate from T2 with 37.50, the highest number of roots from T2 with 4.66 (pieces/plantlets), and the highest root length from T2 application with 1.71 cm. Among the absorbent substances used, the best results were determined from the application of 50 and 100 mg L^{-1} ascorbic acid.

Keywords: Activated carbon, ascorbic acid, phenolic, *in vitro*, *Punica granatum* L., PVP

Introduction

Pomegranate, a fruit species within the Punica genus, has a wide distribution from the Mediterranean region to Asia, North Africa, Europe, and the Indian Peninsula. The main reasons for pomegranate cultivation in Turkey can be attributed to the increased recognition of its health benefits, leading to higher demand and economic value, as well as the realization that existing varieties do not meet all the desired characteristics in the market, prompting breeding efforts to develop new, high-quality, and standardized varieties needed in both domestic and international markets. Consequently, the increasing demand for pomegranates, driven by their nutritional richness and health benefits, necessitates the establishment of new orchards (Levin, 2006; Gölükcü et al., 2008). Therefore, *in vitro* micropropagation techniques, which allow for the rapid and uniform production of new pomegranate plants (clones) with identical characteristics, have gained importance in obtaining clonal pomegranate plants in a fast and efficient manner (Orhan, 2018). Micropropagation involves shoot formation and mass multiplication of plantlets under *in vitro* conditions. Pomegranate micropropagation is moderately difficult due to the leakage of phenolics, which leads to moderate browning, explant necrosis, systemic or latent microbial contamination, and *in vitro* tissue resistance (da Silva et al., 2013).

Special procedures are required to avoid problems such as the formation of explants, the secretion of polyphenolic compounds from the cutting surface, and browning occurring in the culture medium. Various interventions have been made to eliminate the problem of browning, such as pre-treatment of explants in antioxidant solution, addition of oxidants to the environment, dark incubation of cultures, and frequent subculturing of explants (Ahmad et al., 2013). Various absorbent materials such as activated charcoal, polyvinylpyrrolidone, ascorbic acid, sodium nitroprusside, citric acid, oxalic acid, and silver nitrate are used to reduce or prevent browning in the culture medium and to ensure a healthy regeneration process (Naik and Chand, 2003). However, the effectiveness of these methods varies according to species and the physiological conditions of the plant (Chandra et al., 2004; Singh et al., 2011).

This study investigated the possibilities of reducing or preventing browning in the culture medium during the process of in vitro shoot formation of the Hicaz pomegranate variety, which is a vegetative propagation method. The effect of adding different absorbent materials (ascorbic acid, activated charcoal, polyvinylpyrrolidone (PVP)) to the

culture medium on browning occurring in the culture medium and on plant growth was examined.

Materials and Methods

Plant Material

The explants to be used in the research were obtained from the Hicaz pomegranate variety located in the experimental fields of Harran University Faculty of Agriculture.

General Characteristics of Hicaz Pomegranate

The majority of Turkey's pomegranate exports consist of Hicaz pomegranates. Its cold resistance threshold is -10°C. It has a tart flavor. Suitable for storage, it can be stored for up to 6 months under compatible conditions. Depending on the region, soil, and maintenance conditions, economical yield can be obtained as early as the 3rd year. The fruit size is larger compared to other pomegranate varieties. The peel color is red, and the aril color is dark red. The juice yield is 48.91%, and the aril yield is 50%, with an average seed yield of 41 kilograms. Suitable for both culinary and commercial purposes (Orhan, 2018; Ak et al., 2023).

Method

This study was conducted in the tissue culture laboratory of the Department of Horticulture, Faculty of Agriculture, Harran University, during the vegetation period of 2022-2023. To prevent browning, the culture medium was supplemented with 0, 50, 100 mg L^{-1} activated charcoal, 0, 50, 100 mg L^{-1} ascorbic acid, and 0, 10, 20 mg L^{-1} polyvinylpyrrolidone (PVP) during the shoot stage (Table 1) (Shao et al., 2003; Pushpraj and Patel, 2016; Urbinati et al., 2018). Shoots were prepared as single-nodal cuttings. Surface sterilization was performed in a sterile cabinet for 1 minute in 70% ethyl alcohol and then for 7 minutes in 5% sodium hypochlorite. After sterilization, the micro cuttings were transferred to jars containing MS (Murashige and Skoog, 1962) medium solidified with 0.7 g agar, supplemented with 3.0% sucrose, 0.2 mg L^{-1} GA_3, 1.0 mg L^{-1} BAP, and 1.0 mg L^{-1} PPM (Plant Preservative Mixture) to prevent bacterial contamination. After emergence of the shoots, they were transferred to MS medium containing 1.0 mg L^{-1} IBA and 0.1 mg L^{-1} NAA. Cultures were incubated at 25±2°C under a 16/8-hour photoperiod with a light intensity of 3000 lux. Parameters such as bud break rate (%), shoot rate (%), rooting rate (%), number of roots per plantlet, and root length (cm) were examined in the study.

Table 1. Absorbent substances and concentrations

Treatments	**Concentrations**
Control	0 mg/l
T1	50 mg/L Ascorbic acid
T2	100 mg/L Ascorbic acid
T3	25 mg/L PVP
T4	50 mg/L PVP
T5	50 mg/L Active carbon
T6	100 mg/L Active carbon

Measurements and Statical Analysis

Following the planting of micro cuttings in MS nutrient medium enriched with absorbent materials, the bud break rate was obtained by dividing bursting buds by the total number of buds transferred and multiplying by 100 (Bilir Ekbiç, 2010). Likewise, the shoot-forming nodes were divided by the total number of nodes and multiplied by 100 to obtain the shoot rate. The total number of plant leaves was calculated by counting each leaf collected from each *Punica granatum* l. plantlets. Root length was measured as the length of newly regenerated shoots per explant in cm. In the study, one-way analysis of variance was performed in a randomized parcel design in the JMP Pro 13 statistical program and the statistical difference of the mean values was detected utilizing Tukey Multiple Comparison test ($p \leq 0.05$) (Gomez and Gomez, 1984).

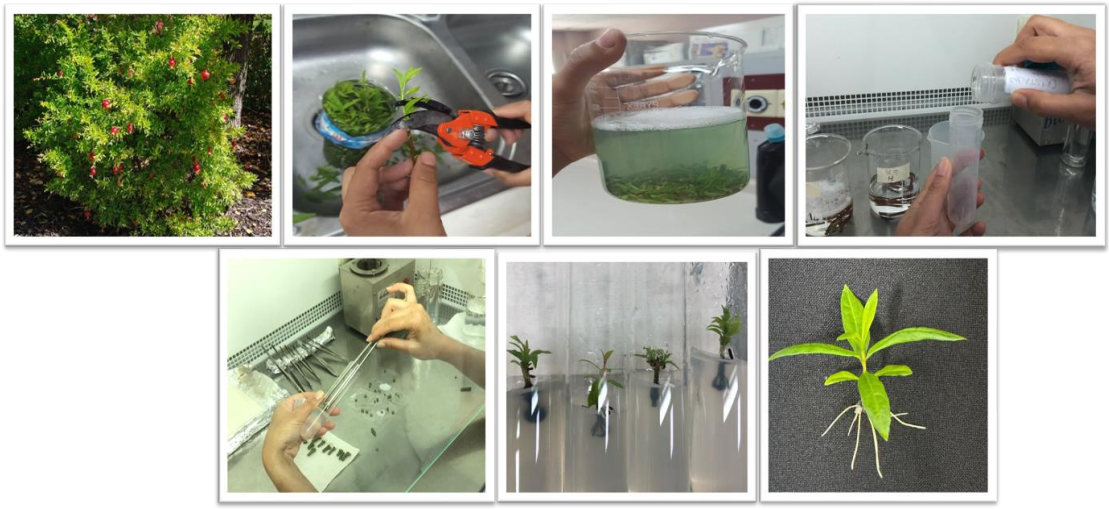


Figure 1. Micropropagation stages of 'Hicaz' pomegranate under *in vitro* conditions.

Results and Discussion

Under *in vitro* conditions, accumulation of inhibitory substances and/or secondary metabolites in the growth medium is a major problem that hinders the micropropagation coefficient and root formation in perennial woody plants (Choudhary et al., 2022). Therefore, in this study, different absorbent materials and concentrations (0, 50, 100 mg L^{-1} activated charcoal, 0, 50, 100 mg L^{-1} ascorbic acid, and 0, 10, 20 mg L^{-1} PVP) were used to improve and enhance shoot regeneration of pomegranate (Table 1). Parameters such as bud break rate (%), shoot rate (%), rooting rate (%), number of roots (per plantlet), and root length (cm) were examined. The highest bud break rate was observed in the T1 (50 mg L^{-1}) treatment, while the lowest bud break rate was determined in the T3 (25 mg L^{-1} PVP) treatment (Figure 2). It has been reported in previous studies that pomegranate contains high levels of phenolics (Choudhary et al., 2022). Therefore, leakage of phenolics from the explants transferred to the culture medium in vitro limits the budding ability of the buds on the explants (da Silva et al., 2013). In our study, it was observed that the addition of absorbent materials to the culture medium positively affected the bud break rate in explants by inhibiting phenolic formation. Moderate browning, caused by the leakage of high levels of phenolics, primarily from bud and shoot tip explants, is a significant issue in pomegranate. This substance leaks from the cut surface of the explant and then oxidizes, causing the medium to turn brown. The accumulation of phenolic compounds in the medium limits the development of explants, causing delays in growth and ultimately leading to complete failure of their survival ability. In the present study, application of T1 (50 mg L^{-1} AsA) prevented the secretion of phenolic compounds, resulting in the highest shoot elongation rate observed. After the transfer of shoots grown in a phenolic secretion-inhibited environment to the rooting medium, the plants obtained from T2 (100 mg L^{-1} AsA) application exhibited the highest rooting rate. No rooting was observed in plants transferred from cultures containing the control, T5 (50 mg L^{-1} activated carbon), and T6 (100 mg L^{-1} activated carbon) treatments. The addition of 50-100 mg L^{-1} activated carbon in the current study reduced the growth of explants (Figure 2). The level of rooting in explants grown in culture media containing activated carbon decreased, and no rooting occurred. The minimum number of roots was observed in the control, T5, and T6 treatments. The maximum number of roots was obtained from plants derived from the T1 treatment, indicating the beneficial effect of ascorbic acid. Ascorbic

acid, being an organic acid with antioxidant properties, has been reported to directly positively effect plant growth and development in previous studies (Zhang et al., 2016; Ekinci et al., 2024).

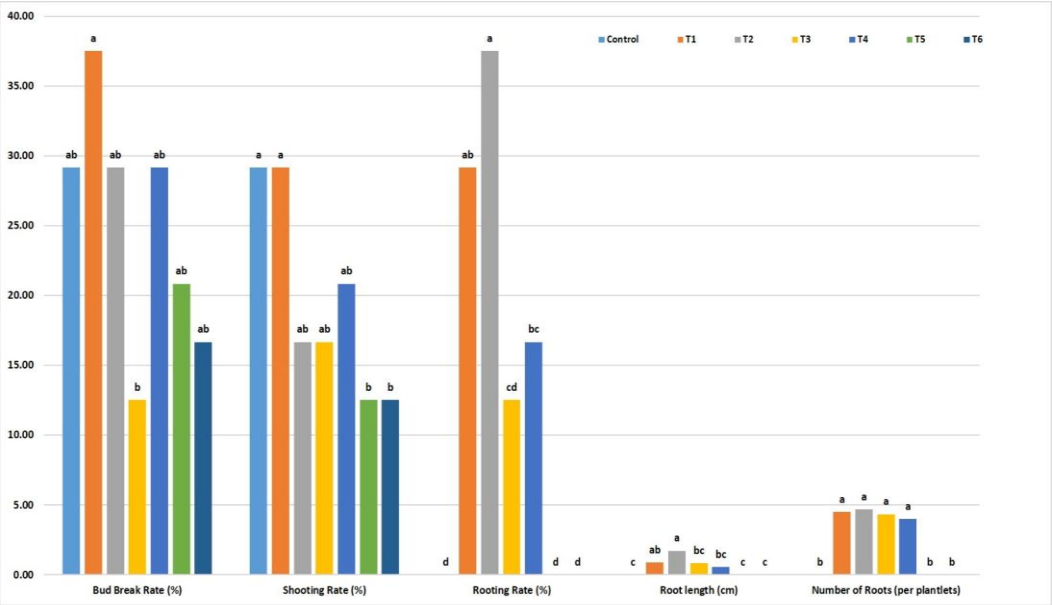


Figure 2. The effect of different absorbent substances on the bud break rate (%), shooting rate (%), rooting rate (%), rooting length (cm) and number of roots (per plantlets) of micro cuttings of 'Hicaz' pomegranate variety

Similarly, it has been found that PVP is also nearly effective in controlling browning. Previous studies have reported that PVP controls the browning of explants (Tyagi et al., 1981; Prajapati et al., 2003). Similar effects have also emerged in the current research. Ascorbic acid plays a role in cell division and expansion. When shoots developed in culture media containing 100 mg L^{-1} ascorbic acid as an absorbent material were transferred to the rooting medium, the plants with the longest roots were obtained. This was followed by the T1 (50 mg L^{-1} AsA), T3 (25 mg L^{-1}), and T4 (50 mg L^{-1}) applications, respectively. The effectiveness of different antioxidants in controlling browning varies among different plant species and varieties. This may be due to the specificity of these chemicals to certain plants and species.

Conclusions

Pomegranate (*Punica granatum* L.) belongs to the "Punicaceae" family. Its homeland is Iran, and it has spread to Asia, Africa, and the Mediterranean region of Europe.

Pomegranate thrives in salty soils and drought conditions. Pomegranate is conventionally propagated by hard wood and soft wood cuttings. However, this traditional propagation method does not guarantee that the plants will be disease-free and healthy. Additionally, this method is quite time-consuming and labor-intensive. Therefore, the current research aims to establish a reliable protocol for micropropagation under *in vitro* conditions with the assistance of different antioxidants, namely activated charcoal, polyvinylpyrrolidone, and ascorbic acid, to promote shoot proliferation and root induction. The results obtained from this study indicate that the absorbent materials added to the culture medium have reduced and prevented the secretion of phenolic compounds from the node explants of 'Hicaz' pomegranate. As a result, shoot regeneration and the formation of new plantlets have increased positively. During *in vitro* plant tissue culture protocols, one crucial factor for success is determining the appropriate propagation medium. The importance of controlling phenolic secretion and selecting suitable absorbent materials will be beneficial to achieve micropropagation goals. Our study confirmed that absorbent materials (AsA, PVP, and activated carbon) possess absorbent properties. According to the results of our study, T1 application (50 mg L^{-1} AsA) yielded positive results in bud break rate (%) and sprouting rate (%), while on the other hand, T2 application (100 mg L^{-1} AsA) positively affected rooting rate (%), root length (cm), and root number (%). In summary, different absorbent substances and concentrations should be tried in order to increase regeneration ability.

Acknowledgements

This study was supported by the TÜBİTAK 2209-A University Students Research Projects Support Program.

References

Ak B.E., Sayiner, D. R., Hatipoğlu, I.H. & Dikmetas, B. (2023). Chemical and biochemical advantages of the 'Hicaznar' pomegranate variety over 'Katina' and 'Suruc' varieties grown in the same ecology. *Turkish Journal of Agriculture and Forestry*, 47(4), p.427-435.

Choudhary, R., Jakhar, M. L., Prajapat, R. K., Kumar, R., Sekhawat, K. & Kumawat, S. (2022). *In vitro* effect of different antioxidants viz., activated charcoal, ascorbic acid, citric acid and polyvinylpyrrolidone on callus and shoot induction in Pomegranate (*Punica granatum* L.). *The Pharma Innovation Journal*, *11*(2): p.615-619.

da Silva, J. A. T., Rana, T. S., Narzary, D., Verma, N., Meshram, D. T. & Ranade, S. A. (2013). Pomegranate biology and biotechnology: A review. *Scientia Horticulturae*, *160*, p.85-107.

Ekbiç, H. B. & Yılmaz, G. (2018). Kokulu kara üzümün (*Vitis labrusca* L.) mikro çelik kültürü ile mikro çoğaltımı. *Yüzüncü Yıl University Journal of Agricultural Sciences*, *28*(1), p.86-91.

Ekinci, H., Saskin, N., Ak, B.E. & Dogan B.D. (2024). Effects of different healing agents on acclimatization success of *in vitro* rooted Garnem (*Prunus dulcis* × *Prunus persica*) rootstock. *In Vitro Cell.Dev.Biol.-Plant*. p. 1-9. https://doi.org/10.1007/s11627-024-10420-5

Gomez K.A. & Gomez A.A. (1984). Statistical procedures for agricultural research, 2nd edn. John Wiley & Sons, New York, p. 680.

Gölükcü, M., Tokgöz, H. & Kıralan, M. (2008). Ülkemizde yetiştirilen önemli nar (*Punica granatum* L.) çeşitlerine ait çekirdeklerin bazı özellikleri. *Gıda*, 33 (6), p. 281-290.

Levin, G. M. 2006. Pomegranate roads: a Soviet botanist's exile from Eden, Pomegranate Roads.

Naik, S.K. & Chand, P.K. (2003). Silver nitrate and aminoethoxyvinylglycine promote in vitro adventitious shoot regeneration of pomegranate (Punica granatum L.). *Journal of Plant Physiology*. 160, p. 421–430.

Orhan, E. (2018). Bitki büyümesini düzenleyici maddelerin farklı konsantrasyon ve kombinasyonlarının nar bitkisinin (*Punica granatum* L.) mikroçoğaltımı üzerine etkileri. Doktora tezi.

Prajapati H.A., Mehta S.R., Patel D.H. & Subramanian R.B. (2003). Direct *in vitro* regeneration of *Curculigo orchioides* Gaertn: An endangered anti-carcinogenic herb. *Current Science*, 84(6), p.747-749.

Pushpraj, S. & Patel, R. (2016). Factors affecting *in vitro* degree of browning and culture establishment of pomegranate. *African Journal of Plant Science*, 10 (2), p.43-49.

Shao, J., Chen, C. & Deng, X. (2003). *In vitro* induction of tetraploid in pomegranate (*Punica granatum L.*). *Plant Cell, Tissue and Organ Culture*, 75 (3), p.241-246.

Tyagi, A.K., Rashid, A. & Maheshiwari S.C. (1981). Promotive effect of polyvinylpolypyrrolidone on pollen embryogenesis in *Datura innoxia*. *Physiologia Plantarum*, 53, p.405-406.

Urbinati, G., Nota, P., Frattarelli, A., Di Cori, P., Lucioli, S., Forni, C. & Caboni, E. (2018). Morpho-physiological and antioxidant response to NaCl-induced stress in *in vitro* shoots of pomegranate (*Punica granatum* L.). *Acta Physiologiae Plantarum*, 40 (8), p.1-12.

Zhang, X., Yu, H.J., Zhang, X.M., Yang, X.Y., Zhao, W.C., Li, Q. & Jiang, W.J. (2016). Effect of nitrogen deficiency on ascorbic acid biosynthesis and recycling pathway in cucumber seedlings. *Plant Physiol Biochem*, 108, p.222–230.

UCB-1 (*P. atlantica x P. integerrima*) FISTIK ANACININ IN VITRO KOŞULLARDA ÇOĞALMA PERFORMANSLARININ BELİRLENMESİ

Zehra GÜNBEĞİ (ORCID: 0009-0009-5073-441X)
Harran University, Faculty of Agriculture, Department of Horticulture, Şanlıurfa-Türkiye
Email: zehragunbegi16@gmail.com

Arş. Gör. Heydem EKİNCİ* (ORCID: 0000-0002-1828-7367)
Harran University, Faculty of Agriculture, Department of Horticulture, Şanlıurfa-Türkiye
Email: heydemekinci@harran.edu.tr

Prof. Dr. Bekir Erol AK (ORCID: 0000-0001-6938-942X)
Harran University, Faculty of Agriculture, Department of Horticulture, Şanlıurfa-Türkiye
Email: beak@harran.edu.tr

Zir. Müh. Necla ŞAŞKIN (ORCID: 0000-0003-3828-0522)
Harran University, Faculty of Agriculture, Department of Horticulture, Şanlıurfa-Türkiye
Email: neclasaskinn@gmail.com

ÖZET
Pistacia türleri rekalsitrant bir bitki olması nedeni ile *in vitro* koşullarda çoğaltılması zor ve başarı oranı çok düşüktür. Bu çalışma önemli bir *Pistacia* anacı olan UCB-1' in *in vitro* koşullarda farklı konsantrasyonlarda BAP hormonuna vereceği rejenerasyon tepkisini anlamak amacıyla yapılmıştır. Çalışmada eksplant olarak üzerinde tek göz bulunduran mikro çelikler kullanılmıştır. Yüzey sterilizasyonu için %70 etil alkolde 1 dakika, %10 sodyum hipokloritte 15 dakika boyunca steril kabinde işlem gerçekleştirilmiştir. Sterilizasyonun ardından mikro çelikler %3.0 sakkaroz, 0, 1.0 ve 2.0 mg L^{-1} BAP ve bakteriyel kontaminasyonu önlemek için 1.0 mg L^{-1} PPM (Plant Preservative Mixture), % 0.7 gr agar ile katılaştırılmış MS (Murashige and Skoog) besi ortamı içeren kavanozlara transfer edilmiştir. Süren bitkicikler daha sonra içerisinde 0, 1.0 ve 2.0 mg L^{-1} IBA bulunan köklendirme ortamına transfer edilmiştir. Köklendirme ortamında bulunan bitkicikler %55-60 hava oransal nemine sahip 24-25 °C sıcaklığında ve 16:8 saat fotoperiyot altında büyütme kabininde 60 gün boyunca bekletilmiştir. Çalışmada patlama süresi (gün), sürme süresi (gün), patlama oranı (%), sürme oranı (%) ve yaprak sayısı (adet/ bitkicik) parametreleri incelenmiştir. Çalışma sonucunda patlama süresi 24.33 ile en yüksek T2 uygulamasında, sürme süresi 22.33 ile en yüksek T2 uygulamasında, patlama oranı 33.33 ile en yüksek T1 uygulamasında, sürme oranı 16.66 ile en yüksek T2 uygulamasında ve yaprak sayısı 7.00 ile en yüksek T1 uygulamasından elde edilmiştir. Çalışmada bitkiciklerde köklenme meydana gelmemiştir.
Anahtar kelimeler: Anaç, *in vitro*, mikroçoğaltım, rejenerasyon, UCB-1

DETERMINATION OF PROLIFERATION PERFORMANCE OF UCB-1 (*P. atlantica* X *P. integerrima*) PISTACHIO ROOTSTOCK IN *IN VITRO* CONDITIONS

ABSTRACT

Pistacia species are challenging to propagate *in vitro* due to their recalcitrant nature, resulting in low success rates. This study aimed to understand the regeneration response of the important *Pistacia* rootstock UCB-1 to different concentrations of the BAP hormone under *in vitro* conditions. Single-bud micro-cuttings were used as explants in the study. Surface sterilization was carried out in a sterile cabinet for 1 minute in 70% ethyl alcohol and then for 15 minutes in 10% sodium hypochlorite. Following sterilization, micro-cuttings were transferred to jars containing MS (Murashige and Skoog) medium solidified with 0.7% agar, supplemented with 3.0% sucrose, 0, 1.0, and 2.0 mg L^{-1} BAP, and 1.0 mg L^{-1} PPM (Plant Preservative Mixture) to prevent bacterial contamination. The resulting plantlets were then transferred to a rooting medium containing 0, 1.0, and 2.0 mg L^{-1} IBA. The plantlets in the rooting medium were kept in a growth chamber for 60 days at a temperature of 24-25 °C with 55-60% relative humidity and a photoperiod of 16:8 hours. Parameters such as bud burst time (days), shoot emergence time (days), bud burst rate (%), shoot emergence rate (%), and leaf number (per plantlet) were examined in the study. The results showed that the bud burst time was highest in the T2 treatment at 24.33 days, shoot emergence time was highest in the T2 treatment at 22.33 days, bud burst rate was highest in the T1 treatment at 33.33%, shoot emergence rate was highest in the T2 treatment at 16.66%, and leaf number was highest in the T1 treatment at 7.00. Rooting did not occur in the plantlets in this study.

Keywords: Rootstock, *in vitro*, micropropagation, regeneration, UCB-1

Introduction

Rootstock selection, indispensable for fruit cultivation, has become one of the significantly followed topics of research and development worldwide and in our country. The selection and use of rootstocks in fruit cultivation are extremely important. In recent years, there has been an increasing interest in clonal rootstocks with superior characteristics. The main desired features in clonal rootstocks include ease of propagation, uniform growth, possession of a vigorous root system, absence of graft incompatibility, resistance to various diseases and pests, good tolerance to abiotic stress conditions, reduction of the juvenile period of the grafted variety, positive effects on fruit yield and quality, and alternate bearing (Ak and Korkmaz, 2019).

The use of rootstocks obtained through vegetative propagation methods is rapidly increasing in world fruit cultivation. Research continues on the propagation of pistachio rootstocks through tissue culture, one of the vegetative propagation methods. *Pistacia* species are generally heterozygous and display segregation when propagated by seeds. Pistachio rootstocks propagated by seeds cause a decrease in yield and irregularities in newly established and old orchards. Additionally, the grafting success rates of rootstock-scion combinations are also low. It is known that the bud break rate of *Pistacia* species seeds is very low, which is a significant problem, especially for plantation producers (Beede, 2017; Jacygrad et al., 2020).

For this purpose, the micropropagation method under *in vitro* conditions offers a significant advantage for the production of *Pistacia* species. The micropropagation method facilitates the production of disease-free plant material, a high multiplication rate, ease in healthy plant production, and the ability to produce irrespective of the vegetative period (Iliev et al., 2010).

In recent years, with the introduction of vegetatively propagated rootstocks, producers tendencies to use these rootstocks have increased. This will lead to uniformity in pistachio orchards in the near future. Moreover, these clonal rootstocks possess positive characteristics such as tolerance to biotic and abiotic stresses, which increase interest in their production and vegetative propagation (Aghasi Kermani et al., 2017).

UCB-1 (*P. atlantica* x P. *integerrima*), a hybrid rootstock widely used and clonally propagated among *Pistacia* rootstocks, is obtained through interspecific hybridization breeding. It has become a preferred rootstock in the establishment of pistachio orchards

in recent years. It is a strong rootstock that provides high yields in gardens where irrigation is available. It has high tolerance to salinity and cold (Jacygrad et al., 2020; Raoufi et al., 2020).

This study aims to investigate the possibilities of micropropagation under *in vitro* conditions, a vegetative propagation method for UCB-1 rootstock, a hybrid of *Pistacia atlantica* and *Pistacia integerrima*. The performance of UCB-1 rootstock under *in vitro* conditions will be determined with different applications during the shoot formation and rooting stages.

Materials And Methods

The study was conducted in the Plant Tissue Culture Laboratory of the Department of Horticulture at Harran University Faculty of Agriculture. Micro cuttings with a single bud were used as the explant source in the study. Micro cuttings belonging to the UCB-1 rootstock were taken from the *Pistacia* rootstock plot of the Department of Horticulture at Harran University Faculty of Agriculture during the active growth period in spring. The micro cuttings were first subjected to a pre-sterilization process in the laboratory. In the pre-sterilization process, the micro cuttings were first soaked in soapy water for 10 minutes. After being removed from the soapy water, the micro cuttings were rinsed with tap water until clean. Then, the micro cuttings were placed into a vertical airflow sterile cabinet. Inside the sterile cabinet, the micro cuttings were soaked in 70% ethanol for 3 minutes and then shaken in a 15% sodium hypochlorite solution for 10 minutes, followed by rinsing with sterile distilled water three times, each for 5 minutes (Ekinci et al., 2023). After the sterilization process was completed, the micro cuttings were transferred to jars containing MS (Murashige and Skoog 1962) nutrient medium solidified with 3.0% sucrose, 0, 1.0, and 2.0 mg L^{-1} BAP, and 0.7% agar (Table 1). To prevent bacterial contamination in the nutrient media, 1.0 ml L^{-1} PPM (Plant Preservative Mixture) was added (Kara et al., 2022). The plantlets were then transferred to rooting media containing 0, 1.0, and 2.0 mg L-1 IBA. The plantlets in the rooting medium were placed in a growth cabinet at a temperature of 24-25 °C with 55-60% relative humidity and under a 16:8 hour photoperiod (Şaşkın et al., 2022). The plantlets were kept in the growth cabinet for 60 days.

Measurements And Statistical Analysis

The study was concluded after 60 days. At the end of the application, parameters such as bud break rate, duration of bud break, shooting rate (%), duration of shooting, number of leaves (per plantlet), rooting rate (%), duration of rooting, root length (cm), and number of roots (per plantlet) were examined. The data obtained at the end of the applications made in the study were analyzed in a randomized block design using one-way analysis of variance in JMP Pro 13 statistical software and compared with the LSD test at a significance level of $p \leq 0.05$ (Gomez and Gomez, 1984).

Table 1. BAP and IBA concentrations in nutrient media

Treatments/Culture Medium	Shoot Medium	Rooting Medium
Control	0 mg L^{-1} BAP	0 mg L^{-1} IBA
T1	1 mg L^{-1} BAP	1 mg L^{-1} IBA
T2	2 mg L^{-1} BAP	2 mg L^{-1} IBA

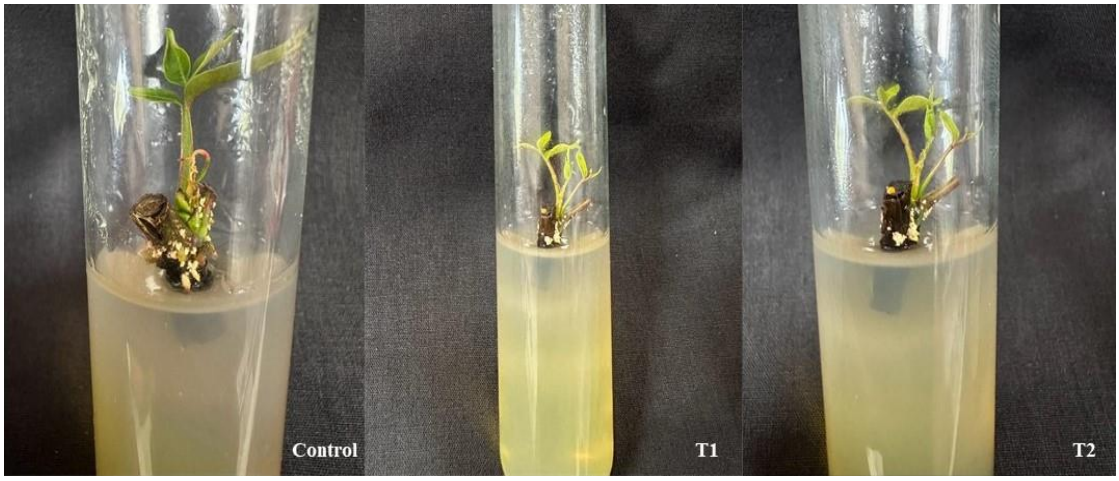


Figure 1. Development of micro cuttings from UCB-1 rootstock in MS nutrient media containing different BAP concentrations

Results and Discussion

Pistacia species are recalcitrant and have low micropropagation success under *in vitro* conditions. The leakage of phenolic substances found in their structure into the nutrient medium causes darkening of the medium and complicates shoot regeneration (Çetin et al., 2021). The success of micropropagation is influenced by genotype, nutrient media, and plant growth regulators. Cytokinins play an active role in plant development, cell

division, cell expansion, and some enzyme activities. Cytokinins have a significant effect on shoot regeneration under *in vitro* conditions. Cytokinins naturally occur in the endogenous structures of plants. However, the explants used under *in vitro* conditions are inadequate in synthesizing sufficient cytokinins. Therefore, *in vitro*, cytokinins are added to the nutrient medium to facilitate cell division and regeneration (Arab et al., 2014; Reddy et al., 2014). This study was conducted to achieve shoot regeneration of UCB-1 rootstock under *in vitro* conditions. In the study, 6-benzylaminopurine (BAP), which is commonly used and has been shown to yield successful results in regeneration protocols under *in vitro* conditions, was used. According to the results obtained, the effects of the cytokinin doses applied in the study on the duration of bud break were not statistically significant. However, the earliest duration of bud break occurred in 5 days with the T1 application, and the latest bud break was detected in 7.83 days with the T2 application (Figure 2). In the study, the fastest bud break for the UCB-1 rootstock was provided by the dose of 1 mg L^{-1} BAP. The study on BAP concentrations supporting the earliest duration of bud break in black grape with fragrant occurring in nutrient media containing 1 mg L^{-1} BAP supports our study (Ekbiç and Yılmaz, 2018). Similarly, another study showing positive results in the micropropagation of the GF-677 rootstock with a dose of 1 mg L^{-1} BAP parallels our findings (Aghaye and Yadollahi, 2012).

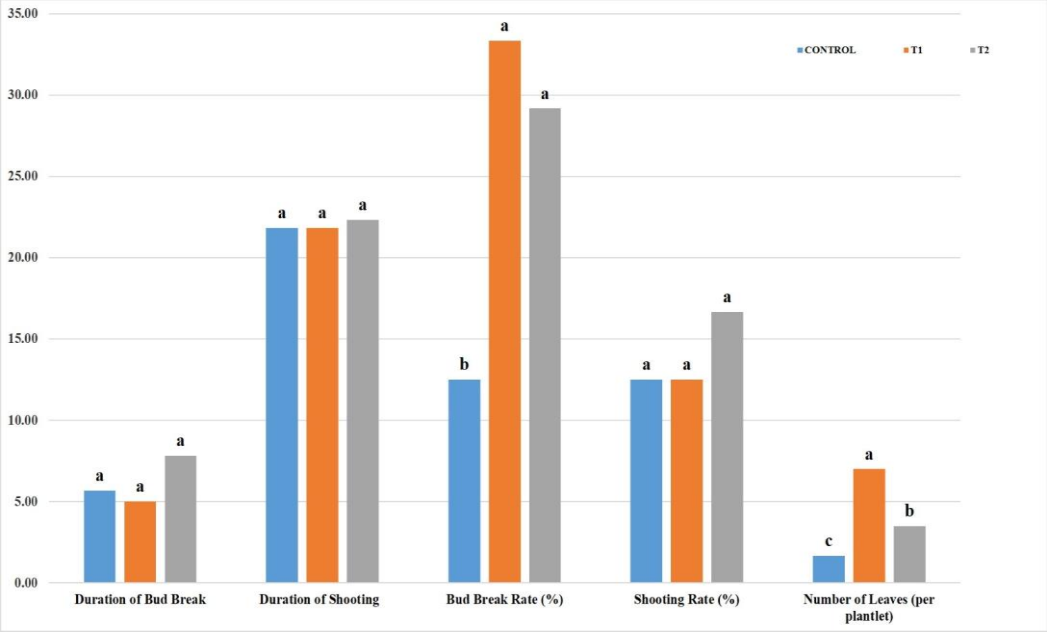


Figure 2. The effect of different BAP concentrations on the duration of bud break (days), duration of shooting (days), bud break rate (%), shooting rate (%) and number of leaves (per plantlet) of micro cuttings from UCB-1 rootstock (LSD, $p \leq 0.05$)

In the study, the duration of shooting showed similarity to the duration of bud break, and no significant difference was found among the applications. However, it was determined that the earliest duration of shooting was 21.83 days with the control and T1 treatments, while the latest shoot time was 22.33 days with the T2 treatment (Figure 2). When the bud break rate was examined, a statistically significant difference was found. The highest bud break rate was 33.33% with the T1 treatment, while the lowest was 12.50% with the control treatment. Cytokinins play an active role in shoot regeneration under *in vitro* conditions by facilitating cell division. The dose and type of cytokinin can vary depending on the species to be regenerated (Nowak and Miczyński, 2002). In our study, a dose of 1 mg L^{-1} BAP was effective (Figure 2). The study on shoot regeneration under *in vitro* conditions in apricots, where a 1 mg L^{-1} BAP dose was effective in shoot regeneration, supports our findings (Šiško et al., 2022). When the shoot rate was examined, no statistically significant difference was found among the applications. However, the highest shoot rate was 16.67% with the T2 treatment, while the lowest shooting rate was 12.50% with the Control and T1 treatments. In the study, a dose of 2 mg L^{-1} BAP was effective for the shooting rate. When the effects of different cytokinins on the shooting rate in Gisela 5 cherry rootstock were examined, BAP hormone was reported to be the most effective (Bošnjak et al., 2012). Another study showing the highest shoot occurrence in the GF-677 rootstock with a 2 mg L^{-1} BAP dose parallels our findings (Hasan et al., 2010). When the effects of cytokinin doses applied in the study on the number of leaves were examined, a statistically significant difference was found among the treatments. The highest number of leaves was 7.00 per plantlet with the T1 treatment, while the lowest was 1.66 per plantlet with the Control treatment. In our study, the parameter of number of leaves was positively affected by a dose of 1 mg L^{-1} BAP. The study supporting the highest number of leaves in plantlets developed in nutrient media containing 1 mg L^{-1} BAP in the micropropagation of plum rootstock corroborates our findings (Gökdere, 2019). Similar studies using the BAP hormone have reported that a dose of 1 mg L^{-1} BAP increases the number of leaves (Yılmaz and Bürün, 2014; Máximo et al., 2018).

Conclusions

In the study, the shoot medium containing BAP hormone yielded positive results. It was determined that the dose of 1 mg L^{-1} BAP provided the best results in terms of duration of bud break, duration of shooting, bud break rate, and number of leaves parameters,

while the dose of 2 mg L^{-1} BAP gave the best result in the shooting rate parameter. However, in the study, rooting did not occur in the plantlets transferred to the rooting medium. Clonal propagation of *Pistacia*, a recalcitrant species, is important, but rooting results are still not sufficient. Different auxin hormones and concentrations should be tried.

Acknowledgements

This study was supported by the TÜBİTAK 2209-A University Students Research Projects Support Program and University of Harran, Scientific Research Project Unit. Project number is HUBAP-22289.

References

Ak, B. E. & Korkmaz, S. (2019). The usage and importance of dwarf rootstocks in modern fruit growing. *Proceedings Book of 1st International Gobeklitepe Agriculture Congress*, (ISBN 978-975-7113-71-3), p.671-676.

Aghasi Kermani, S., Hokmabadi, H. & Ghanbari Jahromi, M. (2017). The evaluation of the effect of Multiwall Carbon Nano Tube (MWCNT) on *in vitro* proliferation and shoot tip necrosis of pistachio rootstock UCB-1 (*P. integerrima*× *P. atlantica*). *Journal of Nuts*, 8 (01), p. 49-59.

Aghaye, R. N. M. & Yadollahi, A. (2012). Micropropagation of GF 677 rootstock. *Journal of Agricultural Science*, 4(5), p.131.

Arab, M.M., Yadollahi, A., Shojaeiyan, A., Shokri, S. & Ghojah, S. M. (2014). Effects of nutrient media, different cytokinin types and their concentrations on *in vitro* multiplication of G×N15 (hybrid of almond×peach) vegetative rootstock. *Journal of genetic engineering and biotechnology*, 12(2), p.81-87.

Beede, R.H. (2017). Pistachio canopy management and its effect on yield components. 8th Advanced in Pistachio Production, University of California, Davis.

Benmahioul, B., Kaïd-Harche, M. & Daguin, F. (2016). *In vitro* regeneration of *Pistacia vera* L. from nodal explants. *Journal of Forest Science*, 62 (5), p.198-203.

Bošnjak, A. M., Kereša, S., Jerčić, I. H. & Barić, M. (2012). The effect of cytokinin type and explant orientation on axillary shoot proliferation and *in vitro* rooting of 'Gisela 5'cherry rootstock. *Journal of Food, Agriculture & Environment*, 10(3-4), p.616-620.

Çetin, N., Güler, B. & Gürel, A. (2021). *In vitro* regeneration potential of thin cell layer explants of Lentisk (Pistacia lentiscus var. Chia) Plant. *Bilecik Şeyh Edebali Üniversitesi Fen Bilimleri Dergisi*, *8*(2), p.960-977.

Ekbiç, H.B. & Yılmaz, G. (2018). Kokulu kara üzümün (*Vitis labrusca* L.) mikro çelik kültürü ile mikro çoğaltımı. *Yüzüncü Yıl University Journal of Agricultural Sciences*, 28(1), p.86-91.

Ekinci, H., Ak, B.E. & Saskin, N. (2023). Screening of some chemical disinfectants for explant sterilization during *in vitro* micropropagation of UCB-1 (*P. atlantica* x *P. integerrima*). *V. Balkan Agrıcultural Congress*, p.159.

Gomez, K.A. & Gomez, A.A. (1984). Statistical procedures for agricultural research. John wiley & sons, p.680

Gökdere, S. (2019). *In vitro* sürgün ucu yöntemiyle erik (*Prunus domestica* L.) anacının klonal çoğaltımı (Master's thesis, Fen Bilimleri Enstitüsü).

Hasan, S. Z. U., Ahmad, T., Hafiz, I. A., & Hussain, A. (2010). Direct plant regeneration from leaves of Prunus rootstock GF677 (*P. amygdalus*× P. persica). *Pakistan Journal of Botany*, 42 (6), p.3817-3830.

Jacygrad, E., Preece, J. E., Palmer, W. J., Michelmore, R. & Golino, D. (2020). Phenotypic segregation of seedling UCB-1 hybrid pistachio rootstock. *Trees*, 34, p.531-541.

Máximo, W.P.F., Santos, P.A.A., Martins, G.S., Mendonça, E.G. & Paiva, L.V. (2018). *In vitro* multiplication of Eucalyptus hybrid via temporary immersion bioreactor: culture media and cytokinin effects. *Crop Breeding and Applied Biotechnology*, 18, p.131-138.

Murashige, T. & Skoog, F. (1962). A revised medium for rapid growth and bioassays with tobacco tissue cultures. *Physiologia plantarum*, 15(3), p.473-497.

Nowak, B. & Miczyński, K. (2002). The Course and Efficiency of organogenesis on leaf explants of plum: 'Wegierka Zwykla' (*Prunus domestica* L.) induced by cytokinins. *Biotechnology*, 5(1).

Raoufi, A., Rahemi, M., Salehi, H. & Pessarakli, M. (2020). *Pistacia* vera L. genotypes; a potential rival for UCB-1 rootstock for cultivating under salt stress conditions. *Biocatalysis and Agricultural Biotechnology*, 25, p.101515.

Reddy, D.R.D., Suvarna, D. & Rao, D.M. (2014). Effects of 6-benzyl amino purine (6-BAP) on *in vitro* shoot multiplication of Grand Naine (*Musa* sp.). International Journal of Advanced Biotechnology and Research, 5(1), p.36-42.

Šiško, M., Ternjak, T. & Grobelnik-Mlakar, S. (2022). The effects of different cytokinin types and their concentration on *in vitro* growth of Apricot (*Prunus armeniaca* L.) shoots. *Agricultura Scientia,* 19(1), p.1-6.

Saskin, N., Ak, B.E. & Ekinci, H. (2022). The usage of node culture *in vitro* conditions**.** 5th. *International Agriculture Congress Proceeding Book. 5-6 December 2022*, ISBN: 978-605-80128-8-2, Turkiye, p.90-98.

Yılmaz, E. & Bürün, B. (2014). *In vitro* koşullarda domates (*Lycopersicon esculentum* Mill.) bitkisinde hipokotil ve kotiledon eksplantlarından kallus ve sürgün oluşumu. *Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, 18(3), p.104-113.

Kara, Z., Yazar, K., Ekinci, H., Doğan, O. & Özer, A. (2022). The effects of ortho silicone applications on the acclimatization process of grapevine rootstocks. *Selcuk Journal of Agriculture and Food Sciences,* 36(2), p.233-237.

Iliev, I., Gajdošová, A., Libiaková, G. & Jain, S.M. (2010). Plant micropropagation. *Plant cell culture: essential methods,* 1, p.1-23.

TİCARİ OLARAK MEVCUT BAZI ANTİSEPTİK/DEZENFEKTANLARIN ÖNEMLİ GIDA PATOJENLERİNE KARŞI ANTİMİKROBİYAL AKTİVİTELERİNİN BELİRLENMESİ

Derya ÖMEROSMANOĞLU (ORCID: 0000-0002-8243-1589)
Yildiz Technical University, Institute of Science and Technology, Department of Food Engineering, PhD Program in Food Engineering Student Istanbul-Türkiye
Email: deryaomerosmanoglu@gmail.com

Asist. Prof. Dr. Bülent HALLAÇ (ORCID: 0000-0002-6948-1565)
Siirt University, Faculty of Engineering, Department of Food Engineering, Siirt-Türkiye
Email: bulenthallac@siirt.edu.tr

ÖZET

Antiseptik ve dezenfektanların, gıda endüstrisinde kullanım amaçlarının başında özellikle patojen mikroorganizmalarla kontaminasyonun önlenmesi ve kontrol altına alınması gelmektedir. *Covid-19* pandemisi sürecinde kullanılan antiseptik ve dezenfektanların çeşitli mikroorganizmalara karşı antimikrobiyal özelliklerinin belirlenmesi amacıyla yapılan bu çalışmada; *E. coli* ATTC 25922, *S. aureus* ATTC 29213, *B. cereus* ATTC 10876, *C. albicans* ATTC 10231 ve *S. cerevisiae* ATTC 9763 suşları test edilmiş ve bu kimyasalların bazı fizikokimyasal özellikleri belirlenmiştir. Yapılan çalışmada numunelerin türüne bağlı olarak mikroorganizmalara karşı farklı seviyelerde etkili olmalarına rağmen bir kısmı etkisiz kalmıştır. Başka bir deyişle bu dezenfektanların 8'nin *S. aureus* ile *B. cereus*'a, 9'nun *E. coli*'ye, 12'sinin *C. albicans* ve 11'nin de *S. cerevisiae*'ye karşı "etkisiz" olduğu belirlenirken, 7'sinin *E. coli*'ye, 5'nin *S. aureus* ile *B. cereus*'a, 3'ünün *C. albicans*, 2'sinin de *S. cerevisiae*'ye karşı "düşük etkili", 2'sinin *S. aureus*'a, 1'nin *E. coli*'ye, 5'nin *B. cereus*'a, 3'ünün *C. albicans* ve 4'ünün de *S. cerevisiae*'ye karşı "etkili", 9'unun *S. aureus*'a, 7'sinin *E. coli* ile *S. cerevisiae*'ye karşı, 6'sının *B. cereus* ile *C. albicans*'a karşı "aşırı etkili" olduğu belirlenmiştir. Fizikokimyasal özellikleri yönünden bazı dezenfektanların belirtilen alkol miktarlarında olmadığı, incelenen 11 alkol bazlı dezenfektan örneğinin 4'ünde alkole rastlanılamamıştır. Kurumadde değerleri yönünden numunelerin 15'i 0.8-7.4, 1'i 7.4-14, 4'ü 14-20.6, 3'ü 20.6-27.2 ve 1'i ise 27.2-32.8/100ml olarak belirlenmiştir. Asidik bazik özellikleri yönünden 11'inin yüksek asitli, 1'inin kuvvetli bazik nitelikte olduğu saptanmıştır. Sonuçta bu çalışma ile özellikle pandemi boyunca kullanılan bu dezenfektanların bir kısmının standartlara uymadığı, hijyen amaçlı kullanılması durumunda hastalıklara karşı koruma sağlamadığı, hastalıkları yayabileceği, böylelikle kullanımlarının potansiyel tehlike oluşturabileceği sonucuna varılmıştır. Ayrıca yetkili otoriteler tarafından antiseptik/dezenfektanların standartlara uygun üretiminin yapılması sağlanmalı ve teşvik edilmelidir.

Anahtar Kelimeler: antimikrobiyal etki, *Covid-19*, dezenfektan/antiseptik, gıda hijyeni/güvenliği, patojen.

DETERMINATION OF THE ANTIMICROBIAL ACTIVITY OF SOME COMMERCIALLY AVAILABLE ANTISEPTICS/DISINFECTANTS AGAINST IMPORTANT FOOD PATHOGENS

ABSTRACT

The main purpose of antiseptics and disinfectants in the food industry is to prevent and control contamination with pathogenic microorganisms. In this study conducted to determine the antimicrobial properties of antiseptics and disinfectants used during the *Covid-19* pandemic against various microorganisms; *E. coli* ATTC 25922, *S. aureus* ATTC 29213, *B. cereus* ATTC 10876, *C. albicans* ATTC 10231 and *S. cerevisiae* ATTC 9763 strains were tested and some physicochemical properties of these chemicals were determined. In the study, although they were effective against microorganisms at different levels depending on the type of samples, some of them were ineffective. In other words, 8 of these disinfectants were "ineffective" against *S. aureus* and *B. cereus*, 9 against *E. coli*, 12 against *C. albicans* and 11 against *S. cerevisiae*, while 7 were "low effective" against *E. coli*, 5 against *S. aureus* and *B. cereus*, 3 against *C. albicans* and 2 against *S. cerevisiae*, 2 were "effective" against *S. aureus*, 1 against *E. coli*, 5 against *B. cereus*, 3 against *C. albicans* and 4 against *S. cerevisiae*, 9 against *S. aureus*, 7 against *E. coli* and *S. cerevisiae*, 6 against *B. cereus* and *C. albicans*. In terms of physicochemical properties, some disinfectants were not at the specified alcohol amounts, and alcohol was not found in 4 of the 11 alcohol-based disinfectant samples examined. In terms of dry matter values, 15 of the samples were determined as 0.8-7.4, 1 as 7.4-14, 4 as 14-20.6, 3 as 20.6-27.2 and 1 as 27.2-32.8/100ml. In terms of acidic-basic properties, 11 were highly acidic and 1 was strongly basic. As a result, it was concluded that some of these disinfectants used during the pandemic did not comply with the standards, did not provide protection against diseases if used for hygiene purposes, could spread diseases, and thus their use could pose a potential danger. In addition, the production of antiseptics/disinfectants in accordance with the standards should be ensured and encouraged by the competent authorities.

Keywords: antimicrobial effect, *Covid-19*, disinfectant/antiseptic, food hygiene/safety, pathogen.

Giriş

Dezenfektan; dezenfeksiyon işleminde kullanılan kimyasal maddelerdir. Teknik olarak tarif edildiğinde 5 dakika üzerinde ancak 10 dakikadan daha az bir süre içinde, çoğunlukla cansız yüzey ve yüzey alanlarında bulunan patojen mikroorganizma sayısını %99.999 oranında düşüren kimyasal maddelerdir (Gürler, 2003). Antiseptik; mikroorganizmaların üremesini durduran, yüksek konsantrasyonda olduğunda ve 30 dk'dan daha kısa süre temas ettiğinde mikroorganizmaları öldüren ve canlı dokulara uygulanabilen kimyasal maddeler antiseptik maddelerdir (Ronald, 1997; Reddish, 1957). Antiseptik ve dezenfektanlar, mikroorganizmaların öldürülmesini sağlamak, gelişmesini durdurmak, kontrol etmek ve hastalıkların yayılmasını engellemek için yaygın olarak kullanılan kimyasal maddelerdir. Bu maddeler, sağlık hizmetlerinden gıda işleme tesislerine ve ev ortamlarına kadar birçok alanda hijyenin sağlanmasında önemli bir rol oynamaktadır. Gıda endüstrisinde kullanım amaçlarının başında ise patojen mikroorganizmalarla kontaminasyonun önlenmesi ve kontrol altına alınması gelmektedir. Özellikle, antimikrobiyal etkinlikleri sayesinde, antiseptik ve dezenfektanlar çeşitli mikroorganizmaların yok edilmesi veya kontrol altına alınması için kullanılmaktadır.

Son dönemde yaşanmış olan *Covid 19* salgını ile ülkemizde ve dünya genelinde dezenfektan ve antiseptik maddelerin yoğun bir şekilde kullanımı dikkat çekmiştir. Bu sebeple yapılan bu çalışmada önemli gıda patojenleri ile bozulma yapan mikroorganizmalara karşı piyasada yaygın olarak bulunan bazı antiseptik ve dezenfektan ürünlerinin etkinliği araştırılması amaçlanmıştır.

Materyal-Metot

Materyal

Çalışma kapsamında, 2023 yılı Mayıs-Haziran aylarında, hastanede ve ticari olarak piyasada satışa sunulan orjinal ambalajlarında toplamda 24 adet antiseptik ve dezenfektan örnekleri materyal olarak kullanılmıştır. Bu örneklerin antimikrobiyal özelliklerinin belirlenmesinde kullanılan *S. aureus* ATTC 29213, *E. coli* ATTC 25922, *B. cereus* ATTC 10876, *C. albicans* ATTC 10231 ve *S. cerevisiae* ATTC 9763 suşları Siirt Üniversitesi Gıda mühendisliği mikrobiyoloji laboratuvarı koleksiyonundan temin edilmiştir.

Metot

Antimikrobiyal Özelliklerin Belirlenmesi

Bu kapsamda Temiz (2010) tarafından önerilen disk-kuyu agar difüzyon yöntemi kullanıldı. Bu amaçla kullanılan bakteri suşları Tryptic Soy Brothta, funguslar ise Subroud Dexrose broth besiyerinde 37°C 18-24 saat boyunca aktif hale getirildikten sonra konsantrasyonları 0.5 McFarland standardına göre ayarlanmıştır. Bakteriler için Mueller Hinton Agar besiyeri, mantar içinde Subroud Dexrose Agar besiyerine her bir mikroorganizma ayrı ayrı steril eküvyon çubuklar yardımıyla aseptik koşullarda alınarak ekimleri yapılmıştır. Mikroorganizma solüsyonlarının besiyerine iyice emilmesi sağlandıktan sonra 0.6 cm çapında metal delici ile her bir kuyucuk arasında en az 2 cm mesafe olacak şekilde kuyucuklar açılmıştır. Sonra bu kuyucuklara her bir örnekten 30 µL aktarıldı ve solüsyonların besiyerinde emilmesi sağlandı. Bu işlemlerden sonra petri kapları ters çevrilerek 37°C 18-24 saat boyunca inkübasyona bırakıldı. İnkübasyon sonunda oluşan şeffaf zone çapları dijital kumpas aracılığıyla, düzensiz şekillerde 3 farklı noktadan düzgün yüzeylilerde ise tek ölçüm yapılarak değerlendirildi. Oluşan inhibisyon zone çaplarının <8mm olması durumunda "etkisiz", 9-14mm olması durumunda "düşük etkili", 15-19 mm olması durumunda "etkili" ve ≥20 mm olması durumunda ise "aşırı etkili" olarak antimikrobiyal şiddeti yorumlandı (Ponce ve ark., 2003).

Fizikokimyasal Analizler

Alkol miktarının belirlenmesi: Alkol bazlı dezenfektanların alkol miktarını belirlemek için, cam mezur içerisine doldurulan her bir örneğe tekniğine uygun şekilde alkolmetre daldırılarak okuma yapılmıştır.

pH ve O/R değerinin belirlenmesi: Ekstraktın pH ile O/R değeri (Mettler Toledo, S220 Seven CompactTM) pH-metrede (Cemeroğlu, 2013) tarafından önerilen metoda göre yapılmıştır.

Kurumadde değerinin belirlenmesi: Kurumadde tayininde ise (Cemeroğlu, 2013)'nun belirttiği metoda göre (Hanna® HI 96801, Romania) cihazında ölçülmüştür.

İstatistiksel Analiz

Çalışma üç tekerrür ve üç paralel olarak yürütülmüştür. Disklerin etrafında meydana gelen düzgün zonlarda tek noktadan, düzgün oluşmamış zonlarda ise 3 farklı noktadan ölçüm gerçekleştirilmiştir. Çalışmada elde edilen bulguların analizi için SPSS 22.0 istatistik paket programı (SPSS, 2013) kullanılmıştır. Ölçümlerin ortalaması alınarak

varyans analizine tabii tutulmuş, önemlilik çıktığında Duncan çoklu karşılaştırma testi uygulanmıştır ($p<0.05$).

Bulgular ve Tartışma

Piyasada satışa sunulan dezenfektan ve antiseptiklerin antimikrobiyal özellikleri üzerine yapılan bu çalışmada mikroorganizmalara karşı dezenfektan ve antiseptiklerin etkinliği Tablo 1'de sunulmuştur.

Tablo 1. Antimikrobiyal Etkide Antiseptik/Dezenfektanların Oluşturduğu Zone Çapları (mm)

Antimikrobiyal Etkide Antiseptik/Dezenfektanların Oluşturduğu Zone Çapları (mm)					
Örnek No	***S. aureus***	***E. coli***	***B. cereus***	***C. albicans***	***S. cerevisiae***
1	30,67	29,33	27,67	38,00	36,67
2	23,67	31,00	27,67	22,33	19,33
3	32,00	20,67	25,33	20,33	22,67
4	34,67	22,33	17,67	0,00	27,67
5	19,67	8,33	10,00	8,67	9,67
6	20,67	27,67	26,67	21,33	19,67
7	0,00	0,00	10,67	19,67	0,00
8	0,00	0,00	0,00	0,00	0,00
9	22,33	22,67	19,33	10,67	22,33
10	23,67	19,33	26,67	44,33	37,33
11	42,33	45,33	44,67	35,67	44,33
12	15,33	12,67	16,67	0,00	26,33
13	0,00	9,33	0,00	0,00	0,00
14	0,00	7,33	0,00	0,00	0,00
15	0,00	0,00	0,00	0,00	0,00
16	0,00	0,00	0,00	0,00	0,00
17	10,33	0,00	9,67	19,67	0,00
18	0,00	0,00	10,33	18,33	0,00
19	15,33	12,67	20,00	11,33	8,33
20	11,67	10,67	8,33	0,00	0,00
21	8,67	8,67	0,00	0,00	10,67
22	0,00	0,00	0,00	0,00	0,00
23	12,67	12,33	17,00	0,00	18,33
24	8,67	9,00	9,67	0,00	16,33

Tablo 1'de mikroorganizmalara karşı antiseptik ve dezenfektanların etkinliği antiseptik/dezenfektan türüne, mikroorganizma türüne, alkol, kurumadde, pH, O/R'lerine

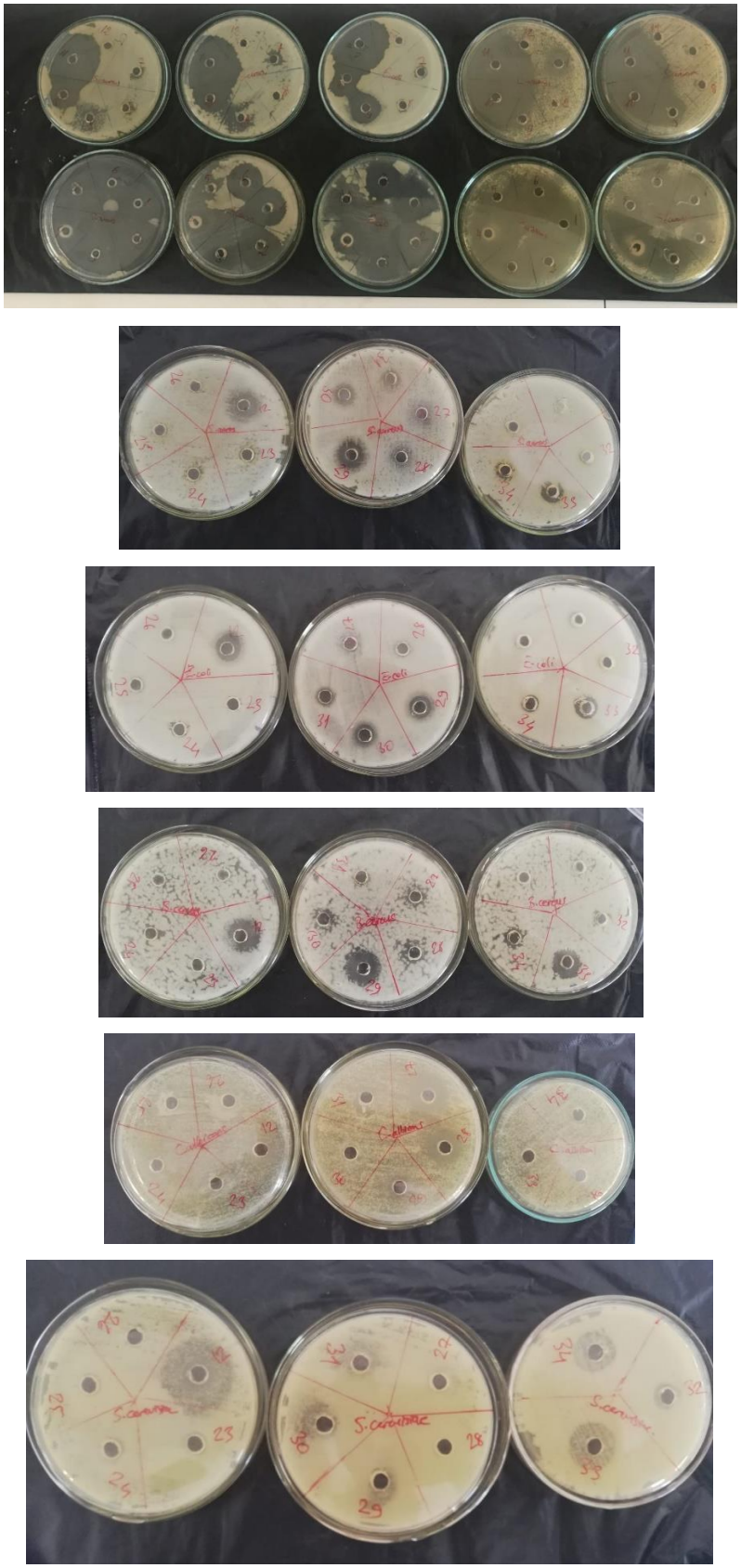
göre önemli bir farklılık ($p<0.01$) belirlenmiştir. Dezenfektanların, çalışmada kullanılan mikroorganizmalara karşı farklı seviyelerde etkili olduğu belirlenmiştir. Çalışmada, alkol dışında incelenen parametreler yönünden $p<0.01$ seviyesinde anlamlı farklılık belirlenmiştir.

Tablo 2. Dezenfektan/Antiseptiklerin Mikroorganizmalara Karşı Antimikrobiyal Şiddeti (mm) ve Sıklığı

Mikroorganizmalar	Antiseptik ve Dezenfektanların Etki Şiddeti (mm) ve Sıklığı			
	<8 (etkisiz=-)	9-14 (düşük etkili=+)	15-19 (etkili=++)	20> (aşırı etkili=+++)
S. aureus	8	5	2	9
E. coli	9	7	1	7
B. cereus	8	5	5	6
C. albicans	12	3	3	6
S. cerevisiae	11	2	4	7

Etki şiddeti değerlendirmesinde oluşan şeffaf zonların etki şiddeti Ponce ve ark. (2003) tarafından yapılan çalışmaya göre yapılmıştır.

Tablo 1 ve Tablo 2'de görüleceği üzere 5 adet antiseptik/dezenfektanların etkinliğinin test edilen mikroorganizmalara karşı hiçbir etkisi olmadığı görülmüştür. Bu 5 adet antiseptik/dezenfektan özelliğinde olmadığını düşündürmektedir. Ayrıca Tablo 2 incelendiğinde test edilen antiseptik ve dezenfektan etkinliği noktasında *S. aureus* için 8'inin etkisiz (-), 5'inin düşük etkili (+), 2'sinin etkili (++) ve 9'unun ise aşırı etkili (+++) olduğu görülmüştür. *E. coli* için 9'unun etkisiz (-), 7'sinin düşük etkili (+), 1'inin etkili (++) ve 7'sinin aşırı etkili (+++) olduğu görülmüştür. *B. cereus* için 8'inin etkisiz (-), 5'inin düşük etkili (+), 5'inin etkili (++) ve 6'sının aşırı etkili (+++) olduğu görülmüştür. *C. albicans* için 12'sinin etkisiz (-), 3'ünün düşük etkili (+), 3'ünün etkili (++) ve 6'sının ise aşırı etkili (+++) olduğu görülmüştür. *S. cerevisiae* için 11'inin etkisiz (-), 2'sinin düşük etkili (+), 4'ünün etkili (++) ve 7' sinin ise aşırı etkili (+++) olduğu görülmüştür (Şekil 1).



Şekil 1. Test edilen mikroorganizmalara karşı antiseptik/ dezenfektanların antimikrobiyal etki görüntüleri

Dezenfektanların tüm mikroorganizmalar üzerine dezenfektanlardan antiseptiklere doğru ($p<0.01$ seviyesinde) gidildikçe etkinin düştüğü görülmüştür.

Tablo 3. Dezenfektan/antiseptiklerin fizikokimyasal özellikleri

Parametreler	Min.	Max.	Ortalama ± Standart Sapma
Alkol (%)	0	75	18,375 ± 31,950
Kurumadde (Briks)	0,8	33,6	8,986 ± 9,735
pH	0,31	14,34	5,495 ± 3,815
O/R (mV)	-364,00	382,40	105,933 ± 202,698

Alkol hacmi olarak, sadece bir örnekte %1 olarak, 6 örnekte ise %60-75 aralığında alkole rastlanırken, geri kalan numunelerde alkole rastlanmamıştır. Kurumadde (%) yönünden, 15 örneğin %0.8-7.4, 1 örneğin %7.4-14, 4 örneğin %14-20.6, 3 örneğin 20.6-27.2 ve bir örneğin ise %27.2-32.8 kurumadde aralığında olduğu tespit edilmiştir. pH yönünden, 11 örneğin 0.31-3.12 pH aralığında, 2 örneğin 3.12-5.93, 5 örneğin 5,93-8,74, 5 örneğin 8,74-11.55 ve 1 örneğin de 11.55-14.36 aralığında olduğu saptanmıştır. O/R çoğunlukla 11 örnek 233.2-382.5 mV aralığında olduğu -364-(-214.7) ile 83.9-233.2 mV arasında olduğu tespit edilmiştir.

Alkol seviyesinin sadece *C. albicans* üzerinde önemli etkisinin olmadığı ancak alkol miktarının düşüşüyle dezenfektanların diğer mikroorganizmalara etki şiddetinin önemli korelasyon ($p<0.01$) gösterdiği tespit edilmiştir. Bu durumda mikroorganizmalara daha etkili olabilecek kimyasalların kullanılabileceğini düşündürmektedir. Kurumaddenin mikroorganizmalar üzerine önemli ilişkisi olmamakla birlikte, alkol miktarıyla ve antiseptik/dezenfektan türleriyle artan bir ilişki ($p<0.01$) sergilediği, pH değerinin düşmesiyle sadece *E. coli* üzerine $p<0.05$ seviyesinde anlamlı ilişkisi söz konusuyken diğer mikroorganizmalara karşı önemli bir ilişkisi saptanamamıştır. pH'nin antiseptik/dezenfektanlarda ve kurumadde seviyesindeki artışla ($p<0.01$) ve alkol miktarıyla ($p<0.05$) seviyesinde paralellik gösterdiği tespit edilmiştir. O/R değerinin *E. coli*'ye karşı paralellik ($p<0.05$), alkol miktarıyla ters orantı olduğu, antiseptik/dezenfektanlarla pH ve kurumadde azalmasıyla ($p<0.01$) ilişkili olduğu belirlenmiştir. Bilindiği üzere küflerin 1.2-11, mayaların 1.0-8.5 ve bakterilerin 4.5-9.0 pH aralığında gelişimleri söz konusudur (Temiz, 2015).

Temizlik ve dezenfeksiyon, toplum sağlığı ve üretim teknolojisi açısından kaçınılmaz bir uygulamadır. Ancak bu uygulamaların eksiksiz ve kurallarına uygun olarak yapılması gerekmektedir. Literatürde bazı çalışmalarda kullanılmış olan dezenfektan ve antiseptiklerde prosese ve sektöre göre uygun olarak kullanılan ürünlerde mikroorganizma yükünün ciddi oranlarda düşüş gözlemlendiği ancak genel amaçlı uygulamada kullanılan dezenfektan ve antiseptiklerde mikroorganizma suşlarına ve dezenfektan/antiseptik türüne bağlı olarak ortaya çıkan farklılık veya benzerliklerin çalışmamızla uyumlu olduğu tespit edilmiştir (Çelik, 2015; Saraç, 2009; Avcı, 2015; Karagözlü, 2004).

Chaudhari (2016) tarafından yapılmış olan çalışmada elde edilen sonuçlara göre, kullanılan Dettol dezenfektan sabununun test edilen tüm patojenik suşlara karşı etkili olduğunu ve en yüksek konsantrasyon olan 500 mg/ml kullanıldığında *S. aureus*'a karşı en yüksek inhibisyon zonuna (42 mm) sahip olduğunu belirlemiştir. Diğer dezenfektan sabun olan Savlon ise *S. aureus*'un gelişimini engellemiş ancak en az zon *Bacillus* türleri için ortaya çıkmıştır. Bu çalışma ile yapmış olduğumuz çalışma bir kısım dezenfektan türleri ile paralellik göstermiştir. Bu sebeple sıvı olarak kullanılan dezenfektanların sabun olarak kullanımında da bazı patojen mikroorganizmalar üzerine etkili olabileceği anlaşılmaktadır.

Yapılan bu çalışma ile Şenel ve Başoğlu (2002) tarafından yapılan çalışma arasında anlamlı bir uyumluluk olmadığı gözlemlenmiştir. Bu farklılıkta mikroorganizma türü ve kullanılan dezenfektan türünün etkili olabileceği düşünülmektedir.

Sonuç ve Öneriler

Çalışma bulgularımıza göre gıda ve ilaç endüstrisinde, veterinerlik ve çeşitli laboratuvarlardaki kontaminasyona ve hastane infeksiyonlarına neden olan mikroorganizmaları kontrol altına almak için kullanılan dezenfektan ve antiseptik maddelerin seçiminde daha özenli ve dikkatli olmanın önemi ortaya çıkmaktadır. Sonuçta bu çalışma ile özellikle pandemi boyunca kullanılan bu dezenfektanların bir kısmının standartlara uymadığı, hijyen amaçlı kullanılması durumunda hastalıklara karşı koruma sağlamadığı, hastalıkları yayabileceği, böylelikle kullanımlarının potansiyel tehlike oluşturabileceği sonucuna varılmıştır. Ayrıca yetkili otoriteler tarafından antiseptik/dezenfektanların standartlara uygun üretiminin yapılması sağlanmalı ve teşvik edilmelidir.

Kaynaklar

Avcı, D. (2015). *Bazı Antiseptik Ve Dezenfektanların Antibakteriyel Etkinliklerinin Araştırılması*. (Yüksek Lisans Tezi). Ulusal Tez Merkezi. (Tez No: 422894).

Cemeroğlu, B. S. (2013). *Gıda Analizleri* (3 ed.). Ankara: Bizim Grup Basımevi.

Chaudhary, V. M. (2016). Studies on antimicrobial activity of antiseptic soaps and herbal soaps against selected human pathogens. *Journal of Scientific and Innovative Research*. 5(6): 201-204.

Çelik, Ç. (2015). *Adana İlinde Toplu Yiyecek Hizmeti Veren Bir Firmanın Hijyen Koşullarının Ve Kullanılan Dezenfektanların Antimikrobiyal Etkinliğinin Belirlenmesi.* (Yüksek Lisans Tezi). Ulusal Tez Merkezi. (Tez No: 377266).

Gürler, B. (2003). Dezenfektan Seçimi ve Dezenfektanların Kullanımı Konusunda Güncel Rehberler. *3. Sterilizasyon Dezenfeksiyon Kongre Kitabı*, Editörler.; Günaydın, M.; Sümbül, M., Simad Yayınları, Samsun, 159-68.

Karagözlü, C. & Karagözlü, N. (2004). Süt Endüstrisinde Deterjan Ve Dezenfektan Kalıntılarının Önemi. *Harran Üniversitesi Ziraat Fakültesi Dergisi.* 8 (3/4):73-81.

Ponce, A. G., Fritz, R., Del Vella, C., & Roura, S. I. (2003). Antimicrobial Activity of Essential Oils on The Native Microflora of Organic Swiss Chard LWT- *Food Sciences and Technology*. 36(7), 679-684. doi: 10.1016/S0023-6438(03)00088-4.

Ronald, M. (1997). Principles of Microbiology. *Atlas*, (2 ed.) 461-67.

Reddish, G.F. (1957). Definition of Terms. *Antiseptics, Disinfectants, Fungicides, and Chemical and Physical Sterilization*, In: Reddish, G.F.(ed); Lea and Febiger, Philadelphia, (2 ed.) 23.

Saraç, Ş. (2009). *Sanayide Kullanılan Dezenfektan Ve Antiseptik Maddelerin Antimikrobiyal Etkinliğinin Araştırılması*. (Yüksek Lisans Tezi). Ulusal Tez Merkezi. (Tez No: 238913).

Şenel, Y. & Başoğlu, F. (2002). Gıda İşletmelerinde Kullanılan Bazı Dezenfektanların Mikroorganizmalar Üzerine Etkileri. *Uludağ. Üniversitesi. Ziraat. Fakültesi.* Dergisi. 16: 105-115.

Temiz, A. (2010). *Antimikrobiyal Maddelere Duyarlılık* Genel Mikrobiyoloji Uygulama Teknikleri (5 ed.). Ankara: Hatiboğlu Yayınevi.

Temiz, A. (2015). *Gıdalarda Mikrobiyal Gelişmeyi Etkileyen Faktörler*. Gıda Mikrobiyolojisi (4 ed.). s,53-82. İzmir: Meta Basım Matbaacılık Hizmetleri

COMMUNITY SOCIAL CAPITAL IN SUPPORTING FOREST SUSTAINABILITY

Lusiana Tursina SILABAN
Department of Forestry, Faculty of Agriculture, University of Lampung, Jl. Sumantri Brojonegoro 1, Bandar Lampung, Lampung
Email: lusianatrs@gmail.com

Christine WULANDARI
Department of Forestry, Faculty of Agriculture, University of Lampung, Jl. Sumantri Brojonegoro 1, Bandar Lampung, Lampung

Indra Gumay FEBRYANO
Department of Forestry, Faculty of Agriculture, University of Lampung, Jl. Sumantri Brojonegoro 1, Bandar Lampung, Lampung

Susni HERWANTI
Department of Forestry, Faculty of Agriculture, University of Lampung, Jl. Sumantri Brojonegoro 1, Bandar Lampung, Lampung

ABSTRACT
In making efforts to preserve natural resources, the main capital that needs to be considered is the social capital of the community. The forms of social capital in this study are trust, norms and social networks that enable individuals and communities to work together to overcome various social and environmental problems. This research aims to analyze the relationship between social capital in supporting efforts to conserve natural resources, especially forests. The method used in this research is qualitative analysis through a case study approach. Community social capital plays an important role in supporting forest sustainability, because it can strengthen the effectiveness and sustainability of other capital needed in conservation efforts.
Keywords: social capital, trust, norms, social networks

INTRODUCTION

Humans are social creatures whose survival and welfare are very dependent on natural resources. The existence of forests with abundant resources has great potential to fulfill various human needs economically, socially and environmentally (Romzy, 2019). Community utilization of forest resources without conservation efforts can cause various negative impacts on forest sustainability. Human behavior that is destructive or does not care about the environment, such as burning forests, water pollution, or excessive use of natural resources, can have very detrimental impacts, such as environmental disasters, ecosystem damage, and loss of biodiversity (Sirait, 2023).

Awareness of the reciprocal relationship between human behavior and environmental conditions is essential for building an ecologically and economically sustainable society. Based on this, communities need to be given maximum access to manage forests in order to achieve economic prosperity, environmental preservation, and prevent conflict in forest areas (Pambudi, 2020). Sustainable forest management requires a high level of social capital. In the context of forest management, social capital can include collaborative activities between government, local communities, non-government organizations and the private sector to plan and implement sustainable forest management practices (Zuraidah, 2022). Sustainable forest management can be more effective and sustainable if it considers individual characteristics, procedural knowledge of forest management, and the role of forest farmer groups in the context of social capital (Lee *et al* ., 2017).

Strong social capital can improve forest conditions. Social capital consisting of social norms, trust and social networks has helped the community in managing forest resources and has become positive energy as an important component in managing forest resources so that it can maintain community cooperation and forest sustainability (Sabar, 2022). Social capital can be considered a strength because it can increase social cohesion, namely the level of solidarity and integration in society. The main thing in social capital is social ties, which means that networks are a very valuable asset and are the basis for social cohesion because they encourage a climate of cooperation to obtain benefits (Melia, 2022; Field, 2010).

Research related to social capital in supporting forest conservation efforts, especially in the Batutegi KPH is still limited. In order to obtain optimal benefits from

forests, this research needs to be carried out to develop the social capital of communities around the forests themselves (Zuraidah, 2022). The people who live in the protected forest area at KPHL Batutegi really depend on utilizing forest resources for their livelihoods. Based on these conditions, strengthen Social capital in communities living around forest areas can increase the effectiveness and sustainability of forest conservation efforts (Puspita, 2020). Therefore, this research aims to analyze the relationship between social capital in supporting efforts to conserve natural resources, especially forests.

RESEARCH METHODS

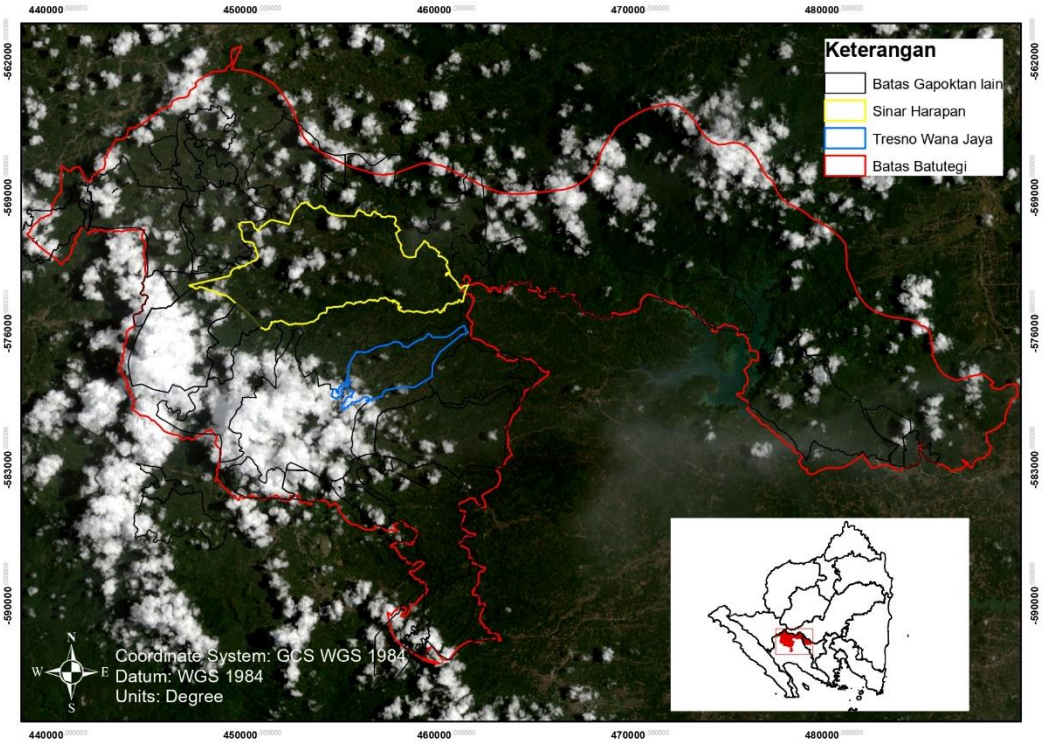


Figure 1. Map of research location

This research was carried out in September 2023. Research activities were carried out at Gapoktan Sinar Harapan and Gapoktan Trisno Wana Jaya, Batutegi Protected Forest Management Unit (KPHL), Air Naningan District, Tanggamus Regency, Lampung Province. The method used in this research is a qualitative research method where the research procedure uses the resulting data in the form of words or speech from people or behavior that can be observed. In this qualitative research, a case study approach is used, namely trying to find meaning and gain in-depth understanding and understanding of

individuals, groups or situations (Idayanti, 2017). The data used is related to community social capital in supporting forest conservation.

RESULTS AND DISCUSSION

Forests provide various vital benefits for human life and the environment. Forests also have a role in regulating the water cycle, absorbing carbon dioxide from the atmosphere, and maintaining ecosystem balance. People who live around forests often depend on natural resources that come from the forest itself. Communities have an important role in forest management. Therefore, forest preservation is very important to maintain the existence and survival of the forest itself (Melia, 2022).

Communities need to be involved in integrated forest management so that the objectives of the management itself can be realized. By paying attention to the interests of local communities and integrating them into forest conservation efforts, a good balance between environmental conservation and sustainable socio-economic development can be achieved (Hidayat, 2020). By actively involving the community in managing forests and other natural resources, it is hoped that it can create a balance between human welfare and environmental preservation (Romzy, 2019).

KPHL Batutegi is one of the provincial KPHs which has an area of around 58,174 hectares with 95% of the area converted into dry land agricultural areas, shrubs or mixed gardens. KPHL Kota Agung is a KPH in the district which has an area of around 56,020 hectares with a composition of around 8.82% forest cover, while the remaining 91.18% is non-forest. In the KPHP Register 47 Way Kanan, with a management area of around 12,500 hectares, around 8% is covered by forest, 52% has no forest cover, and the remainder, around 40%, is swamp. In general, vegetation cover in KPHL Batutegi is dominated by non-forest vegetation, reaching around 76.49% (RPHJP, 2023). Communities around this area are very dependent on forests, with the majority using forests as a source of livelihood, either through agriculture, farming or other activities. However, there are indications that environmental and forest conservation activities by local communities have not been implemented optimally.

In the context of forest management, social capital is very important because it involves cooperation between various stakeholders to achieve sustainable forest management goals. Sustainable forest management does require a fairly high level of social capital. The application of good social capital does have a significant impact in

empowering communities and ensuring sustainable management of natural resources. By implementing good social capital, communities can become more empowered in managing natural resources sustainably, while ensuring economic and social sustainability for future generations (Puspita, 2020). Strengthening social capital in communities in forest areas can be considered an investment that has the potential to provide long-term benefits in obtaining new resources and maintaining environmental sustainability (Melia, 2022). Social capital refers to the network of relationships, norms, and values that enable cooperation and coordination among individuals and groups in a society.

Based on research related to social capital in natural resource management, which has been widely carried out, among others (Adalina, 2014) states that the level of community social capital is significantly related to the level of participation in forest management. The higher the level of social capital, the higher the level of community participation in forest management development. According to (Rosalinda, 2018), the high level of social capital in society can be seen from deeper relationships internally (intra-ethnic), people have more trust in fellow communities, and relationship models are based on values, culture, perceptions and habits. each. Based on research (Rinawati, 2012), community social capital is positively correlated with the level of community participation in forest development.

According to (Puspita, 2020), the KPHL Batutegi community applies elements of social capital, namely trust, social networks and norms. The applied elements of social capital play a positive role in forest management. Collaboration between members of each gapoktan in KPHL Batutegi, which is based on trust, forms a strong social network. This allows them to get to know each other, help each other, and work together well in managing the forest. Apart from that, social norms, both written and unwritten, as well as traditional and religious values, serve as guidelines for Gapoktan members in managing HKm. Compliance with these norms helps maintain harmony and continuity of forest management activities.

The trust that exists between the two Gapoktans at KPHL Batutegi is like helping each other in the form of farming. The exchange of ideas or physical assistance provided is one of the bonds of trust that exists between the two gapoktans. Meanwhile, the form of cooperation between Gapoktan members in social activities among neighbors is a form

of intertwined social network. Social activities that are usually carried out include mutual cooperation in cleaning group meeting places and making fertilizer. The harmony created by the intertwining of trust and social networks is not lost because of the existence of norms, both written and unwritten rules, as well as religious and traditional norms that every Gapoktan member adheres to (Puspita, 2020).

(Irfarinda, 2018) states that interactions between individuals can play an important role in forming a sense of trust and building a strong network. Based on research conducted by (Ekawati, 2014), if the social capital in society becomes stronger, it will have a positive impact on forest sustainability. According to (Puspita, 2020), the more elements of social capital applied in forest management, the better the income generated. This shows that trust, social networks and social norms can increase effectiveness and efficiency in managing natural resources, thus having a positive impact on the welfare of the people who manage the forest.

CONCLUSION

The level of social capital in the community around KPH Batutegi can be categorized as high. This can be seen from forest management activities that are running positively. With strong trust, an established social network, and compliance with applicable norms, Gapoktan in KPH Batutegi can create a conducive environment for collaborating in efforts to preserve forests and develop sustainable agriculture. This will also contribute to improving the welfare of Gapoktan members and the surrounding community as a whole.

BIBLIOGRAPHY

Adalina, Yelin. 2014. *Implications of Community Social Capital for National Park Management*

(Case Study of Mount Halimun Salak National Park). Dissertation. Graduate School

Bogor Agricultural Institute. Bogor.

Ekawati, S., Nurrochmat, DR 2014. The relationship between social capital and utilization

preservation of protected forests. *Journal of Forestry Policy Analysis*. 11(1): 40-53

Hidayat, R., Marsono, D., Susanto, S., Sadono, R. 2020. Community social capital in the region

Mount Ciremai National Park buffer to support a management-based scheme partnership. *Journal of Regions and Environment*. 8(2): 130-146.

Idayanti, Umi Nurul. 2017. *Implementation of Al-Quran Reading Activities to Improve Religious Behavior of Class VIII Students at SMPN 1 Siman Ponorogo Academic Year 2016/2017*. Thesis. Faculty of Tarbiyah and Teacher Training, Department of Religious

Education Islam, State Islamic Institute. Ponorogo.

Irfarinda, M., and Lawang, MZR 2018. Mutual trust between Scavangers and Collectors in

Bekasi Region: social capital perspective. *Socio Conceptual Journal.* 7(3): 1–14.

Lee, Y., Rianti, IP, Park, MS 2017. Measuring social capital in Indonesian community forests

management. *Forest Science Technology*. 13(3): 133-141.

Melia, A., Roslinda, E., Prayogo, H. 2022. Community social capital in management

tembawang in Paloan Village. *Tengkawang Journal*. 12(1): 1-29.

Micho, A. 2015. The role of social capital in the implementation of customary protected forest

institutions. *Journal of Public Administration Science* . 13(2): 105-110.

Pambudi, AS 2020. The development of social forestry in Indonesia. *The Journal of Indonesia*

Sustainable Development Planning. 1(1): 57-66.

Puspita, NT, Qurniati, R., Febryano, IG 2020. Social Capital of Forest Management Communities Community in the Batutegi Forest Management Unit. *Sylva Lestari Journal* .

8(1): 54-64.

Rinawati, R. 2012. *Community Social Capital in Community Forest Development in Sub*

Watersheds Upper Cisadane (Case in the Upper Cisadane Sub-Watershed Micro Watershed Model Area). Thesis. School Bogor Agricultural Institute Postgraduate. Bogor.

Romzy, N., Triwahyudianto, Wardani, NR 2019. Social capital in forest management production at the Forest Village Community Institution (LMDH) Pandantoyo Village,

Regency Kediri. *Journal of Geography Education and Science*. 4(1): 9.

Roslinda, E. 2018. Social capital of the community in the management of Danau Sentarum

National Park, West Kalimantan, Indonesia. *Biodiversity*. 19: 1249-1257.

Sabar, A., Dassir, M., Ita, SEN 2022. Social capital of forest management communities Community (HKM) Buhung Lali, Gantarang District, Bulukumba Regency. *Journal*

Papuasian Forestry. 8(1):94-101.

Sirait, Eka Ria Novita Sari. 2023. *Correlation of Community Social Capital on Effort*

Restoration of the Peat Ecosystem Around Tahura Orang Kayo Hitam (Case Study: Village

Jebus and Gedong Karya). Thesis. Faculty of Agriculture, Department of Forestry, University Lampung. Bandar Lampung.

Zuraidah, A., Sardjono, MA, Rujehan. 2022. Social capital to support programs social forestry (case study in HTR Batu Ampar District, East Kutai). *Ironwood – Tropical*

Forest Journal. 6(2): 135-148.

KİTOSAN UYGULAMALARININ BİTKİLERDE ABİYOTİK STRES FAKTÖRLERİ ETKİLERİ

Eylül Berfin BİRGÜL (ORCID: 0000-0003-3539-0902)
Siirt Üniversitesi, Ziraat Fakültesi, Tarımsal Biyoteknoloji Bölümü, Siirt, Türkiye
Email: eylulbirgul7@gmail.com

Nazlı ÖZKURT (ORCID: 0000-0003-4064-3740)
Van Yüzüncü Yıl Üniversitesi, Fen fakültesi, Moleküler Biyoloji ve Genetik Bölümü, Van, Türkiye
Email: nazli04.ozkurt04@gmail.com

Doç. Dr. Harun BEKTAŞ (ORCID: 0000-0002-4397-4089)
Siirt Üniversitesi, Ziraat Fakültesi, Tarımsal Biyoteknoloji Bölümü, Siirt, Türkiye
Email: bektasharun@gmail.com

Doç. Dr. Yasemin BEKTAŞ (ORCID: 0000-0002-6884-2234)
Siirt Üniversitesi, Ziraat Fakültesi, Tarımsal Biyoteknoloji Bölümü, Siirt, Türkiye
Email: yasemin.bektas@siirt.edu.tr

ÖZET

Canlılar doğaları gereği dış çevre ile sürekli etkileşim halindedir. Çevrede uygunsuz koşullar oluşması durumunda canlılar bazı stres faktörlerine maruz kalırlar. Bitkiler yaşamları boyunca biyotik (Yabani bitkiler, böcekler, mikroorganizmalar (virüs-bakteri), vb.) ve abiyotik stres (Kuraklık, radyasyon, su baskını, mekanik etki, tuzluluk, vb.) faktörlerine maruz kalırlar. Hareket kabiliyeti olan organizmalar stres faktörlerinden kaçabiliyorken, bitkiler strese sabit konumları nedeniyle daha fazla maruz kalmaktadır. Stres faktörleri bitkilerde fizyolojik ve metabolik değişimlere yol açarak büyüme ve gelişmeyi, ürün kalitesini ve miktarını olumsuz etkilediği gibi, organların veya bitkinin ölümüne de sebep olabilmektedir. Stres faktörleri ile başa çıkmak için birçok organik veya inorganik kimyasal incelenmiş ve etkinlikleri kanıtlanmıştır. Bunlardan birisi de potansiyel bir biyostimülan olan kitosandır. Kitosan, böcek dış iskeletindeki kütiküllerden elde edilen doğal bir biyopolimerdir. Yapılan birçok çalışmada kitosanın bakteriler, bitkiler, mantarlar vb. üzerinde çeşitli etkileri olan antimikrobiyal bir ürün olduğu gösterilmiştir. Ayrıca kitosan, bitki büyümesi ve toprak verimliliğinin artırılmasında da önemli rollere sahiptir. Kitosan, tarımsal zararlıların ve patojenlerin kontrol edilmesinin yanı sıra, gübre kirliliğinin azaltılmasında da önemli bir role sahiptir. Kitosanın bu nedenlerden dolayı sürdürebilir ve modern tarımsal üretimde önemli bir yere sahip olacağı düşünülmektedir. Bu derleme çalışması kitosanın abiyotik stres faktörleri üzerindeki etkilerini incelemek ve kitosanın çalışma mekanizmasının anlaşılmasına katkı sunmayı amaçlamaktadır.

Anahtar Kelimeler: kitosan, abiyotik ve biyotik stres, sürdürebilir tarım,

EFFECTS OF CHITOSAN APPLICATIONS ON ABIOTIC STRESS FACTORS IN PLANTS

ABSTRACT

Organisms are constantly interacting with the external environment as a part of their nature. When unfavorable conditions arise in the environment, organisms are exposed to various stress factors. Throughout their lives, plants are exposed to biotic (weeds, insects, microorganisms such as viruses and bacteria, etc.) and abiotic stress factors (drought, radiation, waterlogging, mechanical impact, salinity, etc.). While mobile organisms can escape from stress factors, plants are more exposed to stress due to their stationary nature. Stress factors can negatively affect growth, development, product quality, and quantity in plants by causing physiological and metabolic changes, and sometimes even lead to organ or plant death. To cope with stress factors, many organic or inorganic chemicals have been studied and their effectiveness has been proven. One of these is chitosan, a potential biostimulant. Chitosan is a natural biopolymer derived from the cuticles of insect exoskeletons. Numerous studies have shown that chitosan has various effects on bacteria, plants, fungi, etc., making it an antimicrobial product. Additionally, chitosan plays important roles in enhancing plant growth and soil fertility. Besides its role in controlling agricultural pests and pathogens, chitosan also plays a significant role in reducing fertilizer pollution. Due to these reasons, chitosan is believed to have a significant place in sustainable and modern agricultural production. This review aims to examine the effects of chitosan on abiotic stress factors and contribute to understanding its working mechanism.

Keywords: chitosan, abiotic and biotic stress, sustainable agriculture

GİRİŞ

Canlılar doğaları gereği dış çevre ile sürekli ilişki halindedirler. Çevrede uygunsuz koşullar oluşması durumunda canlılar bazı streslere maruz kalırlar. Bitkiler en iyi gelişimi kendileri için optimum olan koşullarda gösterirler. Normal metabolizmanın esnekliğine bağlı olarak, bitkiler günlük ve mevsimlik değişimler karşısında büyümelerini devam ettirebilmelerine rağmen, beklenmedik bir koşula sürekli veya zaman zaman maruz kalmaları sonucunda, gelişimlerini ve hayatta kalmalarını etkileyecek hastalıklar, hasarlar veya fizyolojik değişimler meydana gelebilir. Bu elverişsiz şartlara sebep olan faktörlere "stres" denir (Büyük ve ark., 2012). Bitkiler yaşamları boyunca abiyotik (kuraklık, tuzluluk, radyasyon, su baskını, mekanik etki vb.) ve biyotik stres (yabani bitkiler, böcekler, virüs-bakteri) faktörlerine maruz kalırlar (Sharma ve ark., 2019).

Bitkilerde belirli bir süre içerisinde transpirasyonla yitirilen suyun, çevreden alınan su miktarından fazla olması durumunda oluşan strese kuraklık stresi denir (Seleiman ve ark., 2021). Kurak koşullarda toprakta su miktarı ve buna bağlı olarak bitkinin su alma potansiyeli azalmaktadır. Stres sonucunda absisik asit (ABA) miktarı artarak stomalar kapanır. Bu nedenden dolayı fotosentez miktarında azalmalar meydana gelir. Sonuç olarak vejetatif gelişim yavaşlar veya durur ve büyüme de buna bağlı olarak inhibe edilmiş olur (Kutlu, 2010). Kuraklık stresi altında topraktaki su miktarının azalması, toprakta bulunan bitki besin maddelerinin alım hızını azaltacaktır, kökler tarafından besin alımında azalmalar oluştuğunda bitkinin büyüme ve gelişimi negatif yönde etkilenecek ve sonuç olarak verim ve kalite kayıpları oluşacaktır (Aroca, 2012). Stres altında, bitkilerdeki klorofil içeriği azaldığı için fotosentez hızı da azalmaktadır; bu nedenle fotosentez verimliliği ve hızı doğrudan klorofil içeriğiyle ilişkilidir (Anjum, 2011).

Bitkilerde tuzluluk stresi, ana kayaların ayrışması, okyanuslardaki tuz depoları, iklim etkileri, aşırı sulama ve tarım alanlarının genişlemesi gibi nedenlerle zenginleşen yer altı suyunun yüzeye yükselmesi, aşırı otlatma ve doğal bitki örtüsünün tahrip edilmesi gibi durumlarda meydana gelir. Bu stres, bitkilerde hücre bölünmesini ve uzamasını etkileyerek kök ve gövde ağırlığının azalmasına, yaprakların küçülmesine ve mumsu tabakanın incelmesine neden olmaktadır. Tuz stresi ayrıca, hücre duvarında bulunan pektinin yapısını bozarak Na birikimine yol açmakta, enzimleri olumsuz etkilemekte ve su potansiyelini azaltmaktadır. Tuz stresi altında, fotosentez hızının azaldığı, stomaların kapanarak kullanılabilir su miktarının azaldığı, kloroplast yapısının değiştiği, oksidatif

stres oluştuğu ve reaktif oksijen türlerinin (ROS) biriktiği bilinmektedir (Çulha ve ark., 2012).

Bitkiler stres faktörleri ile başa çıkabilmek adına, çeşitli mekanizmalar geliştirmişlerdir. Kuraklık ve yüksek sıcaklık gibi abiyotik stres faktörleri, su noksanlığına neden olarak bitkilerde iç dengeyi (homeostazı) bozabilmektedir. Bu durumda, bitkiler osmotik düzenleme yoluyla çözünür maddelerin miktarını artırarak su potansiyelini azaltarak ve kurak veya tuzlu ortamlarda suyun alınmasını sağlayabilmektedir. Bitkilerin membranlarında KCl pompaları bulunur ve tuz stresine maruz kaldıklarında, Na stresi ile birlikte Na iyonu hücre içine girerek K alımını engeller. Bu durumda, Na iyonlarının aşırı birikimi toksik etkilere yol açabilir. Bitkilerdeki H-ATPazlar, iyonların iletimi yoluyla homeostazı sağlayarak bu tür streslere uyum sağlarlar (Büyük ve ark., 2012). Bitkilerde, normal koşullarda büyüme ve gelişme için gerekli olan oksijenin yanı sıra gereğinden fazla miktarda oksijen de hücresel hasara neden olabilmektedir. Oksijenin tam olarak indirgenmemesi durumunda, reaktif oksijen türleri (ROS) olarak bilinen moleküller oluşur ve bu moleküller DNA, proteinler ve lipitler gibi hücresel yapıları hasarlayabilir. Kuraklık stresi, ROS oluşumunu artırarak oksidatif stresin meydana gelmesine neden olabilir (Doğru, 2020). Bu nedenle, bitkiler stres ile başa çıkabilmek için uygun mekanizmalar geliştirmişlerdir. Stresten kaçınma, adaptasyon ve tolerans gibi stratejiler, bitkilerin stres durumunda kullanabileceği yanıtlardır. Özellikle, düşük molekül ağırlıklı çözünen maddeler olan ozmolitler, ROS'ların temizlenmesinde önemli bir rol oynar. Kuraklık stresi altında biriken oligosakkaritler, sukroz, trehaloz gibi şekerler veya prolin gibi aminoasitler, antioksidan olarak işlev görerek stres altında hücre turgorunu korumak için ozmolit olarak hareket ederler (Büyük ve ark., 2012; Shehzad, 2020). Ayrıca, bitkiler oksidatif stres altında yaşamlarını sürdürebilmek ve hasarlardan korunmak için çeşitli antioksidanlar geliştirirler. Bu antioksidanlar, enzimatik olmayanlar olarak askorbik asit, vitamin E, karotenoidler ve fenolik bileşiklerden oluşurken, enzimatik antioksidanlar arasında süperoksit dismutaz (SOD), katalaz (CAT), askorbat peroksidaz (APX) gibi enzimler bulunur. Bu antioksidanlar, oksidatif hasarın etkilerini azaltarak ve hücre hasarını önleyerek bitkilerin stresle başa çıkmasına yardımcı olur (Caverzan, 2016).

Bitkiler doğal ortamlarında stres tehditlerine karşı mekanizmalar geliştirerek bu tehditlerle başa çıkmaya çalışırlar. Bu mekanizmaların bir parçası olarak, hücre içi iletişim ağı olan sinyal iletim yolu kurulur ve hücreler arası iletişim sağlanır. Bitkilerde,

stresin algılanması ve tanınması için hücre zarı veya çeperinde bulunan reseptörler görev yapar. Bu reseptörler, stresi algılayarak buna bağlı olarak sinyal molekülleri sentezler ve biriktirir. Bu sinyaller, gerekli hücre dokularına iletilerek gen ekspresyonu yoluyla uygun proteinlerin sentezlenmesini sağlar ve böylece stres karşısında bitkinin cevap vermesini sağlar. Bu süreçte, salisilik asit, absisik asit, etilen gibi bitki gelişim düzenleyicileri stres koşullarında önemli rol oynarlar. Bu moleküller, stres sinyallerini ileterek bitkinin uygun cevaplar geliştirmesine katkı sağlarlar. Bu şekilde, bitkiler doğadaki stres tehditlerine karşı uygun adaptasyon mekanizmaları geliştirerek hayatta kalma şanslarını artırırlar (Keskin, 2012).

Birçok stres faktörü ile başa çıkmak için organik veya inorganik kimyasal maddeler incelenmiş ve etkinlikleri kanıtlanmıştır. Bu kimyasallardan biri de potansiyel bir biyostimülan olan kitosandır.

Kitin, dünyada selülozdan sonra en yaygın bulunan polisakkarit esaslı bir biyopolimerdir ve N-asetil-D-glukozamin gruplarını içerir. Bu bileşik, eklem bacaklılarda bulunur. Kitin'in önemli bir türevi olan Kitosan ise, alkali ortamda kısmen veya tamamen deasetilasyon yoluyla (asetil fonksiyonel grubunun çıkarılması) elde edilen polikatyonik özellikte bir biyopolimerdir (Chakraborty ve ark., 2020). Kitosan, kabuklu deniz hayvanlarının (karides, yengeç, ıstakoz), mantarların ve bazı böceklerin dış iskeletlerinde bulunur (Kurtuluş ve ark., 2020).

Kitosan, birçok alanda kullanılan çok yönlü bir üründür. Bu alanlar arasında ziraat, gıda, medikal, eczacılık, kozmetik, tekstil ve daha pek çok sektör yer alır. Gıda endüstrisinde koruyucu olarak kullanıldığı gibi, biyomedikal malzemelerin üretiminde de kullanılır. Ayrıca, tarımsal uygulamalarda bitkilerde stres toleransını artırmak için de Kitosan kullanılabilmektedir. Bu özellikleriyle, Kitosan farklı sektörlerde geniş bir kullanım yelpazesine sahiptir (Kuzgun ve ark., 2013; Kurtuluş ve ark., 2020).

Kitosan, doğada bol miktarda bulunur ve toksik etkisi yoktur. Yüksek biyouyumluğa, biyoçeşitliliğe ve antimikrobiyal özelliklere sahiptir. Bu nedenle, biyopestisit olarak kullanılabilir ve biyolojik olarak parçalanabilir olması sayesinde çevre dostudur. kitosan yenilenebilir bir biyopolimerdir ve çevrede sıfır toksisite etkisi oluşturur. Bitkilerin hasat sonrası raf ömrünü uzatarak antioksidan etki gösterdiği ve bağışıklık sistemini aktive ederek koruyucu bir rol oynadığı, böylece biyostimülan etkisi gösterdiği bilinmektedir.

Ayrıca, antimikrobiyal etkisiyle küf ve bakterileri yok ettiği ve virüslerin yayılmasını engellediği rapor edilmiştir (Kuzgun ve ark., 2013; Yıldırım ve ark., 2016).

Buğday tohumlarına uygulanan Kitosan ve kalsiyum karbonat muamelesi, tuz stresinin etkisini azaltmıştır. Elde edilen verilere göre, Kitosan ve kalsiyum karbonat uygulamasının, tuzluluk stresine kıyasla bitki büyümesi, fotosentetik pigmentler, verim, verim bileşenleri ve biyo-verim üzerinde önemli olumlu bir etkiye sahip olduğu belirlenmiştir (Sadak ve ark., 2021). Kitosan'ın eksojen olarak uygulanmasıyla, ayçiçeği bitkisinin (*Helianthus annuus L.*) tuzluluk stresinin etkisi azaltıldığı rapor edilmiştir. Kitosan uygulaması, ayçiçeği bitkisinin büyümesini ve verimliliğini önemli ölçüde artırmıştır (Bakhoum ve ark., 2020).

Kitosan, bitki büyümesi ve toprak verimliliğinin artırılmasında da önemli rollere sahiptir. Kitosan, tarımsal zararlıların ve patojenlerin kontrol edilmesinin yanı sıra, gübre kirliliğinin azaltılmasında da önemli bir role sahiptir. Kitosanın bu nedenlerden dolayı sürdürebilir ve modern tarımsal üretimde önemli bir yere sahip olacağı düşünülmektedir. Bu derleme çalışması kitosanın abiyotik stres faktörleri üzerindeki etkilerini incelemek ve kitosanın çalışma mekanizmasının anlaşılmasına katkı sunmayı amaçlamaktadır.

SONUÇ

Çevrede olumsuz koşulların ortaya çıkmasıyla canlılar çeşitli streslere maruz kalır. Hayvanlar ve insanlar, doğaları gereği hareket edebildiklerinden stresten kaçınma eğilimindedirler. Ancak bitkiler, yerlerinden uzaklaşamadığı için stres faktörlerine doğrudan maruz kalabilirler. Bu durum, bitkilerde fizyolojik ve metabolik değişikliklere neden olarak büyümeyi ve gelişmeyi olumsuz etkileyebilir. Sonuç olarak, bitkilerde ürün kalitesinin ve miktarının azalmasına hatta organ ölümlerine yol açabilir, bu da verim kayıplarına neden olabilmektedir. Bitkiler, insanlar için temel besin kaynağı olduğundan, bitkilerin maruz kaldığı stres faktörleri insanları da etkilemektedir.

Sürdürülebilir tarımın temel hedefi, dünya nüfusunun artışı göz önünde bulundurularak çevresel etkileri minimize ederek kaliteli ve yeterli miktarda gıda üretmektir. Ancak, tarımsal üretimde karşılaşılan stres faktörleri verim üzerinde ciddi bir etkiye sahiptir. Uzun yıllar boyunca bu sorunları çözmek için kimyasallar, gübreler ve pestisitler kullanılmıştır. Ancak, bu ürünler çevre ve insan sağlığını tehdit eden sorunlara yol açmıştır. Bu nedenle, tarımsal üretimde sürdürülebilir ve çevre dostu alternatif yöntemlerin kullanımı kaçınılmaz hale gelmiştir.

Kitosan, çevre dostu tarım uygulamalarına olanak sağlayarak bitki büyümesini teşvik edebilen ve verimliliği artırabilen önemli bir üründür. Doğal kaynaklardan elde edilen bu polisakkarit, biyolojik olarak parçalanabilir ve geri dönüştürülebilir özellikleriyle çevreye duyarlı bir üründür. Kitosanın bitkilerin abiyotik streslere karşı toleransını artırması, tarımsal üretimde kullanımını daha da önemli hale getirmektedir. Özellikle kök gelişimini destekleyerek bitkilerin daha iyi beslenmesine yardımcı olması, kimyasal gübrelerin yerini alabileceği ve bitkilerin besin alımını iyileştirebileceği görüşünü desteklemektedir. Bu özellikleriyle kitosan, çevre dostu tarımın geliştirilmesinde önemli bir potansiyele sahiptir.

Bu noktalar göz önüne alındığında, kitosanın tarım alanında önemli bir rol oynayabileceği ve sürdürülebilir tarım uygulamalarının desteklenmesine katkı sağlayabileceği görülmektedir. Ancak, her uygulamada olduğu gibi, kitosanın etkinliği ve uygulama yöntemleri konusunda daha fazla çalışma yapılması gerekmektedir.

Kaynakça

Anjum, S. A., Xie, X. Y., Wang, L. C., Saleem, M. F., Man, C., Lei, W. (2011). Morphological, physiological and biochemical responses of plants to drought stress, *African journal of agricultural research*, 6(9), 2026-2032.

Aroca, R. (2012). Plant responses to drought stress, *From morphological to molecular features*, Berlim: Springer-Verlag.

Bakhoum,G.S., Sadak, M.S., Badr, E.M. (2020). Mitigation of adverse effects of salinity stress on sunflower plant (Helianthus annuus L.) by exogenous application of chitosan. *Bulletin of the National Research Centre*, 44:79.

Büyük, İ., Soydam-Aydın, S., Aras, S. (2012). Bitkilerin stres koşullarına verdiği moleküler cevaplar. *Türk Hijyen ve Deneysel Biyoloji Dergisi*, 69(2): 97-110.

Caverzan, A., Casassola, A., Brammer, S.P. (2016). Antioxidant responses of wheat plants under stress, *Genetics and Molecular Biology*, 39, 1, 1-6.

Chakraborty, M., Hasanuzzaman, M., Rahman, M., Khan, A.R., Bhowmik, P., Mahmud, N.U., Tanveer, M., Islam, T. (2020). Mechanism of Plant Growth Promotion and Disease Suppression by Chitosan Biopolymer. *Agriculture*, 10, 624.

Çulha, Ş., Çakırlar, H. (2011). Tuzluluğun Bitkiler Üzerine Etkileri ve Tuz Tolerans Mekanizmaları. *Afyon Kocatepe Üniversitesi Fen Bilimleri Dergisi*, 11: (11-34).

Dogru, A. (2020). Bitkilerde Aktif Oksijen Türleri ve Oksidatif Stres, *International Journal of Life Sciences and Biotechnology*, 3(2): 205-226.

Karaton Kuzgun, N., Gürel İnanlı, A. (2013). Kitosan Üretimi ve Özellikleri İle Kitosanın Kullanım Alanları. *Türk Bilimsel Derlemeler Dergisi,* 6 (2): 16-21.

Keskin, B.C. (2012). Bitkilerde Sinyal İletimi, *Türk Bilimsel Derlemeler Dergisi*, 5 (1): 53-73

Kutlu, İ. (2010). Tahıllarda Kuraklık Stresi*, Türk Bilimsel Derlemeler Dergisi*, 3(1): 35-41.

Kurtuluş, G., Vardar, F. (2020). Kitosanın Özellikleri, Uygulama Alanları, Bitki Sistemlerine Etkileri. *Int. J. Adv. Eng. Pure Sci*, 32(3): 258-269.

Sadak, M.SH., Talaat, I. (2021). Attenuation of negative efects of saline stress in wheat plant by chitosan and calcium carbonate. *Bull Natl Res Cent*, 45:136.

Seleiman, M. F., Al-Suhaibani, N., Ali, N., Akmal, M., Alotaibi, M., Refay, Y., Battaglia, M. L. (2021). Drought stress impacts on plants and different approaches to alleviate its adverse effects, *Plants*, 10(2), 259.

Sharma, A., Shahzad, B., Rehman, A., Bhardwaj, R., Landi, M., Zheng, B. (2019). Response of phenylpropanoid pathway and the role of polyphenols in plants under abiotic stress, *Molecules*, 24(13), 2452.

Shehzad, M. A., Nawaz, F., Ahmad, F., Ahmad, N., Masood, S. (2020). Protective effect of potassium and chitosan supply on growth, physiological processes and antioxidative machinery in sunflower (*Helianthus annuus L.*) under drought stress, *Ecotoxicology and environmental safety*, 187, 109841.

Yıldırım, Z., Öncül, N., Yıldırım, M. (2016). Kitosan Ve Antimikrobiyal Özellikleri. *Niğde Üniversitesi Mühendislik Bilimleri Dergisi*, 5, 1, 19-36.

PRİMİNG UYGULAMALARININ BİTKİLERDE BAKTERİYEL HASTALIKLARA KARŞI ETKİSİ

Nazlı ÖZKURT* (ORCID: 0000-0003-4064-3740)
Van Yüzüncü Yıl Üniversitesi, Fen fakültesi, Moleküler Biyoloji ve Genetik Bölümü, Van, Türkiye
Email: nazli04.ozkurt04@gmail.com

Eylül Berfin BİRGÜL (ORCID: 0000-0003-3539-0902)
Siirt Üniversitesi, Ziraat Fakültesi, Tarımsal Biyoteknoloji Bölümü, Siirt, Türkiye
Email: eylulbirgul7@gmail.com

Harun BEKTAŞ (ORCID: 0000-0002-4397-4089)
Siirt Üniversitesi, Ziraat Fakültesi, Tarımsal Biyoteknoloji Bölümü, Siirt, Türkiye
Email: bektasharun@gmail.com

Yasemin BEKTAŞ (ORCID: 0000-0002-6884-2234)
Siirt Üniversitesi, Ziraat Fakültesi, Tarımsal Biyoteknoloji Bölümü, Siirt, Türkiye
Email: yasemin.bektas@siirt.edu.tr

ÖZET

Dünya nüfusunun artması ve tarımsal alanların giderek azalmasına ek olarak birçok stres faktörü tarımsal üretimde verim ve kalite kayıplarına neden olmaktadır. En önemli biyotik stres faktörlerinden olan istilacı patojenler bitkilere verdikleri çeşitli zararlardan dolayı tarımsal üretimde ciddi verim kayıplarına yol açmaktadır. Özellikle bazı bakteriler (*Cmm, Pst* vb.) dünya çapında önemli ekonomik kayıplara neden olmaktadır. Tarımsal üretimde verim ve kaliteyi artırmak için bitkileri patojenlere karşı korumak gerekmektedir. Bitkisel üretimin ilk aşaması, tohumun ekilmesi ve uygun koşullarda çimlenmesidir. Bitki gelişimini desteklemek, çimlenme oranında artış olması, verim ve kayıpların önlenmesi amacıyla; tohum priming adı verilen uygulamalar geliştirilmiştir. Tohum-priming, tohumun çimlenmeden önce belirli organik veya inorganik kimyasallara tabi tutulması ile tohum çimlenmesi ve fide gelişiminde pozitif yönde gelişme görülmesi olarak tanımlanabilir. Tohum priming uygulamalarının birçok çeşidi (ozmopriming, halopriming, biyopriming vs.) olmakla birlikte, hepsindeki ortak nokta tohumun çimlenmesinden önceki aşamayı kapsamasıdır. Bitki savunma elisitörleri, bitkiye dışarıdan uygulandıklarında, bitkinin doğal immün (bağışıklık) sistemini uyararak bitkinin güçlenmesini ve bitki zararlılarına karşı daha dayanıklı ve güçlü kalmalarını sağlamaktadır. Bitki bağışıklık sisteminde priming uygulamalarının önemli etkileri olduğu gösterilmiştir. Bu çalışma, priming uygulamalarının bitki biyotik stres yönetimine etkilerini ve tarımsal üretimin artırılmasında oluşturabileceği alternatifleri irdelemeyi amaçlamaktadır.

Anahtar Kelimeler: priming, bitki savunma sistemi, biyotik stres, bitki-bakteri etkileşimi, sürdürebilir tarım, bitki savunma elisitörleri

EFFECT OF PRIMING APPLICATIONS AGAINST BACTERIAL DISEASES IN PLANTS

ABSTRACT

The increasing global population and decreasing agricultural land, coupled with numerous stress factors, lead to productivity and quality losses in agricultural production. Invasive pathogens, as one of the most significant biotic stress factors, result in significant yield losses in agricultural production due to the various damages they cause to plants. Certain bacteria (such as *Cmm*, *Pst*, etc.) particularly cause substantial economic losses worldwide. Protecting plants against pathogens is crucial to enhance productivity and quality in agricultural production. The first stage of plant production is sowing the seeds and ensuring their germination under suitable conditions. To support plant development, increase germination rates, and prevent losses, various applications called seed priming have been developed. Seed priming can be defined as subjecting the seeds to specific organic or inorganic chemicals before germination, resulting in improved seed germination and seedling development. Although there are various types of seed priming applications (osmopriming, halopriming, biopriming, etc.), they all share the common characteristic of targeting the pre-germination stage of the seeds. Plant defense elicitors, when externally applied to plants, stimulate the plant's natural immune system, strengthening the plant and making it more resistant and resilient against plant pests. Priming applications have shown significant effects on plant immune systems. This study aims to explore the effects of priming applications on plant biotic stress management and investigate alternative approaches to enhance agricultural production.

Keywords: priming, plant defense system, biotic stress, plant-bacteria interaction, sustainable agriculture, plant defense elicitors

GİRİŞ

Dünya nüfusunun giderek artmasından tarımsal alanlarının azalmasına, birçok stres faktörü tarımsal üretimde verim ve kalite kayıplarına neden olmaktadır (Jisha ve ark., 2013; Sher ve ark., 2019; Bonaterra ve ark., 2022). Bitkiler sesil organizmalar oldukları için yaşamları boyunca sürekli biyotik ve abiyotik stres türlerine maruz kalmaktadırlar. Bu türler arasında yer alan zararlı mikroorganizmalardan kaynaklanan bakteriyel hastalıklar bitkiler için önemli bir tehdittir. Çünkü bu hastalıklar bitkilerin büyüme ve gelişmelerini engelledikleri gibi ciddi verim ve ekonomik kayba sebebiyet vermektedir. Tarımsal üretimin verim ve kalitesini artırmak için bitkileri zararlı patojenlere ve farklı mikroorganizmalara karşı korumak gerekmektedir (Kaya, 2008; Sher ve ark., 2019). Bu nedenle bitkisel üretimin ilk aşaması olan tohumun uygun koşullarda çimlenmesi ve ekilmesi önem arz etmektedir (Gamze, 2008; Bhandari ve ark., 2023). Tohumun kalitesini ve çimlenmesini etkileyen durumlar içerisinde tohumun genetik ve fiziksel özellikleri önemli olduğu kadar, ilaçlama, sulama, gübreleme uygulamaları ile, tohumların kurutma şekli, hasat zamanı ve yapılış şekli, patojen bulaşıklığı gibi faktörler de yer almaktadır (McDonald, 1999; Gamze, 2008; Karakurt ve ark., 2010; Gökçöl ve Duman, 2018). Verim kayıplarını ortadan kaldırmak veya minimuma indirmek için efektif, hızlı ve eşdeğer tohum çimlenmesinin yapılabilmesi yetiştiricilikte uygulanabilecek öncelikli adımlardan biridir (Gamze, 2008). Bitkilerde bakteriyel hastalıklara karşı birçok koruma metodu geliştirilmektedir. Bunlardan birisi de, priming adı verilen ve bitki savunma sistemlerini uyararak abiyotik ve biyotik stres faktörlerine karşı dirençlerini artırma da önemli rol oynadığı ortaya koyulmuş olan metoddur. Priming bitkilerin doğal bağışıklık sistemini aktive ederek bakteriyel hastalıklara karşı hızlı ve etkili bir tepki oluşturur. Örneğin; bitkiler patojen (bakteri vb.) saldırısına maruz kaldığında savunma genlerini aktive ederek hastalıklara karşı bir direnç gösterirler.

"Tohum Uygulamaları, Tohum-Priming ya da Ön Uygulama" gibi farklı isimlerle anılan bu çalışmaların hem tohum çimlenmesinde hem de fide gelişiminde pozitif etkilerinin olduğu bilinmektedir (Zulfiqar, 2021). Priming uygulamalarının farklı tipleri olduğu bilinmektedir. Bunlar hydropriming, osmopriming, chemopriming, biopriming gibi birçok alt dala ayrılmaktadır (Ryu ve ark., 2023; Heydecker ve Gibbins, 1978; Karakurt ve ark., 2010; Moameri ve ark., 2018; Kumar ve ark., 2018 ; Raman ve ark., 2020 ; Khalaki ve ark., 2021). Priming materyali olarak; sodyum, potasyum, magnezyum, PEG

6000 (polietilen glikol), PEG 8000 gibi inorganik tuzların yanı sıra etilen ve gibberellik asit (GA) gibi hormonlar tek veya birlikte kullanılabilmektedir (Karakurt ve ark., 2010). Yapılan çalışmalarda priming uygulanan tohumların, priming uygulaması yapılmayan tohumlara göre daha hızlı ve uniform çıkış gösterdikleri rapor edilmiştir (Özkaynak ve ark., 2020). Tohum priming uygulaması ile tohumun çimlenme süreci kısalmakta ve bu süreçte karşılaşabileceği olumsuz (biyotik ya da abiyotik) faktörlere daha az maruz kalmaktadırlar. Aynı zamanda tohum priming uygulamalarının biyotik ve abiyotik streslere karşı dayanıklılığı da artırdığı rapor edilmiştir (Jakab ve ark., 2005; Gökçöl ve Duman, 2018; Özkaynak ve ark., 2020).

Bitki savunma elisitörleri, bitkilerde patojenlere karşı savunma tepkilerini tetikleyen bileşiklerdir. Bitki savunma elisitörleri, bitkiye dışarıdan uygulanan, bitkinin doğal immün (bağışıklık) sistemini uyararak güçlenmesini ve bitki zararlılarına karşı daha dayanıklı ve güçlü kalmalarını sağlayan uyarıcılardır (Bektas ve Eulgem, 2015). Doğal ürünler olabilecekleri gibi (kitin, rizobakter, BABA vb.), sentetik bileşikler de olabilmektedir. Bunlardan birisi de β-aminobütirik asit (BABA)'dir. BABA protein olmayan bir amino asit ve güçlü bir bitki savunma indükleyicisidir (Zimmerli ve ark., 2008). BABA'nın priming etkisi, bitkilerin savunma tepkilerini tetikleyerek hastalıklara karşı daha etkili bir şekilde savunmalarını sağlar. Bitkiler daha sonra bir patojenle karşılaştıklarında daha hızlı ve daha güçlü bir savunma tepkisi gösterirler. Bu, bitkinin enfeksiyonla başa çıkma yeteneğini artırır ve patojenlerin zararlı etkilerini azaltır. Bu şekilde, bitki savunma elisitörleri, priming etkisi yoluyla bitkilerin hastalıklara karşı direncini artırabilirler. Bu durum, tarımsal ürünlerin hastalıklara karşı daha dirençli olmasını sağlayarak verimliliği artırabilir ve kimyasal mücadele yöntemlerine olan ihtiyacı azaltabilir. Bu nedenle, bitki savunma elisitörleri, tarımsal uygulamalarda hastalık yönetimi stratejilerinde önemli bir rol oynayabilir.

Dünya çapında önemli ekonomik kayıplara neden olan *Clavibacter michiganensis* ssp. *michiganensis* (*Cmm)* patojeni Domates (*Solanum lycopersicum* L.) bitkisinde görülen yıkıcı bakteriyel hastalıklardan birisidir (Nandi ve ark., 2018). *Cmm* tohum kaynaklı gram pozitif bir bakteridir (Chang ve ark., 1992; Poysa, 1993; Chalupowicz ve ark., 2017; Nandi ve ark., 2018). *Cmm*, bitkinin yaralı dokularından nufüs ederek bitki gövdesinde lezyon ve yaprakta solma şeklinde görülebilmektedir (Holtsmark ve ark., 2007). Hastalık belirtileri 6 ila 8 hafta arası görülmektedir. Görünürde herhangi bir semptomu olmayan

gizli enfeksiyonlar *Cmm* patojenini daha tehlikeli yapabilmektedir (Eichenlaub ve ar., 2011; Sharaba ve ark., 2013; Vega ve ark., 2015; Nandi ve ark., 2018). *Cmm*'ye dayanıklı, ticari olarak temin edilebilecek bir domates çeşidi bulunmadığından, hastalık veya diğer semptomların kontrolünü sağlamak zordur (Yuging ve ark., 2018; Mohammed ve ark., 2019; Mohd ve ark., 2019). Bu sebeple domates bitkisinin *Cmm* patojenine karşı korunmasına yönelik çalışmalar önem arz etmektedir (Bektaş, 2021). Bitki savunma elisitörleri bitkinin doğal bağışıklığını uyardığından patojenlere karşı daha dayanıklı ve güçlü kalmalarını sağlamaktadır. Bir bitki savunma elisitörü olan metil jasmonat ile bazı çalışmalar ortaya konulmuş ve metil jasmonat'ın funguslarda spor çimlenmesini engellediği ayrıca fidelerde bitki direncini arttırdığı rapor edilmiştir (Krol ve ark., 2015). Salisilik asit ile yapılan bazı çalışmalarda salisilik asidin bakteriyel büyümeyi engellediği tespit edilmiştir (Yokotani ve ark., 2021). Benzer şekilde 15 farklı bitki savunma elisitörüyle yapılan bir çalışmada bazı elisitörlerin farklı sinyal yolaklarını etkilediği gibi bitkilerin streslere karşı da direnç gösterdiği tespit edilmiştir. (Venega-Molina ve ark., 2020). Sentetik elisitör olan INA (2,6-dichloro-isonicotinic acid) ve DPMP (2,4-dichloro-6-{(e)-[(3-methoxyphenyl)imino]methyl}phenol)'nin ise bitki büyüme ve gelişimini arttırdığı ve bakteriyel kanser hastalığına karşı direnç artırdığı rapor edilmiştir (Bektas, 2021). Çok sayıda bitki savunma elisitörünün farklı streslere karşı etkisi, çeşitli çalışmalar ile incelenmiştir, ancak priming yönünden etkileri tam olarak aydınlatılamamıştır (Abbasi ve ark., 2021). Yapılacak çalışmaların literatüre katkı sağlayacağı gibi tarımda tohum priming uygulamalarının uygulanma sıklığına da katkı sağlayacağı ve verim üzerine olumlu etkilerinin olacağı kanaatindeyiz.

SONUÇ

Bitkiler doğaları gereği sürekli dış çevre ile ilişki halindedir. Hareketsiz organizmalar oldukları için yaşamları boyunca sürekli çeşitli stres faktörlerine maruz kalırlar. Yapılan çalışmalarda, bitkilerin önce belirli uygulamalara tabi tutulmasının streslere karşı bir ön hazırlık yapması gerekmektedir. Priming adı verilen bu yöntem ile bitkilerin doğal bağışıklık sistemi harekete geçirilerek hastalıklara karşı dirençleri artırılabilmektedir. Bitki savunma elisitörleri, bitkiye dışarıdan uygulandıklarında, bitkinin doğal immün (bağışıklık) sistemini uyararak bitkinin güçlenmesini ve bitki zararlılarına karşı daha dayanıklı ve güçlü kalmalarını sağlamaktadır. Kimyasal ilaçların kullanımı azaltılarak çevresel etkileri ve maliyetleri azaltılabilecektir. Priming uygulamaları, tarımsal üretimde

sürdürülebilirlik ve verimlilik açısından önemli bir strateji olabilir. Ancak, priming uygulamalarının etkinliği bitki türüne, hastalık etmenine ve çevresel koşullara bağlı olarak değişebilmektedir. Bu nedenle, uygulama yöntemleri ve dozajları dikkatli bir şekilde optimize edilmelidir. Ayrıca, priming uygulamalarının uzun vadeli etkileri ve bu uygulamaların bitki büyümesi ve verimi üzerindeki etkileriyle ilgili daha fazla çalışmaya ihtiyaç vardır. Sonuç olarak, priming uygulamaları bitkilerde bakteriyel hastalıklara karşı, umut vadeden etkili bir kontrol stratejisi olarak görülmektedir. Bu uygulamalar, bitkilerin doğal bağışıklık sistemini güçlendirerek hastalıklara karşı dirençlerini artırır. Ancak, priming uygulamalarının bitki biyotik stres yönetimine etkileri ve tarımsal üretimin artırılmasında oluşturabileceği alternatifleri irdelemek gerekmektedir. Ayrıca yapılacak çalışmaların hem priming uygulamalarının bitki biyotik ve abiyotik stres tolerans/direncinde oluşturacağı moleküler yolakların ortaya çıkarılmasına, hem de çiftçi uygulamaları için bir zemin hazırlayacağı düşünülmektedir.

KAYNAKÇA

Abbasi, S., Sadeghi, A., Omidvari, M. (2021). The stimulators and responsive genes to induce systemic resistance against pathogens: an exclusive focus on tomato as a model plant, *Biocatalysis And Agricultural Biotechnology*, 101993.

Bektas, Y. (2021). The synthetic elicitors 2,6-dichloro-isonicotinic acid (ina) and 2,4-dichloro-6-{(e)-[(3-methoxyphenyl)imino]methyl}phenol (dpmp) enhances tomato resistance against bacterial canker disease with different molecular mechanisms. *Physiological and Molecular Plant Pathology*, 116, 101740. doi:10.1016/j.pmpp.2021.101740

Bektas, Y. and Eulgem, T. (2015). Synthetic plant defense elicitors, *Frontiers in Plant Science*, 5, 804.

Bhandari R. , Sanz-Saez A. , Leisner C.P. , Potnis N. (2023). *Xanthomonas* infection and ozone stress distinctly influence the microbial community structure and interactions in the pepper phyllosphere. p. 24, 10.1038/s43705-023-00232-w

Bonaterra A., Badosa E., Daranas N., Francés J., Roselló G., Montesinos E. (2022). Bacteria as biological control agents of plant diseases. p. 1759, 10.3390/microorganisms10091759

Chalupowicz, L., Barash, I., Reuven, M., Dror, O., Sharabani, G., Gartemann, K. H., Manulis-Sasson, S. (2017). Differential contribution of *Clavibacter Michiganensis* ssp. *Michiganensis* virulence factors to systemic and local infection in tomato, *Molecular Plant Pathology*, 18(3), 336-346.

Chang, R. J., Ries, S. M., Pataky, J. K.. (1992). Reductions in yield of processing tomatoes and incidence of bacterial canker. *Plant Disease*, 76(8), 805-809.

Eichenlaub, R. and Gartemann, K. H. (2011). The *Clavibacter michiganensis* subspecies: molecular investigation of gram-positive bacterial plant pathogens. *Annual Reviews of Phytopathology*, 49(1), 445-464.

Gamze, K. (2008). Tohum uygulamaları (priming)'nin tohum yağ asitleri kompozisyonuna etkisi ve tohum kalitesi ile ilişkisi, *Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi*, 17(1-2).

Gökçöl, A. ve Duman, İ. (2018). Kapari tohumlarının çimlenmesinin iyileştirilmesinde farklı tohum uygulamalarının etkisinin belirlenmesi, *Ege Üniversitesi Ziraat Fakültesi Dergisi*, 55(4), 71-80.

Heydecker, W. and Gibbins, B. (1978). The 'Priming' Of Seeds, [Conference Paper]. *Acta Horticulturae* (Netherlands). No. 83.

Holtsmark, I., Mantzilas, D., Eijsink, V. G. H., Brurberg, M. B. (2007). The tomato pathogen *Clavibacter michiganensis* ssp. *michiganensis*: producer of several antimicrobial substances. *Journal of Applied Microbiology*, 102(2), 416-423.

Jakab, G., Ton, J., Flors, V., Zimmerli, L., Métraux, J.-P., Mauch-Mani, B. (2005). Enhancing Arabidopsis salt and drought stress tolerance by chemical priming for its abscisic acid responses, *Plant Physiology*, 139(1), 267-274.

Jisha, K. C., Vijayakumari, K., Puthur, J. T. (2013). Seed priming for abiotic stress tolerance: an overview. *Acta Physiologiae Plantarum*, 35(5), 1381-1396.

Karakurt, H., Aslantaş, R., Eşitken, A. (2010). Tohum çimlenmesi ve bitki büyümesi üzerinde etkili olan çevresel faktörler ve bazi ön uygulamalar, *Uludağ Üniversitesi Ziraat Fakültesi Dergisi*, 24(2), 115-128.

Kaya, G. (2008). Tohum uygulamalari (Priming)'nın tohum yağ asitleri kompozisyonuna etkisi ve tohum kalitesi ile ilişkisi, *Tarla Bitkileri Merkez Arastırma Enstitüsü Dergisi*, 17, 1-2.

Król, P., Igielski, R., Pollmann, S., Kępczyńska, E. (2015). Priming of seeds with methyl jasmonate induced resistance to hemi-biotroph *Fusarium oxysporum* f. sp. *lycopersici* in tomato via 12-oxo-phytodienoic acid, salicylic acid, and flavonol accumulation. *Journal of Plant Physiology*, 179, 122-132.

Król, P., Igielski, R., Pollmann, S., Kępczyńska, E. (2015). Priming of seeds with methyl jasmonate induced resistance to hemi-biotroph *Fusarium oxysporum* f. sp. *lycopersici* in tomato via 12-oxo-phytodienoic acid, salicylic acid, and flavonol accumulation. *Journal of Plant Physiology*, 179, 122-132.

Martínez-Aguilar, K., Hernández-Chávez, J. L., Alvarez-Venegas, R. (2021). Priming of seeds with ina and its transgenerational effect in common bean (*Phaseolus vulgaris* L.) plants, *Plant Science*, 305, 110834.

Mcdonald, M. (1999). Seed deterioration: physiology, repair and assessment, *Seed Science And Technology*, 27(1), 177-237.

Mohammad, H. B., Lee, S. E., Kim, M. S. (2019). Refining a pathogen's genome to know the enemy better for the winning battles. *Proteomics*, 19(9), 1900005.

Mohd Nadzir, M. M., Vieira Lelis, F. M., Thapa, B., Ali, A., Visser, R. G. F., van Heusden, A. W., van der Wolf, J. M. (2019). Development of an in vitro protocol to screen Clavibacter michiganensis subsp. michiganensis pathogenicity in different Solanum species. *Plant Pathology*, 68(1), 42-48.

Nandi, M., Macdonald, J., Liu, P., Weselowski, B., Yuan, Z. C. (2018). *Clavibacter michiganensis* ssp. *michiganensis*: bacterial canker of tomato, molecular interactions and disease management. *Molecular Plant Pathology*, 19(8), 2036-2050.

Özkaynak, E., Orhan, Y., Kargin, İ. F., Tuncel, M. (2020). Biber Ve Domates Tohumlarında Organik Priming Uygulamaları, *Black Sea Journal Of Agriculture*, 3(4), 301-307.

Poysa, V. (1993). Evaluation of tomato breeding lines resistant to bacterial canker. *Canadian journal of Plant Pathology*, 15(4), 301-304.

Raman R. (2017). The impact of Genetically Modified (GM) crops in modern agriculture: A review *GM Crops Food*, pp. 195-208

Ryu, C.M., Farag, M.A., Hu, C.H., Reddy, M.S., Wei, H.X., Par´e, P.W., Kloepper, J.W., (2003). Bacterial volatiles promote growth in Arabidopsis. *Proc. Natl. Acad. Sci.* 100, 8607. doi.org/10.1073/pnas.1332575100.

Sharabani, G., Manulis-Sasson, S., Borenstein, M., Shulhani, R., Lofthouse, M., Chalupowicz, L., Shtienberg, D. (2013). The significance of guttation in the secondary spread of *Clavibacter michiganensis* subsp. *michiganensis* in tomato greenhouses. *Plant Pathology*, 62(3), 578-586.

Sher, A., Sarwar, T., Nawaz, A., Ijaz, M., Sattar, A., Ahmad, S. (2019). Methods of seed priming. In Priming and pretreatment of seeds and seedlings. *Springer*, Singapore. pp. 1-10

Vega, D. and Romero, A. M. (2016). Survival of *Clavibacter michiganensis* subsp. *michiganensis* in tomato debris under greenhouse conditions. *Plant Pathology*, 65(4), 545-550.

Venegas-Molina J., Proietti S., Pollier J., Orozco-Freire W., Ramirez-Villacis D., Leon-Reyes A. (2020). Induced tolerance to abiotic and biotic stresses of broccoli and

Arabidopsis after treatment with elicitor molecules. *Nature.* doi.org/10.1038/s41598-020-67074-7.

Yokotani, N., Hasegawa, Y., Sato, M., Hirakawa, H., Kouzai, Y., Nishizawa, Y., Yamamoto, E., Naito, Y., Isobe, S. (2021). Transcriptome analysis of Clavibacter michiganensis subsp. michiganensis-infected tomatoes: a role of salicylic acid in the host response. *Plant Biology.* 21:476. doi.org/10.1186/s12870-021-03251-8.

Yuqing, W. A. N. G., Zhang, Y., Zhipeng, G. A. O., Wencai, Y. A. N. G. (2018). Breeding for resistance to tomato bacterial diseases in China: challenges and prospects. *Horticultural Plant Journal*, 4(5), 193-207.

Zimmerli, L., Metraux, J. P., Mauch-Mani, B. (2001). Beta-aminobutyric acid-induced protection of arabidopsis against the necrotrophic fungus botrytis cinerea. *Plant Physiology*, 126, 517-523.

Zulfiqar, F. (2021). Effect of seed priming on horticultural crops. *Scientia Horticulturae*, 286, 110197. doi:10.1016/j.scienta.2021.110197.

KARABUĞDAY TOHUM KABUKLARININ KİMYASAL KOMPOZİSYONU VE *IN VITRO* GERÇEK SİNDİRİLEBİLİRLİĞİNİN DEĞERLENDİRİLMESİ

Dr. Öğretim Üyesi Hülya HANOĞLU ORAL (ORCID: 0000-0003-3626-9637)
Muş Alparslan University, Faculty of Applied Sciences,
Department of Animal Production and Technologies, Muş-Türkiye
Email: h.hanoglu@alparslan.edu.tr

ÖZET

Alternatif kaba yem kaynaklarının değerlendirilmesi sürdürülebilir hayvansal üretim açısından büyük önem taşımaktadır. Bu bakımdan karabuğdayın öğütme veya başka amaçlarla işlenmesinin yan ürünü olan tohum kabuklarının, geviş getiren hayvanlar için alternatif bir yem kaynağı olarak değerlendirilebileceği düşünülmektedir. Bu çalışmanın amacı karabuğday (*Fagopyrum esculentum* Moench) tohum kabuklarının kimyasal bileşimini ve *in vitro* gerçek kuru madde sindirilebilirliğini (IVTDMD) değerlendirmektir. Araştırma materyali olarak 2023 yılında Konya Bahri Dağdaş Uluslararası Tarımsal Araştırma Enstitüsü'nden temin edilen Güneş ve Aktaş çeşitleri kullanılmıştır. Örneklerin kimyasal bileşimleri AOAC (1998), lif bileşenleri ise Van Soest ve ark. (1991)'na göre Ankom 2000 Fiber Analyzer ile deterjan yöntemi kullanılarak belirlenmiştir. Örneklerin IVTDMD değerlerini belirlemek için Ankom DaisyII *in vitro* fermantasyon sistemi kullanılmıştır. Ortalama değerler arasındaki farklar Bağımsız Örneklem T-Testi ile belirlenmiştir. Güneş ve Aktaş çeşitlerinin tohum kabuklarının ham proteini (CP) sırasıyla kuru madde (DM) bazında %6.87 ve %6.68 olarak belirlenmiştir. Çeşide bağlı olarak kabukların nötr deterjan lif (NDF) içeriği 82.24-83.64% arasında değişmiş ve lif bileşenleri açısından çeşitler arasında önemli fark bulunmuştur ($P<0.05$). IVTDMD değerinin %26.85 gibi düşük bir düzeyde bulunması yem kalitesinin düşük olduğunu ortaya koymuştur. Sonuç olarak, insanlar ve çiftlik hayvanları arasındaki besin rekabeti dikkate alındığında, karabuğday tohum kabuklarının geviş getiren hayvanların beslenmesi için alternatif bir kaba yem olarak kullanılabileceği anlaşılmaktadır. Ancak kabukların besleme değeri yüksek lif içeriğinden dolayı sınırlıdır. Ayrıca yüksek lif içeriği sindirilebilirliğini düşürmektedir. Bu nedenle, karabuğday tohum kabuklarının geviş getiren hayvanlar için yem bileşeni olarak kullanımı sırasında, rasyonun enerji ve protein içeriğinin ek yemlerle dengelenmesi gerektiği sonucuna varılmıştır.

Anahtar Kelimeler: Karabuğday kabuğu, Kimyasal kompozisyon, *In vitro* gerçek sindirilebilirlik, Ruminant besleme

EVALUATION OF CHEMICAL COMPOSITION AND *IN VITRO* TRUE DIGESTIBILITY OF HULLS OF BUCKWHEAT SEEDS

ABSTRACT

The evaluation of alternative roughage sources is of great importance in terms of sustainable animal production. In this respect, it is thought that hulls of buckwheat seeds, which is a byproduct of the processing of buckwheat for milling or other purposes, can be considered as an alternative source for ruminants. The aim of this study was to evaluate the chemical composition and *in vıtro* true dry matter digestibility (IVTDMD) of buckwheat (*Fagopyrum esculentum* Moench) seed hulls. The Güneş and Aktaş cultivars were used as the experimental material which was obtained from Konya Bahri Dağdaş International Agricultural Research Institute in 2023. The chemical compositions of all samples were determined by the following AOAC (1998) procedures. The fibre components were determined using the detergent method according to Van Soest et al. (1991) using an Ankom 2000 Fiber Analyzer. The Ankom DaisyII *in vitro* fermentation system was used to determine the IVTDMD of the samples. The differences between the mean values were determined using the Independent Sample T-Test. The crude protein (CP) of the seed hulls from the Güneş and Aktaş cultivars was determined to be 6.87% and 6.68%, respectively, on a dry matter (DM) basis. Depending on the cultivar, the neutral detergent fiber (NDF) content of the hulls varied between 82.24-83.64%, and there was a significant difference in fiber components between the cultivars ($P<0.05$). The IVTDMD value was found to be as low as 26.85%, indicating a low forage quality. In conclusion, hulls of buckwheat seeds can serve as an alternative roughage for ruminant nutrition, taking into the competition for food resources between humans and farm animals consideration. However, the feeding value of hulls is limited by its high fibre content. Moreover, the high fibre content reduces the digestibility. Therefore, it has been concluded that when utilizing buckwheat seed hulls as a feed component for ruminants, the ration must be balanced with supplements rich in energy and protein.

Keywords: Buckwheat hull, Chemical composition, *In vitro* true digestibility, Ruminant nutrition

Introduction

Reducing the use of crops and feed materials suitable for human consumption in the diets of livestock can mitigate the competition between food and feed, offering a viable strategy to enhance the sustainability of ruminant production systems (Schader et al., 2015). Promoting more sustainable feeding practices for ruminants, such as incorporating by-products from food processing industries into their diets, can further enhance the environmental and economic sustainability of livestock production (Cornale et al., 2022). In this respect, it is thought that hulls of buckwheat seeds, which is a byproduct of the processing of buckwheat for milling or other purposes, can be considered as an alternative feed ingredient for ruminants.

Buckwheat, a dicotyledon belonging to the *Polygonaceae* family and the *Fagopyrum* genus (Campbell, 1997), is not a cereal but is often grouped with cereals due to its cultivation and use (Eggum et al., 1980). Although there are about 15 species within this genus, only two species of buckwheat, common buckwheat (*Fagopyrum esculentum* Moench) and Tartary buckwheat (*Fagopyrum tataricum* (L.) Gaertn.), are cultivated globally. Both species originate from China, with common buckwheat accounting for 90% of the world's buckwheat production (Aubert et al., 2021). In 2022, the Russian Federation and China were responsible for 77.3% of the total world buckwheat production of 2,236,492 tons (FAO, 2024).

Buckwheat has a triangular seed, which is covered by a hull (pericarp). The hull may be a glossy or dull brown, black or grey (Mishra & Jain, 2019; Skřivan et al., 2023). Buckwheat hulls are a by-product generated during the processing of buckwheat grain into groats, which is 25–30% of the weight of the whole buckwheat grain (Joka Yildiz et al., 2022; Bączek et al., 2023). Research on the composition and processing of buckwheat hulls is relatively limited. Dziadek et al., (2016) reported that the composition of buckwheat hulls varies with the cultivar, containing 1.88-2.06% minerals, 5.13-5.68% proteins, 0.50-0.81% crude fat, 91.72-92.19% total carbohydrates, and 0.15-2.26% starch. The hulls contained a higher amount of dietary fiber, lignin and cellulose fractions (Dziedzic et al., 2012).

In Türkiye, the interest in buckwheat has increased due to the growing consumer interest in gluten-free foods, the emergence of new information on the health benefits of buckwheat, and its potential to recover marginal areas. The cultivated area of buckwheat

in Türkiye was 1,685 ha, and about 2,530 ton of buckwheat was produced in 2023 (TUİK, 2024). There are two registered buckwheat cultivars known as Aktaş and Güneş (Biçer & Özyazıcı, 2020).

This study aimed to investigate the chemical composition and *in vitro* true dry matter digestibility (IVTDMD) of the hulls of buckwheat cultivars named Güneş and Aktaş.

Materials and Methods

Experimental materials

The buckwheat (*Fagopyrum esculentum* Moench.) cultivars named Aktaş and Güneş, developed at the Konya Bahri Dağdaş International Agricultural Research Institute, were used as experimental materials. The hulls obtained from the processing of these cultivars were sourced from the Bulvar Food Factory in Konya-Türkiye in 2023.

Chemical analysis of samples

The samples were ground through a 1 mm screen in a Wiley mill and then used for the chemical analyses. All chemical analyses were carried out in triplicate. Dry matter (DM), crude protein (CP) and ash analyses were carried out according to AOAC (1998). Ether extract (EE) analysis was carried out using the Ankom XT15 Extraction System device according to AOCS (2005). The contents of the neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined according to Van Soest et al. (1991) using an Ankom 2000 Fiber Analyzer (Ankom Technology Corporation, Fairport, NY, USA).

Prediction of energy values in samples

The metabolic energy value was calculated according to the following equation 1, as reported by the TS 9610 standard (TSI, 1991).

ME (kcal/kg OM) = 3260 + (0.455 x CP) – (4.037 x CF + 3.517 x EE) (1)

ME: Metabolic energy (kcal/kg)

CP: Crude Protein (%)

CF: Crude Fiber (%)

EE: Ether extract (%)

Determination of in vitro true dry matter digestibility of samples

To determine the IVTDMD of the samples, the Ankom DaisyII *in vitro* fermentation system (Ankom Technology Corp. Fairport, NY, USA) was used. Buffer solution and

rumen fluid, collected from three healthy male Holstein cattle (1.5 years old and weighing 400-450 kg), slaughtered at a private slaughterhouse, were added to the digestion jars. Following a 48-hour incubation at 39°C, the jars were taken out of the incubator, the incubation liquid was disposed of, and the bags were washed four times using distilled water. For assessing the *in vitro* true digestibility, the samples were processed using an Ankom fiber (NDF) analyzer, where they were boiled for 75 minutes in a neutral detergent solution. After boiling, the samples were twice rinsed in acetone for 5 minutes each and subsequently dried at 100 °C for a duration of 24 hours. The weight of the bags post-NDF analysis, denoted as W3, was recorded and utilized to calculate digestibility. The computation of the IVTDMD was performed according to the following equation 2, which is detailed in Ankom Technology Method 3.

IVTDMD (%) = 100 – [(W3 – (W1×C1)) × 100)] / (W2 × %DMFeed) (2)

W1: the weight of the filter bag, W2: the weight of the sample, W3: the final weight (filter bag + sample), DMFeed: the percentage of dry matter contained in the feed, and C1: the correction factor for a blank filter bag.

Statistical analyses

The Independent Sample T-Test was used to compare the differences between the means, supplied by the Statistical Analysis System (SAS, 1998).

Findings and Discussion

The chemical compositions and energy values of hulls of buckwheat seed were presented in Table 1. Between the cultivars, there were no significant differences in the contents of DM, ash, CP, EE, and NFE ($P>0.05$). However, statistically significant differences were detected in the concentrations of CF and ME among the cultivars ($P<0.05$).

The average content of ash, which was determined in buckwheat hulls, was 2.54 %. The results correspond to data published by Gasiorowski (2008) and Biel & Maciorowski's (2013). Lower ash content, 1.97%, was reported in hulls by Dziadek et al. (2016). Although protein content was the main chemical component that was affected by cultivar (Vojtíšková et al., 2012; Siracusa et al., 2017), the content of protein in hulls was not affected by cultivar. The determined CP contents for the Güneş and Aktaş cultivars were 6.87% and 6.68%, respectively, confirming Biel & Maciorowski's (2013) findings for the Kora cultivars. Barton et al. (2005) and Dziadek et al. (2016) reported lower CP content

in hulls, with values of 4.17 and 5.42, respectively. EE, a component significantly contributing to the total energy content of buckwheat hulls, was found to be low in the hulls of the cultivars, consistent with the reports by Vojtíšková et al. (2012) and Biel & Maciorowski's (2013).

Table 1. Mean chemical composition (DM %) and energy values (kkal kg^{-1} DM) hulls of buckwheat seed

Nutrients	Güneş		Aktaş		*p*-Value
	Mean	SEM	Mean	SEM	
DM	87.53	0.353	88.12	0.028	0.173
Ash	2.42	0.108	2.66	0.266	0.457
CP	6.87	0.188	6.68	0.244	0.563
EE	1.15	0.049	1.32	0.105	0.222
CF	46.15	0.493	48.66	0.476	0.022*
NFE	43.40	0.762	40.69	0.950	0.090
ME	1389.71	19.485	1285.89	26.241	0.034*

DM: Dry matter; CP: Crude protein; EE: Ether extract; CF: Crude fiber, NFE: nitrogen free extract, Me: Metabolic energy, SEM: Standard error mean.

Among the examined cultivars of buckwheat, Güneş was characterized by a lower content of CF in hulls (46.15%), in comparison to the Aktaş (48.66%). Biel & Maciorowski (2013) reported a CF content of 48.8% in the hulls of the Kora cultivar, which corresponds with our findings. However, they recorded a higher CF content of 53.4% for the Panda cultivar, in contrast to our lower results.

The NFE content of buckwheat hulls, determined as the average of the two cultivars in present study, was found to be in the range of 38.2% to 41.7%, as reported by Biel & Maciorowski (2013). Cultivars differed in the content of ME. Güneş cultivar contained significantly more ME in comparison to Aktaş cultivar due to its lower CF content. The ME content in the hulls of buckwheat cultivars Güneş and Aktaş was 1389.71 and 1285.89 kcal kg^{-1} DM, respectively, which was lower than the 1600 kcal kg^{-1} DM reported by Heuzé et al. (2019). The chemical profile of buckwheat hull varies depending on many factors, such as cultivar, location of cultivation, and related weather and agrotechnical conditions (Wiśniewska et al., 2023).

The results of the fiber composition of the buckwheat hulls were presented in Table 2. The effect of the cultivars on the fiber composition of the buckwheat hulls was significant

(P<0.05). The cultivars differed in content of fiber fractions and Aktaş cultivar contained significantly more NDF, ADF, HS and S fractions than Güneş cultivar. (P<0.05).

Table 2. Mean fibre composition hulls of buckwheat seed (DM %)

Nutrients	Güneş		Aktaş		*p*-Value
	Mean	SEM	Mean	SEM	
NDF	82.24	0.399	83.64	0.416	0.042*
ADF	62.82	0.501	66.67	0.194	0.002**
ADL	29.54	0.491	30.29	1.008	0.539
HS	19.42	0.174	16.97	0.609	0.018*
S	33.29	0.755	36.38	0.865	0.044*

DM: Dry matter; NDF: Neutral detergent fiber; ADF: Acid detergent fiber; ADL: Acid detergent lignin; HC: Hemicellulose (NDF-ADF); C: Cellulose (ADF-ADL); SEM: Standard error mean.

The average NDF contents determined for Güneş and Aktaş buckwheat hulls were 82.24% and 83.64%, respectively. Our results correspond to data published by Biel & Maciorowski (2013), which reported the content of NDF at the level 83.4%. However, the same study reported higher contents of ADF and ADL (71.9% and 35.3%, respectively), and a lower content of HS (11.4%) in the hull. The content of S in buckwheat hulls, determined to be 33.29% for Güneş and 36.38% for Aktaş, was similar to the data published by Biel & Maciorowski (2013), which reported a content of 36.6%. From the literature, it is known that buckwheat hulls have the highest content of dietary fiber (Dziedzic et al., 2012; Heuzé et al., 2019; Matseychik et al, 2021). NDF is negatively related to the intake potential of feeds, and ADF is inversely associated with the digestibility of the feeds (Buxton, 1996). In this respect, buckwheat hulls, with an average 82.94% NDF and a 64.75% ADF content, are similar to high-fiber and low-protein roughages like mature grass hay (NRC 2001).

The mean IVTDMD of the buckwheat hulls were presented in Table 3. The hulls from Güneş exhibited significantly the highest value of IVTDMD in comparison to that from Aktaş (P<0.05). According to Buxton (1996), the cell wall concentration of the plant has a substantial effect on feed digestibility. The lower NDF content in the hulls of the Güneş cultivar resulted in a higher IVTDMD value.

Table 3. Mean *in vitro* true dry matter digestibility hulls of buckwheat seed (DM%)

Nutrients	Güneş		Aktaş		*p*-Value
	Mean	SEM	Mean	SEM	
IVTDMD	27.86	0.455	25.84	0.528	0.044*

DM: Dry matter; IVTDMD: *In vitro* true dry matter digestibility; SEM: Standard error mean.

Conclusion and Recommendations

Hulls of buckwheat seeds can serve as an alternative roughage for ruminant nutrition, taking into consideration the competition for food resources between humans and farm animals. However, the feeding value of the hulls is limited by their high fiber content. Moreover, this high fiber content reduces digestibility. The hull contains a high amount of fiber, more than most cereal products, but buckwheat hull also includes several useful substances such as biologically active polyphenolic complexes, flavonoids, and microelements (Matseychik et al., 2021). In conclusion, as a source of energy and protein for ruminants, the consideration of fiber content in buckwheat hulls, along with their essential amino acid and mineral content, is necessary. Further comprehensive studies will greatly benefit the integration of this potential into the field of animal nutrition.

References

AOAC. (1998) *Official Method of Analysis*. 15th Edition, Association of Official Analytical Chemists, Washington DC.

AOCS. (2005) AOCS Approved Procedure Am 5-04, Rapid determination of oil/fat utilizing high temperature solvent extraction. *AOCS Standard Procedure*, 5-04. from http://www.academia.edu/30938058/AOCS.

Aubert, L., Decamps, C., Jacquemin, G., & Quinet, M. (2021). Comparison of plant morphology, yield and nutritional quality of *Fagopyrum esculentum* and *Fagopyrum tataricum* grown under field conditions in Belgium. *Plants*, 10(2), https://doi.org/10.3390/plants10020258

Bączek, N., Haros, C. M., & Wronkowska, M. (2023). Buckwheat hull, a valuable bakery product ingredient: assessment of bioaccessible phenolics and antioxidant capacity. *European Food Research and Technology*, 249(2), 353-358. https://doi.org/10.1007/s00217-022-04120-w

Barton, H. J., Folta, M., Chlopicka, J., Zachwieja, Z., & Gumul, D. (2005). Antioxidant activity of five varieties of buckwheat seeds (*Fagopyrum esculentum* Moench). *Bromatologia i Chemia Toksykologicznal*, Supl. 71-74.

Biçer, A., & Özyazıcı, G. (2020). İkinci ürün olarak yetiştirilen karabuğday (*Fagopyrum esculentum* Moench.)'da vermikompost dozlarının verim ve bazı kalite özelliklerine etkisi. *Euroasia Journal of Mathematics, Engineering, Natural & Medical Sciences*, 7(9), 273-287. https://doi.org/10.38065/euroasiaorg.48

Biel, W., & Maciorowski, R. (2013). Evaluation of chemical composition and nutritional quality of buckwheat groat, bran and hull (*Fagopyrum esculentum* Möench L.). *Italian Journal of Food Science*, 25(4), 384-389.

Buxton, D. R. (1996). Quality-related characteristics of forages as influenced by plant environment and agronomic factors. *Animal Feed Science and Technology* 59(1-3): 37-49. https://doi.org/10.1016/0377-8401(95)00885-3

Campbell, C. G. (1997). Buckwheat: *Fagopyrum esculentum* Moench. Promoting the Conservation and Use of Underutilized and Neglected Crops. 19. International Plant Genetic Resources Institute: Rome, Italy, 95 p.

Cornale, P., Mimosi, A., & Battaglini, L. M. (2022). Reducing feed-food competition: impact of by-products and grazing in ruminant feeding. In: *Transforming food*

systems: ethics, innovation and responsibility, pp. 282-287, Wageningen Academic Publishers. https://doi.org/10.3920/978-90-8686-939-8_43

Dziadek, K., Kopeć, A., Pastucha, E., Piątkowska, E., Leszczyńska, T., Pisulewska, E., Witkowicz, R., & Francik, R. (2016). Basic chemical composition and bioactive compounds content in selected cultivars of buckwheat whole seeds, dehulled seeds and hulls. *Journal of Cereal Science*, 69, 1-8. https://doi.org/10.1016/j.jcs.2016.02.004

Dziedzic, K., Górecka, D., Kucharska, M., & Przybylska, B. (2012). Influence of technological process during buckwheat groats production on dietary fibre content and sorption of bile acids. *Food Research International*, 47(2), 279-283. https://doi.org/10.1016/j.foodres.2011.07.020

Eggum, B.O., Kreft, I. & Javornik, B. (1980). Chemical composition and protein quality of buckwheat (*Fagopyrum esculentum* Moench). *Plant Foods for Human Nutrition*, 30, 175–179. https://doi.org/10.1007/BF01094020

Food and Agriculture Organization (FAO). 2024. Crops and livestock products in the world. Access Address (19.03.2024): https://www.fao.org/faostat/en/#data/QCL

Gasiorowski, H. (2008). Buckwheat (part 2). Nutritional and chemical characteristics. *Przegląd Zbożowo-Młynarski*, 52, 14-17.

Heuzé, V., Tran, G., Maxin, G., & Lebas, F. (2019). Buckwheat (*Fagopyrum esculentum*) grain and by-products. *Feedipedia, a programme by INRAE, CIRAD, AFZ and FAO*, *11*(31). https://www.feedipedia.org/node/25140

Joka Yildiz, M., Cwalina, P. & Obidziński, S. A. (2022). comprehensive study of buckwheat husk co-pelletization for utilization via combustion. *Biomass Conversion and Biorefinery*. 1-18. https://doi.org/10.1007/s13399-022-03552-4

Matseychik, I. V., Korpacheva, S. M., Lomovsky, I. O., & Serasutdinova, K. R. (2021, February). Influence of buckwheat by-products on the antioxidant activity of functional desserts. In *IOP Conference Series: Earth and Environmental Science*, 640, 022038. https://doi.org/10.1088/1755-1315/640/2/022038

Mishra, M., & Jain, S. (2019). Effect of soaking and germination on nutritional profile and antinutrients of Buckwheat whole (Fagopyrum esculentum). *International Journal of Current Microbiology and Applied Sciences*, 8(2), 3384-3393. https://doi.org/10.20546/ijcmas.2019.802.394

National Research Council (NRC). (2001). Nutrient Requirements for Dairy Cattle. 7th Revised Edition, National Academy Press, Washington DC, 405 p. https://doi.org/10.17226/9825

SAS Institute. (1998). Statistical Analysis System Institute: *StatView Reference Manual*. Cary, NC, USA.

Schader, C., Muller, A., Scialabba, N. E. H., Hecht, J., Isensee, A., Erb, K. H., Smith, P., Makkar, H.P.S., Klocke, P.,Leiber, F., Schwegler, P., Stolze, M., & Niggli, U. (2015). Impacts of feeding less food-competing feedstuffs to livestock on global food system sustainability. *Journal of the Royal Society Interface*, 12(113), 20150891. https://doi.org/10.1098/rsif.2015.0891

Siracusa, L., Gresta, F., Sperlinga, E., & Ruberto, G. (2017). Effect of sowing time and soil water content on grain yield and phenolic profile of four buckwheat (Fagopyrum esculentum Moench.) varieties in a Mediterranean environment. *Journal of Food composition and Analysis*, 62, 1-7. https://doi.org/10.1016/j.jfca.2017.04.005

Skřivan, P., Chrpová, D., Klitschová, B., Švec, I., & Sluková, M. (2023). Buckwheat flour (*Fagopyrum Esculentum* Moench)—A contemporary view on the problems of its production for human nutrition. *Foods*, 12(16), 3055. https://doi.org/10.3390/foods12163055

Turkish Standard Institute (TSI). (1991). Turkish Standard Institute, TS 9610- Animal feeds-metabolic energy determination (Chemical Method). TSI Nr: 9610, Ankara, Turkey

Turkish Statistical Institute (TUIK). (2024). Crop production statistics in Turkey. Access Address (19.03.2024): https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr

Van Soest, P. V., Robertson, J. B., & Lewis, B. A. (1991). Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. *Journal of Dairy Science*, 74(10), 3583-359 7. https://doi.org/10.3168/jds.S0022-0302(91)78551-2

Vojtíšková, P., Kmentová, K., Kubáň, V., & Kráčmar, S. (2012). Chemical composition of buckwheat plant (*Fagopyrum esculentum*) and selected buckwheat products. *Journal of Microbiology Biotechnology and Food Sciences*. 1 (February Special issue), 1011-1019

Wiśniewska, M., Mańkowski, D. R., & Fraś, A. (2024). Variations in chemical composition of common buckwheat (Fagopyrum esculentum Moench) as a result of different environmental conditions. Journal of the Science of Food and Agriculture, 104(1), 286-294. https://doi.org/10.1002/jsfa.12917

ANALYSIS OF VOLATILE OIL COMPOSITION AND FATTY ACID PROFILES OF CARDAMOM SEEDS

Dr. Öğr. Üyesi Damla ÖNDER (ORCID: 0000-0002-6639-3818)
Süleyman Demirel University, Faculty of Engineering and Natural Sciences, Department of Biology, Isparta-Türkiye
Email: damlaguvercin@sdu.edu.tr

Shahad WALEED KHALID KHALID* (ORCID: 0000-0002-5944-8630)
Süleyman Demirel University, Faculty of Engineering and Natural Sciences, Department of Biology, Isparta-Türkiye
Email: wshahd899@gmail.com

Dr. Öğr. Üyesi Sercan ÖNDER (ORCID: 0000-0002-8065-288X)
Isparta University of Applied Sciences, Faculty of Agriculture, Department of Agricultural Biotechnology, Isparta-Türkiye
Email: sercanonder@isparta.edu.tr

Öğr. Gör. Ümit ERDOĞAN (ORCID: 0000-0002-6627-4472)
Isparta University of Applied Sciences, Rose and Aromatic Plants Application and Research Center, Isparta- Türkiye
Email: umiterdogan@isparta.edu.tr

ABSTRACT
Cardamom (*Elettaria cardamomum*), which is generally regarded as small cardamom, Indian cardamom, green cardamom, or true cardamom. It is a herbaceous perennial plant that belongs to the Zingiberaceae family and is grown in India, Guatemala, Sri Lanka, Nepal, Indonesia, Costa Rica, Mexico and Tanzania. Cardamom capsules (fruits) have been used for traditional medicine applications including for the control of asthma, teeth and gum infections, cataracts, carminative, diarrhea, as well as cardiac, digestive and kidney disorders. The present study aimed to evaluate volatile oil yield and fatty acid profile of cardamom oil. The SPME analysis results discovered 66 constituents that constituted 100% of total volatile oil. Components in the classes of menthan monoterpenoid (36.63%), monoterpene hydrocarbon (12.18%) and oxygenated monoterpenes (47.42%) constitute 96.23% of the content of all volatile oil. Volatile oil of cardamom capsules possess predominantly monoterpene constituents, such as 1,8-cineole (23.54%), α-terpinyl acetate (36.37%), linalool (5.11%), linalyl acetate (9.04%), sabinene (3.97%) and β- Myrcene (3.80%) that can be used in food, aroma, and pharmaceutical applications. The composition of oil from cardamom seeds predominantly consisted of oleic acid (43.4%), palmitic acid (25.32%) and linolelaidic acid (15.2%). Fatty acid compositions were analyzed using gas chromatography (GC) and quantified 14 fatty acids. Among the fatty acids, cardamom oil contains 30.2%, 45.6% and 24.2% of oil of total saturated fatty acids (SFA), total mono unsaturated fatty acids (MUFA) and total polyunsaturated fatty acids (PUFA), respectively.
Keywords: cardamom, volatile oil, fatty acids, polyunsaturated fatty acids (PUFAs)

Introduction

Elettaria cardamomum (L.) which is generally regarded as small cardamom, green cardamom is an herbaceous plant that belongs to the Zingiberaceae family wherein the plant is cultivated in India, Guatemala, Costa Rica, Sri Lanka, El Salvador, Vietnam, Mexico, Indonesia and Tanzania (Garg et al., 2016). Cardamom is the third most expensive spice, after saffron and vanilla, and is also called the "queen of spices" because of its distinct flavor and scent. For centuries, cardamom capsules have been used in traditional medicine for controlling asthma, diarrhea, teeth and gum infections, digestive, kidney and cardiac disorders (Khan et al., 2011; Hamzaa & Osman, 2012; Saeed et al., 2014). The distinct scent and potential applications of cardamom as a functional food, medication, and nutraceutical are attributed to the essential oil and other bioactive metabolites that accumulate in the capsules (Hamzaa & Osman, 2012). The production of nutraceuticals from agricultural materials and the byproducts of food processing and agriculture could improve human health and add value to the crop production and processing industries (Parry et al., 2008). Bioactive metabolites in cardamom essential oil (CEO) contribute to its characteristic strong aromatic aroma and applications of cardamom in novel food and pharmaceutical products (Hamzaa & Osman, 2012; Ashokkumar et al., 2019). Depending on the extraction and processing techniques, the CEO content in cardamom capsules can vary from 6 to 14% (Nirmala Menon, 2000). The composition of the CEO may depend on the origin of the sample, the varieties and the parts used (Ashokkumar et al., 2020). In CEO, oxygenated monoterpenes represent 51–71% of the detected components, and monoterpenes such as α-terpinyl acetate, 1,8-cineole, sabinene are the main compounds (Ashokkumar et al., 2019; Bampidis et al., 2019). Potential pharmacological and medicinal uses of these main ingredients include anti-inflammatory, antidiabetic, antitumor, antioxidant, antiviral, and gastroprotective effects (Hamzaa & Osman, 2012; Winarsi et al., 2014). The current study's objective was to investigate the volatile oil yield and fatty acids composition of the cardamom seed oil.

Materials and Methods

Plant material

Cardamom seeds (*Elettaria cardamomum*) were collected from a local market in the Baghdad region (Iraq). Cardamom gardens were irrigated with rainfed, the gardens were

subjected to similar agricultural practices, and cardamom seeds were harvested at full ripeness. The green-colored cardamom was chosen for its pungent scent.

Determination of fatty acid compositions

Powdered cardamom seeds were placed in a cellulose thimble and placed in the extraction chamber of the Soxhlet apparatus and placed in a distillation flask filled with 200 mL of n-hexane solvent. The samples were extracted under reflux for 4 h and the n-hexane solvent was removed using a rotary vacuum evaporator at 40 °C to obtain oils. Fatty acid components were determined from the obtained oil.

Fatty acid compositions were determined by gas chromatography (Shimadzu GC-2025, Japan) equipped with a flame ionization detector (FID). The analysis was carried out by the Teknochroma TR-CN100 selection column (100 m length, 0.25 mm i.d., 0.20 µm film thickness) for the separation of the components. The carrier gas was nitrogen under an internal pressure of 10 psi. The initial oven temperature was held at 140 °C for 10 min, then gradually increased to 240 °C at 3 °C min-1 and maintained held there for 10 min. The injector temperature 250 °C and the detector temperature 260 °C. Fatty acid identification was achieved by comparing the relative retention times of the peaks with those of the commercial standard mix of fatty acid methyl esters. The results were expressed as the relative percentage of each fatty acid in the total.

Determination of floral scent with HS-SPME-GC–MS

The cardamom seeds were dried in the shade at room temperature for 7 days and the powder samples was used for analysis. Before extraction, samples were conditioned at 40 °C for 5 min, and floral scent components were extracted at the same temperature for 30 min. The extraction was performed with solid phase microextraction (SPME, Supelco, Germany) with a fiber precoated with a 75 µm-thick layer of Carboxen/Polydimethylsiloxane (CAR/PDMS).

Analyses were performed using Shimadzu 2010 Plus GC–MS (Shimadzu, Kyoto, Japan) equipped with a Restek Rxi®−5Sil MS capillary column (30 m × 0.25 mm × 0.25 µm; Crossbond®, similar to 5% diphenyl/95%dimethyl polysiloxane). The injector temperature was set at 280 °C, the initial oven temperature was held at 60 °C for 10 min, then gradually increased to 250 °C at 2 °C min^{-1}, and maintained held at 250 °C for 15 min. The carrier gas was helium with a flow rate of 1.0 mL min^{-1} and a split ratio of 1:10. The interface temperature and ion source temperature of the MS were 280 °C, and the

scan mode was 35–450 m/z. Identification of constituents was based on mass spectra and linear retention indexes with data provided in the Wiley, NIST Tutor, Flavors and Fragrances of Natural and Synthetic Compounds 3.0 (FFNSC 3.0) library. The component quantity calculation was based on peak area normalization. The quantitative determination was conducted using Gas Chromatography/Flame Ionization Detector (GC-FID), operating at the same conditions of GC-MS.

Findings and Discussion

3.1. Fatty Acids Composition

In the present study, 14 fatty acids were identified and quantified, utilizing GC-FID analyses (Table 1). The results, given in Table 1, show that oleic (C18:1n9c), palmitic acid (C16:0) and linolelaidic acid (C18:2n6t) are the major constituents of cardamom. Palmitic (C16:0, 25.32%), stearic (C18:0, 2.13%), and myristic (C14:0, 1.15%) acids were the main saturated fatty acids (SFA). The results agree with Parry et al. (2006), who reported that cold pressed cardamom oil contained oleic (49%), palmitic (26%), and linoleic (15%) as abundant fatty acids. According to reports, cardamom seeds had 40.6%–49% of oleic acid (Hamdan et al., 2008), which is consistent with the results of the current study. The percentages of monounsaturated fatty acids (MUFA), saturated fatty acids (SFA), and polyunsaturated fatty acids (PUFA) were 45.57%, 30.23%, and 24.2%, respectively. More than 55% of the oil isolated from the cardamom seed was composed of SFA (Tan et al., 2023). However, in the present study, the oil of the seed flour was highly unsaturated, containing about 70% unsaturated FA. The difference could be a result of the Soxhlet extraction's high temperatures and long extraction times. The PUFA may be better preserved under the generally mild extracting conditions used in oil extraction (Tan et al., 2018). For nutritional and medicinal purposes, cardamom oil is unique due to its high content of MUFA and PUFA and its composition of fatty acids (Ramadan et al., 2022).

Table 1. Fatty acid composition of cardamom

SFA		**Fatty acids (%)**
C11:0	Undecanoic acid	0.1437
C12:0	Lauric acid	0.9226
C14:0	Myristic acid	1.1479
C15:0	Pentadecylic acid	0.1428
C16:0	Palmitic acid	25.3228
C18:0	Stearic acid	2.1312
C21:0	Heneicosanoic acid	0.4183
	Total SFA	30.2293
MUFA		
C16:1	Palmitoleic acid	1.5829
C18:1n9c	Oleic acid	43.4361
C20:1n9	cis-11-eicosenoic acid	0.5527
	Total MUFA	45.5717
PUFA		
C18:2n6t	Linolelaidic acid	15.2138
C18:3n6	gama-linolenic acid	3.1007
C18:3n6	alfa-linolenic acid	0.9500
C22:2	cis-13,16-docosadienoic acid	4.9345
	Total PUFA	24.1990

3.2. Volatile Oil Composition

Volatile compounds are responsible for the aroma of the product from firm fruits, flavored with other positive notes that make cardamom essential oil a unique, edible oil. The volatile oils of cardamom are used as flavoring ingredients in various types of foods, including alcoholic and non-alcoholic beverages, frozen desserts, confectionery, puddings, and baked goods. Cardamom oil is also mixed with massage oil, perfumes and lotions due to its relaxing properties (Madhusoodanan et al., 2002). The chemical profile of cardamom volatile oil showed the presence of 66 constituents when the powdered seed sample was subjected to a headspace SPME GC-MS analysis (Table 2). In terms of general categories, the 66 components identified in the oil are: 17 oxygenated monoterpenes (47.42%), 3 menthane monoterpenoid (36.63%), 14 monoterpene hydrocarbons (12.18%), 7 ester (1.29%), 5 aldehyde (0.80%), 12 sesquiterpene hydrocarbon (0.60%), 1 oxygenated sesquiterpene (0.41%), 1 aliphatic nitriles (0.23%),

1 carboxylic Acids (0.18%), 1 aliphatic alcohol (0.11%), 1 cycloalkene (0.08%), 1 alkene (0.05%), 1 cycloalkanes (0.01%), and 1 ketone (0.01%). The constituents found in the greatest quantity were α-terpinyl acetate (36.37%), eucalyptol (1,8-Cineole) (23.54%), linalyl acetate (9.04%) and linalool (5.11%). Volatile oils were collected in 14 different classes and oxygenated monoterpenes dominated oil composition with 47.42%, followed by menthane monoterpenoid (36.63%) and monoterpene hydrocarbon (12.18%) constitute 96.23% of the content of all volatile oil. Monoterpenic essential oils are reported to natural antioxidants and to have anti-cancer activities (Yanishlieva et al., 1999; Sharma et al., 2009). Also, it is notable that monoterpene hydrocarbons are less valuable than oxygenated compounds in terms of their contribution to the fragrance of the essential oils (Uysal et al., 2011). Among the monoterpenes, α-terpinyl acetate (36.37%) is the predominant constituent and was found in volatile oil of cardamom. Similar results were observed in earlier studies (Ashokkumar et al., 2019), based on that highest α-terpinyl acetate (61.3%) was observed. The second most major monoterpene constituent, eucalyptol (23.54%), also presents cardamom's essential oil. The concentration of α-terpinyl acetate (30.6-41.2%) was greater than eucalyptol (22.0–28.1%) according to a different study by Paul et al. (2020) and Yassin et al. (2022). According to a recent study conducted by Alagupalamuthirsolai et al. (2019), cardamom variety Appangala-1 had a eucalyptol concentration of 41.8% under 75% shade condition. This higher concentration could depend on varietal difference and environmental effects (Ashokkumar et al., 2020). Eucalyptol is a colorless monoterpene that tastes spicy and cool and smells like camphor (Tan et al., 2023). According to Cai et al. (2021), this compound has been shown to mitigate oxidative stress and inflammatory responses by modulating the nuclear factor-kappa B and nuclear factor erythroid-2-related factor 2 pathways. However, α-terpinyl acetate is a monoterpene ester that smells like lavender and herbaceous flowers. Additionally, against fungi and dermatophytes, this compound showed a strong antimicrobial effect (Vaičiulytė et al., 2021).

Table 2. Volatile oil composition (relative content, %) of cardamom and its classes

No	RI[a]	Components	Class	Volatile oil (%)
1	1.898	Acetic acid	Carboxylic Acids	0.18
2	4.617	Hexanal	Aldehyde	0.02
3	8.506	alpha- Thujene	Monoterpene hydrocarbon	0.48
4	8.748	alpha- Pinene	Monoterpene hydrocarbon	1.16
5	9.316	Camphene	Monoterpene hydrocarbon	0.01
6	10.269	Sabinene	Monoterpene hydrocarbon	3.97
7	10.384	beta- Pinene	Monoterpene hydrocarbon	0.38
8	10.765	6-Methyl-5-hepten-2-one	Ketone	0.01
9	10.969	beta- Myrcene	Monoterpene hydrocarbon	3.80
10	11.462	Octanal	Aldehyde	0.50
11	11.982	alpha- Terpinene	Monoterpene hydrocarbon	0.35
12	12.220	p-Cymene	Monoterpene hydrocarbon	0.03
13	12.440	Limonene	Monoterpene hydrocarbon	0.42
14	12.762	Eucalyptol (1,8-Cineole)	Oxygenated monoterpenes	23.54
15	13.148	trans- beta- Ocimene	Monoterpene hydrocarbon	0.27
16	13.574	gamma- Terpinene	Monoterpene hydrocarbon	0.77
17	14.057	trans-Sabinene hydrate	Oxygenated monoterpenes	0.67
18	14.180	1-Octanol	Aliphatic alcohol	0.11
19	14.618	alpha- Terpinolen	Monoterpene hydrocarbon	0.50
20	14.862	beta-Pineoxid	Oxygenated monoterpenes	0.11
21	15.371	Linalool	Oxygenated monoterpenes	5.11
22	15.744	Geranyl nitrile	Aliphatic nitriles	0.23
23	16.155	Sabinene hydrate	Monoterpene hydrocarbon	0.02
24	16.295	(4E,6Z)-2,6-Dimethyl-2,4,6-	Monoterpene hydrocarbon	0.02
25	16.447	cis- Limonene oxide	Oxygenated monoterpenes	0.05
26	16.617	trans- Limonene oxide	Oxygenated monoterpenes	0.01
27	16.752	1,1,2-Trimethyl-3-(2-methyl-1-propenylidene)cyclopropane	Cycloalkanes	0.01
28	17.911	p-menth-1-en-8-ol	Oxygenated monoterpenes	0.17
29	18.304	4-Terpineol	Oxygenated monoterpenes	1.00
30	18.935	alpha-Terpineol	Oxygenated monoterpenes	2.83
31	19.276	Decanal	Aldehyde	0.11
32	19.459	n-Octyl acetate	Ester	0.14
33	19.674	4-Terpinenyl acetate	Oxygenated monoterpenes	1.70
34	20.461	Z-Citral	Oxygenated monoterpenes	0.54
35	20.665	Carvone	Oxygenated monoterpenes	0.01
36	21.039	Linalyl acetate	Oxygenated monoterpenes	9.04
37	21.075	trans-Geraniol	Oxygenated monoterpenes	1.28
38	21.351	Dec-2(E)-enal	Aldehyde	0.03
39	21.590	E-Citral	Oxygenated monoterpenes	1.24
40	22.123	Bornyl acetate	Oxygenated monoterpenes	0.05
41	22.543	4-Terpinenyl acetate	Oxygenated monoterpenes	0.07
42	22.794	1,5,5-Trimethyl-4-vinyl-1-	Cycloalkene	0.08
43	23.148	Ocimenyl acetate	Ester	0.24
44	23.472	Methyl geranate	Ester	0.14
45	23.910	delta- Elemene	Sesquiterpene hydrocarbon	0.02
46	24.793	alpha- Terpinyl acetate	Menthane monoterpenoid	36.37
47	25.227	alpha- Ylangene	Sesquiterpene hydrocarbon	0.03
48	25.446	Geranyl acetate	Ester	0.66
49	25.721	Z-4-Tridecen-1-yl acetate	Ester	0.03
50	25.803	Z-7-Tetradecenal	Aldehyde	0.14
51	26.820	trans-Caryophyllene	Sesquiterpene hydrocarbon	0.02
52	27.130	Germacrene B	Sesquiterpene hydrocarbon	0.02
53	27.251	R(+)-LIMONEN	Menthane monoterpenoid	0.18
54	27.697	Limonene oxide	Menthane monoterpenoid	0.08

55	27.769	Alloaromadendrene	Sesquiterpene hydrocarbon	0.04
56	27.885	Farnesene <(E)-, beta->	Sesquiterpene hydrocarbon	0.01
57	28.042	(-)-cis-Carvyl acetate	Ester	0.06
58	28.419	Geranyl butyrate	Ester	0.02
59	28.808	Germacrene D	Sesquiterpene hydrocarbon	0.06
60	28.928	alpha- Gurjunene	Sesquiterpene hydrocarbon	0.03
61	29.065	Eudesma-4(14),11-diene	Sesquiterpene hydrocarbon	0.18
62	29.294	beta- Selinene	Sesquiterpene hydrocarbon	0.06
63	29.536	gamma- Cadinene	Sesquiterpene hydrocarbon	0.02
64	29.833	delta- Cadinene	Sesquiterpene hydrocarbon	0.11
65	31.326	d-Nerolidol	Oxygenated sesquiterpene	0.41
66	31.701	Squalene	Alkene	0.05
Class compositions (%)				
Aldehyde			0.80	
Aliphatic alcohol			0.11	
Aliphatic nitriles			0.23	
Alkene			0.05	
Carboxylic Acids			0.18	
Cycloalkanes			0.01	
Cycloalkene			0.08	
Ester			1.29	
Ketone			0.01	
Menthane monoterpenoid			36.63	
Monoterpene hydrocarbon			12.18	
Oxygenated monoterpenes			47.42	
Oxygenated sesquiterpene			0.41	
Sesquiterpene hydrocarbon			0.60	
Total			100	

[a]Retention index were determined on a Restek Rxi®-5Sil MS column using a set of standards consisting of C_7-C_{30} *n*-alkanes

Conclusion and Recommendations

The present study investigated the fatty acids yield and volatile oil constituents of cardamom with SPME-GC analysis. Overall, *E. cardamomum* is a functional food as well as a nutraceutical, and taking cardamom capsules on a regular basis could protect people from a number of chronic diseases. A new potential natural source that can be used in the food, fragrance, cosmetics, and pharmaceutical industries is cardamom oil, which contains biologically active molecules like α-terpinyl acetate and eucalyptol as major constituents. Further research of these seed flours may lead to value-added use of these by products in improving human health while enhancing the profitability of seed production and seed oil industries.

References

Alagupalamuthirsolai, M., Ankegowda, S., Murugan, M., Sivaranjani, R., Rajkumar, B. & Akshitha, H. (2019). Influence of light intensity on photosynthesis, capsule yield, essential oil and insect pest incidence of small cardamom (*Elettaria cardamomum* (L.) Maton). *Journal of Essential Oil Bearing Plants*, 22, 1172–1181. doi: 10.1080/0972060X.2019.1690587

Ashokkumar, K., Murugan, M., Dhanya, M., Raj, S. & Kamaraj, D. (2019). Phytochemical variations among four distinct varieties of Indian cardamom *Elettaria cardamomum* (L.) Maton. *Natural Product Research*, 34, 1919–1922. doi: 10.1080/14786419.2018.1561687

Ashokkumar, K., Murugan, M., Dhanya, M. & Warkentin, T. (2020). Botany, traditional uses, phytochemistry and biological activities of cardamom [*Elettaria cardamomum* (L.) Maton] - a critical review. *Journal of Ethnopharmacology*, 246:112244. doi: 10.1016/j.jep.2019.112244

Bampidis V, Azimonti G, de Lourdes Bastos M, Christensen H, Kouba M, Kos Durjava M, López-Alonso M, López Puente S, Marcon F, Mayo B, Pechová A, Petkova M, Ramos F, Sanz Y, Villa R, Woutersen R, Brantom P, Chesson A, Kolar B. & Dusemund B (2019). Safety and efficacy of an essential oil from *Elettaria cardamomum* (L) Maton when used as a sensory additive in feed for all animal species. EFSA J. https:// doi. org/ 10. 2903/j. efsa. 2019. 572

Cai, Z. M., Peng, J. Q., Chen, Y., Tao, L., Zhang, Y. Y., Fu, L. Y., ... & Shen, X. C. (2021). 1, 8-Cineole: A review of source, biological activities, and application. *Journal of Asian natural products research*, 23(10), 938-954. https:// doi. org/ 10.1080/10286020.2020.1839432

Garg, G., Sharma, S., Dua, A. & Mahajan, R. (2016). Antibacterial potential of polyphenol rich methanol extract of Cardamom (*Amomum subulatum*). *Journal of Innovative Biology*, 3, 271–275.

Hamdan, S., Daood, H. G., Toth-Markus, M. & Illés, V. 2008. Extraction of cardamom oil by supercritical carbon dioxide and sub-critical propane. *Journal of Supercritical Fluids*, 44(1), 25–30.

Hamzaa, R. & Osman, N. (2012). Using of coffee and cardamom mixture to ameliorate oxidative stress induced in γ-irradiated rats. *Biochemistry & Analytical Biochemistry*. 1, 113–119. doi: 10.4172/2161-1009.1000113

Khan, A.-U., Khan, Q. J. & Gilani, A.-H. (2011). Pharmacological basis for the medicinal use of cardamom in asthma. *Bangladesh Journal of Pharmacology*, 6, 34–37. doi: 10.3329/bjp.v6i1.8133

Madhusoodanan, K. J., Kumar, K. P., & Ravindran, P. N. (2002). Botany, crop improvement and biotechnology of cardamom. In *Cardamom* (pp. 27-84). CRC Press

Nirmala Menon, A. (2000). Studies on the volatiles of cardamom (*Elleteria cardamomum*). *Journal of Food Science and Technology*, 37, 406–408.

Parry, J. W., Cheng, Z., Moore, J. & Yu, L. L. (2008). Fatty acid composition, antioxidant properties, and antiproliferative capacity of selected cold-pressed seed flours. *Journal of the American Oil Chemists' Society*, 85, 457-464. https://doi.org/10.1007/s11746-008-1207-0

Paul, K., Ganguly, U., Chakrabarti, S. & Bhattacharjee, P. (2020). Is 1, 8-cineole-rich extract of small cardamom seeds more effective in preventing Alzheimer's disease than 1, 8-cineole alone?. *Neuromolecular Medicine*, 22, 150-158. https://doi.org/10.1007/s12017-019-08574-2

Ramadan, M. F., Khider, M., Elbanna, K., Abulreesh, H. H. & Assiri, A. M. (2022). Rediscovery of cold pressed cardamom (Elettaria cardamomum L.) oil: a good source of fat-soluble bioactives with functional and health-enhancing traits. Rendiconti Lincei. *Scienze Fisiche e Naturali*, 33(3), 631-642. https://doi.org/10.1007/s12210-022-01081-w

Saeed, A., Sultana, B., Anwar, F., Mushtaq, M., Alkharfy, K. M. & Gilani, A.-H. (2014). Antioxidant and antimutagenic potential of seeds and pods of green cardamom (Elettaria cardamomum). *International Journal of Pharmacology*, 10, 461–469. doi: 10.3923/ijp.2014.461.469

Sharma, P.R., Dilip, M.M., Muthiah, S., Pal, H.C., Shahi, A.K., Saxena, A.K. & Qazi, G.N. (2009). Anticancer activity of an essential oil from Cymbopogon flexuosus. *Chemico-Biological Interactions.* 179: 160-168. https://doi.org/10.1016/j.cbi.2008.12.004

Tan, C. X., Chong, G. H., Hamzah, H. & Ghazali, H. M. (2018). Comparison of subcritical CO2 and ultrasound-assisted aqueous methods with the conventional solvent method in the extraction of avocado oil. The Journal of Supercritical Fluids, 135, 45-51. https://doi.org/10.1016/J.SUPFLU.2017.12.036

Tan, C. X., Tan, S. S. & Tan, S. T. (2023). Composition and Functional Properties of Cardamom Seeds. In *Cardamom* (*Elettaria cardamomum*): Production, Processing and Properties (pp. 93-104). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-35426-7_7

Uysal, B., Sozmen, F., Aktas, O., Oksal, B.S. & Kose, E.O. (2011). Essential oil composition and antibacterial activity of the grapefruit (*Citrus paradisi* L.) peel essential oils obtained by solvent-free microwave extraction: comparison with hydrodistillation. *International Journal of Food Science and Technology.* 46(7): 1455-1461. https://doi.org/10.1111/j.1365-2621.2011.02640.x

Vaičiulytė, V., Ložienė, K., Švedienė, J., Raudonienė, V., & Paškevičius, A. (2021). α-Terpinyl acetate: Occurrence in essential oils bearing Thymus pulegioides, phytotoxicity, and antimicrobial effects. *Molecules,* 26(4), 1065. https://doi.org/10.3390/molecules26041065

Yanishlieva, N.V., Marinova, E.M., Gordon, M.H. & Raneva, V.G. (1999). Antioxidant activity and mechanism of action of thymol and carvacrol in two lipid systems. *Food Chemistry*. 64: 59-66. https://doi.org/10.1016/S0308-8146(98)00086-7

Winarsi, H., Sasongko, N., Purwanto, A. & Nuraeni, I. (2014). Effect of cardamom leaves extract as antidiabetic, weight lost and hypocholesterolemic to alloxan-induced Sprague Dawley diabetic rats. *International Food Research Journal,* 21, 2253–2261.

Yassin, M. T., Mostafa, A. A. F., Al-Askar, A. A. & Alkhelaif, A. S. (2022). In vitro antimicrobial potency of Elettaria cardamomum ethanolic extract against multidrug resistant of food poisoning bacterial strains. *Journal of King Saud University-Science,* 34(6), 102167. https://doi.org/10.1016/j.jksus.2022.102167

DEPREMLERİN TARIM, ORMAN VE MERA ALANLARI ÜZERİNE ETKİLERİ

Dr. Öğr. Üyesi Bedriye BİLİR* (ORCID: 0000-0002-0038-9509)
Kahramanmaraş Sütçü İmam Üniversitesi, Ziraat Fakültesi, Toprak Bilimi ve Bitki Besleme Bölümü
Email:bbilir@ksu.edu.tr

Dr. Öğr. Üyesi Hava Şeyma İNCİ (ORCID: 0000-0002-2670-401X)
Bingöl Üniversitesi, Gıda Tarım ve Hayvancılık MYO, Bitkisel ve Hayvansal Üretim Bölümü, Tarla Bitkileri Programı
Email:hsyilmaz@bingol.edu.tr

ÖZET
Depremler, en yıkıcı doğal afetlerin başında yer almaktadır. Sadece binalara ve diğer yapılara zarar vermekle kalmayıp aynı zamanda çevreyi ve insanların yaşamlarını önemli ölçüde etkilemektedir. Depremlerin çevresel etkileri, birincil (çökme, yüzey faylanması vs.) ve ikincil etkiler (zemin çatlakları, sıvılaşma, toprak kayması ve tsunami) olarak sınıflandırılabilecek birçok ani değişiklikleri tetikleyebilmektedir. Depremler, orman ekosistemlerinin ciddi şekilde zarar görmesine, geniş bir çevre tahribatına ve önemli biyolojik çeşitlilik kayıplarına neden olmaktadır. Yüzey faylanması ve yer yüzeyinin şiddetli bir şeklide sarsılmasıyla toprak kayması veya çökme gibi nedenlerle ağaçlar sökülebilmekte ve geniş çaplı orman kayıpları meydana gelebilmektedir. Deprem gibi felaketler sonucunda tarım arazilerinin kullanımlarındaki değişiklik ve verimlilik dönüşümleri kritik hale gelmektedir. Bitkisel üretimin yapıldığı bölgeler genellikle sismik açıdan aktif alanların üzerinde yer almaktadır. Sismik bir olayın ardından tarım alanlarında büyük yarıklar ve çatlaklar oluşmakta ve su kanallarında, borularda ve alt yapıda meydana gelen hasarlar sonucu tarımsal üretim zarar görmektedir. Ayrıca deprem sonrası tohum depolama yapılarının tahrip olması, tohumların çökme ile toprağa gömülmesi gibi sebeplerden dolayı yerel çeşitlerin varlığı tehlikeye girebilmektedir. Yine meralarda depremler sonrası meydana gelen heyelanlar meralara ve bitki örtüsüne zarar vermektedir. Depremler sonucunda enkazlar ya da binaların yıkımları nedeniyle oluşan partikül madde ile ağır metaller (kadmiyum (Cd), krom (Cr), nikel (Ni), çinko (Zn)) artış göstermekte ve bu maddeler sağlık sorunlarının yanı sıra toprağın ve yeraltı sularının yapısına dahil olarak tarımsal üretimde ağır metal kirliliği riskine altyapı oluşturmaktadır. 6 Şubat 2023 yılında 2 büyük deprem ile sarsılan Türkiye'de olduğu gibi dünyada da tarım, orman ve mera alanlarındaki değişimler hakkında çalışmalar kısıtlıdır. Bu çalışmada, depremin tarım, orman ve mera alanları üzerindeki etkileriyle ilgili yapılan araştırmaların bir araya getirilmesi ve yapılacak incelemelere öneri ve öngörülerin oluşturulması amaçlanmıştır.
Anahtar Kelimeler: Deprem, Orman, Tarım, Mera

EFFECTS OF EARTHQUAKES ON AGRICULTURE, FOREST AND RANGELAND

ABSTRACT

Earthquakes are among the most destructive natural disasters. They not only damage buildings and other structures, but also significantly affect the environment and people's lives. The environmental effects of earthquakes can trigger many sudden changes that can be classified as primary (subsidence, surface faulting, etc.) and secondary effects (ground cracking, liquefaction, landslides and tsunamis). Earthquakes cause severe damage to forest ecosystems, widespread environmental destruction and significant biodiversity losses. Surface faulting and violent shaking of the earth's surface can cause landslides or subsidence, uprooting trees and causing large-scale forest loss. Changes in agricultural land use and productivity transformations become critical as a result of disasters such as earthquakes. Agricultural production areas are often located on seismically active areas. Following a seismic event, large cracks and fissures appear in agricultural areas and agricultural production suffers as a result of damage to water channels, pipes and infrastructure. In addition, the existence of local varieties may be threatened due to the destruction of seed storage structures after earthquakes and the collapse and burying of seeds in the soil. Again, landslides that occur in rangelands after earthquakes damage rangelands and vegetation. As a result of earthquakes, particulate matter and heavy metals (cadmium (Cd), chromium (Cr), nickel (Ni), zinc (Zn)) increase due to debris or destruction of buildings, and these substances not only cause health problems, but also create an infrastructure for the risk of heavy metal pollution in agricultural production by being included in the structure of soil and groundwater. On February 6, 2023, Turkey was devastated by two major earthquakes and studies on the changes in agricultural, forest and rangeland areas are limited in the world as well as in Turkey. In this study, it is aimed to bring together the studies on the effects of earthquakes on agricultural, forest and rangeland areas and to make suggestions and predictions for future studies.

Keywords: Earthquake, Forest, Agriculture, Rangeland

Giriş

Deprem, yerkabuğundaki enerjinin aniden açığa çıkması ile üretilen sismik dalgalar sonucu dünya yüzeyinin algılanabilir bir şekilde sarsılmasıdır. Deprem, en yıkıcı doğal afetlerden biridir. Sadece binalara ve diğer yapılara zarar vermekle kalmaz aynı zamanda çevreyi ve insanların yaşam tarzlarını önemli ölçüde etkiler. Bir deprem, çevrede birincil (çökme, yüzey faylanması vs.) ve ikincil etkiler (yer değiştiren kayalar, zemin çatlakları, sıvılaşma, toprak kayması ve tsunami) olarak sınıflandırılabilecek birçok ani değişikliği tetikleyebilir. Bütün bu etkiler depremin çevresel etkileri (earthquake environmental effects:EEE) olarak ifade edilmektedir (Choudhury ve ark., 2016). Başka bir ifade ile depremin çevresel etkileri (EEE) bir deprem tarafından ortaya çıkarılan süreçlerdir (Guerrieri ve ark., 2009; Silva ve ark., 2013).

Depremin birincil etkileri direkt depremin bir sonucu olarak ortaya çıkarken ikincil etkiler birincil etkilerin uyarılması veya tetiklenmesi ile ortaya çıkmaktadır (Tatevossian ve ark., 2009).

Daniell ve ark. (2017) ise depremlerin birincil etkisini, fay boyunca yüzey kırılması ve deprem enerjisi salınımı yoluyla yer sarsıntısından kaynaklandığını, ikincil etkilerin ise bu deprem sarsıntısı ve enerji salınımının bir sonucu olarak doğrudan meydana gelen heyelan veya tsunami gibi olayların başlaması olarak ifade etmektedir. Üçüncül etkilerin ise bir depremin birincil etkisinin, bir nükleer santrale zarar veren tsunami şeklinde ikincil bir etkiye neden olması ve ardından bir nükleer felaketin gelişmesi gibi basamaklı etkileri içerebileceğini belirtmiştir. Bu tür bir başka üçüncül etkinin de depremin etkilerinden kaynaklanan salgın hastalıklar veya açlık olduğunu ve çoğu zaman ikincil ve üçüncül etkiler arasında doğru bir ayrım yapmanın net olmadığını ve bazen tüm sürecin basitçe basamaklı bir etki olarak tanımlanabildiğini bildirmiştir.

Birincil Etki

Birincil etkiler, depremin doğrudan bir etkisi sonucu ortaya çıkmaktadır. Birincil etkilerin meydana gelmesi aynı zamanda depremin büyüklüğüne ve stres ortamına bağlıdır. İki aynı miktarda enerjiyi dağıtan ancak farklı stres ortamları ve derinliklerinde meydana gelen depremler farklı çevresel etkiler üretebilir bu nedenle her iki depremin yoğunluk değerleri de değişebilir (Choudhury ve ark. 2016). Deniz seviyesi gibi belirli bir veriye göre yer yüzeyinin yukarıdan aşağıya doğru hareketi yer kabuğunun çökmesi olarak bilinir. Çökme uzunluk birimi ile ölçülmektedir (Comerci ve ark., 2007; Cundy ve ark.,

2000; Evelpidou ve ark., 2012). Bazı depremlerden sonra yapılan gözlemlere göre toprağın çökmesi aynı zamanda kumun sıvı gibi davranmasıyla da tetiklenebilir bu da ciddi sorunlar neden olabilir (Choudhury ve ark. 2016). Bir diğer birincil etki ise yüzey faylanması veya yüzey kırılması olup deprem sırasında içerideki bir fayın hareketi nedeniyle dünya yüzeyine ulaşan bir yer değiştirmedir. Bu olay genellikle sığ depremlerde (derinlik <20 km) meydana gelmektedir (Kumar ve ark., 2010; Xu ve ark., 2009). Bunun tam tersine Daniell ve ark. (2017) yüzey kırılmasını depremin ikincil etkileri arasında sınıflandırmıştır.

İkincil Etki

Birincil etkilerin sonucunda doğal ortamda oluşan olayların tümü ikincil etkiler olarak bilinmektedir. İkincil etkilerden ilki olan sıvılaşma deprem sonucunda yer sarsıntısına tepki olarak toprağın akışkan benzeri bir davranış göstermesi olarak ifade edilmektedir. Sıvılaşan toprak, suya doygun ve kohezyonsuz olduğu için zeminler mukavemetini ve sertliğini kaybeder (Choudhury ve ark. 2016). Tsunami ise açık denizlerde meydana gelen depremlerden sonra fay hareketi tarafından tetiklenen büyük bir yeraltı heyelanı sonucunda veya doğrudan fayın yer değiştirmesiyle ya da iki etkinin bir kombinasyonuyla büyük miktarda suyun yer değiştirmesine neden olduğu durumlarda meydana gelir. Su yüzeyindeki bu değişimler sonucu oluşan dalgalar yaklaşık 800 km s^{-1} hızla hareket eder ve uzak mesafelere çok az zayıflama ile ulaşır. Sonunda su dalgaları daha derin sulardan kıyı şeridindeki sığ sulara doğru hareket ederek dalgayı yavaşlatır, genliği arttırır ve büyük, yıkıcı dalgalara neden olur. 2004 yılında Hint okyanusu ve 2011 yılında Tohoku depremleri sonucunda gerçekleşen tsunami ile çok sayıda ölüm meydana gelmiştir (Daniell ve ark., 2017).

Bir diğer ikincil etki ise tarım ve orman alanları için oldukça önemi olan heyelanlardır. Deprem sonucunda oluşan heyelan ya da toprak kayması, kayaların, enkazın veya toprağın üst tabakasının bir yamaçtan yerçekimi yönünde aşağıya doğru hareket etmesine neden olur. Bir deprem bir veya birden daha fazla heyelan oluşumunu tetikleyebilir (Malamuda ve ark., 2004).

Tarih boyunca depremlerin neden olduğu hasar ve kayıplar üzerine ikincil etkilerin rolü oldukça önemli olmuştur. Ekonomik kayıpların ve ölümlerin %60-%75'i sarsıntıdan kaynaklansa da, bu etkilerin %25-%40'ı tsunami, toprak kayması, sıvılaşma, yangın ve diğer ikincil etkilerden kaynaklanmaktadır (Daniell ve ark., 2017). Coburn ve ark. (1992)

1900'den 1990'a kadar yaptıkları çalışmada yıkıcı depremler sonucu meydana gelen ölümlerin %76'sının sarsıntıdan geriye kalan %24'ününde ikincil etkilerden kaynaklandığını bildirmiştir. Marano ve ark. (2010) PAGER'de Eylül 1968'den Haziran 2008'e kadar meydana gelen 749 ölümcül deprem üzerine yaptığı çalışmada, depremlerdeki ölümlerin %25'inin depremlerin ikincil etkilerinden (tsunami, toprak kayması, yangın, sıvılaşma) kaynaklandığını ortaya koymuştur.

Bununla birlikte depremler sonucu ortaya çıkan materyaller (enkazlardan çıkan molozlar, hasarlı yapıların yıkımı esnasında çıkan malzeme, toz, vb) çevre sorunlarına dolayısıyla deprem bölgesi ekosisteminde önemli zararlara neden olmaktadır (Taş ve ark., 2000). Deprem sonucu yıkılan binalardan kaynaklanan toz ve partiküllerin solunması çok ciddi sağlık sorunlarına da yol açabilmektedir (Balbay, 2023).

Deprem sonrası kentsel alanda (örneğin yollar) enkazlar ya da bina yıkımları nedeniyle oluşan partikül madde ile ağır metaller artış göstermektedir. Bu metaller arasında kadmiyum (Cd), krom (Cr), nikel (Ni), çinko (Zn) yer almaktadır. Bu maddeler sağlık sorunlarının yanı sıra toprağın yapısını değiştirmek suretiyle de ekosisteme zarar vermektedir (Zeydan, 2021; Adıgüzel, 2023).

Yıkıntı atıklarında en büyük tehlike arz eden maddeler asbest, gaz tüpleri, petrokimyasallar, boyalar, böcek ilaçları, elektronik atıkların içerisindeki ağır metaller vb. malzemelerdir (Küçüker ve Kaplangı, 2023).

Türkiye, kara kütlesinin %42'si Alp-Himalaya kıvrımında bulunan bir ülke olup birinci derece deprem kuşağında yer almaktadır. Bu nedenle Türkiye'de yıkıcı depremlerin olma olasılığı her zaman bulunmaktadır (Çoban ve ark., 2017). Yapılan çalışmalarda yüzyıllar boyunca her üç yılda bir ciddi can kaybına ve kentsel yıkımların neden olan büyük depremlerin meydana geldiği kaydedilmiştir (Adıgüzel, 2023).

6 Şubat 2023 günü meydana gelen depremler ülke tarihinde yaşanmış en yıkıcı depremler olarak kayıtlara geçmiştir. 06 Şubat 2023 günü, Türkiye saati ile 04:17'de ve 13:24'de sırası ile merkez üssü Pazarcık (Kahramanmaraş) ve Elbistan (Kahramanmaraş) olan 7.7 Mw ve 7.6 Mw büyüklüğünde depremler meydana gelmiştir. Bu depremler Türkiye'de yaşanan en büyük ikinci ve üçüncü depremler olarak bildirilmiştir (İTÜ, 2023; Özer, 2023). Deprem fırtınası Doğu ve Güneydoğu Anadolu Bölgesinde 11 ili (Kahramanmaraş, Hatay, Adıyaman, Malatya, Gaziantep, Elazığ, Osmaniye, Şanlıurfa, Diyarbakır, Kilis ve Adana) kapsayan 108.812km^2'lik bir alanda etkili olmuş, çok şiddetli

hissedilmiş, can kaybı ve ağır hasara neden olmuştur (AFAD, 2023; Demirhan ve Hacıoğlu, 2024).

Büyük bir kısmı aktif faylar üzerinde bulunan ülkemizde tarih boyunca birçok deprem meydana gelmiştir. Depremlerin meydana geldiği bölgelerde; yangın, su baskınları, altyapının zarar görmesi, hava kirliliği, salgın hastalıklar, ekonomik durgunluk, sanayi alanlarından zararlı madde sızıntısı, tarımsal alanların zarar görmesi, yüzey şekillerinin yer değiştirmesi ile beraber, flora ve faunanın yaşama ortamlarında ani değişimlere neden olabilecek risklerle karşılaşmıştır (Okutan ve Çavuş, 2012). Fakat deprem kaynaklı tarım, orman ve mera alanlarındaki değişimler hakkında çalışmalar dünyada olduğu gibi Türkiye'de de sınırlı kalmıştır. 6 Şubat 2023 tarihinde gerçekleşen depremler kaynaklı kayıpların birincil veya ikincil etmenler kaynaklı mı olduğu ve ikincil etmenlerden kaynaklanan kayıpların (hangi koşullar altında ve hangi bölgelerde) ne kadar baskın olduğu sorularının cevaplanması oldukça önemlidir. Bu çalışmada depremlerin tarım, orman ve mera alanları üzerindeki etkilerini inceleyen araştırmaların bir araya getirilmesi, öneri ve öngörülerin oluşturulması amaçlanmıştır.

Depremlerin Tarım, Orman ve Mera Ekosistemi Üzerine Etkileri

Tarım, orman ve mera arazileri doğal-yarı doğal ekosistemin parçalarıdır ve yaşamsal döngüde oldukça önemlidir. Depremlerin orman ekosistemi üzerine ciddi zararları bulunmasına rağmen genellikle göz ardı edilmiştir. 21. yy'da meydana gelen depremler incelendiğinde dünya genelinde yıkıcı depremler sürekli artmaktadır (Anonim, 2024). Meydana gelme olasılığının daha yüksek olması ve heyelan, çığ vs. gibi sebeplerle ilişkili ikincil jeo-tehlikeler nedeniyle depremler en yıkıcı doğal afetlerden biri olarak kabul edilir (Pandey ve ark., 2023). Depremlerin meydana gelmesiyle can kaybı ve kişisel yaralanmalar, ekonomik etkiler, topoğrafik değişiklikler, dağ ormanlarının büyümesi ve üretkenliği, orman ekosistemlerinin işleyişini ve sağlığı değişmektedir (Pandey ve ark., 2023). Depremler, insanların ölümüne ve mal kaybına neden olmakla kalmayıp aynı zamanda ekolojik çevreyi derinden etkileyerek ve ekosistemde çeşitli kayıplara yol açarak ekolojik güvenliği tehdit etmektedir. Afet sonrasında ekosistem düzenlemeleri için kayıpların değerlendirilmesi oldukça önemlidir (Wang ve ark., 2012).

Ormanların bozulma nedenleri; yangınlar (Heinselman, 1973), seller (Duncan, 1993), kasırgalar (Foster ve Boose, 1995), depremler (Veblen ve ark., 1992) ve volkanik patlamalar (Turner ve ark., 1997) olarak sıralanabilir. Depremler, tektonik olarak aktif

bölgelerdeki orman ekosistemlerinde kritik bozulmalara yol açarak geniş bir çevre bozulmasına ve önemli biyolojik çeşitlilik kaybına neden olmaktadır (Garwood ve ark., 2012).

Deprem sonrasında orman ekosistemi ciddi şekilde zarar görerek geniş orman alanları tamamen yok olmuştur (Allen ve ark., 1999). Yüzey çatlakları ve gevşemiş toprak, orman bitki örtüsünün zarar görmesine, eğilmesine, kırılmasına veya çökmesine doğrudan yol açmıştır (Kitzberger ve ark., 1995).

Yüzey faylanması ve yer yüzeyinin şiddetli bir şeklide sarsılmasıyla toprak kayması veya çökme nedeniyle ağaçlar sökülebilir ya da gömülebilir ve depremler geniş çaplı orman kayıplarına neden olabilirler (Gorum ve ark., 2011; Zeng ve ark., 2012).

Wenchuan depremi sonrasında arazi kullanım şekilleri oldukça önemli düzeyde etkilenmiştir. Deprem sonrasında ormanlık alanlar toplam orman alanın %7.66 oranında azalmasına, geçirimsiz yüzey alanının ise 24.558,61 ha alandan 67.935,41 ha alana çıktığı bildirilmiştir (Cai ve Guo, 2008).

Depremlerin orman ekosistemi üzerine etkilerini incelemek için uzaktan algılama tekniklerinin geliştirilmesi ile görüntülerin kullanılabilir hale gelmesine kadar veri toplama için saha tabanlı değerlendirmeler yapılmaktaydı (Garwood ve ark., 1979; Pascal ve ark., 2001) fakat, meydana gelen depremlerin yolları tahrip etmesi sonucunda, saha alanlarına erişim sınırlanmış ve orman hasarının değerlendirilmesi zorlaşmıştır. Uydu ve hava görüntülerinin geliştirilmesi ile uzaktan algılama teknikleri kullanarak depremlerden kaynaklı orman kaybının tahmin edilmesi mümkün olmuştur. Bu tahminlerin doğruluğu ise uzaktan algılama tekniklerinin kullanımı, etkilenen alana (yani boşluk boyutuna) ve uzaktan algılama sensörlerinin çözünürlüğe bağlıdır. Bozulmuş ormanlarda oluşan büyük boşluklar kolayca tespit edilirken, daha küçük alanlar yüksek mekansal çözünürlüğe sahip uzaktan algılama görüntüleri ile bulunmuştur (Asner ve ark., 2014).

2016 yılında Japonya'da meydana gelen Kumomoto depreminin tetiklediği heyelanların orman ve mera alanları üzerine etkisi incelenmiştir. Hava fotoğrafları kullanarak 190 heyelan alanı ve bunların boyutlarını coğrafi bilgi sistemi (CBS) ile analiz edilmiştir. Seçilen 38 heyelanın (21'i ormanlarda ve 17'si meralarda) heyelan derinliği, hacmi ve çökellerinin belirlenmesi amacıyla saha araştırmaları yapılmıştır. Meralarda tespit edilen minimum heyelan alanı (400 m^2), ormanlardakinden (1000 m^2) daha küçüktür bunun nedeni ise meraların bitki örtüsü altındaki heyelanların tespit edilebilirliğinin sınırlı

olmasıdır. Havzalardaki belirli bir eğim aralığı için heyelanlar tarafından kaplanan toplam alanın oranı, hafif eğimli (10-15°) meralarda %3.2'den dik (>45°) eğimli meralarda %15.5'e çıkmıştır. Bunun tersine orman alanlarındaki maksimum oran (%7.4) nispeten orta eğimlerde (25–30°) meydana gelmiştir. Tahmini heyelan hacmi, her heyelanın ortalama derinliğine dayalı olarak 27 m^3 ile 9622 m^3 arasında değişmektedir. Ayrıca heyelan çökelleri hacminin toplam heyelan hacmine oranı orman içi heyelanların %48'inde, mera heyelanlarının ise %35'inde %100'ü aşmıştır. Bulgular, arazi örtüsünün heyelanların özellikleri üzerinde kapsamlı ve fark edilebilir etkileri olduğunu göstermektedir (Koyanagi ve ark.,2020).

Depremler, deprem kaynaklı coğrafi tehlikelerle birlikte potansiyel olarak ağaçlara büyük fiziksel zarar vererek dağ ormanlarının dinamiklerini etkileyebilir (Keefer, 2002). Örneğin deprem sırasında meydana gelen yer sarsıntısı potansiyel olarak kök sistemine zarar verebilir, gövdeleri kırabilir, bu da büyümenin baskılanmasına hatta ağaçların ölümüne yol açabilir (Jacoby ve ark., 1988; Qiu ve ark., 2015; Yamaguchi ve ark., 1997). Bununla birlikte ağaç kayıpları sonucunda rekabet azalır, yeterli toprak besin maddesi ve nemi sağlandığında (Bekker ve ark., 2018; Cheng ve ark., 2012a) veya fotosentez (Mohr ve ark., 2021) gerçekleşebildiğinde ağaçların büyümesi kolaylaşabilir (Kitzberger ve ark., 1995). Bu nedenle ağaçlardaki yıllık büyümedeki değişiklikler (ağaç halkası genişliği verileri) genellikle deprem olaylarını tarihlendirmek için kullanılır ve bu nedenle depremlerin ormanlar üzerindeki etkilerinin anlaşılmasında potansiyel göstergelerden biri olarak kabul edilir (Pedrera ve ark., 2014; Stoffel ve ark., 2019).

Deprem kaynaklı heyelanların ağaçların besin elementi alımına etkisinin belirlenmesine ait çalışmalar kısıtlıdır. Cheng ve ark. (2012b) Wenchuan depremi sonrası oluşan heyelan bölgelerindeki ağaçların türleri ile organlarının besin elementi içeriklerinin önemli ölçüde değiştiğini bildirmişlerdir. *Cupressus funebris* türünün iğne yapraklarında Mn içeriği, dallarında ise Fe ve S artarken köklerinde herhangi bir besin elementi değişikliği meydana gelmemiştir. *Cryptomeria fortunei* türünün ise yapraklarında P içeriği artarken dallarında besin elementi içerikleri değişmemiş, köklerinde ise toplam organik karbonun azaldığı rapor edilmiştir. Zeng ve ark. (2016) tektonik olarak aktif bölgelerde depremlerin orman karbon dinamiğinin azaltıcı güçleri olabileceğini bildirmiştir.

Deprem kaynaklı ağaç kaybına ağacın meşcere özellikleri ve çevresel faktörler neden olmaktadır. Deprem esnasında ağaç kayıplarına neden olan en etkili faktör topografyadır.

Dik eğime sahip topografyada yer alan ağaçları kaybetme oranı daha yüksektir. Aynı zamanda depremin neden olduğu heyelan ve çökmeler ise yine dik eğime sahip alanlarda daha çok meydana gelmektedir. Bununla birlikte yaşlı ağaçlar depremin verdiği zararlara daha duyarlıdır. Ağaç türleri arasında ağaç kayıpları açısından önemli bir fark bulunmamıştır (Zeng ve ark., 2016).

Pandey ve ark. (2023) tarafından yürütülen çalışmada 1833, 1905, 1916, 1934 ve 1936 yıllarında Himalaya'larda meydana gelen depremler sonucunda ağaçların radyal büyüme halkaları analiz edilmiştir. Analiz edilen ağaçlar sırasıyla %77, %64, %73, %72 ve %77'si bu sismik olaylara tepki vermiştir. Ortalama olarak ise ağaçların %72'sinin depremler sonucunda büyümesi baskılanmıştır. Dönemsel yapılan analizlerde ise depremden 1-5 yıl sonra büyümede güçlü bir düşüş kaydedilmiştir. Ağaçların %75'inin iyileşmesi için gereken ortalama süre ise depremin gerçekleştiği tarihlere göre sırasıyla 5, 5, 5, 13 ve 28 yıla kadar ulaşmıştır. Depremlerin eğimli dağ ekosistemi üzerindeki etkilerini en aza indirmek için uyarlanabilir yönetim stratejilerinin geliştirilmesi gerektiği bildirilmiştir.

Deprem sonrasında tahrip olan orman ve bazı bitki örtüsü doğal yenilenme ile iyileşebilmesine rağmen bu süreç yavaş ilerlemektedir. Bu nedenle çeşitli müdahalelere ihtiyaç duyulmaktadır. Ormanlık alanlarda bu müdahaleler sağlanırken dikilecek ağaç türlerinde bazı özelliklere (hızlı büyüyen türler; tohum dağıtan kuşlar için koruyucu bitki örtüsü ve tünekler için, çalılıklar; ormanlara yapısal çeşitlilik kazandırmak ve toprakları koruma kapasitelerini geliştirmek için, derin köklü türler; eğimli alanlardaki toprakların stabilizasyonunu sağlamak için) dikkat edilmelidir (Whitten ve Lamb, 2010).

Deprem gibi felaketler sonucunda tarım arazilerinin kullanımlarındaki değişiklik (Khan ve ark., 2015) ve verimlilik (Lesk ve ark., 2016) dönüşümleri kritik hale gelmektedir (Folke, 2006).

Depremin meydana geldiği hem yağmur ile beslenen hem de sulanan ekim sistemlerinin yürütüldüğü tarım alanlarında büyük yarıklar ve çatlaklar meydana gelmiştir. Depremin ardından su kanallarında, borularında ve alt yapıda meydana gelen hasarlar sonucu su miktarında ve kalitesinde azalmalar olmuştur. Depremler ve ardından oluşan sık artçılar dik bölgelerde erozyon sorunlarını daha da şiddetlendirmiştir Çiftçiler oluşan çatlak ve yarıklardan suyun hızla tahliyesi sonucu heyelan riski arttığı için mevcut tarlalarında bitkisel üretime devam edememişlerdir (DiCarlo ve ark., 2018).

Deprem-su arasındaki bağlantı tarımsal üretkenlik açısından özel bir tehdit oluşturmasına rağmen hasarın yerini, tahribatını ve boyutunu tahmin etmekte zorluk yaşanmaktadır. Bitkisel üretimin yapıldığı tarım alanları genellikle sismik açıdan aktif alanların üzerinde yer almaktadır ve bu da sismik bir olayın ardından hidrolojik ve tarımsal sistemlere etkisinin anlaşılması için izlenmesi gereken bir noktadır (Rodriguez ve ark., 2016).

Deprem sonrasında meydana gelen heyelan sonucunda birçok çevresel problem ortaya çıkmaktadır. Heyelanın meydana gelen kısımlarında üst toprağın taşınması sebebi ile yüzeyde kalan kısım alt toprak hatta ana kaya olabilir. Buda o alandaki toprakların organik maddesinin ve mikroorganizma sayısının az olması nedeniyle verimsiz kısmı oluşturmaktadır. Bununla birlikte topraklar sığ olduğu için suyun infiltrasyonu ve nem rezervleri de azalmakta ve bitki büyümesi yavaşlamakta ve/veya durmaktadır. Heyelan sonucunda aşağı kısımlara taşınan üst topraklar ise organik madde ve mikroorganizmalarca zengin olmasına rağmen üst ve alt toprağın karışması ile oluştuğu için pekişmemiş durumda olacaktır (Whitten ve Lamb, 2010).

25 Nisan 2015 yılında Nepal'de meydana gelen deprem hem doğrudan hem de dolaylı yoldan tarım ve tarımsal biyoçeşitlilik üzerine olumsuz etkilere neden olmuştur. Depolama yapılarının tahrip olması, depolanan tohumların çökme ile toprağa gömülmesi sonucu 104 yerel çeşidin kayıp olduğu ve 68 yerel çeşidin ise deprem sonucunda tehlikeye girdiği bildirilmiştir. Bununla birlikte toprak kayması, arazi bozulması, su kaynaklarının kuruması, zorunlu göç sonucunda insan iş gücünün azalması, bozulan alt yapı ve tedarik zincirindeki aksamalar gibi faktörler sebebi ile tarımsal üretim ciddi anlamda etkilenmiştir (Gauchan ve ark., 2017). Tohumların ve tarımsal altyapının kaybı da sonraki üretim sezonlarında potansiyel kayıp riskine neden olmuştur (FAO, 2015)

Çin'de 2008 yılında meydana gelen Wenchuan depremi son 50 yılın en güçlü ve en yıkıcı sismik olayı (Huang ve Fan, 2013) olarak rapor edilmiş olup çevreye, orman ekosistemine, bölgesel karbon dinamiklerine ve alt yapıya önemli ölçüde zarar vermiştir (Zeng ve ark., 2016). Bu deprem sonucunda meydana gelen iki büyük heyelanla toprağın potansiyel enerjisinin 1.52×10^{15} J azaldığı öne sürülmüştür. Bununla birlikte yok olan bitki örtüsü ile 235 Tg C toprağın solum katmanına ilave olmuştur. Toprağa karışan C önümüzdeki yıllar boyunca atmosfere kümülatif yollar ile CO_2 salınımına neden olmaktadır. Bu salınım ise fosil yakıtların yanmasından kaynaklanan karbon emisyonlarının yaklaşık %2'ine eşdeğerdir. Azot kaybı, 2007 Kaliforniya Yangını (~2.5

× 10-2 Tg) tarafından salınanın iki katıdır. Azot kaybının önemli bir kısmı (%14) atmosferik ozon tabakasını etkileyebilen azot oksit formundadır (Ren ve ark., 2009). Bununla birlikte Wenchuan fay bölgesindeki yer üstü biyokütle kaybı (117 Mg ha^{-1}) Katrina kasırgası (87 Mg ha^{-1}) sonrasındaki biyokütle kaybından daha fazladır (Chapman ve ark., 2008).

Çin'de 12 Mayıs 2008 yılında meydana gelen depremin su tutma, toprak koruma ve karbon depolama gibi 3 kritik ekosistem üzerindeki mekansal değişkenliğini analiz etmek amacıyla CBS tabanlı ekosistem değerlendirme modeli olan InVEST niceliksel bir değerlendirme yapılmak için kullanılmış ve depremlerin bazı bölgelerde hasarının az olmasına rağmen ekosistem üzerinde kayıplarının oldukça büyük olduğu sonucuna varılmıştır. En ciddi hasarı toprak muhafazası alırken bunu karbon depolama ve su tutma kriterleri takip etmiştir. Ekosistem üzerinde ki olumsuz etkiler deprem merkezinden uzaklaştıkça azalmıştır (Wang ve ark., 2012). En fazla hasarın toprak muhafazasında olması depremin gerçekleştiği bölgenin güçlü erozyon dinamiğine yol açan jeolojik yapısı ve dik yamaçlara sahip olmasıyla birlikte depremden etkilenen arazilerin büyük bir kısmının hasarlı toprak yapısı ve aşınabilirliğinden kaynaklanmaktadır. Toprağın muhafazası azalmakla kalmamış uzun vadeli toprak erozyonu önemli ölçüde artmıştır. Karbon depolama fonksiyonu ise karbonun karmaşık süreci nedeniyle daha az kayıplara maruz kalmıştır. Ayrıca su altında uygun sıcaklık koşulları, bitki örtüsünün yeniden büyümesi karbon depolama fonksiyonundaki kaybı azaltmıştır (Wu ve ark., 2008). Su tutma fonksiyonu ise en az etkilenen parametrelerdendir. Su tutmanın ana kaynağı toprak olduğundan bu fonksiyon üzerinde depremin etkisi diğerlerine göre çok daha az olmuştur çünkü bu bölgede suyun ana kaynağı depremden doğrudan etkilenmeyen yağışlardan sağlanmaktadır (Wang ve ark., 2012).

Nepal nüfusunun %60'ından fazlası tarımla uğraşmakta olup gayri safi milli hasılanın %37'si tarımsal faaliyetler sonucunda sağlanmaktadır (MoA, 2015). Nepal'de 2015 yılında 7.8 büyüklüğünde bir deprem meydana gelmiş olup ardından 6.3 büyüklüklerine ulaşan bir çok artçı meydana gelmiştir. En ağır hasarı ise depremin merkez üssüne yakın küçük ölçekli çiftlikler almıştır. Afet sonrası süreçler tarımsal uygulamaları kökten değiştirebilmektedir. Nepal'de depremin ekolojik ve sosyo-ekonomik etkilerinden dolayı kakule yetiştiriciliği dikkat çekici boyutta artmıştır. Deprem sonrası arazi mevcudiyetindeki ve kalitesindeki değişimler ile işgücü ve artan gelir ihtiyacı sonucu

daha yüksek getirisi olan ürünlere doğru tarımsal üretimde değişimler meydana gelmiştir. Kakule ise yetiştirme, pazar ve ekolojik uyum özelliği ile çiftçilerin öncelikleri olmuştur (DiCarlo ve ark., 2018). Bununla birlikte Nepal'in Dolakha eyaletinde yaşayan ailelerin %80'ni hayvancılıkla (öküz, inek, manda, keçi ve tavuk) uğraşmaktayken birçoğu deprem ile birlikte hayvanlarını doğrudan kaybetmiş, kaybetmeyen aileler ise yer sıkıntısı nedeniyle hayvanlarını satmak zorunda kalmıştır (DiCarlo ve ark., 2018).

Özdemir ve Gür (2016) yaptıkları çalışmada tarihsel dönemlerde sık sık depremlerin gerçekleştiği Afyonkarahisar Dinar ilçesi 1 Ekim 1995'te meydana gelen 5.9 büyüklüğünde ki depremin arazi kullanım değişikliğine etkisini incelemek amacıyla 1995 ve 2015 yılları arasındaki CBS ortamında uzaktan algılama yöntemi ile belirlemişlerdir. Sonuç olarak Dinar ilçesi ve yakın çevresinde tarım alanları ve çorak araziler azalırken, orman alanları ve yerleşim alanlarının arttığı belirlenmiştir. Orman alanlarındaki artış ağaçlandırma çalışmalarının, deprem sonrasında bölgede iyi yürütüldüğünü ve geçmişe göre orman tahribatının azaldığını göstermektedir. Kullanılmayan alanlar 19 km^2, tarım alanları ise 8 km^2 azalmıştır. Yerleşim alanları 5 km^2, orman alanları ise 21 km^2 artmıştır. Sulak alanlar da ise önemli bir değişiklik olmamıştır. Dinar ilçe merkezinin 1995'ten 2015 yılına nüfusunda artış görülmezken, yerleşim alanlarının artması konutların kat sayısı deprem öncesinde dikeye öncelikli iken, deprem sonrasında daha çok yatay şekilde olması ile ilişkilendirilmiştir. Ancak, yerleşim alanları tarım alanlarını işgal etmiş ve genişlemiş, tarım alanları da azalmıştır. İlçe merkezinin güneyinde 1995 yılında tarım arazisi olarak kullanılan birçok alan ekilip-biçilmediği için 2015 yılında kullanılmayan arazi sınıfına dâhil olmuştur. Tarım alanlarının kullanılmaması da bölgeden dışarıya göç olduğuna işaret etmektedir.

11 Mart 2011'de Büyük Doğu Japonya Depremi olarak bilinen deprem güçlü bir tsunamiyi tetiklemiş ve dünyanın en büyük nükleer enerji santrallerinden biri olan Fukushima Daichi'de nükleer kazaya neden olmuştur. Depremin ikincil etkilerinden olan tsunami toprakta, peyzajda, doğal flora ve fauna yaşamında tüm kıyı ekosisteminde büyük tahribatlara neden olmuştur. Tsunami nedeniyle sular altında kalan bölgede bitki örtüsü değişmiş ve bazı kıyı şeritleri çorak arazilere dönüşmüştür (Bachev ve Ito, 2017).

Dündar ve ark. (2003) yaptıkları çalışmada Sapanca gölüne akan derelerdeki bazı ağır metallerin 17 Ağustos 1999 Marmara depremi öncesi ve sonrası konsantrasyonlarını karşılaştırmışlardır. İstanbul, Mahmudiye ve Kuruçay derelerindeki Pb ve Cd birikiminin

deprem sonrasında arttığı, Cu bakımından standartlara uyduğu, Zn ve Fe bakımından deprem öncesi kirlilik gözlemlenirken deprem sonrası bu değerlerin düştüğü görülmüştür. Gölün tek deşarj noktası olan Çark deresinde ise Cd dışındaki metal kirliliğinin standartların altında kaldığı gözlemlenmiştir.

Çığ ve Toprak (2023) depremler sonrasında ortaya çıkabilecek tarımsal problemler için alınabilecek önlemleri;

- Deprem üretme potansiyelinin yüksek olduğu şehirlerde fay hatları üzerine tarıma dayalı sanayi tesisleri, endüstriyel imalathaneler ile birlikte kırsal yerleşim yerlerinin kurulmaması,
- Üretilen tarımsal ürünlerin depolama kapasitelerinin artırılması,
- Deprem konusunda çiftçilerin bilinçlendirilmesine yönelik eğitimlerin verilmesi,
- Deprem sonucunda çatlayan yeraltı kuyularına alternatif olarak taşıma usulü ile salma sulama olanaklarının yaygınlaştırılması, basınçlı sulamaya (yağmurlama sulama) teşvik edilmesi ve ortaya çıkacak maliyette çiftçinin desteklenmesi,
- Suyun kısıtlı olduğu havzalara dış havzalardan suyun iletilmesi projeleri yeniden gözden geçirilmeli, devam eden baraj ve gölet projeleri tamamlanmalı,
- Nadasa bırakılan tarım arazilerinin nadas yılında daha seyrek ekilmek suretiyle başta buğday olmak üzere, serin iklim tahılları, kışlık baklagil yem bitkileri, nohut ve mercimek gibi tane baklagiller, ayçiçeği ve aspir gibi yağ bitkilerinin yetiştirilmesi teşvik edilmeli,
- Kırsal alanlarda göçün önüne geçebilmek adına sosyal projelerin üretilmesi, şeklinde sıralanmaktadır.
- Deprem kaynaklı heyelanlarda iyileşme ve toprak kaybının azaltılması için bitki örtüsünün iyileştirilmesi ve uzun vadeli izlenmesi gerekmektedir (Lin ve ark., 2006).

FAO (2024), 6 Şubat sonrasında 2023'ün Aralık ayına kadar deprem bölgesinde gerçekleştirilen müdahalelerde; çiftçilikle uğraşan ailelere tarım ekipmanı, gübre, tohum, fide, hayvan ve hayvan yemi dağıtımı yapıldığını ve bununla birlikte hayvancılıkla uğraşanlara süt sağım makinesi, süt depolama ünitesi, soğutma tankı ve gıda işleme makinesi temin edildiği bildirilmiştir. Aynı zamanda ağaçlandırma ve fidan üretimi desteği, uygulamalı çiftçi okulları ve tarımsal beceri geliştirme programları yoluyla deprem bölgesinde tarım kapasitesinin artırıldığı rapor edilmiştir.

Sonuç

Bu çalışma ile deprem gibi doğal bir afet sonucunda tarım, orman ve mera alanlarında ortaya çıkan veya çıkabilecek olan problemlerin altını çizmek hedeflenmiştir. Depremlerin ikincil etkileri bölgelerin jeolojik ve jeomorfik koşullarına bağlı olarak büyük ölçüde ve sistematik olarak değişiklik göstermektedir. İkincil etkenlerden kaynaklanan kayıpların belirlenmesi ve alınabilecek önemlerin belirlenmesi oldukça önemlidir. Deprem, çevre üzerinde ağır etkileri olan bir doğa olayıdır ve bu etkileri inceleyerek depremin belirli bir bölgede yol açtığı gerçek hasar miktarı veya sismik faaliyetler döngüsü hakkında bilgi edinebiliriz. Ormanlar, çeşitli bitki türlerinin yanı sıra birçok hayvan türüne de ev sahipliği yapmaktadır. Orman ekosistemlerinin yapısında meydana gelen herhangi bir değişiklik büyük bir biyolojik çeşitliliğe etki etmektedir. Bu nedenle ormanlık alanlardaki doğal bozulmaların etkileri anlamak, bozulmuş ormanların yönetimi ve eski haline getirilmesi için önemli bir faktördür. Afet sonrası tarım sektörünün iyileştirilmesi ve yeniden inşası en önemli önceliklerden olmalıdır. Mera alanlarında deprem kaynaklı meydana gelecek hasarların önceden bilinmesi deprem sonrasında yapılacak ıslah çalışmalarına yol gösterici katkılar sağlayacaktır.

KAYNAKÇA

Adıgüzel, F. 06 Şubat 2023 Kahramanmaraş (Pazarcık 7.7 mw. ve Elbistan 7.6 mw.) depremleri sonrası Kahramanmaraş şehrinde yaşanan partikül madde kirliliğinin incelenmesi. *Türk Coğrafya Dergisi*, (83), 35-43.

AFAD. (2023, 08 20). 06 şubat 2023 Kahramanmaraş (Pazarcık Ve Elbistan) Depremleri Saha Çalışmaları Ön Değerlendirme Raporu. Deprem Dairesi Başkanlığı. 1-29.

Allen, R. B., Bellingham, P. J., & Wiser, S. K. (1999). Immediate damage by an earthquake to a temperate montane forest. *Ecology*, 80(2), 708-714.

Anonim(2024).https://tr.wikipedia.org/wiki/21._y%C3%BCzy%C4%B1l_depremlerinin_listleri

Asner, G. P., Anderson, C. B., Martin, R. E., Knapp, D. E., Tupayachi, R., Sinca, F., & Malhi, Y. (2014). Landscape-scale changes in forest structure and functional traits along an Andes-to-Amazon elevation gradient. *Biogeosciences*, 11(3), 843-856.

Bachev, H., & Ito, F. (2017). Agricultural Impacts of the Great East Japan Earthquake–Six Years Later. *Available at SSRN 2977972*.

Balbay, E. G. (2023). Earthquake and the Lung. *Duzce Medical Journal*. 25(1), 1-5.

Bekker, M. F., Metcalf, D. P., & Harley, G. L. (2018). Hydrology and hillslope processes explain spatial variation in tree-ring responses to the 1983 earthquake at Borah Peak, Idaho, USA. *Earth Surface Processes and Landforms*, *43*(15), 3074–3085.

Cai, L., & Guo, L. (2008). A research of land-cover change of Wenchuan Earthquake before and after based on object-oriented method. *Acta Ecologica Sinica*, *28*(12), 5927-5937.

Chapman, E. L., Chambers, J. Q., Ribbeck, K. F., Baker, D. B., Tobler, M. A., Zeng, H., & White, D. A. (2008). Hurricane Katrina impacts on forest trees of Louisiana's Pearl River basin. *Forest Ecology and Management*, *256*(5), 883-889.

Cheng, S., Yang, G., Yu, H., Li, J., & Zhang, L. (2012a). Impacts of Wenchuan Earthquake-induced landslides on soil physical properties and tree growth. *Ecological Indicators*, *15*(1), 263–270. https://doi.org/10.1016/j.ecolind.2011.09.028

Cheng, S., Yu, H., Yang, G., Yang, R., Liu, Y., Zhang, Z., ... & Li, J. (2012b, May). Impacts of Wenchuan Earthquake-induced landslides on tree organ nutrients. In *2012*

International Conference on Biomedical Engineering and Biotechnology (pp. 1518-1520). IEEE.

Choudhury, M., Verma, S., & Saha, P. (2016, December). Effects of earthquake on the surrounding environment: an overview. In *Proceedings of international conference on recent advances in mechanics and materials (ICRAMM-2016).*

Coburn, A. W., and Spence, R. J. S. (1992). *Earthquake Protection*. Wiley. Available at: http://books.google.de/books?id=8L83AQAAIAAJ

Comerci, V., Capelletti, S., Michetti, A.M., Rossi, S., Serva, L. and Vittori, E. (2007), Land subsidence and Late Glacial environmental evolution of the Como urban area (Northern Italy), *Quaternary International*, 173–174, 67–86.

Cundy, A.B., Ortekaasb, S.K., Dewez, T., Stewartc, I.S., Collins, P.E.F., Croudace, I.W., Maroukian, H., Papanastassiou, D., Gaki-Papan- astassiou, P., Pavlopoulos, K. and Dawson, A. (2000), Coastal wetlands as recorders of earthquake subsidence in the A egean: a case study of the 1894 Gulf of A talanti earthquakes, central Greece, *Marine Geology*, 170, 3–26.

Çığ, F., & Toprak, Ç. C. (2023). Buğday Üretimi Üzerinde Depremlerin Etkileri. 4rd Internatıonal Cukurova Agrıculture And Veterınary Congress 27 -28 February 2023, Adana / Türkiye

Çoban, M., Sözbilir, M., & GöktaŞ, Y. (2017). Deprem deneyimini yaşamış kişilerin deprem öncesi hazırlık algılarının belirlenmesi: Bir durum çalışması. *Doğu Coğrafya Dergisi*, *22*(37), 113-134.

Demirhan, T., & Hacıoğlu, İ. (2024). 6 Şubat 2023 Türkiye'deki Deprem Fırtınasının X (Twıtter) Özelinde Tanımlayıcı Analizlerinin Yapılması. *Fırat Üniversitesi Sosyal Bilimler Dergisi*, *34*(1), 285-300.

Daniell, J. E., Schaefer, A. M., & Wenzel, F. (2017). Losses associated with secondary effects in earthquakes. *Frontiers in Built Environment*, *3*, 30.

DiCarlo, J., Epstein, K., Marsh, R., & Måren, I. (2018). Post-disaster agricultural transitions in Nepal. *Ambio*, *47*(7), 794-805.

Duncan, R. P. (1993). Flood disturbance and the coexistence of species in a lowland podocarp forest, south Westland, New Zealand. *Journal of Ecology*, 403-416.

Dündar, M. Ş., Altundağ, H., Boz, V., Akkaya, K., & Sayın, M. (2003). Sapanca gölüne akan derelerdeki bazı eser elementlerin 17 Ağustos 1999 Marmara depremi öncesi ve sonrası karşılaştırmalı analizi.

Evelpidou, N., Melini, D., Pirazzoli, P. and Vassilopoulos, A. (2012), Evidence of a recent rapid subsidence in the S–E Cyclades (Greece): An effect of the 1956 Amorgos earthquake?, *Continental Shelf Research*, 39 (40), 27–40.

FAO, (2015). Nepal Earthquake: Agricultural Livelihood Impact Appraisal inSixMost AffectedDistricts. FAO. http://www.fao.org/emergencies/resources/documents/resources-detail/en/c/293041/.

FAO, (2024). Türkiye:Müdahaleye bakış. Roma. https://www.fao.org/3/cc9356tr/cc9356tr.pdf

Folke, C. 2006. Resilience: The emergence of a perspective for social-ecological systems analyses. Global Environmental Change 16: 253–267.

Foster, D.R. & Boose, E.R. (1995) Hurricane disturbance regimes in temperate and tropical forest ecosystems. *Wind and Trees* (eds M. Coutts & J. Grace), pp. 305–339. Cambridge University Press, Cambridge

Garwood, N.C.; Janos, D.P.; Brokaw, N. Earthquake caused landslides: A major disturbance to tropical forests. Science **1979**, 205, 997–999. [CrossRef] [PubMed]

Gauchan, D., Joshi, B. K., & Ghimire, K. H. (2017). Impact of 2015 earthquake on economy, agriculture and agrobiodiversity in Nepal. *Rebuilding Local Seed System of Native Crops in Earthquake Affected Areas in Nepal. Proceedings of National Sharingshop*.

Gorum, T., Fan, X., van Westen, C. J., Huang, R. Q., Xu, Q., Tang, C., & Wang, G. (2011). Distribution pattern of earthquake-induced landslides triggered by the 12 May 2008 Wenchuan earthquake. *Geomorphology*, *133*(3-4), 152-167.

Guerrieri, A.L., Porfido, S., Esposito, E., Blumetti, A.M., Michetti, A.M. and Vittori, E. (2009), Cataloguing Earthquake Environmental Effects: A Tool for The Comparison of Recent, Historical and Paleo Earthquakes, 1*st INQUA-IGCP-567 International Workshop on Earthquake Archaeology and Palaeoseismology*, Baelo Claudia, Spain (2009).

Heinselman, M.L. (1973) Fire in the virgin forests of the Boundary Waters Canoe area, Minnesota. *Quaternary Research*, **3**, 329–382.

Huang, R., & Fan, X. (2013). The landslide story. *Nature Geoscience*, *6*(5), 325-326.

İstanbul Teknik Üniversitesi-İTÜ (2023). 6 Şubat 2023: 04.17 Mw 7,8 Kahramanmaraş ve 13.24 Mw 7,7 Kahramanmaraş depremleri: Ön inceleme raporu. İstanbul Teknik Üniversitesi.

Jacoby, G. C., Sheppard, P. R., & Sieh, K. E. (1988). Irregular recurrence of large earthquakes along the San Andreas Fault: Evidence from trees. *Science*, *241*(4862), 196–199. https://doi.org/10.1126/science.241.4862.196

Keefer, D. K. (2002). Investigating landslides caused by earthquakes—A historical review. *Surveys in Geophysics*, *23*(6), 473–510. https://doi.org/10.1023/A:1021274710840

Khan, M.D., M. Hossain, I. Bryceson, K.N. Kolivras, F. Faruque, M.M. Rahman, and U. Haque. 2015. Natural disasters and landuse/ land-cover change in the southwest coastal areas of Bangladesh. Regional Environmental Change 15: 241–250.

Kitzberger, T., Veblen, T. T., & Villalba, R. (1995). Tectonic influences on tree growth in northern Patagonia, Argentina: The roles of substrate stability and climatic variation. *Canadian Journal of Forest Research*, *25*(10), 1684–1696. https://doi.org/10.1139/x95-182

Koyanagi, K., Gomi, T., & Sidle, R. C. (2020). Characteristics of landslides in forests and grasslands triggered by the 2016 Kumamoto earthquake. *Earth Surface Processes and Landforms*, *45*(4), 893-904.

Kumar, S., Wesnousky, S.G., Jayangondape-rumal, R., Nakata, T., Kumahara, Y. and Singh, V. (2010), Paleoseismological evidence of surface faulting along the northeastern Himalayan front, India: Timing, size, and spatial extent of great earthquakes, Journal of Geophysical Research: Solid Earth, Vol. 115, Iss. B12.

Küçüker, M. A., & Kaplangı, B. B. (2023). Afet sonrası atıkların yönetimi hakkında değerlendirme.

Lesk, C., P. Rowhani, and N. Ramankutty. 2016. Influence of extreme weather disasters on global crop production. Nature 529: 84–87.

Lin, W. T., Lin, C. Y., & Chou, W. C. (2006). Assessment of vegetation recovery and soil erosion at landslides caused by a catastrophic earthquake: a case study in Central Taiwan. *Ecological Engineering*, *28*(1), 79-89.

Malamuda, B.D., Turcotteb, D.L., Guzzettic, F. and Reichenbachc, P. (2004), Landslides, earthquakes, and erosion, Earth and Planetary Science Letters, 229, 45– 59

Marano, K. D., Wald, D. J., and Allen, T. I. (2010). Global earthquake casualties due to secondary effects: a quantitative analysis for improving rapid loss analyses. *Nat. Hazards* 52, 319–328. doi:10.1007/s11069-009-9372-5

Ministry of Agricultural Development, Agribusiness Promotion and Statistics Division (MoAD). 2015. Trade Flow Analysis of Large Cardamom in Eastern Region. Government of Nepal.

Mohr, C. H., Manga, M., Helle, G., Heinrich, I., Giese, L., & Korup, O. (2021). Trees talk tremor–wood anatomy and content reveal contrasting tree–growth responses to earthquakes. *Journal of Geophysical Research: Biogeosciences*, *126*(10), e2021JG006385. https://doi.org/10.1029/2021JG006385

Okutan, A. E., & Çavuş, G. (2012). Deprem Sonrası Ortaya Çıkabilecek Orman Yangınları; Peyzaj Mimarlığı Alanında Alınabilecek Pasif Önlemler. *Düzce Üniversitesi Orman Fakültesi Ormancılık Dergisi*, *8*(1), 19-33.

Özdemir, M. A., & Gür, E. (2016). Dinar depremi öncesinde ve sonrasında dinar şehri ve yakın çevresinde arazi kullanımı. *TÜCAUM Uluslararası Coğrafya Sempozyumu Ankara*.

Özer, M. (2023). Education Policy Actions by the Ministry of National Education after the Historical Earthquake Disaster on February 6, 2023 in Türkiye. *Bartın University Journal of Faculty of Education*, 12(2), 1-14.

Pandey, J., Camarero, J. J., Lu, X., Sigdel, S. R., Gao, S., & Liang, E. (2023). Forest resilience in the Himalayas inferred from tree growth after earthquake disturbances. *Journal of Geophysical Research: Biogeosciences*, *128*(9), e2023JG007502.

Pascal, V.; Glenn, S.H.; Richard, D.P. Earthquake impacts in old-growth Nothofagus forests in New Zealand. J. Veg. Sci. 2001, 12, 417–426.

Pedrera, A., Galindo-Zaldivar, J., Ruiz-Constan, A., Bohoyo, F., Torres-Carbonell, P., Ruano, P., et al. (2014). The last major earthquakes along the Magallanes-Fagnano

fault system recorded by disturbed trees (Tierra del Fuego, South America). *Terra Nova*, *26*(6), 448–453. https://doi.org/10.1111/ter.12119

Qiu, S., Xu, M., Zheng, Y., Li, R., Wong, M. H. G., Zhang, L., et al. (2015). Impacts of the Wenchuan earthquake on tree mortality and biomass carbon stock. *Natural Hazards*, *77*(2), 1261–1274. https://doi.org/10.1007/s11069-015-1653-

Ren, D., Wang, J., Fu, R., Karoly, D. J., Hong, Y., Leslie, L. M., ... & Huang, G. (2009). Mudslide-caused ecosystem degradation following Wenchuan earthquake 2008. *Geophysical Research Letters*, *36*(5).

Rodriguez, J., Ustin, S., Sandoval-Solis, S., & O'Geen, A. T. (2016). Food, water, and fault lines: Remote sensing opportunities for earthquake-response management of agricultural water. *Science of the Total Environment*, *565*, 1020-1027.

Silva, P.G., Perez-Lopez, R., Rodriguez-Pascua, M.A., Giner, J.L., Huerta, P., Bardaji, T. and Martin- Gonzalez, F. (2013), Earthquake Environmental Effects (EEEs) triggered by the 2011 Lorca earthquake (Mw 5.2, Betic Cordillera, SE Spain): Application of the ESI-07 Macroseismic Scale, *4th International INQUA Meeting on Paleoseismology, Active Tectonics and Archeoseismology (PATA)*, 9-14 October 2013, Aachen, Germany.

Stoffel, M., Ballesteros Cánovas, J. A., Luckman, B. H., Casteller, A., & Villalba, R. (2019). Tree-ring correlations suggest links between moderate earthquakes and distant rockfalls in the Patagonian Cordillera. *Scientific Reports*, *9*(1), 12112.

Taş, M., Taş, N., Payan, F., & Elmacı, A. (2000). 17 Ağustos İzmit ve 12 Kasım Düzce depremlerinde ortaya çıkan yapısal ve çevresel hasarların değerlendirilmesi. *Uludağ Üniversitesi*

Mühendislik Dergisi, 6(1), 83-88.

Tatevossian, R.E., Rogozhin, E.A., Arefiev, S.S. and Ovsyuchenko, A.N. (2009), Earthquake intensity assessment based on environmental effects: principles and case studies, *The Geological Society, London, Special Publications*, 316, 73–91.

Turner, M. G., Dale, V. H., & Everham, E. H. (1997). Fires, hurricanes, and volcanoes: comparing large disturbances. *BioScience*, *47*(11), 758-768.

Veblen, T.T., Kitzberger, T. & Lara, A. (1992) Disturbance and forest dynamics along a transect from Andean rain forest to Patagonian shrubland. *Journal of Vegetation Science*, **3**, 507–520.

Wang, Y. K., Fu, B., & Xu, P. (2012). Evaluation the impact of earthquake on ecosystem services. *Procedia Environmental Sciences*, *13*, 954-966.

Whitten, A., & Lamb, D. (2010). Forest restoration following earthquake damage.

Wu N., Lu T., Luo P.,Zhu D. A review of the impacts of earthquake on mountain ecosystems:taking 5.12 Wenchuan Earthquake as an example *Acta Ecologica Sinica.* 2008;**28:**5810-19. (in Chinese)

Xu, X., Wen, X., Yu, G., Chen, G., Klinger, Y., Hubbard, J. and Shaw, J. (2009), Coseismic reverseand oblique-slip surface faulting generated by the 2008 Mw 7.9 Wenchuan earthquake, China, *Geological Society of America*, 37(6), 515–518.

Yamaguchi, D. K., Atwater, B. F., Bunker, D. E., Benson, B. E., & Reid, M. S. (1997). Tree-ring dating the 1700 Cascadia earthquake. *Nature*, *389*(6654), 922–923. https://doi.org/10.1038/40048

Zeng, H., Lu, T., Jenkins, H., Negrón-Juárez, R. I., & Xu, J. (2016). Assessing earthquake-induced tree mortality in temperate forest ecosystems: A case study from Wenchuan, China. *Remote Sensing*, *8*(3), 252.

Zeydan, Ö. (2021). 2019 Yılında Türkiye'deki Partikül Madde (PM10) Kirliliğinin Değerlendirilmesi. Journal of the Institute of Science and Technology, 11(1), 106-118.

ŞIRNAK ÜNİVERSİTESİ MEHMET EMİN ACAR KAMPÜS ALANI TOPRAKLARININ TARIMSAL AÇIDAN BAZI ÖZELLİKLERİNİN DEĞERLENDİRİLMESİ

Dr. Öğr. Üyesi Bedriye BİLİR* (ORCID: 0000-0002-0038-9509)
Kahramanmaraş Sütçü İmam Üniversitesi, Ziraat Fakültesi, Toprak Bilimi ve Bitki Besleme Bölümü
Email:bbilir@ksu.edu.tr

Dr. Öğr. Üyesi Hava Şeyma İNCİ (ORCID: 0000-0002-2670-401X)
Bingöl Üniversitesi, Gıda Tarım ve Hayvancılık MYO, Bitkisel ve Hayvansal Üretim Bölümü, Tarla Bitkileri Programı
Email:hsyilmaz@bingol.edu.tr

ÖZET

Şırnak ilinin, içinde bulunduğu coğrafyanın arazi koşulları sebebiyle tarımsal açıdan kullanıma elverişli alanları sınırlı kalmıştır. Üniversitenin içinde bulunduğu kampüs alanında ise seracılık ve peyzaj faaliyetleri gerçekleştirilmektedir. Bu çalışmada Şırnak Üniversitesi Mehmet Emin Acar Kampüs alanı topraklarının bazı kimyasal özellikleri ile besin elementi düzeylerinin belirlenmesi amaçlanmış ve belirlenen bu özelliklerin tarımsal açıdan değerlendirilmesi yapılmıştır. Bu amaç doğrultusunda kampüs alanının 10 farklı noktasından 0-30 cm derinlikte toprak örnekleri alınmıştır. Alınan toprak örneklerinde pH, EC, kireç, organik madde içerikleri ile bazı makro ve mikro besin elementlerinin konsantrasyonları belirlenmiştir. Çalışma sonucuna göre kampüs toprakları hafif alkalin reaksiyon gösterirken tuzluluk problemi bulunmamaktadır. Toprakların tamamında kireç fazla olup toprakların büyük bir kısmında organik madde içeriği az olarak belirlenmiştir. Çalışma alanı topraklarının ortalama konsantrasyonları; fosfor (P): 5.62 mg kg^{-1}, potasyum (K):159.9 mg kg^{-1}, kalsiyum (Ca): 10601 mg kg^{-1}, magnezyum (Mg): 378.5 mg kg^{-1}, demir (Fe):4.04 mg kg^{-1}, çinko (Zn): 0.38 mg kg^{-1}, mangan (Mn): 1.54 mg kg^{-1} ve bakır (Cu): 1.31 mg kg^{-1} olarak belirlenmiştir. Kampüs topraklarının tamamında Ca, Mg, Fe ve Cu konsantrasyonları, büyük bir kısmında ise Mn ve K konsantrasyonları yeterliyken P ve Zn noksan olarak belirlenmiştir Bu sonuçlar dikkate alındığında kampüs alanında yürütülen sera ve peyzaj çalışmalarında P ve Zn içerikli gübre uygulamalarının yapılması uygun olabilir.

Anahtar Kelimeler: Şırnak Üniversitesi, toprak özellikleri, sera, bitki besin elementleri

THE ASSESSMENT OF SOME AGRICULTURAL PROPERTIES OF THE SOILS OF ŞIRNAK UNIVERSITY MEHMET EMIN ACAR CAMPUS AREA

ABSTRACT

The province of Sirnak has limited areas suitable for agricultural use because of the terrain conditions of its geography. In the campus area where the university is located, greenhouse and landscaping activities are carried out. In this study, it was aimed to determine some chemical properties and nutrient levels of the soils of Sirnak University, Mehmet Emin Acar Campus area and to evaluate these properties in terms of agricultural aspects. For this purpose, soil samples were taken at 0-30 cm depth from 10 different points of the campus area. The pH, EC, lime, organic matter contents and some macro and micronutrient concentrations were determined in the soil samples. According to the results of the study, the campus soils have a slightly alkaline reaction and there is no salinity problem. Lime is high in all soils and organic matter content is low in most of the soils. The average concentrations of the soils of the study area were; phosphorus (P): 5.62 mg kg^{-1}, potassium (K): 159.9 mg kg^{-1}, calcium (Ca): 10601 mg kg^{-1}, magnesium (Mg): 378.5 mg kg^{-1}, iron (Fe): 4.04 mg kg^{-1}, zinc (Zn): 0.38 mg kg^{-1}, manganese (Mn): 1.54 mg kg^{-1} and copper (Cu): 1.31 mg kg^{-1}. Ca, Mg, Fe and Cu concentrations in all of the campus soils and Mn and K concentrations in most of the campus soils were adequate, while P and Zn were found to be deficient. Considering these results, it may be convenient to apply P and Zn-containing fertilizers in greenhouse and landscape activities carried out in the campus area.

Keywords: Sirnak University, soil properties, greenhouse, plant nutrients

Giriş

Şırnak ili 37°31' kuzey enlemi ve 42°27' doğu boylamları arasında yer almakta olup 7.172 km² yüzölçümü, ortalama 1.400 metre rakımı ile deniz seviyesinden oldukça yüksektir. Şırnak ili topraklarının batı kesimi Güneydoğu Anadolu Bölgesinin Dicle bölümünde, diğer yarısı da Doğu Anadolu Bölgesi içerisinde kalmaktadır. Şırnak ili iki agro-ekolojik alt bölgeye ayrılmakta olup 300-400 metre rakım ile Cizre, Silopi ve İdil İlçeleri gibi geniş ovaların yer aldığı bölge birinci agro-ekolojik alt bölge, 1000 metre ve üzerindeki engebeli, sarp yamaçlar ve yüksek dağların yer aldığı, tarım alanı az, buna karşılık orman ve meraların geniş çapta bulunduğu Merkez, Beytüşşebap, Güçlükonak ve Uludere İlçelerini ikinci agro-ekolojik alt bölge olarak ifade edilmektedir (Toraman, 2023).

Şırnak ilinde bulunan Şırnak Üniversitesi Mehmet Emin Acar kampüsü şehir merkezinin güneyinde ve 7 km uzaklıkta Şırnak-Cizre yolu üzerinde yer almaktadır (Anonim, 2024a). 2008 yılında kurulmuş olan Şırnak Üniversitesinin Kuza Mevkiindeki Mehmet Emin Acar Kampüsü inşaatı 14 Mayıs 2013 tarihinde başlamış olup 533750 m^2 yüz ölçümüne sahip kampüs alanı 2015-2016 eğitim öğretim yılında faaliyete geçmiştir (Anonim, 2024b). Kampüs alanı içerinde rektörlük, mühendislik fakültesi, iktisadi ve idari bilimler fakültesi, ilahiyat fakültesi, güzel sanatlar fakültesi, sağlık bilimleri fakültesi, enstitüler ve araştırma merkezleri, kültür merkezi, merkezi kütüphane ve bilgi işlem merkezi, sera, merkezi kafeterya, misafirhane ve sosyal tesisler yer almaktadır.

Şırnak merkez, Uludere ve Beytüşşebap ilçeleri Doğu Anadolu bölge sınırlarında kalmakta olup yer şekilleri bakımından oldukça dağlık ve engebelidir. Bu nedenle tarımsal faaliyetler ancak vadi tabanındaki düzlüklerde veya yamaçlarda yapılabilmektedir (Koday, 2006). Mehmet Emin Acar kampüsünde kurulan portatif seralar ile tüm yıl boyunca bazı sebzelerin yetiştiriciliğinin yapılması hedeflenmiştir. Bununla birlikte kampüs alanının çimlendirme, ağaçlandırma vs. peyzaj çalışmaları son dönemlerde daha da önem kazanmıştır. Tüm bu faaliyetlerin sağlıklı bir şekilde yürütülebilmesi için toprağın verimliliği oldukça önemli bir parametredir. Toprak verimliliğindeki bir düşüş, toprağın organik C, pH, KDK ve bitki besin maddelerinin seviyelerinde bir azalış anlamına gelmektedir (Hartemik, 2006).

Şahin (2019), kampüs alanlarındaki toprakların çeşitli özelliklerini belirlenmesinin verimli toprakların korunması ve toprak türüne uygun bitkilerin seçilmesi yönünden önem arz ettiğini bildirmiştir. Ülkemizde ise bu amaçla birçok çalışma yürütülmüştür.

Gülser ve Candemir (2006) Ondokuz Mayıs Üniversitesi Kurupelit Kampüs topraklarını işlenebilirlik açısından değerlendirmek amacıyla mekaniksel özellikleri ile birlikte pH, EC, organik madde ve kireç içeriklerini belirlemişlerdir. Çalışma alanına ait toprakların pH'sı 5.74 ile 7.16 arasında değişirken tuz içeriklerinin 0.340-0.589 dS m^{-1} aralığında olduğunu bildirmişlerdir. Toprak serileri az kireçli-kireçli sınıfında (%0.16-%3.10) yer alırken organik madde içeriği %2.83-%4.10 olarak rapor edilmiştir.

Gündoğan ve ark. (2013) Kahramanmaraş Sütçü İmam Üniversitesi Avşar Kampüsü toprakları serileri ve fazları dikkate alarak detaylı bir şekilde etüt etmişler, pH, EC, organik madde, kireç ve değişebilir katyonlar gibi bazı önemli özelliklerini belirleyerek arazileri uygunluk yönetimine göre değerlendirmişlerdir. Genel olarak çalışma alanı toprakları hafif bazik reaksiyon gösterirken organik madde içerikleri düşüktür. İncelenen iki serinin toprakları kireçsiz sınıfına girerken diğer tüm seriler orta kireçli sınıfına girmektedir. Araştırma alanının büyük bir kısmında tarımsal kullanımı sınırlandıran eğim, sığlık ve taşlılık vs. özelliklerinden dolayı tarımsal kullanıma uygun olmadığı rapor edilmiştir.

Demir ve ark. (2020) Bilecik Şeyh Edebali Üniversitesi Kampüs alanında bulunan toprak serilerinin bazı fiziksel, kimyasal ve mekaniksel özelliklerini belirlemek amacıyla yürüttükleri çalışmada 20 farklı noktadan 0-20 cm derinliğinde Gülümbe ve Aşağıköy serilerinden toprak örnekleri almışlardır. Çalışmanın sonucunda Gülümbe serisinde toprakların tekstürü; killi (C), killi tınlı (CL), pH'sı 7.74 ile hafif alkalin, orta düzeyde organik madde (%2.01) içerirken kireç içeriği fazla kireçli (%17.08) sınıfında yer almaktadır. Toprakların değişebilir K, alınabilir Zn ve Cu konsantrasyonları yeterliyken alınabilir Fe ve Mn konsantrasyonu topraklarda noksandır. Aşağıköy serisindeki topraklar tınlı (L) ve kumlu killi tın (SCL) tekstürlü, hafif alkalin (pH=7.74), organik maddesi düşük (1.81%), orta düzeyde kireç (6.75%) içerirken, yarayışlı P (18.76 kg P_2O_5 da^{-1}) ve değişebilir K (133.94 kg K_2O da^{-1}) konsantrasyonları yeterli düzeydedir. Toprakların mikro elementlerden Fe ve Cu konsantrasyonları yeterliyken Zn ve Mn konsantrasyonları noksan olarak belirlenmiştir.

Bitki örtüsünün artırılması amacıyla günümüzde peyzaj uygulamaları oldukça önem kazanmıştır. Bitki kompozisyonunun ve dekoratif görünümün devamlılığını sağlayabilmek amacıyla peyzaj çalışmasına başlamadan önce arazi ve toprak hazırlığı, uygun bitki türü seçimi, başarılı dikim teknikleri ve yapılacak kültür bakımları ile bitkilerin sağlıklı gelişim göstermesi sağlanabilmektedir (Karaöz, 1992).

Üniversiteler sosyal, kültürel, ekonomik açıdan ülkelerin gelişiminde oldukça önemlidirler Ülkenin ihtiyaç duyduğu hizmet alanlarında uzman işgücü yetiştiren üniversiteler, toplumun ihtiyacına uygun yeni bilgiyi üretip, bunu gelecek kuşaklara aktarırken aynı zamanda toplumun ufkunu açarak sürekli gelişmesini sağlamaktadırlar. Temel noktada, eğitim ve öğretim veren üniversiteler; bununla birlikte, akademik ve idari personeller, öğrenciler ve bulunduğu kent halkının fiziksel, sosyal ve psikolojik gelişimlerini destekleyici bir işlev üstlenirler (Şahin, 2019).

Şırnak Üniversitesi, Türkiye'nin genç üniversitelerinden bir olarak yeniliklere ve gelişmeye oldukça açık bir üniversitedir. Artan öğrenci sayısı ve bölgenin ihtiyaçları göz önünde bulundurulduğunda kampüs alanının oldukça önemli olduğu ortaya çıkmaktadır. Bu araştırmada kampüs alanında gerçekleştirilmekte olan peyzaj çalışmalarında ve portatif seralarla yapılan tarımsal üretimde kullanılan toprakların kimyasal özellikleri ile bazı makro ve mikro besin elementi içeriklerinin belirlenmesi ve devam eden bu faaliyetlere önerilerin oluşturulması amaçlanmıştır.

2.Materyal ve Metot

2.1. Çalışma Alanı

Şırnak Üniversitesi Mehmet Emin Acar Kampüsünü temsil edecek şekilde belirlenen 10 noktadan 0-30 cm derinliğinde toprak örnekleri alınmıştır (Şekil 1). Toprak örneklerinin alındığı noktaların koordinatları not edilmiştir (Çizelge 1).

Şekil 1. Çalışma alanı ve alınan toprak örneklerinin harita üzerindeki konumu

Çizelge 1. Çalışma için alınan toprak örneklerine ait koordinatlar

Toprak No	Koordinatlar N/E	
1	37° 30.037’	42° 25.517’
2	37° 29.902’	42° 25.577’
3	37° 30.142’	42° 25.672’
4	37° 30.183’	42° 25.627’
5	37° 30.356’	42° 26.050’
6	37° 30.417’	42° 25.676’
7	37° 30.431’	42° 25.551’
8	37° 30.349’	42° 25.500’
9	37° 30.224’	42° 25.579’
10	37° 30.117’	42° 25.390’

2. 2. Toprak Örneklerinin Analiz Yöntemleri

Çalışma alanı topraklarının pH ve EC McLean (1982) tarafından belirlenen yönteme göre toprak-su (1:2.5) karışımından toprak reaksiyonu Thomas (1996) tarafından belirlenen şekilde pH metre ile elektriksel iletkenlik ise EC metre aleti ile ölçülerek belirlenmiştir (Rhoades, 1996). Toprakların organik madde düzeyleri Modifiye Walkley-Black tarafından bildirilen yönteme göre (Nelson ve Sommers, 1996), toplam kireç ise Scheibler

kalsimetresi ile ölçülmüştür (Allison ve Moodie, 1965). Bitkiye yarayışlı makro besin elementlerinden değişebilir Ca, Mg ve K, 1N amonyum asetat (NH_4 OAC, pH=7) yöntemine göre (Helmke ve Sparks, 1996), yarayışlı fosfor ise Olsen ve Sommers (1982) tarafından bildirilen 0.5 M $NaHCO_3$ yöntemiyle belirlenmiştir. Topraklardaki ekstrakte edilebilir mikro elementlerden Fe, Cu, Zn ve Mn Lindsay ve Norvell (1978) tarafından bildirilen DTPA yöntemiyle belirlenmiştir.

3. Bulgular ve Tartışma

3.1. Kampüs topraklarının pH, EC, organik madde ve kireç içeriklerinin değerlendirilmesi

Şırnak Üniversitesi Mehmet Emin Acar Kampüsünden alınan toprak örneklerinin pH, EC, organik madde ve kireç içerikleri Çizelge 2.'de verilmiştir.

Çizelge 2. Çalışma alanı topraklarının pH, EC, organik madde ve kireç içerikleri

Toprak No	pH	EC ($\mu s\ cm^{-1}$)	Organik Madde (%)	Kireç (%)
1	7.67	184.2	1.74	25.7
2	7.84	169.3	1.18	34.4
3	7.69	141.8	2.05	23.1
4	7.80	130.2	1.80	35.7
5	7.59	161.1	4.97	17.6
6	7.57	133.9	1.52	31.2
7	7.49	150.3	3.00	16.6
8	7.73	186.5	1.38	27.0
9	7.86	102.3	1.04	36.9
10	7.68	224.0	2.58	20.3
Min.	7.49	102.3	1.04	16.6
Mak.	7.86	224.0	4.97	36.9
Ort.	7.69±0.12	158.4±34.5	2.12±1.16	26.8±7.47

Toprak reaksiyonu (pH) ve elektriksel iletkenlik (EC)

Çalışma alanı topraklarının pH içeriği 7.49 ile 7.86 arasında değişmekte olup ortalama 7.69 ile hafif alkalin sınıfında yer almaktadır (Sağlam, 2012). Toprakların tuz içeriği ise minimum 102.3 $\mu S\ cm^{-1}$, maksimum 224 $\mu S\ cm^{-1}$ ortalama ise 158.4 $\mu S\ cm^{-1}$'dir. Çalışmanın yürütüldüğü topraklar Dellavalle (1992) tarafından belirlenen sınır değerlere göre (0-400 $\mu S\ cm^{-1}$) tuzsuz sınıfında yer almaktadır. Çalışma alanı toprakları tarımsal açıdan değerlendirildiğinde tuz içeriğinin verimliliği etkileyecek bir problem teşkil etmediği söylenebilir. Bilir ve ark. (2023) Silopi ilçesinde yürüttükleri çalışmada

toprakların pH'sının ortalama 7.97 ile hafif ve orta derece alkalin ve çalışma alanının tamamına yakınında tuzluluk probleminin olmadığını bildirmiştir. Çimrin ve Boysan (2006) Van ili buğday tarlalarında yürüttükleri çalışmada toprakların pH'sının 6.52 ile 8.22 arasında değiştiğini ortalama 7.70 ile büyük bir kısmının hafif alkalin reaksiyon gösterdiklerini bildirmişlerdir. Orman ve Kaplan (2004) domates bitkisinin pek çok sebze gibi hafif asit ve nötr toprak reaksiyonu koşullarında daha iyi geliştiğini bu nedenle de gübreleme programları hazırlanırken asit karakterli gübrelerin tercih edilmesi gerektiğini bildirmişlerdir. Yüksek kirece bağlı toprak pH'sının azaltılması amacıyla elementel toz kükürt uygulaması da bir diğer önemli seçenektir (Tuna ve Altunay, 2017).

Organik Madde (%)

Mehmet Emin Acar Kampüs topraklarının organik madde içeriği %1.04 ile %4.97 arasında değişmekte olup ortalama %2.12 olarak belirlenmiştir. Ülgen ve Yurtsever (1974)'in sınıflandırmasına göre çalışma alanı topraklarının büyük bir kısmında organik madde içeriği azken (%1-2), %20'si orta (%2-3), %20'si ise iyi (%3-4) sınıfına girmektedir. Munis ve Sakin (2019) Cizre'de yürüttükleri çalışmada toprakların organik madde içeriğini %1.27 ile %2.93 arasında olup ortalama %1.90 olduğunu bildirmişlerdir. Söğüt ve ark. (2018) nitelikli peyzaj uygulamaları için toprağın bitki köklerinin rahatça büyüyüp gelişeceği bir ortam sağlaması gerektiğini bu nedenle toprak kalitesini artırmak amacıyla organik madde eklenerek saçak köklerin en yoğun bulunduğu 30 cm derinliğe karıştırılması gerektiğini bildirmişlerdir. Orman ve Kaplan (2004) sera topraklarının organik madde içeriklerini düzenlemek ve iyileştirmek amacıyla başta seralardaki bitki artıkları olmak üzere çeşitli bitki artıklarının kompostlaştırılıp organik gübre olarak uygulanmasını önermektedir. Tuna ve Altunay (2017) ise seralardaki düşük organik madde içeriğini yükseltebilmek amacıyla yılda 2-3 ton da^{-1} iyi yanmış çiftlik gübresi uygulamasını önermektedir.

Kireç (%)

Çalışma alanı topraklarının kireç içerikleri %16.6 ile %36.9 arasında değişmekte olup ortalama %26.8 olarak belirlenmiştir. Toprakların %40'ının kireç içeriği fazla kireçli sınıfında (%15-25) yer alırken geriye kalan toprakların tamamı çok fazla sınıfında (>%25) bulunmaktadır (Çağlar, 1949; Evliya, 1964). Demirekin ve Erdal (2015) Hakkari Çukurca yöresinde yürüttükleri çalışmada topraklarının %6-%32 aralığında kireç içerdiğini belirlemiştir. Orman ve Kaplan (2004) Kumluca ve Finike yörelerindeki

seraların kireç içeriklerinin yüksek olduğunu bildirmişlerdir. Bu nedenle seralarda yapılacak olan gübrelemede bu durumun dikkate alınarak gübreleme yapılmasının ve kirece dayanıklı çeşitlerin seçilmesi gerektiğini ayrıca kireç kaynaklı beslenme sorunlarının ortaya çıkması durumunda yapraktan gübrelemenin tercih edileceğini önermektedirler. Toprakların yüksek kireç düzeyi bitkilerin besin elementlerinin alımı üzerine olumsuz etki edebileceği için bu durumun çözümü önem arz etmektedir. Bu amaçla kaliteli sulama suyu temini ve fizyolojik asit karakterli gübre kullanımının yanı sıra, damla sulama sistemlerinden toprak kirecinin ve pH'sının düşürülmesine yönelik hümik asit vb. uygulamaların yapılması yararlı olabilir (Tuna ve Altunay, 2017).

3.2. Kampüs topraklarının yarayışlı P, değişebilir K, Mg ve Ca konsantrasyonlarının değerlendirilmesi

Şırnak Üniversitesi Mehmet Emin Acar Kampüsünden alınan toprak örneklerinin yarayışlı P, değişebilir K, Mg ve Ca konsantrasyonları Çizelge 3'te verilmiştir.

Çizelge 3. Çalışma alanı topraklarının P, K, Mg ve Ca konsantrasyonları

Toprak No	P (mg kg^{-1})	K (mg kg^{-1})	Mg (mg kg^{-1})	Ca (mg kg^{-1})
1	3.69	151.5	479	10287
2	1.30	73.0	428.5	7937
3	6.75	147.5	359	12662
4	6.90	129.5	299	10662
5	3.99	174.5	398.5	11187
6	5.26	126.5	377.5	9962
7	16.1	283.0	404	10912
8	3.24	166.0	326	10925
9	4.43	47.5	253.5	9512
10	4.58	300.0	460	11962
Min.	1.30	47.5	253.5	7937
Mak.	16.1	300.0	479	12662
Ort.	5.62±4.02	159.9±79.9	378.5±71.0	10601±1309

Çalışma alanı topraklarının P konsantrasyonu 1.30 mg kg^{-1} ile 16.1 mg kg^{-1} arasında değişmekte olup ortalama 5.62 mg kg^{-1} olarak belirlenmiştir (Çizelge 3.). FAO (1990) tarafından bildirilen sınıflandırmaya göre toprakların tamamına yakınının P içerikleri az (2.5-8 mg kg^{-1}) sınıfında yer alırken yalnızca toprakların bir tanesinde P çok az (<2.5 mg

kg^{-1}) ve bir tanesinde yeterli (8-25 mg kg^{-1}) sınıfındadır. Bildirici ve Demir (2019) Hakkari Depin mevkiinde yer alan toprakların P düzeyinin 5.33 mg kg^{-1} ile az olduğunu bildirmiştir. Koçhan (2010) doğal olarak yetişen, peyzaj tasarım ve onarım çalışmalarında bol miktarda kullanılabilecek olan kuşburnunun toprakta P eksikliği nedeni ile vitamin oranının düştüğü bildirilmiştir. Kampüs topraklarının K konsantrasyonu 47.5 mg kg^{-1} ile 300 mg kg^{-1} arasında değişmekte olup ortalama 159.9 mg kg^{-1} olarak belirlenmiştir. Topraklardan bir tanesi çok az (<50.7 mg kg^{-1}), bir tanesi de fazlayken (288.6-998.4 mg kg^{-1}) geriye kalan tüm topraklarda K konsantrasyonu yeterli sınıfında (109.2-288.6 mg kg^{-1}) yer almaktadır (FAO, 1990). Çalışma alanı topraklarının Mg konsantrasyonu 253.5 mg kg^{-1} ile 479 mg kg^{-1} arasında değişmekte olup ortalama 378.5 mg kg^{-1} olarak belirlenmiştir. FAO (1990) tarafından bildirilen sınıflandırmaya göre toprakların tamamında Mg konsantrasyonu yeterli (159.6-480 mg kg^{-1}) sınıfındadır. Toprakların tamamında Mg içeriğinin yeterli düzeylerde olması Mg beslenmesi açısından bir sorun olmadığı şeklinde ifade edilebilir. Kampüs topraklarının Ca konsantrasyonu 7937 mg kg^{-1} ile 12662 mg kg^{-1} arasında değişmekte olup ortalama 10601 mg kg^{-1} olarak belirlenmiştir. Çalışma alanı topraklarının %70'inde Ca konsantrasyonu çok fazlayken (>10 000 mg kg^{-1}) geriye kalan topraklarda ise fazla sınıfında (3500-10 000 mg kg^{-1}) yer almaktadır (FAO, 1990). Orman ve Kaplan (2004) yaptıkları çalışmada paralel sonuçlar bulmuşlar ve Ca ile Mg konsantrasyonlarının yeterli olduğu için beslenme açısından bir problem teşkil etmediklerini bildirmişlerdir.

3.3. Kampüs topraklarının ekstrakte edilebilir Fe, Zn, Mn ve Cu konsantrasyonlarının değerlendirilmesi

Şırnak Üniversitesi Mehmet Emin Acar Kampüsünden alınan toprak örneklerinin ekstrakte edilebilir Fe, Zn, Mn ve Cu konsantrasyonları Çizelge 4'de verilmiştir.

Çizelge 4. Çalışma alanı topraklarının Fe, Zn, Mn ve Cu konsantrasyonları

Toprak No	Fe (mg kg^{-1})	Zn (mg kg^{-1})	Mn (mg kg^{-1})	Cu (mg kg^{-1})
1	4.97	0.41	2.01	1.59
2	3.10	0.34	1.18	0.88
3	5.14	0.32	2.04	1.56
4	4.14	0.30	1.38	1.32
5	4.75	0.64	1.40	1.99
6	3.71	0.38	1.42	1.08
7	3.02	0.45	1.53	1.34
8	4.62	0.32	2.32	1.12
9	3.08	0.28	0.70	0.91
10	3.86	0.35	1.41	1.29
Min.	3.02	0.28	0.70	0.88
Mak.	5.14	0.45	1.41	1.99
Ort.	4.04±0.81	0.38±0.10	1.54±0.47	1.31±0.33

Çalışma alanı topraklarının Fe konsantrasyonu 3.02 mg kg^{-1} ile 5.14 mg kg^{-1} arasında değişmekte olup ortalama 4.04 mg kg^{-1} olarak belirlenmiştir (Çizelge 4). Lindsay ve Norwell (1978) tarafından bildirilen sınıflandırmaya göre toprakların %60'ı orta düzeyde (2.5-4.5 mg kg^{-1}) Fe içerirken geriye kalan toprakların tamamı fazla sınıfında (>4.5 mg kg^{-1}) yer almaktadır. Kampüs topraklarının Zn konsantrasyonu 0.28 mg kg^{-1} ile 0.45 mg kg^{-1} arasında değişmekte olup ortalama 0.38 mg kg^{-1} olarak belirlenmiştir. FAO (1990) tarafından bildirilen sınıflandırmaya göre çalışma alanı topraklarının tamamında Zn azdır (<0.7 mg kg^{-1}). Türkiye'nin de dahil olduğu FAO tarafından yapılan, bir çalışmada dünyadaki tarım topraklarının %30'unda ve Türkiye topraklarının da %83'ünde Zn noksanlığı saptanmıştır (Silanpaa, 1982; Çakmak ve ark., 1996). Yağmur ve Aydın (2013) çinkonun noksan olduğu sera koşullarında topraktan veya yapraktan çinko sülfat ($ZnSO_4.7H_2O$) uygulamasının marul bitkisinin bazı gelişme parametrelerinde ve bitkinin N, K ve Zn içeriklerinde artışların sağladığını bildirmişlerdir. Çalışma alanı topraklarının Mn konsantrasyonu 0.70 mg kg^{-1} ile 1.41 mg kg^{-1} arasında değişmekte olup ortalama 1.54 mg kg^{-1} olarak belirlenmiştir. Lindsay ve Norwell (1978) tarafından yapılan sınıflandırmaya göre 9. numaralı toprak (<1.2 mg kg^{-1}) dışında tamamında yeterlidir (>1.2 mg kg^{-1}). Kampüs topraklarının Cu konsantrasyonu 0.88 mg kg^{-1} ile 1.99 mg kg^{-1} arasında

değişmekte olup ortalama 1.31 mg kg^{-1} olarak belirlenmiştir. Follet (1969) tarafından bildirilen sınıflandırmaya göre çalışma alanı topraklarının tamamında Cu yeterli sınıfında (>0.2 mg kg^{-1}) yer almaktadır. Bilir ve ark. (2023) Silopi topraklarının değişebilir Ca, Mg, K ile mikro elementlerden Fe, Cu, Mn yeterli düzeyde bulunduğunu fakat toprakların %27.5'inde P, %20'sinde ise Zn noksanlığı olduğunu bildirmişlerdir.

4. Sonuç

Şırnak Üniversitesi, Mehmet Emin Acar Kampüsü topraklarının verimlilik düzeylerini incelemek amacıyla pH, EC, organik madde ve kireç içerikleri ile birlikte bazı makro ve mikro besin elementleri belirlenmiştir. Çalışma sonucunda kampüs topraklarının toprak reaksiyonu yönüyle hafif alkalin karakter gösterirken toprakların tamamında tuzsuz sınıfında yer alması bitki yetiştirme açısından tuzluluk probleminin bulunmadığını ortaya koymaktadır. Çalışma alanı topraklarının tamamında kireç fazla olup toprakların büyük bir kısmında az organik madde içeriğine sahip olduğu belirlenmiştir. Kampüs alanı toprakları verimlilik açısından incelendiğinde topraklarının tamamında Ca, Mg, Fe ve Cu konsantrasyonları, büyük bir kısmında ise Mn ve K konsantrasyonları yeterliyken P ve Zn noksan olarak belirlenmiştir. Özetle, çalışma alanı topraklarının yeterlilik sınırı altında olan besin elementleri için sera ve peyzaj çalışmalarında uygun gübre çeşidi ile dozu belirlenerek gübreleme yapılması önerilmektedir.

KAYNAKlAR

Allison, L. E., & Moodie, C. D. (1965). Carbonate. In A. G. Norman (Ed). Methods of Soil Analysis: Part 2 Chemical and Microbiological Properties (pp. 1379-1396). American Society of Agronomy. doi:10.2134/agronmonogr9.2.c40

Anonim(2024a). Erişim Adresi: https://www.arkiv.com.tr/proje/sirnak-universitesi kampusu/3310, Erişim Tarihi: 19.02.2024.

Anonim (2024b). Erişim Adresi: https://www.sirnak.edu.tr/ar/aktivite/kampus-projesi/19997 Erişim Tarihi: 19.02.2024.

Bildirici, N., & Demir, S. (2019). Hakkari ekolojik koşullarında bazı kuru fasulye (Phaseolus Vulgaris L.) çeşitlerinin verim ve verim özelliklerinin belirlenmesi. *Bitlis Eren Üniversitesi Fen Bilimleri Dergisi*, *8*(4), 1250-1257.

Bilir, B., Irmak, S., & Doğan, M. (2023). Şırnak İli Silopi İlçesi Tarım Topraklarının Bazı Özellikleri Ve Besin Elementi Düzeylerinin Belirlenmesi. *Yüzüncü Yıl Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, *28*(3), 1174-1186.

Çağlar, K. Ö. (1949). Toprak Bilgisi. Ankara Üniversitesi Ziraat Yayınları.

Çakmak, İ., Torun, B., Erenoğlu, B., Kalaycı, M., Yılmaz, A., Ekiz, H., & Braun, H. (1996). Türkiye'de toprak ve bitkilerde çinko eksikliği ve bitkilerin çinko eksikliğine dayanıklılık mekanizmaları. *Turkish Journal of Agriculture and Forestry*, *20*, 13-23.

Çimrin, K. M., & Boysan, S. (2006). Van yöresi tarım topraklarının besin elementi durumları ve bunların bazı toprak özellikleri ile ilişkileri. Yüzüncü Yıl Üniversitesi Ziraat Fakültesi Tarım Bilimleri Dergisi, 16(2), 105-111.

Dellavalle, N. B. (1992). Determination of specific conductance in supertanat 1:2 Soil:Water Solution. In Handbook on Reference Methods for Soil Analysis.

Demir, Z., Zeki, M., Hanife, M. & Gülümser, E. (2021). Bilecik Şeyh Edebali Üniversitesi Kampüs Topraklarının Bazı Fiziko-Kimyasal Ve Mekaniksel Özellikleri Ve İşlenebilirlikleri. *Anadolu Tarim Bilimleri Dergisi*, *36*(1), 146.

Demirekin, H., & Erdal, İ. (2015). Hakkâri-Çukurca yöresi topraklarının verimlilik durumlarının belirlenmesi. Yüzüncü Yıl Üniversitesi Tarım Bilimleri Dergisi, 25(2), 140-147. doi:10.29133/yyutbd.236328.

Evliya, H. (1964). Kültür Bitkilerinin Beslenmesi. Ankara Üniversitesi Ziraat Fakültesi Yayınları.

FAO. (1990). Micronutrient, Assesment at the Country Level: An International Study. FAO Soil Bulletin by Mikko Silanpaa, Rome.

Follet, R. H., 1969. Zn, Fe, Mn and Cu in Colorado Soils. PhD. Dissertation. Colo. State Univ., USA.

Gülser, C., & Candemir, F. (2006). Ondokuz Mayıs Üniversitesi Kurupelit Kampüs Topraklarının Bazı Mekaniksel Özellikleri ve İşlenebilirlikleri. *Anadolu Tarım Bilimleri Dergisi*, *21*(2), 213-217.

Gündoğan, R., Yılmaz, K., Demirkıran, A. R., & Yakupoğlu, T. (2013). Kahramanmaraş Sütçü İmam Üniversitesi Avşar Kampüsü topraklarının özellikleri, oluşumu, sınıflandırılması ve kullanımı. III. *Ulusal Toprak ve Su Kaynakları Kongresi, Bildiriler Kitabı*, 238-245.

Hartemink, A. E. (2006). Assessing soil fertility decline in the tropics using soil chemical data. *Advances in agronomy*, *89*, 179-225.

Helmke, P.A. ve Sparks, D.L. 1996. Lithium, Sodium, Potassium, Rubidium, and Calcium. In: Sparks D.L. Methods of Soil Analysis: Part 3 Chemical Methods s. 551-574.

Koçhan, N. (2014). Peyzaj Planlama Ve Tasarım Çalışmalarında Kuşburnu (Rosa Canina L.) Bitkisinin Değerlendirilmesi. *Harran Tarım Ve Gıda Bilimleri Dergisi*, *14*(4), 33-37.

Koday, Z. (2006). Doğu Anadolu Bölgesinde Zirai Faaliyetlerdeki Farklılıkların Yeri Ve Önemi. Ankara Üniversitesi Türkiye Coğrafyası Araştırma Ve Uygulama Merkezi 25-26 Mayıs 2006 Iv. Ulusal Coğrafya Sempozyumu, Türkiye.

Karaöz, M. (1992). Gübreler Ve Peyzaj Uygulamalarında Gübreleme Teknikleri. *Journal Of The Faculty Of Forestry Istanbul University*, *42*(3-4), 49-60.

McLean, E.O. (1982). Soil pH and Lime Requirement. In: A. L. Page, R. H. Miller, and D. R. Keeney (Eds.). Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties, Agronomy Monograph Number 9, Madison, Soil Science Society of America.

Lindsay, W. L., & Norvell, W. A. (1978). Development of a DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of American Proceeding, 42, 421-428. doi:10.2136/sssaj1978.03615995004200030009x

Munis, M. M., & Sakin, E. (2013). Cizre ilçesi topraklarının verimlilik durumlarının belirlenmesi. Türk Doğa ve Fen Dergisi, 2(2), 38-43.

Nelson, D. W., & Sommers, L. E. (1996). Total carbon, organic carbon and organic matter. In D. L. Sparks (Ed.). Methods of Soil Analysis. Part 3, Chemical Methods, Madison. doi:10.2136/sssabookser5.3.c34

Olsen, S. R., & Sommers, E. L. (1982). Phosporus Soluble in Sodium Bicarbonate. In Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties (pp. 404- 430).

Orman, Ş., & Kaplan, M. (2004). Kumluca Ve Finike Yörelerinde Serada Yetiştirilen Domates Bitkisinin Beslenme Durumunun Belirlenmesi. *Akdeniz University Journal Of The Faculty Of Agriculture*, *17*(1), 19-29.

Rhoades, J. D. (1996). Salinity: Electrical Conductivity and Total Dissolved Solids. in: Sparks, D.L., Page, P.A., Helmke, R.H., Loeppert, P.N., Soltanpour, M. A., Tabatabai, C. T., Johnston, M. E. Sumner. (Ed.), Methods of Soil Analysis. Part 3, Chemical Methods. doi:10.2136/sssabookser5.3.c14

Toraman, M. C. (2023). Şırnak İli ve İlçelerinin Tarımsal Mekanizasyon Düzeyi. *Turkish Journal of Agriculture-Food Science and Technology*, *11*(9), 1628-1638.

Thomas, G.W. (1996). Soil pH and soil acidity. in: Sparks, D.L. A.L. Page, P.A. Helmke, R.H. Loeppert, P. N. Soltanpour, M. A. Tabatabai, C. T. Johnston, M. E. Sumner (Ed.), Methods of Soil Analysis. Part 3, Chemical Methods. SSSA Book Series 5. ISBN: 9780891188254, Madison,1390.

Sağlam, T.M. (2012). Toprak Kimyası. Namık Kemal Üniversitesi Ziraat Fakültesi.

Söğüt, Z., Çolakkadıoğlu, D., Şenol, D., & Satar, M. (2018). Kuşadası'nda Kurakçıl Peyzaj Uygulamalarının Önemi. *T. Birişçi ve AK Önaç (editör) Kuşadası Peyzaj Değerleri*, 12-26.

Şahin, L. (2019). *Kampüslerin dış mekan tasarım ilkeleri açısından irdelenmesi; ışık ayazağa kampüsü örneği* (Master's thesis, Namık Kemal Üniversitesi).

Tuna, A. L., & Altunay, İ. (2017). Ortaca yöresi sera domatesi bitkisinin (Solanum lycopersicum L.) beslenme durumunun belirlenmesi. *Ege Üniversitesi Ziraat Fakültesi Dergisi*, *54*(2), 141-147.

Ülgen, N., & Yurtsever, N. (1974). Türkiye gübreler ve gübreleme rehberi. Toprak ve Gübre Araştırma Enstitüsü Müdürlüğü, Teknik Yayınlar No:28. Ankara

ENHANCEMENT OF THE GROWTH OF *NICITIANA TABACUM* BY INDOLE ACETIC ACID (IAA) USED IN SOIL TREATMENT AGAINST ORGANIC CONTAMINANT POLLUTION

Raymond Oriebe ANYASI*
Department of Environmental Sciences

Harrison Ifeanyichukwu ATAGANA
Institute for Nanotechnology and Water Sustainability
University of South Africa, Florida Campus, Roodepoort-South Africa

Desmond Chiagozie AGBO
Department of Water Science Ebonyi State University, Abakaliki

Joyce Onyenaturuchi ANYASI RAYMOND
Department of Construction management Technology Tshwane University of Technology

ABSTRACT
The effect of Indole Acetic Acid (IAA) hormone towards the enhancement of growth of seedlings of tobacco (*Nicotiana tabacum)* was the sole purpose of this study. Seedlings of *N. tabacum* treated with equal quantities of IAA hormone (0.7%) were grown in 1kgs of vermuculate, perlite, planting soil, sand, and equal mixture of all media. The set up were treated equally with water and organic manure. Control set up was made with a mixture of different rooting media without IAA. Data on shoot development were noted for 6 weeks and root length was measured on the day of harvest. The parameters measured were analysed statistically using ANOVA, and it was found out that root and shoot lengths were significant at $p>0.05$ in the entire rooting media and the highest percentage development (49 and 51%) respectively for root and stem respectively, was observed in the rooting media that has equal measure of each constituent (i.e. the mixed constituents). Germination rate among the media were 100, 70, 60, 50 and 40% for mixed, sand, planting soil and vermiculate, perlite and control respectively. Different sections of mature stem tested with IAA hormone were not significant in their root and stem development, although basal cutting stems tend to mature faster than epical. This therefore means that propagating *N. tabacum* by seedlings can be optimally achieved through mixture of 0.7% of IAA in a collection of different rooting media.
Keywords: Nicotiana tabacum, Indole Acetic acid, Root formation, Rooting media, Growth enhancement

1.0 Introduction

Tobacco is an important commercial and agricultural plants growth in several part of the globe because of its economic need. This is a plant with a common name of several plants in the genus *Nicotiana* of the family *Solanaceae,* and the general term for any product prepared from the cured leaves of these plants. More than 70 species of tobacco are known, but the chief commercial crop is Nicotiana tabacum. (Singh *et al.* 2009). Tobacco is a plant (Nicotiana tabacum and Nicotiana rustica) that contains nicotine, an addictive drug with both stimulant and depressant effects. Tobacco leaves are used to make products that can be consumed in different ways: smoked in cigarettes, cigars or pipes. smoked in loose form in hookahs. All forms of tobacco are harmful, and there is no safe level of exposure to tobacco. Cigarette smoking is the most common form of tobacco use and the reason is because it contains nicotine because of the highly addictive stimulant alkaloid nicotine as well as harmala alkaloids. Tobacco use is a cause or risk factor for many deadly diseases, hence is always advised that tobacco smoking is dangerous to health.

Indole acetic acid (IAA) is the main auxin in plants, regulating growth and developmental processes such as cell division and elongation, tissue differentiation, apical dominance, and responses to light, gravity, and pathogens. IAA stimulates overproduction of root hairs and lateral roots in plants and release of saccharides from plant cell walls during the elongation (Sosnowski *et al*. 2023). Saccharides are a source of nutrients for microorganisms and can increase the colonization ability of plant-associated bacteria, this is because IAA production is a major property of rhizosphere bacteria that stimulate and facilitate plant growth. Indoleacetic acid (IAA) is a molecule that is synthesized by plants and a few microbes (Ansari *et al.* 2023). In plants, IAA plays a key role in both root and shoot development. The hormone moves from one part of the plant to another by a designated importer (AUX1) and efflux pumps (PIN1–7). IAA also regulates geotropism by accumulating on the underside of shoots and roots. In shoots, IAA causes cell elongation on the underside of the shoot, causing it to bend upwards, away from the force of gravity. In roots, IAA inhibits cell growth, causing roots to grow downwards, towards the force of gravity.

The medicinal properties of plants lie in their phytochemical components like alkaloids, flavonoids, tannins in addition to other phenolics that co-opt as to producing definite

physiological functions to the body of man and animals (Taiwo et al. 2000; Che Man 2010). However, analysis of extracts of *N. tabaccum* were found to be rich in flavonoid and flavonones, triterpene, terpenic compounds, chalcone, steroids as well as peroxidise isoenzymes (Anup et al. 2011; Anyasi *et al*. 2019; Raymond Anyasi and Anyasi, 2020). It is also rich in carbohydrates, high content of total proteins in addition to high percentage of nitrogen. All these contribute to the high phytochemical properties of the plant. *N. tabacum* is therefore grown as a medicinal plant for the treatment of skin wounds especially in Indonesia (Metwally and Ekejuba 1981; Phan et al. 1996). In South Africa for example, the leaf of *N. tabacum* is used for the production of tobacco by the tobacco companies. However, because everyone deserves a fair and just opportunity to be as healthy as possible, this is known as health equity. Therefore, achieving health equity means addressing system-wide problems, unfair practices, and unjust conditions that have a negative impact on the health of specific groups. To achieve health equity, it is important to eliminate health disparities which are differences in health outcomes that are closely linked with social, economic, and/or environmental factors, that affect the entire people of the globe (Taiwo et al, 2000). To improve health equity, we must consider the role of commercial tobacco (Phan et al. 1996; Akinmoladun et al., 2007; Anup et al., 2011). *N. tobacum* has also been implicated by its diuretic, hepatotropic and astringent properties (Weninger and Robenean 1988; Iwu 1993).

N. tobacco can be propagated mainly by seeds, this is one of the significant agronomic properties of the plant (Tanhan *et al*., 2007; Anyasi *et al*. 2019). However, it has been reported that germination of seeds from weeds are most likely affected by soil compositions especially in the field study, therefore such propagation is aided by agronomic factors that enhances the growth and multiplication of such plant (Adebayo *et al*., 2005; Agbo and Obi 2007). Moreover, as some other types of propagation such as stem cuttings propagation prolongs hybridization of genome as segregation through recombinant gene is avoided, this may not be possible in some plants for example in the tobacco plant we are studying.

The success of rooting has been attributed amongst other factors to the rooting medium as well as the presence of rooting hormone and its concentration (Al-Saqri and Alderson 1996; Hartmann *et al*. 1997). Influences of rooting media and hormone on rooting in different kinds of plant have been documented and its effects in structure propagations

were elucidated (Akwatulira *et al.* 2011). These media combination used in the rooting of the seedlings provide physical support as well as oxygen and water to the plant seeds (Larsen and Guse 1997). However, IAA; an auxin containing product was reported to stimulate adventitious roots in of some plants (Araya *et al*. 2007). This was buttressed by the study by Rao *et al*. (2005) which reported that IAA was the leading plants hormone used to promote the formation of roots in Tomatoes. Hence with the quest for a systematic search for specific useful factors from plants like *N. tobacum,* even though most plants can root without hormone, there is need for an improved method of propagation and growth for such nutraceutical plants. This will therefore form a rational approach towards drug and nutritional research. The aim of this study was to evaluate the effect of IAA hormone and rooting media for optimal rooting of propagated *N. tabacum*.

2.0 Materials and methods

Seeds of *N. tobacco* plants was collected from the greenhouse at the University of South Africa in Pretoria (25^{o}46’1”S, 28^{o}12’2”E) and 1439m above sea level. The experiment took place in polyvinyl chloride (PVC) pots with dimensions 30x25x30 at a garden at the University of South Africa at Florida Campus. The pots contain 1kgs of different rooting medium that has been mixed with equal volume of organic manure collected at the animal farm of the University of Pretoria in Onderstepoort. Inside each pot was made holes designed to contain equal weight of IAA hormone (0.7%), for the plants. The set up was made in a complete randomized design containing a 3x4 factorial treatment model (Jeruto *et al*. 2008). The rooting media used here were planting soil and humus in the ration of 2:1 (w/w). About thirty-six plantlets were used in each set of rooting media and IAA hormone concentration by volume percentage. Then sets of water treated seedlings were sawn into holes containing the IAA hormone in the rooting media and were replicated by three. Random allocation of plant seedlings to the rooting media using random digit from a table was employed as to eliminate bias (Johnson and Bhattacharyya 2006).

2.1 Rooting media

The rooting media was homogenized by hand, mixed with equal volume of organic manure and air dried on an impervious polythene sheet for 24 hours, there were pasteurized and fumigated, measured into the PVC pots with the hole containing about 0.7% of IAA hormone. This concentration was chosen because of its optimum performance from other unpublished trials.

2.2 Propagation of the seedlings

The 10.0 cm Plantlets with lateral buds were about 360 collected at tale end of the afternoon when the weather was moist and were kept in a bow containing water (Agbo and Obi 2007). The bases were made squared using sharp sickle to spread the rooting. For each of the cuttings, about half of it was dipped into the IAA hormone that has been made into hole in each of the pots as to soak the powder. Excess of it was shaken off the base of the cuttings and the hormone was manually made to concentrate at the base. The plantlets were then inserted into the soil to about 6 cm, watered and maintained to about 70% humidity (Tanhan *et al.* 2007). Fungicides were sprayed onto the plants to control infections (Yeboah and Amoah 2009). The set up was allowed to grow for six weeks while monitoring in between days to remove any invading weeds. Data on shoot development was taken at interval of weeks and root length was measured on the day of harvest after weeks.

2.3 Data collection

Data collection which commenced on the first week after propagation continued till the sixth week and the parameters measured were survived seedlings, length of shootings/buds, and the root length, number, and weight of the plant on the day of harvest.

2.4 Data analysis

The data collected was analysed using Microsoft excel to obtain the mean number and percentage of plants that were able to form developed root and sprouted shoots from the series of transplanted seedlings. The data was then imported into SPSS version 13.0 and was analysed using analysis of variance (ANOVA) and standard deviation for the length of shoot and roots. The significance effects were determined at 5% level of significance.

3.0 Results

N. tabacum seedlings treated with concentration of 0.7% (w/w) IAA hormone propagated in different growth media recorded the highest mean number of the seedlings that developed roots and sprouted shoots in the set up with equal mixtures of the 4 growth media with organic manure. While the stem seedlings propagated in the perlite and control recorded the least mean rooted (2 each) and sprouted shoots (4 and 3) as recorded in Table 3.1. Amazingly, perlite and vermiculate maintained almost equal numbers of shoot developed (4 and 3 respectively) like in the root (2 each). However, significant difference existed among the different media with reference to their mean rate of

development and formation of root and shoot. The efficacy of IAA hormone to the development of root and shoots was noticed by the difference between the treated samples and the controls without the hormone. There was significance difference between the two samples.

Number and length of roots developed among different rooting medium and the concentration of hormone were not significant (Table 1.0) but shoot lengths and number per sprouted stem was significant. Increase in shoot length occurred in this order: mixture>vermiculate>perlite>planting soil>sand>control while increase in root length were in the order: mixture>vermiculate>perlite>planting soil>sand>control. But it made a turnaround in the number that rooted and shooted within the rooting media, i.e., sand and planting soil had the same mean number of roots (4) and a little difference in Shoots (6 and 12). The control media maintained equal numbers. In fresh weight of the plants (apical and basal), there were higher weight measurement in the basal sections than the apical ones, though not significant. Equally, set up containing the mixture of the rooting media still maintained the highest weight followed by sand, perlite, planting soil, vermiculate and the control. The same sequence was also followed in their dry weights. In sand however, there were greater number of root numbers while in other rooting media had the same number of roots. Shoot and root length of mixture of rooting media and vermiculate were synonymous with each other and were almost significant with the rest of the medium. Root lengths were 34 and 33mm for mixture and vermiculate respectively, 39 and 37mm in sand and planting soil. The shoot length was 41mm in both sand and vermiculate, while 43mm all in planting soil and mixture respectively. The set up containing equal mixtures of all media had 100% germination rate compared to 70, 60 50 and 40% for sand; planting soil/vermiculate; perlite and control respectively. However, the rest of the media demonstrated improved significant effects in all the parameters measures compared to the control.

Discussion

The rooting medium supplement that has mixtures of planting soil, perlite, sand and vermiculate at equal proportion enabled highest development of root and shoot in a cutting of *N. tabacum*. This improved effect could be attributed to the fact that the combined nutrient supplement of the entire rooting media acted optimally with the IAA hormone concentration added which created the enabling soil condition for example,

optimum aeration and moisture level (Kalyoncu and Ozer 2000; Akwatulira *et al.* 2011). Meanwhile dose application of IAA hormone was shown to be an aid to improved moisture content in the soil for an optimal rooting and shooting development of cuttings (Milleton *et al*. 1980; Leakey *et al*., 1982; Aminah et al. 2006; Akwatulira *et al.* 2011; Raymond Anyasi and Anyasi 2020). However, most of these past studies maintained their IBA hormone concentration to about 0.7-0.8% of the rooting media used while this study based its IAA measurement on the weight of the cuttings. Morever, the control sample of rooting medium supported low development of root and shoot than the auxin treated samples in the entire experiment. This could perhaps be becouse soil resistant to root penetration is dependent on amongst other factors on water content, structure and strength of soil as well as bulk densities though these were not measured in the rooting media (Amri *et al*. 2009). Soils do not posses the required aeration porosity for optimal gas exchange required for rooting of the cuttings resulting in poor rooting in the control. Poor rooting numbers in control could also be attributed to the feel of anoxia which is an effect of low oxygen in the soil (Hartmann *et al*. 2002). Low incidence of rooting was found in the control samples. Non-theless, there are instances where optimum concentration of IAA in the soil has resulted in the failure of the development of roots by stem cuttings as was reported by Griffin and Shroeder (2004). That was an indication of the sensitivity of root formations to hormone formulations (Akwatulira *et al.* 2011; Anyasi 2023). It has also been reported that rooting hormone to a certain instance could be inhibitory to the development of roots in the cutting especially during the initiation stage (Akwatulira *et al*. 2011). This then means that different rooting media accommodates different concentration of auxin for optimal growth of plants.

Conclusions

Mixture of various rooting media in the right proportion with 0.7% of IAA hormone has been proven to be effective in the root and shoot development of cuttings of tobacco irrespective of the position of the cuttings. Although the individual medium did not have high incidences in most of the parameters measured, but there were able to support root and shoot development as well. Therefore, there is need for a study of IAA concentration effects on the media as to be able to determine if concentration was not the factor responsible for the low root and shoot development. This will promote mass production of *N. tabacum* especially in areas that the plants do not occur naturally.

Acknowledgements

Wish to express my appreciation to the University of South Africa and National Research Foundation for their assistance in this project.

Tables and Figures

Table 1.0 Number of rooted and shooted seedlings within rooting media. Values are mean of replicates (Numbers with same superscript within same row are not statistically significant at p=0.05)

Rooting media	Number of cuttings		IAA hormone concentration
	Rooted	Shooted	
Planting soil	4±0.75[a]	12±2.55[b]	0.7
Control	2±0.69[a]	3±0.00[a]	0.7

Table 2.0 Rate of germination of shoots among rooting media with 0.7% concentration of IAA hormone. Values are mean of replicates (Numbers with same superscript within same row are not statistically significant at p=0.05)

Rooting media	IAA hormone concentration (%)	Rate of germination (%)
Planting soil	0.[7a]	60[b]
Control	0.7[a]	40[a]

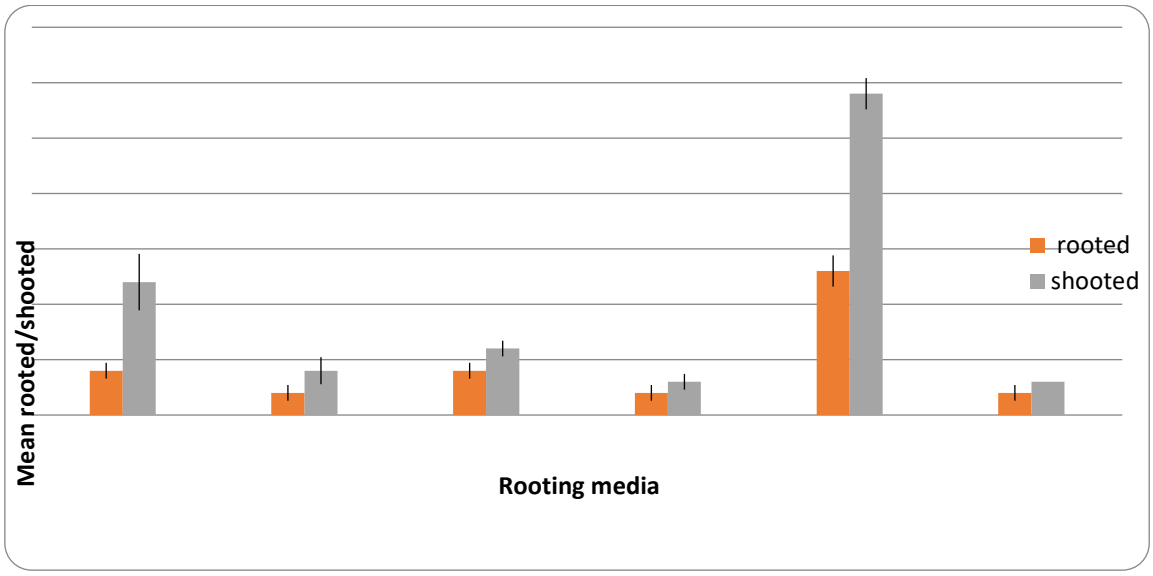


Figure 1.0 Bar chart representation of the means values of rooted and shooted seedlings within rooting media (The error bars represent the standard error from the mean).

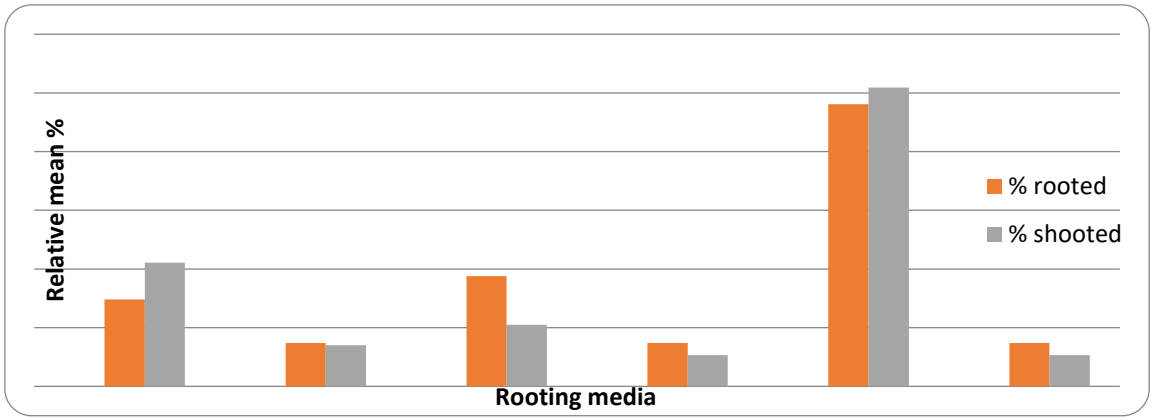


Figure 2.0 Relative mean percentage of the rooted and shooted seedlings among the rooting media.

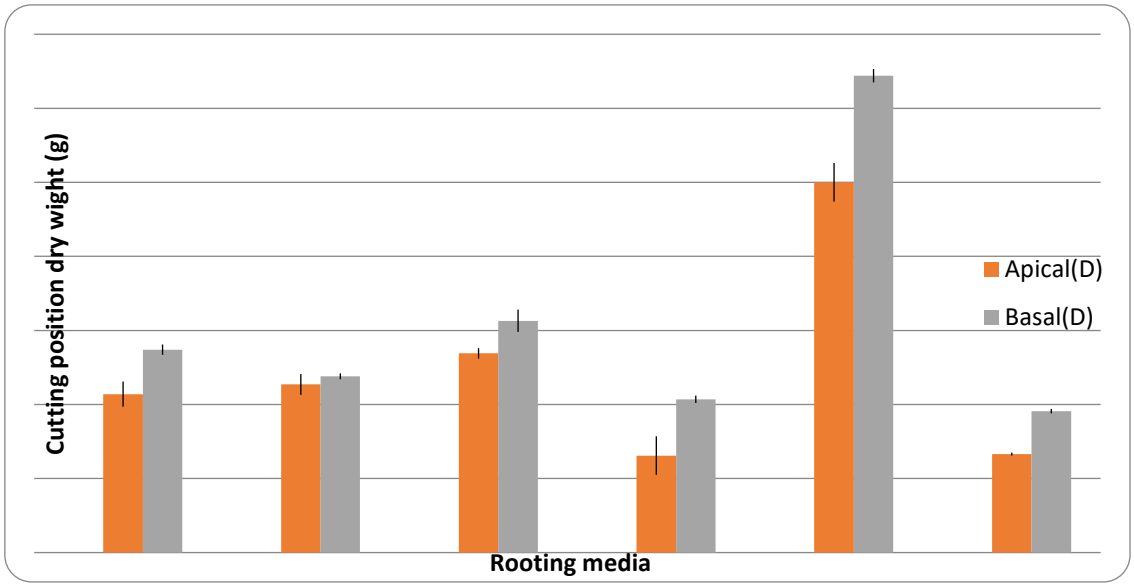


Figure 3.0 Dry weight of Cutting positions within different rooting media (The error bars represent the standard error from the mean)

References

Adebayo, O.B., Lawal, O.I., Alabi, B.S., Owolade, O.F. 2005. Allelopathic effects of siam weed (*Chromolaena odorata*) on seed germination and seedling performance of selected crop and weed species. Fourth World Congress on Allelopathy 2005 "Establishing the scientific base". Charles Sturt University, Wagga Wagga- New Australia, pp. 197-198.

Agbo, C.U., Obi, I.U. 2007. Variability in propagation potentials of stem cuttings of different physiological ages of *Gongronema latifolia* Benth. *World Journal of Agricultural Sciience*, 3(5): 576-581.

Akinmoladun, A.C., Ibukun, E.O., Dan-Ologe, I.A. 2007. Phytochemical constituents and antioxidants properties of extracts from the leaves of *Chromolaena odorata*, *Scientific Research and Essay*, 2(6): 191-194.

Akwatulira, F., Gwali, S., Okullo, J.B.L., Ssegawa, P., Tumwebaza, F.B., Mbwabo, J.R. Muchugi, A. 2011. Influence of rooting media and indole-3-butyric acid (IBA) concentration on rooting and shooting formation on *Warburgia Ugandensis* stem cuttings, *African Journal of Plant Soil*, 5(8): 421-429.

Al-Saqri, F., Alderson, P.G. 1996. Effects of IBA, cutting type and rooting media on rooting of *Rosa centifolia*. *Journal of Horticultural Science*, 71,729-737.

Aminah, H., Nor Hasnita, R.M.N., Hamzah, M. 2006. Effects of Indolebutyric acid concentrations and media on rooting of leafy cuttings of *Shorea parvifolia* and *Shorea macroptera. Journal of Tropical Forest Science*, 18(1): 1-7.

Amri, E., Lyarun, H.V.M, Nyomora, A.S., Kanyek, Z.L. 2009. Evaluation of provenances and rooting media for rooting ability of African Blackwood (*Dalbergia melanoxylon* Guill. and Perr.) stem cuttings. *Research Journal of Agriculture and Biological Science*, 5(4): 524-532.

Ansari, M.B., Megala, D., Ankita S., Anirudha, C., Lovkush, S., Pooraniammal, B., Manoj, Choudhary., Muhammad, A.S., Jailani, A.A.K. 2023. Microbial Exudates as Biostimulants: Role in Plant Growth Promotion and Stress Mitigation. *Journal of Xenobiotics* 13(4): 572-603.

Anup, K.C., Sujit, R., Umesh, K.P. 2011. *Chromolaena odorata* (L.): An overview. *Journal of Pharmacy Research*, 4(3): 573-576.

Anyasi R.O. (2023). Studying the growth of *Chromolaena odorata* in two soil samples under greenhouse condition. Proceedings of the *ISPEC* 11th International Conference on Agriculture, Animal Sciences and Rural Development, Mus, Turkiye, March 03-05, 2023. Pg 591-608

Anyasi, R.O., Atagana, H.I. and Sutherland, R 2019. Comparative study of the colonization of *Chromolaena* and tobacco plants by *Bacteria safensis* CS4 using different methods of inoculation. *Pakistan Journal of Biological Sciience,* 22(7): 309-317.

Raymond Anyasi, J.O. and Anyasi, R.O. 2020. Use of Bacterial Endophyte as a Control for White Aphid's Infestation in Tobacco Plant Sumerianz Journal of Agriculture and Vetrinary. 2(10): 88-95.

Araya, H.T., Soundy, P., du Toit, E.S., Mudau, F.N. 2007. Influence of cutting position, medium, hormone and season on rooting of Bush tea (*Athrixia phylicoides* DC). Stem cuttings. *Medicinal and Aromatic Plants Science and Biotechnology,* 1: 243-252.

Che Man, N.B. 2010. Phytochemical analysis of the leaves of *Chromolaena odorata* (Asteraceae). BSc Hons. Thesis, Faculty of Applied Sciences-University of Technology, Mara, pp 9-12.

Griffin, J.J., Schroeder, K.R. 2004. Propagation of *Ulmus parvifolia* "Emerald Prairies" by stem cuttings. *Journal of* (2 *Environmental Horticulture*, 22): 55-57.

Hartmann, H.T., Kester, D.E., Davies, F.T. Jr., Geneve, L.R. 1997. Plant propagation: Principles and Practices (6^{th} Edn), Prentice Hall International Edition, Englewood Cliffs, New Jersey, USA, pp 880.

Iwu, M.M. 1993. Handbook of African Medicinal Plants, CRC Press Inc., Beca Raton. pp. 181-182.

Jeruto, P., Lukhoba, C., Ouma, G., Mutai, C. 2008. Propagation of some endangered Indigenous trees from the South Nandi District of Kenya using cheap, non-mist Technology. ARPN *Journal of Agriculture and Biological Sciences*, 3(3): 1-6.

Johnson, R.A., Bhattacharyya, G.K. 2006. Statistics: Principles and Methods. 5th Edition. John Wiley and Sons, USA, p. 688

Kalyoncu, H., Ozer, E. 2000. Gilaburu'nun (*Viburnum opulus* L.), green side köklendirilmesi steels and to obtain seedlings. II. *National Nursery Symposium* (25-29 September 2000). Almond-Edema, Izmir, 1: 1-10

Larsen, F.E., Guse, W.E. 1997. Propagating deciduous and evergreen shrubs, trees and vines with stem cuttings. A Pacific Northwest Cooperative Extension Publication, Washington, USA, p. 10.

Leakey, R.R.B., Chapman, V.R., Longman, K.A. 1982. Physiological studies for tree improvement and conservation. Some factors affecting root initiation of *Triplochiton scleroxylon* K.. *Ecological Management*, 4: 53-66.

Metwally, A.M., Ekejuba, E.C. 1981. Methoxylated flavonols and flavones from *Eupatorium odoratumI. Planta Medica*, 42: 403.

Milleton, W., Jarvis, B.C., Booth, A. 1980. The role of auxins in leaves and boron dependant on rooting stem cuttings of *Phaseous aureus* Roxb. *New Phytology*, 84: 251-259.

Montesano R, Orci L. 1988. Transforming growth factor /3 stimulates coUegen-matrix contraction by fibroblasts: Implications for wound healing. *Proceedings of the National Academy of Sciences*, 85:4894-4897.

Phan, T. T., Wang, L., See, P., Grayer, R.J., Chan, S.Y., & Lee, S.T. 2001. "Phenolic compounds of *Chromolaena odorata* protect cultured skin cells from oxidative damage: implication for cutaneous wound healing." *Biological and Pharmceutical Bulletin.* 24(12): 1373-1379.

Phan, T.T., Hughes, M.A., Cherry, G.W., Le, T.T., Pharm, H.M. 1996. An aqueous extract of the leave of *Chromolaena odorata* (Formerly Eupatorium odoratum) (Eupolin) inhibits hydrated collagen lattice contraction by normal dermal fibroblasts. *The Journal of Alternative and Complementary Medicine*, 2(3): 335-343.

Rao, V. K., Kasula, K., Umate, P., Sree, T., A. V. Rao, A.V., Abbagani, S. 2005. Introduction of multiple shoots from leaf segments, *in vitro* flowering and fruiting of dwarf tomato. *Journal of Plant Physiology*, 162(8): 959-962.

Singh, S., Thorat, V., Kaushik, C.P., Raj, K., Eapen, S., D'Souza, S.F. 2009. Potential of *Chromolaena odorata* for phytoremediation of ^{137}Cs from solution and low level nuclear waste. *Journal of Hazardous Material*, 162: 743-745.

Sosnowski, J., Milena, T., and Viliana, V. 2023. "The Impact of Auxin and Cytokinin on the Growth and Development of Selected Crops" *Agriculture* 13(3): 724.

Taiwo, O.B., Olajide, O.A., Soyannwo, O.O., Makinde, J.M. 2000. Antiinflammatory, antipyretic and antispasmodic properties of *Chromolaena odorata. Pharmceutical Biology*, 38: 367-370.

Tanhan, P., Kruatrachue, M., Pokethitiyook, P., Chaiyarat, R. 2007. Uptake and accumulayion of cadmium, lead and zinc by siam weed [*Chromlaena odorata* (L) King & Robinson]. *Chemosphere*, 68:323-329.

Tanhan, P., Pokethitiyook, P., Kruatrachue, M., Chaiyarat, R., Upatham, S. 2011. Effects of soil ammendements and EDTA on lead uptake by *Chromolaena odorata*: Greenhouse and field trial experiments. *International Journal of Phytoremediation*, 13: 897-911.

Wniger, B., Robinean, L. 1988. Elements for Carribean Pharmacopoiea. *Proceedings of TRAMIL workshop*, Cuba. Pp 16-23.

Yeboah, J.S.T.L., Amoah, F.M. 2009. The rooting performance of Shea tree (*Vitellaria paradoxa* C.F. Gaertn) cuttings leached in water and application of rooting hormone in different media. *Journal of Plant Science*, 4(1): 10-14.

EFFECTS OF RISK MANAGEMENT STRATEGIES ON THE EFFICIENCY OF RICE FARMERS IN KEBBI AND EBONYI STATES NIGERIA

David I. A.
Institute for Agricultural Research / Faculty of Agriculture, Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria

Oladimeji Y. U.
Institute for Agricultural Research / Faculty of Agriculture, Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria

Yusuf O.
Institute for Agricultural Research / Faculty of Agriculture, Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria
Email: yusuf.dimeji@yahoo.com

Abdulrahman S.
Institute for Agricultural Research / Faculty of Agriculture, Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria

Hussaini A.S.
Institute for Agricultural Research / Faculty of Agriculture, Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria

Magaji B.D.
Institute for Agricultural Research / Faculty of Agriculture, Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria

ABSTRACT

Improving the productivity along with risk management strategies of Smallholder farming households is the primary means of reducing poverty. The study assessed the effects of risk management strategies on the efficiency of rice farmers in Kebbi and Ebonyi States, Nigeria. A two-stage sampling procedure give rise to random selection of 378 rice farmers for the study comprising 317 and 70 rice farmers from Kebbi and Ebonyi, respectively. A Tobit regression model was used to estimate the parameters on how rice farmers risk management strategies affect their efficiency. The DECOMP-based fit measure is 0.64, ANOVA fit measure of 0.63 and Log likelihood of 40.94, suggested that the model has a good fit for the data. The coefficient of ddiversification into off-farm activities (0.637) correlates directly with efficiency and statistically significant at $p<0.01$. This indicate that 63.7% likelihood of increased efficiency with a one unit increase in diversification. Similarly, the coefficient of diversification into other crops (0.003) is significant at 5%, suggesting a 0.3% likelihood of improved efficiency. The coefficients of ggovernment relief (-0.036) and minimum investment (-0.066) exhibits an inverse relationship, potentially reducing efficiency by 0.036 and 0.066 levels, respectively. The observed inefficiencies may stem from market constraints, structural limitations, or

unforeseen shocks impacting household productivity. The study recommend that rice farmers should employ diversification, contract farming and saving as a means of risk management strategy.
Keywords: Efficiency, risk, management, rice farmers, strategies

INTRODUCTION

In Nigeria, cereal production including rice plays an important role as the primary source of food, creates jobs for the booming population and helps the economy thrive (World Bank, 2018). In 2021 at least, about 82.5% of the Nigerian population consumes rice as a staple food. The nation's consumption of rice is rising quickly (CBN, 2022). Nigeria was the world's top importer of rice a few years ago, accounting for an average of 4.7 percent of imports in the worldwide market, since consumption has already exceeded domestic production (FAO, 2022). The yearly rice milling demand in the country is about 7.2 million tonnes, with the need to produce an additional 5.0 million tonnes to meet the annual demand (FAO, 2022).

It is important to note that in order to close the supply-demand gap in Nigeria, more rice must be produced because the biological processes involved in its production are subject to a wide range of unpredictable natural events, including weather-related biological processes, disease-causing biological processes, and pest-related biological processes that affect yield variability. The management of the rice farming industry is more challenging due to the complicated nature of weather and climate, as well as physical and environmental elements.

(Oladimeji *et al.,* 2019). In addition to production and technical hazards, risks associated with rice production are also related to socioeconomic, financial, market and price, political, and physical or human-induced risks. (Magaji *et al.,* 2021). Improving the productivity along with risk management strategies of smallholder rice farmers uses agriculture for development as the primary means of escaping poverty. (World Bank, 2018). Furthermore, improved agricultural productivity for smallholders can reduce poverty and improve household welfare (Abraham *et al.*, 2017).

In the case of Nigeria, and more specifically that of Ebonyi and Kebbi states, smallholders rice farmers are particularly vulnerable to certain risks such as environmental, technological, financial, institutional, yield, market risk, and the effects can be severe, sometimes even driving smallholders with inadequate resources into even greater poverty (Yusuf and Abdulrahman 2018). The aim of the research was to assess how the rice farmers' risk management strategies affect their efficiency in Nigeria.

Justification of the Study

Efficiency studies can demonstrate if it is feasible to increase productivity in an economy with limited resources and limited possibilities without expanding the resource base of the farmers. Productivity and efficiency studies are very important in the provision of information on how to improve rice output and enhance productivity and efficiency of farmers. Continuous increase in Nigerian population, decline in per capita arable land and per capita water availability, declining soil fertility, climate change variability has heightened the risks for farmers in their agricultural activities that may lead to diminishing household income.

METHODOLOGY

This study targeted Kebbi and Ebonyi States in Nigeria. The duo is among the the primary rice-producing states in the nation and these two states had similar characteristics in the management strategies, gender participation in rice production, land degradation, and both upland and low land production. Kebbi State is situated in the semi-arid Sudano-Sahelian ecological zone and suffers from a severe year-round lack of precipitation (Singh, 1995). Nonetheless, the state's southern region is located in the northern Guinea Savannah Ecological Zone. while Ebonyi State lies in the south-eastern part of the country's geopolitical zones.

To determine the sample size, a multistage sampling procedure was employed. In the first phase, three of the thirteen Local Government Areas (LGAs) in Ebonyi State were chosen at random due to their high rice farmer population, while the four main rice-producing LGAs in Kebbi State were purposefully chosen.

Thereafter, power analysis software was used to arrive at the accurate sample size of 315 rice farmers from Kebbi States and 63 rice farmers from Ebonyi State from a total population of 9693 and 2130, respectively.

Primary data for this study was obtained with the aid of structured questionnaire administered by the trained enumerators consisted of states' agricultural development projects staff and postgraduate students. The data, involving information on 2021 farming season, was collected in December, 2021. The data consist of information on the farmers' Staff members of state agricultural development programs and postgraduate students served as trained enumerators, using a systematic questionnaire to collect primary data for this study.

the data was gathered in December 2021 and included details about the farming season of 2021. Information about the farmers' inputs and its associated cost such as: seed, fertilizer, agrochemical, farm size, types of agricultural risks and strategies adopted.

Descriptive statistics, exploratory factor analysis, Frontier 4.1 was used following to estimate efficiency as adopted from Coelli (1995) and multinomial logit was used to analyse the effect of risk on efficiency.

Multinomial logit Model used in the study is specified explicitly as:

$$Y_{i1} = V_1 + \lambda_{11}\eta_{i1} + \lambda_{12}\eta_{i2} + \lambda_{13}\eta_{i3} + \lambda_{14}\eta_{i4} + \lambda_{15}\eta_{i5} + \lambda_{16}\eta_{i6} + \lambda_{17}\eta_{i7} + \lambda_{18}\eta_{i8} + \boldsymbol{e_i} \quad \ldots\ldots\ldots\

estimated factors loading 0.93 and positive above 0.5 being positive threshold is consistent with research by Ozkan and Akcaoz from 2005; Lien *et al*., 2006. The factor shows rural households diversify into other crops as a risk coping/risk-reducing strategy. The third factor which is name savings explained 13.88% of the variance in the rural households' scores for savings, with one of the estimated factors loading 0.53 and positive above 0.5 being positive threshold for factor 3. Financial risk results from the way the firm's capital is raised and financed (Harwood *et al.*, 2009). Farmers must plan ahead for costs in order to fulfill the requirements because many agricultural production cycles are lengthy.

Table 1: Exploratory factor analysis for risk coping/risk-reducing strategies

Variable		**Factors**		**Communality**
Component	**1**	**2**	**3**	
Eigenvalues	2.01	1.63	1.39	-
% of Variance	20.09	16.33	13.88	-
Cumulative %	20.09	36.42	50.29	-
Risk coping/risk-reducing strategies				
Diversification into other crops		0.93		1.00
Social support	0.99			1.00
Savings			0.53	0.37
Remittances	0.79			0.66
Temporary		0.58		0.62
Government relief	0.78			0.62
Diagnostic statistics				
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.672			
Bartlett's Test of Sphericity:				
$\chi^2(18)$	277.27			
Sig.	0.000			

Note: Factor loading >0.5 are reported in the Table. The name of factors for 1, 2, 3 are social support (Government, NGOs & IGOs), diversification, and savings strategies respectively

Frequency distribution of production efficiency of rice farmers

Frequency distribution of production efficiency of rice farmers is given in figure 1. According to the study, roughly 64% of farmers worked at a technical efficiency (TE) of 0.61 or higher, whereas 36% of farmers had a TE of less than 0.6. Technical efficiencies for the farmer with the least amount of practice and the best were 0.003 and 0.892, respectively. This suggests that, as a result of inefficiency, output decreased by 36% on

average from the highest level that might be achieved. This result is similar to von Cramon-Taubadel and Saldias, 2014: Binuyo *et al*. 2016).

Effect of risk management strategies on rice farmers' efficiency

The characteristics determining how the risk management tactics of rice farmers impact their efficiency were estimated using the Tobit regression model in Table 2. The fit measure based on DECOMP is 0.64.

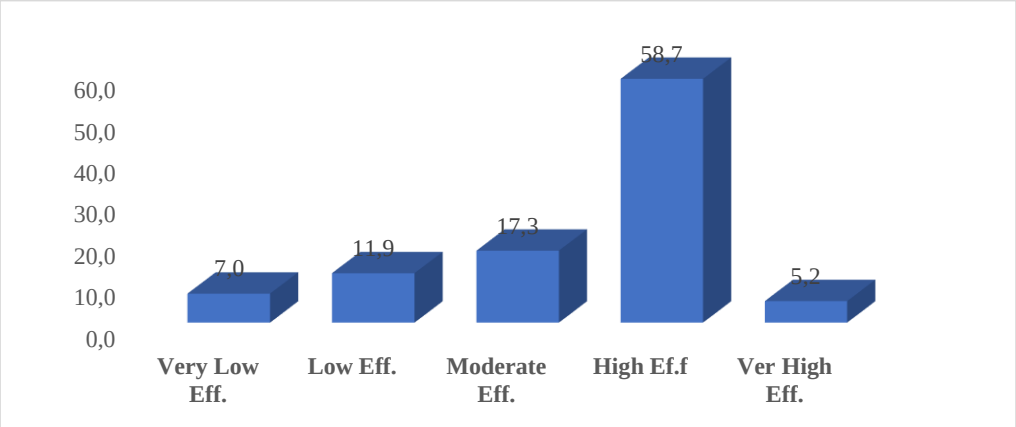


Figure 1: Production efficiency distribution of rice farmers

The coefficient of diversification to off-farm activities (0.637) has a direct relationship with rice farmers' efficiency and is significant at a 1 percent level. Specifically, for every 1 unit increase in farmers' diversification to off-farm activities, respondents were 63.7% likely to be more efficient in rice production. Farmers utilize income diversification as a coping mechanism against different risks. (Ping *et al.*, 2016). The coefficient of diversification into other crops (0.001) has a direct relationship with rice farmers' efficiency and is significant at a 5 percent level. This implies that as rice farmers diversify into other crops, he is more likely to be efficient by 0.1%. As a diversification strategy, male farmers are more likely to engage in activities related to agriculture.

Table 2: Effect of risk management strategies on rice farmers' efficiency

Variable	Coefficient	Std Error	b/St.Er
Constant|	-0.013	0.019	-0.682
Diversification to off-farm activities	0.637***	0.067	9.465
Savings or borrowing from the bank	0.023	0.018	1.228
Social support	0.000*	0.000	-1.964
Diversification to other crops	0.001**	0.001	2.147
Minimum investment	-0.066***	0.024	-2.765
Sale of assets	0.67D-04	0.000	0.609
Borrowing from neighbor	-0.78D-04	0.000	-0.508
Temporary wage employment	0.004	0.024	0.162
Remittances	-0.010	0.019	-0.506
Govt relief	0.036**	0.017	2.086
Sigma	0.218***	0.008	27.821
Number of observations	387		
Log-likelihood function	40.94		
ANOVA-based fit measure	0.63		
DECOMP-based fit measure	0.64		

Note: *** = 1%, ** = 5% and * = 10%

The result also showed that the coefficient minimum investment (-0.066) has a negative and significant influence on rice farmers efficiency and is significant at 1%. This suggests that the little investment in rice production such as land size, fertilizer and other productive resource increases farmers' inefficiency. Furthermore, government relief such as agricultural programme was inversely related to efficiencies, a unit increase in government relief will probably reduce farmers' efficiency by 0.036 units.

CONCLUSION AND RECOMMENDATIONS

Rice farmers adopted social support such as government relief fund, remittance, contract farming from non-governmental organisation as well as diversification into on- and off-farm activities, and savings to mitigate risk associate with rice production. Diversifications to on-farm and off-farm activities and government support had positive effect on rice farmers' efficiency while minimum investment was inversely related to efficiency of rice farmers. There is need to give awareness to farmers about what the possible risk sources and their beneficial schemes. Timely and on low price of inputs supply can enhance the farmers efficiency, therefore, government, seed, fertilizer company and other stakeholders in rice production should ensure the availability of inputs on time and on low prices.

REFERENCES

Abraham, H., Gizaw, S. and Urge, M. (2017a). Begait goat production systems and breeding practices in Western Tigray, North Ethiopia. *Open Journal of Animal Sciences*, 7(2): 198–212

Abdulrahman, S., David, A. I, Yusuf, O. Abdulazeez, R.O. Binuyo, G. (2016). Analysis of Livelihood Diversification by Farming Households in Kaduna State, Nigeria. 2nd International conference on Dryland Agriculture, Centre for Dryland Agriculture, Bayero University, Kano. 12th -16th December, 2016. Pp45-49

Central Bank of Nigeria. (2022). *Statistical Bulletin* Vol. 12, December 2021 Abuja: Central Bank of Nigeria.

Harwood, J., Heifner, R., Coble, K., Perry, J. and Somwaru, A. (2009). *Managing Risk in Farming: Concept s, Research and Analysis*, Agricultural Economic Report No 774, United States Department of Agriculture, Washington D.C., USA.

Magaji, B. D., Oladimeji, Y. U., Hassan, A. A., Siewe, Francois and Njiforti, P. P. (2021). Risk management strategies of micro, small and medium agribusiness enterprises in north-west, Nigeria. *Journal of Agripreneurship and Sustainable Development*, 4(2): 214-227

Oladimeji, Y. U., Hassan, A. A., Egwuma, H., Sani, A. A., Galadima, S. A., and Ajao, A. M. (2019). Analysis of Risks in Honeybee Production Farms in Nigeria: A Boost to Food Security. *Egyptian Academic Journal of Biological Science*, 12(1): 163– 176. P

Ping, Q., Iqbal, M.A., Abid, M., Ahmed, U.I., Nazir, A., Rehman, A., (2016). Adoption of Offfarm Diversification Income Sources in Managing Agricultural Risks among Cotton Farmers in Punjab Pakistan. J. Appl. Environ. Biol. Sci 6, 47–53.

World Bank (2018). *Nigeria: Economic Report*. No. 2, Washington, D .C: World Bank Group. http://documents.world bank.org/curated/en/2018/12/1988323/Nigeria-economic report-no-2

Yusuf, H. O., and Abdulrahman, S. (2018), Evaluation of Gender Differential in Resource utilization and Estimation of Efficiency under Accelerated Rice Production Programme in Kogi State, Nigeria. *Journal of Agriculture and Environment*, 14(2): 89-96. Published by Faculty of Agriculture Usman Danfodio University, Sokoto. www.jae.uduso.edu.ng

TÜRKİYE'DE PEKİN ÖRDEĞİ YETİŞTİRİCİLİĞİ

Dr. Selda KARADAĞ* (ORCID: 0000-0003-0571-9711)
Kafkas Üniversitesi Sağlık Bilimleri Enstitüsü, Zootekni Anabilim Dalı, Kars-Türkiye
Email: selda.krdg36@gmail.com

Prof. Dr. Turgut KIRMIZIBAYRAK (ORCID: 0000-0003-3626-6137)
Kafkas Üniversitesi Veteriner Fakültesi, Zootekni ve Hayvan Besleme Bölümü, Zootekni Anabilim Dalı, Kars-Türkiye
Email: turgut98@hotmail.com

Dr. Öğr. Üyesi Buket BOĞA KURU (ORCID: 0000-0002-7170-270X)
Kafkas Üniversitesi Veteriner Fakültesi, Zootekni ve Hayvan Besleme Bölümü, Zootekni Anabilim Dalı, Kars-Türkiye
Email: buket_vetfak@hotmail.com

ÖZET
Tüm dünyada en baskın kanatlı hayvan yetiştiriciliği tavuk yetiştiriciliğidir. Alternatif kanatlı hayvan yetiştiriciliklerinden olan ördek yetiştiriciliği ise dünya genelinde tavuk yetiştiriciliğinden sonra ikinci sırada gelmektedir. Ördek yetiştiriciliğinden et, yağlandırılmış karaciğer ve tüy üretimi sağlanmaktadır. Yetiştiriciliği yapılan evcil ördek ırkları içerisinde en popüler ırk ise Pekin ördekleridir. Birçok ülke marketlerinde Pekin ördeği eti dondurulmuş ya da pişirilmiş şekilde kolaylıkla bulunabilmekte ve eti, yağlandırılmış karaciğeri ve tüyü de ticari olarak değerlendirilmektedir. Geçmişi çok eski olmamakla birlikte Türkiye'de ise ticari ördek yetiştiriciliği Pekin ördeği yetiştiriciliği ile yaygınlaşmıştır. Türkiye'de ördek yetiştiriciliğinde başlıca amaç et üretimidir. Yüksek döl verimi Pekin ördeği yetiştiriciliğini canlı tutmaktadır. Ülke genelinde Pekin ördeği yetiştiriciliği ağırlıklı olarak küçük aile işletmelerinde, doğal kuluçka yöntemi ile ekstansif olarak yapılmakta iken, son yıllarda yetiştirme kapasitesi yüksek işletme sayısı artmış ve yapay kuluçka yönteminin kullanılması yaygınlaşarak ördek varlığı da artış göstermiştir. Ülkemizde hemen her bölgede ördek yetiştiriciliği yapılmaktadır. Balıkesir ili ördek yetiştiriciliğinde baskın il konumunda olup yıllara göre ördek varlığı değişse de yaklaşık %30'luk pay ile birinci sırada yer almaktadır. Balıkesir ilinden sonra ördek varlığı ile Ankara, Samsun, Muş ve Diyarbakır illeri öne çıkarak aralarındaki sıralama yıllara göre değişmektedir.
Anahtar kelimeler: Kanatlı hayvan yetiştiriciliği, Türkiye'de ördek yetiştiriciliği, Pekin ördeği

PEKIN DUCK BREEDING IN TÜRKİYE

ABSTRACT
The most dominant poultry farming all over the world is chicken farming. Duck farming, which is one of the alternative poultry farming, ranks second after chicken farming worldwide. Duck farming produces meat, fatty liver and feathers. Pekin ducks are the most popular breed among domestic duck breeds. Pekin duck meat is readily available frozen or cooked in markets in many countries, and its meat, fatty liver and feathers are also commercially exploited. Although its history is not very old, commercial duck breeding in Türkiye has become widespread with Pekin duck breeding. The main purpose of duck farming in Türkiye is meat production. High fertility keeps Pekin duck breeding alive. While Pekin duck breeding has been carried out extensively with natural incubation method in small family enterprises, the number of enterprises with high breeding capacity has increased in recent years and the use of artificial incubation method has become widespread and the number of ducks has also increased. Duck breeding is practiced in almost every region of our country. Balıkesir province is the dominant province in duck breeding and ranks first with a share of approximately 30%, although the duck presence varies from year to year. After Balıkesir, Ankara, Samsun, Muş and Diyarbakır provinces come to the forefront with duck presence and the ranking between them changes according to years.
Keywords: Poultry farming, duck farming in Türkiye, Pekin duck

Giriş

Ördek, Anatidae familyası içerisindeki çok sayıda su kuşlarından biri ve günümüzden 4000 yıl önce Çin'de evcilleştirilmiş bir kanatlı hayvan türüdür. Ördekler zoolojik sınıflandırmada Anseriformes takımı, Anatidae familyası ve Anatinae alt familyasının üyeleridir. Muscovy ördekleri *Cairina moschata'*dan köken almışken evcil ördeklerin (*Anas platyrhynchos domesticus*) neredeyse tümünün yeşilbaş veya yaban ördeği olarak bilinen ördeklerden (*Anas platyrhynchos)* köken aldığı bildirilmektedir (Rodenburg ve ark. 2005, Al-Obaidi ve Al-Shadeedi 2016, Naik ve ark. 2022). Ördekler, diğer su kuşlarından olan kaz ve kuğudan yapı olarak küçüktürler. Görünüm olarak kısa boyunlu, basık gövdeli, yassı gagalı, kısa bacakları ve perdeli ayakları olan bir kanatlı hayvandır. Evcil ördekler verim özelliklerine göre etçi, yumurtacı ve görünüm olarak ise süs ırkları olmak üzere üç gruba ayrılmaktadır (Lee 1933). Dünya genelinde ördekler et ve yumurta verimleri için yetiştirilmektedir. Pekin, China Duck, Muscovy ve Ruel Kagua et üretimi, Khaki Campbell, Nageswari, Indian Runner, Chara Chemballi gibi ırklar yumurta üretimi, Mandarin ırkı ise görsel amaçlı yetiştiriciliği yapılan ördek ırklarındandır (Lee 1933). Bu ırklar içerisinde tüm dünyada yaygın olarak yetiştiriciliği yapılan en popüler ırk ise Pekin ördekleridir.

Pekin ördeğinin kökeni Çin'dir. Çin'den 1873 yılında Amerika Birleşik Devletleri (ABD)'ne getirilen Pekin ördeği, burada ıslah edilerek günümüzde et kalitesi ve hızlı büyümesiyle tanınan ve tüm dünyada ticari et üretiminde kullanılan başlıca ırk haline gelmiştir (Zhang ve ark. 2018). Pekin ördeklerinin genel olarak tüyleri kremsi beyaz, gaga ve ayaklar turuncu renkli olup geniş ve derin bir gövdesi vardır (Lee 1933). Pekin ördeği üzerine ıslah çalışmaları İngiltere ve ABD'de devam etmektedir. Yemden yararlanma oranı üzerine yapılan ıslah çalışmalarında, Pekin ördeklerinin yemden yararlanma oranının 2,5'in altına düştüğü ve yemden yararlanma oranının en iyi 7. hafta olduğu bildirilmiştir (Cherry ve Morris 2008). Pekin ördekleri ergin canlı ağırlıklarının %70-80'ine 7 haftalık yaşta ulaşırlar ve erkekler yaklaşık 3,4 kg, dişiler ise 3,1 kg canlı ağırlığa sahiptirler (Pingel 1999, Fan ve ark. 2008, Heo ve ark. 2015). Kesim yaşı canlı ağırlığa bağlı olmakla birlikte yaklaşık 9-13 haftalık yaşta kesim ağırlığına ulaşabilmektedirler (Lee 1933). Erişkin Pekin ırkı ördeklerinde canlı ağırlık erkeklerde ortalama 4,00–4,50 kg düzeyinde iken dişilerde 3,50–3,75 kg düzeyindedir (Alpay 2008).

Pekin ördeği, etçi ördek ırkları içerisinde gruplandırılıyor olsa da yumurta verimleri de oldukça iyi düzeydedir. Bir yumurtlama sezonunun yaklaşık 42 hafta sürdüğü ve bir sezonda 150 adetten fazla yumurta verimi bildirilmektedir (Lee 1933, Ekarius 2007). Pekin ördeklerinde yumurta ağırlığı canlı ağırlığının yaklaşık %4,5'i ağırlığında olup 70-90 g'dır (Srikanth ve ark. 2018, Eriş 2019). Pekin ördekleri genellikle 24 haftalık yaşta ilk yumurtlama periyoduna başlar ve 31 haftalık yaşta pik yumurta verimine ulaşırlar. Pik yumurta veriminin elde edildiği haftada sürünün %90'nının yumurtladığı bildirilmektedir (Erdem ve Akçapınar 2013). Pekin ördekleri de Runner ördekleri gibi nadiren gurk davranışı göstermektedirler (Lee, 1933, Alpay 2008). Ticari yetiştiricilik yapan işletmelerde yumurtalar kuluçka makinesi kullanılarak kuluçka edilmektedir. Ördek yumurtalarının kuluçka süresi genel olarak 28 gün olup Muscovy ırkı ördeklerde ise bu süre 35 gündür (Lee 1933, Abd El-Hack ve ark. 2022). Pekin ördeği yumurtalarının uygun depolama ve kuluçka koşullarında kuluçka özelliklerinin iyi düzeyde olduğu bildirilmektedir. Kuluçka işlemlerinde döllülük oranı %83-90, çıkış gücü %85-88, kuluçka randımanı %72-78 düzeyinde saptanmıştır (El-Hanoun ve ark. 2012, İpek ve Sözcü 2017, Kuru ve ark. 2023).

Ticari hibrit tavuklardan sonra kümes hayvanları içerisinde en çok yetiştiriciliği yapılan ördeklerin varlığı yaklaşık %4'lük pay ile dünyada 2. sırada yer almaktadır (FAO 2021). Ticari olarak ördek yetiştiriciliği yapan ülkelerde yaygın olarak entansif veya yarı entansif sistemlerde yetiştiricilik yapılmaktadır (Cherry ve Moris 2008).

Tablo 1. Dünyada ördek varlığı fazla olan ilk 10 ülke (FAO 2022).

S.N.	Ülke	Varlık (x1000 baş)	Oran (%)
1.	Çin	683.075	61,55
2.	Vietnam	83.700	7,54
3.	Bangladeş	63.845	5,75
4.	Endonezya	58.352	5,26
5.	Hindistan	33.421	3,01
6.	Fransa	22.076	1,99
7.	Rusya	21.359	1,92
8.	Tayland	14.564	1,31
9.	Myanmar	12.000	1,08
10.	Ukrayna	10.000	0,90
Dünya		1.109.775	100,00

FAO 2022 yılı verilerine göre dünya genelinde 1.109.775.000 baş ördek varlığı bulunmaktadır (FAO 2022). Ördek varlığı en fazla olan ülke Çin'dir. Çin ördek kökenli et, yumurta ve tüy üretiminde dünyada birinci sırada yer almaktadır. Sırasıyla Vietnam, Bangladeş, Fransa, Myanmar ve Ukrayna ördek varlığı yüksek olan diğer ülkelerdir (Tablo 1). Dünya genelinde ördek yetiştiriciliği et, yumurta, yağlandırılmış karaciğer ve tüy üretiminde oldukça önemli bir yere sahiptir. Dünyada yıllık olarak yaklaşık 6 milyon (5.968.904) ton ördek eti üretimi yapılmaktadır (FAO 2022). Dünya ördek eti üretiminin genel olarak %90'ının Pekin, %4'ünün Muscovy ördeklerinden, geri kalanı ise diğer genotiplerden elde edilmektedir (Thiele 2016). Fransa, Macaristan, Polonya, Bulgaristan, Almanya ve Tayland ördek eti ihracatında önde gelen ülkelerdir (FAO 2022).

Pekin ördeği eti yumuşaklığı ve tadının çeşitli aromatik malzemelerle daha da hoş hale getirilmesi sonucunda dünya genelinde sevilerek tüketilmektedir. Çin başta olmak üzere çoğu ülkede portakallı Pekin ördeği meşhur olup sevilerek tüketilmekte ve menülerde yer almaktadır (Zhang ve ark. 2020). Avrupa ülkelerinde Pekin ördeği eti dondurulmuş ya da pişirilmiş şekilde market raflarında bulunmaktadır. Almanya'da ördek eti pratik olması nedeniyle önceden pişirilmiş olarak, bütün veya parçalanmış şekilde dondurularak satışa sunulmaktadır (Mountney 2017, Biswas ve ark. 2019). Kaz yumurtaları kadar olmasa da ördek yumurtalarının da sofralık olarak tüketilmesi pek yaygın değildir. Ancak bazı ülkelerde ördek yumurtaları farklı şekillerde tüketime sunulabilmektedir. Özellikle kil ve tuz karışımına ördek yumurtalarının konulup çeşitli işlemlerin ardından elde edilen tuzlu ördek yumurtalarının tüketimi Çin'de ve Filipinler'de çok eski bir gelenektir. Ayrıca Filipinler ve ABD'de Balut olarak bilinen döllenmiş ördek yumurtalarının kuluçkanın 16. ile 20. gününde haşlandıktan sonra tüketime sunulan meşhur bir sokak yemeği mevcuttur (Magat 2002, Monleon 2015).

Ördeklerin yetiştirilme amaçlarından biri de yağlandırılmış karaciğer elde etmektir. Yağlandırılmış kaz veya ördek karaciğeri Fransa başta olmak üzere bazı ülkelerde sevilerek tüketilmekte ve yüksek fiyatlarla pazarlanabilmektedir. Fransızlar için yağlandırılmış karaciğer geleneksel bir gıda niteliğindedir (Guemene ve Guy 2004). Fransa yağlandırılmış karaciğer üretiminde yetersiz olduğunda dışarıdan alım yapmaktadır. Ülkede ördeklerin başlıca yetiştirme amacı yağlandırılmış karaciğer elde etmektir. Ayrıca dünya genelinde ördek yetiştiriciliği tüy üretimi için de oldukça önemli bir yere sahiptir. Dünya tüy üretimi konusunda istatistik bilgiler yeterli olmamakla

birlikte, tüm dünyada tüy üretiminin %80-90'ının ördeklerden elde edildiği bildirilmekte ve üretimde birinci sırada Çin gelmektedir (Kırmızıbayrak ve ark. 2016). Bazı ülkelerde yetiştiriciliği yapılan ördeklerin gübresi de değerlendirilmekte ve sazan yetiştiriciliğinden yem olarak kullanılmaktadır. Ördek gübrelerinin havuz sularında ayrışması balık üretimi artırmakta ve balıklar için verilen yemden %50 tasarruf sağladığı bildirilmektedir (Wu ve ark. 2000). Ördek-balık entegrasyon sistemleri Çin, Macaristan, Almanya, Polonya, Rusya gibi ülkelerde çok yaygındır (Cherry ve Morris 2008, Kumar ve ark. 2012, Sapcota ve ark. 2022).

Türkiye'de Pekin Ördeği Yetiştiriciliği

Türkiye'de yetiştirilen kanatlı hayvan türleri içerisinde en başta tavuk gelmekte bunu hindi, kaz, ördek ve beç tavuğu sırasıyla takip etmektedir (TÜİK 2022). Türkiye'ye Pekin ördeği 1984 yılında Çin'den hediye olarak gelmiştir. Gelen ördekler Antalya Kepez Su Ürünleri Araştırma İstasyonu'nda yetiştirilerek sayıları artırılmış ve damızlık ördekler TİGEM işletmelerine dağıtılmıştır. Ülke genelinde ördek varlığının artırılması ve bütün illerde yetiştiriciliğinin yapılması amacıyla 1988 yılında "Pekin Ördeği Yetiştiriciliğini Geliştirme Projesi" uygulamaya konulmuştur. Projeye bağlı olarak 1990 yılı ülke geneli ördek varlığında artış olmuş (Alpay 2008) ve ülkemizde ticari ördek yetiştiriciliği Pekin ördeği yetiştiriciliğiyle yaygınlaşmıştır.

Türkiye'de hemen her bölgede ördek yetiştiriciliği yapılmakla birlikte bazı illerde çok daha yoğun olarak yapılmaktadır. Ülkemizde yetiştiriciliği yapılan ördek genotipleri yerli ördekler ile Pekin ördeği olup yetiştiricilik ağırlıklı olarak küçük aile işletmelerinde doğal kuluçka yöntemi ile ekstansif olarak yapılmaktadır (Demir ve ark. 2010, Sarı ve ark. 2012). Son yıllarda ördek yetiştiriciliğine artan ilgi nedeniyle yüksek üretim kapasitesine sahip işletme sayısı artmış ve kuluçka makinesi kullanımı yaygınlaşarak entansif ve yarı entansif sistemler kullanılarak yetiştiricilik de yaygınlaşmıştır (Eriş 2019, Yamak ve ark. 2022). Ayrıca yüksek döl veriminin Pekin ördeği yetiştiriciliğini canlı tuttuğu görülmektedir. Ülkemizde öncelikle et üretimi amacıyla ördek yetiştiriciliği yapılmaktadır. Turizm potansiyeli yüksek olan illerimizdeki restoranlarda ördek eti menülerde yer almaktadır. Ördek eti dünya ülkelerindeki gibi çeşitli aromalar katılarak pişirilip farklı şekillerde servis edilmektedir. Yıl içerisinde fazla sayıda yabancı turistlerin ziyaret ettiği illerimizde ördek yetiştiriciliği yapılmasa dahi çevre illerden ördek eti temini yapılmaktadır. Ördek eti sadece restoran menülerinde kalmayıp internet üzerinden yemek

siparişi alan işletmelerde de satışa sunulmaktadır (Anonim 2024a, Anonim 2024b, Anonim 2024c). Ayrıca iç organları bazı yörelerde sevilerek tüketilmekte ve tüyü yastık minder yapımında değerlendirilmektedir (Sarı ve ark. 2012). Gübresinin de dünya ülkelerinde olduğu gibi entegre olarak sazan yetiştiriciliğinde önemli olduğu bildirilmektedir (Alpay 2008). Böylece ördek etine talep süreklilik kazanmakta ve fiyat artışı ile birlikte yetiştiricilik ülke geneline yayılmaktadır.

Türkiye İstatistik Kurumu'nun hayvancılık istatistikleri incelendiği zaman iller bazındaki ördek varlığında tutarlılık olmadığı bariz bir şekilde görülmektedir. Birbirini takip eden yıllar içerisindeki bu ani açıklanamayan değişimlere rağmen ördek varlığı ile öne çıkan illerimizin Balıkesir, Samsun, Muş, Kars, Diyarbakır, Adana ve Ankara olduğunu söyleyebiliriz (Tablo 2). Ördek varlığı yoğun olan illerimizde sıralama değişse de ördek varlığının büyük bir çoğunluğu Balıkesir ilimizde bulunmaktadır. Balıkesir, Türkiye kanatlı hayvan yetiştiriciliğinde öne çıkan illerden biridir. Türkiye'nin kanatlı hayvan sektöründe önde gelen ticari kuruluşlarından birinin Bandırma ilçesinde faaliyet göstermesi, ildeki ticari tavuk yetiştiriciliğinin temelini oluşturmaktadır. Türkiye'de etlik piliç ve sofralık yumurta üretiminin önemli bir kısmını karşılamakla birlikte ördek yetiştiriciliği de ilde ön plana çıkmaktadır (Özek 2022). İlde yoğun bir şekilde ördek yetiştiriciliği yapılmasında İstanbul ve Antalya gibi illerde bulunan bazı lüks restoranlar, tatil köyleri ve otellerden ördek etine fazlaca talep gösterilmesi ildeki ördek varlığında artışa neden olmaktadır. İlde ördek eti tüketim alışkanlığı bulunmamaktadır (Anonim 2024d). Balıkesir ili ördek popülasyonu bakımından 2017-2021 yılları arasında Türkiye'de hep birinci sırada yer almıştır. İlin 2017 yılında ördek varlığı 116.940 baş iken 2020 yılında 159.766 başa yükselmiş ve 2021 yılında ise 143.693 baş ördek varlığının olduğu bildirilmektedir (TÜİK 2023). Söz konusu yıllarda Balıkesir ili Türkiye ördek varlığının yaklaşık %30 gibi çok önemli bir payına sahip olmuştur. Balıkesir ilindeki ördek varlığı ilçeler düzeyinde en yoğun Susurluk, Manyas ve Altıeylül ilçelerinde bulunmaktadır (TÜİK 2023). Türkiye'de ördek varlığının yoğun olduğu diğer iller ise Samsun, Muş, Kars, Adana, Ankara ve Diyarbakır'dır (Tablo 2). Kaz yetiştiriciliğinin yoğun olarak yapıldığı Kars, Muş ve Samsun illerinde ördek yetiştiriciliğinin de yapıldığı görülmektedir. Kars ve Muş illerinde ördek yetiştiriciliğine olan ilginin kaz yetiştiriciliği ile benzerlik gösterdiği görülmektedir. Bu illerde ağırlıklı olarak küçük aile işletmelerinde ekstansif şartlarda ve doğal kuluçka yöntemi ile yerli ve Pekin ördeklerinin

yetiştiriciliği yapılmaktadır. Merada ve entansif koşullarda beslenerek kesilen ördeklerin eti ve iç organları sevilerek tüketilmektedir. Tüyü ise yastık ve yorgan yapımında kullanılmaktadır (Sarı ve ark. 2012).

Tablo 2. Türkiye ördek ve beç tavuğu varlığı en yüksek iller (TÜİK 2023).

	2021		2022		2023	
S.N.	**İl**	**Baş**	**İl**	**Baş**	**İl**	**Baş**
1.	Balıkesir	143.963	Ankara	39.512	Ankara	51.975
2.	Samsun	25.977	Balıkesir	31.767	Diyarbakır	28.671
3.	Ankara	24.359	Adana	30.283	Adana	27.598
4.	Muş	23.268	Samsun	24.113	Samsun	22.008
5.	Diyarbakır	23.209	Diyarbakır	22.764	Muş	20.799
11.	-	-	-	-	Balıkesir	8.983
TÜRKİYE		539.897		432.457		420.515

Sonuç

Ülkemizde Pekin ördeği yetiştiriciliği 1990'lı yıllardan itibaren başlamıştır. Pekin ördeklerinin verim özelliklerinin yüksek olmasının yanı sıra etinin de turizm işletmelerinde değerlendiriliyor olmasından dolayı, talepte artış gözlemlenmesi Pekin ördeği yetiştiriciliğinin devamlılık göstergesi olarak söylenebilir. Ancak son birkaç yılda ördek varlığı ile öne çıkmış iller de dahil olmak üzere yetiştiricilik maliyetindeki artışlar nedeniyle ülke geneli ördek sayısında azalmalar meydana gelmiştir. Yetiştiricilerin yem maliyetinin azaltılmasına yönelik çalışmaların ve yetiştiricilerin yaşadığı diğer sorunların tespit edilerek sahaya yönelik çalışmaların yapılmasının ördek yetiştiriciliğinin devamlılığı için önemli olacağı düşünülmektedir. Ülkemizde entansif ve yarı entansif büyük kapasiteli işletmelerde yetiştiricilik yapılsa da üretimin azımsanmayacak bir kısmı halen daha küçük aile işletmelerinde geleneksel yöntemlerle devam etmektedir. Bu üreticilerimizin devlet tarafından desteklenmesi ve teknik bilgi yetersizliklerinin giderilmesi gerekmektedir. Ülkemizde yapılan ördek yetiştiriciliği ekonomik getirisi yüksek bir sektör özelliği kazanacak potansiyelde olup etinin ve tüyünün dünya ülkelerinde olduğu gibi değerlendirilmesi için stratejik politikalara ihtiyaç duyulmaktadır. Böylece ülke genelinde yapılan yetiştiriciliğin istikrar kazanabileceği düşünülmektedir. Ayrıca ördek yetiştiriciliğini geliştirmek için ördek popülasyonu fazla olan illerimize daha fazla destek verilmesi ülke ördek yetiştiriciliğinin devamlılığı ve üretimin sürekliliği açısından önemli olacaktır.

Kaynaklar

Anonim: https://www.reddragon.com.tr/, Erişim tarihi: 03.02.2024a.

Anonim: https://konoha.com.tr/iletisim, Erişim tarihi: 03.02.2024b.

Anonim:https://www.yemeksepeti.com/restaurant/j99e/chinese-life, Erişim tarihi: 03.02.2024c.

Anonim:https://www.milliyet.com.tr/ekonomi/balikesirde-yetistiriliyor-istanbul-ve-antalyada-tuketiliyor-2110990, Erişim tarihi: 08.03.2024d.

Abd El-Hack, M. E., Hurtado, C. B., Toro, D. M., Alagawany, M., Abdelfattah, E. M., Elnesr, S. S. (2022). Impact of environmental and incubation factors on hatchability of duck eggs. *Biological Rhythm Research*, 53(1), 79-88.

Al-Obaidi, F.A., Al-Shadeedi, S.M.J. (2016). Comparison study of egg morphology component and chemical composition of Mallard duck and domestic Peking duck. *Journal of Genetic and Environmental Resources Conservation*, 4(1):5-9.

Alpay, F. (2008). Ördeklerde kuluçkalık yumurta ağırlığı ve depolamanın kuluçka sonuçları, civcivlerde büyüme performansı ile kesim ve karkas özelliklerinin etkisi üzerine etkisi (Doktora tezi, Bursa Uludağ Üniversitesi (Türkiye)).

Biswas, S., Banerjee, R., Bhattacharyya, D., Patra, G., Das, A. K., Das, S. K. (2019). Technological investigation into duck meat and its products-a potential alternative to chicken. *World's Poultry Science Journal*, *75* (4), 609-620.

Cherry P., Morris T.R. (2008). Domestic Duck Production: Science and Practice. *CABI, Oxfordshire, UK.*

Demir, P., Erişir, Z., Poyraz, O., Erdem, E. (2010). Farklı barındırma sistemleri ve kesim yaşına göre Pekin Ördeği besisinin fayda-maliyet analizi. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi*, *16* (3).

Ekarius, C (2007). Storey's Illustrated Guide to Poultry Species. North Adams, (https://archive.org/details/Storeys_Illustrated_Guide_to_Poultry_Breeds_Complete/page/n196/mode/1up).

El-Hanoun, A. M., Rizk, R. E., Shahein, E. H. A., Hassan, N. S., & Brake, J. (2012). Effect of incubation humidity and flock age on hatchability traits and posthatch growth in Pekin ducks. *Poultry science*, *91*(9), 2390-2397.

Erdem. E., Akçapınar, H. (2013). Pekin ördeklerinde çıkımdan sonraki yemleme şeklinin büyüme, yaşama gücü ve kesim özelliklerine etkisi. *Lalahan Hay. Araşt. Enst. Derg*, 52 (2): 27-38.

Eriş, C. (2019). Pekin Ördeklerinde Büyüme Hormonu Geni Polimorfizminin İncelenmesi (Doctoral dissertation, Bursa Uludag University (Turkey)).

Fan, H.P., Xıe, M., Wang, W.W., Hou, S.S. and Huang, W. (2008). Effects of dietary energy on growth performance and carcass quality of white growing Pekin ducks from two to six weeks of age. *Poultry Science* 87: 1162–1164.

FAOSTAT: Food And Agriculture Organization. https://www.fao.org/faostat/en/#home, Erişim Tarihi: 03.02.2024.

Guemene, D., Guy, G. (2004). The past, present and future of force-feeding and "foie gras" production. *World's poultry science journal*, 60(2), 210-222.

Heo, K. N., Hong, E. C., Kim, C. D., Kim, H. K., Lee, M. J., Choo, H. J., Kim, J. H. (2015). Growth performance, carcass yield, and quality and chemical traits of meat from commercial Korean native ducks with 2-way crossbreeding. *Asian-Australasian journal of animal sciences*, *28* (3), 382.

İpek, A., Sözcü, A. (2017). Comparison of hatching egg characteristics, embryo development, yolk absorption, hatch window, and hatchability of Pekin Duck eggs of different weights. *Poultry Science*, *96* (10), 3593-3599.

Kırmızıbayrak, T, Yazıcı K, Kuru BB. (2016). Kazlarda tüy verimi ve kalite özellikleri ile dünyada ve Türkiye'de kaz tüyü üretimi. *Türkiye Klinikleri J Repord Artif İnsemin-Special Topics*, 2 (1):48-55.

Kumar, J. Y., Chari, M. S., Vardia, H. K. (2012). Effect of integrated fish-duck farming on growth performance and economic efficiency of Indian major carps. *Live. Res. Rural Dev*, *24* (12), 15-19.

KURU, B., Kirmizibayrak, T., CENGİZ, M., IŞIK, S. (2023). The effect of egg weight on egg external quality characteristics and hatching performance in Pekin ducks. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi,* 29(4).

Lee, A. R. (1933). Duck raising (No. 697). (https://smallfarmersjournal.com/duck-raising/).

Magat, M. (2002). Balut:" Fertilized Duck Eggs and Their Role in Filipino Culture". *Western Folklore*, *61* (1), 63-96.

Monleon, A. M. (2015). Traits of economic importance in duck egg production in the Philippines. *International Journal of Research (IJR), 2* (2), 154-159.

Mountney, V. (2017). Poultry products technology. *Routledge*.

Naik, P. K., Swain, B. K., Beura, C. K. (2022). Scenario of duck production in India. *Poultry Line*, 25-7.

Özek, K (2022). Balıkesir İlinin Hayvancılık Potansiyeli ve Geleceği. *Dicle Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, *11*(1), 239-251.

Pingel H. (1999). Influence Of Breedıng And Management On The Effıcıency Of Duck Productıon. *Lohmann information*, 22: 7-13.

Rodenburg, T. B., Bracke, M. B. M., Berk, J., Cooper, J., Faure, J. M., Guémené, D. Guy., Ruis, Maw. (2005). Welfare of ducks in European duck husbandry systems. *World's Poultry Science Journal*, *61* (4), 633-646.

Sapcota, D., Begum, K. (2022). Integrated duck farming. In *Duck Production and Management Strategies* (pp. 247-264). Singapore: Springer Nature Singapore.

Sari, M., Önk, K., Tilki, M., Aksoy, A. (2012). Ördeklerin Kesim ve Karkas Özelliklerine Cinsiyet ve Irkın Etkisi. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi*, *18* (3).

Srikanth, D., Brahmanandam, V., Teja, M. R. (2018). Emerging trends in duck farming in India. *International Journal of Science and Management Studies*, *1* (1), 6-13.

Thiele, H. H. (2016). Breeding Pekin ducks for meat production. *Lohmann Information*, *50* (1), 28-31.

TÜİK: Türkiye İstatistik Kurumu Http://Www.Tuik.Gov.Tr. Hayvansal Üretim İstatistikleri Erişim Tarihi: 08.03.2024.

Wu, S., Hu, C., Chen, Y. (2000). Livestock-Fish Integrated Systems and Their Application. In *Acıar Proceedıngs* (pp. 281-286).

Yamak, U. S., Sarıca, M., Boz, M. A., Erensoy, K. (2022). Yetiştirme sisteminin Pekin ördeklerinde bazı et kalitesi özellikleri üzerine etkisi. *Anadolu Tarim Bilimleri Dergisi*, *37* (1), 13.

Zhang, F., Zu, J., Hu, M., Zhu, D., Kang, Y., Gao, S., Huang, Z. (2020). Uncovering inconspicuous places using social media check-ins and street view images. *Computers, Environment and Urban Systems*, *81*, 101478.

Zhang, Z., Jia, Y., Chen, Y., Wang, L., Lv, X., Yang, F., Qu, L. (2018). Genomic variation in Pekin duck populations developed in three different countries as revealed by whole-genome data. *Animal genetics*, *49* (2), 132-136.

AMARANT UNU İLE ELDE EDİLEN BİSKÜVİLERİN BAZI FİZİKOKİMYASAL ÖZELLİKLERİ VE ESMERLEŞME İNDEKSİ

Gülşah ÇAVUŞ (ORCID: 0000-0002-2957-5815)
Ege Üniversitesi, Mühendislik Fakültesi, Gıda Mühendisliği Bölümü, İzmir-Türkiye
Email: gulsahsatiroglu@gmail.com

Prof. Dr. Sibel KARAKAYA (ORCID: 0000-0001-5514-9521)
Ege Üniversitesi, Mühendislik Fakültesi, Gıda Mühendisliği Bölümü, İzmir-Türkiye
Email: sibel.karakaya@ege.edu.tr

ÖZET

Son yıllarda glutensiz ürünlere yönelik ilginin artması ve sürdürülebilir protein kaynaklarına ait farkındalığın artması yalancı tahılların geçmişe göre çok daha fazla miktarda tüketiciye ulaşmasına yol açmıştır. Yalancı tahıllar arasında en nadir kullanılanı amaranttır. Amarant iyi bir protein kaynağı olmasının yanı sıra diyet lifi, fitokimyasallar, çoklu doymamış yağ asitleri, fitosteroller, vitaminler, mineraller, antioksidan özellik taşıyan birçok biyoaktif bileşen içermektedir. Yalancı tahıllar genellikle tahıllara ikame olarak kullanıldıkları için yüksek sıcaklıkların uygulandığı gıdalarda bileşen olarak kullanılmaktadır. Yüksek sıcaklık uygulanan gıdalarda meydana gelen akrilamid, 5-hydroxymethylfurfural, furfural gibi bileşiklerin yalancı tahıl içeren gıdalarda da oluşup oluşmadığı bir araştırma sorusudur. Bu çalışmada %100 buğday unu, %100 amarant unu, %50 buğday unu ve %50 amarant unu ile hazırlanan 205 ̊C'de pişirilen bisküvilerin yayılma oranı, pişme kaybı, tekstür özellikleri (sertlik ve gevreklik), Maillard reaksiyonları için önemli olan nem, su aktivitesi, pH değerleri, CIELAB renk sonuçları ve esmerleşme indeksi belirlenmiştir. %100 buğday unu içeren bisküvilerde nem, su aktivitesi, pH değerleri diğer örneklere göre daha yüksek bulunmuştur. Amarant içeren bisküvilerde amarant oranı arttıkça nem, su aktivitesi ve pH değerlerinin arttığı saptanmıştır. Maillard reaksiyonlarının bir göstergesi olarak bisküvilerin CIELAB renk sonuçları ve esmerleşme indeksi değerlendirilmiştir. Amarant oranı arttıkça a^* değeri artarken L^* değeri azalmıştır. Amarant içeren bisküvilerde b^* değeri daha yüksek bulunmuş ve amarant oranı arttıkça azaldığı tespit edilmiştir. Esmerleşme indeksi amarant unu ile hazırlanan bisküvilerde (%100 amarant unu için 60,83 ± 0,54 ve %50 amarant unu için 60,14 ± 0,14 %100 buğday unu ile hazırlanan bisküvilere göre (51,38 ± 0,45) daha yüksek bulunmuştur. Bu sonuç oldukça ilginçtir ve ilerleyen süreçlerde bisküvilerde amaranth unu kullanımının akrilamid oluşumu üzerine etkisi araştırılacaktır.
Anahtar Kelimeler: yalancı tahıl, buğday unu, Maillard reaksiyonu, renk, tekstür

SOME PHYSICOCHEMICAL PROPERTIES AND BROWNING INDEX OF BISCUITS MADE WITH AMARANTH FLOUR

ABSTRACT

In recent years, increased interest in gluten free products and increased awareness of sustainable protein sources have led to pseudocereals reaching more consumers than in the past. The most rarely used pseudocereal is amaranth. Besides being a good source of protein, amaranth contains dietary fibre, phytochemicals, polyunsaturated fatty acids, phytosterols, vitamins, minerals, and many bioactive components with antioxidant properties. Since pseudocereals are often used as substitutes for cereals, they are used as ingredients in foods where high temperatures are applied. It is a research question whether compounds such as acrylamide, 5-hydroxymethylfurfural and furfural, which occur in foods exposed to high temperatures, also occur in foods containing pseudocereals. In this study, the spreading ratio, baking loss, texture properties (hardness and fracturability) and moisture, water activity, pH values, CIELAB color results, browning index which are important for Maillard reactions for biscuits prepared with 100% wheat flour, 100% amaranth flour, 50% wheat flour and 50% amaranth flour and baked at 205℃ was determined. Moisture, water activity and pH values were found to be higher in biscuits containing 100% wheat flour than other samples. It has been determined that as the amaranth ratio increases in biscuits containing amaranth, moisture, water activity and pH values increase. CIELAB color results and browning index of biscuits were evaluated as an indicator of Maillard reactions. As the amaranth ratio increased, the a^* value increased while the L^* value decreased. The b^* value was found to be higher in biscuits containing amaranth and it was found to decrease as the amaranth content increased. Browning index for biscuits prepared with amaranth flour (60.83 ± 0.54 for 100% amaranth flour and 60.14 ± 0.14 for 50% amaranth flour) was found higher compared to biscuits prepared with 100% wheat flour (51.38 ± 0.45). This result is quite interesting and the effect of using amaranth flour in biscuits on acrylamide formation will be investigated in the future.

Keywords: pseudocereal, wheat flour, Maillard reaction, browning, colour, texture

1.GİRİŞ

Yalancı tahıllar yüksek nişasta içeriği ve fiziksel görünüşlerinin sebebiyle tahıllara benzese de çift çeneklidirler ve *Poacea* ailesinin *dicotyledonous* cinsidirler. Yalancı tahıllar yüksek genetik çeşitliliği ve tropikal şartlardan ılıman iklim koşullarına kadar farklı çevre koşullarında yetişmesi sebebiyle avantajlıdırlar. Bu özellikleri ile yüzlerce yıldır tüketilmekte ve gelecek için de umut vericidirler (Malik ve Singh, 2022).

Küresel anlamda protein ihtiyacı ve yüksek kaliteli gıda proteinine ulaşmak için önümüzdeki yıllarda sürdürülebilir çözümler üretmek her zamankinden çok daha önemli olacaktır. Çünkü günümüzde protein talebi 202 milyon ton/yıl iken 2050 yılında insan nüfusunun 7,3 milyardan 9,6 milyara yükselmesi beklendiği için protein ihtiyacı gittikçe artacaktır. Fizyolojik ve patolojik ihtiyaçlar veya bireysel gıda ve yaşam tarzları sebebiyle bitkisel protein kaynakları gelecekte hayvansal kaynakların yerini alacaktır. Son zamanlarda bitkisel proteinlere yönelim artmıştır. Bu konuda yalancı tahıllar protein içeriği ve esansiyel aminoasitleri içermesi özellikleri ile gelecekteki sürdürülebilir çözümler için iyi bir alternatiftir (Alonso-Miravalles ve Mahony, 2018; Silva vd., 2021).

Yalancı tahıllar gluten içermedikleri için başta Çölyak hastaları olmak üzere gluten hassasiyeti ile ilgili diyetlerde ve çeşitli sebeplerle sıklıkla tercih edilmektedir. Glutensiz beslenme vitaminler ve mineraller açısında yetersiz beslenmeye sebep olmaktadır. Son yıllarda yapılan araştırmalar yalancı tahılların diyete eklenmesi ile protein, diyet lifi, aminoasit profili, fitokimyasallar, vitaminler, mineraller, antioksidan özellik gösteren biyoaktif bileşikleri ile dikkat çekici özellikler göstermektedir. Karabuğday (*Fagopyrum esculentum, Fagopyrum tartaricum)*, çiya (*Salvia hispanica L.),* kinoa (*Chenopodium quinoa L.)* en çok bilenen; amarant (*Amaranthus caudatus L.)* en nadir bilenen yalancı tahıllardandır.

Amarant ile ilgili yapılan araştırmalara bakıldığında yetiştirildiği iklim ve varyete özellikleri göz önünde alındığında majör ve minör besin öğelerinin yaklaşık değerleri şöyledir:

Amarantın protein içeriği %15 civarındadır (%65 albümin, %17 globulin, %11 prolamin, %7 glutenin) ve lizin, kükürtlü aminoasitler ve çocuk beslenmesi için önemli arjinin ve histidin amino asitlerince zengindir. Karbonhidrat içeriği %65 civarındadır ve toplam karbonhidratın %4-5'i diyet lifinden oluşur. Ortalama %25 oranında beta-glukan içerir ve bu oran tahıllara göre yüksektir. Yağ oranı %7 ile 9 arasındadır bununda %77 si çoklu

doymamış yağ asitlerinden oluşur. Antioksidan özellik gösteren E vitamini içeriği yüksektir ve fitosteroller içerir (Coelho vd 2018; Meza vd 2023).

Karotenoidler, flavonoidler, rutin ve kuersetin içerikleri vardır. Yüksek demir içeriği olması ile birlikte kalsiyum, magnezyum, fosfor, çinko, manganez gibi mineraller içerir. %8 civarında skualen içeriği olduğu bilinmektedir. Antinutrisyonel öğeler olan fitat, fitik asit ve oksalat içermektedir (Venskutonis ve Kraujalis, 2013; Coelho vd., 2018; Meza vd., 2023). Bu bileşimi nedeniyle birçok fonksiyonel özellik taşımaktadır. Kardiyovasküler sağlık, kolon, karaciğer, cilt, sinir sistemi sağlığı üzerine olumlu etkileri olup antitümör, antikanser, antiinflamasyon, antioksian ve antidiyabetik özellikler taşımaktadır (Thakur vd., 2021).

Günümüzde dünya genelinde buğday bazlı fırıncılık ürünlerinde meydana gelen ısıl işlem kontaminantları önemli bir problemdir. Yüksek sıcaklık uygulamalarında oluşan Maillard reaksiyonu gıdaların tat, aroma, yapı ve renk gibi özelliklerini oluştururken aynı zamanda akrilamid, 5-hydroksimetilfurfural (HMF) ve furfural gibi gibi ısıl işlem kontaminantı oluşmasına da sebep olmaktadır (Galluzzo, 2021).

Uluslararası gıda otoriteleri akrilamidi nörotoksik ve potansiyel kanserojen olarak yayınlamıştır (Galluzzo vd.,2021). Avrupa Birliği akrilamid ile ilgili yasal düzenlemeler yapmış olsa da yapılan bilimsel araştırmalarda hali hazırda satılan fırıncılık ürünlerinde bu limitlerin yaklaşık 10 kat üzerinde akrilamid sonuçları belirlenmiştir (Jing vd, 2019; Mousa ve Mousa, 2022). HMF ise genotoksik ve mutajenik etkileri olan bir bileşiktir (Kukurova vd.,2013). Yalancı tahılların amino asit profilleri incelendiğinde akrilamid reaksiyonunun reaktantı olan asparajin amino asidini içerdikleri görülmektedir (Procopet ve Oroian, 2022). Bu nedenle yalancı tahıllar ile yapılan ürünlerde de akrilamid oluşma olasılığı göz ardı edilmemelidir. Birçok çalışma yüksek sıcaklık uygulamalarında meydana gelen esmerleşmenin Maillard reaksiyonu sonucu oluşan ısıl işlem kontaminantlarının göstergesi olduğunu ortaya koymuştur (Michalak vd., 2019).

Bu çalışmada; %100 buğday unu, %100 amarant unu, %50 buğday unu ve %50 amarant unu ile hazırlanan bisküvilerin fizikokimyasal özellikleri ile esmerleşme indeksleri incelenmiştir.

2.MATERYAL VE METOT

2.1.Materyaller

Buğday unu: Türk Gıda Kodeksi Buğday Unu Tebliği'ne uygun olarak üretilmiş olan özel amaçlı buğday unu. Buğday ununun besin etiketindeki değerler (100 g için) enerji; 350 kcal, yağ; 1,0 g, toplam karbonhidrat; 75,8 g, protein; 11,1 g, kül en az %1,2'dir. Amarant unu için bu değerler (100 g için) enerji; 365 kcal, yağ; 5,5 g, toplam karbonhidrat; 59 g, protein; 16,1 g, nem maksimum %15, kül maksimum %3'tür.

2.2. Metot

%100 buğday unu, %100 Amarant unu, %50Amarant ve %50 buğday unu ile hazırlanan bisküviler için yayılma oranı, pişme kaybı, sertlik ve gevreklik değerleri tespit edilmiş olup Maillard reaksiyonları için önemli parametreler olan nem, su aktivitesi, pH analizleri yapılmıştır. CIELAB renk değerleri tespit edilmiştir ve Maillard reaksiyonu ürünü ısıl işlem kontaminantlarının göstergesi için esmerleşme indeksi hesaplanmıştır.

2.2.1. Bisküvi Yapımı

Bisküvi reçetesinde AACC Metot 10-54D modifiye edilerek kullanılmıştır. Bisküvi reçetelerinde yalancı tahıl ve buğday ununun yanı sıra öğütülmüş şeker, margarin, tuz, su, yağsız süt tozu, amonyum bikarbonat, sodyum bikarbonat kullanılmıştır. Unlar %100 buğday unu, %100 amarant unu ve %50 amarant %50 buğday unu olacak şekilde kullanılmıştır. Bisküvi reçetesinde 40 g un için şeker 17,4 g, tuz 0,5 g, su 8,8 g, yağsız süt tozu 0,4 g, sodyum bikarbonat 0,4 g, amonyum bikarbonat 0,2 g olarak kullanılmıştır. Margarin miktarı %100 buğday unu için 16 g, %100 amarant için 14,2 g, %50 buğday %50 amarant için 15,1 g kullanılmıştır. Şekillendirilen hamurlar (çap: 5 cm; yükseklik: 3 mm) 205 ^{0}C de Ege Üniversitesi Gıda Mühendisliği Bölümü Beslenme laboratuvarında bulunan Arçelik marka 9629CMS model fırında pişirilmiştir.

2.2.2. Pişme kaybı

Bisküvinin pişme öncesi toplam hamur ağırlığı ve pişirildikten sonraki ağırlığı saptanmış ve aşağıdaki formül ile hesaplanmıştır. (AACC, 2000).

$$\text{Pişme kaybı} = \frac{(Hamur\ ağırlığı - pişmiş\ ağırlık) x 100}{Hamur\ ağırlığı}$$

2.2.2. Yayılma oranı

Bisküviler pişirildikten bir saat sonra örneklerin çap (W) ölçümü ve kalınlık (T) ölçümü yapılmıştır. Yayılma oranı, çap ortalamasının (W) kalınlık (T) ortalamasına oranı ile hesaplanmıştır (AACC, 2000).

Yayılma oranı = W / T

W: çap uzunluğu (mm)

T: kalınlık (mm)

2.2.3. Tekstür analizi

Bisküvilerin sertliği tekstür analiz cihazı (TA-XTplus, Texture Analyzer, İngiltere) ve üç noktada kırma başlığı (HDP/3PB 3-Point bending rig) kullanılarak belirlenmiştir. Bisküvilerin sertlik (g), gevreklik (mm) değerleri saptanmıştır.

2.2.4. Nem ve Kuru Madde Tayini

Örneklerin nem ve kül tayinleri AOAC (2005)'e göre belirlenmiştir. Öğütülmüş bisküvi örneklerinden 2 g tartılıp vakumlu etüvde (100 mmHg) sabit tartıma gelene kadar bekletildikten sonra ağırlığı ölçülerek, aşağıdaki formülden nem miktarı hesaplanmıştır.

$$\% \text{ Nem} = \frac{Ağırlık\ farkı}{İlk\ tartım} x100$$

Toplam kuru madde miktarı aşağıdaki formüle göre hesaplanmıştır.

% Toplam kuru madde oranı = 100 – nem miktarı

2.2.5. Su aktivitesi (aw)

Örneklerdeki su aktivitesi ölçümü Testo 350 XL-Testo 454 cihazı ile yapılmıştır (Testo, Freiburg, Almanya).

2.2.6. pH

Örneklerde pH ölçümü pH metre yardımıyla potansiyometrik olarak belirlenmiştir. Tüm ölçümler WTW InoLab pH7110) Almanya cihazı ile 20 ^{0}C'de gerçekleşmiştir.

2.2.7. Renk ve Esmerleşme İndeksi Tayini

Renk ölçümleri için L* (parlaklık), a* (+ kırmızı, - yeşil), b* (+ sarı, - mavi) değerleri CIELAB sistemine göre HunterLab ColorFlex CFLX 45-2 cihazı ile numuneler öğütüldükten sonra homojen şekilde renk kabına yerleştirilerek gerçekleştirilmiştir. Esmerleşme İndeksi (BI) aşağıdaki formülden hesaplanmıştır (Chudy vd., 2019).

$$BI = \frac{100.[\frac{(a+1{,}75*L)}{(5{,}645*L+a-3{,}012*b)}-0{,}31]}{0{,}17}$$

2.2.8. İstatistiksel Analiz

Örnekler için çalışılan tüm analizlerin verileri SPSS 25 paket programı kullanılarak varyans analizi ile (ANOVA) değerlendirilmiştir. İstatistiksel farklılıklar $p \leq 0.05$ önem seviyesinde Duncan çoklu karşılaştırma metotları ile değerlendirilmiştir.

3. BULGULAR ve TARTIŞMA

Bisküvi örneklerinin yayılma oranı, pişme kaybı, sertlik, gevreklik değerleri, nem, su aktivitesi, pH sonuçları Tablo.1'de sunulmuştur. Bisküvilerin yayılma oranı ve pişme kaybı incelendiğinde en fazla yayılma oranı %100 amarant unu ile hazırlanan bisküvilerde, en az yayılma oranı ise %100 buğday unu ile hazırlanan bisküvilerde tespit edilmiştir. Chauhan ve ark. (2016) amarant unu ile yapılan bisküvilerde reçetedeki amarant unu miktarı arttıkça yayılma oranının arttığını tespit etmiştir. Bu bulgunun aksine en düşük pişme kaybı %100 amarant unu ile hazırlanan bisküvilerde en yüksek pişme kaybı ise %100 buğday unu ile hazırlanan bisküvilerde saptanmıştır. Tekstür özellikleri bakımından örnekler incelendiğinde sertlik değerleri en fazla %100 amarant unu ile hazırlanan bisküvilerde olup en az sertlik değeri %50 amarant unu ile hazırlanan bisküvilerde tespit edilmiştir. %100 yalancı tahıl ile yapılan bisküvi ve ekmek gibi diğer ürünlerde %100 buğday unu ile yapılanlarına göre sertlik değerlerinde artış gösterdiği bazı çalışmalar ile ortaya konmuştur (Graziano vd., 2022). Gevreklik değerleri ise en fazla %100 buğday unu ile hazırlanan bisküvilerde en az %100 amarant unu ile hazırlanan bisküvilerde tespit edilmiştir. Örneklerin nem değerlerinin TS2383 Bisküvi standardına uygun olduğu belirlenmiştir (nem oranı <%6). Örneklerin pH değerleri ise literatür ile uyumludur. Buğday unu ile üretilen bisküvi örneklerinde pH değerlerinin (pH 8-9) civarında olduğu belirtilmektedir (Açar, 2010). Maillard reaksiyonları için önemli parametreler olan nem, su aktivitesi ve pH en yüksek %100 buğday unu ile hazırlanan bisküvilerde en az ise %50 amarant unu ile hazırlanan bisküvilerde tespit edilmiştir. Bunun sebebi Mancebo ve ark. (2015)'in belirttiği gibi tahıl ve yalancı tahıl karışımı ile hazırlanan fırıncılık ürünlerinde zayıf gluten ağı oluşması ve yüksek sıcaklık ile bu zayıf gluten ağının hızlı bir şekilde çökmesidir. Gluten ağının hızlı çöküşü nem, su aktivitesi ve pH değerlerinde diğer çeşitlere göre daha düşük değerlerin tespitine neden olmaktadır.

Tablo 1. Bisküvilerin Fizikokimyasal Özellikleri

Bisküvi Çeşidi	Yayılma Oranı*	Pişme Kaybı (%)*	Nem (%)*	Su aktivitesi*	pH*	Sertlik (g)	Gevreklik (mm)*
%100B	8,63±0,43^{a}	15,80±0,67^{a}	4,20±0,38^{a}	0,38±0,33^{a}	8,86±0,66^{a}	1307,62	37,82±0,30^{a}
%50A%50B	9,42±0,11^{b}	15,00±0,78^{a}	3,66±0,46^{a}	0,33±0,45^{a}	7,14±0,40^{b}	1175,38	37,10±0,25^{a}
%100A	9,74±0,13^{c}	13,38±0,95^{b}	4,06±0,35^{a}	0,36±0,28^{a}	7,70±0,80^{ab}	1794,47	36,70±0,30^{a}

100B: %100 Buğday unu ile hazırlanan bisküvi, %50A%50B: %50 Amarant unu ve %50 Buğday unu ile hazırlanan bisküvi, 100A: %100 Amarant unu ile hazırlanan bisküvi

*Değerler ortalama ± standart sapma olarak verilmiştir.

$^{a-c}$: Farklı harfler aynı sütundaki değerler arasındaki istatistiksel farklılığı gösterir ($p<0,05$).

Bisküvi örneklerinin CIELAB renk sonuçları ve esmerleşme indeksleri Tablo.2'de sunulmuştur. Amarant oranı arttıkça *a** değeri artarken parlaklığın göstergesi *L** değeri azalmıştır. Amarant içeren bisküvilerde sarı rengi ifade eden b* değeri daha yüksek bulunmuş ve bu değerin amarant oranı arttıkça azaldığı tespit edilmiştir.

Hussein ve ark. (2023) yalancı tahıl içeren bisküvilerde glutensiz un oranı arttıkça daha koyu renkli bisküviler elde edildiğini bildirmiştir. *L** değerleri glutensiz un ilave edildiğinde ve glutensiz un oranı arttıkça azalmış ve *b** değerleri yalancı tahıl oranı arttıkça azalmıştır. Çalımada elde ettiğimiz sonuca benzer olarak *a** değeri yalancı tahıl oranı arttıkça artmıştır. Başka bir çalışmada *L** değerinin protein içeriği ile ilişkili olduğu, yalancı tahıl ilavesi ile protein miktarı arttığı ve *L** değerinin azaldığı belirtilmiştir (TV, 2014).

Bisküvi örneklerinde esmerleşmenin şeker karamelizasyonu ve Maillard reaksiyonu sebebiyle oluştuğu bilinmektedir (Hussein vd., 2023). Bu çalışmada örnekler için şeker oranları sabit tutularak Maillard reaksiyonları sebebiyle oluşan esmerleşmeye odaklanılmıştır. Esmerleşme indeksi amarant unu ile hazırlanan bisküvilerde %100 buğday unu ile hazırlanan bisküvilere göre daha yüksek bulunmuştur ($p<0,05$). En yüksek değer %100 amarant unlu bisküvide tespit edilmiştir. Hussain ve Kaul (2018) karabuğday içeren bisküvilerde yalancı tahıl oranı arttıkça enzimatik olmayan esmerleşme indeksinin arttığını saptamıştır.

Tablo 2. Bisküvilerin renk değerleri ve esmerleşme indeksi

Bisküvi Çeşidi	*L**	*a**	*b**	BI
%100B	74,85±0,09^{a}	3,93±0,10^{a}	28,37±0,11^{ab}	51,38±0,45^{a}
%50A%50B	67,34±0,51^{b}	6,77±0,09^{b}	28,55±0,22^{a}	60,14±0,14^{b}
%100A	65,09±0,47^{c}	7,32±0,24^{c}	27,95±0,15^{b}	60,83±0,54^{b}

100B: %100 Buğday unu ile hazırlanan bisküvi, %50A%50B: %50 Amarant unu ve %50 Buğday unu ile hazırlanan bisküvi, 100A:%100 Amarant unu ile hazırlanan bisküvi, BI: Esmerleşme indeksi

Değerler ortalama ± standart sapma olarak verilmiştir.

$^{a-c}$: Farklı harfler aynı sütundaki değerler arasındaki istatistiksel farklılığı gösterir ($p<0,05$).

Amarant oranı arttıkça esmerleşme indeksinin artma eğiliminde olması kanserojen ve mutajenik etkileri olan akrilamid ve HMF gibi gıda kontaminantların amarant içeren bisküvilerde daha çok olabileceğini, yalancı tahıl oranı arttıkça da riskin artacağını düşündürmektedir. Akrilamid öncülü olan asparajinden yola çıkarak akrilamid ile ilgili bir değerlendirme yapıldığında; amarantta yaklaşık 2,97 g asparajin /100 g protein, buğdayda 5 g asparajin /100 g protein olduğu bilinmektedir (Tsochatzis vd., 2019; Procopet ve Oroian, 2022). Çalışma kapsamında elde edilen bisküvilerin protein miktarları %100 buğday unlu bisküvi için 6,22 ± 0,06, %50 amarant unlu bisküvi için 7,68 ± 0,05, %100 amarant unlu bisküvi için 8,80 ± 0,09 olarak tespit edilmiştir. Bisküvilerdeki asparajin miktarları teorik olarak hesaplandığında %100 buğday unlu bisküvi için 0,311 g, %50 amarant unlu bisküvi için 0,306 g, %100 amarant unlu bisküvi için 0,261 g değerleri elde edilmektedir. Bu sonuçlara göre bisküvi örneklerinde akrilamid değerlerinin yakın olma ihtimali vardır.

4. SONUÇ ve ÖNERİLER:

Amarant veya diğer yalancı tahılların özellikle sürdürülebilir protein kaynağı olma özellikleri ve sağlığa çeşitli faydaları ile günümüzde artan düzeyde birçok insanın diyetinde yer aldığı ve gelecekte de diyetin önemli bir parçası olacakları düşünülmektedir. Gıda güvenliğinin bütünsel yaklaşımı gereği yalancı tahılların beslenme, sağlık etkilerinin yanı sıra gıda kontaminantları açısından da değerlendirilmeleri gerekli ve önemlidir. Amarant içerikli bisküvilerin esmerleşme indeksinin buğday unlu bisküviye göre daha yüksek olması ve amarant oranı arttıkça bu değerin artması oldukça dikkat çekicidir. Fırıncılık ürünlerinde sağlığa olumsuz etkisi olduğu bilinen akrilamid, HMF

gibi gıda kontaminantları açısından yalancı tahıllar dikkatlice incelenmelidir. İlerleyen süreçlerde bisküvilerde amaranth unu kullanımının akrilamid oluşumu üzerine etkisi araştırılacaktır. Tüm karbonhidrat ve protein içeren gıdalarda Maillard reaksiyonu ürünlerini benzer şekilde oluştuğu tahmin edilse bile gıda matriksi ısıl işlem kontaminatlarının oluşumunu farklı şekilde etkileyebilir. Çalışmalarda amarantın farklı gıda matrislerinde ele alınması ve incelenmesi gerekir.

5. REFERANSLAR:

Alonso-Miravalles, L., & O'Mahony, J. A. (2018). Composition, protein profile and rheologica properties of pseudocereal-based protein-rich ingredients. Foods, 7(5), 73.

Chauhan, A., Saxena, D. C., & Singh, S. (2016). Physical, textural, and sensory characteristics of wheat and amaranth flour blend cookies. *Cogent Food & Agriculture*, *2*(1), 1125773.

Chudy, S., Makowska, A., Piątek, M. and Krzywdzińska-Bartkowiak, M., 2019, Application of microwave vacuum drying for snack production: Characteristics of pure cheese puffs, *International Journal of Dairy Technology*, 72(1):82-88.

Coelho, L. M., Silva, P. M., Martins, J. T., Pinheiro, A. C., & Vicente, A. A. (2018). Emerging opportunities in exploring the nutritional/functional value of amaranth. *Food & function*, *9*(11), 5499-5512.

Galluzzo, F. G., Cammilleri, G., Pantano, L., Lo Cascio, G., Pulvirenti, A., Macaluso, A., & Ferrantelli, V. (2021). Acrylamide assessment of wheat bread incorporating chia seeds (Salvia hispanica L.) by LC-MS/MS. *Food Additives & Contaminants: Part A*, *38*(3), 388-395

Graziano, S., Agrimonti, C., Marmiroli, N., & Gullì, M. (2022). Utilisation and limitations of pseudocereals (quinoa, amaranth, and buckwheat) in food production: A review. *Trends in Food Science & Technology*, *125*, 154-165.

Hussein, A. M., Abd El-Aal, H. A., Morsy, N. M., & Hassona, M. M. (2023). Chemical, rheological, and sensory properties of wheat biscuits fortified with local buckwheat.

Hussain, A., & Kaul, R. (2018). Formulation and Characterization of Buckwheat-Barley Supplemented Multigrain Biscuits. *Current Research in Nutrition & Food Science*, *6*(3).

Jing, Y., Li, X., Hu, X., Ma, Z., Liu, L., & Ma, X. (2019). Effect of buckwheat extracts on acrylamide formation and the quality of bread. *Journal of the Science of Food and Agriculture*, 99(14), 6482-6489.

Kukurová, K., Ciesarová, Z., Mogol, B. A., Açar, Ö. Ç., & Gökmen, V. (2013). Raising agents strongly influence acrylamide and HMF formation in cookies and conditions for asparaginase activity in dough. *European food research and technology*, *237*, 1-8.

Malik, A. M., & Singh, A. (2022). Pseudocereals proteins-A comprehensive review on its isolation, composition and quality evaluation techniques. *Food Chemistry Advances*, *1*, 100001.

Mancebo, C. M., Picón, J., & Gómez, M. (2015). Effect of flour properties on the quality characteristics of gluten free sugar-snap cookies. *LWT-Food Science and Technology*, *64*(1), 264-269

Michalak, J., Czarnowska-Kujawska, M., & Gujska, E. (2019). Acrylamide and thermal-processing indexes in market-purchased food. *International Journal of Environmental Research and Public Health*, *16*(23), 4724.

Mousa, R. M. A. (2022). Inhibition of acrylamide in gluten-free quinoa biscuits by supplementation with microbial dextran. *International Journal of Food Properties*, 25(1), 11-23.

Procopet, O., & Oroian, M. (2022). Amaranth Seed Polyphenol, Fatty Acid and Amino Acid Profile. *Applied Sciences*, *12*(4), 2181.

Rivero Meza, S. L., Hirsch Ramos, A., Cañizares, L., Raphaelli, C. D. O., Bueno Peres, B., Gaioso, C. A., Egea,I.,Estrada,Y.,Flores,F.B. and Oliveira, M. (2023). A review on amaranth protein: composition, digestibility, health benefits and food industry utilisation. *International Journal of Food Science & Technology*, *58*(3), 1564-1574.

Silva, A. D., Ávila, S., Küster, R. T., Dos Santos, M. P., Grassi, M. T., de Queiroz Pereira Pinto, C., Miguel, O.G. & Ferreira, S. M. R. (2021). İn vitro bioaccessibility of proteins, phenolics, flavonoids and antioxidant activity of Amaranthus viridis. Plant Foods for Human Nutrition, 76(4), 478-486.

Thakur, P., Kumar, K., & Dhaliwal, H. S. (2021). Nutritional facts, bio-active components and processing aspects of pseudocereals: A comprehensive review. *Food Bioscience*, *42*, 101170.

Tsochatzis, E., Papageorgiou, M., & Kalogiannis, S. (2019). Validation of a HILIC UHPLC-MS/MS method for amino acid profiling in triticum species wheat flours. *Foods*, *8*(10), 514.

TV, H. (2014). Effect of hydrocolloids on cooking quality, protein and starch digestibility of ready-to-cook gluten free extruded product. *Agricultural Engineering International: CIGR Journal*, *16*(2), 119-125.

TS2383, Bisküvi Standardı, Türk Standartları Enstitüsü

Venskutonis, P. R., & Kraujalis, P. (2013). Nutritional components of amaranth seeds and vegetables: a review on composition, properties, and uses. *Comprehensive reviews in food science and food safety*, *12*(4), 381-412.

YENILEBILIR YABANI OTLARIN SÜRDÜRÜLEBILIR BESLENME AÇISINDAN DEĞERLENDIRILMESI: KALDIRIK OTUNUN (*Trachystemon orientalis*) FIRINCILIK ÜRÜNÜNDE KULLANIMI

Merve Eda EKER ÖZKACAR* (ORCID: 0000-0002-4926-4758)
Ege University, Faculty of Engineering, Department of Food Engineering, İzmir-Türkiye
Email: merveedaeker@gmail.com

Prof. Dr. Sibel KARAKAYA (ORCID: 0000-0001-5514-9521)
Ege University, Faculty of Engineering, Department of Food Engineering, İzmir-Türkiye
Email: sibel.karakaya@ege.edu.tr

ÖZET
Günümüzde nüfus artışı, yetersiz beslenme ve buna bağlı hastalıklar, yaşam tarzı değişiklikleri, yoksulluk gibi problemler gıda güvenliği açısından risk oluşturmaktadır. Bu durum gıda sistemlerinin ve beslenme kalıplarının çevre ve sağlık açısından yeniden tanımlanması gerekliliğine yol açmıştır. Yetersiz beslenme ve buna bağlı hastalıkların önlenmesi ve sağlıklı toplumların oluşması, sürdürülebilir beslenme ve sürdürülebilir gıda sistemlerinin oluşturulması ile mümkün olacaktır. Doğada kendiliğinden yetişen bitkiler (genellikle yerel/yabani bitkiler olarak adlandırılır) besleyici, sürdürülebilir bir diyet ve yerel çiftçiliği teşvik etmesi açısından da büyük bir ekonomik potansiyel oluşturmakta ve sürdürülebilir beslenmeye katkı sunmaktadırlar. Bu çalışmada araştırma materyali olarak Karadeniz Bölgesi'nde geleneksel olarak tüketilen *Boraginaceae* familyasına ait yerel bir bitki olan *Trachystemon orientalis* (kaldırık otu/hodan) kullanılmıştır. Kaldırık otu yaprakları sert tüylü, çiçekleri mavi renkli olan genellikle nem oranı yüksek, gölgeli yerlerde, kayın ormanları altı, akarsu kenarlarında yetişen bir bitkidir. Ülkemizde genelde Karadeniz Bölgesi ve çevresinde yetişir ve Nisan-Haziran ayları arasında hasat edilir. Halk arasında en çok idrar söktürücü, kan temizleyici, rahatlatıcı, sindirimi kolaylaştırıcı ve ateş düşürücü etkileriyle bilinen bu bitkinin bu çalışmada bir fırıncılık ürünü olan kurabiyede kullanımı planlamıştır. Bu çalışmada yerli bir gıda olan kaldırık otunun fizikokimyasal özelliklerinin aydınlatılması ve kurabiye üretiminde kullanımı gerçekleştirilmiştir. Bu tür yerel ürünlerin ekonomiye katkıda bulunup gıda sanayiinde de avantaj yaratabileceği düşünülmektedir. Ürünün tüketici testi ile duyusal olarak kabul edilebilirliği test edilmiş, pişme kaybı, yayılma oranı, tekstür analizi ve besin öğeleri belirlenmiştir. Böylece kaldırık otunun gıda sanayiinde değerlendirilebilecek bir ürün formülasyonunda kullanım potansiyeli değerlendirilmiştir.
Anahtar Kelimeler: *Trachystemon orientalis*, kurabiye, besleyici değer, duyusal kabul

EVALUATION OF WILD EDIBLE PLANTS IN TERMS OF SUSTAINABLE NUTRITION: USE OF TRACHYSTEMON ORIENTALIS IN BAKERY PRODUCTS

ABSTRACT

Nowadays, problems such as population growth, malnutrition, related diseases, lifestyle changes, poverty, etc. are risk factors for food security. This situation has led to the necessity of redefining food systems and nutritional patterns in terms of the environment and health issues. Preventing malnutrition and related diseases and creating healthy societies will be possible by creating sustainable nutrition and food systems. Plants that grow naturally in nature (often called local/wild plants) create great economic potential by promoting a nutritious, sustainable diet, local farming, and contributing to sustainable nutrition. This study used *Trachystemon orientalis* (borage), a local plant belonging to the *Boraginaceae* family, traditionally consumed in the Black Sea Region, as research material. *Trachystemon orientalis* is a plant with hard pilose leaves and blue flowers that generally grows in shady places with high humidity, under beech forests, and along streams. In our country, it generally grows in and around the Black Sea Region and is harvested between April and June. Local people also use this plant for medicinal purposes such as diuretic, blood purifying, relaxing, digestive, and antipyretic properties. This study aimed to use *Trachystemon orientalis* in the cookie formulation. For this aim, the physicochemical properties of *Trachystemon orientalis*, were elucidated, and its use in cookie production was carried out. This may bring advantages to the local plant to be used in the food industry with added value. A hedonic scale was used to evaluate the sensory acceptability of the cookie containing *Trachystemon orientalis*. The cooking loss, spreading ratio, texture analysis, and nutritive value were also determined. The results are promising in terms of the potential of *Trachystemon orientalis* to be used in a product formulation and in the food industry.

Keywords: *Trachystemon orientalis*, cookie, nutritive value, sensory acceptability

Giriş

Artan nüfusun beslenme ihtiyaçlarının karşılanması, açlığın ve yetersiz beslenmenin ortadan kaldırılması, sürdürülebilir gıda ve sürdürülebilir çevre kaygıları gelecek yüzyılın en kritik sorunları arasında yer almaktadır. Günümüzde gıda ve beslenme açısından insanlığın karşı karşıya kaldığı başlıca sorunlar: sağlıksız ve yetersiz beslenme ve yetersiz beslenmenin oluşturduğu düşük bağışıklık, yüksek inflamasyon vb. sorunlar sonucu küresel hastalık yükünde görülen artış (Katona ve Katona-Apte, 2008; Oz, 2017), popülasyonun artması ve buna bağlı olarak günümüzde ve gelecekte Dünya nüfusunun gıda ihtiyacının karşılanmasında küresel boyutta sorun olması (FAO, 2017; WHO, 2018), gıda ihtiyacının hayvansal kaynaklardan karşılanması durumunda sera gazı emisyonu vb. olumsuz çevresel etkilerin söz konusu olması (FAO, 2017; WHO, 2018), günümüze kadar tüm gıda üretimi ve tedariğinin küresel boyutta düşünülmesine karşın günümüzde bunun çevre açısından önemli bir risk olması (karbon ayak izi, su ayak izinin artmasına yol açması sebebiyle) (FAO, 2019; FAO ve WHO, 2019), gıda sanayiinde üretim zincirinde yöresel/bölgesel gıdaların kazandırılmasında yetersizlik (PRIMA-MED, 2022) şeklinde özetlenebilir.

Su/karbon ayak izi, sera gazı emisyonları bakımından çevreye duyarlı yeni kaynakların araştırılması, yerel/bölgesel üretimlerin özendirilmesi, bu kapsamda katma değerli ürünlerin üretimine olanak sağlayacak araştırmaların yapılması, çeşitliliğin sağlanması, toplumun kültürüne uygun güvenli gıda üretiminin gerçekleştirilmesi (UN, 2022), yerel/bölgesel ürünler üzerinde yapılacak araştırmalarla bu ürünlerin gıda sanayii açısından tanınırlığının sağlanması vb. iyileştirici aksiyonlar daha düşük çevresel etki yaratmak açısından avantaj sağlayacak ve yukarıda belirtilen küresel sorunların çözümüne katkıda bulanacak yollardır. Beslenmemizde yaptığımız seçimlerin sağlığımızın yanı sıra ekosistemler üzerinde neden olduğu çevresel ve ekonomik bir etki de söz konusudur. Bu yüzden gıdaların seçiminde düşük çevresel etkiye sahip sürdürülebilir kaynaklara yönelmemiz önem taşımaktadır. Bitkisel gıda ve protein kaynakları içerisinde özellikle yerel gıdalar ve doğada kendiliğinden yetişebilen bitkisel kaynaklar lojistik maliyetlerini ve sera gazı emisyonlarını azaltmaya yardımcı olduğu ve gıda üreticisinin kalite kontrolünü, izlenebilirliğini ve şeffaflığını basitleştirdiği için küresel bir trend haline gelmektedir. Bu tür yerel ürünler ekonomiye katkıda bulunup gıda sanayiinde de avantaj yaratabilirler (Borelli vd., 2020; Comerford vd., 2021)

Bu çalışmada da yerel ve bitkisel bir kaynak olan ve doğada kendiliğinden yetişen kaldırık otunun/hodanın (*Trachystemon orientalis*) fizikokimyasal özelliklerinin aydınlatılması ve kurabiye üretiminde değerlendirilmesi, böylece gıda sanayiinde sürdürülebilir bir kaynak olarak kullanım potansiyelinin araştırılması amaçlanmıştır.

Materyal ve Metot

Materyal

Kaldırık otu Weintek marka tepsili kurutucuda 42-45 °C'de son nem içeriği %5 ±1 olacak şekilde kurutulmuştur. Kurutma işlemi sonrası öğütülüp vakumlanarak paketlenmiş ve kuru ve serin bir yerde saklanmıştır.

Kaldırık Otunda Gerçekleştirilen Analizler

Nem Tayini: Kaldırık otunun nem tayini Özer ve Aksoy (2019) tarafından önerildiği gibi 105 °C'de sabit tartıma gelinceye kadar etüvde kurutularak ve gravimetrik olarak nem hesaplanarak gerçekleştirilmiştir.

Protein Tayini: Kjeldahl yöntemi ile toplam N içeriği belirlendikten sonra veriler 6.25 katsayısı ile çarpılarak protein içerikleri hesaplanmıştır (Özer ve Aksoy, 2019).

Kül Tayini: Numune sabit tartıma getirilen krozelere alınmış, ön yakma işleminden sonra gri-beyaz kül elde edilene kadar yaklaşık 8 saat boyunca 550 °C'de bir kül fırınında yakılmıştır. Kül miktarı (%) hesaplanmıştır (Özer ve Aksoy, 2019).

Yağ Tayini: Folch vd. (1957) yöntemi kullanılarak gerçekleştirilmiştir.

Toplam Karbonhidrat Tayini: Gıdanın protein, yağ, kül, nem içeriği belirlendikten sonra gıdanın toplam ağırlığından çıkarılarak kalan miktar karbonhidrat olarak belirlenmiştir.

Kurabiyelerde Gerçekleştirilen Analizler

Kurabiye Formülasyonunun Geliştirilmesi: Kontrol kurabiye formülasyonu Banerjee vd. (2022)'nin çalışmasına uygun şekilde gerçekleştirilmiştir. Kullanılacak malzemeler ve miktarları tabloda belirtilmiştir (Tablo 1). Kurabiye hamuru, oklava kullanılarak yuvarlanmıştır. Yuvarlanan hamur istenilen şekillerde kalıp yardımıyla 5 cm çapında şekillendirilmiş ve 180°C'de 12 dakika pişirilmiştir.

Tablo 1. Kurabiye yapımında kullanılan malzemeler

Malzemeler	**Kontrol Kurabiye (%)**	**Kaldırık Otu İçeren Kurabiye (%)**
Çok amaçlı buğday unu (g)	55	50
Şeker (g)	14	14
Tereyağ (g)	30	30
Karbonat (g)	1	1
Kaldırık otu (g)	-	5

Eklenecek kaldırık otu miktarına yapılan ön deneme üretimlerinin duyusal değerlendirilmesi sonrası karar verilmiştir. %3, 5, 10 oranında kaldırık otu içeren numunelerden en çok beğenilen oran %5 olduğu için çalışma bu oran kullanılarak yürütülmüştür.

Kurabiyelerin Nem, Protein, Kül, Yağ ve Karbonhidrat Tayinleri: Üretilen tüm kurabiyelerde kaldırık otunda yapılan analizlerde uygulanan yöntemlere uygun şekilde nem, protein, kül ve toplam karbonhidrat analizleri gerçekleştirilmiştir. Yağ içeriği reçetede tek yağ girdisi tereyağ olduğundan reçeteye dayandırılarak %30 şeklinde hesaplanmıştır.

Pişme Kaybı Tayini: Kurabiyelerde pişme kaybını saptamak için pişme öncesi toplam hamur ağırlığı ve pişirildikten sonraki ağırlığı ölçülmüş ve aşağıdaki formül kullanılarak hesaplanmıştır (AACC, 1990).

Pişme kaybı = ((Hamur ağırlığı−pişmiş ağırlık) x 100) / Hamur ağırlığı

Yayılma Oranı Tayini: Kurabiyeler pişirildikten bir saat sonra kurabiyede çap (W) ve kalınlık (T) ölçümü gerçekleştirilmiştir. Yayılma oranı, çap ortalamasının (W) kalınlık (T) ortalamasına oranı hesaplanarak ölçülmüştür (AACC, 1990).

Yayılma oranı = W / T

W: çap uzunluğu (mm)

T: kalınlık (mm)

Tekstür Analizi: Üretilen kurabiyelerin sertliği tekstür analiz cihazı tekstür cihazı (TA-XTplus, Texture Analyzer, İngiltere) ile üç noktada kırma başlığı (HDP/3PB 3-Point bending rig) kullanılarak belirlenmiştir. Kurabiyeler fırından çıkarıldıktan 2 saat sonra sertlik, gevreklik/kırılganlık değerleri saptanmıştır (AACC, 1990).

Sonuçlar ve Tartışma

Kaldırık otu

Yapılan analizler sonucunda kaldırık otunun nem değeri %5,43; protein değeri %14,42; kül değeri ise %17,94; yağ içeriği ise %1,47 olarak bulunmuştur. Karbonhidrat değeri protein, yağ, kül, nem içeriğinin gıdanın toplam ağırlığından çıkarılması sonucu %60,74 olarak hesaplanmıştır.

Tablo 2. Kaldırık otunun kompozisyonu

	Kaldırık Otunun Kompozisyonu
Nem (%)	5,43±0,036
Kül (%)	17,94±0,207
Yağ (%)	1,47±0,17
Protein (%)	14,42±0,07
Karbonhidrat (%)	60,74 ±0,68

Literatürle kıyaslandığında protein içeriği farklı bölgelerden toplanan kaldırık otlarında yapılan çalışmaların sonuçlarıyla uyumlu bulunmuştur. Bu çalışmalarda kaldırık otlarının protein içeriği %15.71-19.96 (Kibar ve Kibar, 2017) ve %14.1-20.3 olarak tespit edilmiştir (Özer ve Aksoy, 2019). Kül içeriği de Özer ve Aksoy (2019)'un çalışmasında bulunan maksimum kül içeriği olan %17'ye yakın bulunmuştur.

Kurabiyeler

Kurabiyelerin kül, nem, yağ, protein ve karbonhidrat içeriği Tablo 3'de verilmiştir. Kül ve nem içeriğinde istatistiksel olarak anlamlı bir değişim görülürken ($p < 0.05$), protein değerindeki artış anlamlı bulunmamıştır ($p > 0.05$). Karbonhidrat değerleri de birbirine oldukça yakın bulunmuştur. Kül içeriğindeki artış kaldırık otunun yüksek kül içeriği ile ilişkilendirilmiştir.

Tablo 3. Kurabiye örneklerinin kompozisyonları

	Kül (%)	**Protein (%)**	**Yağ (%)**	**Nem(%)**	**Karbonhidrat (%)**
Kontrol kurabiye	0,51±0,02^{a}	6,23±0,21^{a}	30	1,88±0,22^{a}	61,38
Kaldırık otu içeren kurabiye	1,4±0,04^{b}	6,71±0,32^{a}	30	2,4±0,08^{b}	59,49

Kontrol ve kaldırık otu eklenen kurabiyelerin ağırlık, çap, kalınlık, yayılma oranı ve pişme kaybı değerleri Tablo 4'te verilmiştir. Kurabiyelerin ağırlık değerlerinde istatistiksel olarak anlamlı bir farklılık görülmezken ($p > 0.05$) çap ve kalınlık değerlerinde farklılıklar saptanmıştır ($p < 0.05$). Dolayısıyla yayılma oranlarında da farklılık görülmüştür. Yüksek kaliteli kurabiye unu genellikle daha yüksek yayılma oranıyla ilişkilendirildiğinden kurabiyelerde daha yüksek bir yayılma oranı istenir (Mudgil vd., 2017; Yang vd., 2022). Kontrol kurabiyeler kaldırık otu içeren kurabiyelere kıyasla daha geniş çap, daha düşük kalınlık göstermiştir. Buna bağlı olarak, kontrol kurabiyeye kıyasla daha yüksek yayılma oranına sahiptir. Bunun sebebinin kaldırık otunun formülasyona eklenmesiyle artan lif miktarı ve dolayısıyla artan su tutma

kapasitesiyle ilgili olabileceği düşünülmektedir. Benzer olarak Mudgil vd. (2022) çalışmalarında çözünür lif miktarının artmasıyla kurabiyelerin yayılma oranını azaldığını göstermişlerdir. Ayrıca, Jeltema vd. (1983)'te yaptıkları çalışmalarında da suda çözünür pentozanlar, pektin, suda çözünmeyen hemiselülozlar, selüloz ve buğday kepeği, yulaf kepeği, mısır kepeği, lacivert fasulye kabuğu ve soya kabuğundan elde edilen lignin gibi diyet lifi bileşenlerinin artmasının, kurabiye yayılmasını ve kurabiyelerin yumuşaklığını önemli ölçüde azalttığını göstermişlerdir.

Tablo 4. Kurabiye örneklerinin fiziksel özellikleri

Örnekler	**Ağırlık (g)***	**Çap (mm)***	**Kalınlık (mm)***	**Yayılma oranı**	**Pişme kaybı (%)***
Kontrol kurabiye	16,062±0,57[a]	60,371±0,209[a]	8,3±0,33[a]	7,27	9,81±0,44[a]
Kaldırık otu içeren kurabiye	16,077±0,40[a]	59,102±0,395[b]	8,74±0,347[b]	6,76	9,35±0,17[a]

***Değerler ± standart sapma olarak verilmiştir.

[a-b] Aynı sütundaki farklı harfler istatistiksel olarak anlamlı farklılığı gösterir ($p<0,05$).

Kurabiyelerin sertlik ve kırılganlıklarının değerlendirildiği tekstür analizlerinin sonuçları Tablo 5'te verilmiştir. Bu analiz sonuçlarına göre sertlik değerinde kontrol kurabiyeye kıyasla anlamlı bir artış gözlenirken ($p< 0.05$) kırılganlık değerinde anlamlı bir farklılık görülmemiştir ($p> 0.05$). Literatür incelendiğinde çalışmamız benzer olarak Lafarga vd. (2019), dondurularak kurutulup toz haline getirilmiş brokoli sapları ile zenginleştirilen krakerlerde, Gül vd. (2021) ise kırmızı pancar tozu eklenen bisküvilerde sertlik değerinin kontrole göre arttığını bildirmiştir. Bir başka çalışmada Kuchtova vd. (2018) sonuçlarımıza benzer olarak %5 ve %10 üzüm kabuğu ve %5 üzüm çekirdeği içeren kurabiyelerin kırılganlığıyla kontrol numunesi arasında anlamlı bir fark gözlememiştir. Ancak, sertlik seviyesinde ise sonuçlarımızdan farklı olarak azalma gözlemlemiştir. Lifçe zengin gıdaların fırıncılık ürünlerinde kullanımı sonucu bu ürünlerin sertlik değerlerinin genel de arttığı; bu durumun su bağlama kapasitesi yüksek olan liflerin formülasyonda kullanılmasıyla buğday ununun, gluten-protein ağını geliştirecek kadar suyu tutamayarak daha sert bir yapı oluşumundan kaynaklanabileceği bildirilmiştir (Chang vd., 2015; Aydogdu vd., 2017).

Örnekler	Sertlik (N)*	Gevreklik (mm)*
Kontrol kurabiye	19,79 ± 1,740[a]	39,72 ± 0,323[a]
Kaldırık otu içeren kurabiye	28,15 ± 1,196[b]	40,14 ± 0,245[a]

*****Değerler ± standart sapma olarak verilmiştir.

[a-b] Aynı sütundaki farklı harflaer istatistiksel olarak anlamlı farklılığı gösterir ($p<0,05$).

Tekstür değerlerinin birçok çalışmada farklılaşması ve çok geniş aralıkta olmasının sebebinin formülasyonda kullanılan maddelerin ve kullanılan miktarların tüm çalışmalarda farklı olmasından kaynaklandığı düşünülmektedir.

Sonuç olarak, kaldırık otunun fırıncılık ürünü olan kurabiyede kullanımında bir kısıt olmadığı, elde edilen kaldırık otu içeren kurabiyede fiziksel, tekstürel ve duyusal açıdan herhangi bir probleme rastlanmadığı ve gıda sanayiinde değerlendirilmeye uygun olduğunu söylemek mümkündür.

Kaynaklar

AACC. (1990). Approved methods of the American Association of Cereal Chemists Official Method no.10-54. https://www.cerealsgrains.org/resources/methods/Pages/default.aspx Son erişim tarihi: 18 Mart 2024.

Aydogdu, A., Sumnu, G., & Sahin, S. (2018). Effects of addition of different fibers on rheological characteristics of cake batter and quality of cakes. *Journal of food science and technology*, 55, 667-677.

Banerjee, S., Haldar, S., Reddy, N., Reddy, R., Nagananda, G. S., & Mitra, J. (2022). Under-utilized germinated horse gram (Macrotyloma uniflorum) protein–Extraction, process optimization, characterization and its use in cookies fortification. *LWT*, 160, 113276.

Borelli, T., Hunter, D., Padulosi, S., Amaya, N., Meldrum, G., de Oliveira Beltrame, D. M., ... & Tartanac, F. (2020). Local solutions for sustainable food systems: The contribution of orphan crops and wild edible species. *Agronomy*, 10(2), 231.

Chang, R. C., Chia-Yen, L. I., & Shiau, S. Y. (2015). Physico-chemical and Sensory Properties of Bread Enriched with Lemon Pomace Fiber. *Czech Journal of Food Sciences*, 33(2).

Comerford, K. B., Miller, G. D., Reinhardt Kapsak, W., & Brown, K. A. (2021). The complementary roles for plant-source and animal-source foods in sustainable healthy diets. *Nutrients*, 13(10), 3469.

FAO ve WHO. (2019). Sustainable healthy diets – Guiding principles https://www.fao.org/3/ca6640en/ca6640en.pdf Son erişim tarihi:19 Mart 2024.

FAO. (2017). The Future of Food and Agriculture, Trends and Challenges. http://www.fao.org/3/a-i6583e.pdf Son erişim tarihi:19 Mart 2024.

FAO. (2019). The State of Food and Agrıculture. Movıng Forward on Food Loss and Waste Reduction. https://www.fao.org/3/ca6030en/ca6030en.pdf Son erişim tarihi: 19 Mart 2024.

Folch, J., Lees, M., & Stanley, G. S. (1957). A simple method for the isolation and purification of total lipides from animal tissues. *Journal of biological chemistry*, 226(1), 497-509.

Gül, H., Hayıt, F., Özer, B., & Acun, S. (2021). Kırmızı Pancar Ununun Glutensiz Bisküvi Üretiminde Kullanılması. *Mühendislik Bilimleri ve Tasarım Dergisi*, 9(4), 1166-1173.

Jeltema, M. A., Zabik, M. E., & Thiel, L. J. (1983). Prediction of cookie quality from dietary fiber components. Cereal Chemistry, 60(3), 227-230.

Katona, P., & Katona-Apte, J. (2008). The interaction between nutrition and infection. Clinical infectious diseases, 46(10), 1582-1588.

Kibar, B., & Kibar, H. (2017). Determination of the nutritional and seed properties of some wild edible plants consumed as vegetable in the Middle Black Sea Region of Turkey. South *African Journal of Botany*, 108, 117-125.

Kuchtová, V., Kohajdová, Z., Karovicova, J., & Lauková, M. (2018). Physical, textural and sensory properties of cookies incorporated with grape skin and seed preparations. *Polish Journal of Food and Nutrition Sciences*, 68(4).

Lafarga, T., Gallagher, E., Bademunt, A., Bobo, G., Echeverria, G., Viñas, I., & Aguiló-Aguayo, I. (2019). Physiochemical and nutritional characteristics, bioaccessibility and sensory acceptance of baked crackers containing broccoli co-products. *International Journal of Food Science & Technology*, 54(3), 634-640.

Mudgil, D., Barak, S., & Khatkar, B. S. (2017). Cookie texture, spread ratio and sensory acceptability of cookies as a function of soluble dietary fiber, baking time and different water levels. *LWT*, 80, 537-542.

Oz, H. S. (2017). Nutrients, infectious and inflammatory diseases. *Nutrients*, 9(10), 1085.

Özer, M. Ö., & Aksoy, M. (2019). Mineral composition and nutritional properties of Trachystemon orientalis (L.) G. Don populations in the Central Black Sea Region of Turkey. *Acta Scientiarum Polonorum Hortorum Cultus*, 18(4), 157-167.

PRIMA-MED. (2022). Agro-Food Value Chaın. https://prima-med.org/wp-content/uploads/2022/01/4.-PRIMA2022_Infoday-Day_Agrofood-Mohamed.pdf Son erişim tarihi: 25 Mart 2023.

UN. (2022). The Sustainable Development Goals Report. https://unstats.un.org/sdgs/report/2022/The-Sustainable-Development-Goals-Report-2022.pdf Son erişim tarihi: 19 Mart 2024.

WHO. (2018). A healthy diet sustainably produced''. http://apps.who.int/iris/bitstream/handle/10665/278948/WHO-NMH-NHD-18.12-eng.pdf?ua=1%0Ahttp://dx.doi.org/10.1016/j.jand.2016.11.005.

Yang, L., Wang, S., Zhang, W., Zhang, H., Guo, L., Zheng, S., & Du, C. (2022). Effect of black soybean flour particle size on the nutritional, texture and physicochemical characteristics of cookies. *LWT*, 164, 113649.

BAZI ANTOSİYANİNLERİN α-AMİLAZ VE α-GLUKOZİDAZ ENZİMLERİNİ *IN-SLICO* BAĞLAMA KAPASİTESİNİN ARAŞTIRILMASI

Nergis Gizem KIRKHAN (ORCID: 0009-0000-3112-9681)
Ege Üniversitesi, Mühendislik Fakültesi, Gıda Mühendisliği Bölümü, İzmir-Türkiye
Email: nergiskirkhan@hotmail.com

Prof. Dr. Sibel KARAKAYA (ORCID: 0000-0001-5514-9521)
Ege Üniversitesi, Mühendislik Fakültesi, Gıda Mühendisliği Bölümü, İzmir-Türkiye
Email: sibel.karakaya@ege.edu.tr

ÖZET

Tip 2 diyabet bozulmuş insülin salımı insülinin periferal aksiyonuna direnç ya da her ikisinin birlikte olduğu ve buna lipitler, proteinler, tuzlar veya elektrolitlerde metabolik anormalliğin eşlik ettiği bir metabolik rahatsızlıktır. Daha az yan etkiye sahip antidiyabetik ilaçların bulunması önem kazanmakta ve bu kapsamda doğal kaynakların antidiyabetik etkisinden faydalanma ön plana çıkmaktadır. Bir diğer yaklaşım nişastanın parçalanmasının kontrolü ve α-amilaz ile α-glukozidaz gibi karbonhidrat sindiriminde görev alan enzimlerin inhibisyonu ile glukoz emilimini geciktirmek/yavaşlatmaktır. Akarboz gibi güçlü α-amilaz ve α-glukozidaz inhibitörleri tip 2 diyabette postprandial hiperglisemiyi regüle etmede kullanılmakla birlikte bu inhibitörlerin hepatotoksisite gibi ciddi yan etkilere neden olması bir sorundur. Antosiyaninler pH, ışık, sıcaklık, sülfitler, oksijen, askorbik asit ve enzimlere karşı duyarlı moleküllerdir. Antosiyaninlerin stabilitesini artırmak için uygulanabilecek yaklaşımlardan biri antosiyanin protein kompleksi oluşturmaktır. Bu çalışmada öncelikle gıdalardaki başlıca antosiyaninlerden petunidin-3-O-glukozit (P3G), delfinidin-3-O-glukozit (D3G) ve malvidin-3-O-glukozit (M3G)'ın tip 2 diyabettte postprandial hiperglisemiyi kontrol etmede etkili olup olamayacağının bir ön analizi olarak *in slico* araçlar ile α-amilaz ve α-glukosidaz enzimlerini inhibe etme kapasitesi araştırılmıştır. Ayrıca antosiyaninlerin stabilitesini artırma amacıyla antosiyanin-protein kompleksi oluşturmak için moleküler kenetlenme kapasitesi lektin glikoproteini için araştırılmıştır. Karbonhidrat sindiriminde görev alan enzimlerin ve antosiyaninlerin moleküler kenetlenme analizi ile belirlenen bağlanma enerjileri sırasıyla α-amilaz ve α-glukosidaz olmak üzere P3G için -8,1 kcal/mol, -7,5 kcal/mol; D3G için -8,0 kcal/mol, -7,4 kcal/mol ve M3G için -7,9 kcal/mol, -7,5 kcal/mol olarak bulunmuştur. Her üç antosiyanin molekülünün α-amilaz ve α-glukozidaz için oldukça yüksek kenetlenme skorlarına sahip olduğu görülmektedir. Bu antosiyaninlerin lektin ile bağlanma enerjileri ise P3G, D3G ve M3G için sırasıyla -4,8 kcal/mol, -4,9 kcal/mol, -4,8 kcal/mol olarak bulunmuştur. *İn slico* çalışmanın sonuçlarının *in vitro* çalışmalarla doğrulanması amacıyla şarap üretiminde açığa çıkan atıklardan ekstrakte edilen antosiyaninlerin nohut unu, aquafaba ve nohut proteini izolatı ile *in vitro* koşullarda bağlanma analizi gerçekleştirilmiştir. *İn vitro* koşullarda protein-antosiyanin kompleksinde antosiyaninlerin bağlanma oranı ise %74,41±0,41 olarak bulunmuştur.

Anahtar Kelimeler: Tip 2 diyabet, delfinidin, petunidin, malvidin, moleküler kenetleme.

INVESTIGATION of *IN SLICO* BINDING CAPACITY OF SOME ANTHOCYANINS ON α-AMYLASE AND α-GLUCOSIDASE ACTIVITIES

ABSTRACT

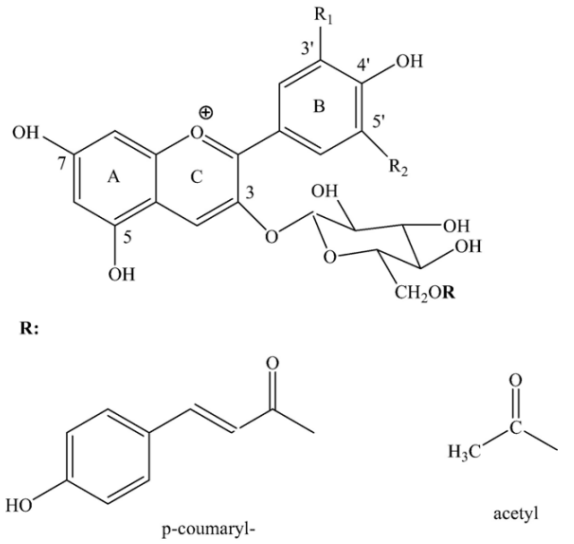
Type 2 diabetes is a metabolic disorder characterized by impaired insulin secretion, resistance to the peripheral action of insulin, or both, accompanied by metabolic disorders in lipids, proteins, salts, or electrolytes. Finding new antidiabetic medicines with fewer side effects has gained importance. For this reason, and in this context, benefiting from the antidiabetic effects of natural resources comes to the fore. Another approach is to delay or slow down glucose absorption by controlling the breakdown of starch or inhibiting enzymes involved in carbohydrate digestion such as α-amylase and α-glucosidase. Although α-amylase and α-glucosidase inhibitors such as acarbose are used to regulate postprandial hyperglycemia in type 2 diabetes, these inhibitors may cause serious adverse effects such as hepatotoxicity. Anthocyanins are molecules sensitive to pH, light, temperature, sulfides, oxygen, ascorbic acid, and enzymes. An approach to increase the stability of anthocyanins is to form an anthocyanin protein complex. This study aims to investigate the capacity of petunidin-3-O-glucoside (P3G), delphinidin-3-O-glucoside (D3G), and malvidin-3-O-glucoside (M3G), the major anthocyanins in foods, to inhibit α-amylase and α-glucosidase enzymes by *in slico* assays as a preliminary analysis of whether they could be effective in controlling postprandial hyperglycemia in type 2 diabetes. In addition, the molecular docking capacity for the formation of an anthocyanin protein complex to increase the stability of anthocyanins was investigated for the lectin glycoprotein. The free energy of binding of anthocyanins with the enzymes was found to be -8.1 kcal/mol, -7.5 kcal/mol for P3G, -8.0 kcal/mol, -7.4 kcal/mol for D3G, and -7.9 kcal/mol, -7.5 kcal/mol for M3G, α-amylase, and α-glucosidase, respectively. All three anthocyanin molecules exhibited high binding free energy for α-amylase and α-glucosidase. The binding energies of these anthocyanins for lectin were -4.8 kcal/mol, -4.9 kcal/mol, and -4.8 kcal/mol for P3G, D3G, and M3G, respectively. To verify the results of the *in slico* study with *in vitro* studies, binding analysis of anthocyanins extracted from the wastes of wine production with chickpea flour, aquafaba, and chickpea protein isolate was performed under *in vitro* conditions. The binding ratio of anthocyanins in protein-anthocyanins complex under *in vitro* conditions was 74.41±0.41%.

Keywords: Type 2 diabetes, delphinidin, petunidin, malvidin, molecular docking.

1. GİRİŞ

Bitkisel gıdalarla zenginleştirilmiş diyetler, sağlığın korunması ve bulaşıcı olmayan birçok hastalığın önlenmesi ile ilişkilendirilmektedir. Meyve ve sebze tüketiminin sağlık üzerindeki etkileri temel olarak vitamin ve mineraller de dahil olmak üzere mikro besin öğelerinin ve bitki ikincil metabolitleri olan polifenollerin varlığından kaynaklanmaktadır. Fenolik bileşiklerin en önemli sınıflarından biri, çilek, şeftali, erik, kırmızı soğan, mor mısır, patlıcanın yanı sıra mor havuç, tatlı patates ve kırmızı lahana gibi birçok gıdaya tipik mor-kırmızı rengi veren antosiyaninlerdir (Giampieri vd., 2023). Antosiyaninler (Yunanca'da çiçek anlamına gelen anthos ve koyu mavi anlamına gelen kyanos) meyve, sebze, çiçek ve tohumlarda bulunan suda çözünür doğal renk pigmentleridir. Kırmızı, mavi, mor ve turuncu dahil olmak üzere çeşitli renklerden sorumludurlar. Renk özellikleriyle ürünü daha çekici hale getirmenin yanı sıra sağlık açısından birçok olumlu etkiye sahip olması antosiyaninlere olan ilginin artmasına neden olmuştur (Ayvaz vd., 2023).

Antosiyaninler hidroksil ve metoksil sübstitüentlerinin sayısına ve konumuna bağlı olarak, yayınlarda altı tanesi meyve ve sebzelerde yaygın olarak bulunan yaklaşık bir düzine farklı antosiyanin tanımlanmıştır (de Pascual-Teresa ve Sanchez-Ballesta, 2008). Pelargonidin, siyanidin, delfinidin, peonidin, petunidin ve malvidin bitkilerde yaygın olarak bulunan altı antosiyanindir (Şekil 1) (Wu vd., 2023).



Antosiyanin	R_1	R_2
Siyanidin	OH	H
Delfinidin	OH	OH
Malvidin	OCH_3	OCH_3
Peonidin	OCH_3	H
Petunidin	OH	OCH_3
Pelargonidin	H	H

Şekil 1. Antosiyaninlerin genel yapısı (Corrales vd., 2008).

Antosiyaninlerin etkisi doğal renklendirici veya fonksiyonel bileşen olarak kullanılsalar bile insan vücudundaki biyoerişilebilirlik ve biyoyarayışlılıklarına bağlıdır (Wu vd., 2023). Özellikle antosiyanin içeren nutrasötiklerin ve antosiyanin içeren ve/veya antosiyanin eklenmiş fonksiyonel gıdaların sağlık üzerine etkilerinin değerlendirilmesinde antosiyanin biyoerişilebilriliği ve biyoyarayışlılığı önemlidir. Antosiyanin tüketiminin, çeşitli metabolik iz yollarıyla insülin direncini ve insülin sekresyonunu önleyerek antidiyabetik etki gösterdiği bilinse de bu etki başta biyoerişilebilirlik/biyoyarayışlılık olmak üzere çok sayıda faktöre (Şekil 2) bağlı olarak değişmektedir (Gowd vd., 2020). Antosiyaninlerin biyoyararlanımı son derece düşüktür. Yapılan çalışmalarda antosiyaninlerin *in vitro* biyoyararlanımı *in vivo* koşulardakine göre daha yüksek bulunmuştur. Bu nedenle antosiyaninlerin olası antidiyabetik etkisinden yararlanabilmek antosiyaninlerin stabilitesi ile yakından ilişkilidir. Antosiyaninlerin gıda işleme, depolama ve sindirim sırasında stabilitesini sağlayabilmek için geliştirilebilecek stratejiler arasında antosiyanin-protein kompleksi oluşturmak, antosiyanin enkapsülasyonu gibi yöntemlere kıyasla hem ekonomik hem de uygulama kolaylığı bakımından daha avantajlı gibi görünmektedir. Antosiyaninlerin protein ile kompleks oluşturması, antosiyaninleri gıda işleme, depolama ve sindirim sırasında antosiyaninlerin stabilitesini etkileyebilecek olan koşullara maruz kalmasını önleyebilir ve dolayısıyla antosiyanin biyoerişilebilirliği artabilir (Li vd., 2021). Antosiyanin ve süt proteinleri arasında oluşturulmuş komplekslerin stabilitesini araştıran çalışmalar mevcuttur. Bu çalışmalarda antosiyaninlerin ısı ve ışık stabilitelerinin arttığı gösterilmiştir (Ren vd., 2021). Kurubaklagil proteinleri, hayvansal protein kaynaklarına göre düşük olmakla birlikte sindirilirlikleri diğer protein kaynaklarına göre nispeten daha yüksek olan proteinlerdir.

Şekil 2. Antosiyanin stabilitesini dolayısıyla biyoerişilebilriliği ve biyoyarayışlılığı etkileyen faktörler (Castañeda-Ovando vd., 2009).

Tip 2 diyabet tedavisinde kullanılan akarbozun etki mekanizması karbonhidratların sindiriminde görev alan α-amilaz ve α-glukozidaz inhibisyonuna dayanmaktadır (Dong vd., 2022). Benzer etkiyi antosiyaninlerin de gösterebileceği belirtilmekte ancak antosiyaninlerin sindirim ortamındaki koşullar nedeniyle stabilitelerinin azalmasının en önemli kısıt olduğu belirtilmektedir. Bazı araştırmacılar, antosiyaninler tarafından nişasta sindirim enzimlerinin aktivitesinin engellendiğini bildirmişlerdir. Nişasta-antosiyaninler sistemindeki serbest antosiyaninler de nişasta sindirim enzimlerinin enzim aktivitelerini düşürerek nişasta sindirim hızının azalmasına katkıda bulunmuştur (Miao vd., 2021). Birçok çalışma, antosiyaninlerin veya antosiyanin açısından zengin gıda alımının yararlı olduğunu ve α-amilaz ve α-glukosidaz enzimlerinin etkili inhibisyonunun yanı sıra glukoz taşınmasına müdahale ederek postprandiyal glisemiyi baskıladığını göstermiştir (Oliveira vd.,2020).

Bu kapsamda, çalışmada öncelikle gıdalardaki başlıca antosiyaninlerden petunidin-3-O-glukozit (P3G), delfinidin-3-O-glukozit (D3G) ve malvidin-3-O-glukozit (M3G)'ın tip 2 diyabettte postprandial hiperglisemiyi kontrol etmede etkili olup olamayacağının bir ön analizi olarak *in slico* araçlar ile α-amilaz ve α-glukosidaz enzimlerini inhibe etme kapasitesinin saptanması, antosiyanin-protein kompleksi oluşumunun tahminlenmesi için bu antosiyaninlerin lektin glikoproteini ile moleküler kenetlenme kapasitesinin belirlenmesi ve şarap üretiminde açığa çıkan atıklardan ekstrakte edilen antosiyaninlerin nohut unu, aquafaba ve nohut proteini izolatı ile *in vitro* koşullarda bağlanma kapasitelerinin araştırılması amaçlanmıştır.

1. MATERYAL VE METOT

2.1.Materyaller

Üzüm cibresi Lucien Arkas Bağları (İzmir, Türkiye)'ndan, nohut unu İpek Değirmen (Amazon.com)'den, aquafaba Döhler Gıda Sanayi A.Ş. (İzmir.Türkiye)'den temin edilmiştir Metanol, hidroklorik asit, sodyum asetat, potasyum klorür Ege Üniversitesi Gıda Mühendisliği Beslenme laboratuvarından temin edilmiştir. Kimyasal reaktiflerin her biri analitik saflıkta kullanılmış ve çözeltiler saf su ile hazırlanmıştır.

2.2.Moleküler Kenetleme Analizi

Malvidin 3-O-Glikozit (M3G), Petunidin 3-O-Glikozit (P3G) ve Delfinidin 3-O-glikozidin (D3G) 3D yapısı PubChem veri tabanından, lektinin ve enzimlerin 3D yapısı ise Protein Veri Bankası (PDB)'ndan alınmıştır. Alınan yapılar kenetleme uygulanmasından önce Chimera 1.16 programı yardımıyla kenetlemeye hazır hale getirilmiştir. Chimera 1.16 programında moleküller 3D görünüme dönüştürülmüştür. Kenetleme, hazırlanan antosiyaninler ve proteinler arasında Autodock Vina programı kullanılarak gerçekleştirilmiştir (Eberhardt vd., 2021; Trott vd., 2010). Moleküller arasındaki bağlar ise PLIP uygulaması ile belirlenmiştir (Adasme vd., 2021).

2.3. Antosiyanin Ekstraksiyonu

Ekstraksiyon Wang vd., (2016)'ne göre bazı modifikasyonlar yapılarak gerçekleştirilmiştir. Ekstraksiyondan hemen önce, dondurulmuş posa rondo kullanılarak homojenize edilmiştir. Homojenize üzüm cibresi ve %70'lik metanol çözeltisi ile 50 ml'lik santrifüj tüplerinde 1:10 katı-çözgen oranında karıştırılmıştır. Karışım 35 kHz ultrasonik su banyosunda (Bandalin Sonorex Digiplus DL 512 H, 35 kHz, 30 °C ve 20 dakika) ekstrakte edilmiştir. Elde edilen ekstraktlar 10.000 g'de 4 C'de 15 dakika santrifüj edilmiş ve süpernatanttaki metanol vakumlu döner evaporatör aracılığıyla uzaklaştırılmıştır.

2.4. Nohut Proteini İzolatı Eldesi

Nohut proteini izolatı eldesi Karaca vd., (2011)'e göre bazı modifikasyonlarla gerçekleştirilmiştir. 100 g nohut unu 1:10 oranında saf su ile karıştırılmış ve karışımın pH'ı 1M NaOH kullanılarak 9'a ayarlanmıştır. Karışım 4000 g'de ve 4°C'de 20 dakika boyunca santrifüjlenmiştir. Ardından süpernatantlar toplanmış ve proteinleri çöktürmek amacıyla pH 4,6'ya ayarlanmıştır. Pelet sonraki analizlerde kullanılmak üzere dondurarak kurutulmuştur.

2.5. Toplam Monomerik Antosiyanin Konsantrasyonun Belirlenmesi

Toplam monomerik antosiyanin konsantrasyonu Lee vd. (2005) tarafından gerçekleştirilen pH diferansiyel metodu ile saptanmıştır. Ekstrakt pH 1 ve pH 4,5 tamponları ile karıştırılmış sonrasında her birinin absorbansı hem 520 nm'de hem de 700 nm'de ölçülmüştür.

2.6. Antosiyanin-Protein Komplekslerinin Oluşturulması

Kompleksler Xiong vd., (2020) ve Zhao vd., (2020) tarafından önerilen yöntemlerde bazı modifikasyonlar yapılarak gerçekleştirilmiştir. Komplekslerde nohut unu, aquafa ve nohut proteini izolatı protein kaynağı olarak kullanılmıştır. Protein ile kompleksleşme %10 (w/v) protein kaynağının antosiyanin ekstraktına eklenmesiyle (protein: antosiyanin, 1:9 (v/w)) gerçekleştirilmiştir. Karışım yarım saat boyunca karıştırılmış ardından 10 dakika boyunca 35 kHz'de ultrasonik su banyosunda tutulmuştur. Oluşturulan kompleksler buzdolabında 2 gün bekletilmiştir. Ardından 20 dakika boyunca 8000×g'de santrifüjlenmiştir. Elde edilen pelet protein antosiyanin kompleksini içermektedir. Antosiyanin bağlanma oranı süpernatantta kalan antosiyaninlerin pH diferansiyel yöntemi ile tespiti sonrasında aşağıdaki formülle hesaplanmıştır.

$$\text{Antosiyanin konsantrasyonu (siyanidin 3 glukozit eşdeğeri, mg/L)} = \frac{A \; x \; M_w \; x \; DF \; x10^3}{\varepsilon \; x \; 1}$$

A: = ($A_{520nm} - A_{700nm}$) pH 1.0 – ($A_{520nm} - A_{700nm}$) pH 4.5;

M_w: 449,2 g/mol (Siyanidin-3-glukozit için moleküler ağırlık)

DF: Seyretme faktörü

10^3= g'dan mg'a dönüştürme faktörü

ε: 26900 $\frac{L}{mol \; x \; cm}$ (Siyanidin-3-glukozit için molar ekstinksiyon katsayısı)

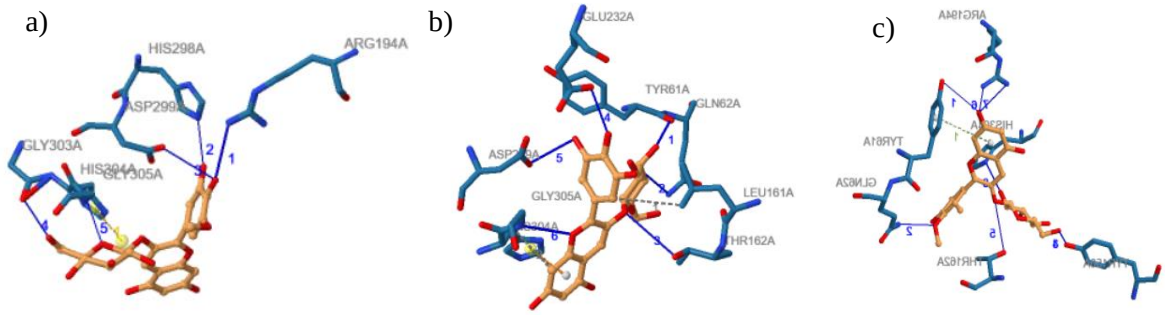
1: Işın yolu uzunluğu (cm)

3. BULGULAR VE TARTIŞMA

3.1. Moleküler Kenetleme Analizi

Moleküler kenetleme analizi ile deneysel veriler hesaplamalı modellerle birleştirilerek, bağlanma etkileşimlerinde yer alan fonksiyonel grupların ve moleküler kuvvetlerin doğası hakkında ayrıntılı bilgi elde etmek mümkündür (Guo vd., 2022). Karbonhidrat sindiriminde görev alan enzimlerin ve antosiyaninlerin moleküler kenetlenme analizi ile belirlenen

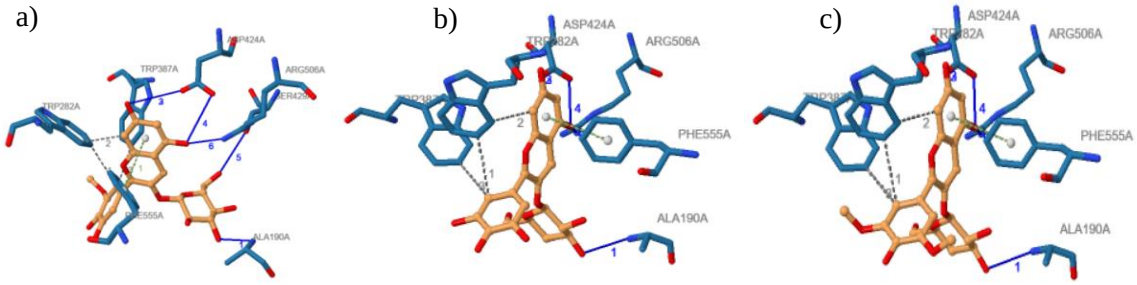
bağlanma enerjileri sırasıyla α-amilaz ve α-glukosidaz olmak üzere P3G için -8,1 kcal/mol, -7,5 kcal/mol; D3G için -8,0 kcal/mol, -7,4 kcal/mol ve M3G için -7,9 kcal/mol, -7,5 kcal/mol olarak bulunmuştur (Tablo 1). Her üç antosiyanin molekülünün α-amilaz ve α-glukozidaz için oldukça yüksek kenetlenme skorlarına sahip olduğu görülmektedir. P3G, D3G ve M3G'nin α-amilaza α-glukozidaza göre daha yüksek düzeyde kenetlendiği görülmektedir. α-Amilaz ve D3G arasında hidrofobik etkileşim, hidrojen bağları ve π-katyon etkileşimleri olduğu görülmüştür. Bu bağlanmada LEU161A ve HIS304A hidrofobik etkileşimlere, TYR61A, GLN61, THR162A, GLU232A, ASP299A ve GLY305A hidrojen bağlarına ve HIS304A π-katyon etkileşimlerine katılmıştır (Şekil 3). α-Amilaz ve P3G arasında hidrojen bağları ve tuz köprüleri olduğu belirlenmiştir. Hidrojen bağlarına ARG194A, HIS298A, ASP299A, GLY303A ve GLY30A, tuz köprüleri ise HIS304A katılmıştır. α-Amilaz ve M3G arasında ise π-π etkileşimi (dik) ve hidrojen bağları saptanmıştır. Hidrojen bağlarının M3G ve TYR61A, GLN62A, TYR150A, THR162A, ARG194A ve HIS304A arasında olduğu, π-π etkileşimlerinin ise TYR61A ile M3G arasında gerçekleştiği görülmektedir.



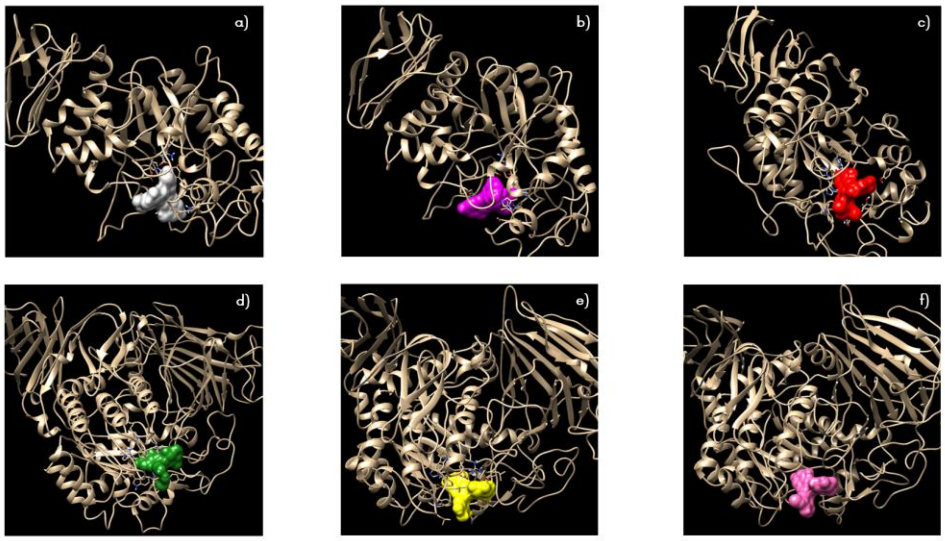
Şekil 3. α-Amilaz ve antosiyaninler arasındaki bağlar. a) α-Amilaz ve P3G, b) α-Amilaz ve D3G, c) α-Amilaz ve M3G.

α-Glukozidaz ve P3G arasında hidrofobik etkileşimler, hidrojen bağları π-π etkileşimleri olduğu görülmektedir. TRP282A ve TRP387A hidrofobik etkileşimlere, ALA190A, ASP424A, SER429A ve ARG508A hidrojen bağlarına ve PHE555A ise π-π etkileşimlere katılmıştır (Şekil 4). α-Glukozidaz ve D3G arasında yine hidrofobik etkileşimler, hidrojen bağları π-π etkileşimleri olduğu görülmektedir ancak TRP282A ve TRP387A hidrofobik

etkileşimlere, ALA190A, ASP424A, ARG506A hidrojen bağlarına ve PHE555A ise π-π etkileşimlere katılmıştır. α-Glukozidaz ve M3G arasında da her iki antosiyanine benzer olarak hidrofobik etkileşimler, hidrojen bağları π-π etkileşimleri olduğu belirlenmiştir. TRP282A ve TRP387A hidrofobik etkileşime, ALA190A, ASP424A ve ARG506A hidrojen bağlarına ve PHE555A ise π-π etkileşimlere katılmıştır. α-Glukozidazın üç antosiyaninle de benzer bağlar yaptığı görülmektedir. Şekil 5'te ise antosiyaninlerin α- amilaz ve α-glukosidaz enzimlerini bağlama görüntüleri yer almaktadır.

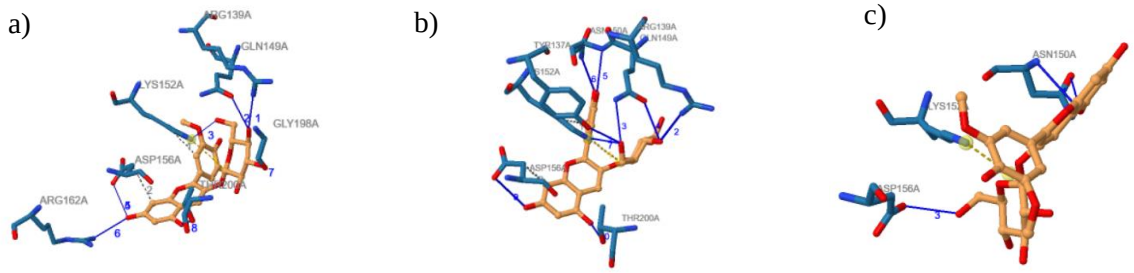


Şekil 4. α-Glukosidaz ve antosiyaninler arasındaki bağlar. a) α- Glukosidaz ve P3G, b) α-Glukosidaz ve D3G, c) α-Glukosidaz ve M3G.



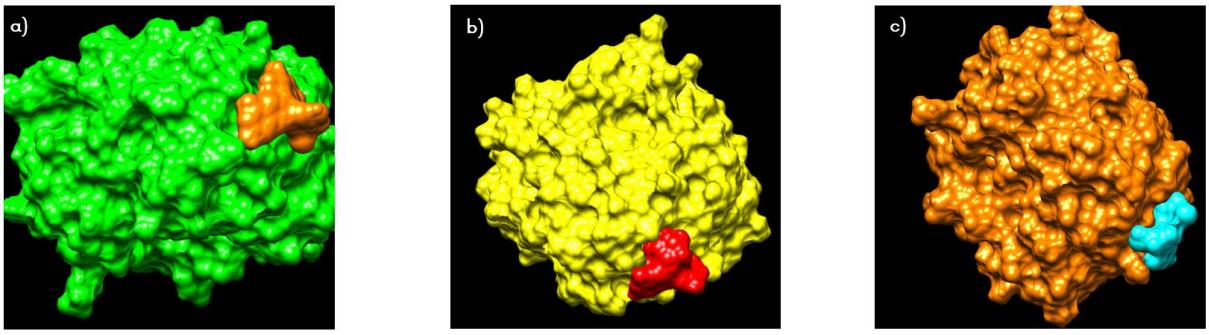
Şekil 5. α-Amilaz ve α-Glukosidaz'ın antosiyaninlerle moleküler kenetlenme ile bağlanması. *a) α-Amilaz - P3G, b) α-Amilaz – D3G, c) α-Amilaz - M3G, d) α-Glukosidaz – P3G, e) α-Glukosidaz – D3G, f) α-Glukosidaz – M3G.*

Lektin seçilmesinin nedeni çalışmada kullandığımız nohut proteinlerden birisinin lektin olmasıdır. Bağlanma bölgesi, protein ya da enzim molekülündeki koordinatların ortalaması alınarak bulunmuştur. Lektin ve bahsi geçen ve antosiyaninlerin moleküler kenetlenme analizi ile belirlenen bağlanma enerjileri lektin ve P3G için -4,8 kcal/mol; D3G için -4,9 kcal/mol ve M3G için -4,8 kcal/mol olarak bulunmuştur (Tablo 1). Lektinin ve üç farklı antosiyanin ile benzer bağlanma kapasitesine sahip olduğu belirlenmiştir. Lektin ve P3G arasında hidrofobik etkileşimler, hidrojen bağları ve tuz köprüleri olduğu saptanmıştır. LYS152A ve ASP156A hidrofobik etkileşimlere, ARG139A, GLN149A, LYS152A, ASP156A, ARG162A, GLY198A ve THR200A hidrojen bağlarına ve LYS152A tuz köprülerine katılmıştır (Şekil 6). Lektin ve D3G arasında da benzer olarak hidrofobik etkileşimler, hidrojen bağları ve tuz köprüleri olduğu görülmektedir. LYS152A ve ASP 156A hidrofobik etkileşimlere, TYR137A, AGR139A, GLN149A, ASN150A, LYS152A, ASP156A ve THR200A hidrofobik bağlara, LYS152 ise tuz köprülerine katılmıştır. Lektin ve M3G arasında ise hidrojen bağları ve tuz köprüleri görülmektedir. 150A ve 156A hidrojen bağlarına LYS152 ise tuz köprülerine katıldığı saptanmıştır. Genel olarak lektin ve antosiyaninler arasında hidrojen bağlarının baskın olduğu söylenebilir. Şekil 7'te P3G, M3G ve D3G ile lektin arasında yer alan bağlanma görüntüleri yer almaktadır.



Şekil 6. Lektin ve antosiyaninler arasındaki bağlar. a) Lektin ve P3G, b) Lektin ve D3G, c) Lektin ve M3G.

Moleküler kenetlenme analizi antosiyaninler ve proteinler arasındaki bağlanma, kovalent olmayan bağlanma yoluyla gerçekleşmektedir. Hidrojen bağları ve hidrofobik etki, antosiyanin-protein komplekslerinin ana güçleridir. Özellikle güçlü hidrojen bağları, antosiyanin-protein kompleksini daha da stabilize edebileceği bilinmektedir (Zang vd., 2022).



***Şekil** 7.* Lektin ve antosiyaninler arasında moleküler kenetlenme ile bağlanma. *a) Lektin - P3G, b) Lektin – D3G, c) Lektin – M3G.*

Tablo 1. Karbonhidrat sindiriminde görev alan enzimler, lektin ve bazı antosiyaninlerin moleküler kenetlenme analizi ile belirlenen bağlanma enerjileri (kcal/mol).

Protein/Ligand	Delfinifin 3-O-Glukozit	Petunidin 3-O-Glukozit	Malvidin 3-O-Glukozit
	-4,9	-4,8	-4,8
α-Amilaz	-8,0	-8,1	-7,9
α-Glukosidaz	-7,4	-7,5	7,5

3.2. Antosiyanin- Protein Komplekslerinin Oluşturulması

Şarap üretiminden atık olarak çıkan üzüm cibresindeki toplam monomerik antosiyanin konsantrasyonu 6,82 ±0,61 mg/100g olarak bulunmuştur. Nohut ununda elde edilen protein izolatının protein miktarı ise %73,18±1,76 olarak saptanmıştır (Tablo 2).

Antosiyanin-protein komplekslerinde antosiyanin bağlanma yüzdesi her protein kaynağı için farklı bulunmuştur. Nohut unu-antosiyanin kompleksindeki bağlanma yüzdesi %67,23±2,98, aquafaba-antosiyanin kompleksindeki bağlanma yüzdesi %56,62±5,04, protein izolatı-antosiyanin kompleksindeki bağlanma yüzdesi ise %74,41±0,41 olarak bulunmuştur (Tablo 2). Antosiyaninler ile en iyi bağlanmanın nohut proteini izolatı tarafından gerçekleştiği görülmektedir. Bu da izolattaki protein miktarının fazla olmasından kaynaklanıyor olabilir.

Tablo 2. Antosiyanin-protein komplekslerinin oluşturulması.

Protein Kaynağı	Protein miktarı (%)	Peletteki antosiyanin
Nohut unu	21,05±0,15	67,23±2,98
Aquafaba	25,12±0,026	56,62±5,04
Nohut proteini izolatı	73,18±1,76	74,41±0,41

Protein içeren fonksiyonel gıdaları ve nutrasötik bileşenleri kasıtlı olarak formüle etmek için bu kararlı bağlanma fenomeninden daha fazla yararlanılmak istenmektedir. Antosiyaninlerin stabilitesini arttırmak için uygulanabilecek yaklaşımlardan biri proteinlerle kompleks oluşturmaktır. Diyet proteinlerine bağlanan antosiyaninler, gelişmiş oksidatif, renk ve termal stabilite ve raf ömrü sergilerler. Aynı zamanda bağırsak sindirimi sürecinde bozulmaya karşı daha iyi korunma eğilimindedirler (Wu vd., 2023). Bitki proteini ve antosiyaninler arasındaki kovalent ve kovalent olmayan bağlar, antosiyaninlerin bozulmasını önleyebilmektedir. Bitki proteinleri ile kovalent konjuge olan antosiyaninler, proteinlerin ikincil yapısını ve üçüncül yapısını değiştirerek proteinlerin stabilitesini ve emilimini arttırabilir. Hidrojen bağları ve hidrofobik etki, antosiyanin-protein komplekslerinin ana güçleridir. Hidrofobik etkileşim esas olarak alifatik protein, aromatik amino asitler ve antosiyaninlerin benzen halkası arasında gerçekleşir. Özellikle güçlü hidrojen bağları, antosiyanin-protein kompleksini daha da stabilize edebilir (Zang vd., 2022).

4. SONUÇ

Bu çalışmada, karbonhidrat sindiriminde görev alan α-amilaz ve α-glukosidaz enzimleri ile antosiyaninler arasında moleküler kenetleme analizi gerçekleştirilmiştir. Kenetleme analizi sonuçları, bu enzimlerin antosiyaninler tarafından inhibe edilebilme kabiliyetinin oldukça iyi olduğu göstermektedir. P3G, D3G ve M3G'nin α-amilaza α-glukozidaza göre daha yüksek düzeyde kenetlendiği görülmektedir. En düşük kenetlenme skoru P3G ile α-Amilaz arasındadır ve bu değer -8,1 kcal/mol'dür. Ayrıca oldukça duyarlı olan antosiyaninlerin stabilitesini koruyabilmesi adına proteinlerle olan kompleks oluşturma yatkınlığına da bakılmış olup kenetleme analizi sonuçları ile pH diferansiyel metodu ile yapılan sonuçlar örtüşmektedir. Özellikle nohut proteini izolatının antosiyaninlerle kompleksleşme isteği oldukça yüksektir ve proteinle bağlanan antosiyanin yüzdesi %74,41±0,41'dir. Bu bulgular

ile ileriki çalışmalarımızda antosiyanin-protein komplekslerinin bu enzimleri ne derecede inhibe edebileceği araştırılacak ve tip 2 diyabet için olası etkisi akarboz ile kıyaslanacaktır.

REFERANSLAR

Adasme, M. F., Linnemann, K. L., Bolz, S. N., Kaiser, F., Salentin, S., Haupt, V. J., & Schroeder, M. (2021). PLIP 2021: Expanding the scope of the protein–ligand interaction profiler to DNA and RNA. Nucleic acids research, 49(W1), W530-W534.

Ayvaz, H., Cabaroglu, T., Akyildiz, A., Pala, C. U., Temizkan, R., Ağçam, E., ... & Diaconeasa, Z. (2022). Anthocyanins: Metabolic digestion, bioavailability, therapeutic effects, current pharmaceutical/industrial use, and innovation potential. Antioxidants, 12(1), 48.

Castañeda-Ovando, Araceli, Pacheco-Hernández, Ma, de Lourdes, Páez.-Hernández, Elena, Ma, Rodríguez, José A., & GalánVidal, Carlos Andrés (2009). Chemical studies of anthocyanins: A review. Food Chemistry, 113(4), 859–871.

Corrales, M., Toepfl, S., Butz, P., Knorr, D., & Tauscher, B. (2008). Extraction of anthocyanins from grape by-products assisted by ultrasonics, high hydrostatic pressure or pulsed electric fields: A comparison. Innovative Food Science & Emerging Technologies, 9(1), 85-91.

de Pascual-Teresa, S., & Sanchez-Ballesta, M. T. (2008). Anthocyanins: from plant to health. Phytochemistry reviews, 7, 281-299.

Dong, Y., Sui, L., Yang, F., Ren, X., Xing, Y., & Xiu, Z. (2022). Reducing the intestinal side effects of acarbose by baicalein through the regulation of gut microbiota: An in vitro study. Food Chemistry, 394, 133561.

Eberhardt, J., Santos-Martins, D., Tillack, A. F., & Forli, S. (2021). AutoDock Vina 1.2. 0: New docking methods, expanded force field, and python bindings. Journal of chemical information and modeling, 61(8), 3891-3898.

Giampieri, F., Cianciosi, D., Alvarez-Suarez, J. M., Quiles, J. L., Forbes-Hernández, T. Y., Navarro-Hortal, M. D., ... & Diaz, Y. A. (2023). Anthocyanins: what do we know until now?. Journal of Berry Research, 13(1), 1-6.

Gowd, V., Karim, N., Xie, L., Shishir, M., Xu, Y., Chen, W. (2020). In vitro study of bioaccessibility, antioxidant, and αglucosidase inhibitory effect of pelargonidin-3-O-glucoside after interacting with beta-lactoglobulin and chitosan/pectin, International Journal of Biological Macromolecules, 154:380-389.

Guo, Z., Huang, Y., Huang, J., Li, S., Zhu, Z., Deng, Q., & Cheng, S. (2022). Formation of protein-anthocyanin complex induced by grape skin extracts interacting with wheat gliadins: Multi-spectroscopy and molecular docking analysis. Food Chemistry, 385, 132702.

Karaca, A. C., Low, N., & Nickerson, M. (2011). Emulsifying properties of chickpea, faba bean, lentil and pea proteins produced by isoelectric precipitation and salt extraction. Food research international, 44(9), 2742-2750.

Lee, J., Durst, R. W., Wrolstad, R. E., & Collaborators: Eisele T Giusti MM Hach J Hofsommer H Koswig S Krueger DA Kupina; S Martin SK Martinsen BK Miller TC Paquette F Ryabkova A Skrede G Trenn U Wightman JD. (2005). Determination of total monomeric anthocyanin pigment content of fruit juices, beverages, natural colorants, and wines by the pH differential method: collaborative study. Journal of AOAC international, 88(5), 1269-1278.

Li, J., Wang, B., He, Y., Wen, L., Nan, H., Zheng, F., ... & Zhang, H. (2021). A review of the interaction between anthocyanins and proteins. Food Science and Technology International, 27(5), 470-482.

Miao, L., Xu, Y., Jia, C., Zhang, B., Niu, M., & Zhao, S. (2021). Structural changes of rice starch and activity inhibition of starch digestive enzymes by anthocyanins retarded starch digestibility. Carbohydrate Polymers, 261, 117841.

Oliveira, H., Fernandes, A., F. Brás, N., Mateus, N., de Freitas, V., & Fernandes, I. (2020). Anthocyanins as antidiabetic agents—in vitro and in silico approaches of preventive and therapeutic effects. Molecules, 25(17), 3813.

Ren, S., Jiménez-Flores, R., & Giusti, M. M. (2021). The interactions between anthocyanin and whey protein: A review. Comprehensive Reviews in Food Science and Food Safety, 20(6), 5992-6011.

Trott, O., & Olson, A. J. (2010). AutoDock Vina: improving the speed and accuracy of docking with a new scoring function, efficient optimization, and multithreading. Journal of computational chemistry, 31(2), 455-461.

Wang, W., Jung, J., Tomasino, E., & Zhao, Y. (2016). Optimization of solvent and ultrasound-assisted extraction for different anthocyanin rich fruit and their effects on anthocyanin compositions. LWT-Food Science and Technology, 72, 229-238

Wu, Y., Han, T., Lyu, L., Li, W., & Wu, W. (2023). Research progress in understanding the biosynthesis and regulation of plant anthocyanins. Scientia Horticulturae, 321, 112374.

Xiong, J., Chan, Y. H., Rathinasabapathy, T., Grace, M. H., Komarnytsky, S., & Lila, M. A. (2020). Enhanced stability of berry pomace polyphenols delivered in protein-polyphenol aggregate particles to an in vitro gastrointestinal digestion model. Food chemistry, 331, 127279.

Zang, Z., Tang, S., Li, Z., Chou, S., Shu, C., Chen, Y., ... & Li, B. (2022). An updated review on the stability of anthocyanins regarding the interaction with food proteins and polysaccharides. Comprehensive Reviews in Food Science and Food Safety, 21(5), 4378- 4401.

Zhao, C., Miao, Z., Yan, J., Liu, J., Chu, Z., Yin, H., Zheng, M., & Liu, J. (2022). Ultrasound-induced red bean protein–lutein interactions and their effects on physicochemical properties, antioxidant activities and digestion behaviors of complexes. LWT, 160.

PESTİSİTLERE MARUZ KALMANIN BAL ARILARI ÜZERİNDEKİ OLUMSUZ ETKİLERİNİ AZALTMAYA YÖNELİK STRATEJİLER VE TEKNİKLER

Öğr. Gör. Zeynep ASUTAY (ORCID: 0000-0002-5854-1040)
Bitlis Eren University, Vocational School of Hizan, Department of Plant and Animal Production, Bitlis-Türkiye
Email: zeynpyn@gmail.com

ÖZET

Dünya çapında gıda, lif ve yakıt üretimini desteklemek amacıyla zararlıları, bitki hastalıklarını ve yabani otları kontrol altına almak amacıyla her yıl tarım arazilerine milyarlarca kilogram pestisit uygulanmaktadır. Dünya çapında gıda, lif ve yakıt üretimini desteklemek amacıyla zararlıları, bitki hastalıklarını ve yabani otları kontrol altına almak amacıyla her yıl tarım arazilerine milyarlarca kilogram pestisit uygulanmaktadır. Bu tarlalar ticari açıdan en önemli tozlaştırıcı olan ve birçok tarımsal ürünün verimini ve kalitesini artıran bal arısına (Apis spp.) ev sahipliği yapmaktadır. Bitki sağlığını geliştirmek için kullanılan pestisitler arı sağlığını etkileyebilmektedir. Pestisit kullanımı ile bal arılarına bağımlılık arasındaki çatışma, dünya çapında bal arısı kolonilerinde önemli kayıplara yol açmıştır. Bal arıları üzerindeki etkilerin azaltılmasına yönelik tavsiyeler literatürde, pestisit düzenlemelerinde ve ürün danışmanları tarafından sıklıkla önerilmektedir, ancak bal arısı korumasının gerçekçi sınırları hakkında ayrıntılı bir tartışma bulunmamaktadır. Dünya çapında gıda, lif ve yakıt üretimini desteklemek amacıyla zararlıları, bitki hastalıklarını ve yabani otları kontrol altına almak amacıyla her yıl tarım arazilerine milyarlarca kilogram pestisit uygulanmaktadır. Bu tarlalar ticari açıdan en önemli tozlaştırıcı olan ve birçok tarımsal ürünün verimini ve kalitesini artıran bal arısına (Apis spp.) ev sahipliği yapmaktadır. Bitki sağlığını geliştirmek için kullanılan pestisitler arı sağlığını etkileyebilmektedir. Pestisit kullanımı ile bal arılarına bağımlılık arasındaki çatışma, dünya çapında bal arısı kolonilerinde önemli kayıplara yol açmıştır. Bal arıları üzerindeki etkilerin azaltılmasına yönelik tavsiyeler literatürde, pestisit düzenlemelerinde ve ürün danışmanları tarafından sıklıkla önerilmektedir, ancak bal arısı korumasının gerçekçi sınırları hakkında ayrıntılı bir tartışma bulunmamaktadır. Tarım ve arıcılıktaki yeni teknikler, arıların maruziyetini azaltarak, pestisitlerin toksisitesini düşürerek ve maruziyete yanıt olabilecek çareler sunarak pestisit maruziyetini azaltabilir. Ancak bu yeni teknikler sistematik ve kapsamlı bir çerçevede değerlendirilmezse, arıları pestisit zararlarından koruma potansiyellerini olduğundan fazla veya eksik gösterebilir. Bu incelemede hem tarımda hem de arıcılıkta pestisit azaltma uygulamalarının geliştirilmesini ve uygulanmasını kolaylaştırmak için mevcut ve yeni ortaya çıkan strateji ve teknikleri özetlemektedir.

Anahtar Kelimeler: Bal Arısı, Pestisit, Tarım, Arı Sağlığı, Arıcılık

DEVELOPMENT OF STRATEGIES TO REDUCE THE NEGATIVE EFFECTS OF PESTICIDES IN HONEY BEES

ABSTRACT

Billions of kilograms of pesticides are applied to farmland each year to control pests, plant diseases and weeds to support food, fibre and fuel production worldwide. Billions of kilograms of pesticides are applied to farmland each year to control pests, plant diseases and weeds to support food, fibre and fuel production worldwide. These fields are home to the honey bee (Apis spp.), the most commercially important pollinator, which increases the yield and quality of many agricultural crops. Pesticides used to improve plant health can affect bee health. The conflict between pesticide use and dependence on honey bees has led to significant losses of honey bee colonies worldwide. Recommendations to reduce impacts on honey bees are often suggested in the literature, in pesticide regulations and by crop advisors, but there is no detailed discussion on the realistic limits of honey bee protection. Billions of kilograms of pesticides are applied to farmland each year to control pests, plant diseases and weeds to support food, fibre and fuel production worldwide. These fields are home to the honey bee (Apis spp.), the most commercially important pollinator, which increases the yield and quality of many agricultural crops. Pesticides used to improve plant health can affect bee health. The conflict between pesticide use and dependence on honey bees has led to significant losses of honey bee colonies worldwide. Recommendations to reduce impacts on honey bees are often suggested in the literature, in pesticide regulations and by crop advisors, but there is no detailed discussion on the realistic limits of honey bee protection. New techniques in agriculture and beekeeping can reduce pesticide exposure by reducing exposure of bees, lowering the toxicity of pesticides and providing remedies that can respond to exposure. However, if these new techniques are not evaluated in a systematic and comprehensive framework, they may over- or underestimate their potential to protect bees from pesticide harm. This review summarises existing and emerging strategies and techniques to facilitate the development and implementation of pesticide mitigation practices in both agriculture and beekeeping.

Keywords: Honey bee, Pesticide, Agriculture, Bee health, Beekeeping

Giriş

Arılar, dünyanın gıda tedariki açısından son derece önemlidir. İnsanlar tarafından tüketilen gıda ürünlerinin yaklaşık %70'ine uygun, güvenilir tozlaşma hizmetleri sunarak tahmini 170 milyar dolarlık bir değere katkıda bulunmaktadır (Calderone, 2012; Gallai et al., 2009; Klein et al., 2007). Artan küresel nüfus, tarımsal ürünlere yönelik talebin artmasıyla tarımın bal arılarının tozlaşmasına daha fazla bağımlı hale gelmesine neden olmuştur. Ancak, ABD ve Avrupa'daki yüksek koloni ölüm oranları, pestisitlere maruz kalma da dahil olmak üzere çeşitli stres faktörleri nedeniyle (%30'a kadar) bu bağımlılığı tehdit etmektedir (Gray et al., 2020; Neumann and Carreck, 2010; Potts et al., 2010; vanEngelsdorp and Meixner, 2010).

Pestisitlerin akut toksisitesi, bal arılarını hemen öldürebilir ve insektisitler, genellikle akut toksisiteye neden olan diğer pestisit türlerinden daha toksiktir (Ulziibayar and Jung, 2019). Ancak, bazı herbisit ve fungisitlerin laboratuvar testlerinde larva ölümlerini artırdığı, yetişkin arıların ömrünü azalttığı ve diğer pestisitlerle birleştirildiğinde sinerjik etkilere neden olabileceği gösterilmiştir (Wade et al., 2019). Mitisitler genellikle bal arıları için güvenli kabul edilir, ancak bazı sentetik mitisitlerin yetişkin arı sağlığını etkileyebileceği ve yavru ölümlerine neden olabileceği bilinmektedir (Jack and Ellis, 2021).

Pestisitlere kronik maruziyet, bal arısı sağlığını tehlikeye atabilir ve çeşitli etkilerle sonuçlanabilir, bu da diyet kalitesini azaltabilir, hastalıklara duyarlılığı artırabilir ve bağışıklık fonksiyonunu etkileyebilir (Milone et al., 2021; Schuehly et al., 2021). Pestisit uygulamasının temel amacı, mahsul alanlarında haşere kontrolü sağlamaktır. Ancak, pestisit kullanımının azaltılması çiftçiler, arıcılar ve genel halkın hedefidir, ancak bu, pestisitlere olan bağımlılığın kısa vadede tersine çevrilemeyeceği anlamına gelmektedir (Sharma et al., 2019). Bu nedenle, arıcılar, çiftçiler ve pestisit uygulayıcıları için yeni çözümlerin geliştirilmesi gerekmektedir. Bildiride, bal arılarının pestisit maruziyetini azaltmak için mevcut veya gelişmekte olan strateji ve teknikler özetlenmektedir. Bu stratejiler pestisit maruziyetinin kesilmesi, pestisit kullanımının azaltılması ve pestisit kalıntılarının azaltılması gibi alanlarda yoğunlaşmaktadır. Amacımız, uygun pestisit uygulamasına ve bal arıları üzerindeki olumsuz etkilerini azaltmak için yeni tekniklerin benimsenmesine ve geliştirilmesine ilham vermektir.

2. Pestisite Maruz Kalma Yolları

2.1 Sahada Maruz Kalma

Pestisitler, genellikle tarla ürünlerinde haşere kontrolü için kullanılır ve bu ürünlerin çiçek açtığı dönemler, bal arıları için önemli beslenme alanları haline gelir (Durant et al., 2021). Yem arayan arılar, doğrudan bir tarlaya püskürtüldüklerinde veya işlenmiş tohumlar ekildiğinde pestisitlere maruz kalabilirler. Bu pestisitlerin tohum ekiminden kaynaklanan sprey ve tozları, yakındaki tarlalara da taşınabilir ki bu tarlalar da arıların beslenme alanlarıdır. Ek olarak, bal arıları kontamine polen ve nektarı toplayıp tüketerek oral maruziyete neden olurlar. Bu temas ve oral maruziyet, toplayıcılar için akut toksisiteye yol açabilir. Pestisit kullanımından sonra ise kalıcı pestisit kalıntıları, bal arılarının kovanlarında ve yavrularını beslerken veya saklarken kontamine nektar, polen ve su toplamaları durumunda kronik toksisiteye neden olabilir (Shawki et al., 2010).

Toksik insektisitler arasında neonikotinoid tohum ilaçları, yüksek toksisiteleri ve özellikle soya fasulyesi, mısır ve kanola gibi ana ekim sistemlerinde yaygın kullanılmaları nedeniyle bal arısı sağlığı için ciddi bir endişe kaynağıdır (Dainese et al., 2019; Douglas et al., 2020; Simon-Delso et al., 2014). Bal arıları, neonikotinoidlere özellikle işlenmiş tohum ekimi sırasında yayılan tozlar yoluyla maruz kalırken, bitkilerdeki sistematik pestisitlerin çiçeklerde kalıcı kalıntılar bırakması ve tohum işleminin neden olduğu sızıntılar ve akıntılar aracılığıyla kirlenmiş suyun da bir maruziyet kaynağı olduğu belirlenmiştir (Girolami et al., 2013; Krupke et al., 2012; Krupke and Long, 2015).

2.2 Arı Kovanlarında Maruz Kalma

Tarlacı arılar, kontamine gıdaları kovanlara geri getirdiklerinde, bu durum kolonide akut veya kronik zehirlenmelere neden olabilir. Gıda paylaşımı ve iletişimin önemli bir unsuru olan trophallaxis yoluyla veya kontamine gıdanın depolanması yoluyla, tüm koloni pestisitlerle temas edebilir ve zarar görebilir (Murcia Morales et al., 2020; Sponsler and Johnson, 2017). Ana arılar ve gelişmekte olan larvalar arı sütü ile beslense de, düşük seviyelerdeki pestisit kalıntıları dönüşüm yoluyla bu bireylere geçebilir ve olumsuz etki yaratabilir (Böhme et al., 2017; Milone et al., 2021). Kontamine polen ve nektar, balmumu peteğinde depolandıktan sonra, pestisitler balmumu tarafından emilebilir. Daha sonra,

olgunlaşmamış arılar ve depolanmış yeni arı gıdaları bu pestisitlere maruz kalacaktır çünkü kontamine balmumu ile temas halinde olacaklardır (Wu et al., 2011).

Pestisitler arıcılar tarafından sıklıkla Parazitik akar (Varroa destructor), trakeal akar, küçük kovan böceği, balmumu güvesi ve Nosema gibi zararlıları veya parazitleri kontrol etmek amacıyla uygulanır (Bartlett, 2022). Arı kovanlarının kapalı olması nedeniyle, tüm arılar, depolanan gıda ve balmumu, uygulama sırasında ve sonrasında temas ve oral yollarla pestisitlere maruz kalabilmektedir. Varroa akarı, dünya genelinde bal arıları için en yaygın ve zararlı haşerdir, bu nedenle bir mitisit uygulamak arıcılık için rutin bir uygulama haline gelir ve arıcılık uygulamasında pestisit maruziyetinin ana kaynağıdır (Fulton et al., 2019; Mullin et al., 2010; Traynor et al., 2021a).

3.Maruziyeti Azaltmak İçin Geleneksel Öneriler

3.1. Sahada

3.1.1 Ürün Etiketi Politikası, Çiftçiler Ve Pestisit Uygulayıcıları

Pestisit spreyi, bal arılarına yüksek dozda temas edebileceği için kısa sürede akut toksisiteye neden olabilir. Bu nedenle, alınması gereken önlemler çiftçilerin veya pestisit uygulayıcılarının çabalarıyla, spreyin arıların yiyecek arama faaliyetleriyle çakışmasını önleyerek temas maruziyetini azaltmaya odaklanmalıdır. Önlemenin ilk seviyesi, devlet kurumları veya yönetmelikler aracılığıyla etiketleme gerekliliklerinde belirtilmelidir. Bu gereklilikler, toksik pestisit kullanımını bal arıları varken önlemek veya çiçeklenme sırasında ve doğrudan arı kovanlarına püskürtülmemesini sağlamak şeklinde olabilir (Durant, 2021). Ancak, bu tavsiyeler, geniş pestisit kullanımının ve bal arısı tozlaşmasının kaçınılmaz olduğu büyük ölçekli mahsullerde sprey planının ayarlanmasındaki zorluklar nedeniyle yakından takip edilemeyebilir (Durant et al., 2021; Wade et al., 2019).

3.1.2. Koloni Yönetimi Ve Arıcılık

Bal arısı kovanlarını hedef ürün alanından uzaklaştırmak, pestisit uygulama dönemi boyunca arıcılar için bir öneridir. Ancak, bir tozlaşma olayı sırasında arıları tarladan uzaklaştırmak ve geri getirmek tozlaşmayı kesintiye uğratabilir ve arıcılar için işçilik ve nakliye maliyetini artırabilir. Diğer bir sınırlama ise, bal arılarının tozlaşma için kullanılıp kullanılmadığına bakılmaksızın, birçok bölgede muhtemelen eşzamanlı pestisit uygulamasına maruz kalan tek bir ürün hakim olduğundan, pestisite maruz kalmayan geçici bir bekletme yeri belirlemek

mümkün olamayabileceğidir (Mourtzinis et al., 2019). Arı kovanı girişlerini mühürlemek veya kovanın tamamını elekle kaplamak, yiyecek arama faaliyetlerini tamamen durdurarak pestisit maruziyetini önlemek için seçenekler olabilir, ancak arıcılar yetersiz havalandırma endişesi ve ek işçilik veya ekipman gereksinimleri nedeniyle bu önlemi tercih etmemektedir (Kumar et al., 2020; Sanford, 1983). Pestisit uygulaması bal arılarının yiyecek arama mesafesi içinde farklı günlerde yapıldığında, mühürleme ve üzerini örtme yöntemlerinin tüm pestisit maruziyetlerini azaltması mümkün görünmemektedir. İzolasyon odak alanlarındaki insektisitleri toksik uygulamalardan kaynaklanan maruziyeti kontrol etmek şeklinde olabilir (Beekman and Ratnieks, 2000; Couvillon et al., 2015).

3.1.3. Çiftçiler Ve Pestisit Uygulayıcıları İle Arıcılar Arasındaki İletişim

Bahsedilen tavsiyelerin başarılı bir şekilde uygulanması (arı kovanlarının kapatılması veya yerlerinin değiştirilmesi), yetiştirici veya pestisit uygulayıcısı ile arıcı arasında pestisit uygulama gününden önce açık ve zamanında iletişim kurulmasını da gerektirir. Büyük çaplı arıcılar, genellikle geniş bir mesafede bulunan yüzlerce veya binlerce kovanı yönettikleri için, kısa bir süre içinde yüzlerce uygulama raporu alabilirler. Pestisit uygulamasının zamanlaması, çiftçilerin ve uygulayıcıların programlarına veya hava durumuna bağlı olarak değişebilir, bu da arıcıların kovanları zamanında kapatmalarını veya taşımalarını zorlaştırır. Arıcılık sahalarına seyahat, bu yönetim seçeneğinin uygulanmasındaki bir diğer zorluktur. Arılarını geniş alanlara taşımayan sabit veya küçük çaplı arıcılar için daha etkili olabilir (Zhang et al., 2020)

3.2. Arı Kovanlarında

3.2.1 Pestisit Uygulama Yöntemleri

Sahada pestisit maruziyetini azaltmanın aksine, bal arısı zararlısı (özellikle Varroa) kontrolü veya arıcılar tarafından kovanlara geri getirilen pestisitler nedeniyle arı kovanlarında maruziyeti azaltma çabalarına genellikle arıcıların kendileri katkıda bulunur. Bal arısı koloni zararlısı kontrolü için uygulama yöntemleri (örneğin, damlatma, fumi gating, mitisitle muamele edilmiş şerit veya pedin uygulanması) balmumu peteği, bal ve arı ekmeği yoluyla kalıntı seviyesini ve süresini etkiler (arı kovanında depolanmış polen) (Abd El-Wahab et al., 2021).

Farklı uygulama yöntemleri benzer etkinliğe sahip olduğunda, en güvenli seçim, zaman içinde en az kalıntıya ve en az sayıda uygulamaya neden olandır. Peteklerin yanına asılan pestisitle muamele edilmiş şeritler, damlatma, fümigasyon veya çerçevelerin üzerine serilen pestisit taşıyıcı gibi petekle dolaylı teması içeren yöntemlere kıyasla, balmumu peteğine doğrudan temas nedeniyle akut pestisit maruziyetini artırabilir. Damlatma veya fümigasyon yöntemi, arı faaliyetleri yoluyla kısa sürede dağılabilir; çerçevelerin üzerine yerleştirilen pestisit taşıyıcıları (kağıt malzeme veya pamuk pedler gibi), yavruların bulunduğu veya gıdanın depolandığı peteğe kronik maruziyeti önler. Damlatma veya fumigasyonun dezavantajı, aktif bileşenlerin kimyasal özellikleri (örneğin uçucu) veya yüksek arı aktiviteleri nedeniyle yeterli süre devam edemediği durumlarda birden fazla uygulama yapılması gerekliliğidir (Qadir et al., 2021).

3.2.2. Eski Tarakların Çıkarılması

Arı kovanlarındaki pestisit maruziyetini azaltabilecek en iyi yönetim uygulamalarından biri (mahsul zararlısı veya arı zararlısı kontrolünden kaynaklanan) arıcıların eski petek çerçevelerini değiştirmesi ve her yıl yeni çerçeveler getirmesidir (Hooven et al., 2013). Pestisit yüklü peteklerin uzaklaştırılması, kovanlardaki genel pestisit seviyelerini azaltır (özellikle kontamine petekle doğrudan temas eden yavrular için) (de Souza et al., 2022). Yaygın bir öneri, çerçevelerin üç yıl boyunca kullanılmasıdır (Spivak and Reuter, 2006). Bu genellikle 3-4 yeni çerçevenin her yıl her kovan kutusunda değiştirilmelidir. Ancak, eğer yeni çerçeveler kısa sürede yüksek kalıntılar biriktirirse, bal arıları kronik olarak bu çerçeveler üç yıl sonra değiştirilmeden önce açığa çıkar

4. Sahada Maruz Kalmayı Ve Kullanımı Azaltacak Yeni Stratejiler Ve Teknikler

4.1.Yüksek Teknolojili Püskürtücü – Hem Pestisit Kullanımını Hem De Sprey Sürüklenmesini Azaltarak Maruziyetin Azaltılması

Tarımda, pestisit miktarını azaltmak ve uygulanan kimyasalları hedef üzerinde tutmak için yeni teknoloji seçenekleri sürekli olarak geliştirilmektedir. Bu teknolojiler arasında yüksek teknolojili püskürtücüler, dronelar ve sensör tabanlı veya elektrostatik püskürtücüler yer almaktadır (Ahmad et al., 2021; Warneke et al., 2019)

Bu teknolojilerin kullanımıyla, pestisit sürüklenmesi ve bitki üzerindeki kalıntı miktarı azaltılabilir. Özellikle drone ve sensör tabanlı püskürtücüler, hassas ve hedeflenmiş

uygulama yaparak bal arılarının maruziyetini azaltabilir ve pestisit kullanımını optimize edebilir. Bu teknolojiler, geleneksel yöntemlere kıyasla daha esnek, düşük maliyetli ve etkili bir şekilde pestisit uygulamasını sağlayabilir. Elektrostatik püskürtücüler ise yapışkan özellikleri sayesinde pestisit kullanımını büyük ölçüde azaltabilir. Bu yeni teknolojilerin ticari olarak mevcut olması ve maliyetlerinin düşmesi, tarımda geniş kullanım potansiyeline sahip olmalarını sağlamaktadır (Salcedo et al., 2020).

4.2. Tohum Kaplamaları Ve Tohum Ekim Mühendisliği - Tohum İşleme Sürüklenmesinin Azaltılması

Tohum kaplamalarındaki iyileştirmeler, tohum kabuğundan sıyrılan partikülleri ve pestisit tozu oluşumunu azaltabilir. Örneğin, mısır ve kanola tohumunda kullanılan polimer kaplamalar, tozu %98'in üzerinde azaltabilir ve potansiyel bir yol sunarak kullanımı azaltabilir (Accinelli et al., 2021; Accinelli et al., 2018). Pestisit tozu, basınçlı hava kullanan ekim makinelerinin egzoz havası yoluyla üretilebilir. Ekim makinesinde yapılan mühendislik değişiklikleri ile pestisit tozunu azaltmanın iki genel stratejisi vardır: tozu toprağa itmek veya temiz hava yaymadan önce filtrelemek (Biocca et al., 2019). Egzoz havasını gübre sistemiyle birleştirmek veya ekim makinesine saptırıcı eklemek, pestisit tozunda %69'a kadar azalmaya yol açabilir. Ancak, bu tozun hala toprakta kalması, toprakta yaşayan arılar için bir maruziyet yolu olabilir (Manzone et al., 2014; Manzone and Tamagnone, 2018). Pestisit tozunu %99,4'e kadar azaltan filtreleme yöntemi önerilir. Bu geliştirilmiş sistemler veya cihazlar ticari olarak mevcuttur ve maliyetleri düştükçe daha yaygın olarak kullanılabilir hale gelmektedir (Biocca et al., 2015; Biocca et al., 2017; Foqu´ e et al., 2018; Manzone et al., 2015).

4.3. Bal Arısı Kovucu - Arıların Yiyecek Arama Davranışını Engelleyerek Maruz Kalmayı Azaltması

Pestisitler tarımsal sistemlerde önemli bir rol oynamaktadır ve arıların maruz kalmasını önlemenin bir yolu, pestisit sprey kimyasına bal arısı kovucuları eklemek veya arıları pestisitle işlenmiş alanlardan uzaklaştırmak için kovucuları ayrı olarak püskürtmektir. Araştırmalar, birçok kimyasalın koku veya tat alma yoluyla bal arılarını ilaçlı alanlardan uzaklaştırmada etkili olduğunu ve zehirli pestisitlerden kaynaklanan arı ölümlerini azalttığını göstermektedir (Atkins et al., 1975)

Ancak, ticari olarak mevcut bir bal arısı kovucusu bulunmamaktadır ve kovucuların etkinliği ve güvenliğini değerlendirmeye yönelik araştırmalar yetersizdir. Kovucuların geliştirilmesiyle ilgili endişelerden biri, çevresel kullanımın bal arılarını koruma ihtiyacının ötesine geçebilecek potansiyel bir risk oluşturmasıdır. Ayrıca, tarım uygulamaları bal arısı tozlaşmasına dayanmayan veya daha az dayanan yetiştiricilerin kovucu kullanımına ilgisizdir. Kovucuların kullanılması ayrıca pestisit uygulayıcılarına başka bir toksisite riski ekleyebilir.Bal arısı kovucuları genellikle uçucu olduğundan ve mahsulde kısa bir süre kaldığından, bu kullanım zorluklarına sahiptir. Ancak, mikrokapsül ve nanopartiküller gibi düşük salınımlı teknolojiler, bu zorlukların üstesinden gelmeye yardımcı olabilir (Wang and Liu, 2019). Bal arıları, kendi kimyasal özelliklerine dayanarak maruziyeti azaltmak için güvenilir olmayan bir çözüm olduğunu gösteren pestisitlere karşı tutarsız kaçınma davranışı göstermektedir. Ancak, pestisitlerin uzun süreli ve yaygın kullanımı durumunda, bu savunma mekanizmalarının etkisiz hale gelebileceği belirtilmektedir (Węgorek et al., 2015; Zhang et al., 2019).

4.4. Arı Kovanının Yer Seçimi – Kovanları Her Türlü Pestisit Kullanımından Uzak Tutmak İçin Dikkate Alınması Gereken Husus

Pestisit spreyi veya tohum ilaçlama tozu arı kovanlarına sürüklenerek tüm koloniyi tehdit edebilir. Koloniler pestisitlerle tedavi edilen mahsul alanlarına ne kadar yakınsa, o kadar yüksek risk altında olabilirler (Goebel et al., 2022). Bal arılarına belirli bir ürünün tozlaşması için ihtiyaç duyulmadığından, pestisitlerle muamele edilen tarlalardan yeterince uzakta bir arılık yeri belirlemek kolaylıkla uygulanabilecek bir yöntemdir. Ancak, bu potansiyel stratejiye ilişkin araştırma ve tartışmalar, arıların yerleştirildiği arazinin genellikle kendilerine ait olmaması nedeniyle arıcıların arılık yerlerini seçme özgürlüğünün düşük olması nedeniyle hala eksiktir. Genel pestisit sürüklenme çalışmaları, tarlalardan en az 50 m uzaklığın potansiyel olarak insanlara veya diğer organizmalara (Burn, 2003; Cunha et al., 2012; Goebel et al., 2022; Ricchio, 2018), yönelik pestisit riskini azaltabileceğini ve bu bulguların bal arılarının pestisit maruziyetini en aza indirmek için arıcılık için geçerli olabileceğini göstermektedir. Bununla birlikte, pestisit uygulama yöntemleri ve hava koşulları, özellikle rüzgar ve mahsul özellikleri (örneğin, düşük ve yüksek yükseklik) gibi

birçok faktör pestisit sürüklenmesini etkileyebilir, arı kovanı konumu için güvenlik mesafesi bilimsel olarak araştırılmalıdır.

4.5. Entegre Haşere Yönetimi - Pestisit Kullanımının Azaltılması

Kimyasal olmayan yöntemler (biyolojik, kültürel, mekanik, fiziksel kontrol ve zararlı izleme), entegre zararlı yönetimi (IPM) için popüler bir uygulamadır. Ancak, entegre zararlı ve tozlayıcı yönetiminin (IPPM) dahil edilmesi, hem zararlı kontrolünü hem de tozlaşmanın korunmasını en üst düzeye çıkarmak için yeni bir kavramdır (Lundin et al., 2021). IPM uygulayıcıları, takvime dayalı pestisit uygulamalarını takip eden geleneksel tarımla karşılaştırıldığında, toplam pestisit kullanımını azaltmanın yanı sıra gıda ve çevredeki kalıntıları da azaltır (Arora et al., 2019). Ancak, pestisit uygulaması hala birçok önemli ürün için birincil zararlı kontrol aracıdır. (Deguine et al., 2021). Örneğin, soya fasulyesi ve kanola gibi ürünler dünya çapında yüz milyonlarca hektar alanda yetiştirilmekte ve genellikle bir veya birden fazla böcek ilacı ile muamele edilmektedir (Bueno et al., 2021). . IPM dikkate alınmadığında, bu ürünler bal arılarını yoğun bir şekilde pestisitlere maruz bırakabilir. IPM sistemleri, her ürün için dikkatli bir değerlendirme ve karmaşık stratejiler gerektirirken, bilim insanları ve yetiştiricilerin yeni ve etkili IPM araçları geliştirmesini ve benimsemesini zorlaştırabilir (Alwang et al., 2019; Baker et al., 2020). Ancak, mevcut ve yeni IPM tekniklerinin benimsenmesi için devrim niteliğindeki yenilikler ve geniş çaplı işbirliği, tarımsal sistemlerde pestisit kullanımını azaltarak bal arıları için daha çevre dostu yaşam alanları yaratma potansiyeline sahiptir (Anderson et al., 2019; Lamichhane, 2017).

5. Maruziyeti Ve Kullanımı Azaltmak İçin Yeni Stratejiler Ve Teknikler Arı Kovanları

5.1. Gıda Pestisit Bozunma Teknolojileri - Depolanmış Arı Gıdası Ve Balmumu Peteğindeki Pestisit Kalıntılarını Azaltma

Pestisit kalıntılarını azaltmak ve dolayısıyla gıda güvenliğini artırmak için insan gıdalarını çeşitli tekniklerle işlemek, yaygın bir uygulamadır. Örneğin, ozon, soğuk plazma ışınlama, gama ışınlama, darbeli elektrik alanı ve ultrasonikasyon gibi teknikler, pestisitleri hızlı bir şekilde etkisiz hale getirerek gıda güvenliğini sağlar. (Mir et al., 2022). Bu teknikler, pestisit temizleme uygulamalarını arıcılıkta da kullanılarak, kovan bileşenlerinde yüksek konsantrasyonda bulunan pestisit birikimini azaltmaya yardımcı olabilir. (Murcia Morales et al., 2020).

Son araştırmalar, ozonun petek veya baldaki pestisit kalıntılarını azaltmak için etkili olduğunu göstermektedir. Ozon, pestisitleri daha az toksik veya toksik olmayan bir duruma oksitleyerek biyolojik bozunmayı hızlandırır (Jasim et al., 2006).

Bu, arı sağlığını iyileştirirken, pestisit kalıntılarını azaltır. Ayrıca, soğuk plazma ışınlama ve gama ışınlama gibi teknikler de pestisitleri etkisiz hale getirerek gıdalardan temizlenmelerine yardımcı olur (James, 2011; Zanet et al., 2019).

Gelecekteki çalışmaların, bu parçalanma yöntemlerinin arıcılığa uygunluğunu ve etkinliğini belirlemesi gerekmektedir. Örneğin, ozonun balmumuna düşük nüfuz etme özelliğinin potansiyel sınırlamaları gibi. Bir parçalanma yönteminin tek başına sınırlamaları olduğundan, birden fazla tedavi yaklaşımının bir araya getirilmesi dezavantajları aşmak için yararlı olabilir.

Yeni öneriler yapılırken, parçalanma tedavisinin arıcılık yönetimiyle uyumlu olmasına dikkat edilmelidir. Örneğin, arıcılık ekipmanının kovanların üzerinde tutulmadığı kış aylarında parçalanma tedavisi için bir dönüşüm fırsatı sağlayabilir. Ayrıca, yüksek maliyetli parçalanma ekipmanlarını karşılayamayan küçük ölçekli arıcılar kiralama seçeneğini tercih edebilirler.

5.2. Probiyotikler - Arı Bağırsak Mikrobiyomu Yoluyla Toksisitenin Olumsuz Etkisini Azaltır

Bağırsak mikrobiyal topluluğu, birçok hayvan, insan ve bal arıları için önemli bir konu haline gelmiştir. Araştırmalar, sağlıklı bir bağırsak mikrobiyotasının sindirim, bağışıklık fonksiyonu, metabolizma ve hatta zihinsel sağlık açısından olumlu etkilerinin olduğunu göstermektedir. Bal arıları için, sağlıklı bir bağırsak mikrobiyotasının varlığı, yuva arkadaşlarının tanınmasını geliştirmek ve arı iç organlarında ve dokularında detoksifikasyon yollarını uyararak ek faydalar sağlayabilir (Alberoni et al., 2016; Chmiel et al., 2020). Pestisit kirlenmiş yiyecek tüketen bal arıları için, yararlı bakteriler tarafından domine edilen bağırsak mikrobiyal topluluğu, böcek ilaçlarının negatif etkilerini azaltmak için birincil savunma hattıdır (Chmiel et al., 2020; Kwong ve Moran, 2016). Ancak, neonicotinoid pestisitlerin bağırsak mikrobiyal topluluğunu önemli ölçüde değiştirmeyebileceği ve bal arılarının pestisit maruziyetine karşı daha duyarlı hale gelebileceği de gözlemlenmiştir (Raymann et al., 2018). Pestisit maruziyeti, bağırsak mikrobiyomunu ve diğer normal sağlık göstergelerini

değiştirebilir. Bu etkiler, pestisit türüne ve konsantrasyonuna bağlıdır. Düşük maruziyet oranlarında, bağırsak mikrobiyotası pestisiti etkili bir şekilde nötralize edebilirken, yüksek maruziyet oranlarında mikrobiyom aşılabilir ve konakların sağlığını olumsuz etkileyebilir (Almasri et al., 2022; DeGrandi-Hoffman et al., 2016; Raymann et al., 2018). Probiyotikler, bal arıları üzerinde pestisit etkilerini azaltmada potansiyel bir çözüm olabilir. Ancak, probiyotiklerin etkinliğini etkileyebilecek birçok faktör vardır, bu nedenle yüksek kaliteli, maliyet etkin ürünlerin kullanımı için daha fazla araştırmaya ihtiyaç vardır. Bu faktörler arasında tedavi dozu ve süresi, mikrop suş bileşimi, hava koşulları ve dağıtım yöntemi yer alır (Chmiel et al., 2020). Sonuç olarak, bal arılarının bağırsak mikrobiyotasının pestisit maruziyetini yönetmede ve sağlıklarını korumada önemli bir rol oynadığı görülmektedir. Ancak, bu alanda daha fazla araştırmaya ihtiyaç vardır, özellikle de probiyotiklerin etkinliği ve uygulanabilirliği konusunda (Nowak et al., 2021).

5.3. Kaliteli Diyet Ve Bitkisel İlaçlar - Arı Vücudundaki Detoksifikasyon Yollarını İyileştirir

Pestisitlerin sindirilmesi veya temas etmenin olumsuz etkilerini hafifletmek için bal arılarının vücutlarında üç genel yol ile pestisitlerin detoksifikasyonu ikincil savunma hattıdır. Bu yollar; fonksiyonelleştirme, bağlama ve enzimler (sitokrom P450'ler, glutatyon-S-transferazlar ve karboksil/ kolinesterazlar dahil) ve pestisitlerin metabolizmasına yardımcı olan çeşitli proteinler tarafından kolaylaştırılan atılma yollarıdır (Gong and Diao, 2016). Bu süreçlerin düzenlenmesi, detoksifikasyon ve antioksidan gen transkripsiyonu tarafından kontrol edilir. Bal arılarının basit detoksifikasyon yolları nedeniyle, özellikle pestisitler birbirleriyle etkileşime girerek tek başına olduğundan daha güçlü veya farklı reaksiyonlar oluşturduğunda, pestisitlere oldukça duyarlıdırlar. (Claudianos et al., 2006). Sinerjizm, detoksifikasyon yolları ve gen transkripsiyonu kalıplarının daha fazla araştırılması, hem tarım üreticileri hem de arıcılıkla uğraşanlar için etkili ve güvenli pestisit kullanımına daha fazla destek sağlayacaktır. Besinlerin mevcudiyeti ve kalitesi, bal arılarının detoksifikasyon yollarını destekleyerek pestisitlere karşı dirençlerini artırabilir. (Archer et al., 2014; Barascou et al., 2021; Schmehl et al., 2014).

5.4. Detoksifikasyon Enzimleri Ve Aktif Kömür - Akut Pestisit Zehirlenmesi İçin Potansiyel Çözümler

Yapay diyetlerin, probiyotiklerin ve bitkisel ilaçların genel amacı, arıların düşük seviyedeki pestisit maruziyetini geri püskürtmek veya mikroorganizmaları veya arıların kendilerinde detoksifikasyon enzimlerini aktive ederek arı sağlığını iyileştirmektir. Probiyotiklerin aksine, diyet ve bitkisel ilaçlar, akut maruziyet veya toksisite tarafından baskılanabilir; üretilmiş detoksifikasyon enzimlerinin ise kısa reaksiyon süresi ve yüksek detoksifikasyon kapasitesi vardır (Thakur et al., 2019). Pestisit detoksifikasyonunda kullanılan birçok enzim bulunmaktadır, ancak fosfotriesteraz, organofosfat pestisitlerin detoksifikasyonunda en yaygın olarak kullanılan enzimdir ve bal arıları için umut vadeden bir çözüm olabilir (Alejo-Gonz´alez et al., 2018; Pedroso et al., 2021; Thakur et al., 2019). Bir çalışmada, fosfotriesteraz enzimi, akut organofosfat pestisit maruziyetinde %100 hayatta kalma oranı göstermiştir. Bu, bal arıları için akut pestisit zehirlenmesine karşı bir çözüm olarak değerlendirilebilir (Chen et al., 2021). Ancak, bal arıları geniş bir spektrumda pestisite maruz kalmaktadır ve tek bir enzim tüm pestisit sınıflarını detoksifiye edemez. Bu nedenle, farklı enzimlerin test edilmesi gerekmektedir. Ayrıca, yüksek etkinliğe sahip bir enzim veya taşıyıcıda mühendislik yapılmış bir enzim kompleksi, farklı akut maruziyet senaryoları için tasarlanabilir (Bhatt v et al., 2020). Akut zehirlenmiş bal arılarına yanıt vermek için başka bir teknik, pestisitleri bağırsaklarından emmek için aktif karbon verilmesidir. Bu yöntem, hayvan yemlerindeki toksinlerin etkilerini hafifletmek için etkili bir yol olarak gösterilmiştir. Aktif karbonun verimliliği, karbon açısından zengin mikro parçacıkları kullanılarak test edilmiştir ve sonuçlar, karbon tedavisinin, belirli bir pestisit ile tedavi edilen arıların hayatta kalmasını önemli ölçüde artırdığını göstermiştir.Ne detoksifikasyon enzimleri ne de aktif karbon şu anda arıcılıkta ticarileştirilmiştir, ancak bu yöntemlere ilişkin daha fazla araştırma, akut toksisiteye benzersiz çözümler sunabilir ve gelecekte arıcılar için daha fazla araç sağlayabilir. Arıcılık ölçeği ne olursa olsun, probiyotikler, kaliteli diyetler ve bitkisel ilaçlar, detoksifikasyon enzimi ve aktif karbonun hepsi tüm arıcılık işletmeleri tarafından benimsenmesi için engel teşkil etmez. Bu yöntemler, arı sağlığını iyileştirmek ve pestisit maruziyetini azaltmak için çeşitli ve etkili bir yaklaşım sunabilir (Holanda and Kim, 2021; Mgbeahuruike et al., 2018).

5.5. Arı Kovanlarında IPM - Pestisit Kullanımını Azaltmak İçin Varroa Akarının Daha İyi Kontrolü

Parazitik Varroa akarı, günümüz arıcılığında en fazla zarar veren zararlılardan biridir ve kış kolonisi ölümlerinin çoğuyla ilişkilendirilmektedir (Guzmán-Novoa et al., 2010; Kulhanek et al., 2017). Birçok ülkede yüksek koloni kayıplarından sorumlu olan Varroa akarlarını kontrol etmek için çeşitli yöntemler araştırılmaktadır Varroa akarları için kimyasal olmayan kontrol uygulamaları sıklıkla önerilmektedir (Vilarem et al., 2021). Ancak bu yöntemlerin etkinliği hakkında sağlam veri eksikliği bulunmaktadır. Bu nedenle, arıcılar çoğunlukla mitisitlere başvurarak Varroa popülasyonunu kontrol etmektedirler. Ancak, mitisitlerin de bazı sınırlamaları bulunmaktadır ve tek başına etkili olmayabilirler. (Jack and Ellis, 2021). Günümüzde, arıcılık ölçeğinde benimsenmesi amaçlanan ve umut verici olan yeni Varroa kontrol yöntemleri geliştirilmektedir. Bu yöntemler arasında Varroa patojenleri, RNA interferansı ve kemo-bozulma gibi çeşitli yaklaşımlar bulunmaktadır (Jack and Ellis, 2021; Liu et al., 2020). Ancak, bu yeni yöntemlerin güvenlik ve etkinlik konularında daha fazla araştırmaya ihtiyaç vardır ve henüz ticari olarak geniş ölçekte kullanıma hazır değildir (Whitehead, 2017).

Bu nedenle, Varroa akarlarının kontrolü için etkili ve güvenli yeni yöntemlerin geliştirilmesi ve yaygınlaştırılması için daha fazla araştırmaya ve teknolojik gelişmelere ihtiyaç vardır. Bu yöntemlerin arıcılık endüstrisinde kullanılabilir hale gelmesi, arıcıların Varroa akarlarıyla mücadele etme konusundaki çabalarını destekleyebilir ve koloni kayıplarını azaltabilir (Vilarem et al., 2021; Han et al., 2021).

6. Doğal Habitatlar - Kovanlardaki Beslenme Durumunu Artırır Ve Tarladaki Pestisit Maruziyetini Dengeleyebilir

6.1. Beslenmedeki Faydaları Ve Pestisit Toksisitesine Karşı Direnç

Arılar için çeşitli çiçek kaynaklarına erişim, beslenme ve pestisitlere karşı direnç açısından önemli bir faktördür. Doğal habitatlarda yüksek çiçek çeşitliliği, arıların çeşitli faydalar elde etmelerini sağlar. Bunlar arasında yüksek kaliteli yiyecek, dengeli beslenme, farklı bitkilerden gelen çeşitli mikrobiyomlar ve bitkisel desteklerin artan sıklığı bulunmaktadır (Garibaldi et al., 2013; Paredes et al., 2019). Ancak, tek ürünlü tarım sistemlerinde, özellikle Orta Batı ABD gibi bölgelerde, arılar için besin kaynağı çeşitliliği sınırlı olabilir. Bu

sistemlerde, tarım alanları genellikle tek bir bitki türüyle domine edilmekte ve çiçeklenme dönemlerinde bile arılara yeterli beslenme kaynağı sağlanamamaktadır (Zhang, 2020). Bu durum, arı kolonilerinin gücünde dramatik bir düşüşe neden olabilir (Dolezal et al., 2019). Tek ürünlü tarım sistemleri ayrıca zararlı sorunlarına da duyarlıdır ve pestisit kullanımı bu sistemlerin bir parçası olarak yaygındır. Bu da arıları pestisit maruziyeti gibi stres faktörlerine maruz bırakır.

Doğal habitat kayıplarının önlenmesi ve doğal habitatın yeniden oluşturulması, arılar ve diğer tozlayıcılar için daha iyi beslenme koşulları sağlama açısından önemlidir. Ancak, bu yeniden oluşturma çiftçiler veya arazi sahipleri için maliyetli olabilir ve habitat bakımı için artan yatırımlar gerektirebilir. Hükümetler veya kamu kurumları, doğal habitatın yeniden oluşturulmasını teşvik etmek için çeşitli programlar ve destekler sağlayabilirler. Örneğin, Amerika Birleşik Devletleri'ndeki Koruma Rezerv Programı (CRP) ve Avrupa Birliği'ndeki Tarım-Çevre Şeması (AES) gibi programlar, tarım arazilerinde doğal habitat koruma alanlarının oluşturulmasını teşvik etmektedir. Bu tür koruma uygulamaları, arılar için pestisit etkisini azaltma ve daha iyi beslenme koşulları sağlama gibi önemli fırsatlar sunabilir. Bu nedenle, doğal habitatın korunması ve yeniden oluşturulması, arıların sağlığı ve genel tozlaşma hizmetleri açısından kritik öneme sahiptir (Otto et al., 2018).

6.2. Tampon Etkisi Yoluyla Maruziyetin Azaltılması

Tarla kenarlarına veya çevredeki manzaraya kurulan doğal habitatlar, orta düzeyde pestisit kullanımının arılar gibi tozlaşmacılara veya diğer faydalı böceklere olan olumsuz etkisini azaltabilir. Ancak, bu etki, pestisitlerin aşırı kullanımı altında kaybolabilir. Farklı doğal habitat geliştirme taktikleri, pestisit maruziyetini azaltmada çeşitli roller oynar. Örneğin, ağaç bariyerleri pestisit sürüklenmesini engellemek için kullanılabilirken, çiçeklenme alanları pestisit uygulama döneminde arılara yiyecek ve sığınak sağlayabilir (Obregon et al., 2021; Okubo et al., 2021). Tarım alanlarındaki yoğun doğal habitatın pestisit açısından tamamen temiz bir yer olmadığı ve bu habitatlarda yuvalanan veya yiyecek arayan arıların yakındaki işlenmiş tarla alanlarından sürüklenen pestisitlere maruz kalabileceği doğrudur (Bruehl et al., 2021; Burn, 2003; Long and Krupke, 2016). Ancak, tarım manzaralarında doğal habitat oluşturulması, arılara etkiyi azaltma fırsatı sunar ve onları potansiyel doğal floral kaynaklardan dışlamaz. Bu da maruz kalma olasılığını azaltır ve beslenme durumunu

artırır. Çalışmalar, arıların tarla kenarlarına yerleştirilen çayırlık bitki örtüsü şeritlerine erişiminin neonicotinoid ile muamele edilmiş tohumların büyüdüğü alanlara göre daha sağlıklı olduğunu göstermektedir. Bu, doğal habitatların pestisitlerden kurtarma etkisini önermektedir (Hall et al., 2022; Zhang, 2020). Doğal habitat ayrıca, yaban arılarına bal arısı tozlaşmasını desteklemek için ek beslenme ve yuva alanları sağlayabilir. Böylece, zararlıların biyolojik kontrolünü başlatarak pestisit kullanımını potansiyel olarak azaltabilir. Ancak, daha fazla araştırma, arıların yerel doğal habitatlardaki maruziyetini anlamak ve azaltmak için gereklidir. Bu şekilde, doğal habitatların pestisitlerin olumsuz etkilerinden korunma potansiyeli daha iyi değerlendirilebilir (Schulte et al., 2017).

7. Sonuç

Bal arılarının topladığı nektarlarda veya arı kovanlarında bulunan yüzlerce pestisitin, tarım alanlarındaki tarımsal uygulamalara dayandığı belirlenmiştir. Tarla içinde maruz kalma yolunu önleme yaklaşımları, arıcıların kontrol edemediği, çiftçilerin veya pestisit uygulayıcılarının karar verdiği alanlarda belirlenir, bu da mevcut stratejileri (uygun uygulama zamanını seçme ve uygulama ekipmanını seçme gibi) veya yeni tekniklerin keşfini (yenilenmiş tohum kaplama tekniği, dikim makinesi ve püskürtücü gibi) içerir.

Arıcıların yapabileceği şey, pestisitlerle işlenmiş tarla alanlarına güvenli bir mesafede arı kovanı konumları seçmektir veya doğal habitatlara yerleşmektir, ancak tercih edilen arı kovanı konumları genellikle çiftçilerin arama habitatına erişimini kontrol ettiği için arıcılar tarafından serbestçe seçilemez. Entegre Zarar Yönetimi tarım ürünlerinde pestisit kullanımını azaltabilir, ancak mevcut çalışmalar, her bir Entegre Zarar Yönetimi sisteminin her bir tarıma uyarlanmasını değerlendirmeye odaklanır, çünkü Entegre Zarar Yönetimi prosedürlerinin karmaşıklığı nedeniyle bal arılarını dikkate almaz.Tarımın bir bölümü olarak, arıcılığın sürdürülebilirliği, arıcılık tekniklerinin gelişimine değil, aynı zamanda arıların geniş ölçüde yer aldığı endüstrinin teknolojik ilerlemeleriyle de yakından ilişkilidir. Çevre dostu tarımın oluşturduğu eğilimler, bal arılarının sağlığında iyileşme temelini oluşturacaktır; örneğin,

1) Tarımla ilgili politikaların, çevresel kirliliği ve tozlaşıcılar ve diğer faydalı organizmalar için riski azaltmak için pestisit uygulamasının daha iyi yönetimini gerektirmesi.

2) Çiftçilerin veya uygulayıcıların çevreye daha az yük getiren daha yeşil ürünler elde etmek için yeni teknolojiyi benimsemeye daha istekli olması.
3) Yeni teknolojilerin çevre hasarını azaltmada etkili yöntemler olarak geliştirilmesi ve çoğu çiftçiye uygun fiyatlı olmasıdır.

Yeni teknolojilerin ve Entegre Zarar Yönetimi 'nin kullanımından kaynaklanan olumlu sonuçlar üzerine yapılan çalışmalar, insanlar ve bal arıları gibi hem insanlar için güvenli hem de çevre dostu bir ortam yaratan benimsemeye teşvik sağlayacaktır.Bu derlemede birçok strateji sunulmasına rağmen, maruziyeti etkileyebilecek diğer potansiyel faktörler tartışılmamış ve gelecekteki çalışmalarda azaltmak için değerlendirilmelidir. Örneğin, toprak dökümü, bal arılarına potansiyel bir maruziyet oluşturabilir, ancak etkisi ve maruziyeti azaltma yaklaşımı hakkında sağlam verilerle açıklanmamıştır.Varroa akarlarını yönetmek için yeni Entegre Zarar Yönetimi stratejileri bulma konusunda arıcıları ve araştırmacıları birlikte çalışmaya teşvik ediyoruz, çünkü mevcut Entegre Zarar Yönetimi araçları kovanda kullanılan akarisitlerin kullanımını önlemek için yeterli değildir ve yeni araçlar kısa vadede mevcut değildir. Akaritlerin konsantrasyonunu ve süresini azaltmak için akarisitlerin formülasyonunun geliştirilmesi mümkündür. Ortaya çıkan teknikler, kovandaki pestisitleri parçalamayı ve probiyotikler, yapay beslenme ve bitkisel ilaçlarla beslemeyi içerir, bunlar gıda biliminde iyi geliştirilmiştir ve arıcılık endüstrisine uygulanabilir. Pestisitleri kovan bileşenlerinde parçalamak etkili olabilir, ancak pestisit kontaminasyonu yıl boyunca meydana gelir ve parçalanma tedavisi, zamanın, işgücünün ve ekipmanın maliyeti göz önüne alındığında sık sık uygulanamaz. Bal arılarına probiyotikler, yapay besin ve bitkisel ilaçlarla beslemek, pestisit maruziyetinin zararını azaltmanın yollarıdır ve yan etkiler olmadan kullanılabilir; ancak, bal arılarına doğal habitatlara erişim sağlamak, bu hedefleri başarmak için doğal bir yöntemdir. Ek besleme veya doğal yem sağlama, kökten maruziyet sorunlarını çözemez ve ciddi maruziyet durumlarında etkisiz hale gelir. Arılara beslenme yoluyla ek detoksifiye edici ajanlar sağlamak, akut toksisite için gelecekteki bir çözüm olabilir. Burada bahsedilen tüm teknolojiler, toplam pestisit maruziyetini azaltma hedefine katkıda bulunur.

Kaynaklar

Abd El-Wahab, T.E., Shalaby, S.E.M., Al-Kahtani, S.N., Al Naggar, Y., Jamal, Z.A., Masry, S.H.D., 2021. Mode of application of acaricides against the ectoparasitic mite (Varroa destructor) infesting honeybee colonies, determines their efficiencies and residues in honey and beeswax. J. King Saud Univ. Sci. 33, 101236.

Accinelli, C., Abbas, H.K., Shier, W.T., 2018. A bioplastic-based seed coating improves seedling growth and reduces production of coated seed dust. J. Crop Improv. 32, 318–330.

Accinelli, C., Abbas, H.K., Bruno, V., Vicari, A., Little, N.S., Ebelhar, M.W., Shier, W.T., 2021. Minimizing abrasion losses from film-coated corn seeds. J. Crop Improv. 35, 666–678.

Ahmad, F., Khaliq, A., Qiu, B., Sultan, M., Ma, J., 2021. Advancements of Spraying Technology in Agriculture, Technology in Agriculture. IntechOpen, London.

Alberoni, D., Gaggìa, F., Baffoni, L., Di Gioia, D., 2016. Beneficial microorganisms for honey bees: problems and progresses. Appl. Microbiol. Biotechnol. 100, 9469–9482.

Alejo-Gonz´ alez, K., Hanson-Viana, E., Vazquez-Duhalt, R., 2018. Enzymatic detoxification of organophosphorus pesticides and related toxicants. J. Pestic. Sci. 43, 1–9.

Almasri, H., Liberti, J., Brunet, J.-L., Engel, P., Belzunces, L.P., 2022. Mild chronic exposure to pesticides alters physiological markers of honey bee health without perturbing the core gut microbiota. Sci. Rep. 12, 4281, 4281.

Alwang, J., Norton, G., Larochelle, C., 2019. Obstacles to widespread diffusion of IPM in developing countries: lessons from the field. Journal of Integrated Pest Management 10, 1–8.

Anderson, J.A., Ellsworth, P.C., Faria, J.C., Head, G.P., Owen, M.D.K., Pilcher, C.D., Shelton, A.M., Meissle, M., 2019. Genetically engineered crops: importance of diversified integrated pest management for agricultural sustainability. Front. Bioeng. Biotechnol. 7, 24, 24.

Archer, C.R., Pirk, C.W.W., Wright, G.A., Nicolson, S.W., Raubenheimer, D., 2014. Nutrition affects survival in African honeybees exposed to interacting stressors. Funct. Ecol. 28, 913–923.

Arora, S., Sehgal, M., Srivastava, D.S., Arora, S., Sarkar, S.K., 2019. Rice pest management with reduced risk pesticides in India. Environ. Monit. Assess. 191, 1–20.

Atkins, E.L., Macdonald, R.L., Greywood-Hale, E.A., 1975. Repellent additives to reduce pesticide hazards to honey bees: field tests. Environ. Entomol. 4, 207–210.

Baker, B.P., Green, T.A., Loker, A.J., 2020. Biological control and integrated pest management in organic and conventional systems. Biol. Control 140, 104095.

Barascou, L., Sene, D., Barraud, A., Michez, D., Lefebvre, V., Medrzycki, P., Di Prisco, G., Strobl, V., Ya˜nez, O., Neumann, P., Le Conte, Y., Alaux, C., 2021. Pollen Nutrition Fosters Honeybee Tolerance to Pesticides, vol. 8. Royal Society Open Science, p. 210818, 210818.

Bartlett, L.J., 2022. Frontiers in effective control of problem parasites in beekeeping. Int. J. Parasitol.: Parasites and Wildlife 17, 263–272.

Beekman, M., Ratnieks, F.L.W., 2000. Long-range foraging by the honey-bee, Apis mellifera L. Funct. Ecol. 14, 490–496.

Bhatt, P., Bhatt, K., Huang, Y., Lin, Z., Chen, S., 2020. Esterase is a powerful tool for the biodegradation of pyrethroid insecticides. Chemosphere 244, 125507, 125507.

Biocca, M., Fanigliulo, R., Pochi, D., Gallo, P., 2019. Dust drift mitigating devices applied on precision pneumatic seed drills: a mini-review. INMATEH 273–284.

Biocca, M., Pochi, D., Fanigliulo, R., Gallo, P., Pulcini, P., Marcovecchio, F., Perrino, C., 2017. Evaluating a filtering and recirculating system to reduce dust drift in simulated sowing of dressed seed and abraded dust particle characteristics. Pest Manag. Sci. 73, 1134–1142.

Böhme, F., Bischoff, G., Zebitz, C.P.W., Rosenkranz, P., Wallner, K., 2017. From field to food—will pesticide-contaminated pollen diet lead to a contamination of royal jelly? Apidologie 49, 112–119.

Bruehl, C.A., Bakanov, N., Koethe, S., Eichler, L., Sorg, M., Hoerren, T., Muehlethaler, R., Meinel, G., Lehmann, G.U.C., 2021. Direct pesticide exposure of insects in nature conservation areas in Germany. Sci. Rep. 11, 24144, 24144.

Bueno, A.D.F., Panizzi, A.R., Hunt, T.E., Dourado, P.M., Pitta, R.M., Gonçalves, J., 2021. Challenges for adoption of integrated pest management (IPM): the soybean example. Neotrop. Entomol. 50, 5–20.

Burn, A., 2003. Pesticide buffer zones for the protection of wildlife. Pest Manag. Sci. 55, 583–590.

Calderone, N. W. (2012). Insect pollinated crops, insect pollinators and US agriculture: trend analysis of aggregate data for the period 1992–2009. *PloS one*, *7*(5), e37235.

Chen, J., Webb, J., Shariati, K., Guo, S., Montclare, J.-K., McArt, S., Ma, M., 2021. Pollen-inspired enzymatic microparticles to reduce organophosphate toxicity in managed pollinators. Nature Food 2, 339–347.

Chmiel, J.A., Daisley, B.A., Pitek, A.P., Thompson, G.J., Reid, G., 2020. Understanding the effects of sublethal pesticide exposure on honey bees: a role for probiotics as mediators of environmental stress. Frontiers in Ecology and Evolution 8, 22.

Claudianos, C., Ranson, H., Johnson, R.M., Biswas, S., Schuler, M.A., Berenbaum, M.R., Feyereisen, R., Oakeshott, J.G., 2006. A deficit of detoxification enzymes: pesticide sensitivity and environmental response in the honeybee. Insect Mol. Biol. 15, 615–636.

Couvillon, M.J., Riddell Pearce, F.C., Accleton, C., Fensome, K.A., Quah, S.K.L., Taylor, E. L., Ratnieks, F.L.W., 2015. Honey bee foraging distance depends on month and forage type. Apidologie 46, 61–70.

Cunha, J.P., Chueca, P., Garcer´ a, C., Molt´ o, E., 2012. Risk assessment of pesticide spray drift from citrus applications with air-blast sprayers in Spain. Crop Protect. 42, 116–123.

Dainese, M., Martin, E. A., Aizen, M. A., Albrecht, M., Bartomeus, I., Bommarco, R., ... & Steffan-Dewenter, I. (2019). A global synthesis reveals biodiversity-mediated benefits for crop production. *Science advances*, *5*(10), eaax0121.

DeGrandi-Hoffman, G., Corby-Harris, V., DeJong, E.W., Chambers, M., Hidalgo, G., 2016. Honey bee gut microbial communities are robust to the fungicide Pristine® consumed in pollen. Apidologie 48, 340–352.

Deguine, J.P., Aubertot, J.N., Flor, R.J., Lescourret, F., Wyckhuys, K.A.G., Ratnadass, A., 2021. Integrated Pest Management: Good Intentions, Hard Realities. A Review, vol. 41. Agronomy for Sustainable Development, pp. 1–35.

de Souza, A.P.F., Rodrigues, N.R., Fern´andez-Alba, A.R., Reyes Reyes, F.G., 2022. Occurrence of pesticide residues in Brazilian Apis mellifera beeswax by gas chromatography-tandem mass spectrometry and pesticide hazard evaluation. J. Apicult. Res.

Dolezal, A.G., St Clair, A.L., Zhang, G., Toth, A.L., O'Neal, M.E., 2019. Native habitat mitigates feast-famine conditions faced by honey bees in an agricultural landscape. Proc. Natl. Acad. Sci. USA 116, 25147–25155.

Douglas, M.R., Sponsler, D.B., Lonsdorr, E., Grozinger, C.M., 2020. County-level analysis reveals a rapidly shifting landscape of insecticide hazard to honey bees (Apis mellifera) on US farmland. Sci. Rep. 10, 797.

Durant, J.L., Goodrich, B.K., Chang, K.T., Yoshimoto, E., 2021. Growers follow the label: an analysis of bee-toxic pesticide use in almond orchards during bloom. Calif. Agric. 75, 90–99.

Foqu´ e, D., Biocca, M., Pochi, D., Pulcini, P., Nuyttens, D., 2018. Comparing two dust drift mitigation strategies to the outcomes of a conventional vacuum based precision drill using in-field validated indoor static tests. Aspect Appl. Biol. 137, 285–292.

Fulton, C.A., Huff Hartz, K.E., Fell, R.D., Brewster, C.C., Reeve, J.D., Lydy, M.J., 2019. An assessment of pesticide exposures and land use of honey bees in Virginia. Chemosphere 222, 489–493.

Gallai, N., Salles, J. M., Settele, J., & Vaissière, B. E. (2009). Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological economics*, *68*(3), 810-821.

Garibaldi, L. A., Steffan-Dewenter, I., Winfree, R., Aizen, M. A., Bommarco, R., Cunningham, S. A., ... & Klein, A. M. (2013). Wild pollinators enhance fruit set of crops regardless of honey bee abundance. *science*, *339*(6127), 1608-1611.

Girolami, V., Marzaro, M., Vivan, L., Mazzon, L., Giorio, C., Marton, D., Tapparo, A., 2013. Aerial powdering of bees inside mobile cages and the extent of neonicotinoid cloud surrounding corn drillers: aerial powdering of bees in mobile cage. J. Appl. Entomol. 137, 35–44.

Goebel, K.M., Davros, N.M., Andersen, D.E., Rice, P.J., 2022. Tallgrass prairie wildlife exposure to spray drift from commonly used soybean insecticides in Midwestern USA. Sci. Total Environ. 818, 151745, 151745.

Gray, A., Adjlane, N., Arab, A., Ballis, A., Brusbardis, V., Charrière, J. D., ... & Brodschneider, R. (2020). Honey bee colony winter loss rates for 35 countries participating in the COLOSS survey for winter 2018–2019, and the effects of a new queen on the risk of colony winter loss. *Journal of Apicultural Research*, *59*(5), 744-751.

Gong, Y., Diao, Q., 2016. Current knowledge of detoxification mechanisms of xenobiotic in honey bees. Ecotoxicology 26, 1–12.

Guzm´an-Novoa, E., Eccles, L., Calvete, Y., McGowan, J., Kelly, P., Correa-Benítez, A., 2010. Varroa destructor is the main culprit for the death and reduced populations of overwintered honey bee (Apis mellifera) colonies in Ontario, Canada. Apidologie 41, 443–450.

Hall, M.J., Zhang, G., O'Neal, M.E., Bradbury, S.P., Coats, J.R., 2022. Quantifying neonicotinoid insecticide residues in milkweed and other forbs sampled from prairie strips established in maize and soybean fields. Agric. Ecosyst. Environ. 325, 107723.

Han, J.O., Naeger, N.L., Hopkins, B.K., Sumerlin, D., Stamets, P.E., Carris, L.M., Sheppard, W.S., 2021. Directed evolution of Metarhizium fungus improves its biocontrol efficacy against Varroa mites in honey bee colonies. Sci. Rep. 11, 10582, 10582.

Holanda, D.M., Kim, S.W., 2021. Mycotoxin occurrence, toxicity, and detoxifying agents in pig production with an emphasis on deoxynivalenol. Toxins 13, 171.

Hooven, L., Sagili, R.R., Johansen, E., 2013. How to Reduce Bee Poisoning from Pesticides. Oregon State University Extension Service, Oregon State University, Corvallis.

Jack, C.J., Ellis, J.D., 2021. Integrated pest management control of Varroa destructor (Acari:Varroidae), the most damaging pest of (Apis mellifera L. (Hymenoptera: Apidae)) colonies. J. Insect Sci. 21, 6.

James, R.R., 2011. Potential of ozone as a fumigant to control pests in honey Bee (Hymenoptera: Apidae) hives. J. Econ. Entomol. 104, 353–359.

Jasim, S.Y., Irabelli, A., Yang, P., Ahmed, S., Schweitzer, L., 2006. Presence of pharmaceuticals and pesticides in Detroit river water and the effect of ozone on removal. Ozone: Sci. Eng. 28, 415–423.

Klein, A. M., Vaissière, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C., & Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world crops. *Proceedings of the royal society B: biological sciences*, *274*(1608), 303-313.

Krupke, C.H., Long, E.Y., 2015. Intersections between neonicotinoid seed treatments and honey bees. Current Opinion In Insect Science 10, 8–13.

Krupke, C.H., Hunt, G.J., Eitzer, B.D., Andino, G., Given, K., 2012. Multiple routes of pesticide exposure for honey bees living near agricultural fields. PLoS One 7, e29268.

Kulhanek, K., Steinhauer, N., Rennich, K., Caron, D.M., Sagili, R.R., Pettis, J.S., Ellis, J.D., Wilson, M.E., Wilkes, J.T., Tarpy, D.R., Rose, R., Lee, K., Rangel, J., Vanengelsdorp, D., 2017. A national survey of managed honey bee 2015-2016 annual colony losses in the USA. J. Apicult. Res. 56, 328–340.

Kumar, G., Singh, S., Nagarajaiah, R.P.K., 2020. Detailed Review on Pesticidal Toxicity to Honey Bees and its Management. IntechOpen Limited, London.

Kwong, W.K., Moran, N.A., 2016. Gut microbial communities of social bees. Nat. Rev. Microbiol. 14, 374–384.

Lamichhane, J.R., 2017. Pesticide use and risk reduction in European farming systems with IPM: an introduction to the special issue. Crop Protect. 97, 1–6.

Liu, F., Xu, X., Zhang, Y., Zhao, H., Huang, Z.Y., 2020. A meta-analysis shows that screen bottom boards can significantly reduce Varroa destructor population. Insects 11, 624.

Long, E.Y., Krupke, C.H., 2016. Non-cultivated plants present a season-long route of pesticide exposure for honey bees. Nat. Commun. 7, 1–12.

Lundin, O., Rundl¨ of, M., Jonsson, M., Bommarco, R., Williams, N.M., 2021. Integrated pest and pollinator management – expanding the concept. Front. Ecol. Environ. 19, 283–291.

Manzone, M., Tamagnone, M., 2018. Reducing pollutant drift from a pneumatic maize seed drill using exhaust air into the fertilizer system. Crop Protect. 109, 110–114.

Manzone, M., Balsari, P., Marucco, P., Tamagnone, M., 2014. Indoor assessment of dust drift effect from different types of pneumatic seed drills. Crop Protect. 57, 15–19

Manzone, M., Paolo, M., Mario, T., Balsari, P., 2015. Performance evaluation of a cyclone to clean the air exiting from pneumatic seed drills during maize sowing. Crop Protect. 76, 33–38.

Mgbeahuruike, A.C., Ejioffor, T.E., Christian, O.C., Shoyinka, V.C., Karlsson, M., Nordkvist, E., 2018. Detoxification of aflatoxin-contaminated poultry feeds by 3 adsorbents, bentonite, activated charcoal, and fuller's earth. J. Appl. Poultry Res. 27, 461–471.

Milone, J.P., Chakrabarti, P., Sagili, R.R., Tarpy, D.R., 2021. Colony-level pesticide exposure affects honey bee (Apis mellifera L.) royal jelly production and nutritional composition. Chemosphere 263, 128183.

Milone, J.P., Tarpy, D.R., 2021. Effects of developmental exposure to pesticides in wax and pollen on honey bee (Apis mellifera) queen reproductive phenotypes. Sci. Rep. 11, 1020, 1020.

Mir, S.A., Dar, B.N., Mir, M.M., Sofi, S.A., Shah, M.A., Sidiq, T., Sunooj, K.V., Hamdani, A.M., Khaneghah, A.M., 2022. Current strategies for the reduction of pesticide residues in food products. J. Food Compos. Anal. 106, 104274.

Morales, M. M., Ramos, M. J. G., Vázquez, P. P., Galiano, F. J. D., Valverde, M. G., López, V. G., ... & Fernández-Alba, A. R. (2020). Distribution of chemical residues in the beehive compartments and their transfer to the honeybee brood. *Science of the Total Environment*, *710*, 136288.

Mourtzinis, S., Krupke, C. H., Esker, P. D., Varenhorst, A., Arneson, N. J., Bradley, C. A., ... & Conley, S. P. (2019). Neonicotinoid seed treatments of soybean provide negligible benefits to US farmers. *Scientific reports*, *9*(1), 11207.

Mullin, C.A., Frazier, M., Frazier, J.L., Ashcraft, S., Simonds, R., Vanengelsdorp, D., Pettis, J.S., 2010. High levels of miticides and agrochemicals in North American apiaries: implications for honey bee health. PLoS One 5, e9754.

Murcia Morales, M., G´omez Ramos, M.J., Parrilla V´azquez, P., Díaz Galiano, F.J., García Valverde, M., G´amiz L´opez, V., Manuel Flores, J., Fern´andez-Alba, A.R., 2020. Distribution of chemical residues in the beehive compartments and their transfer to the honeybee brood. Sci. Total Environ. 710, 136288, 136288.

Neumann, P., Carreck, N., 2010. Honey bee colony losses. J. Apicult. Res. 49, 1–6.

Nowak, A., Szczuka, D., Gorczynska, A., Motyl, I., Kregiel, D., 2021. Characterization of Apis mellifera gastrointestinal microbiota and lactic acid bacteria for honeybee protection-A review. Cells 10, 701.

Obregon, D., Guerrero, O.R., Stashenko, E., Poveda, K., 2021. Natural habitat partially mitigates negative pesticide effects on tropical pollinator communities. Global Ecology and Conservation 28, e01668.

Okubo, S., Shoji, A., Kimura, K., Morimoto, N., Yoshiyama, M., 2021. Effectiveness of f loral enhancement in reducing honeybee exposure to insecticides. Appl. Entomol. Zool 56, 207–215.

Otto, C.R.V., Zheng, H., Gallant, A.L., Iovanna, R., Carlson, B.L., Smart, M.D., Hyberg, S., 2018. Past role and future outlook of the Conservation Reserve Program for supporting honey bees in the Great Plains. Proc. Natl. Acad. Sci. USA 115, 7629–7634.

Qadir, Z.A., Idrees, A., Mahmood, R., Sarwar, G., Bakar, M.A., Ahmad, S., Raza, M.M., Li, J., 2021. Effectiveness of different soft acaricides against honey bee ectoparasitic mite Varroa destructor (Acari: varroidae). Insects 12, 1032.

Paredes, D., Karp, D.S., Chaplin-Kramer, R., Benítez, E., Campos, M., 2019. Natural habitat increases natural pest control in olive groves: economic implications. J. Pest. Sci. 92, 1111–1121.

Pedroso, M.M., Hine, D., Hahn, S., Chmielewicz, W.M., Diegel, J., Gahan, L., Schenk, G., 2021. Pesticide degradation by immobilised metalloenzymes provides an attractive avenue for bioremediation. EFB Bioeconomy Journal 1, 100015.

Potts, S.G., Roberts, S., Dean, R., Marris, G., Brown, M.A., Jones, R., Neumann, P., Settele, J., 2010. Declines of managed honey bees and beekeepers in Europe. J. Apicult. Res. 49, 15–22.

Ramakrishnan, M., Kumar, S., Bhardwaj, R., Thukral, A.K., 2019. Worldwide pesticide usage and its impacts on ecosystem. SN Appl. Sci. 1, 1–16.

Raymann, K., Motta, E.V.S., Girard, C., Riddington, I.M., Dinser, J.A., Moran, N.A., 2018. Imidacloprid decreases honey bee survival rates but does not affect the gut microbiome. Appl. Environ. Microbiol. 13, e00545, 00518.

Ricchio, J.L., 2018. Pesticide Drift in the Midwest 2010-2016. Master Thesis. University of Iowa, Ames.

Salcedo, R., Llop, J., Campos, J., Costas, M., Gallart, M., Ortega, P., Gil, E., 2020. Evaluation of leaf deposit quality between electrostatic and conventional multi-row sprayers in a trellised vineyard. Crop Protect. 127, 104964.

Sanford, M.T., 1983. Protecting Honey Bees from Pesticides. Florida Cooperative Extension Service. Institute of Food and Agricultural Sciences, University of Florida.

Schuehly, W., Riessberger-Gall´ e, U., Hern´ andez L´opez, J., 2021. Sublethal pesticide exposure induces larval removal behavior in honeybees through chemical cues. Ecotoxicol. Environ. Saf. 228, 113020, 113020.

Schmehl, D.R., Teal, P.E.A., Frazier, J.L., Grozinger, C.M., 2014. Genomic analysis of the interaction between pesticide exposure and nutrition in honey bees (Apis mellifera). J. Insect Physiol. 71, 177–190.

Schulte, L. A., Niemi, J., Helmers, M. J., Liebman, M., Arbuckle, J. G., James, D. E., ... & Witte, C. (2017). Prairie strips improve biodiversity and the delivery of multiple ecosystem services from corn–soybean croplands. *Proceedings of the National Academy of Sciences*, *114*(42), 11247-11252.

Sharma, A., Kumar, V., Shahzad, B., Tanveer, M., Sidhu, G.P.S., Handa, N., Kohli, S.K., Yadav, P., Bali, A.S., Parihar, R.D., Dar, O.I., Singh, K., Jasrotia, S., Bakshi, P.,

Shawki, M.A.A., Titˇ era, D., Kazda, J., Kohoutkov´ a, J., T´aborský, V., 2010. Toxicity to honeybees of water guttation and dew collected from winter rape treated with Nurelle D. Plant Protect. Sci. 42, 9–14.

Simon-Delso, N., Amaral-Rogers, V., Belzunces, L. P., Bonmatin, J. M., Chagnon, M., Downs, C., ... & Wiemers, M. (2015). Systemic insecticides (neonicotinoids and fipronil): trends, uses, mode of action and metabolites. *Environmental Science and Pollution Research*, *22*, 5-34.

Spivak, M., Reuter, G.S., 2006. Honey Bee Diseases and Pests. Department of Entomology and Minnesota Extension Service, University of Minnesota, St. Paul.

Sponsler, D.B., Johnson, R.M., 2017. Mechanistic modeling of pesticide exposure: the missing keystone of honey bee toxicology. Environ. Toxicol. Chem. 36, 871–881.

Thakur, M., Medintz, I.L., Walper, S.A., 2019. Enzymatic bioremediation of organophosphate compounds – progress and remaining challenges. Front. Bioeng. Biotechnol. 7, 289, 289.

Traynor, K.S., Tosi, S., Rennich, K., Steinhauer, N., Forsgren, E., Rose, R., Kunkel, G., Madella, S., Lopez, D., Eversole, H., Fahey, R., Pettis, J., Evans, J.D., Dennis, v., 2021a. Pesticides in honey bee colonies: establishing a baseline for real world exposure over seven years in the USA. Environ. Pollut. 279, 116566.

Ulziibayar, D., Jung, C., 2019. Comparison of acute toxicity of different groups of pesticides to honey bee workers (Apis mellifera L.). Journal of Apiculture 34, 305–313.

vanEngelsdorp, D., Meixner, M.D., 2010. A historical review of managed honey bee populations in Europe and the United States and the factors that may affect them. J. Invertebr. Pathol. 103, S80–S95.

Vilarem, C., Piou, V., Vogelweith, F., Vetillard, A., 2021. Varroa destructor from the laboratory to the field: control, biocontrol and IPM perspectives-A review. Insects 12, 800.

Wade, A., Lin, C.-H., Kurkul, C., Regan, E.R., Johnson, R.M., 2019. Combined toxicity of insecticides and fungicides applied to California almond orchards to honey bee larvae and adults. Insects 10, 20.

Wang, L., Liu, X., 2019. Sustained release technology and its application in environmental remediation: a review. Journal of Environmental Research and Public Health 16, 2153.

Warneke, B. W., Pscheidt, J. W., Rosetta, R., & Nackley, L. (2019). *Sensor Sprayers for Specialty Crop Production*. Oregon State University.

Węgorek, P., Zamojska, J., Dworza´ nska, D., 2015. Impact of selected active substances in insecticides on the behavior of honey bees (Apis mellifera L.) and silvery moths (Autographa gamma L.) after insecticide plant treatment. Fresenius Environ. Bull. 24, 1742–1746.

Whitehead, H.R., 2017. Varroa Mite Management Among Small-Scale Beekeepers: Characterizing Factors that Affect IPM Adoption, and Exploring Drone Brood Removal as an IPM Tool. The Ohio State University, Columbus.

Wu, J.Y., Anelli, C.M., Sheppard, W.S., 2011. Sub-lethal effects of pesticide residues in brood comb on worker honey bee (Apis mellifera) development and longevity. PLoS One 6, e14720.

Zanet, S., Battisti, E., Alciati, R., Trisciuoglio, A., Cauda, C., Ferroglio, E., 2019. Nosema ceranae contamination in bee keeping material: the use of ozone as disinfection method. J. Apicult. Res. 58, 62–66.

Zhang, G., 2020. Honey Bee Nutritional Health in Agricultural Landscapes: Relationships to Pollen and Habitat Diversity. Doctoral Dissertation. Iowa State University, Ames.

Zhang, Z.Y., Li, Z., Huang, Q., Zhang, X.W., Ke, L., Yan, W.Y., Zhang, L.Z., Zeng, Z.J., 2019. Deltamethrin impairs honeybees (Apis mellifera) dancing communication. Arch. Environ. Contam. Toxicol. 78, 117–123.

KANATLI HAYVANLARDA PREBİYOTİK KULLANIMI VE BU AMAÇLA KULLANILAN PREBİYOTİKLER

İzzet BEYOĞLU (ORCID: 0000-0001-6047-9955)
Bingöl Üniversitesi Fen Bilimleri Enstitüsü Zootekni ABD Bingöl -Türkiye
Email: beyogluizzet1@gmail.com

ÖZET
Kanatlı hayvan yetiştiriciliği, küresel gıda üretiminde kritik bir rol oynamaktadır. Özellikle tavuk eti ve yumurta gibi besin açısından zengin ürünleri sağlamasıyla bilinir. Ancak, sektörün karşılaştığı zorluklar özellikle bağırsak sağlığı sorunları ve enfeksiyonlar üreticileri olumsuz etkileyebilmektedir. Bu sorunların üstesinden gelmek ve kanatlı hayvanların sağlığını iyileştirmek amacıyla yeni uygulamalar geliştirilmektedir. Son yıllarda, prebiyotikler kanatlı hayvan yetiştiriciliğinde önemli bir yer edinmiştir. Prebiyotikler, bağırsak mikrobiyotasının sağlığını iyileştirmek için kullanılan doğal besin takviyeleridir. Bağırsak mikrobiyotası, sindirim, bağışıklık sistemi ve metabolik fonksiyonlar gibi kritik süreçlerin düzenlenmesinde önemli bir rol oynar. Ancak çevresel etmenlerin stres, enfeksiyonlar ve antibiyotik kullanımının bağırsak mikrobiyotasının dengesini bozabileceği unutulmamalıdır. Prebiyotikler, kanatlı hayvanlarda bir dizi olumlu etkiye sahiptir. Öncelikle, faydalı bakterilerin çoğalmasını teşvik ederek patojenlerin üremesini engelleyerek gastrointestinal sistemin sağlıklı bir mikrobiyal dengeye kavuşmasına yardımcı olurlar. Ayrıca, bağırsak mikrobiyotasını çeşitlendirerek sindirim süreçlerini optimize edebilir ve böylece yem verimliliğini artırabilir, besin emilimini iyileştirebilirler. Prebiyotiklerin bağırsak sağlığı üzerindeki etkilerinin yanı sıra, bağışıklık sistemini destekleme kapasiteleri de önemlidir. Prebiyotikler, immünoglobulin üretimini artırarak bağışıklık hücrelerinin aktivitesini etkileyerek hayvanların hastalıklara karşı daha dirençli olmalarına katkıda bulunurlar. Oligosakkaritler ve polisakkaritler gibi yaygın olarak kullanılan prebiyotik türleri, kanatlı hayvan yetiştiriciliğinde önemli bir rol oynamaktadır. Ancak, prebiyotiklerin etkinliğini optimize etmek için tür, yaş, çevresel faktörler ve besleme programları gibi çeşitli faktörlerin dikkate alınması gerekmektedir. Kanatlı hayvan yetiştiriciliğinde prebiyotik kullanımı, hayvan sağlığını ve performansını artırma potansiyeli ile umut verici bir uygulamadır. Ancak, bu alanda daha fazla araştırma yapılması ve prebiyotik kullanımının çeşitli faktörlere göre optimize edilmesi gerekmektedir.
Anahtar Kelimeler: Kanatlı yetiştiriciliği, Prebiyotik, Bağırsak sağlığı, Bağışıklık sistemi, Besin emilimi

USE OF PREBIOTIC IN POULTRY AND PREBIOTICS USED FOR THIS PURPOSE

ABSTRACT

Poultry farming plays a critical role in global food production. It is known for providing nutrient-rich products, especially chicken meat and eggs. However, the difficulties faced by the sector, especially intestinal health problems and infections, can negatively affect producers. New applications are being developed to overcome these problems and improve the health of poultry. In recent years, prebiotics have gained an important place in poultry farming. Prebiotics are natural nutritional supplements used to improve the health of the gut microbiota. The gut microbiota plays an important role in regulating critical processes such as digestion, the immune system and metabolic functions. However, it should not be forgotten that environmental factors such as stress, infections and antibiotic use may disrupt the balance of the intestinal microbiota. Prebiotics have a number of positive effects in poultry. First of all, they help the gastrointestinal tract achieve a healthy microbial balance by encouraging the proliferation of beneficial bacteria and inhibiting the growth of pathogens. Moreover, by diversifying the intestinal microbiota, they can optimize digestive processes and thus increase feed efficiency and improve nutrient absorption. In addition to the effects of prebiotics on intestinal health, their capacity to support the immune system is also important. Prebiotics contribute to animals being more resistant to diseases by increasing the production of immunoglobulins and affecting the activity of immune cells. Commonly used types of prebiotics, such as oligosaccharides and polysaccharides, play an important role in poultry farming. However, to optimize the effectiveness of prebiotics, several factors such as species, age, environmental factors and feeding schedules need to be taken into account. The use of prebiotics in poultry farming is a promising practice with the potential to improve animal health and performance. However, more research is needed in this area and the use of prebiotics needs to be optimized according to various factors.

Keywords: Poultry farming, Prebiotic, Intestinal health, Immune system, Nutrient absorption

Giriş

Kanatlı hayvan yetiştiriciliği, küresel gıda üretiminde önemli bir yere sahiptir. Kanatlı hayvanlardan sağlanan tavuk eti ve yumurta, yüksek besin değerine sahip başlıca ürünlerdir. Ancak, kanatlı hayvan yetiştiriciliğinde karşılaşılan bazı zorluklar üreticiyi zor durumlarda bırakabilmektedir. Kanatlı ürünleri üretiminde karşılaşılan önemli sorunlardan biri de, hayvanlarda görülen bazı bağırsak sağlığı sorunları ve enfeksiyonlar olup, söz konusu durum hayvanların yem tüketim etkinliğinde azalmalara neden olmaktadır. Bu tip sorunların üstesinden gelmek ve kanatlı hayvanların sağlığını korumak ve performansını artırmak için yeni uygulamalar gündeme gelmiştir.

Son yıllarda, prebiyotikler kanatlı hayvan yetiştiriciliğinde bu amaçla kullanılan doğal besin takviyeleri olarak öne çıkmıştır (Ribeiro ve ark., 2021). Prebiyotikler, bağırsak mikrobiyotasının sağlığını iyileştirmek için kullanılan besin bileşikleridir. Bağırsak mikrobiyotası, sindirim, bağışıklık sistemi ve metabolik fonksiyonlar gibi bir dizi önemli sürecin düzenlenmesinde kritik bir rol oynar. Ancak, stres, enfeksiyonlar, antibiyotik kullanımı gibi çevresel faktörler, kanatlı hayvanların bağırsak mikrobiyotasının dengesini bozabilir. Bu durum, patojen mikroorganizmaların büyümesini teşvik edebilir ve bağırsak sağlığını olumsuz etkileyebilir. İşte bu noktada prebiyotikler devreye girer. Kanatlı hayvanlarda prebiyotik kullanımının bir dizi olumlu etkisi bulunmaktadır. İlk olarak, prebiyotikler, bağırsak mikrobiyotasında faydalı bakterilerin büyümesini teşvik ederek patojenlerin çoğalmasını engeller. Böylece, gastrointestinal sistemin sağlıklı bir mikrobiyal dengesinin korunması sağlanır ve enfeksiyon riski azalır. Prebiyotikler ayrıca, bağırsak mikrobiyotasını çeşitlendirerek ve dengeleyerek sindirim süreçlerini optimize edebilir. Bu da yem verimliliğini artırabilir ve besin emilimini iyileştirebilir (Patterson ve Burkholder, 2003). Prebiyotikler, bağırsak sağlığı üzerindeki etkilerinin yanı sıra, hayvanların bağışıklık sistemini desteklemektedir. Çünkü, bağışıklık sistemi, mikrobiyal dengenin korunmasıyla doğrudan ilişkilidir. Prebiyotikler, immünoglobulin üretimini artırarak ve bağışıklık hücrelerinin aktivitesini etkileyerek bağışıklık sistemini güçlendirmektedir. Bu durum, kanatlı hayvanların hastalıklara karşı daha dirençli olmalarına yardımcı olmaktadır (Canoğulları ve Yıldırım, 2019). Kanatlı hayvan yetiştiriciliğinde yaygın olarak kullanılan prebiyotikler arasında, oligosakkaritler ve polisakkaritler bulunmaktadır. Oligosakkaritler,

fruktooligosakkaritler (FOS) ve galaktooligosakkaritler (GOS) gibi çeşitli türleri içerir. Polisakkaritler ise, beta-glukan ve mannooligosakkaritler (MOS) gibi bileşiklerden oluşur. Söz konusu prebiyotikler, kanatlı hayvanların bağırsak sağlığını ve bağışıklık sistemini desteklerken, besin sindirimini ve emilimini optimize etme potansiyeline sahiptir (Murugesan ve ark., 2015).

Sonuç olarak, kanatlı hayvan yetiştiriciliğinde prebiyotik kullanımı, hayvan sağlığını ve performansını iyileştirmede umut verici bir uygulama olarak önerilmektedir. Ancak, bu konuda daha fazla araştırmaya ihtiyaç duyulmaktadır. Prebiyotiklerin kullanımının tür, yaş, çevresel faktörler ve besleme programları gibi çeşitli faktörlere göre optimize edilmesi gerekmektedir.

Probiyotik ve Prebiyotik Nedir?

Probiyotikler, hayvanların sindirim kanalındaki mikrofloranın ekolojik dengesini düzene sokmak, mikroflora içerisindeki potansiyel patojen mikroorganizmaların zararlı hale gelmesini önlemek ve hayvanların yemden yararlanmalarını arttırmak gibi amaçlarla içme suyu ya da yem içerisine karıştırılarak verilen bir grup canlı bakteri, maya ve mantar kültürleri içeren biyolojik ürünlerdir (Fuller, 1989; Hooper, 1989; Aytuğ, 1989).

Probiyotikler, birçok ülkede büyütme faktörü olarak 1970'li yıllardan itibaren sığır, koyun, keçi, domuz, kanatlı, at ve küçük ev hayvanlarının diyetlerinde kullanılmaktadır (Nemeskery, 1983; McCormick, 1984; Fuller, 1989; Vanbelle ve ark., 1990).

İyi bir probiyotik, patojen olmamalı, mide ve duedenum'dan geçişi sırasında buradaki yüksek asitliğe toleranslı olmalı, ince bağırsağın üst kısmından geçişi sırasında safra tuzlarına karşı dirençli olmalı, bağırsak epitel hücrelerinde kısa sürede kolonize olup çoğalmalı, çeşitli organik asitleri üreterek bağırsağın pH'sını düşürmeli, antimikrobiyal maddeler üreterek patojen mikroorganizmaların sindirim sisteminde barınmalarını önlemeli, peletleme sırasında yüksek sıcaklığa toleranslı olup canlılığını sürdürmeli, yemlerde kullanılan antimikrobiyal maddelere dirençli olmalı, depolanma süresince canlılığını ve stabilitesini korumalı, konakçıya spesifik olmalı, antikor üretimini teşvik ederek bağışıklık sistemini güçlendirmelidir (Nousiainen ve Setala, 1993; Tuncer, 2000).

Probiyotikler üzerine yapılan çalışmalar ve probiyotiklerin öneminin anlaşılması prebiyotiklerin gelişmesine yol açmıştır.

Prebiyotikler, sınırlı sayıdaki kolonik bakterilerin aktivitesini selektif olarak artıran ve böylece konakçının sağlığını geliştirerek konakçıya olumlu etkide bulunan sindirilmeyen gıda maddeleridir (Gibson ve Roberfroid, 1995). Prebiyotikler, bağırsaktaki yararlı mikrofloranın gelişimini teşvik eder, sindirimin düzenli ve sağlıklı bir şekilde gerçekleşmesi için olumlu etkide bulunur, mineral emilimini artırır, bağışıklık sistemini güçlendirir ve böylelikle tüm sağlığa katkıda bulunur. Prebiyotikler, probiyotiklerin aksine canlı olmayan gıda katkılarıdır ve etki göstermeleri için minimum dozda alınmaları gerekir. Ancak, bu gıda maddelerini doğal yoldan tüketilerek bu seviyeye ulaşmak mümkün değildir. Bu nedenle, prebiyotikler özellikle bisküviler, şekerlemeler, tahıllar, süt ürünleri, içecekler, bebek mamaları ve çocuk gıdalarına ilave edilmektedir (Nakakuki, 2003). Bir gıdanın prebiyotik olarak sınıflandırılması için, gastrointestinal yolun üst kısmında hidrolize ve absorbe olmaması, büyümeyi hızlandırıcı *Bifidobakteriler* ve *Laktobasiller* gibi sınırlı sayıdaki yararlı bakteriler tarafından selektif olarak fermente edilebilmesi ve kolonik mikroflorayı daha sağlıklı bir kompozisyona doğru değiştirmesi gerekmektedir (Kolida ve ark., 2002). Prebiyotikler, doğal olarak kuşkonmaz, muz, hindiba, sarımsak, soğan, buğday ve domates gibi sebze, meyve ve tahıllarda bulunmaktadır (Zhang, 2005).

Fonksiyonel gıda maddeleri olarak kabul edilen bulunan prebiyotikler; inulin, enzimatik olarak hidrolize edilmiş inulin (oligofruktoz) veya sentetik fruktoz oligosakkaritlerdir (Roberfroid ve Delzenne, 1998; Roberfroid ve ark., 1998). Prebiyotikler, kalın bağırsaktaki bakterilerin aktivitesini veya gelişimini seçici olarak uyararak, konakçı sağlığını olumlu yönde etkileyen gıda maddeleri olarak tanımlanmıştır (Gibson ve Roberfroid, 1995). Daha sonra bu tanım genişletilerek, "bağırsaktaki mikroorganizmalar tarafından metabolize edilmesiyle, bağırsak mikrobiyotasının kompozisyonunu ve aktivitesini düzenleyen, böylece konakçı üzerinde yararlı fizyolojik etkiler sunan sindirilmeyen bileşikler" olarak yeniden tanımlanmıştır.

Ancak, bir bileşenin prebiyotik olarak tanımlanabilmesi için;

- Sindirim kanalının üst kısımlarında hidrolize olmamalı veya emilmemeli,
- Sekum/kolondaki bir veya sınırlı sayıdaki bakterinin gelişmesini veya metabolik olarak aktivitesini uyarmak için seçici bir substrat olmalıdır,
- Kolonik florayı daha sağlıklı bir kompozisyon lehine değiştirebilmeli,

- Konakçı savunma sisteminin luminal veya sistemik yönlerini değiştirebilmeli,
- Gıda maddesi olarak işlenmesi kolay olmalı ve lezzetli olmalı,
- Bilinen bir yapıya sahip olmalı gibi birtakım özellikleri taşıması gerektiği bildirilmiştir.

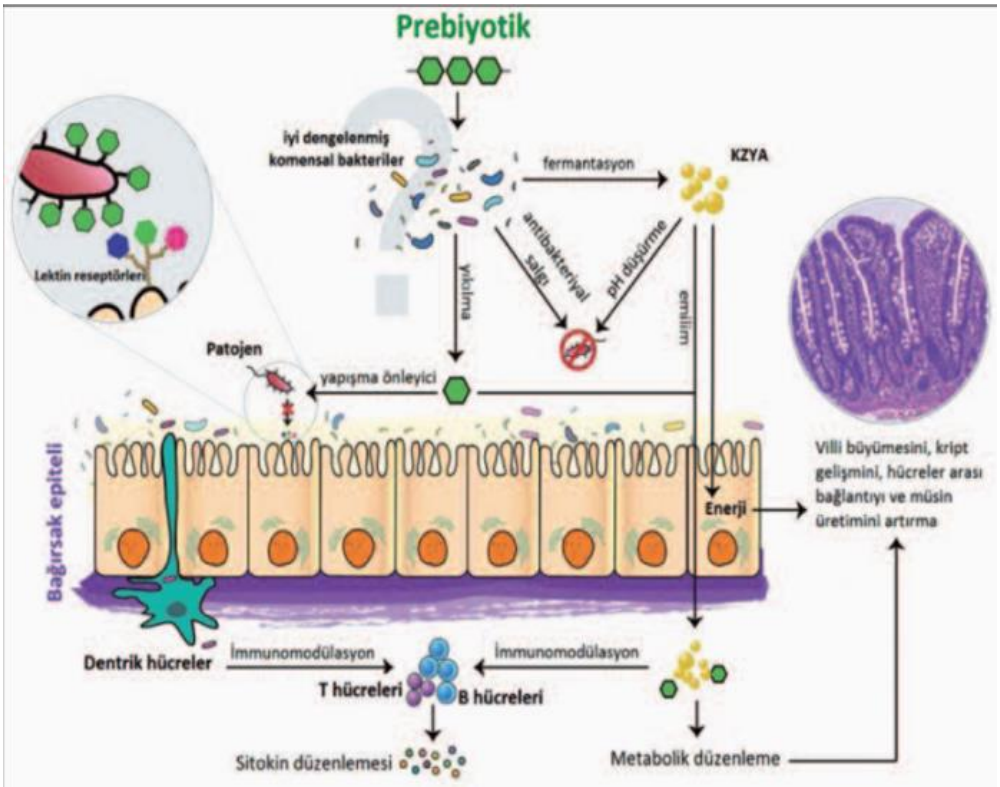
Esas olarak prebiyotikler karbonhidratların küçük parçalarıdır ve en baskın prebiyotikler fruktooligosakkaritler (FOS), oligofruktoz ve inülin gibi fruktooligosakkarit ürünleridir. (Patterson ve Burkholder, 2003). Bununla birlikte, prebiyotiklere benzer şekilde ince bağırsakta sindirilmeyen, kolonda yer alan yararlı ve patojen bakteriler için seçici olamayan substrat olarak görev alan ve kolonik gıdalar olarak tanımlanan bileşikler de mevcuttur. Bir bileşiğin prebiyotik olup olmaması, yararlı bakteriler tarafından sindirilmesine bağlıdır. Bu nedenle, her kolonik gıdanın mutlaka prebiyotik olmayacağı bildirilmiştir. Bu kolonik gıdalar veya aday prebiyotikler, dirençli nişasta, nişasta olmayan polisakkaritler, sindirilmeyen oligosakkaritler, transgalaktooligosakkaritler, glikooligosakkaritler, maltooligosakkaritler, ksilooligosakkaritler ve maya fermentasyon ürünleridir (Roto ve ark. 2015).

Kanatlı sektöründe kullanılan en yaygın prebiyotikler veya kolonik gıdalar, inulin, fruktooligosakkaritler (FOS), mannanoligosakkaritler (MOS), galactooligosakkaritler (GOS), soya-oligosakkaritleri (SOS), ksilooligosakkaritler (XOS), pirodekstrinler, isomaltooligosakkaritler (IMO), stakiyoz ve oligokitosandır. Bunlara ilaveten, kanatlılar için prebiyotik etkiye sahip olan laktozun izomeri olan laktuloz da prebiyotik olarak kanatlıların beslenmesinde kullanılmaktadır.

Prebiyotiklerin Etki Mekanizmaları

Prebiyotiklerin konakçı üzerine birçok yararlı etkileri olmasına rağmen, en temel etkileri *bifidobakteria* ve *laktobacillus* gibi probiyotik bakteriler için enerji ve karbon kaynağı olarak görev almaları ve böylece sindirim sistemi mikrobiyal dengesini sağlamalarıdır (Yadav ve ark. 2016). Prebiyotiklerin, sindirim sistemindeki bakterilerin gelişimini teşvik ettiğinden dolayı probiyotiklerden daha etkili olduğu söylenmektedir (Sugiharto, 2016). Sindirim sistemindeki yararlı bakterileri artırmasına bağlı olarak prebiyotiklerin, patojen bakterileri önleyici, bağışıklık uyarıcı, enzim reaksiyonunu artırarak, bağırsak mikrobiyal dengesini sağlayarak, amonyak ve fenol ürünlerini azaltarak bağırsak sağlığını koruyucu, kolesterol düşürücü, B vitamini sentezini ve mineral emilimini artırıcı olmak üzere çok çeşitli olumlu etkiler gösterdiği bildirilmektedir (Yadav ve ark. 2016).

Prebiyotikler, bağırsak komensal bakterileri tarafından metabolize edilir. Ayrıca, bu bakteriler prebiyotikleri kısa zincirli yağ asitlerine fermente ederler. Kısa zincirli yağ asitleri, luminal pH' yı düşürür, epitel hücreler için enerji kaynağı sağlar ve metabolik düzenlemeler üzerine önemli etkileri vardır. İyi dengelenmiş bağırsak mikroflorası ayrıca bağırsak mukozal yapısını geliştirir. Bazı bakteriler antibakteriyel bileşikler üretir ya da dentrik hücrelerine sinyal göndererek bağışıklık sistemini uyarır. Oligosakkaritler ve monosakkaritler, patojenlerin epitel hücre yüzeyine yapışması için kullanılan reseptör bölgeleri bloke ederek patojen kolonizasyonunu azaltabilir. Prebiyotiklerin konakçı üzerine olan etkileri Şekil 1'de gösterilmiştir.



Şekil 1. Prebiyotiklerin konakçı üzerine olan yararlı etkileri.

Prebiyotiklerin Kanatlıların Performansı Üzerine Etkileri

Prebiyotikler, bahsedilen etki mekanizmalarından dolayı, yem tüketimini, yemden yararlanmayı ve verim performansını artırmak, ürün kalitesini iyileştirmek, bağırsak

sağlığını korumak ve bağışıklığı güçlendirmek amacıyla kanatlılarda yaygın olarak kullanılmaktadır (Kum ve Sekkin, 2012).

Etlik piliçlerde yürütülen çalışmalarda, çeşitli prebiyotik bileşenlerin kullanılması ile kanatlı performansında önemli gelişmeler gözlendiği bildirilmiştir Yapılan çalışmada, rasyona, %0.25 fruktooligosakkarit (FOS) ve %0.05 mannanoligosakkarit (MOS) ilavesiyle, hayvanların canlı ağırlık kazançlarında artış meydana geldiği, yemden yararlanma oranı ve yem tüketiminde ise herhangi bir değişiklik olmadığı saptanmıştır (Kim ve ark. 2011). MOS kullanımıyla, genellikle etlik piliçlerin canlı ağırlıklarında ve yemden yararlanma oranlarında gelişme gözlenirken, yem tüketiminde herhangi bir değişiklik görülmemiştir.

Ancak, Al-Sultan ve ark. (2016), bu bulgulardan farklı olarak etlik piliç rasyonlarına MOS ilavesi ile birlikte yem tüketiminde azalma meydana geldiğini bildirmişlerdir. Yürütülen diğer çalışmada, etlik piliç rasyonlarına inülin, oligofruktoz, ksilooligosakkarit, β-glukan, izomaltooligosakkarit ve laktuloz ilavesinin hayvanların performanslarını olumlu yönde etkilediği bildirilmiştir (Gheisar ve ark. 2016). Prebiyotiklerin, etlik piliçler dışında çeşitli kanatlı türlerinde de performans kriterleri üzerine olan etkilerinin araştırıldığı birçok çalışma bulunmaktadır. Bu çalışmalarda, yumurtacı tavuklarda, bıldırcınlarda ve hindilerde, etlik piliçlerde olduğu gibi prebiyotik ilavesiyle birlikte performans parametrelerinde gelişmeler gözlendiği bildirilmiştir (Abdelqader ve ark. 2013).

Prebiyotiklerin Kanatlıların Sağlığı Üzerine Etkileri

Prebiyotiklerin konakçının bağışıklık fonksiyonları üzerine olan etkileri tam olarak anlaşılamamakla birlikte, başlıca etkisinin sindirim sisteminde yer alan *Bifidobacterium sp. ve Lactobacillus sp.*'ın belirli bütirat üreten bakterilerin büyümesini seçici olarak uyarmasından kaynaklandığı bildirilmektedir (Alloui ve ark. 2013).

Bu bakterilerin artmasıyla birlikte, prebiyotiklerden kısa zincirli yağ asitlerinin (KZYA) oluşumu da artış göstermektedir. KZYA, kolonik çevre pH'sını düşürerek, müsin üretimini artırarak, bağırsakla ilişkili lenfoid dokularda (GALT) yer alan immun hücreler üzerindeki özel reseptörlere KZYA' nın bağlanmasını artırarak, IgA, T hücreleri ve NK (Natural killer) hücrelerinin sayısını artırarak *Salmonella, Camphylobacter, Clostridium perfringens ve Escherichia coli* gibi patojen bakterilerin engellenmesini sağlamaktadır (Sugiharto, 2016). Kanatlı beslemede kullanılan bazı prebiyotikler ve etkileri Çizelge 1'de verilmiştir.

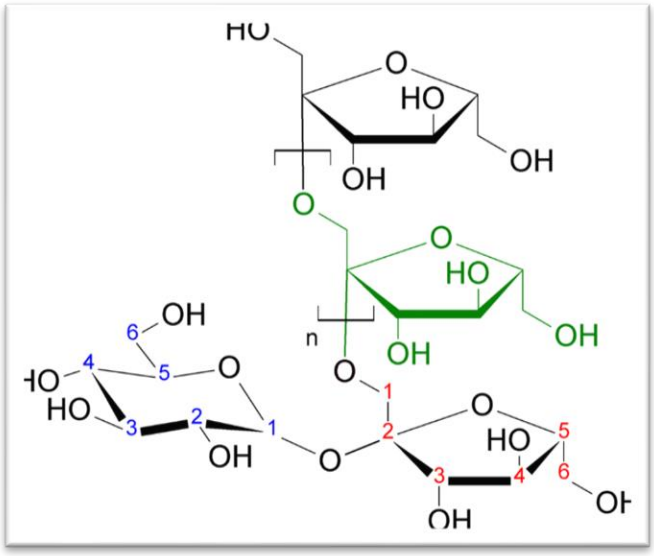
Çizelge 1. Kanatlı beslemede kullanılan bazı prebiyotikler ve etkileri.

Prebiyotik	**Tür**	**Etkisi**
MOS (1 g/kg yem)	Etlik piliç	Canlı ağırlık, canlı ağırlık artışı, yemden yararlanma oranında ve antikor üretiminde artışı.
MOS (0.75 g/kg yem)	Etlik piliç	Canlı ağırlık artışı, yemden yararlanma ve ileum villus yüksekliğinde artış, *C.perfingers* sayısında azalma.
İnülin (%1)	Etlik piliç	Canlı ağırlık, canlı ağırlık ve yemden yararlanmada artış, duodenum ve ileum villus yüksekliğinde artış ve *Enterobacteriaceae* sayısında azalma.
Ksilooligosakkarit (%0.5)	Etlik piliç	Canlı ağırlık, canlı ağırlık artışı, yemden yararlanma oranında ve ileum villus yüksekliğinde artış.
β -glukan(60 ppm)	Etlik piliç	Yemden yararlanma ve yaşama gücünde artış.
IMO (5 ve 10g/kg yem)	Etlik piliç	Canlı ağırlık artışı, yemden yararlanma sekum *Lactobacillus* ve *Bifidobacteria*'da artış, E.coli'de azalma.
Laktuloz (%0.2)	Etlik piliç	Büyüme performansı ve gerçek metabolize edilebilir. N miktarında artış, dışkı *E.coli,* NH_3 ve H_2S miktarında azalma.
İnülin (1 g/kg yem)	Yumurtacı	Yumurta verimi, yumurta ağırlığı, yumurta kabuğu kalitesi, yemden yararlanma, Ca kullanılabilirliği, bağırsak villus uzunluğu ve kript genişliği ile ileum ve sekumda *Lactobacillus* ve *Bifidobacteria*'da sayısında artış, ileum ve sekumda *Clostridum* ve *Coliform* sayısında azalma.
MOS (2 kg/t yem)	Yumurtacı	Yemden yararlanma, yumurta ağırlığı, ileum villus uzunluğu, villus genişliği ve goblet hücre sayısında artış.
İnülin (%2, 4 ve 6)	Bıldırcın	Yumurta verimi, yumurta kütlesi ve yumurta kabuğu Ca miktarında artış.
Aspergillusniger miselyum prebiyotik (%0.2)	Hindi	Canlı ağırlık, yemden yararlanma ile kemik kırılma direnci ve kemik parametrelerinde artış

MOS: Mannaoligosakkarit; IMO: İzomaltooligosakkarit.

Bitkilerin Yüksek Düzeyde İçerdiği Prebiyotikler

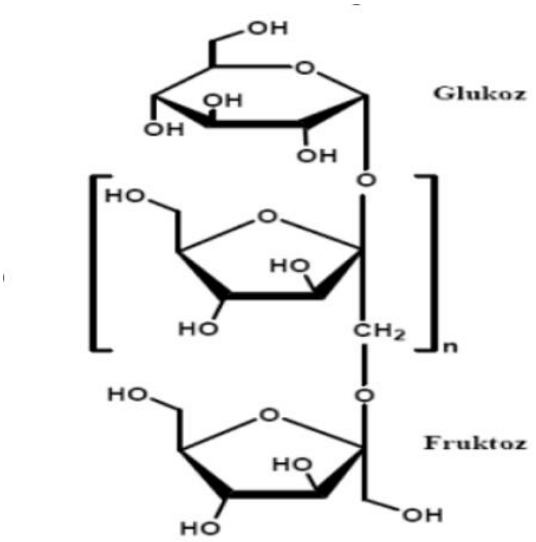
İnülin: İnülin, bitkilerde bulunan bir polisakkarittir. Soğan, sarımsak, muz, kepekli tahıllar ve enginar gibi bazı bitkilerde yüksek düzeyde bulunur. Kök ve yumrularda bulunur. Hidrolize olduğunda öncelikle fruktoz buradan da fruktozana dönüşür. Bir diğer ifadeyle, iyi bir fruktoz kaynağıdır. En tatlı şekerler grubunu oluşturur, kolay erir ve özellikle hindiba, yerelması, yıldız çiçeği ve enginarda bol bulunur. İnülinin kimyasal yapısı Şekil 2'de verilmiştir.



Şekil 2. İnülinin kimyasal yapısı.

İnülin, bitkisel kaynaklı bir fruktooligosakkarit bulunduran pek çok meyve ve sebzede bulunur. Bitkilerin yaprakları ve kökleri karbonhidrat deposu görevi görerek inülini de depo ederler.

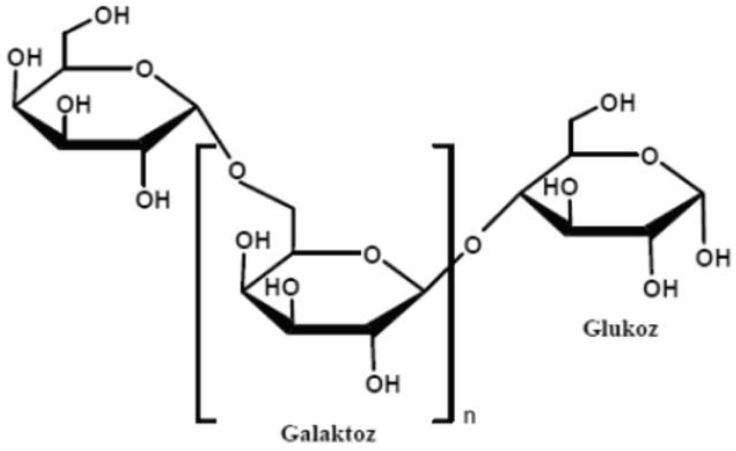
Fruktooligosakkaritler (FOS): Fruktooligosakkaritler, bitkilerde doğal olarak yüksek düzeyde bulunan bir prebiyotiktir. Fruktooligosakkaritlerin kimyasal yapısı Şekil 3'te gösterilmiştir.



Şekil 3. Fruktooligosakkaritlerin kimyasal yapısı.

Fruktooligosakkarit, muz, sarımsak, soğan, domates, buğday, kuşkonmaz, enginar, pırasa, bal, çavdar, esmer şeker, arpa, marul, hindiba, yer elması, dulavratotu, pancar, elma, çiçek soğanı gibi bitkilerde yüksek miktarda bulunmaktadır (Oliveira ve ark., 2011). Bunların yanı sıra şeker otu bitkisi (*Stevia rebaudiana bertoni*) atıklarından da elde edildiği bildirilmektedir (Lopes ve ark., 2017). Fruktooligosakkaritler (FOS), fruktozil birimlerinin 2®1 bağıyla bağlandığı kısa ve orta zincirli b-Dfruktanlardır. FOS, a-amilaz, sakkaraz veya maltaz gibi enzimlerle sindirilememektedir. FOS bakterilerin sahip olduğu b-fruktofuranosidaz enzimi ile früktoz molekülüne hidrolize olarak bakteri içerisine transfer edilmektedir. (Yerlikaya ve Karagözlü, 2009). Ayrıca Aspergillus sp. ve Aureobasidium sp. gibi bakterilerden elde edilen fruktoziltransferazlar ile sükrozdan FOS üretilir (Ölçer, 2011). Alataş ve ark. (2010), saha şartlarında yumurta tavuğu rasyonlarına ilave edilen FOS'in satılabilir yumurta ve yemden yararlanma oranını arttırdığını ve hasarlı yumurta oranı, günlük yem tüketimini düşürdüğünü tespit etmişlerdir. Ancak bu konuda rasyonlara farklı oranda FOS katılarak ve istatistiki analizlerin de yapılabileceği daha detaylı çalışmalara gereksinim olduğunu da belirtmişlerdir (Alataş ve ark., 2010).

Galaktooligosakkaritler (GOS): Dünya genelinde en çok üretilen oligosakkaritlerden biri olan GOS, sığır ve anne sütünde doğal olarak bulunmanın yanısıra, yapay olarak da sentezlenir (Cho ve Finocchiaro, 2009). GOS, galaktoz moleküllerinin laktoza bağlanması sonucu oluşur. 3 ile 6 adet sakkaritin 2-5 arası galaktoz ünitesi ile çoğunlukla β (1-4;1- 6) bağları ile bağlanması sonucu meydana gelir. Bitkisel kaynaklardan (baklagiller, soya fasulyesi) ekstraksiyon yöntemi ile izole edilirler (Bouhnik ve ark., 1997). Galaktooligosakkaritlerin kimyasal yapısı Şekil 4'te verilmiştir.



Şekil 4. Galaktooligosakkaritlerin kimyasal yapısı.

Laktoz-oligosakkaritler (LOS): Sütte bulunan bir prebiyotiktir. Anne sütünde de doğal olarak bulunur ve bazı bebek formüllerinde bulunabilir.

Arapinoksilan: Bu prebiyotik, yüksek düzeyde tahıllarda bulunan bir polisakkarittir. Buğday kepeği ve yulaf kepeği gibi tahıllar arapinoksilan içerir.

Beta-glukan*:* Yulaf, arpa, mantar ve bazı deniz ürünlerinde bulunan bir prebiyotiktir. Bağışıklık sistemini güçlendirmeye yardımcı olabilir.

Pektin*:* Meyve ve sebzelerde özellikle elma, armut, portakal, limon, havuç ve lahana gibi lifli kısımlarda bulunan bir prebiyotiktir.

Ksilooligosakkaritler (XOS): Odun selülozunda doğal olarak bulunan bir prebiyotiktir. Bu prebiyotik, bazı meyve, sebze ve tahıllarda da bulunabilir.

Rafinoz*:* Baklagillerde (fasulye, nohut, bezelye) ve bazı sebzelerde (brokoli, lahana) bulunan bir prebiyotiktir.

Laktuloz: Laktozun bazı enzimler tarafından parçalanmasıyla oluşan bir prebiyotiktir. Bu prebiyotik, bazı besin takviyelerinde ve ilaçlarda kullanılır.

Oligofruktoz: 2-9 polimerizasyon derecesine sahip olan inülinin kontrollü hidrolizi ile elde edilen prebiyotiktir.

Soyaoligosakkaritleri (SOS): Soya fasulyesinde bulunan ana oligosakkaritler rafinoz ve stakiyozdur.

Çizelge 2. Prebiyotiklerin moleküler yapısı.

Prebiyotikler	**Moleküler yapı**
Siklodekstrin	$(Gu)_n$
Fruktooligosakkaritler	$(Fr)_n$-Gu
Galaktooligosakkaritler	$(Ga)_n$-Gu
Gentioligosakkaritler	$(Gu)_n$
Glikozilsukroz	$(Gu)_n$-Fr
İzomaltooligosakkaritler	$(Gu)_n$
İzomaltuloz	$(Gu\text{-}Fr)_n$
Laktosukroz	Ga-Gu-Fr
Laktuloz	Ga-Fr
Maltooligosakkaritler	$(Gu)_n$
Raffinoz	Ga-Gu-Fr
Soyaoligosakkaritleri	$(Ga)_n$-Gu-Fr
Ksilooligosakkaritler	$(Xy)_n$

*Ga: Galaktoz, Gu: Glukoz, Fr: Fruktoz, Xy: Ksiloz.

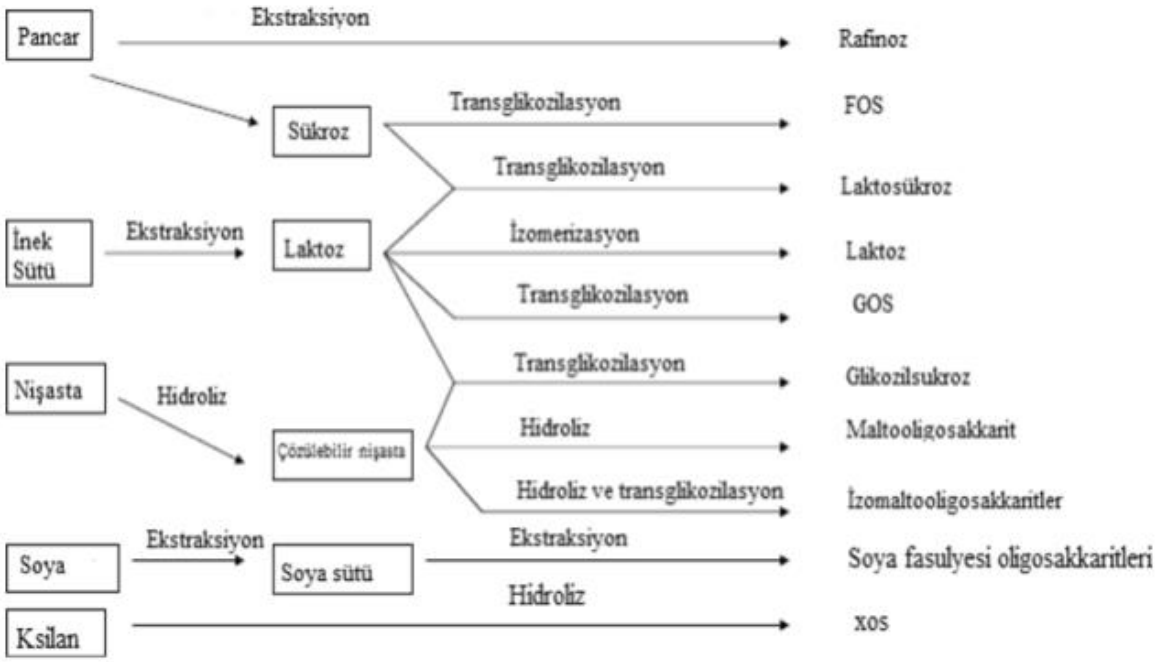
Prebiyotik Üretimi

Son yıllarda gerek insan sağlığı ve gerekse hayvanlarda yem tüketimini artıran gıda katkısı olarak oligosakkaritlerin üretimi için çok sayıda çalışma yapılmaktadır.

Prebiyotikler üç yolla elde edilirler;

- Doğal kaynaklardan direkt ekstraksiyonla, polisakkaritlerin enzimatik ve kimyasal hidroliziyle veya disakkaritlerden enzimatik ve kimyasal sentezle elde edilebilirler (Saad ve ark., 2013; Al-Sherajja, ve ark., 2013). Bitkilerden (hindiba, soğan, pırasa ve sarımsak) ekstraksiyonla elde edilen prebiyotiklere inülin, anne sütünden elde edilenlere galaktooligosakkaritler, soyadan elde edilenlere ise soyaoligosakkaritler örnek olarak verilebilir. Polisakkaritlerin enzimatik hidrolizi ile elde edilen prebiyotiklere inülinden oligofruktoz; ksilooligosakkarit ve izomaltooligosakkaritler ve mono veya disakkaritlerden elde edilenlere ise, sukrozdan frukooligosakkaritler ve laktoztan transgalaktosilatlanmış oligosakkaritler veya galaktooligosakkaritler örnek verilebilir (Wang, 2009). Yeni tiplerin

elde edilmesi için biyoteknolojiden yaygın olarak yararlanılmaktadır (Gibson, 2006). Prebiyotiklerin elde edilmesindeki üretim aşamaları Şekil 5'te verilmiştir.



Şekil 5. Prebiyotiklerin üretim aşamaları.

Bitkisel Materyallerden Prebiyotiklerin Ekstraksiyonu

Bazı prebiyotikler bitkisel materyallerde bulunmaktadır. İnülin gibi fruktanlar, hindiba ve sabır otu gibi doğal kaynaklardan ekstrakte edilirler. Hindiba gibi kolay büyüyen bitkilerden ekstraksiyon yöntemleri ile prebiyotik ürün (inülin) elde edilmesi ekonomik açıdan önemli bir avantaj sağlamaktadır (Ötleş, 2014). Soyaoligosakkaritler ise, soya fasulyesinden ekstrakte edilmektedir.

Prebiyotiklerden Hidroliz ile Üretimi

Fruktooligosakkaritler inülinin hidroliziyle üretilebilirler. Hindibadan elde edilen inülin, ortalama 4 polimerizasyon derecesine sahip fruktooligosakkaritlerin karışımını elde etmek için endo-inülin tarafından hidrolize edilebilir. Ksilooligosakkaritlerin üretimi ise, lignoselülozik materyallerden elde edilebilmektedir. Ksilanın eterik bağlarının bazıları daha düşük polimerizasyon derecesi vermesi için hidroliz edilebilir (Ötleş, 2014).

Çizelge 3. Prebiyotik kaynaklar ve üretim metotları.

Karbonhidratlar	Doğal Kaynaklar	Kimyasal Yapı	Üretim Metodu
İnülin	Meyveler ve sebzeler (soğan, muz, sarımsak vb.)	β(2-1)-Fruktanlar	Hindiba kökü ve *Agave tequilana*'dan ekstraksiyon
Fruktooligosakkaritler	Meyveler ve Sebzeler (soğan, muz, sarımsak vb.)	β(2-1)-Fruktanlar	Hindiba inülinlerinin hidrolizi veya sukrozdantransfruktosilasyonu
Galaktooligosakkaritler	İnsan sütü	Galaktoz oligomerleri ve bazı glukoz/laktoz/galakto z birimleri	B-galaktosidaz tarafından laktozdan üretimi
Soyaoligosakkaritler	Soya fasulyesi	Nişasta ve rafinozun karışımı	Soya fasulyesinde ekstrakte edilir
Ksilooligosakkaritler	Bambu filizleri, meyveler, sebzeler, süt ve bal	β(1-4) bağlı ksiloz	Ksilanın enzimatik hidrolizi,doğal lignoselülozik materyallerden enzimatik uygulamalarla, mineral asitlerin seyreltilmiş çözeltileri, su veya buharla ksilanın hidrolitik bozulmasıyla
İzomaltooligosakkaritler	Nişasta (Buğday, arpa, mısır, pirinç, patates vb	α(1-4) glukoz ve α(1-6) dallanmış glukoz	Maltozun mikrobiyal veya enzimatik transgalaktosilasyonu, sukrozdan enzimatik sentez
Pirodekstrinler	Nişasta (mercimek, sorgumun çekirdekleri, sago kökleri vb.)	Glukoz içeren oligosakkarit karışımı	Mısır veya patates nişastasının pirolizi

Prebiyotiklerin Enzimatik Glikozil Transferiyle Üretimi

Prebiyotik üretimi için yararlanılan diğer bir yöntem, enzimle katalizlenen transfer reaksiyonlarıdır. Genellikle sukroz ve galaktoz gibi uygun substratlar kullanılır ve uygun glikoziltransferaz veya glikosidaz enzimi yeni oligosakkaritler üretmek için kullanılır. Galaktooligosakkarit sentezi için tercih edilen metot glikosit hidrolazlar veya glikosiltransferazlar kullanılarak laktozdan enzimatik katalizle sentezlenmesidir. Glikoziltransferazlar ve glikosit hidrolazlar verici şekerden bir alıcıya glikozil parçasının transferinden sorumludur. Ancak GOS, sonraki uyumsuzluktan dolayı glikotransferazlardan ziyade glikozid hidrolazların katalitik aktivitesini kullanarak üretilir. Reaksiyon kinetik

olarak kontrol edilir ve böylece ürünlerin optimum verimi laktoz konsantrasyonuna ve reaksiyon zamanına bağlıdır. Ticari GOS ürünler yaklaşık olarak oligosakkaritlerin % 55' idir (Ötleş, 2014). Endüstriyel olarak sukrozdan FOS üretimi 2 şekilde gerçekleşir,

-Çözülebilir enzim kullanılan kesikli sistemle ve bütün hücre veya immobilize enzimler kullanılarak sürekli sistemler;

Galaktooligosakkaritler, β-galaktosidazın transgalaktosilaz aktivitesini kullanarak laktoz şurubundan üretilirler. Enzim kaynaklarına bağlı olarak laktozdan GOS üretiminin sonuçları final ürün tipleri ve verimlerinde oldukça farklılık gösterirler. GOS miktarı enzim kaynağına bağlıdır ve toplam şekeri %1'den 45'e değiştirebilir. Oligosakkaritler sürekli sentezlenir ve bozulabilir (Gibson ve Rastall, 2006).

IMO, çeşitli fermente olmuş gıdalardan, soya fasulyesi ve baldan doğal olarak elde edilmeltedir. IMO, enzimatik transfer reaksiyonlarının ürünleridir. Nişasta, başlangıç materyalidir ve 3 ayrı enzim tarafından hareket eder. İlk olarak, nişasta α-amilaz ve pullulanaz tarafından maltooligosakkaritlere hidrolize olur. Sonra α -glukosidaz α-1,4 bağlı maltodekstrinlerin α-1,6'ya dönüşmesini sağlar. Glukoz, ürünün daha yüksek konsantrasyonunu üretmek için uzaklaştırılır. Son üründe biriken IMO'nun maksimum konsantrasyonu yaklaşık % 40'tır (Gibson ve Rastall, 2006).

Kimyasal Sentez

Laktulaz, sadece kimyasal sentezle elde edildiğinden prebiyotikler arasında bilinmez. Fruktozdaki glukozil parçasını dönüştüren borat veya sodyum hidroksit tarafından katalizlenen laktozun izomerizasyonu ile üretilir (Ötleş, 2014).

Kanatlı Hayvan Beslemede Yaygın Olarak Kullanılan Prebiyotikler

Mannanoligosakkaritler: Mannanoligosakkaritler, maya hücre duvarlarından elde edilen ve kanatlı hayvanların bağırsak sağlığını iyileştirmeye yardımcı olan prebiyotiklerdir. Patojenik mikroorganizmaların bağırsaklara yapışmasını engelleyerek bağırsak florasını düzenlerler.

Fruktooligosakkaritler: Bitkilerde doğal olarak bulunan ve kanatlı hayvanlarda prebiyotik etkileri olan besin maddeleridir. Sindirim sistemini iyileştirir, yem emilimini artırır ve bağırsak sağlığını destekler.

Galaktooligosakkaritler: Süt ürünlerinden elde edilen prebiyotiklerdir. Kanatlı hayvanların bağırsak florasını düzenleyerek sindirim sağlığını iyileştirir ve bağırsak enfeksiyonlarını azaltabilir.

Beta-glukanlar: Mantarlar, yulaf ve bazı tahıllarda bulunan prebiyotiklerdir. Kanatlı hayvanlarda bağışıklık sistemini güçlendirir, bağırsak sağlığını destekler ve hastalıklara karşı direnci artırır.

Ksilooligosakkaritler*:* Odun selülozundan elde edilen prebiyotiklerdir. Sindirim sistemi sağlığını iyileştirir, yem emilimini artırır ve bağırsak florasının dengesini destekler.

Laktuloz*:* Laktozun bazı enzimler tarafından parçalanmasıyla oluşan bir prebiyotiktir. Kanatlı hayvanlarda bağırsak sağlığını destekleyerek sindirim verimliliğini artırabilir.

Glukanoligosakkaritler*:* Bazı bitki ve deniz ürünlerinde doğal olarak bulunan prebiyotiklerdir. Kanatlı hayvanlarda sindirim sistemi sağlığını destekler ve bağırsak mikrobiyotasını düzenler.

Arabinoksilan: Tahılların hücre duvarlarında bulunan bir prebiyotiktir. Kanatlı hayvanlarda sindirim sağlığını geliştirir ve yem emilimini artırır.

Pektin*:* Pektin, meyve ve sebzelerde özellikle elma, armut, portakal, limon ve havuç gibi lifli kısımlarda bulunan bir prebiyotiktir. Kanatlı hayvanlarda bağırsak sağlığını destekler ve sindirim sürecini iyileştirir.

Lignosellüloz: Bitki hücre duvarlarında bulunan bir prebiyotiktir. Kanatlı hayvanlarda bağırsak sağlığını iyileştirir, sindirim sistemi sağlığını destekler ve yem verimliliğini artırabilir.

SONUÇ

Prebiyotikler, bağırsak mikrobiyotasının sağlığını iyileştirmek için kullanılan besin bileşikleridir. Kanatlı hayvanlarda prebiyotik kullanımının bir dizi olumlu etkisi bulunmaktadır. İlk olarak, prebiyotikler, faydalı bağırsak bakterilerinin büyümesini teşvik ederek patojenlerin çoğalmasını engeller. Bu, gastrointestinal sistemin sağlıklı bir mikrobiyal dengesinin korunmasına yardımcı olur ve enfeksiyon riskini azaltır. Ayrıca, prebiyotikler kanatlı hayvanların bağışıklık sistemini destekler. Bağırsak mikrobiyotasının sağlıklı olması, bağışıklık yanıtlarının düzenlenmesinde önemli bir rol oynar. Prebiyotikler, immünoglobulin üretimini artırarak ve bağışıklık hücrelerinin aktivitesini etkileyerek bağışıklık sistemini

güçlendirebilir. Bununla birlikte, kanatlı hayvanlarda kullanılan prebiyotikler arasında en yaygın olarak kullanılanlar arasında oligosakkaritler ve polisakkaritler bulunmaktadır. Bu prebiyotikler, kanatlı hayvanların bağırsak sağlığını iyileştirirken, besin sindirimini artırabilir ve besin emilimini optimize edebilir.

Sonuç olarak, hayvanların bağırsak sağlığını ve bağışıklık sistemini destekleyerek sağlıklı büyümeyi teşvik etmesi ve hastalıklara karşı direncini artırması gibi olumlu etkileri nedeniyle, prebiyotiklerin kanatlı üretiminde kullanımı ve önemi gittikçe artmaktadır. Bu prebiyotikler arasında özellikle oligosakkaritler ve polisakkaritlerin kullanımının, kanatlı hayvan yetiştiriciliğinde verimliliği artırma potansiyeline sahip olduğu ortaya konulmuştur. Ancak, prebiyotikler konusunda daha fazla araştırmaya ihtiyaç duyulmakta olup, çalışmalar tür, yaş, çevresel faktörler ve besleme programları gibi çeşitli faktörlere göre optimize edilmelidir.

KAYNAKLAR

Abdelqader, A., Irshaid, R., Al-Fataftah, AR., 2013. Effects of dietary probiotic inclusion on performance, egg shell quality, cecal micro flora composition, and tibia traits of laying hens in the late phase of production. Trop Anim Health Prod;45:1017-24.

Alataş, M.S., Gürbüz, E., Balevi, T. (2010). Yumurta Tavuklarında Pik Dönemde Frukto-Oligosakkaritin Verim Performansı Üzerine Etkisi. Atatürk Üniversitesi Vet. Bil. Derg. 5(3): 121-127.

Alloui, M.N., Szczurek, W., Świątkiewicz, S., 2013. The usefulness of prebiotics and probiotics in modern poultry nutrition: A review. Ann Anim Sci. 13(1):17-32.

Alp, M., Kahraman, R., Kacobağlı, N., Eren, M., Şenel, H. S. 1993. Lactiferm-L5 ve bazı antibiyotiklerin broyler performansı, abdominal yağ ve ince bağırsak ağırlığı ile kan kolesterolüne etkileri. İstanbul Üniv. Veteriner Fakültesi Derg. 19(2):145-147.

Al-Sherajia, S.H., Ismail, A., Manap, M.Y., Mustafa, S., Yusof, R.M., Hassan, F.A., 2013. Prebiotics as functional foods: A review. Journal of Functional Foods 5: 1542-1553.

Al-Sultan, S.I., Abdel-Raheem, S.M., El-Ghareeb, W.R., Mohamed, M.H.A., 2016. Comparative effects of using prebiotic, probiotic, symbiotic and acidifier on growth performance, intestinal microbiology and histomorphology of broiler chicks. Jpn J Vet Res 64 (Supp.2):187-95.

Aravinth, A., Prakash, S., 2015. Application of prebiotics in poultry production. GJRA, 4(12):13-4.

Aytuğ, C.N. 1989. Probiyotikler ve Yoğurt. Animalia, 22: 13-15.

Bindels, L.B., Delzenne, N.M., Cani, P.D., Walter, J., 2015. Towards a more comprehensive concept for prebiotics. Nat Rev Gastroenterol Hepatol 12:303-10.

Bouhnik, Y., Flourie, B., D'Agay-Abensour, L., Pochart, P., Gramet, G., Durand, M. Rambaud, J.C. 1997. Administration of transgalacto-oligosaccha-rides increases faecal bifidobacteria and modifies colonic fermentation metabolism in healthy humans. Journal of Nutrition, 127, 444-448.

Callaway, T.R., Edrington, T.S., Harvey, R.B., Anderson, R.C., Nisbet, D.J., 2012. Prebiotics in food animals, a potential to reduce foodborne pathogens and disease. Rom Biotechnol Lett., 17(6):7808-16.

Canoğulları, S., Yıldırım, O. 2019. Effects of prebiotics and probiotics on the gut health of broilers. Turkish Journal of Veterinary and Animal Sciences, 43(5), 688-696.

Cho, S. S., Finocchiaro, T., (Eds.) 2009. Handbook of prebiotics and probiotics ingredients: health benefits and food applications. CRC Press.

Fuller, R. 1989. Probiotics in man and animals. J. Appl. Bact., 66: 365-378.

Gheisar, M.M., Hosseindoust, A., Kim, I.H., 2016. Effects of dietary Enterococcus faecium on growth performance, carcass characteristics, faecal microbiota, and blood profile in broilers. Vet Med Czech. 61(1):28-34.

Gibson, G.R., Roberfroid, M.B., 1995. Dietary modulation of the human colonic microbiota: Introducing the concept of prebiotics. Journal of Nutrition, 125: 1401-1412.

Gibson, G. R., Rastall, R. A., 2006. Prebiotics: Development & Application, John Wiley & Sons.

Hajati, H., Rezaei, M., 2010. The application of prebiotics in poultry production. Int J Poult Sci. 9 (3):298-304.

Hooper, P., 1989. The role of probiotics (intestinal inoculants) in production animals. World Association of Veterinary Food Hygienists Xth (Jubilee) International Symposium, 2-7 July, Stockholm, p.27-30.

Hooper, R., 1990. Probiotics-intestinal inoculants for production animals. In: Probiotics in Animal Nutrition of Animals. Sbornik Prednasek. Brno.Pp.69-88.

Kahraman, R., Alp, M., Kocabağlı, N., Irmak, G., Şenel, H. S., 1996. The effects of fast rack and sodium bicarbonate on performance of broilers. Tr. J. of Veterinary and Animal Sciences 20:383-386.

Kim, G.B., Seo, Y.M., Kim, C.H., Paik, I.K., 2011. Effect of dietary prebiotic supplementation on the performance, intestinal microflora, and immune response of broilers. Poult Sci 90:75-82.

Kolida, S., Tuohy, K., Gibson, G.R. 2002. Prebiotic effects of inulin and oligofructose. British Journal of Nutrition, 87(2): 193-197.

Kum, C., Sekkin, S., 2012. [Alternative approaches to antibiotics]. Turkiye Klinikleri J Vet Sci ;3(3): 84-116.

Lopes, S. M. S., Krausová, G., Carneiro, J. W. P., Gonçalves, J. E., Gonçalves, R. A. C., de Oliveira, A. J. B., 2017. A new natural source for obtainment of inulin and fructooligosaccharides from industrial waste of Stevia Rebaudiana Bertoni. Food Chemistry. (225), p.154-161.

McCormick, M.E. 1984. Probiotics in ruminant nutrition and health. Proceedings. Georgia Nutrition Conference for the Feed Industry, Atlanta, p.62-69.

Murugesan, G.R., Syed, B., Haldar, S., & Pender, C. (2015). Phytobiotics and botanical extracts as natural feed additives improving intestinal microflora in poultry. In Gut Health and Poultry Production (pp. 187-209). Springer, Dordrecht.

Nakakuki, T. 2003. Development of functional oligosaccharides in Japan. Trends in Glycoscience and Glycotechnology, 15: 57-64.

Nemeskery, T. 1983. Probiotics for young animals. Feed International, p.46-48.

Nousiainen, J., Setala, J. 1993. Lactic acid bacteria as animal probiotics. (S. Salminen and A. Von Wrright Editors). Lactic Acid Bacteria, Marcel Dekker, New York, USA, p.315-356.

Ohimain, E.I., Ofongo, R.T.S., 2012. The effect of probiotic and prebiotic feed supplementation on chicken health and gut microflora: A review. Int J Anim Vet Adv;4(2):135-43.

Oliveira, R.P.Z., Perego, P., Oliveira, M.N., Converti, A., 2011. Effect of inulin as prebiotic and symbiotic interactions between probiotics to improve fermented milk firmness. Journal of Food Engineering 107 (1) 36-40.

Ölçer, Z. (2011). Prebiyotik Üretimi. Gebze Yüksek Teknoloji Enstitüsü. Mühendislik ve Fen Bilimleri Enstitüsü Doktora Tezi.

Ötleş, S., 2014. Probiotics and Prebiotics in Food. Nutrition and Health, CRC Press.

Patel, S., Goyal, A.. 2012. The current trends and future perspectives of prebiotics research:a review. 3 Biotech 2:115-25.

Patterson, J.A., Burkholder, K.M. 2003. Application of prebiotics and probiotics in poultry production. Poultry Science, 82(4), 627-631.

Pourabedin, M., Zhao, X., 2015. Prebiotics and gut microbiota in chickens. FEMS Microbiol Lett. 362(15):1-8.

Ribeiro, T., Lordelo, M., Ponte, P., Igrejas, G. (2021). The impact of prebiotics in poultry production. Animals, 11(3), 758.

Roberfroid, M.B., Delzenne, N. 1998. Dietary fructans. Annu. Rev. Nutr., 18:117-143.

Roberfroid, M.B., Van Loo, J.A.E., Gibson, G.R. 1998. The bifidogenic nature of chicory inulin and its hydrolysis products. J. Nutr., 128: 11-19.

Roberts, T., Wilson, J., Guthrie, A., Cookson, K., Vancraeynest, D., Schaeffer, J., 2015. New issues and science in broiler chicken intestinal health: Emerging technology and alternative interventions. J Appl Poult Res. 24:257-66.

Roto, S.M., Rubinelli, P.M., Ricke, S.C., 2015. An introduction to the avian gut microbiota and the effects of yeast-based prebiotic-type compounds as potential feed additives. Front Vet Sci.2:28.

Saad, N., Delattre, C., Urdaci, M., Schmitter, J.M., Bressollier, P., 2013. An overview of the last advances in probiotic and prebiotic field. LWT - Food Science and Technology 50: 1-16.

Samal, L., Behura, N.C., 2015. Prebiotics: An emerging nutritional approach for improving gut health of livestock and poultry. Asian J Anim Vet Adv;10(11):724-39.

Sugiharto, S., 2016. Role of nutraceuticals in gut health and growth performance of poultry. J Saudi Soc Agric Sci. 15: 99-111.

Tuncer, İ. 2000. Kanatlı rasyonlarında probiyotik kullanımı. Çiftlik Dergisi, Mayıs, 195: 39-42.

Vanbelle, N., Teller, E., Focant, M. 1990. Probiotics in animal nutrition: A review. Arch. Anim. Nutr., 40: 543-567.

Wang, Y., 2009, Prebiotics: Present and future in food science and technology. Food Research International 42: 8–12

Yadav, A.S., Kolluri, G., Gopi, M., Kumaragurubaran, K., Malik, S.Y., Dhama, K., 2016. Exploring alternatives to antibiotics as health promoting agents in poultry- a review. J Exp Biol Agr Res. 4, (3): 368-83.

Yerlikaya, O., Karagözlü, C. (2009). Prebiyotik Ürünler ve İnsan sağlığına Etkileri. Akademik Gıda 7 5: 51- 55.

Zhang, Z. 2005. Development of probiotics and prebiotics-opportunities and challenges. www.ttcbinzen.de/ttcsite/dokumente/zhang.pdf

ILIMAN BÖLGELERE UYGUN GELİŞMİŞ KARMA MAHSUL-YEM-HAYVANCILIK YÖNETİMİ KONSEPTİ: LİVESTOCKPLUS

Feyza Döndü BİLGİN (ORCID: 0000-0002-7435-4130)
Aydın Adnan Menderes Üniversitesi, Koçarlı MYO, Bitkisel ve Hayvansal Üretim Bölümü, Aydın

ÖZET

Dünyanın farklı bölgelerinde hayvancılık sektörü farklı sorunlarla ve farklı çözüm önerileriyle karşı karşıyadır. "LivestockPlus" yaklaşımı, "Uluslararası Tropikal Tarım Merkezi" tarafından dünyanın ılıman bölgeleri için yeni tasarlanmış bir çözüm önerisidir. Bu konseptte, iyileştirilmiş yem bitkilerinin, uygun şekilde yönetildiğinde tropik bölgelerde karma mahsul-yem-hayvancılık sistemlerinin sürdürülebilirliğini nasıl güçlendireceğini ve birçok sosyal, ekonomik ve çevresel hedefe nasıl katkıda bulunabileceğini göstermektedir. Bu yaklaşımda, ılıman bölgelerde, süt ve et üretimindeki verim farklarını azaltmak için strese dayanıklı, iklime dirençli buğdaygil ve baklagil yem bitkileri geliştirmek, yem seçeneklerini çeşitlendirmek, işlevsel biyolojik çeşitliliği artırmak, yeni çeşit karışımları keşfetmek, özellikle kurak mevsimde yem kısıtına karşı mahsul artıklarını yemlerle birlikte kullanmak gibi uygulamaların sinerjisinden faydalanmak tavsiye edilmektedir. Bu sayede, arazi bozulmasının tersine çevrilmesi, sera gazı emisyonlarının azaltılması, toprakta karbon birikimi sağlamak, topraktan N_2O emisyonunu azaltmak mümkün olabilecektir. Sistemin başarısı için yem araştırmacıları, hayvan yetiştiricileri, genetikçiler, politika yapıcılar, yayımcılar, çiftçiler ve tüketiciler arasındaki etkileşimi, bu paydaşlar tarafından kullanılacak karar destek araçlarını geliştirmeye, yem sistemine çok sayıda paydaşla müdahaleler yapmaya ve tutumlarını etkilemeye vurgu yapılmaktadır.

Anahtar Kelimeler: LivestockPlus, ılıman, tropik, karma hayvancılık, yem üretimi

ADVANCED MIXED CROP-FORAGE-LIVESTOCK MANAGEMENT CONCEPT FOR TEMPERATE REGIONS: LIVESTOCKPLUS

ABSTRACT

The livestock industry in different parts of the world faces different solutions for different problems. The "LivestockPlus" approach is a newly designed solution proposal for the temperate regions of the world by the "International Center for Tropical Agriculture". This concept demonstrates how improved forage crops, when properly managed, can strengthen the sustainability of mixed crop-forage-livestock systems in the tropics and contribute to many social, economic and environmental goals. In temperate regions, to reduce yield differences in milk and meat production, the synergy of practices such as developing stress-resistant, climate-resistant forage grasses and legumes, diversifying feed options, increasing functional biodiversity, discovering new variety mixtures, and using crop residues together with conventional feed against feed shortages especially in the dry season is recommended. In this way, it will be possible to reverse land degradation, reduce greenhouse gas emissions, ensure carbon accumulation in the soil, and reduce N2O emissions from the soil. For the success of the system, emphasis is placed on the close interaction between feed-forage researchers, animal breeders, geneticists, policy makers, publishers, farmers and consumers; along with developing decision support tools to be used by these stakeholders, for intervening with multiple stakeholders in the feed system and influencing their attitudes.

Keywords: LivestockPlus, temperate, tropical, mixed livestock farming, feed production

1. Giriş

Dünyanın farklı bölgelerinde hayvancılık sektörü farklı sorunlarla karşı karşıyadır. Bu sorunların en önemlileri, düşük verimlilik, toprak erozyonu ve pazarlara yetersiz giriş nedeniyle düşük karlılıktır (Arango ve ark., 2019). Tarımsal üreticiler, düşük çiftlik verimleri ve kendi alanlarında zayıflayan ekosistem hizmetleriyle boğuşmaktadır. Bazı durumlarda, tarımsal üretim sistemleri sosyoekonomik ve ekolojik (kaynakların korunması ve kullanımı ve doğaya etkisi) açıdan büyük ölçüde sürdürülemez olarak değerlendirilebilir. Küçük çiftçilerin geçim kaynaklarının iyileştirilmesi de dahil olmak üzere birçok faydanın sağlanmasını teşvik edecek araçlar olarak hizmet edebilecek yeni teknoloji ve yönetim seçeneklerine ihtiyaç vardır. Yalnızca verimli (daha az kaynak kullanarak ve daha az atık üretirken daha fazla mal ve hizmet üretme kavramına dayalı kalkınmayı teşvik etme aracı olarak hizmet eden) değil, aynı zamanda dikkate alınabilecek tarım sistemlerinin tasarlanmasına ve uygulanmasına izin verecek bir paradigma değişikliği gerekmektedir (Chirinda ve ark., 2017).

İklim değişikliği yakın tarihte genel olarak insani gelişmeye, özel olarak da gıda güvenliğine yönelik en büyük zorluklardan biridir. Et ve süt üretimi de dahil olmak üzere tarım, üç ana sera gazı (GHG) üretir: karbondioksit (CO_2), metan (CH_4) ve nitröz oksit (N_2O). Hayvancılık sistemlerinin tüm tarım sektörü sera gazı emisyonlarının yaklaşık %50'sine, tüm antropojenik CO_2 emisyonlarının %10'una, CH_4'ün %35-50'sine ve N_2O'nun %65–85'ine katkıda bulunduğu tahmin edilmektedir (Peters ve ark., 2012). Sera gazı emisyonları esas olarak, otlayan hayvanlardan elde edilen gübrenin enterik fermantasyonu ve mineralizasyonunun bir ürünü olan metan (CH_4) formundadır. Karbondioksit (CO_2), arazi kullanımı değişikliğinin bir ürünüdür. Nitröz oksit (N_2O) ise toprak nitrojeninin nitrifikasyon ve denitrifikasyon proseslerinden ortaya çıkmaktadır. Sera gazı üretiminin azaltılması dünya çapında tarım için bir zorluk teşkil etmektedir. Meraların bileşim kalitesini iyileştirmek için uygun mera yönetimi (otlatma yoğunluğu) ve toprağın fiziksel ve kimyasal koşullarını iyileştiren uygulamaların tasarlanması yoluyla emisyon azaltma stratejileri geliştirmek için büyük çaba sarf edilmiştir. Her ikisi de tarımsal sistemlerin sürdürülebilirliğinde kilit faktörlerdir (Durango ve ark., 2017).

Yeni teknolojilerin ve uygulamaların benimsenmesi, iklim değişikliğine uyum

sağlama ve kaynak bozulmasını iyileştirme kapasitesine sahip olmanın temelidir. Çiftçilerin belirli tarım teknolojilerinin ve uygulamalarının kullanımını teşvik eden veya zorlayan politikalara vereceği muhtemel tepkinin değerlendirilmesi de çok önemlidir. Sonuç olarak, tarımsal yeniliklerin çiftçiler tarafından benimsenme ölçeğini ve oranını tahmin etme becerisine sahip olmak, onların uyum sağlama kapasitelerini ölçmek açısından merkezi bir öneme sahiptir. 'Benimseme oranı', yeni teknolojinin veya uygulamanın belirli bir orandaki çiftlik tarafından ne kadar hızlı benimsendiğini ifade eder (Kaine & Wright, 2022)). Geniş anlamda 'basit teknoloji veya uygulama', çiftçinin aşina olduğu çalışma prensiplerine dayanan ve çiftlik sistemine entegrasyonu nispeten kolay olan teknoloji veya uygulamadır. 'Karmaşık teknoloji veya uygulama' ise, çiftçinin aşina olmadığı ilkelere dayanan ve çiftlik sistemine entegre edilmesi nispeten zor olan teknoloji veya uygulamadır. Bir teknoloji veya uygulama hakkında ilgili bilgilerin aranması, anlaşılması, değerlendirilmesi ve uygulanması için harcanan çaba ve maliyet, teknoloji veya uygulama ne kadar karmaşık olursa o kadar artar (Kuehne ve ark., 2017).

Özellikle son 20 yılda tahıl fiyatlarında insanların gıda güvenliğini azaltacak bir artış yaşanmıştır. Tahıl fiyatlarındaki bu artışa katkıda bulunan unsurlardan biri de sığırlarda tahıl bazlı yem kullanımının artmasıdır (Rudel ve ark., 2015). Yem, hayvancılıkta ana faktörlerden biri haline gelen yerel bir kaynaktır. Yem mevcudiyetinin kalitesi ve miktarı hayvancılık verimliliğini etkiler, dolayısıyla hayvancılığın gelişmesinde ana faktörlerden biridir. Potansiyel yem bitkisinin benimsenmesinin kolay olması için çiftçilerin ihtiyaçlarına uygun tür seçilmelidir. Çünkü çiftçilerin ihtiyaçlarına ve isteklerine uygun bir yeniliği benimsemeleri daha kolaydır (Pratama ve ark., 2021).

Hayvan beslemedeki iyileştirmeler ve sürdürülebilir yoğunluk, bu olumsuz etkilerin azaltılmasına yönelik en umut verici stratejilerdir. Baklagil yem bitkilerinin büyükbaş hayvan üretim sistemlerine dahil edilmesi, daha az çevresel etki ile kaba yem verimini, verimliliğini ve besin değerini artırma potansiyeline sahiptir. Ancak üreticiler tarafından benimsenmesi ve kullanımı şu nedenlerden dolayı sınırlı kalmaktadır: 1) Ekonomik faktörler 2) Bilgi eksikliği 3) Üretici tarafından algılanan faydaların sınırlı olması 4) Riskten kaçınma ve belirsizlik (Peters ve ark., 2018).

Meralarda otlatma sürecini ve hayvanların otlak yapılarına tepkisini (örneğin otlatma

yüksekliği) anlamak, etkili otlatma yönetimi için hedeflerin belirlenmesinde anahtardır (Marin Gomez ve ark., 2022). Aynı mera üzerinde birden fazla hayvan türünün bulunduğu karma otlatma oldukça yaygındır ve uzun yıllardan beri mevcuttur. Merada et üretimini artırmak için karma otlatma sistemleri uygun bir strateji olarak önerilmiştir. Karışık otlatma, geviş getiren hayvanların performansını artırmak ve mide-bağırsak nematodlarını azaltmak için kullanılabilecek alternatif bir mera yönetimidir. Karışık otlatma sistemleri üzerine yayınlanan çalışmaların çoğunluğu koyun ve sığırları kapsamaktadır; koyunlara hem üretim hem de gastrointestinal nematodların etkisinin azaltılması açısından faydalar gösterilmiştir. Bu otlatma stratejisi, aynı meradaki hayvan türleri arasındaki etkileşimlerden ve bunların tamamlayıcı seçici otlatma davranışlarından faydalanma potansiyeline sahip olabilir; bu da meranın besleme değerinde bir artışa ve/veya artık biyokütlede bir azalmaya neden olur (d'Alexis ve ark., 2014).

Meraların çeşitlendirilmesi ve temel bitki fonksiyonel gruplarının (baklagiller) dahil edilmesi genellikle besin döngüsünü iyileştirir ve sıklıkla toprakta karbon tutulmasının artmasına yol açar. Ayrıca meralara ağaçların dahil edilmesi toprak özelliklerini iyileştirirken, büyükbaş hayvanlar ve toprağın biyolojik aktivitesi için daha uygun bir mikro iklim yaratır (Arango ve ark., 2019).

Şekil 1. Silvopastoral sistemde otlayan büyükbaş hayvanlar (Peters ve ark., 2018)

Özellikle çok sayıda hayvanın yetiştirildiği tropikal bölgelerdeki küçük çiftliklerde hayvanlara ekstra yem verilmesi hedefine ulaşmak için kullanılan yeni bir teknik olan "LivestockPlus" tekniğinde, otların, çalıların, ağaçların ve hayvanların sürdürülebilir yöntemlerle yönetimine odaklanılır. İnsan gıdası ile hayvan yemi sistemlerini bu şekilde birbirinden ayırarak küresel gıda sisteminin dayanıklılığı artabilecektir. Etkili LivestockPlus yaklaşımları iki biçimden birini alır: 1) Çiftçiden çiftçiye kulaktan kulağa yayılan yeni yem çeşitleri ve hayvan yönetimi uygulamaları gibi basit iyileştirmeler veya 2) Yem üretimini çiftliklerin diğer tarımsal uğraşlarına ve tarımsal ekolojilere daha derinlemesine entegre eden karmaşık yeni teknikler dizisi (Rudel ve ark., 2015).

2. LivestockPlus nedir?

LivestockPlus, CIAT'nin (Uluslararası Tropikal Tarım Merkezi, The International Center for Tropical Agriculture), 2014-2020 dönemi için yeni tasarlanmış bir stratejik girişimdir. Uluslararası Tropikal Tarım Merkezi ve ortakları, iyileştirilmiş yem bitkilerinin, uygun şekilde yönetildiğinde tropik bölgelerde karma mahsul-yem-hayvancılık sistemlerinin sürdürülebilir şekilde güçlendireceğini ve birçok sosyal, ekonomik ve çevresel hedefe nasıl katkıda bulunabileceğini göstermek için LivestockPlus konseptini geliştirmiştir. LivestockPlus yaklaşımı ile toprak, bitkiler, hayvanlar, insanlar ve çevre arasındaki sinerjiden faydalanılarak bu hedeflere ulaşmak amaçlanmaktadır. LivestockPlus konseptinde iyileştirilmiş yem bitkileri üretiminin, çok sayıda sosyal, ekonomik ve çevresel fayda üreterek tropik bölgelerde karma ürün-yem-hayvancılık-ağaç sistemlerinin sürdürülebilir şekilde güçlendirilmesine nasıl katkı sağlayabileceği gösterilmektedir. Sürdürülebilir güçlendirme, yalnızca tropikal yem bazlı sistemlerin üretkenliğini arttırmakla kalmaz, aynı zamanda hayvancılık üretiminin ekolojik ayak izini de azaltır ve toprak kalitesinin iyileştirilmesi ve erozyon ile sera gazı emisyonlarının azaltılması gibi çeşitli ekosistem hizmetleri sağlar. İyileştirilmiş ot ve baklagil yemlerinin karma üretim sistemlerine (mahsul-hayvancılık, ağaç-hayvancılık, mahsul-ağaç-hayvancılık) entegre edilmesi, bozulmuş arazileri eski haline getirebilir ve sistemin iklim değişikliğiyle ilişkili kuraklık ve su basmasına karşı dayanıklılığını artırabilir. Tropikal yemler uygun şekilde yönetildiğinde toprakta büyük miktarlarda karbon biriktirir, atmosferik azotu baklagillerle sabitler, toprakta nitrifikasyonu engeller ve nitröz oksit emisyonlarını buğdaygillerle azaltır ve birim

hayvancılık ürünü başına sera gazı emisyonlarını azaltır. LivestockPlus konsepti, birbiriyle ilişkili üç güçlendirme sürecine dayanan yem bazlı sistemlerin sürdürülebilir güçlendirilmesi olarak tanımlanmaktadır: 1) Genetik güçlendirme (hayvancılık verimliliğini artırmak için üstün buğdaygil ve baklagil çeşitlerinin geliştirilmesi ve kullanılması); 2) Ekolojik güçlendirme (gelişmiş çiftlik ve doğal kaynak yönetimi uygulamalarının geliştirilmesi ve uygulanması); 3) Sosyo-ekonomik güçlendirme (teknolojilerin iyileştirilmesine olanak tanıyan ve bunların kalıcı kullanımını destekleyen yerel ve ulusal kurumların ve politikaların geliştirilmesi). Hayvancılık verimliliğindeki artışlar, hem ürünler hem de sağlanan ES için yatırımları ve adil piyasa tazminatını teşvik eden destekleyici hükümet, sivil toplum kuruluşları ve özel sektör politikalarının geliştirilmesine yönelik koordineli çabalar gerektirecektir. Yem bazlı sistemlerin tarımsal ve çevresel faydalarını destekleyen etkili geliştirme araştırma çabaları, LivestockPlus'ın çeşitli coğrafi, politik ve sosyo-ekonomik bağlamlarda uygulanmasına katkıda bulunabilir (Rao ve ark., 2015).

3. Sürdürülebilir genetik güçlendirme

Genetik güçlendirme, hayvancılık verimliliğini artırmak için gelişmiş özelliklere sahip buğdaygil ve baklagil çeşitlerinin geliştirilmesi ve kullanılmasıdır. Bu, gelişmiş hayvan ırklarının geliştirilmesi ve kullanılmasıyla birleştirilmelidir. Pek çok tropikal buğdaygil türleri ekili yem bitkisi olarak faydalıdır ki bazıları geniş çapta ticarileşmiştir (Cook ve ark. 2005). Son 50 yılda tropikal ve subtropik bölgelerdeki agronomik denemelerde türlerin ürettikleri otların miktarı değerlendirilmiş ve bunun sonucunda, hayvancılık üretimini iyileştirmek için yem olarak kullanılmak üzere binlerce çeşidin piyasaya sürülmesi sağlanmıştır. Bir dizi çeşit, yaygın olarak mera türü olarak kullanılmaktadır. Yarı kurak tropikler ve subtropikler için 30'dan fazla *Cenchrus ciliaris* çeşidi (şimdiki adlandırmayla *Pennisetum ciliare*) mevcuttur; bazıları yaygın olarak kullanılmaktadır. Birçok türü artık *Urochloa* spp. olarak kabul edilen *Brachiaria* cinsinden türlerinin farklı çeşitleri, tropik bölgelerde hayvan üretimine etkileyici bir katkıda bulunmuştur; örneğin *B. brizantha* cv. Marandu ve Toledo; *B. humicola* cv. Tully ve Llanero; *B. decumbens* cv. Basilisk; ve *B. ruziziensis* cv. Kennedy (Miles ve ark. 2004).

Gine otu (*Panicum maksimum*; şimdiki adlandırması *Megathyrsus maximus*) nemli ve yarı nemli tropik ve subtropik bölgelerdeki verimli topraklarda çok yüksek verimlidir.

Paspalum'un çeşitli türleri ıslak sahalara uyarlanmıştır. *Pennisetum purpureum* (napier otu veya fil otu), "kes ve taşı" sistemlerinde yaygın olarak kullanılmaktadır, ancak mevcut çeşitler, yüksek verimi sürdürmek için gübre gerektirir. Hem bitki ıslahının hem de germplazm seçiminin amaçları, kalıcı ve zararlılara ve hastalıklara karşı dirençli, yem verimi yüksek, besin değeri yüksek ve tohum verimi ve kalitesi iyi olan bitkileri tanımlamak veya üretmektir. Asitli topraklara, kuraklığa ve su basmasına karşı tolerans da önemlidir. Kuraklığa toleransı ve verimsiz topraklarda toprak besinlerini alma yeteneğini arttırmak için derin köklülük de çalışılmıştır (Rao ve ark., 2015).

Yemlik baklagiller önemli özelliklere sahiptir: 1) Tarımsal ve doğal sisteme azot katkısı sağlayan simbiyotik azot fiksasyonu yeteneği ve yüksek protein konsantrasyonlarına olma; 2) Kuraklığa toleransa katkıda bulunan ve verimsiz topraklarda besin maddelerini çekme yeteneğini artıran derin kazık köklere sahip olma; 3) Çok çeşitli kimyasal bileşikler içerme; ve 4) Geniş çapta genetik, morfolojik, taksonomik ve ekolojik çeşitliliğe sahip olma. Tropikal yemlik baklagiller yalnızca yüksek kaliteli hayvan yemi sağlamakla kalmaz, aynı zamanda toprak yapısını ve su sızmasını iyileştirir, toprak verimliliğini ve karbon birikimini artırır, ayrıca yabani ot kontrolüne ve toprağın korunmasına katkıda bulunur. Ek olarak, yemlik baklagillerin çoğu, biyohidrojenasyon ve metanogenez süreçlerine olumlu şekilde aracılık eden fenoller içerir (Jayanegara ve ark., 2011).

1930'larda, Avustralya'da, doğal meralarda doğallaştırılmış *Stylosanthes humilis*'in mevcudiyetinin hayvan büyüme oranlarını artırdığı gözlemlendi. Sonrasında baklagillerin tropikal otlaklara dahil edilmesinin yararları üzerine kapsamlı araştırmalar yapıldı. Geniş germplazm koleksiyonlarından yapılan seçimlerle, tropikal ve subtropikal Avustralya'da kullanım için *Centrosema*, *Desmodium*, *Leucaena* ve *Stylosanthes* cinslerinden türler ve çeşitler belirlendi. Yalnızca birkaç çeşit ıslah edildi; örneğin Avustralya'da *Macroptilium atropurpureum* cv. Siratro ve *Centrosema pascuorum* cv. Cavalcade. Hawaii'de ise psyllid'e dayanıklı *Leucaena* melezleri gibi. Tropikal Amerika'da odak noktası asidik, verimsiz topraklara ve biyotik kısıtlamalara uyum sağlayan baklagillerdi. Belirlenen en umut verici türler şunlardı: *Arachis pintoi*, *Cratylia argentea*, *Desmodium heterocarpon* ssp. *ovalifolium* (“*D. ovalifolium*”), *Stylosanthes capitata* ve *S. macrocephala*; son ikisi de “Estilosantes Campo Grande”de karışım olarak piyasaya sürüldü (Fernandes ve ark. 2005). *Centrosema*,

Desmodium ve *Stylosanthes* cinsindeki diğer türler de umut vericidir ancak henüz üreticiler tarafından çok az benimsenmiştir. Genel olarak, baklagil yem bitkilerinin kullanımının artması ve etkisinin önündeki ana kısıtlamaların şunlar olduğu düşünülmektedir: 1) Hastalıklar ve böcek zararlıları, örneğin *Stylosanthes*'te antraknoz (etmeni *Colletotrichum gloeosporioides*) ve *Leucaena leucocephala*'da psyllidler. 2) Anti-besleyici bileşiklerin mevcudiyeti, örneğin *L. leucocephala*'daki mimosin ve *Flemingia macrophylla*'daki tanenler. 3) Baklagillerin buğdaygil-baklagil karışımlarında baklagilin yeterli oranda kalıcılığını sağlayacak net yönetim ilkelerinin bilinmemesi. 4) Bazı durumlarda, kullanılan hayvanların genetik potansiyelinin düşük olması nedeniyle çiftçilerin hayvan üretimi artış beklentilerinin karşılanamaması (Rao ve ark., 2015).

Tropikal hayvancılık üretim sistemlerinde (mahsul-ağaç-hayvancılık sistemleri dahil) ve doğal kaynak yönetiminde kullanılan önemli ticari buğdaygil ve baklagil yem bitkileri şunlardır: 1) Buğdaygiller: *Brachiaria brizantha, Brachiaria decumbens, Brachiaria humidicola, Brachiaria* hybrids, *Cenchrus ciliaris, Chloris gayana, Cynodon nlemfuensis, Digitaria eriantha, Panicum maximum, Paspalum atratum, Pennisetum purpureum, Pennisetum* hybrids. 2) Otsu baklagiller: *Arachis pintoi, Calopogonium mucunoides, Centrosema molle, Centrosema pascuorum, Desmodium heterocarpon* subsp. *ovalifolium, Desmodium uncinatum, Lablab purpureus, Macroptilium atropurpureum, Mucuna pruriens, Pueraria phaseoloides, Stylosanthes capitata + S. macrocephala* (karışım), *Stylosanthes guianensis, Stylosanthes hamata, Stylosanthes scabra*. 3) Çalı ve ağaç baklagiller: *Calliandra calothyrsus, Cratylia argentea, Flemingia macrophylla, Gliricidia sepium, Leucaena leucocephala* (Rao ve ark., 2015).

Tropikal yem bitkilerinin üretimini artırmak, kırsal yoksulluk ve gıda güvenliği sorunlarına çözüm olacaktır. Birincisi, insanların tüketmediği ancak hayvanların tükettiği kaba yemlere ağırlık verilerek insan ve hayvan tüketimini ayrıştırarak insan gıda sisteminin dayanıklılığını artıracaktır. Bu uygulama eğer yeterince büyük olursa, temel tahıllar üzerinde aşağı yönlü fiyat baskıları yaratacak ve bu da yoksul insanların gıda güvenliğini artıracaktır. Yem bitkilerinin üretimini artırmanın ikinci yolu, çok az sermaye gerektiren bir metod olarak, daha verimli yem bitkileri veya yem bitkileri-mahsul kombinasyonları gibi yenilikleri kullanmaktır. Bu yenilikler, kırsal küçük çiftçilerin kolayca benimseyebileceği durumlardır.

Bu anlamda böyle bir yaklaşım, sanayileşmiş hayvancılık ekonomisindeki yeniliklerin asla sağlayamayacağı şekilde doğrudan kırsal kesimdeki yoksullara fayda sağlayacaktır. Üçüncüsü, yem bazlı sistemler, özellikle buğdaygiller, baklagiller ve ağaçları birlikte barındıran sistemler, kuraklık gibi hava koşullarına karşı daha dayanıklıdır. Dördüncüsü, tahıl monokültürünü terkedip çeşitlendirilmiş mahsul-hayvancılık sistemlerine geçiş, birçok küçük ölçekli üreticiyi etkileyen üretimle ilişkili mali zayıflıkları azaltacaktır. İlave tropik ormanların meraya dönüştürülmesini önlemeye yönelik güncel çabalar göz önüne alındığında, hayvan yemi arzındaki artış büyük olasılıkla meraların genişliğindeki artışlardan değil, mevcut meralarda sürdürülebilir yoğunlaşmadan kaynaklanacaktır (Rudel ve ark., 2015).

4. Ekolojik güçlendirme

Ekolojik güçlendirme, gelişmiş çiftlik ve doğal kaynak yönetimi uygulamalarının uygulanmasıdır (Rao ve ark., 2015). İyileştirilmiş yemler bireylerin, hane halklarının, toplulukların ve tüm ülkelerin refahını artırarak sosyal faydalar sağlar. Ayrıca sisteme bağlı olarak aile üyelerinin işgücü kullanımındaki artışları veya azalmaları içerir. Hayvancılık üretimindeki artışlar gıda ve beslenme güvenliğini artırabilir (Rosegrant ve ark., 2009). Diğer sosyal faydalar arasında, kurumsal ve politika değişikliklerine yol açabilecek, refah ve eşitliğin iyileştirilmesine yol açabilecek topluluk kuruluşlarına katılım kapasitesinin arttırılmasıdır. İyileştirilmiş yemler çeşitli ekonomik faydalar sağlayabilir. Çiftlik düzeyinde toprağın fiziksel, kimyasal ve biyolojik özelliklerinde meydana gelen değişiklikler gübre gereksinimlerinin azalmasına neden olabilir (Ayarza ve ark. 2007).

Yem bitkileri, artan arazi ve hayvan verimliliğine olanak tanıyabilir, bu da geçim odaklılıktan pazar odaklılığa geçişe yol açabilir. Geleneksel hayvancılık ürünleri, taze yem satışı, mera tohumu üretimi, peynir, baklagil tahıllarından elde edilen konsantreler ve organik hayvancılık ürünleri gibi özel pazar nişleri ortaya çıkabilir. Yem bazlı sistemlerin ekolojik ayak izi, besi çiftliklerine göre daha düşüktür (Rao ve ark., 2015).

Mahsul artıkları önemli bir stratejik yem kaynağıdır (Blümmel ve ark. 2012). Dünya çapında toplam mahsul artıkları yaklaşık 3,8 milyar ton DM/yıl olup, bunun %74'ü tahıllar, %10'u şeker bitkileri, %8'i baklagiller, %5'i yumrular ve %3 yağ bitkileridir (Lal, 2005). Tahıl mahsulü kalıntılarının besin kalitesi düşüktür, ancak baklagil mahsulü kalıntıları çok

besleyici olabilir. Yem bitkilerinin aksine, ürün artıklarının üretim maliyetleri bunları üreten ürüne yansıtılır (Blümmel ve ark. 2009). Yem olarak kullanılmak üzere tahıl mahsulü kalıntılarının besleyici kalitesi kimyasal, fiziksel veya biyolojik işlemlerle iyileştirilebilse de, bu teknolojilerden çok az faydalanılmıştır. Biyoyakıt üretimine yönelik ikinci nesil işlemler, bitki lignoselülozlarının şekerlere hidrolize edilmesine ve bunların daha sonra etanole fermente edilmesine odaklanmaktadır. İşlem ucuz ve verimli hale getirilebiliyorsa, düşük kaliteli saman, odunsu malzemenin hayvan yemi olarak kullanılmak üzere hidrolize edilmesi uygun bir seçenek olabilir. Karar, hidrolize malzemenin hayvan yemi olarak mı kullanılacağı yoksa etanol mü yapılacağı arasında olacaktır (Dixon ve ark., 2010).

İyi yönetilen çayır ve baklagil meraları, orman sistemleriyle kıyaslanabilir değerlere ve büyük bir karbon biriktirme potansiyeline sahiptir. Ancak mera bozulması, yem bazlı sistemler tarafından depolanan karbonu önemli ölçüde azaltabilir (Amézquita ve ark. 2010). Baklagillerin buğdaygillere dahil edilmesi veya ağaçların tarımsal ormancılık sistemlerine dahil edilmesi, yem bazlı sistemlerde biriken karbonu artırabilir. Üstelik iklimsel streslere iyi adapte olan yem bitkileri, özellikle marjinal koşullarda daha düşük net birincil üretkenliğe sahip olan tarla bitkilerine göre daha yüksek karbon biriktirme potansiyeline sahiptir (Rao ve ark., 2015). Yemlerde bulunan tanenler gibi bazı bileşikler geviş getiren hayvanların metan emisyonlarını azaltabilse de, emisyonları azaltmanın en etkili stratejisi verimliliği artırmaktır. Bu da birim hayvancılık ürünü başına metan emisyonlarını azaltır. Bu bağlamda sindirilebilirliği ve besin içeriği daha yüksek olan yemler, tüketilen birim yem başına daha az metan üretir (Oliveira ve ark. 2007). Ek olarak yemlik buğdaygillerin ve baklagillerin derin ve güçlü kök sistemleri toprak yapısını ve havalandırmayı iyileştirir. Bunu yaparken, metanı bir karbon ve enerji kaynağı olarak oksitleyici aerobik metanotroflar için uygun ortamlar oluşturur ve yem bazlı sistemlerdeki toprakları metan için önemli yutaklar haline getirir (Mosier ve ark. 2004).

Baklagil ve buğdaygil yem bitkileri karışımlarını içeren başarılı mera türlerine örnekler şunlardır: 1) *Heteropogon contortus* + baklagil *Stylosanthes humilis*, 2) *Urochloa mosambicensis* + baklagil *Leucaena leucocephala*, 3) *Urochloa mosambicensis* + baklagil *Leucaena diversifolia*, 4) *Brachiaria humidicola* + baklagil *Desmodium heterocarpon* subsp. *ovalifolium*, 5) *Brachiaria decumbens* + baklagil *Pueraria phaseoloides*, 6) *Brachiaria*

humidicola + baklagil *Arachis pintoi*, 7) *Brachiaria humidicola* + baklagil *Centrosema acutifolium*, 8) *Brachiaria humidicola* + baklagil *Stylosanthes capitata*, 9) *Brachiaria brizantha* + baklagil *Cratylia argentea*, 10) *Brachiaria humidicola* + *Hyparrhenia rufa* + *Cynodon dactylon* + baklagil *Stylosanthes scabra*, 11) *Brachiaria decumbens* + baklagil *Cratylia argentea*, 12) *Cynodon nlemfuensis* + baklagil *Arachis pintoi*, 13) *Cynodon nlemfuensis* + baklagil *Desmodium heterocarpon* subsp. *ovalifolium*, 14) *Andropogon gayanus* + baklagil *Centrosema macrocarpum*, 15) *Andropogon gayanus* + baklagil *Canarium acutifolium* (González-Arcia et al., 2012; Rao ve ark., 2015; Mupenzi et al., 2009).

Gelişmekte olan dünyada üretilen et ve sütün çoğu ve küresel tahıl üretiminin neredeyse yarısı karma ürün-hayvancılık sistemlerinden gelmektedir (Herrero ve ark. 2010). Sürdürülebilir yoğunlaşma için hem mahsullerin hem de hayvanların performansının iyileştirilmesi esastır (McDermott ve ark. 2010). Yem sistemlerinin ürün yetiştirme sistemleriyle entegrasyonu, ürün yetiştirme sistemlerinin yoğunlaşmasından kaynaklanan olumsuz çevresel etkilerin azaltılmasına yardımcı olmalı ve periyodik restorasyon yoluyla yem sistemlerinin kalitesini arttırmalıdır (Lemaire ve ark. 2014). Ekonomik faydaları en üst düzeye çıkaracak en uygun hayvan genotiplerinin karakterizasyonu ve belirlenmesine, program ve politikaların koordine edilmesine ihtiyaç vardır (Rao ve ark., 2015).

5. Sosyo-ekonomik güçlendirme

Sosyo-ekonomik güçlendirme, teknolojinin benimsenmesini sağlayan ve kalıcı kullanımını destekleyen yerel ve ulusal kurum ve politikaların geliştirilmesini içerir. Ayrıca hem girdi hem de çıktılarla ilişkili mal ve hizmetlere adil ve etkin pazar erişimi esastır (Rao ve ark., 2015). Yem bitkilerinin tropik bölgelerde geçim kaynaklarına ve çevresel koşullara üst seviyede katkısını gerçekleştirebilmesi için üç eyleme ihtiyaç vardır: 1) Zihniyet ve tutumların değiştirilmesi; 2) Çiftçiler, araştırmacılar ve yayımcılar arasında teknoloji ve pazarın ortak gelişimi için fırsatların arttırılması; 3) Hayati önem taşıyan politikaların ve yatırımların sağlanması için kamu ve özel kuruluşlar arasındaki koordinasyonun geliştirilmesi (Rao ve ark., 2015). Kişisel ve profesyonel davranışları değiştirmek karmaşık bir girişimdir ve toplumun her düzeyinde yenilikçi politikalar ve pratik çözümler gerektirir. Farkındalığı artıran basit yaklaşımlar davranış değişikliklerini engelleyen karmaşık engelleri ortadan kaldırabilir. Sosyal uygulamaların analizi, altta yatan normların, değerlerin, kimliğin,

politikaların ve tüketim kalıplarının daha iyi anlaşılmasını sağlayabilir ve böylece baskın çevresel uygulamalara yol açan karmaşık süreçleri ortaya çıkarabilir (Barr ve ark., 2011).

Yem bitkilerinin mahsul-hayvancılık-ağaç sistemlerine entegre edilmesi için çiftçiler, yayımcılar, araştırmacılar ve politika yapıcılar arasındaki diyaloga ihtiyaç vardır. Tarım ürünü satıcıları, yerel tüccarlar, tüketiciler ve hükümet yetkilileriyle karşılıklı ilişki kurmak ve müzakere etmek güven ve işbirliğini artırır. Bu tür faaliyetler, izleme, değerlendirme ve bilgi yönetimi ve paylaşımıyla birleştiğinde, değer zincirleri boyunca hem bağlantıların sayısını hem de ilgili bağlantıların performansını artırır (Rao ve ark., 2015).

6. Sonuç

Etkili LivestockPlus yaklaşımları gelişitrmek için dikkat edilmesi gerekli noktalar özetle şunlardır: • Strese dayanıklı ve iklime dirençli buğdaygil ve baklagil yem bitkileri geliştirmek. • Metanojenezin azalmasına ve çoklu doymamış yağ asitlerinin artmasına katkıda bulunan ve insanlar için sağlık açısından önemli olan yemlik buğdaygilleri ve baklagilleri geliştirmek. • İşlevsel biyolojik çeşitliliği geliştirmek ve arazi bozulmasını azaltmak için yeni çeşit karışımları geliştirmek. • Yem araştırmacıları ile hayvan yetiştiricileri ve genetikçiler arasındaki etkileşimi geliştirmek. • Özellikle kurak mevsimde yem kısıtının üstesinden gelmek için mahsul artıklarını iyileştirilmiş yemlerle birlikte kullanmanın sinerjik etkisinden faydalanmak. • Her sistem için uygun giriş noktaları belirlemek, yoğun tarımdan yarı yoğun tarıma kadar farklı tarım sistemleri için yem sistemine çok sayıda paydaşla müdahaleler yapmak. • Yem seçeneklerini çeşitlendirerek süt ve et üretimindeki verim farklarını azaltmak. • Arazi bozulmasının tersine çevrilmesine ve sera gazı emisyonlarının azaltılmasına katkıda bulunmak. • Yem bazlı sistemlerin karbon biriktirme potansiyelini ayrıntılı olarak değerlendirmek. • İyi yönetilen ve bozulmuş meralar arasındaki karbon biriktirme kapasiteleri arasındaki farkları ölçmek ve karbon birikimi potansiyelini iyileştirmede baklagillere ve ağaçlara rol vermek. • Yem verimliliği, yem kalitesi ve sera gazı emisyonları arasındaki dengeleri analiz etmek. • Toprakta karbon birikimi, topraktan N_2O emisyonu ve monokültür buğdaygil, buğdaygil-baklagil ve buğdaygil-baklagil-ağaç ilişkilerini kullanarak toprak kalitesinin iyileştirilmesi. • Politika yapıcılar, yayımcılar ve çiftçiler tarafından kullanılacak karar destek araçları geliştirmek. • Yem bazlı mahsul-hayvancılık-ağaç sistemlerinin, üretkenlik, gıda ve beslenme güvenliği ve

çevresel faydalar açısından seçenekleri belirlemek ve alternatif senaryolarla karşılaştırmak • Çevre dostu ürünlerin, ürün farklılaştırılması yoluyla çiftçilere doğrudan ekonomik faydalarının değerlendirilmesi. • Çiftçileri ödüllendirmeye yönelik fırsatları belirlemek. • Yem temelli sistemlerle iyileştirilmiş arazi yönetiminin önemi ve potansiyeli konusunda hem üreticilerin hem de tüketicilerin zihniyetlerini ve tutumlarını etkilemek. • Teknoloji ve pazarın ortak gelişimi için fırsatları artırmak. • Hayati önem taşıyan politikaların ve yatırımların sağlanması için kamu ve özel kuruluşlar arasındaki koordinasyonun iyileştirilmesi.

Kaynakça

Amézquita, M. C., Murgueitio, E., Ibrahim, M., & Ramírez, B. (2010). Carbon sequestration in pasture and silvopastoral systems compared with native forests in ecosystems of tropical America. Grassland carbon sequestration: management, policy and economics, 11, 153.

Arango, J., Sotelo Cabrera, M. E., Gutiérrez Solís, J. F., Hincapie, B., Vazquez, E., Teutscherova, N., ... & Peters, M. (2019). Integral assessment of productive and environmental parameters of a forage-based silvopastoral system.

Ayarza, M., Amézquita, E., Rao, I., Barrios, E., Rondón, M., Rubiano, Y., & Quintero, M. (2007). Advances in improving agricultural profitability and overcoming land degradation in savanna and hillside agroecosystems of tropical America. In Advances in integrated soil fertility management in sub-Saharan Africa: challenges and opportunities (pp. 209-229). Dordrecht: Springer Netherlands.

Barr, S., Gilg, A., & Shaw, G. (2011). Citizens, consumers and sustainability:(Re) Framing environmental practice in an age of climate change. Global Environmental Change, 21(4), 1224-1233.

Blümmel, M., Anandan, S., & Wright, I. A. (2012). Improvement of feed resources and livestock feeding in mixed cropping systems. Satish Serial Publishing House, New Delhi, India. p. 459−475.

Blümmel, M., Samad, M., Singh, O. P., & Amede, T. (2009). Opportunities and limitations of food–feed crops for livestock feeding and implications for livestock–water productivity. The rangeland journal, 31(2), 207-212.

Chirinda, N., Arenas, L., Loaiza, S., Trujillo, C., Katto, M., Chaparro, P., ... & Barahona, R. (2017). Novel technological and management options for accelerating transformational changes in rice and livestock systems. Sustainability, 9(11), 1891.

Cook, B. G., Pengelly, B. C., Brown, S. D., Donnelly, J. L., Eagles, D. A., Franco, M. A., ... & Schultze-Kraft, R. (2005). Tropical Forages: an interactive selection tool.

d'Alexis, S., Sauvant, D., & Boval, M. (2014). Mixed grazing systems of sheep and cattle to improve liveweight gain: a quantitative review. The Journal of Agricultural Science, 152(4), 655-666.

de Oliveira, S. G., Berchielli, T. T., dos Santos Pedreira, M., Primavesi, O., Frighetto, R., & Lima, M. A. (2007). Effect of tannin levels in sorghum silage and concentrate supplementation on apparent digestibility and methane emission in beef cattle. Animal feed science and Technology, 135(3-4), 236-248.

Dixon, J. A., Li, X., Msangi, S., Amede, T., Bossio, D. A., Ceballos, H., ... & Szonyi, J. A. (2010). Feed, food and fuel: Competition and potential impacts on small-scale crop-livestock-energy farming systems.

Durango, S., Gaviria, X., Gonzalez, R., Sotelo Cabrera, M. E., Gutiérrez Solís, J. F., Chirinda, N., ... & Barahona Rosales, R. (2017). Climate change mitigation initiatives in beef production systems in tropical countries. CCAFS Info Note.

Fernandes, C. D., Grof, B., Chakraborty, S., & Verzignassi, J. R. (2005). Estilosantes Campo Grande in Brazil: a tropical forage legume success story. In XX International Grassland Conference: Offered papers (pp. 330-330). Wageningen Academic.

González Arcia, M., Valles de la Mora, B., Alonso Díaz, M. Á., Castillo Gallegos, E., Ocaña Zavaleta, E., & Jarillo Rodríguez, J. (2012). Effect of grazing Cratylia argentea associated with Brachiaria brizantha-Toledo on quality pasture and weight gain in Holstein× Zebu heifers. Tropical and Subtropical Agroecosystems, 15(Suppl. 2).

Herrero, M., Thornton, P. K., Notenbaert, A. M., Wood, S., Msangi, S., Freeman, H. A., ... & Rosegrant, M. (2010). Smart investments in sustainable food production: revisiting mixed crop-livestock systems. Science, 327(5967), 822-825.

Jayanegara, A., Kreuzer, M., Wina, E., & Leiber, F. (2011). Significance of phenolic compounds in tropical forages for the ruminal bypass of polyunsaturated fatty acids and the appearance of biohydrogenation intermediates as examined in vitro. Animal Production Science, 51(12), 1127-1136.

Kaine, G., & Wright, V. (2022). Relative advantage and complexity: Predicting the rate of adoption of agricultural innovations. Frontiers in Agronomy, 4, 967605.

Kuehne, G., Llewellyn, R., Pannell, D. J., Wilkinson, R., Dolling, P., Ouzman, J., & Ewing, M. (2017). Predicting farmer uptake of new agricultural practices: A tool for research, extension and policy. Agricultural systems, 156, 115-125.

Lal, R. (2005). World crop residues production and implications of its use as a biofuel.

Environment International, 31(4), 575-584.

Lemaire, G., Franzluebbers, A., de Faccio Carvalho, P. C., & Dedieu, B. (2014). Integrated crop–livestock systems: Strategies to achieve synergy between agricultural production and environmental quality. Agriculture, Ecosystems & Environment, 190, 4-8.

Marin Gomez, A., Laca, E. A., Baldissera, T. C., Pinto, C. E., Garagorry, F. C., Zubieta, A. S., ... & Carvalho, P. C. D. F. (2022). Determining the pre-grazing sward height of Kikuyu grass (Cenchrus clandestinus-Hochst. ex Chiov.) for optimizing nutrient intake rate of dairy heifers. PloS one, 17(7), e0269716.

Miles, J. W., Do Valle, C. B., Rao, I. M., & Euclides, V. P. (2004). Brachiariagrasses. Warm-season (C4) grasses, 45, 745-783.

Mosier, A., Wassmann, R., Verchot, L., King, J., & Palm, C. (2004). Methane and nitrogen oxide fluxes in tropical agricultural soils: sources, sinks and mechanisms. Tropical Agriculture in Transition—Opportunities for Mitigating Greenhouse Gas Emissions?, 11-49.

Mupenzi, M., Karenzi, E., Kanani, T., & Lussa Burasa, A. (2009). Use of supplement levels of Stylosanthes scabra (Stylo) leaf meal on milk yield of Ankole cows. Livestock Research for Rural Development, 21(5).

Peters, M., Burkart, S., Arango, J., Castiblanco, V., Cardoso Arango, J. A., & Urrea-Benítez, J. L. (2018). Sustainable forage based livestock systems. International Center for Tropical Agriculture (CIAT). CLIFOOD SDG Graduate School. November 28.

Peters, M., Rao, I. M., Fisher, M. J., Subbaraoa, G. V., Martens, S., Herrero, G., ... & Hyman, G. G. (2012). Tropical forage-based systems to mitigate greenhouse gas emissions. International Center for Tropical Agriculture (CIAT).

Pratama, I. W., Agustine, R., Astuti, A., Noviandi, C. T., Agus, A., & Putra, A. R. S. (2021). Local forage development strategies based on beef cattle farmer's preferences. In IOP Conference Series: Earth and Environmental Science (Vol. 782, No. 2, p. 022086). IOP Publishing.

Rao, I. M., Peters, M., Castro, A., Schultze-Kraft, R., White, D., Fisher, M., ... & Rudel, T. K. (2015). LivestockPlus: The sustainable intensification of forage-based agricultural systems to improve livelihoods and ecosystem services in the tropics.

Rosegrant, M. W., Fernández, M., Sinha, A., Alder, J., Ahammad, H., Fraiture, C. D., ... & Yana-Shapiro, H. (2009). Looking into the future for agriculture and AKST.

Rudel, T. K., Paul, B., White, D., Rao, I. M., Van Der Hoek, R., Castro, A., ... & Peters, M. (2015). LivestockPlus: Forages, sustainable intensification, and food security in the tropics. Ambio, 44, 685-693.

DETERMINANTS OF CROP FARMERS' EFFICIENCY DURING PRE-PEAK AND POST PEAK BOKO HARAM INSURGENCY PERIODS IN NORTH EAST, NIGERIA

Sani A.A.
Institute for Agricultural Research / Faculty of Agriculture, Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria

Oladimeji Y.U.
Institute for Agricultural Research / Faculty of Agriculture, Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria

Magaji B. D.
Institute for Agricultural Research / Faculty of Agriculture, Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria

Hussaini A.S.
Institute for Agricultural Research / Faculty of Agriculture, Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria

Ibrahim H. A.
Institute for Agricultural Research / Faculty of Agriculture, Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria
Email: yusuf.dimeji@yahoo.com

ABSTRACT

The Boko Haram insurgency's manifestation has posed a serious danger to Nigeria's agro-allied sectors since it is impeding agricultural output and associated commercial activity. In addition, the convergence of drought, environmental degradation, malnutrition, conflict, and long-standing historical socio-economic inequality and marginalization have resulted in profound reduction in agricultural production for localities in the area. This study's primary focus was to determined crop farmers' efficiency during pre-peak and post-peak insurgency periods in states of north eastern Nigeria. A multi-stage sampling procedure that included purposive and random sampling techniques and a proportional factor led to three hundred and seventy-six (376) farmers from three (3) selected States of Borno, Yobe, and Adamawa in northeastern Nigeria. Utilizing a stochastic frontier production function, the effectiveness of agricultural growers in the study area was examined. Thereafter a t-test was used to test the significant difference of pre peak and post peak the farmers' effectiveness. The results show that the mean technical efficiency of millet- and sorghum- based crop were 0.65 and 0.63, during the pre-peak compared to 0.52 and 0.49 in post-peak, respectively. Similarly, the allocative efficiency for millet- and sorghum- based farmers were 0.74 and 0.71 during the pre-peak of insurgency and 0.56 and 0.52 in post-peak period, respectively. The difference was statistically significant (P>0.01) between both mean technical and allocative efficiencies of pre- and post- peak insurgency periods. This implies that the farmers' technical

and allocative efficiency were decrease after post peak period of insurgency. The communities concerned should liaise with government to access agricultural inputs, extension services, adequate security, markets and transport infrastructures to enhance agricultural efficiency. Resettlement and rehabilitation of the population in northern eastern Nigeria should continue to allow the farming community to take advantage of opportunities in the region so as to regain and improve their productive capacity.
Keywords: Boko Haram, Farmers, Efficiency, Insurgency Pre-peak, Post -Peak

INTRODUCTION

For maximum output, agricultural development needs timely and sufficient supply of vital farm inputs. Unfortunately, because they are impoverished and unable to satisfy the rising demand for input purchases and the leasing of agricultural machinery, the bulk of our farmers have little investment capacity. The insurgency of Boko Haram has made it more difficult to access both input and output markets. The term "insurgency" refers to a planned uprising that uses armed combat and subversion to overthrow a legitimate government and cause havoc. As defined by Powell and Abraham (2006), an insurgency is a violent action taken by an individual or group of individuals to oppose or resist the administration of the law, to rebel against the established authority of the State, or to take part in an uprising. A battle for control of a disputed political area involving a state, a coalition of states, occupying powers, and one or more widely supported non-state opponents is also referred to as an insurgency (Onwauaroh *et al.*, 2017).

Millions of people in northeastern Nigeria have lost their lives and means of subsistence due to the Boko Haram conflict. Furthermore, the region's populations have seen a significant decline in agricultural output as a result of the combination of long-standing historical socioeconomic inequality and marginalization, food insecurity, conflict, displacement, and drought. Over the last ten years, the extreme food insecurity in the area has drawn attention from throughout the world (Eme et al., 2018). Due to the disruptions to farming and other economic operations, the Boko Haram insurgency has posed a serious danger to the Nigerian business climate. Significant production of staple foods such cowpeas, rice, millet, sorghum, maize, sesame, and yams, as well as fish, tomatoes, onions, and animals for both domestic and export markets, is produced in the hardest-hit areas of Borno, Yobe, and Adamawa. Nigeria has lost one of its biggest potential sources of income due to the region's severely damaged agricultural export business. Determining agricultural producers' productivity before and after the peak of the insurgency was the main objective of this research.

RESEARCH METHODOLOGY

Adamawa, Borno, and Yobe States in northeastern Nigeria were the study's locations. (Figure 1).

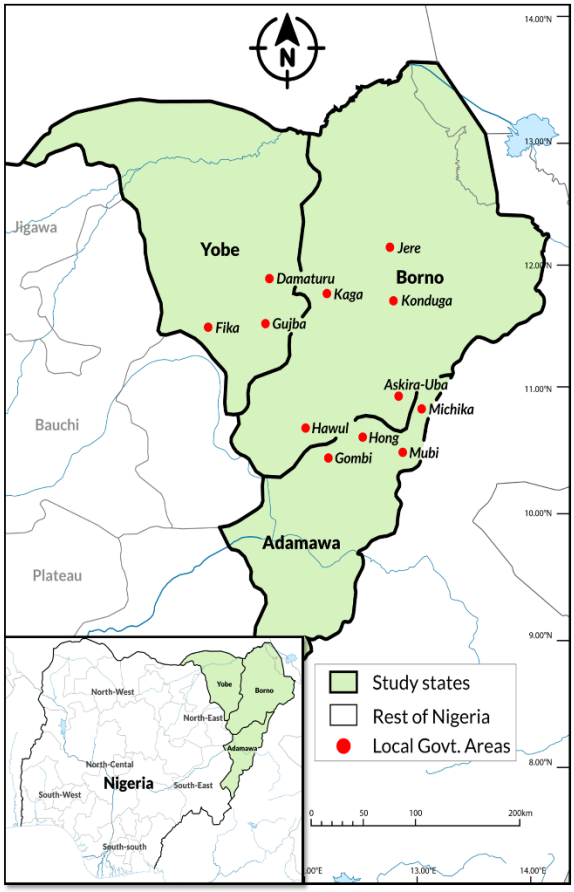


Figure 1: Map of Nigeria showing sampled states, and selected Local Government Areas

It is important to remember that the data was gathered as part of the Food and Agricultural Organization's insurgency research project, which the Institute for Agricultural Research (IAR) was in charge of. The study employed a multistage sampling technique to pick specific sites and respondents. Purposively selecting five LGAs in Borno state, three in Yobe state, and four in Adamawa state (Figure 1) was the initial step. This was done since the LGAs were the most affected by the insurgency in the states and were therefore accessible as normalcy was returning.

. Two communities were chosen at random from each of the chosen LGAs for the second stage. Lastly, the pertinent ministries and organizations in each of the three States provided the lists of farmers in each community. 376 farmers in all were chosen at random from a sample frame of 5369 farmers in the three states to participate in the survey. For this study,

both primary and secondary data were employed. The secondary data for this study came from published publications on terrorism, insurgency, agricultural production, and food security in the region. The primary data came from field surveys. Pre-peak data was gathered based on crop farming activities that occurred in or before 2012–2013, and post-peak data was gathered based on farming activities that occurred in the research area in 2019–2020.Stochastic frontier production function was used to achieve the objective of the study. The empirical model specification for technical efficiency is;

$$\ln Y_{i=} \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + V_i - U_i \quad (1)$$

Where: Y = Output (millet- and sorghum-based crop) of the ith farmers (kg). For millet- and sorghum-based systems, outputs namely groundnut and cowpea were converted to grain equal weight supporting the studies of Oladimeji *et al.* (2021) and Clark and Haswell (1970). X_1 = Farm size (hectare), X_2 = Seed (kg), X_3 = Fertilizer (kg), X_4 = Labour (Man-hour) and X_5 = Agrochemical (litres)

The inefficiency effects, V_i is a random error term assumed to be independently and identically distributed as N (0, σ^2). U_i represents technical inefficiency and is identically and distributed as a truncated normal with truncations at zero of the normal distribution (Battese *et al.*, 1993). The U_i is defined as:

$$U_i = \delta_0 + \delta_1 \ln Z_{1i} + \delta_2 \ln Z_{2i} + \delta_3 \ln Z_{3i} + \delta_4 \ln Z_{4i} + \delta_5 \ln Z_{5i} + \delta_6 \ln Z_{6i} \quad (2)$$

Where Ui is the farmer's technical inefficiency, Z_1 is the farmer's age in years, Z_2 the farmer's years of education, Z_3 is the farmer's household size in numbers, Z_4 is the farmer's participation in the cooperative association in years, Z_5 is the farmer's number of contacts with extension, and Z_6 is the farmer's access to credit in Naira.

RESULTS AND DISCUSSION

The frequency distribution of the technical efficiency estimates of millet-based and sorghum is presented in Table 1. According to the findings, the average technical efficiency of millet- and sorghum- based crop were 0.65 and 0.63, during the pre-peak of insurgency compared to 0.52 and 0.49, respectively during the post-peak-period of insurgency. Although, these results indicates that the farmers are not utilizing their production resources efficiently with during the post-peak-period of insurgency. This finding is comparable with Oladimeji *et al.* (2021), in their study of economic during the pre-peak and post-peak of the insurgency, but

when compared to efficiency and its ddeterminants in millet-based production systems in the Nigerian derived savanna zone, the technical efficiency achieved during the pre-peak of the insurgency was higher.

Table 1: Technical efficiency of millet-based and sorghum-based farmers

	Pre-peak	Post-peak			Pre-peak	Post-peak		
TE	Millet	based crop			Sorghum	Based crop		
	F	%	F	%	F	%	F	%
≤0.20	27	11.0	39	15.9	25	11.7	37	17.4
0.21-0.40	53	21.6	98	39.8	58	27.2	77	36.2
0.41-0.60	78	31.7	75	30.5	39	18.3	65	30.5
0.61-0.80	69	28.0	24	9.8	76	35.7	25	11.7
0.81-1.0	19	7.7	10	4.0	15	7.0	9	4.2
Total	246	100.0			213	100	213	100
Mean	0.65		0.52		0.63		0.49	
Stdev (±)	0.18		0.29		0.23		0.26	
Minimum	0.14		0.10		0.16		0.09	
Maximum	0.85		0.57		0.82		0.52	

Source: Field survey by FAO/IAR, 2019/2020

Similarly, the estimations of allocative efficiency's frequency distribution of millet-based and sorghum-based crop is presented in Table 2. The results show that the mean allocative efficiency of millet- and sorghum- based crop were 0.74 and 0.71, during the pre-peak insurgency compared to 0.56 and 0.52, respectively during the post-peak-period of insurgency. This also implies that substantial percentage of millet- and sorghum- based farmers were more allocative efficient in the use of production resources while insurgency was in its pre-peak phase as opposed to its post-peak phase. This result is consistent with the findings of Akpaeti and Umoh (2015), who examined the effects of conflict on agricultural productivity using data from agrarian communities in Akwa Ibom state, Nigeria, and Oladimeji et al. (2021), who studied economic efficiency and its determinants in millet-based production systems in the derived savanna zone of Nigeria

Table 2: Allocative efficiency of millet-based and sorghum-based farmers

	Pre-peak		Post-peak		Pre-peak	Post-peak		
AE	Millet				Sorghum			
	F	%	F	%	F	%	F	%
≤0.20	23	9.3	39	15.9	17	8.0	31	14.6
0.21-0.40	39	15.9	50	20.3	38	17.8	52	24.4
0.41-0.60	62	25.2	106	43.1	69	32.4	94	44.1
0.61-0.80	97	39.4	36	14.6	73	34.3	30	14.1
0.81-1.0	25	10.2	15	6.1	16	7.5	6	2.8
Total	246	100	246		213		213	
Mean	0.74		0.56		0.71		0.52	
Stdev (±)	0.09		0.27		0.08		0.28	
Minimum	0.19		0.12		0.17		0.06	
Maximum	0.89		0.69		0.84		0.64	

Source: Field survey by FAO/IAR, 2019/2020Furthermore,

Table 3: Economic efficiency of millet-based and sorghum-based farmers

EE	**Millet-based farms**				**Sorghum-based farms**			
	Pre-peak		**Post-peak**		**Pre-peak**		**Post-peak**	
	F	%	F	%	F	%	F	%
≤0.20	17	6.9	32	13.0	28	13.1	41	19.2
0.21-0.40	105	42.7	102	41.5	101	47.4	94	44.1
0.41-0.60	93	37.8	99	40.2	65	30.5	73	34.3
0.61-0.80	26	10.2	11	4.5	16	7.5	5	2.4
0.81-1.0	06	2.4	2	0.8	3	1.4	0	0
Total	246	100	246	100	213	100	213	100
Mean	0.49		0.29		0.46		0.26	
Stdev (±)	0.13		0.24		0.17		0.21	
Minimum	0.12		0.06		0.15		0.05	
Maximum	0.63		0.55		0.59		0.59	

Source: Field survey by FAO/IAR, 2019/2020

Table 3 revealed that economic efficiency regression model of millet-based and sorghum-based farmers in the study area. About 87.4 and 94.7 % of millet-based farmers both before and after the peak of the insurgency as well as 91.0 and 97.6 % of sorghum-based farmers both before and after the insurgency's peaks respectively had economic efficiency between 0.01 and 0.60. This implies that larger proportions of millet-based farmers are not economically efficient in the use of input resources during the pre-peak and post-peak insurgency. This inefficiency could arise from farmer's inability to minimize cost or maximizing the potential profit. The results on conflict and technical efficiency of resource-poor farmers using a stochastic frontier approach in Akwa Ibom State are similar to those of Akpaeti and Umoh (2012).

Determinants of economic efficiency of millet-based crop farmers

The Tobit regression analysis result, which was utilized to determine the factors influencing economic efficiency of millet- and sorghum- based cropping systems are shown in Table 4. The coefficients that were found to be statistically significant and positive increase the economic efficiency by their respective unit of coefficient. This result is consistent with the research conducted by Oladimeji et al. (2021) on the factors that influence economic efficiency in millet-based production systems located in the Nigerian derived savanna zone.

Table 4: Tobit regression estimate of factors affecting the economic efficiency of millet-based cropping system during the pre-peak and post-peak insurgency

Variable	Pre-peak of insurgency			Post-peak of insurgency		
	Coeff	Stdev	t-value	Coeff	Stdev	t-value
Constant	0.006 ***	0.002	3	-0.217**	0.094	-2.31
Marital status	1.027	0.921	1.12	0.043***	0.017	2.53
Level of education	0.521	0.389	1.34	0.327	0.279	1.17
Dependency ratio	-0.035***	0.009	-3.89	-0.328***	0.103	-3.18
Farming experience	0.008***	0.003	2.67	0.642***	0.205	3.13
Cooperative	0.221	0.25	0.88	0.108	0.095	1.14
Credit accessed	-0.008***	0.003	-2.67	-7.0E-06**	3.00E-06	-2.34
Extension contact	-0.432***	0.115	-3.76	-0.655***	0.207	-3.16
Farm size	-2.0E-05**	1.00E-05	-2.01	0.309	0.199	1.55
Non-farm income	7.0E-04**	3.00E-04	2.33	0.421***	0.106	3.97
Diagnostic statistics						
Observation	246			213		
Log-likelihood	-106.9			-93.1		
Prob> Chi	0.001***			0.0003***		
LR $chi^2(9)$	19.5			22.6		
Pseudo R^2	0.159			0.200		

Source: Field survey by FAO/IAR, 2019/2020

CONCLUSION AND RECOMMENDATIONS

post-peak insurgency and efficiencies parameters were lower during the post-peak-period of insurgency compared to during the peak-period of insurgency. The results of the Tobit regression analysis showed that the main factors contributing to inefficiency in the millet-based production system were socioeconomic and institutional variables such marital status, educational attainment, dependence ratio, experience in farming, and non-farm income Farmers operate below technical, allocative and economic efficiency during the pre-peak and.

REFERENCES

Akpaeti, A. J., & Umoh, G. S. (2012). Does conflict affect agricultural productivity: evidence from agrarian communities in Akwa Ibom state, Nigeria. *Nigeria Research*, 4(12), 77-83.

Akpaeti, A. J., & Umoh, G. S. (2015). Conflict and technical efficiency of resource poor farmers: a stochastic frontier analysis. *Russian Agric. Sci.*, 41: 299-304.

Eme O. I., Azuakor P. O., & Mba. C. C. (2018). Boko haram and population displacement in Nigeria: a case for psychological input. *Practicum Psychologia*, 8, 76-98.

Oladimeji, Y.U., Offokansi, C.C., & Egwuma,H(2021) Analysis of economic efficiency and its determinnats in millet based production systems in derived savannah zone of Nigeria.Alanya Academic Review, 5(1): 177-192 Publisher ;Alanya Alaadin Keykubat University, Turkey

Onwauaroh, A. S., Yusuf, R. O., Yusuf, O., & Akpu, B. (2017). Impact of insurgency on income of farmers in northeastern Nigeria. *Dutse J. of Pure and App Sci*, 3(2), 101-113

Powell, C.H, & Abraham, G. (2006).'Terrorism and International Humanitarian Law',1st African Yearbook of International Humanitarian Law 118:127.

BİR KEDİDE MEYDANA GELEN DOKU KAYIPLI AÇIK YARANIN RANDOMİZE DERİ FLEPİ İLE SAĞALTIMI

Doç. Dr. İlker ŞEN* (ORCID: 0000-0001-8288-4871)
Sivas Cumhuriyet Universitiy, Fakültesi of Veterinary, Department of Surgery.
Email: ilkersenn@yandex.com

Melisanur URAL (ORCID:0009-0009-3975-212)
Sivas Cumhuriyet Universitiy, Fakültesi of Veterinary, Department of Surgery.
Email: melisanurural@gmail.com

Nazlı BÜYÜKYILDIZ (ORCID:0009-0007-0792-2381)
Sivas Cumhuriyet Universitiy, Fakültesi of Veterinary, Department of Surgery.
Email: nazlibyk@gmail.com

ÖZET

Deri flepleri, maddi kayıplı büyük yaraların onarılmasında kullanılan, lezyona komşu veya bölgesel deriyi ilerleterek veya rotasyon yaptırarak defektin yara dudaklarıyla birleştirilip kapatılması yöntemidir. Deri flepleri, defektlerin hemen kapanmasını sağlar ve sekonder iyileşme nedeniyle uzun süren iyileşmeyi, taşkın granulasyon oluşumunu ve kontraktürü önler. Flepler konumlarına, beslenme orijinine ve doku oluşumuna bağlı olarak çeşitli şekillerde sınıflandırılabilirler. Çalışma materyalini sağ ön ekstremitesinde maddi kayıplı yumuşak doku lezyonu olan 1.5 yaşlı erkek bir Ankara kedisi oluşturmuştur. Genel durumunun bozuk olmasından dolayı hastaya hızlıca şok tedavisi ve devamında destek tedavi başlanmıştır. Buna paralel olarak ilgili maddi kayıplı kontamine açık yaranın antiseptikli ılık sularla temizliği yapılmış ve bölgeden toprak kökenli yabancı cisimler ve nekroze dokular uzaklaştırılmıştır. Yaranın enfeksiyonu giderildikten sonra operasyon için hasta sahibine randevu verilmiştir. Scapula düzeyinde hâlihazırda sağlam olan deri dokusu deri altı dokulardan diseke edilerek derinin hareket kabiliyeti artırılmıştır. Bu sayede yaranın scapula ve humerusun diyafizi düzeyindeki bölümü rutin dikişlerle kapatılmıştır. Antebrachiumun cranial, caudal ve lateral yönlerinde deride maddi kayıp bulunduğundan bu bölgenin kapatılması için torakoabdominal bölge üzerindeki deri dokusundan yararlanılmıştır. Diseksiyon işlemi tamamlandıktan sonra randomize paternli yarım ada flepi antebrachium üzerine doğru yönlendirilerek bölgeye dikilmiştir. Torakoabdominal bölgede meydana gelen sekonder defekt ise bölgedeki yara dudakları birbirine yaklaştırılıp dikilmesiyle kapatılmıştır. Bölge deri altı ve derinin rutin dikişleriyle kapatıldıktan sonra anestezi sonlandırılmıştır. Postoperatif 10. güne gelindiğinde bölgede otonomizasyon konseptinin tamamen sağlandığı, bölgeye kaydırılan deri flebinin neredeyse tamamen uyum gösterdiği kaydedilmiştir. Flebin radiocarpal bölgede birleştirildiği deri bölümüyle bağlantısını sağlayan dikişlerden ikisi erken dönemde açılmış ve bundan dolayı meydana gelen açık yara sekonder iyileşmeye bırakılmıştır. Bunun dışında bölgede herhangi bir komplilkasyona rastlanmamıştır. Sonuç olarak, kedilerde meydana gelen maddi kayıplı açık yaraların sağaltımında randomize flep uygulamaları alternatif bir tedavi seçeneği olarak düşünülebilir.

Anahtar Kelimeler: Açık yara, kedi, randomize deri flebi, sağaltım.

TREATMENT OF AN OPEN WOUND WITH TISSUE LOSS USING A RANDOMIZED SKIN FLAP IN A CAT

ABSTRACT

Skin flaps are a method used in the repair of large wounds with material loss, involving the advancement or rotation of adjacent or regional skin to bring together and close the defect's wound edges. These flaps facilitate the immediate closure of defects, preventing prolonged healing, excessive granulation formation, and contracture associated with secondary healing. Flaps can be classified in various ways based on their location, vascular supply, and tissue formation. A 1.5-year-old male Ankara cat with a material loss-associated soft tissue lesion on its right forelimb was included in the study. Due to the deteriorated general condition of the patient, shock and supportive treatment were initiated. Simultaneously, the contaminated open wound with tissue loss was cleaned with antiseptics, and soil-derived foreign bodies and necrotic tissues were removed from the area. After resolving the infection in the wound, an appointment for surgery was scheduled for the owner. The intact skin tissue at the scapula level was dissected from the subcutaneous tissues to enhance the mobility of the skin. Consequently, the portion of the wound at the level of the scapula and humerus diaphysis was closed with routine sutures. Due to skin loss in the cranial, caudal, and lateral directions of the antebrachium, the skin tissue from the thoracoabdominal area was utilized to close this region. After completing the dissection, a randomized patterned skin flap was directed towards the antebrachium and sutured to the area. The secondary defect in the thoracoabdominal area was closed and suturing the wound edges on this site. After closing the region with routine subcutaneous and skin sutures, anesthesia was finished. On the 10th postoperative day, autonomisation in the area was achieved, and it was noted that the transferred skin flap almost completely adapted. Two sutures connecting the flap to the skin section in the radiocarpal region failured and it resulted in an open wound. This open wound was left for secondary healing. No other complications were encountered in the region. In conclusion, randomized flap applications may be considered as an alternative treatment option in the treatment of tissue loss-associated open wounds in cats.

Keywords: Cat, open wound, randomized skin flap, treatment.

Giriş

Deride meydana gelen yaralar genellikle travmalar, yanıklar, ısırıklar, kimyasal irkiltiler ve tümör ekstirpasyonları tarafından meydana gelir. Deride meydana gelen yaralar genellikle iki yara dudağının birbirine yaklaştırılıp dikilmesiyle sağaltılır, ancak mevcut açık yara büyükse, sağaltımda deri fleplerinden yararlanılır (2, 3). Sağaltımda bu tekniğe başvurulmadığı zaman lezyon bölgesinde kalın bir skar dokusu meydana gelebilir. Maddi kayıplı açık yaralarda standart bir tedavi protokolü belirlenmemiştir. Ancak uygulama prensipleri içerisinde yara debridmanı yer almaktadır. Deri flepleri, anatomik vaskülarizasyona, kullanım yöntemine ve doku bileşenlerine dayalı olarak sınıflandırılabilir. Açık yaranın yakınındaki bölgeden alınan deri ile oluşturulan flepler yerel flep olarak adlandırılırken, yaranın uzak bir bölgesinden alınan deri ile oluşturulan flepler uzak flep olarak adlandırılır (1).

Fleplerin iyileşme süreci, cerrahi sağaltım sonrası postoperatif bakım uygulamalarının başarısına bağlıdır. Deri flebi uygulama tekniği, derinin uygulama sonrasında hayatta kalmasını desteklemek için yeterli vaskülarizasyona sahip donör bölge seçimini gerektirir. Özellikle uzak deri flepleri, lateral ön ve arka ekstremitenin yoğun maddi kayıplı yaralarının sağaltımında sıklıkla kullanılır. Donör bölge olarak da deri ve derialtı dokuların görece daha gevşek olması nedeniyle lateral torasik ve abdominal alanlardan seçilebilir (5, 7).

Bu çalışmada, sağ ön ekstremitesinde yoğun maddi kayıplı açık yara meydana gelen bir kedide, randomize deri flebinin bölgeye uygulanmasının klinik sonuçlarının değerlendirilmesi amaçlanmıştır.

Olgu Sunumu

Çalışma materyalini sağ ön ekstremitesinde maddi kayıplı yumuşak doku lezyonu olan 1.5 yaşlı erkek Ankara kedisi oluşturmuştur. Alınan anamnezde hayvanın evden kaçtığı ve bir süre sonra sağ ön ekstremitesini çevreleyen derinin scapula düzeyinden kesilerek ayak bileğine doğru sıyrıldığı bildirilmiştir. Yapılan detaylı klinik muayenesinde genel durumunun bozuk olduğu gözlenmiş ve derhal damar yolu açılarak, hastaya şok tedavisi ve destek tedavi başlanmıştır. Yaralanmış bölgenin detaylı incelemesinde antebrachiumun distalinden scapula düzeyine kadarki olan deri bölümü sıyrılarak antebrachio-carpal eklem

düzeyinde toplanmış olduğu tespit edilmiştir. Buna ek olarak, açığa çıkan derialtı ve kas dokuların toprak ve birçok toprak kökenli yabancı cisimle kontamine olduğu gözlenmiştir. Ayrıca ilgili bölgede yer yer nekroze dokuların da varlığı dikkati çekmiştir (Şekil 1).

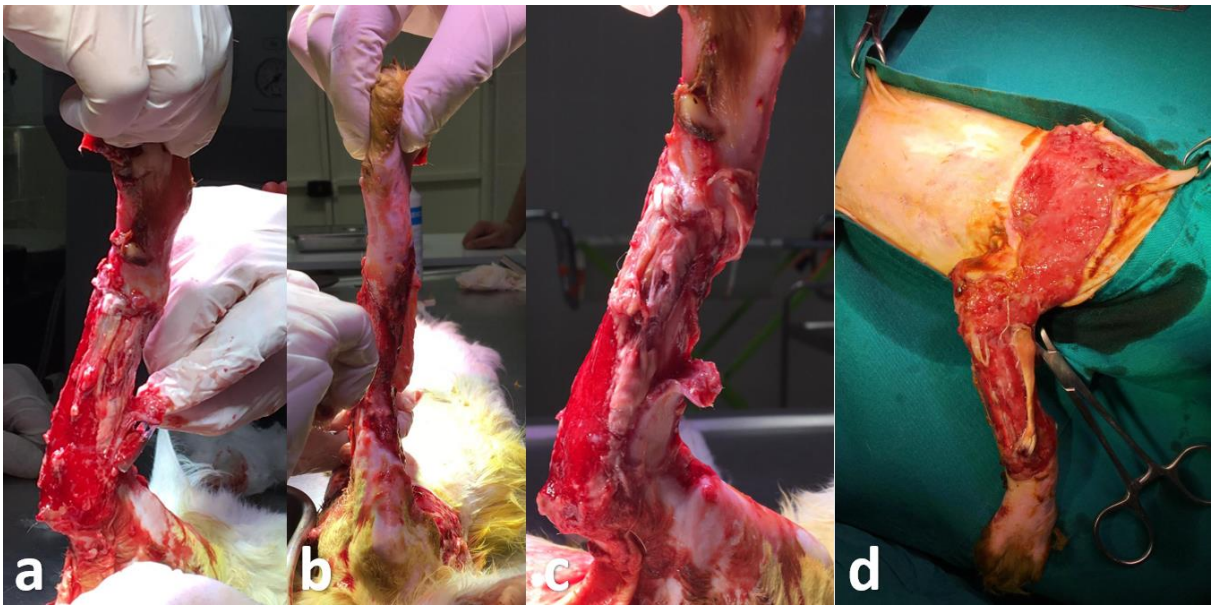
Yara bölgesinin etrafındaki ve ekstremiteden sıyrılan derinin üzerindeki kıllar uzaklaştırıldı ve bölge nemli bir pamuk yardımıyla yapışan kıllardan temizlenmiştir. Isıtılan 1000 ml'lik izotonik NaCl serum steril bir böbrek küvet içerisine boşaltılarak üzerine 1 gr toz rivanol eklenerek izotonik içerisinde eritilmiştir. Elde edilen antiseptikli izotonik içerisine ekstremite daldırılarak pansumanı yapılmış, yabancı cisimler uzaklaştırılmaya, kontaminasyon yükü azaltılmaya ve nekroze dokular uzaklaştırılmaya çalışılmıştır.

Şekil 1. a ve b) Olguya ait maddi kayıplı açık yaranın klinik muayene öncesi görüntüleri.

Yara bölgesinin enfeksiyonunun tamamen giderilmesi ve aynı zamanda postoperatif süreçte de kullanılmak üzere hastaya 25 mg/kg dozda klindamisin (Klindan® 300 mg Ampul/Bilim İlaç- İstanbul) iv olarak uygulanmaya başlanmıştır. İlgili ekstremite ıslak bandaja alınarak hasta sahibine, her gün gelmesi gerektiği söylenmiştir. Her gün bandaj değiştirilmiş ve 1 haftanın sonunda bölgenin ve hayvanın genel durumunun operasyona uygun olduğu yönünde değerlendirme yapılmış, tüm kan ve serum biyokimya analizleri yapılarak hasta sahibine operasyon randevusu verilmiştir.

Gıda ve su alımı kısıtlanarak kliniğimize getirilen kedinin damar yolu açıldıktan sonra 6 mg/kg dozda propofol iv olarak verilerek genel anestezi indüksiyonu gerçekleştirilmiştir. Daha sonra hasta entübe edilerek anestezinin idamesi izofluran ile sağlanmıştır.

Lezyonlu bölgenin steril örtülerle sınırlandırılmasından önce yaranın üzerindeki nekrotik deri alanları ve diğer nekrotik alanlar uzaklaştırılarak yaranın debridamanı yapılmıştır. Radius ulna düzeyinde bölgeyi çevreleyen yeterli deri dokusu olmadığından buraya kaydırılması planlanan flep için torakoabdominal bölgenin lateral duvarındaki kıllar geniş bir alanda uzaklaştırılmıştır. Asepsi antisepsi uygulamalarından sonra bölge steril örtülerle sınırlandırılmıştır (Şekil 2).



Şekil 2. a, b ve c) Genel anestezi altında operasyondan hemen önce bölgedeki nekrotik dokuların uzaklaştırılması ve yaranın debridemanı, **d)** lezyonun steril örtülerle sınırlandırılması.

Scapulohumeral bölge düzeyindeki canlı deri dokusu altındaki derialtı bağ dokudan dikkatlice diseke edilmiş ve serbestleşen yara dudaklarının birbirine kolaylıkla ağızlaştırılabildiği görülmüştür. Bu bölgedeki derialtı dokular ve deri rutin bir şekilde kapatılmıştır.

Antebrachiumun cranial, caudal ve lateral yönlerinde deride maddi kayıp bulunduğundan bu bölgenin kapatılması için torakoabdominal bölge üzerindeki deri dokusundan yararlanılması planlanmıştır. Bu amaçla lateral abdomen duvarından flep

oluşturmak için dikdörtgen bir ensizyon hattı oluşturulmuştur. Ancak cranial yönde herhangi bir ensizyon yapılmayarak flebin yarımada flep olması sağlanmıştır. Ensizyon hattından başlayarak derialtı dokuların flep üzerinde kalacak şekilde diseksiyonu yapılmıştır. Bu işlem sırasında ilgili flep dokusunu besleyen damarların bütünlüğü korunmuştur. Diseksiyon işlemi tamamlandıktan sonra randomize paternli yarım ada flebi antebrachium üzerine doğru yönlendirilmiştir. Flebin serbest ucu antebrachiocarpal bölgedeki sağlam deri dokusuyla ağızlaştırılacak ve çepeçevre kapatacak şekilde dikilmiştir. Flebin uzun kenarı da antebrachiumun proksimali düzeyinde canlı kalan küçük deri dokusuyla ağızlaştırılarak dikilmiş ve açık bulunan cranial, lateral ve caudal düzlemde açıkta bulunan antebrachiumun kapatılması sağlanmıştır. Abdomende meydana gelen sekonder defekt ise abdomen üzerindeki yara dudakları birbirine yaklaştırılıp dikilmesiyle kapatılmıştır. Köşeli ensizyondan kaynaklı meydana gelen fazla deri dokusu uzaklaştırılmış ve abdomen üzerindeki sekonder defektin düzgün şekilde onarımı gerçekleştirilmiştir (Şekil 3).

Şekil 3. a, b ve c) Yara dudaklarının canlandırılması, **d)** scapulohumeral düzeydeki sağlam derinin deri altı dokulardan diseksiyonu ile serbestleştirilmesi ve yara dudaklarının bir araya

getirilmesi, **e)** torakoabdominal bölgeden randomize deri flebinin hazırlanması, **f ve g)** flebin sağlam deri ile birleştirilmesi.

Postoperatif 10. güne gelindiğinde bölgede otonomizasyon konseptinin tamamen sağlandığı, bölgeye kaydırılan deri flebinin neredeyse tamamen uyum gösterdiği kaydedilmiştir. Flebin radiocarpal bölgede birleştirildiği deri bölümüyle bağlantısını sağlayan dikişlerden ikisi erken dönemde açılmış ve bundan dolayı meydana gelen açık yara sekonder iyileşmeye bırakılmıştır. Bunun dışında bölgede herhangi bir komplilkasyona rastlanmamıştır. Uzun dönemde flep olarak kullanılan derinin tüylerinin kontralateral ekstremiteye kıyasla daha uzun çıktığı gözlenmiştir (Şekil 4).

Şekil 4. a) Postoperatif 10. günde radiocarpal bölgede meydana gelen açık yara (ok), **b ve c)** postoperatif 12. ayda hastanın kendi yaşam alanında alınmış görüntüleri.

Tartışma ve Sonuç

Uzak deri flepleri, meydana gelen maddi kayıplı açık yaraların etrafında sağlıklı deri dokusu bulunmadığı durumlarda kullanılır. Bu flepler, deri, fasya, kaslar, kemikler veya bunların bazı kombinasyonlarını içeren çeşitli dokuların, ihtiyaç duyan başka bir vücut kısmına, yani alıcı bölgeye, donör yani verici bölgeden hareket ettirilmelerini içerir (6). Uzak deri flebi uygulamaları, hayvanlar iyileşme sürecinde ekstremitelerini rahat kullanamadıklarından ve uzun tedavi sürelerinden dolayı, hayvanın rahatsızlık hissetmesine, eklem sertliği yaşamasına ve kas atrofisine neden olur (4). Çalışmada donör bölge olarak torakoabdominal bölge seçilmiştir. Uygulanan randomize deri flebi ayrıca uzak deri flebi olarak da değerlendirilebilir. Cerrahi prosedür sonrası postoperatif 10. günde radiocapral bölgede flebin sağlam deri ile birleştirildiği hatta birkaç dikişin başarısız olduğu ve buna bağlı bir açıklık meydana geldiği tespit edilmiş ve bu açıklık sekonder iyileşmeye bırakılmıştır. Bu amaçla bölgeye antibiyotikli pomad ve skatrizan özellikli pomad karışımı sürülmesi önerilmiş ve yaranın 10 günde tamamen kapandığı gözlemlenmiştir. Bunun dışında herhangi bir komplikasyonla karşılaşılmamıştır. Litaretür verilerde bahsedilen kas atrofisi, eklem sertliği vb. olumsuzluklar gözlenmemiştir.

Yapılacak sağaltımın başarılı olabilmesi için flep uygulanacak alıcı bölge, nekrotik doku ve kontaminasyondan arındırılmış olmalıdır. Aseptik cerrahi prosedür, enfeksiyonu en

aza indirmek ve yara bölgesindeki kan akışını korumak amacıyla atravmatik doku manipülasyonlarını gerektirir (1). Uygulama için donör bölgeden ayrılan deri flebindeki kırmızılık, flebin beslenebildiğini, iyi bir vaskülarizasyona sahip olduğunu ve donör bölgesinden gelen vaskülarizasyona ihtiyaç duymadan hayatta kalabileceğini gösterir (2). Çalışmada donör bölgeden ayrılan randomize deri flapi sağ ön ekstremitenin radiocarpal bölgesinden distal humerus düzeyine kadarki alanda uygulanmıştır. İntraoperatif ve postoperatif dönemde uygulanan flebin vaskülarizasyonu ve ısısı kontrol edilmiş ve herhangi bir sorunla karşılaşılmamıştır.

Tüylerin uzaması, uygulanan flep prosedürünün başarısını gösterir. Tüylerin uzaması, donör bölgesiyle uyumlu olup çevresindeki deriden biraz farklı olabilir (1). Çalışmada donör bölge görece daha gevşek derialtı bağ doku ve geniş deri flapleri oluşturabilme imkanından dolayı torakoabdominal bölgeden seçilmiştir. Bu bölgeden antebrachiuma uygulanan flap başarılı bir şekilde bölgeye uyum sağlamıştır. Uzun dönem postoperatif değerlendirmelerde flap üzerindeki tüylerin uzadığı görülmüştür. Bu bölgedeki kılların, kontralateral ekstremitedeki benzer alana oranla çok daha uzun olduğu görülmüştür.

Maddi kayıplı açık yaraların sağaltımında birçok cerrahi prosedür tanımlanmıştır. sonuç olarak bu tür lezyonların sağaltımında randomize flap uygulamaları alternatif bir tedavi yöntemi olarak düşünülebilir.

Kaynaklar

1. Erwin E, Etriwati E, Zamzami RS, Hosea CTP. Moist wound dressing and its application in distant skin flap in cats. Vet World. 2021 Mar;14(3):734-738. doi: 10.14202/vetworld.2021.734-738.

2. Erwin, E., Noviana, D., Gunanti, G. and Putra, IG.A. (2016) The wound healing of lateral thoracic area with skin flap H-plasty and linear closure. J. Sain Vet., 34(2): 203-209.

3. Ferrari, R., Boracchi, P., Romussi, S., Ravasio, G. And Stefanello, D. (2015) Application of hyaluronic acid in the healing of non-experimental open wounds: A pilot study on 12 wounds in 10 client-owned dogs. Vet. World, 8(10): 1247-1259.

4. Fowler, D. (2006) Distal limb and paw injuries. Vet. Clin. North Am. Small Anim. Pract., 36(4): 819-845.

5. Lemarie, R.J., Hosgood, G., Read, R.A., Lewis, D.D., Bellah, R., Salisbury, S.K. and Goldsmid, S. (1995) Distant abdominal and thoracic pedicle skin flaps for treatment of distal limb skin defects. J. Small Anim. Pract., 36(6): 255-251.

6. Mesimeris, T.A. (2006) Compromised skin graft and flap. In: Mathieu, D., editors. Handbook on Hyperbaric Medicine. Springer, Dordrecht. p329-361.

7. Pavletic, M.M. (2010) Skin-stretching techniques. In: Pavletic, M.M., editor. Atlas of Small Animal Wound Management and Reconstructive Surgery. 3rd ed. Wiley-Blackwell, Ames. p287-305.

RATLARDA BORİK ASİDİN SERUMDA BAZI MİNERALLER ÜZERİNE ETKİSİ

Taha Can TAŞ (ORCID: 0009-0008-7274-8436)
Sivas Cumhuriyet University, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Diseases, Sivas-Türkiye
Email: tahacangs@gmail.com

Prof. Dr. Recep GÜMÜŞ (ORCID: 0000-0002-8812-191X)
Sivas Cumhuriyet University, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Diseases, Sivas-Türkiye
Email: rgumus@cumhuriyet.edu.tr

ÖZET
Bor, hem hayvan hemde insan biyolojisi için önemli bir iz element olup vücudun çeşitli organlarını ve sistemlerini etkilemektedir. Bor, toprakta, kayalarda ve suda bulunmakla birlikte doğal olarak tek bir formda bulunmaz. En çok bulunan formu ise borik asit formudur. Bu çalışmada ratların içme suyuna katılan farklı miktarlardaki borik asidin serumda mineral metabolizması ile ilgili olarak kalsiyum (Ca), fosfor (P) ve magnezyum (Mg) seviyeleri üzerine etkisi araştırıldı. Çalışmada ortalama 21 günlük yaşta 24 adet dişi rat kullanıldı. Çalışmada ratlar her grupta 8 adet olacak şekilde Grup1 (Kontrol), Grup2 ve Grup3 olmak üzere 3 gruba ayrıldı ve grupların sularına sırasıyla 0 mg/L, 100 mg/L ve 200 mg/L borik asit katıldı. Çalışma, 10 günü alıştırma, 30 günü deneme olmak üzere 40 gün sürdürüldü. Çalışmada tüm hayvanlar rat yemi ile *ad libitum* olarak beslendi. Denemenin sonunda ratlardan anestezi altında kalbinden kan alınarak serumlar çıkarıldı ve analizler yapıldı. Yapılan incelemelerde serum Ca, P ve Mg seviyelerinin tüm gruplarda istatistiksel olarak bezer olduğu tespit edildi ($P > 0.05$). Sonuç olarak elde edilen bulgulara göre ratların içme suyuna katılan borik asidin serum mineral seviyeleri üzerine etkisinin olmadığı görüldü.
Anahtar Kelimeler: Borik asit, mineral, rat, serum

EFFECT OF BORIC ACID ON SOME MINERALS IN SERUM IN RATS

ABSTRACT
Boron is an important trace element for both animal and human biology and affects various organs and systems of the body. Although boron is found in soil, rocks and water, it is not found naturally in a single form. The most common form is boric acid. In this study, the effect of different amounts of boric acid added to the drinking water of rats on serum calcium (Ca), phosphorus (P) and magnesium (Mg) levels related to mineral metabolism was investigated. The 24 female rats with an average age of 21 days were used in the study. In the study, the rats were divided into 3 groups, Group1 (Control), Group2 and Group3, with 8 in each group, and 0, 100 mg/L and 200 mg/L boric acid was added to the water of the groups, respectively. The study continued for 40 days, 10 days of adaptation and 30 days of trial. In the study, all animals were fed with rat diet ad libitum. At the end of the experiment, blood was taken from the heart of the rats under anesthesia, serum was taken and analyzed. In the examinations, serum Ca, P and Mg levels were found to be statistically similar in all groups ($P > 0.05$). As a result, according to the findings, it was seen that boric acid added to the drinking water of rats had no effect on serum mineral levels.
Keywords: Boric acid, mineral, rat, serum

Giriş

Borun yaklaşık olarak yüzyıl önce bitkiler için temel besin maddesi olduğu kabul edilmesine (Warington, 1923) rağmen hayvanlarda ve insanlardaki kesin biyolojik işlevi hala tam anlamıyla açıklığa kavuşturulamamıştır (Zumreoglu-Karan & Kose, 2015). Borun bir besin maddesi olarak gerekliliği, bunun hayvan ve insan metabolizmasındaki rolü üzerine yapılan araştırmalar giderek artan bir ilgi uyandırmakta ve bu konuda yeni çalışmalara ihtiyaç olduğunu göstermektedir. Biyolojik sistemlerde inorganik bor, ayrışmamış ortoborik asit (borik asit) [$B(OH)_3$] veya borat iyonu [$B(OH)_4^-$] halinde bulunur (Hunt, 2004). Sulu çözeltilerde bu iki form kimyasal dengededir (Warington, 1923) ve ortamın pH'ına bağlı olarak bir saniyeden daha kısa sürede bir form diğerine dönüşebilir. Kanın pH'ı 7,4 olduğundan bu iki türün kandaki bolluğu sırasıyla %98.4 borik asit ve %1.6 borat iyonu şeklinde olduğu belirtilmiştir (Zumreoglu-Karan & Kose, 2015).

Canlı metabolizmasında birçok faaliyete katılan Bor elementinin Dünya'daki rezervlerinin büyük bir kısmı Türkiye'de bulunmaktadır. Bor doğada; toprakta, kayalarda ve suda birden fazla formda bulunmaktadır ve en çok % 96 oran ile borik asit formundadır (Khaliq ve ark., 2018). Yine canlılarda metabolizmaya dahil olan bor bileşiğinin büyük bir kısmı borik asit formuna dönüşmektedir (Singh ve ark., 2021). Hafif bir asit olan borik asidin insanoğlu tarafından binlerce yıldır bilinen pek çok kullanım alanı vardır ve her gün ilaçlardan pestisitlere ve endüstriyel ürünlere kadar pek çok yeni kullanım alanı bulunmaktadır (Hosmane, 2011). Organik biyomoleküllere sahip sentetik kompleksler, beslenme ve/veya farmasötik uygulamalar için değerlendirilmektedir (Zumreoglu-Karan & Kose, 2015). Borik asit genellikle antibakteriyel, gıda koruyucusu, insektisit, zirai gübre ve temizlik malzemesi gibi birçok farklı alanda yaygın şekilde kullanılmaktadır (Bialek ve ark., 2019). Borun, hayvanlarda biyolojik, metabolik ve fizyolojik olarak oldukça fazla işlevi bulunmaktadır. Bor, bağışıklık sistemi, antioksidan ve mineral metabolizmaları üzerine etkiler göstermektedir (Bhasker ve ark., 2016).

Bu çalışmada ratların içme suyuna katılan farklı dozlardaki borik asidin serumda Ca, Mg ve P minerallerinin seviyeleri üzerine etkisi araştırılmıştır.

Materyal ve Yöntem

Deneme dizaynı, Hayvan ve Yem

Araştırmada hayvan materyali olarak Sivas Cumhuriyet Üniversitesi Deney Hayvanları Uygulama ve Araştırma Merkezi'nden temin edilen ortalama 21 günlük, toplam 24 adet dişi rat (*Wistar albino*) kullanıldı. Çalışmada Grup1 (Kontrol) grubundaki hayvanların içme suyuna 0 mg/L dozunda borik asit, Grup2' deki hayvanların içme suyuna 100 mg/L dozunda borik asit ve Grup3'teki hayvanların içme suyuna 200 mg/L dozunda borik asit katıldı. Çalışmada hayvanlar 10 gün alıştırma ve 30 gün deneme süresi olmak üzere 40 gün beslendi. Çalışmada tüm hayvanlar rat yemi ile beslendi. Yem ve su *ad libitum* olarak verildi. Çalışma süresince tüm hayvanlara konfor sıcaklığı (22°C) uygulandı.

Borik Asit

Marka: Kimyalab, Ürün kodu: V55901, Moleküler formülü: H3BO3, Saflık derecesi: %99.9, Molar kütle: 61,83 g/mol, CAS No: 10043-35-3, EC NO:233-139-2, BeyanLab Laboratuvar Ürünleri San. Tic. Ltd. Şti. İstanbul/Türkiye.

Biyokimyasal Analizler İçin Kan Örneklerin Alınması ve Analizi

Çalışmanın sonunda her gruptan 8 adet rattan anestezi altında (Ketamin HCL-Xylazin) kalpten kan alındı. Hayvanlardan antikoagulansız tüplere (Becton Dickinson Co. USA) yaklaşık 5 cc kadar alınan kanlar soğutmalı santrifüjde (Hettich 38R, Hettich Zentrifugen, Tuttlingen Germany) +4 °C'de 4000 rpm'de 10 dk santrifüj edilerek elde edilen serumlar analiz edileceği güne kadar -80 C°'de saklandı. Serum örneklerinde Ca, Mg ve P seviyeleri ticari test kitleri kullanılarak otomatik analizörde (Mindray BS-200, P.R. China) ölçüldü.

İstatistiksel Analizler

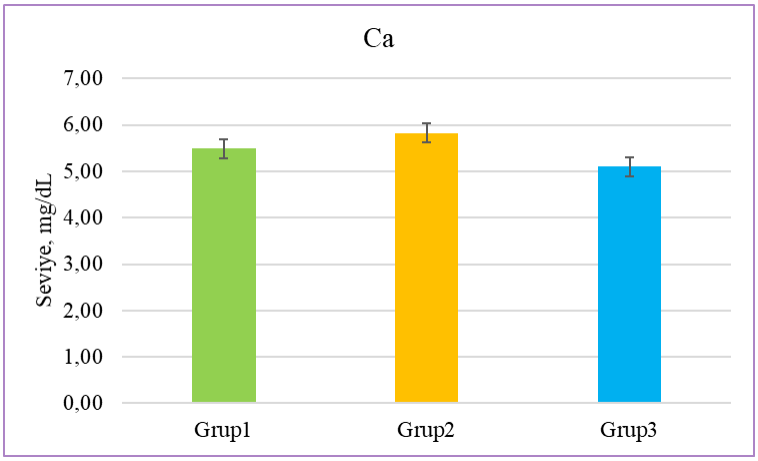
Elde edilen veriler SPSS istatistik paket programı kullanılarak değerlendirildi (SPSS, 2011). Gruplardan elde parametreler ile ilgili veriler arasında istatistiksel farklılığın olup olmadığını saptamak için tek yönlü ANOVA testi, hangi gruplar arasında farklılığın olduğunu belirlemek için Duncan testi uygulandı ($P < 0.05$).

Bulgular ve Tartışma

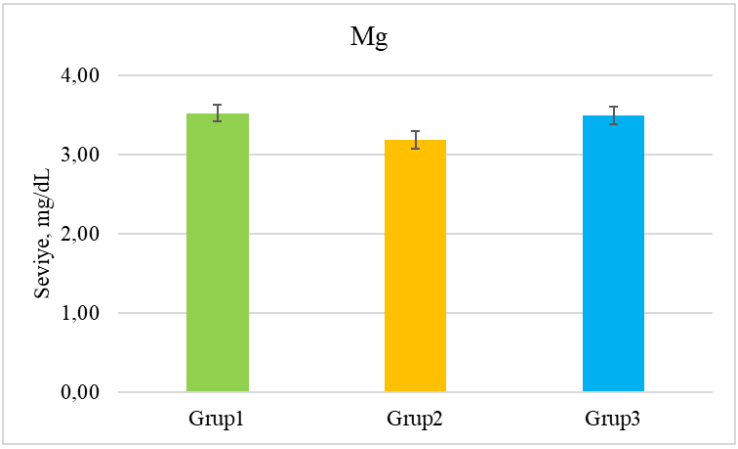
Yapılan çalışmada Grup1, Grup2 ve Grup3'te Ca seviyeleri (mg/dL) sırasıyla (ortalama±standart hata) 5.49±0.15, 5.83±0.2 ve 5.10±0.27; Mg seviyeleri (mg/dL) sırasıyla 3.53±0.26, 3.19±0.21 ve 3.5±0.3; P seviyeleri (mg/dL) sırasıyla 12.01±0.63, 13.11±0.59 ve 12.06±1.05 olarak belirlenmiştir ve gruplar arasında istatistiksel olarak farklılık olmadığı tespit edilmiştir ($P>0.05$) (Figür 1, 2 ve 3).

Canlıların besinler ve su ile aldıkları maddeler vücutta bazı metabolik parametreleri değiştirebilmektedir (Gümüş & Özbilgin, 2022). Kemik dokusunun gelişimi üzerine Ca ve P minerallerinin büyük etkisi olduğu belirtilmiştir (Waldenstedt, 2006). Yine Mg minerali biyolojik sistemler için gerekli olup, biyokimyasal olarak çeşitli enzimatik ve metabolik reaksiyonlarda yer almaktadır (Fischer ve Giroux, 1991). Biyokimyasal olarak serum parametreleri de beslenmeye bağlı olarak etkilenebilmekte ve borun mineral metabolizması üzerine de bazı etkileri bulunmaktadır (Yiğit ve ark., 2013).

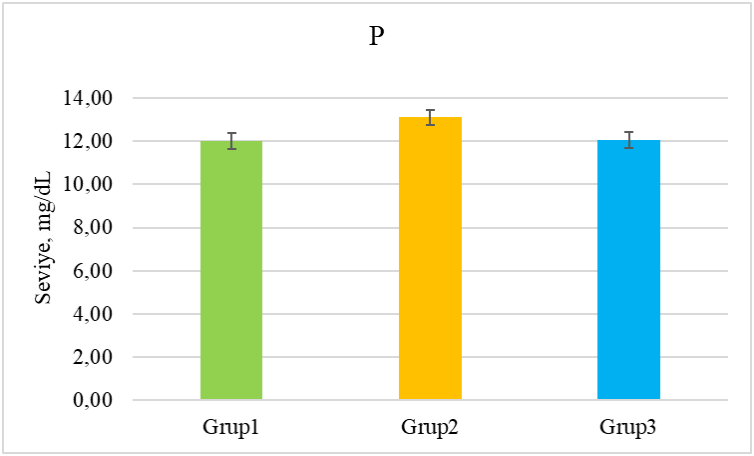
Ratlarda yeme katılan borun serum Ca (Chapin ve ark., 1997; Hunt & Herbel, 1991), inorganik fosfor (iP) ve Mg (Chapin ve ark., 1997) seviyelerini düşürdüğü belirtilmiştir. Tavşanların içme suyuna katılan borik asidin kemik metabolizması ile ilişkili parametrelerden olan serum Ca ve Mg seviyesini değiştirmediği, iP seviyesini ise artırdığı bildirilmiştir (Yiğit ve ark., 2013). Başka bir araştırmada ise Mg yönünden yetersiz rasyonla beslenen broylerlerde rasyona bor ilavesinin plazmada Ca ve Mg konsantrasyonlarını yükselttiği tespit edilmiş (Hunt, 1989). Ratlarda yapılan diğer bir çalışmada da 3.25, 13, 36 ve 58.5 mg/kg dozlarında uygulanan borik asidin serum Ca, iP ve Mg düzeylerini değiştirmediği belirtilmiştir (Geyikoğlu ve Türkez, 2009). Benzer olarak farelerde de içme suyuna 0.28 mg/250 ml dozunda ilave edilen borik asidin serum Ca düzeyini etkilemediği bildirilmiştir (Aysan ve ark., 2011). Yukarıdaki literatür bilgilerine benzer olarak yapılan mevcut çalışmada da ratların içme suyuna ilave edilen 100 ve 200 mg/L dozlarındaki borik asidin serumda Ca, Mg ve P düzeylerini etkilemediği görülmüştür.



Figür 1. Ratların içme suyuna ilave edilen borik asidin serum Ca seviyeleri üzerine etkisi.



Figür 3. Ratların içme suyuna ilave edilen borik asidin serum Mg seviyeleri üzerine etkisi.



Figür 3. Ratların içme suyuna ilave edilen borik asidin serum P seviyeleri üzerine etkisi.

Sonuç ve Öneriler

Sonuç olarak; ratların içme suyuna ilave edilen 100 ve 200 mg/L dozlarındaki borik asidin serumda Ca, Mg ve P düzeylerini etkilemediği görülmüştür. Ancak borik asidin mineral metabolizması üzerine etkilerinin tam anlamıyla açıklanabilmesi için yeni çalışmalara ihtiyaç olduğu düşünülmektedir.

Teşekkür ve Bilgi Notu

Bu çalışma, Sivas Cumhuriyet Üniversitesi Bilimsel Araştırma Projeleri (CÜBAP) tarafından V-2023-129 proje numarası ile desteklenmiştir.

Kaynaklar

Aysan, E., Sahin, F., Telci, D., Yalvac, M. E., Emre, S. H., Karaca, C., & Muslumanoglu, M. (2011). Body weight reducing effect of oral boric acid intake. *International Journal of Medical Sciences, 8*(8), 653.

Bhasker, T. V., Gowda, N. K. S., Mondal, S., Krishnamoorthy, P., Pal, D. T., Mor, A., ... & Pattanaik, A. K. (2016). Boron influences immune and antioxidant responses by modulating hepatic superoxide dismutase activity under calcium deficit abiotic stress in Wistar rats. *Journal of Trace Elements in Medicine and Biology, 36,* 73-79.

Bialek, M., Czauderna, M., Krajewska, K. A., & Przybylski, W. (2019). Selected physiological effects of boron compounds for animals and humans. A review. *Journal of Animal and Feed Sciences, 28*(4), 307-320.

Chapin, R. E., Ku, W. W., Kenney, M. A., McCoy, H., Gladen, B., Wine, R. N., ... & Elwell, M. R. (1997). The effects of dietary boron on bone strength in rats. *Toxicological Sciences, 35*(2), 205-215.

Fischer, P. W., & Giroux, A. (1991). An evaluation of plasma and erythrocyte magnesium concentration and the activities of alkaline phosphatase and creatine kinase as indicators of magnesium status. *Clinical Biochemistry, 24*(2), 215-218.

Geyikoğlu, F., & Türkez, H. (2009). Effects of boric acid on aluminium-mediated ionic changes in rat serum. *IV. Uluslararası Bor Sempozyumu*, 15-17 Ekim, Eskişehir-Türkiye.

Hosmane, N. S. (2011) Boron Science: New Technologies and Applications. *Chapt. 7, 147–163, CRC Press,* Boca Raton, FL, USA.

Gümüş, R., & Özbilgin, A. (2022). Effects of Resveratrol and Curcumin Extracts Added to Broiler Diet on Biochemical Parameters and Liver Enzymes in Serum. *Turkish Journal of Agriculture-Food Science and Technology*, *10*(3), 434-439.

Hunt, C. D. (1989). Dietary boron modified the effects of magnesium and molybdenum on mineral metabolism in the cholecalciferol-deficient chick. *Biological Trace Element Research, 22,* 201-220.

Hunt, C. D., & Herbel, J. L. (1991). Effects of dietary boron on calcium and mineral metabolism in the streptozotocin-injected, vitamin D3-deprived rat. *Magnesium and Trace Elements*, *10*(5-6), 387-408.

Hunt, C. D. (2004). "Boron" in Encyclopedia of Dietary Supplements, Coates, P. M., Paul, M. C., Blackman, M., Blackman, M. R., Cragg, G. M., Levine, M., Moss, J., White, J. D. (Eds.), *2nd. Ed., pp 55–63, CRC Press*, NewYork, USA.

Khaliq, H., Juming, Z., & Ke-Mei, P. (2018). The physiological role of boron on health. *Biological Trace Element Research*, *186*, 31-51.

Singh, A. K., Kewalramani, N., Mani, V., Sharma, A., Kumari, P., & Pal, R. P. (2021). Effects of boric acid supplementation on bone health in crossbred calves under tropical condition. *Journal of Trace Elements in Medicine and Biology*, *63*, 126647.

SPSS. (2011). Statistical Packages for the Social Sciences, *20 ed. IBM Inc.*, Chicago

Waldenstedt, L. (2006). Nutritional factors of importance for optimal leg health in broilers: A review. *Animal Feed Science and Technology*, *126*(3-4), 291-307.

Warington, K. (1923). The effect of boric acid and borax on the broad bean and certain other plants. *Annals of Botany*, *37*(148), 629-672.

Yiğit, P., Eren, M., Sarıca, Z., & Şentürk, M. (2013). Tavşanlarda borik asidin kan kimyasına etkisi. *Erciyes Üniversitesi Veteriner Fakültesi Dergisi, 10*(2), 77-85.

Zumreoglu-Karan, B., & Kose, D. A. (2015). Boric acid: a simple molecule of physiologic, therapeutic and prebiotic significance. *Pure and Applied Chemistry*, *87*(2), 155-162.

SPECTRAL EFFECTS OF ECO-INNOVATIONS' ADOPTION ON SUSTAINABLE LIVELIHOODS' RESILIENCE AMONG SMALL-SCALE WHEAT FARMERS IN JIGAWA STATE OF NIGERIA

Sadiq M. S. (ORCID: 0000-0003-4336-5723)
Department of Agricultural Economics and Extension, FUD, Dutse, Nigeria
Email: sadiqsanusi30@gmail.com

Singh I. P. (ORCID: 0000-0002-1886-5956)
Department of Agricultural Economics, SKRAU, Bikaner, India

Ahmad M. M. (ORCID: 0000-0003-4565-0683)
Department of Agricultural Economics and Extension, BUK, Kano, Nigeria

Gama E. N. (ORCID: 0000-0003-4532-7982)
Department of Agricultural Economics and Extension, FUD, Dutse, Nigeria

Sambo A. A. (ORCID: 0009-0006-2977-4968)
Graduate Student, Department of Agricultural Economics and Extension, FUD, Dutse, Nigeria

ABSTRACT

The adoption of eco-innovations for sustainable livelihoods among wheat farmers in Jigawa State, Nigeria, presents a pressing problem that necessitates attention and intervention. Despite the potential benefits associated with eco-friendly agricultural practices, the rate of adoption remains a significant challenge, hindering the attainment of sustainable livelihoods for wheat farmers in the region. Consequently, this research is timely as it investigates the spectral effects of eco-innovations on the sustainable livelihood resilience of small-scale wheat farmers in Jigawa State, Nigeria. Using cross-sectional data elicited through a well-structured questionnaire coupled with an interview schedule from a total of 284 farmers selected via a multi-stage sampling technique during the 2022–2023 cropping season, the research gap was analyzed using both descriptive and inferential statistics. Inspite of the accumulative livelihood strategy and high adoption of eco-innovations among the majority of farmers, the extension gap challenge hampered the landslide adoption of eco-innovations and the intention to key into crop insurance among these farmers. Though marginally above the average sampled population, the majority of the farmers accepted the idea of crop insurance, and this owed to the skeletal reach of the risk sharing system of the NIRSAL programme in the study area. Nevertheless, the majority of the farmers had their farms to be sustainable, which underscores the importance of adopting eco-innovations as a climate change resilience measure, thus enabling them to achieve the accumulated livelihood strategy in the study area. Succinctly, adoption of eco-innovations has a strong endogenous effect on livelihood status en-route farm sustainability but a weak endogenous effect on livelihood status en-route willingness-to-pay (WTP). Consequently, onus lies on policymakers to address the extension gap by enhancing advisory services for effective feed-forward and

feed-backward flows of information sources, risk orientation, and slight modification of the neo-conventional eco-innovations in order to suit the farms' ecological settings in the study area. This singular approach has the potential to be a single silver bullet that will enhance farmers' climate change resilience, farms' sustainability, and guarantee a prosperous sustainable farm family livelihood status in the study area.

Keywords: Eco-innovations; Adoption; Sustainability; Livelihood; Resilience; Wheat farmers; Nigeria

INTRODUCTION

An important part of Nigeria's agricultural landscape is Jigawa State, which is situated in the north. One of the main economic activities in the area is agriculture, with wheat farming having a special significance. Small-scale farming, where many families make their living from growing wheat, is the main driver of the state's economy. Nigerian wheat is a staple crop that is very important both economically and nutritionally. In Jigawa State, wheat farming is the main source of income for many people and makes a significant contribution to both revenue generation and food security. However, a number of issues, such as soil erosion, climate variability, and conventional agricultural practices that could upset the ecological balance, pose a threat to the sustainability of wheat production.

Eco-innovations comprise a range of methods and tools intended to reduce environmental effects while fostering economic viability/feasibility (Dybikowska and Graczyk, 2019; Dudek and Wrzaszcz, 2020; Alizadeh *et al*., 2022). These advancements encompass sustainable resource management, organic farming, agro-ecological methods, and water-saving strategies (Aroonsrimorakot *et al*., 2021; Buchana, 2023). Farmers that embrace eco-innovations may be able to decrease their reliance on hazardous agrochemicals, increase the sustainability of the environment overall, and strengthen the resilience of their farming systems to climate change (Tretiak *et al*., 2021; Todorova, 2022). Like many other places in the world, Jigawa State struggles with issues related to the environment, such as irregular rainfall patterns, degraded soil, and limited water supplies. Unsustainable farming methods, including overusing chemical inputs, might make these problems worse and force a move toward eco-innovations. Although Jigawa State may have some broad studies on agriculture, there aren't many studies specifically looking at wheat farmers' adoption of eco-innovations. If any research has been done thus far, it might not fully cover the special opportunities and problems related to sustainable farming methods in the area. Therefore, a crucial field of research with significant consequences for environmentally conscious farming, sustainable farming methods, and small-scale farmers' livelihoods is the adoption of eco-innovations by wheat farmers in Jigawa State, Nigeria.

The policies and other support systems in place have an impact on the adoption of eco-innovations. Jigawa State's current agriculture laws don't have any explicit clauses or

incentives to encourage wheat growers to widely implement eco-innovations. It is difficult to incorporate environmentally friendly techniques into regular agricultural operations when there are gaps in policy or poor execution. Nonetheless, Jigawa State's wheat farmers are not fully guided or encouraged to embrace sustainable practices by the policies that have been put in place. Furthermore, there is a dearth of research on wheat farmers' reasons for adopting eco-innovations, as well as their obstacles and viewpoints. Designing effective solutions therefore requires an awareness of farmers' attitudes, knowledge gaps, and sociocultural issues.

Jigawa State's wheat producers are particularly susceptible to the negative effects of climate change, which is a danger to agricultural productivity. The need for sustainable and environmentally friendly farming methods is growing as worries about climate change and environmental sustainability spread around the world (Durán-Romero *et al*., 2020; Leszek and Grzegorz, 2021; Yordanova, 2023). Under these conditions, implementing eco-innovations becomes an essential means of reducing environmental deterioration, strengthening climatic resilience, and guaranteeing the sustainability of agricultural practices. Furthermore, investigating eco-innovations becomes essential for determining methods that can improve climate resilience, reduce environmental hazards, and support wheat farming's long-term sustainability. Furthermore, wheat cultivation in Jigawa State plays a vital role in the financial stability of many families. Understanding the uptake of eco-innovations is vital for assessing their potential to boost farmers' income, cut production costs, and contribute to overall livelihood sustainability.

Even with the potential advantages of eco-innovations, further research is needed to determine how widely adopted they are among Jigawa State's wheat growers. Comprehending the variables impacting the implementation of sustainable practices is imperative in order to formulate focused interventions, formulate efficacious policies, and endorse environmentally conscious farming techniques that conform to the distinct socio-economic and environmental milieu of Jigawa State.

Succinctly, the need to solve environmental issues, strengthen climate resilience, and promote small-scale farmers' social and economic well-being is what drives this research. This study is to close knowledge gaps and offer insightful information to the farming

community, academic institutions, policymakers, and agricultural extension services in order to ensure the long-term sustainability of wheat growing in Jigawa State and to encourage sustainable practices. To put it another way, this study aims to provide important insights that can guide policies for improving sustainable livelihoods, safeguarding the environment, and ensuring the continued existence of wheat farming in the area by examining the current state and dynamics of adoption. Research on the particular nuances of these problems in the context of Jigawa State, however, will be crucial for developing strategies that encourage wheat farmers to adopt eco-innovations, which will ultimately help the region achieve sustainable livelihoods. Consequently, the following specific research objectives were carefully designed: to assess the current adoption status of eco-innovations among wheat farmers; to identify the key drivers and barriers influencing the adoption of eco-innovations practices; to determine sustainability of wheat farm in the study area; to assess the livelihood status of the wheat farmers; to assess willingness-to-pay (WTP) for crop insurance in the study area; to evaluate the environmental and economic impacts of eco-innovations adoption on wheat farming sustainability and livelihoods' of the farmers; and to provide insights for policymakers, extension services, and farmers to enhance the adoption of eco-friendly practices.

RESEARCH METHODOLOGY

The State is one of the 36 States in the country that shares common borders with Kano State and Katsina State to the West, Bauchi State to the East and Yobe State to the Northeast. The State has a shared international border with the Zinder Region of the Republic of Niger to the north, which presents a special possibility for cross-border trade activity (Jigawa State Government (JSG), 2017; 2021). It is located in the country's Northwestern region between latitudes 11°N and 13°N and longitudes 8°E and 10.15°E Greenwich meridian time. It is the eighth most populous state in terms of ethnic composition, with a predominance of Hausa and Fulani residents (JSG, 2017). Rainfall volume normally varies between 600 and 1000 millimetres during the rainy season, which runs from May to September, according to Sadiq and Sani (2022). The province's southern region has heavier rainfall than its northern region does (Sadiq and Sani, 2022). The State's overall land area is about 22,410 square kilometres, and the estimated population is 4,361,002 (National population Commission (NPC), 2017),

with a current projection of 4,884,322 million people at a 3% growth rate. Sand dunes of varied sizes that extend several kilometres in some areas of the state add to its undulating geography. The Hadejia, Kafin-Hausa, and Iggi Rivers are the primary rivers, and other tributaries in the state's northeast feed large marshlands. The Hadejia and Kafin-Hausa Rivers traverse the state from the west to the east through the Hadejia-Nguru wetlands before emptying into the Lake Chad Basin. The state's economy is still heavily dependent on agriculture, and because of its semi-arid climate, workers frequently migrate to nearby states like Kano State in search of seasonal work (JGS, 2021). One of the state's most valuable natural resources is its large tracts of lush arable land, to which nearly all tropical crops may adapt. A large portion of the Sudanese savannah vegetation zone consists of grazing areas that are ideal for raising livestock.

Using a multi-stage sampling technique, a total of 283 selected active wheat farmers were used to elicit farm survey data. Firstly, given that wheat production cuts across all the agricultural strata of the state, the saturated sampling frame of the stratified Jigawa State Agricultural and Rural Development Agency (JARDA) zones, namely, Zone 1(Birnin-Kudu), Zone II (Hadejia), Zone III (Gumel) and Zone IV (Kazaure) was taken. Secondly, the major producing Local Government Areas (LGAs) in each zone were purposively selected. The selected LGAs in Zones I, II, III and IV were Jahun; Ringim; Hadejia; and, Kazaure respectively. Thirdly, from each of the selected LGAs, three (3) villages were randomly selected, thus giving a total of 12 selected villages. Lastly, based on the sampling frame obtained from the JARDA and Reconnaissance survey (Table 1), a Krejcie and Morgan formula (Equation 1) was used to generate the representative sample size for the study. Thus, a total of 283 active wheat farmers were randomly selected. Using an easy cost-route approach, farm survey data for the 2022 wheat production season were elicited with the aid of a well-structured questionnaire coupled with an interview schedule. In descending order, the objectives were achieved using adoption index; confirmatory factor analysis (CFA) jointly with composite index, farm sustainability index; livelihood sustainability index; contingent valuation method; and CFA (formative and reflective models).

Table 1: Sampling frame of wheat farmers in the study area

Zones	LGAs	Villages	Population	Sample size
Birnin Kudu Zone (Zone I)	Jahun	Harbo Tsohuwa	134	16
		Harbo Sabuwa	149	18
		Jama'a	137	17
Gumel Zone (Zone II)	Ringim	Ringim Town	130	16
		Gabarin	143	18
		Dabi	198	24
Hadejia Zone (Zone III)	Hadejia	Sunamu	178	22
		Mai Alkama	258	31
		Hago	184	23
Kazaure Zone (Zone IV)	Kazaure	Farin Daba	321	39
		Gada	230	28
		Tudun Wayo	250	31
Total 4	**4**	**12**	**2312**	**283**

Source: Reconnaissance survey, 2021; Jigawa State Agricultural and Rural Development (JARDA), 2021

$$n_P = \frac{N(X)}{X + (N-1)} \quad \text{..... (1)}$$

$$X = \frac{Z^2 * P(1-P)}{e^2} \quad \text{..... (2)}$$

n = Sample size; N = Population size; e = Acceptable sampling error; X= Finite sample size; and, P = Proportion of the population

Model Specification

1. **Adoption index**:

Using a numerical strength, the adoption index is given as follows (Table 2a):

$$ADPI = \frac{Adoptedtechnology(s)}{Totalavailabletechnologies} \quad \text{..... (3)}$$

Where, ADPI is Adoption index

2. **Eco-innovation attributes**:

Following Alizadeh *et al*.(2022), the six attributes of eco-innovations statuses viz. awareness (AW), attitude (AT), knowledge (KN), information access (IN), willingness to creativity (WC), and risk orientation (RT) were assessed using composite index (Table 2a). Adapted from Sadiq *et al*.(2023), the following are the formulae used to achieve the composite index:

$$I_s = \frac{I_i - I_{\min}}{I_{\max} - I_{\min}} \quad \text{..... (4) (Minimization normalization index)}$$

$$I_s = \frac{I_{\max} - I_i}{I_{\max} - I_{\min}} \quad \text{..... (5) (Maximization normalization index)}$$

Where, I_s is the sub-indicator index, I_i is the value of the i^{th} sub-indicator; $I_{min}$is the minimum value of the i^{th}sub-indicator; and, I_{max} is the maximum value of the i^{th} sub-indicator.

$$I = \sum_{i=1}^{n=0} \left(\frac{w_{si} * I_{si} + \ldots\ldots\ldots + w_{sn} I_{sn}}{w_{si} + \ldots\ldots\ldots + w_{sn}} \right) \quad \text{..... (6) (Composite index)}$$

Where, *I'* is the indicator/dimension index of i^{th} farmers and *w* is the weight of i^{th} sub-indicator index.

Table 2a: Eco-innovations and their attributes

Eco-innovations	**Mechanism**	**Effects**
Bio-fertilizers	Process	Reduces costs; Easier to use; Marketability
Bio-control	Process	Protects soil microorganisms; Increases crop yield ; Increases the profit
Conservation tillage	Process	Increases fertility; Save water; Reduces costs
Crop rotation with legumes	Process	Increases fertility; Increases income; Increases the quality of the product
Soil mulching	Process	Increases fertility; Protects soil microorganisms; Increases crop yield
Water management	Process	Saves water usage; Reduces costs; Makes irrigation easier
Waste management	Marketing	Increases profits ; Product marketability
Organic production	Product	Improve the health of the community; Increases income in the long time
Product in ecological packing	Marketing	Desire to buy; Increases profit; Waste limiting
Social media for the production of organic products	Organizational	Increases knowledge and information; Development of organic products production
Personalities and cognitive characteristics		
Eco-innovation awareness		6 likert scale (Very highly aware to Very unaware)
Attitude towards eco-innovation		6 likert scale (Very high to Poor)
Eco-innovation knowledge		6 likert scale (Very high to Poor)
Access to sources of information		6 likert scale (Very high to Poor)
Creativity willingness		6 likert scale (Very high to Poor)
Risk oriented		6 likert scale (Very high to Poor)

Source: Adapted from Alizadeh *et al*.(2022)

3. **Farm sustainability assessment index**:

In measuring farm sustainability index, three dimensions of farm sustainability vis-à-vis economic (ES), social (SS) and environmental (ENS) sustainability indicators were aggregated (Nazir *et al*., 2017; Ranasinghe *et al*., 2021) (Appendix). The economic, social and environmental sustainability were measured using economic efficiency index, social security index and environmental security index respectively. Given below is the model; succinctly, the composite index of the sustainability indicators were first subjected to normalization (minimum and maximum) (see equations 4 and 5 for the normalization formula). Presented below are the sub-sustainability and sustainability composite indexes.

$$S_s = \sum_{i=1}^{n=0}\left(\frac{w_{si} * S_{si} + \ldots\ldots\ldots + w_{sn} S_{sn}}{w_{si} + \ldots\ldots\ldots + w_{sn}}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(8) (Composite index)}$$

Where, S_s is the sub-dimension (ESI/SSI/ENSI) index of i^{th} farmer(s) and *w* is the weight of i^{th} sub-dimension index.

$$S_i = \frac{ES + SS + ENS}{w_{ES} + w_{SS} + w_{ENS}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(9)}$$

Where, S_s is the farm sustainability index of i^{th} farmer(s).

Note: S= sustainable (>= 2.00); SS= somewhat sustainable (>=1.00); IN= intermediate (>=0.00); PU= possibly unsustainable (>= -1.00); PQU= possibly quite unsustainable (>= -2.00); PVU= possibly very unsustainable (< -2.00) (Adopted categorized names by Shamsudin *et al*., 1994; Sultana *et al*., 2021).

4. **Livelihood sustainability index (LSI):**

Before specifying the index, the various livelihood indicators were subjected to the normalization index (Equation 4). Nevertheless, the LSI index is given below:

$$LSI_i = \frac{H + N + S + F + P}{w_H + w_N + w_S + w_F + w_P} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(7)}$$

Where, LSI_i is the Livelihood strategy index of i^{th} households; *w* is the weight of i^{th} dimension.

The livelihood capital assets' classification (Sadiq and Sani, 2022): < 20% = very poor; ≥ 20% = poor; ≥ 40% = moderate; ≥ 60% = good; ≥ 80% = very good.

The livelihood strategy classification is: < 1 = survival strategy, ≥1 = coping strategy, ≥2 = adaptation strategy, ≥3 = accumulation strategy (four-scale) (Morris *et al*., 2001); <1 = survival strategy, ≥1 = coping strategy, ≥2 = adaptation strategy, ≥3 = consolidation and ≥4 = accumulation strategy (five-scale).

Livelihood assets:

The household's livelihood may be constructed on a foundation that is represented by the assets accessible for generating income. The five categories listed below serve as representations of these assets in the DFID framework (Table 2b).

Natural capital (N): refers to the stocks of natural resources that provide resource flows necessary for subsistence (such as land, water, animals, biodiversity, and environmental resources);

***Human capital (H)*:** refers to the abilities to work, learn, and maintain good health, all of which are necessary for pursuing a variety of livelihood options;

***Physical capital (P)*:** is the production machinery and tools that allow individuals to pursue their livelihoods, as well as the essential infrastructure (transportation, housing, water, energy, and communications);

Social capital (S): the social assets (networks, group membership, trust-based relationships, and access to larger institutions of society) that people rely on in order to support themselves; and,

Financial capital (F): the available financial resources that enable people to choose from a variety of sources of income, such as savings, credit, regular remittances, or pensions.

These assets include both the intangible resources more commonly studied by sociological and anthropological research (such as social capital, health, and educational status) and the tangible productive resources more commonly linked with economic studies (such as land, labor, capital, and stocks).

Table 2b: Livelihood assets

Dimension	Indicator	Dimension	Indicator
Human capital	Farming knowledge	Financial capital	Income
	Farming skills		Savings
	Farming experience		Assistance / Subsidies
	Health		Individual Credit
	Household size		Credit from Credit Institutions
	Other business skills		Remittances
	Other business experiences	Physical capital	Access to transportation and ICT
Natural capital	Land fertility		Production facilities
	Irrigation water sources		Infrastructures
	Climate suitability		Working equipment
	Farm production		Accessibility to institutions
Social capital	Community Organizations		
	Social Networking		
	Mutual cooperation		
	Trust		

Source: modified from Illu *et al.*(2021); Sadiq and Sani (2022)

Livelihood strategy

Among others, Devereaux (1993) and Davies (1996) have distinguished between survival, coping, adaptive, and accumulative strategies (Table 2c). In response to an opportunity, accumulative techniques boost asset stocks and consumption results. Adaptive strategies aim to disperse consumption failure risk in response to foreseen negative trends. This could be achieved by expanding into new activities or by intensifying current livelihood methods. Coping mechanisms involve lowering consumption and depleting assets in order to lessen the effects of a negative shock. In the absence of respite, coping may result in survival tactics. In an effort to avoid poverty and death, survival methods not only dramatically cut back on consumption but also significantly, and most frequently irreparably, deplete household assets.

Table 2c: Typology and examples of different livelihood strategies

Livelihood strategy	Internal livelihood system component		
	Change to assets	Strategies	Consumption outcomes
Accumulative	Increased asset stock. Increased flexibility across asset base.	As for adaptive	More income. Better nourishment. Increased security.
Adaptive	Altering the mix of assets. Prudently preserving money and other assets.	Extensification (cultivation of more land). On-farm & off-farm diversification (e.g. change in cropping mix, wage labour). Intensification of cash cropping. Investments in social capital. Migration.	Consumption and income smoothing Lowering of risk Spreading of risk. smoothening of labor
Coping	Increased livestock sales Calling down impromptu claims (for instance, via kin networks).	Farm labor, piecework Temporary migration Youngsters being taken out of school.	Reduced meal frequency, size, and quality. Use where available of relief food. Less social and ceremonial duties.
Survival	Selling of useful assets (like bicycles and land). Sale of furniture and other home items.	Illicit behavior. Begging.	Permanent out-migration Poverty and starvation.

Source: Morris *et al*.(2001); Davies (1996); Devereaux (1993)

5. **Contingent valuation method (CVM)**

In non-marketed commodities like insurance, CVM is frequently used to evaluate WTP modifications (Gidey *et al*., 2019; Ogundeji *et al*., 2019; Njie *et al*., 2023). The contingent valuation method, which is based on a fictitious market scenario, is frequently used to gauge public willingness to pay. It is also frequently employed in cost-benefit analyses in the field of actuarial economics. The fact that welfare economics serves as the methodology's theoretical underpinning is a notable aspect of WTP's (willingness to pay) approach to

economic evaluation. One of the most popular participative approaches for determining the total economic value (TEV) of different categories of environmental goods and services that are difficult to exchange on the open market is the contingent valuation method (CVM).

Let W_i^0 represent welfare prior to policy intervention (or the status quo), and W_i^1 represent welfare following policy intervention. Additionally, let $W_i^0 \equiv (y_i^0, P^0)$ and $W_i^1 \equiv (y_i^1, P^1)$ reflect, respectively, the budgets that gauge the prices (p) and incomes (y) that consumer i will encounter under the new policy plan. Thus, the change from the status quo level to the level following the implementation of the policy is just the variation in the indirect utility denoted by:

$$v\left(y_i^1, P^1\right) - v\left(y_i^0, P^0\right) \quad \text{..... (8)}$$

If $v\left(y_i^1, P^1\right) - v\left(y_i^0, P^0\right) > 0$, the consumer i will consent to the modification brought on by the new insurance plan. On the other hand, $v\left(y_i^1, P^1\right) - v\left(y_i^0, P^0\right) < 0$, the customer will reject the proposal. Nevertheless, $m(q; y, P)$ tells us how much money a particular person, i, would require at a vector of pricing, q, in order to be well off as they would be facing prices, P, while having income, y. As a result, equation (8) can be expressed as follows:

$$m(q; y_i^1, P^1) - m(q; y_i^0, P^0) \quad \text{..... (9)}$$

If the sole difference between the pre-policy intervention and post-policy intervention levels is a price shift, such as $q \equiv P^0$ or $q \equiv P^1$, this results in the CV and EV indicators of welfare changes, respectively. They are each defined as follows:

$$EV = m(P^0; y_i^1, P^1) - m(P^0; y_i^0, P^0) = m(P^0; y_i^1, P^1) - y_i^0 \quad \text{..... (10)}$$

$$CV = m(P^1; y_i^1, P^1) - m(P^0; y_i^0, P^0) = y_i^1 - m(P^1; P^0, y_i^0) \quad \text{..... (11)}$$

Equation (11), when expressed in absolute terms, reflects the consumer's WTP to be at W_i^1 or the sum of money the customer is WTA (willingness to accept) from the policy planner to maintain the previous, declining level of welfare W_i^1.

AG = Age (years); GEN = Gender (male =1, otherwise =0); ED = Education (year(s)); HHS = Household size (number of person(s)); FEXP = Farming experience (year(s)); AGH = Agricultural holding (hectare); OPH = Operational holding (hectare); LAIN = Logarithm income (Naira); LS Livestock ownership (Tropical livestock unit (TLU)); EXT = Extension contact (yes =1, otherwise= 0); CR = Credit access (yes =1, otherwise= 0); COP = Co-operative membership (yes=1, otherwise= 0); IAW = Insurance awareness (yes =1, otherwise =0); IK = Insurance knowledge (yes =1, otherwise =0); and, CFI = Confidence in financial institutions designated as fund managers for crop insurance

RESULTS AND DISCUSSION

Eco-innovations' Adoption Status

A perusal of the results showed that the majority (80.9%) of the farmers adopted the eco-innovations, possible as resilience and adaptation measures against weather-induced changes (Figure 1). However, only a handful of the farmers (4.6%) didn't adopt the eco-innovation, and this is likely to have happened among the laggard farmers owing to their reservations about the non-conventional or indigenous technologies. Nevertheless, few of the farmers moderately (11.7%) and less (2.8%) adopted the eco-innovation, and this might be largely attributed to capital paucity and poor knowledge on these technologies, especially the non-conventional eco-innovations.

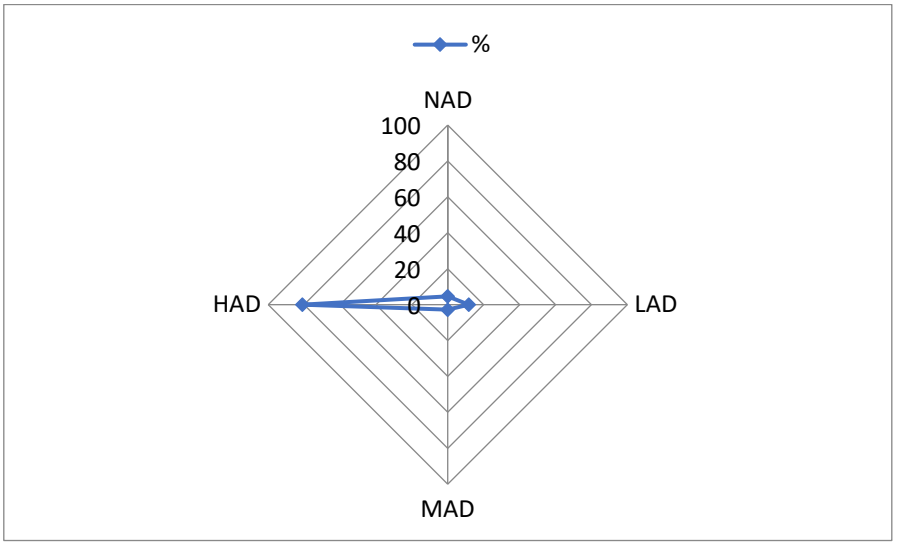


Figure 1: Adoption status of the farmers

Source: Field survey, 2022

Note: NAD = Non-adoption; LAD = Less adoption; MAD = Moderate adoption; HAD = High adoption

Furthermore, the individual-wise results vis-à-vis the eco-innovation indicators showed that the majority of the farmers had moderate awareness (AW) about the eco-innovations; likewise, moderate knowledge (KN), access to information sources (IN) and creativity willingness (WC) on eco-innovations (Figure 2). Besides, the attitude (AT) towards eco-innovation was established to be high among the majority of the farmers in the study area. However, the majority of the farmers had poor risk orientation (RT) on eco-innovation for sustainable wheat production.

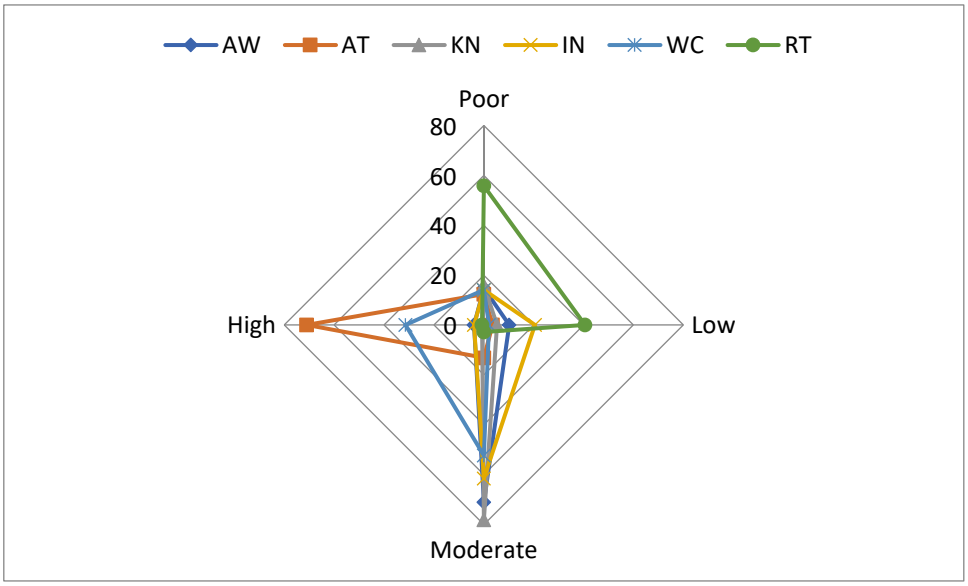


Figure 2: Individual-wise perceptions on eco-innovations' indicators

Source: Field survey, 2022

Nevertheless, average-wise, the farmers were moderately aware about eco-innovations; had moderate creativity willingness on the innovation; moderate knowledge on the innovation; and a moderate attitude towards adoption of the eco-innovation (Figure 3). However, the low access to information sources and risk orientation on eco-innovation might be attributed to the extension gap and poor cosmopolitan link of the farmers; likewise, risk aversion due to

fear of capital loss, a limiting factor in a subsistence agrarian setting, is a portend/significant contributory factor. Consequently, it can be inferred that the duo of the foregoing indicators were the challenge to adequate adoption of eco-innovation for sustainable wheat farming in the study area.

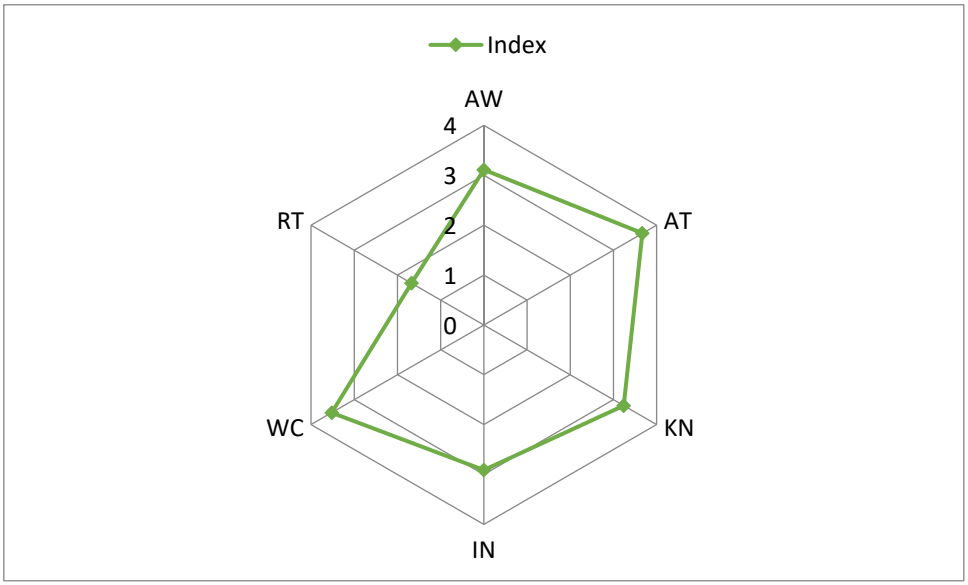


Figure 3: Average-wise perceptions on eco-innovations' indicators
Source: Field survey, 2022

Furthermore, the CFA results after satisfying the diagnostic validity of model fit showed all the indicators, except creativity willingness (WC), to have significantly influenced adoption of eco-innovation, as evident by their respective coefficients, which were within the acceptable error margin of 1% probability level (Table 3a). Empirically, the inelastic of awareness (AW), knowledge (KN), and risk orientation (RT) coefficients implied they are necessities for eco-innovation adoption. The elastic of attitude (AT) coefficient means it is a superfluity for eco-innovation adoption; while, the perfect inelastic of access to information sources (IN) coefficient implied it has a secondary effect on eco-innovation adoption (Table 3b and Figure 4). Thus, the implication is that the farmers had a keen interest in awareness, knowledge and risk orientation in the adoption of eco-innovations. However, the less interest in the sources of information might be attributed to the fact that most of these farmers fall

into the early majority adoption category, characterized by a non-cosmopolitan nature and relying heavily on information from contact farmers/lead farmers. Consequently, the perfect inelastic and non-significant of the willingness creativity (WC) coefficient implied that most of these farmers had little or no intent of being creative in their adoption of these eco-innovations, i.e., modification of the technologies that proved to be stereotyped to the farming ecology of the study area. Generally, the positive significant of AW, KN, RT and AT coefficients means that farmers with adequate awareness, knowledge, risk orientation and positive attitude toward these eco-innovations are likely to adopt these technologies. However, farmers with little or no access to information sources on eco-innovations are less likely to adopt these technologies in the study area, as evident by the negative significant of 'IN' coefficient. Therefore, an increase in awareness, knowledge, risk orientation and favourable attitudes towards eco-innovations has the likelihood of increasing adoption of these innovations by 0.882, 0.619, 0.464 and 2.078% respectively (Table 3c). However, an increase in the information sources on these innovations has the likelihood of decreasing the adoption of eco-innovations by 2.326%.

Table 3a: Model fit summary

Category name	Index name	Obtained	Recommended
Absolute fit	CMIN	17833.23	-
	DF	1764	-
	P	0	p<=0.05
	RMSEA	0.18	< 0.08
	RMR	0.631	<0.02
	GFI	0.289	> 0.90
Incremental fit	AGFI	0.238	> 0.90
	NFI	0.486	> 0.90
	RFI	0.467	> 0.90
	TLI	0.493	> 0.90
	CFI	0.511	> 0.90
	IFI	0.512	> 0.90
	PGFI	0.269	> 0.90
	FMIN	63.238	> 0.90
Parsimonious fit	CMIN/DF	10.11	< 5.0

Source: Field survey, 2022

Table 3b: Effects of adoption's attributes on eco-innovation's adoption

Variable (←)		Estimate (US)	S.E.	C.R.	P	Estimate (S)	R^2
AW1	AW	1	-	-	-	0.973	0.947
AW2	AW	1.24	0.018	68.693	***	0.999	0.997
AW3	AW	1.257	0.025	50.634	***	0.974	0.949
AW4	AW	1.238	0.035	35.131	***	0.924	0.853
AW5	AW	0.504	0.08	6.315	***	0.354	0.125
AW6	AW	0.764	0.053	14.289	***	0.656	0.431
AW7	AW	0.735	0.033	22.017	***	0.81	0.656
AW8	AW	0.606	0.024	25.415	***	0.851	0.725
AW9	AW	0.011	0.06	0.184	0.854	0.011	0
AW10	AW	0.25	0.06	4.154	***	0.241	0.058
AT1	AT	1.992	0.077	26.028	***	0.983	0.967
AT2	AT	2.368	0.09	26.237	***	0.987	0.973
AT3	AT	1.838	0.077	23.838	***	0.948	0.898
AT4	AT	1.968	0.077	25.447	***	0.974	0.95
AT5	AT	1.891	0.111	17.048	***	0.795	0.632
AT6	AT	0.658	0.119	5.517	***	0.319	0.102
AT7	AT	0.872	0.097	8.997	***	0.496	0.246
AT8	AT	0.863	0.065	13.183	***	0.67	0.449
AT9	AT	0.788	0.05	15.87	***	0.76	0.578
AT10	AT	1	-	-	-	0.852	0.726
RT1	RT	1	-	-	-	0.95	0.903
RT2	RT	1.11	0.03	37.329	***	0.968	0.936
RT3	RT	0.723	0.054	13.466	***	0.647	0.418
RT4	RT	0.771	0.025	30.327	***	0.92	0.847
RT5	RT	0.408	0.071	5.718	***	0.329	0.108
RT6	RT	0.258	0.063	4.079	***	0.24	0.058
RT7	RT	-0.032	0.052	-0.621	0.535	-0.038	0.001
RT8	RT	0.025	0.049	0.512	0.609	0.031	0.001
RT9	RT	0.242	0.057	4.281	***	0.252	0.063
RT10	RT	0.079	0.048	1.65	0.099	0.099	0.01
KN1	KN	2.443	0.14	17.404	***	0.973	0.947
KN2	KN	2.849	0.16	17.83	***	0.994	0.989
KN3	KN	2.071	0.122	16.997	***	0.953	0.908
KN4	KN	2.155	0.128	16.811	***	0.944	0.891
KN5	KN	1.702	0.138	12.364	***	0.714	0.509
KN6	KN	1.287	0.12	10.742	***	0.625	0.391
KN7	KN	1.052	0.115	9.122	***	0.535	0.286
KN8	KN	1.015	0.08	12.684	***	0.731	0.534
KN9	KN	1.011	0.08	12.657	***	0.729	0.532
KN10	KN	1	-	-	-	0.732	0.535
WC1	WC	1	-	-	-	0.951	0.904
WC2	WC	1.198	0.027	44.927	***	0.985	0.97
WC3	WC	1.222	0.029	41.553	***	0.974	0.948
WC4	WC	1.015	0.035	28.645	***	0.9	0.811
WC5	WC	0.885	0.023	37.77	***	0.958	0.918
WC6	WC	0.927	0.023	39.45	***	0.966	0.932
WC7	WC	0.209	0.035	5.985	***	0.339	0.115
WC8	WC	0.358	0.033	10.733	***	0.549	0.302
WC9	WC	0.518	0.036	14.524	***	0.672	0.451
WC10	WC	0.563	0.037	15.016	***	0.685	0.469
IN1	INF	2.095	0.344	6.081	***	0.915	0.838

IN2	INF	2.494	0.409	6.098	***	0.932	0.868
IN3	INF	2.46	0.402	6.118	***	0.951	0.905
IN4	INF	2.777	0.452	6.137	***	0.973	0.947
IN5	INF	2.402	0.402	5.971	***	0.824	0.679
IN6	INF	2.251	0.379	5.938	***	0.801	0.642
IN7	INF	1.457	0.297	4.914	***	0.44	0.194
IN8	INF	1.044	0.234	4.453	***	0.362	0.131
IN9	INF	0.901	0.22	4.093	***	0.313	0.098
IN10	INF	1	-	-		0.348	0.121
ADPI	AW	0.882	0.091	9.705	***	0.375	0.595
ADPI	INF	-2.362	0.471	-5.009	***	-0.332	
ADPI	KN	0.619	0.176	3.516	***	0.138	
ADPI	WC	-0.28	0.09	-3.115	0.002	-0.12	
ADPI	AT	2.078	0.178	11.677	***	0.496	
ADPI	RT	0.464	0.071	6.495	***	0.254	

Source: Field survey, 2022

Note: ***, **, * & NS mean significant at 1, 5, 10% and non-significant respectively; US= Unstandardized; S= Standardized; SE= Standard error: CR= Critical ratio; P= Probability; R^2= Squared multiple correlation; → = relationship; and, INF/IN.

Table 3c: Total, direct and indirect effects of adoption's attributes on eco-innovation's adoption

Item	**INF**	**WC**	**KN**	**RT**	**AT**	**AW**
ADPI	Total effect (unstandardized)					
	-2.362	-0.28	0.619	0.464	2.078	0.882
	Standardized					
	-0.332	-0.12	0.138	0.254	0.496	0.375
	Direct effect (unstandardized)					
	-2.362	-0.28	0.619	0.464	2.078	0.882
	Standardized					
	-0.332	-0.12	0.138	0.254	0.496	0.375
	Indirect effect (unstandardized)					
	0	0	0	0	0	0
	Standardized					
	0	0	0	0	0	0

Source: Field survey, 2022

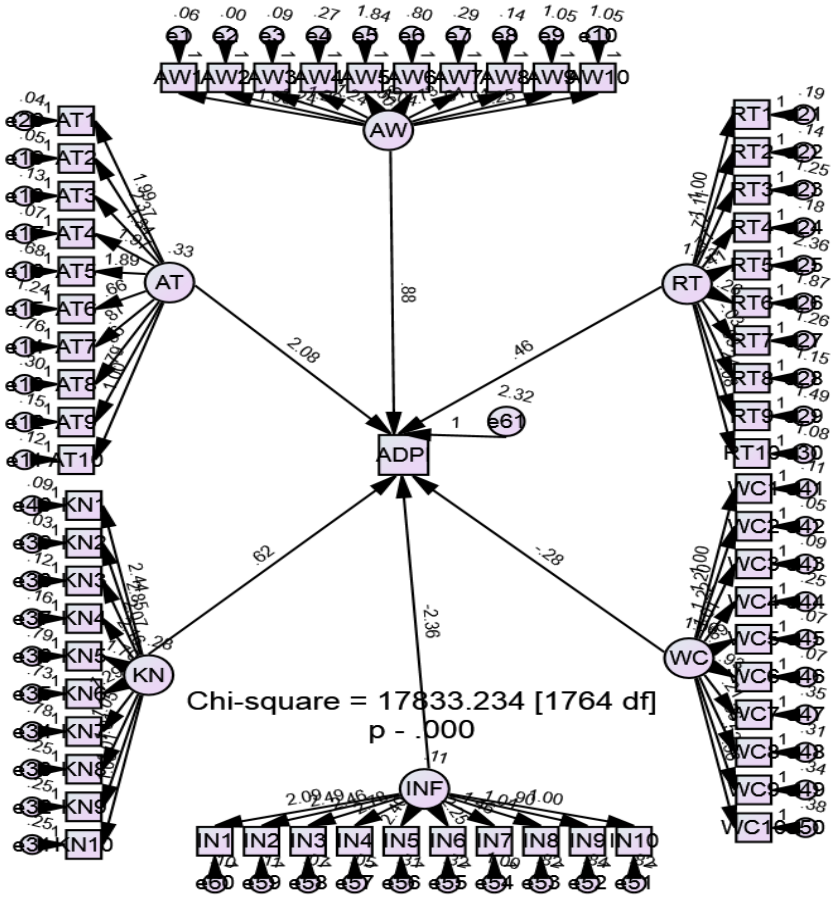


Figure 4: Structural modeling of the effect of eco-innovations indicators on eco-innovation's adoption

Sustainability Assessment of Wheat Farming

A perusal of sustainability index showed that majority (78.8%) of the farmers had their farms to be sustainable while an insignificant of the sampled population had their farms to be unstainable (Figure 5). Nevertheless, indicator-wise results showed that only 10.6, 46.3 and 83.4% of the farmers, respectively, had their farms to be economically, socially and environmentally sustainable. Thus, the heightened index of environmental sustainability is a possible reason for the robust farm sustainability achieved by the majority of the farmers in the study area. Consequently, the study calls on the few farmers whose wheat farms are unsustainable to enhance their economic and social sustainable farm practices. Therefore, it

can be inferred that the farmers were conscious of the effects climate change on their farms, thus used climate change adaptive strategies. Though in a different enterprise, this finding is contrary to the findings of Ranasinghe *et al*.(2021) and Sultana *et al*.(2021), who in their various study areas found the majority of paddy rice farmers not to have sustainable farms, thus recommending the need to enlighten and inculcate good agricultural practices (GAP) to these farmers.

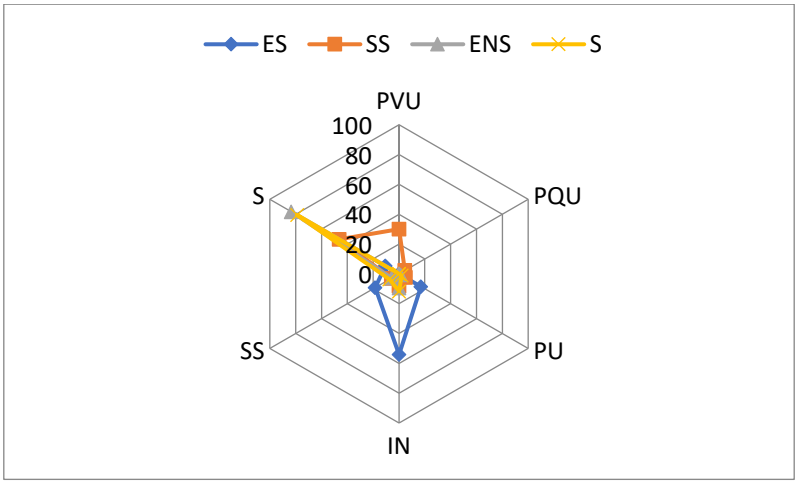


Figure 5a: Farm sustainability assessments of wheat farmers

Source: Field survey, 2022

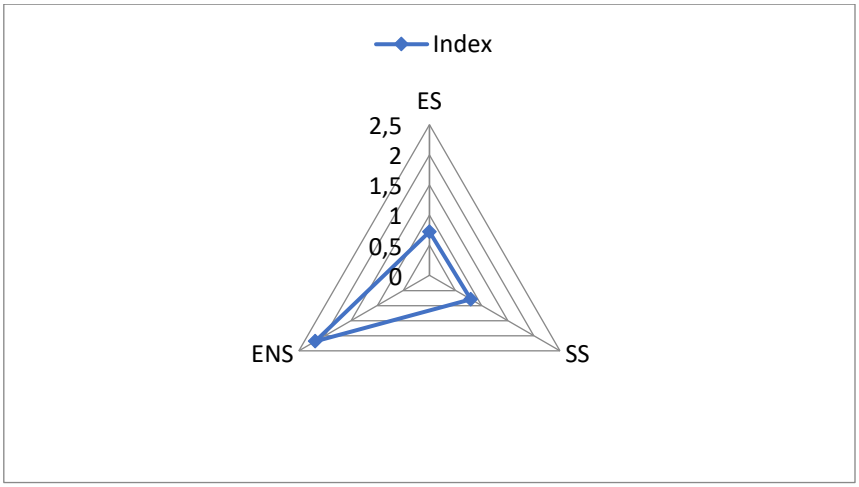


Figure 5b: Aggregate indicator level of farm sustainability

Source: Field survey, 2022

Livelihood Status of the Farmers

On the average, the empirical evidence showed the statuses of human (80.19%), natural (65.13%) and social (62.24%) livelihood's capital assets in the study area to be good while that of financial and physical capital assets respectively were moderate (50.02%) and poor (-218.55%)(Figure 6a). By implication, it can be inferred that most of the farmers had good possession of human, natural and social livelihood's capital assets against financial and physical assets possession that were poor. The moderate status of financial asset may be attributed to poor supply of credit facilities and low income base. However, the poor physical asset is attributed to poor access to institutions, inadequate working implements, poor production facilities, inadequate provision of infrastructural facilities, i.e., public commodities *viz*., poor feeder road networks, social amenities e.t.c., and poor access to transportation and information and communication technology. Therefore, the study advises policymakers to remedy the challenges that affected the livelihood's financial and physical capital assets so as not to jeopardize the good statuses of the trio livelihood's capital assets, thus containing the near likelihood of livelihood vulnerability of most of the respondents to shocks and stresses, especially those caused by weather induced extremities in the study area.

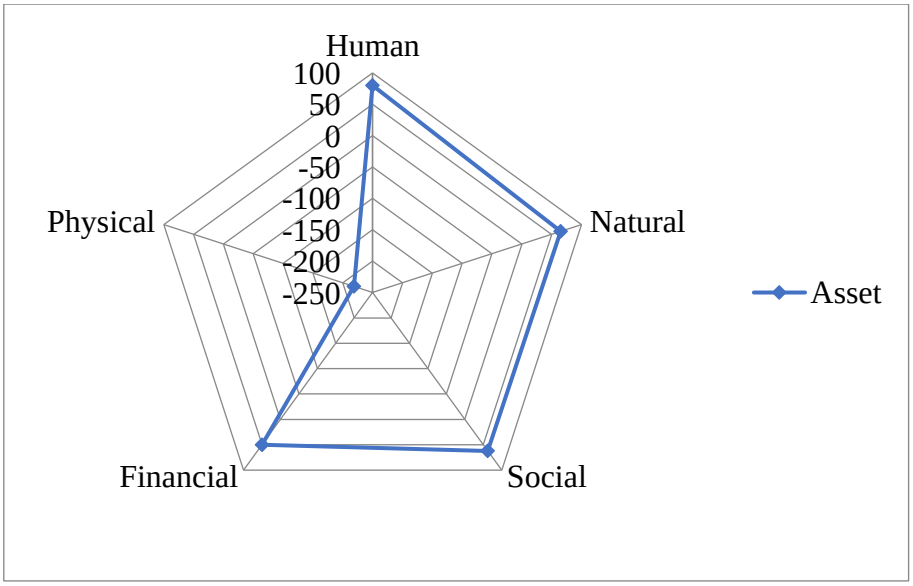


Figure 6a: Livelihood's capital assets distribution of the respondents

Moreover, the results in Figure 6b (five-dimension, modified) showed that majority (51.9%) of the respondents adopted consolidation strategy for livelihood sustenance, 31.8% used accumulation strategy, and 2.5% adopted adaptive strategy while 9.2 and 4.6% respectively resorted to coping and survival strategies for livelihood sustenance. On four-dimension, majority (71%) of the farmers adopted accumulation strategy for livelihood sustenance, while handful of 14.1, 8.1 and 6.7% respectively used adaptive, coping and survival strategies for livelihood sustenance (Figure 6c). Generally, it can be inferred that in response to opportunities, majority of the respondents adopted strategies (accumulation and consolidation) that increased their stocks and consumption outcomes. Nevertheless, for those that adopted adaptive strategy, it can be concluded that in response to anticipated adverse trends, they tend to spread their risks of consumption failure. However, for those that adopted coping, it can be inferred that in order to absorb the impact of adverse shocks, they draw down their assets and reduce consumption. For those that were caught in the survival strategy, it can be concluded that the respondents didn't only cut down consumption drastically, but household's assets were extensively, most often irreversibly eroded, in an attempt to ward-off destitution and mortality.

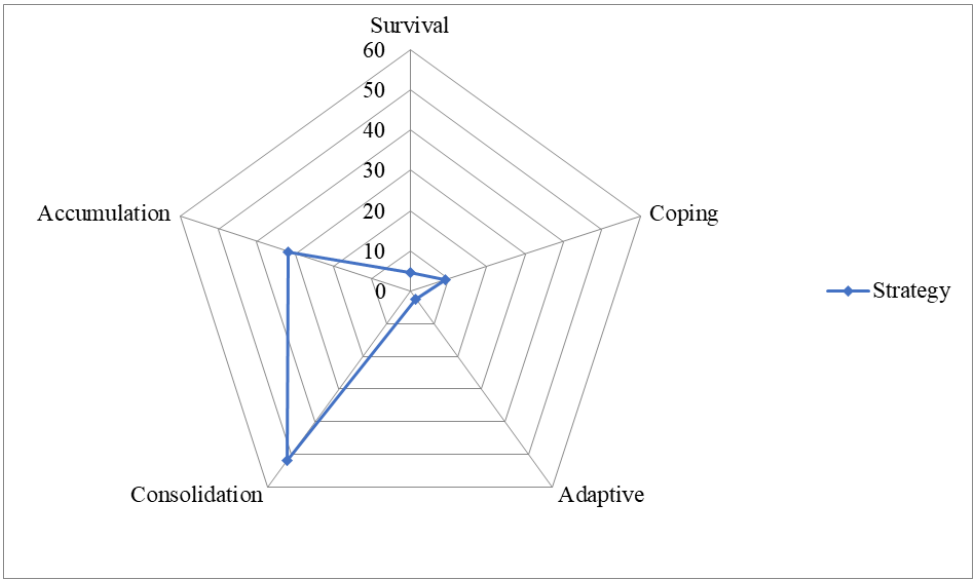


Figure 6b: Distribution of the respondents based on livelihood strategies

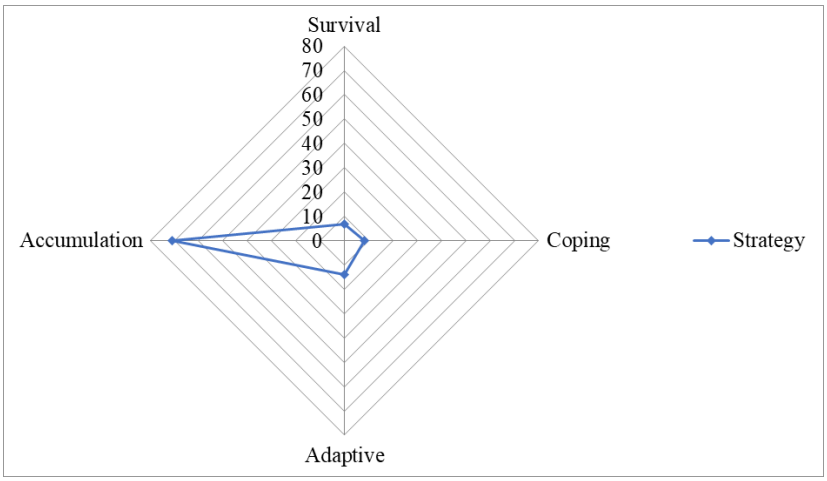


Figure 6c: Distribution of the respondents based on livelihood strategies

Willingness to Pay (WTP) for Crop Insurance

A cursory review of the WTP results showed that the majority (55.8%), though just marginally above the average of the sampled population, were willing to pay for crop insurance while barely close to the average (44.2%) of the sampled population were not willing to pay for crop insurance (Table 4). The possible reason for this slight marginal difference between the farmers willing to pay and not willing to pay may be attributed to adequate awareness and knowledge about crop insurance coupled with capital paucity, which is a common phenomenon in a typical agrarian setting. However, government incentives on risk de-escalation adopted by the Nigerian incentive-based risk sharing system for agricultural lending (NIRSAL) cannot be overruled in influencing most of the farmers who keyed into the idea of crop insurance in the study area. Consequently, at an initial bid (IBID) of 5% of the annual income, though still the majority, the percentage of farmers willing to insure their crop plummeted by 8.78%, thus justifying the challenge of economic capital paucity among most of these farmers in the study area (Table 4). As a rider, there was a slight increase in the percentage of farmers who were not willing to pay for crop insurance at an initial bidding. Nevertheless, at the initial IBID, the minimum and maximum cum average premiums the farmers were willing to pay are ₦ 13750 ($39.29), ₦ 170000 ($485.71) and ₦ 39129.17 ($111.80) respectively.

Table 4: Willingness to pay and IBID of the farmers

Items	Frequency	Percent
WTP		
No	125	44.2
Yes	158	55.8
Total	283	100.0
IBID		
Total	283	100.0

Source: Field survey, 2022

Note: $1= ₦350 at the time of the study: 2022

Nexus between Eco-innovation's Adoption and Livelihood Status via WTP and Sustainability

The nexus between eco-innovation's adoption and livelihood status via WTP and sustainability was verified using CFA, and the diagnostic test results proved the model to be fit for the specified equation as evident by its test statistics that are within the recommended thresholds (Table 5a). Thus, the SEM is reliable for future prediction with accuracy, efficiency, certainty and consistency. Empirically, eco-innovation's adoption has significant twin influence on WTP and sustainability; likewise, it transcends a significant influence on livelihood status via sustainability as a mediating variable (Table 5b and Figure 7). However, the effect of eco-innovation becomes elusive on livelihood status through WTP and sustainability as mediating factors. Generally, sustainability has a significant effect on the livelihood status of farmers. The significant effect of eco-innovation's adoption on WTP and sustainability might be attributed to the need for climate change resilience among farmers, thus a catalyst for livelihood resilience. However, the negative sign and non-significant of the WTP coefficient might be attributed to risk aversion due to fear of capital loss, a limiting factor in a small operational holding, a common phenomenon among most of these farmers. Furthermore, the total effect of ADPI on WTP, SI and LV respectively, is 0.023, 0.077 and 0.267; the total effect of WTP on SI and LV is -0.017 and -0.060; whilst the total effect of SI on LV is 3.484 (Table 5c). Therefore, for a robust eco-innovation's adoption, a catalyst for livelihood's vulnerability resilience, the study calls for an effective utilization of the social capital pool, i.e., co-operative associations, as a complement in addressing capital paucity;

likewise, a holistic implementation of the risk sharing system project of NIRSAL coupled with a wider scope of coverage in the study area.

Table 5a: Model fit summary

Category name	Index name	Obtained	Recommended
Absolute fit	CMIN	5012.68	-
	DF	299	-
	P	0.00	p<=0.05
	RMSEA	0.023	< 0.08
	RMR	0.020	<0.02
	GFI	0.954	> 0.90
Incremental fit	AGFI	0.941	> 0.90
	NFI	0.911	> 0.90
	RFI	0.942	> 0.90
	IFI	0.921	> 0.90
	TLI	0.950	> 0.90
	CFI	0.918	> 0.90
	PGFI	0.301	> 0.90
	FMIN	17.775	> 0.90
Parsimonious fit	CMIN/DF	4.765	< 5.0

Source: Field survey, 2022

Table 5b: Nexus between eco-innovation's adoption and livelihood status via WTP and farm sustainability

Variable (←)		Estimate (US)	S.E.	C.R	P	Estimate (S)	R^2
ADPI	AW	1.311	0.079	16.638	***	0.464	0.781
ADPI	AT	1.673	0.079	21.128	***	0.589	
ADPI	KN	0.341	0.08	4.236	***	0.118	
ADPI	INFO	-1.399	0.096	-14.543	***	-0.406	
ADPI	WC	-0.293	0.078	-3.759	***	-0.105	
ADPI	RISK	-0.488	0.081	-6.002	***	-0.167	
WTP	AG	0.004	0.001	3.367	***	0.111	0.692
WTP	GEN	0.021	0.035	0.587	0.557	0.019	
WTP	ED	0.001	0.003	0.306	0.76	0.01	
WTP	HHS	-0.003	0.003	-0.954	0.34	-0.032	
WTP	FEXP	-0.004	0.002	-1.694	0.09	-0.056	
WTP	AGH	-0.047	0.014	-3.419	***	-0.113	
WTP	OPH	0.084	0.019	4.322	***	0.143	
WTP	LAIN	0.02	0.037	0.556	0.578	0.018	
WTP	LS	-0.07	0.007	-10.429	***	-0.345	
WTP	EXT	0.17	0.035	4.823	***	0.159	
WTP	CR	-0.284	0.075	-3.761	***	-0.124	
WTP	COP	0.026	0.029	0.895	0.371	0.03	
WTP	IBID	0.536	0.026	20.221	***	0.668	
WTP	IAW	0.054	0.036	1.508	0.132	0.05	
WTP	IK	-0.018	0.037	-0.491	0.624	-0.016	
WTP	CFI	0.016	0.03	0.531	0.595	0.018	
WTP	ADPI	0.023	0.004	5.368	***	0.177	
SI	ADPI	0.077	0.003	22.972	***	0.814	0.657
SI	WTP	-0.017	0.026	-0.658	0.51	-0.023	
LV	SI	3.484	0.103	33.825	***	0.896	0.802

Source: Field survey, 2022

Note: INFO/IN, Risk/RT, LV = livelihood status, SI = farm sustainability index; for the other acronyms, check the appendix table

Table 5c: Total, direct and indirect effects of eco-innovation's on livelihood status via WTP and SI

Variable	ADPI	WTP	SI
	Total effect (unstandardized)		
WTP	0.023	0	0
SI	0.077	-0.017	0
LV	0.267	-0.06	3.484
	Standardized		
	0	0	0
WTP	0.177	0	0
SI	0.81	-0.023	0
LV	0.726	-0.021	0.896
	Direct effect (unstandardized)		
	0	0	0
WTP	0.023	0	0
SI	0.077	-0.017	0
LV	0	0	3.484
	Standardized		
	0	0	0
WTP	0.177	0	0
SI	0.814	-0.023	0
LV	0	0	0.896
	Indirect effect (unstandardized)		
	0	0	0
WTP	0	0	0
SI	0	0	0
LV	0.267	-0.06	0
	Standardized		
	0	0	0
WTP	0	0	0
SI	-0.004	0	0
LV	0.726	-0.021	0

Source: Field survey, 2022

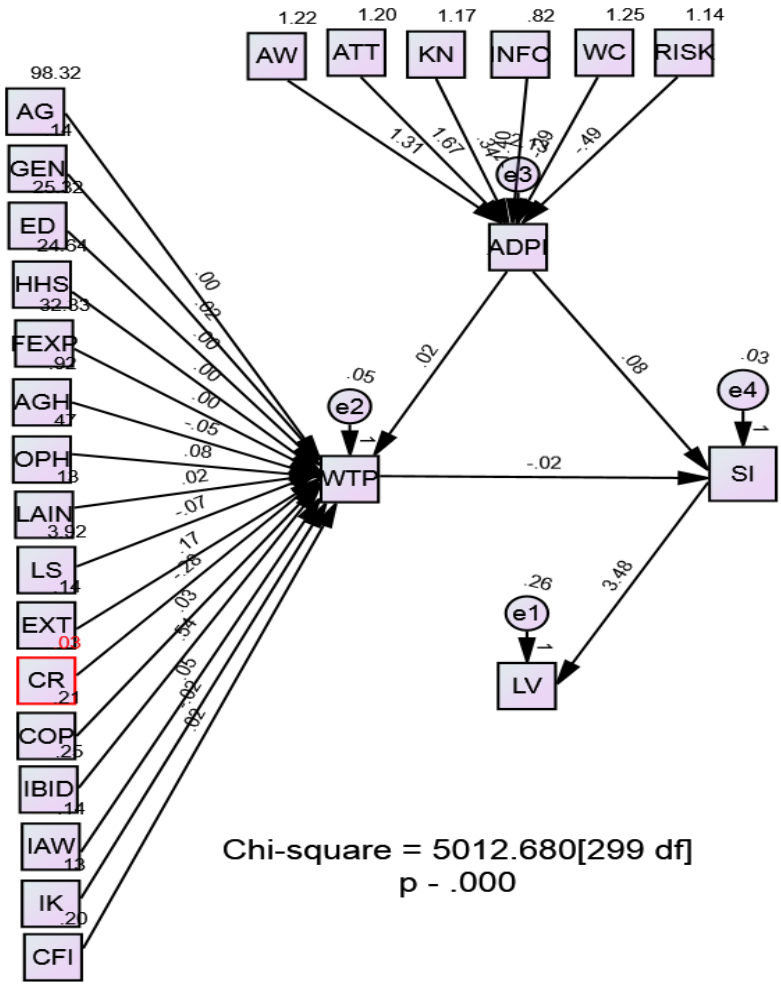


Figure 7: Structural modeling of nexus between eco-innovation's adoption and livelihood status via WTP and farm sustainability

CONCLUSION AND RECOMMENDATIONS

Empirically, there is high adoption of eco-innovation in the study area which owed to livelihood accumulation status of majority of the farmers. However, adoption of eco-innovation is hindered by an extension gap owing to low access to information and poor risk orientation. Consequently, this extension gap marred the intention of almost all of the average sampled farmers, who were not willing to key into the idea of crop insurance, a precursor against risk and uncertainty that are largely driven by weather-induced vagaries, a threat to farm families' livelihood status. Nevertheless, it was just marginally above the average

sampled population, though the majority accepted the idea of crop insurance, and this was due to skeletal reach of the risk sharing system of the NIRSAL programme in the study area. Furthermore, the majority of the farmers had their farms to be sustainable, which underscores the importance of adopting eco-innovation as a climate change resilience measure, thus enabling the majority of the farmers to achieve the accumulated livelihood strategy in the study area. Generally, adoption of eco-innovation has a strong endogenous effect on livelihood status en-route sustainability but a weak endogenous effect on livelihood status en-route WTP. Therefore, the study recommends the need for enhancement of extension services as a measure to address the extension gap that marred effective feed forward-backward flows of information sources and risk orientation on the technologies. Besides, good advisory services will enable the farmers to adapt the eco-innovations, especially non-conventional ones, in a manner that suits their farms' ecological settings, thus enhancing the farmers' climate change resilience, farms' sustainability, and a guarantee of prosperous, sustainable livelihood status.

REFERENCES

Alizadeh, M., Ommani, A. R., Noorollah Noorivandi, A., & Maghsoodi, T. (2022). Determinants of eco-innovations in agricultural production cooperatives in Iran. *Journal of Agricultural Science and Technology*, *24*(1), 1-12.

Aroonsrimorakot, S., Laiphrakpam, M., & Paisantanakij, W. (2021). Application of innovative eco-friendly energy technology for sustainable agricultural farming. *Green Technological Innovation for Sustainable Smart Societies: Post Pandemic Era*, 211-231.

Buchana, Y. (2023). Eco-innovation and agricultural sustainability: empirical evidence from South Africa's agricultural sector. *Innovation and Development*, 1-20.

Davies, S. (1996). Adaptable livelihoods: coping with food insecurity in the Malian Sahel. Sciences. *Technology and Development*, 14(1), 144-156.

Devereux, S. (1993). Goats before ploughs: dilemmas of household response sequencing during food shortages. *Ids Bulletin*, 24(4), 52-59.

Dudek, M., & Wrzaszcz, W. (2020). On the way to eco-innovations in agriculture: Concepts, implementation and effects at national and local level. The case of Poland. *Sustainability*, *12*(12), 4839.

Durán-Romero, G., López, A. M., Beliaeva, T., Ferasso, M., Garonne, C., & Jones, P. (2020). Bridging the gap between circular economy and climate change mitigation policies through eco-innovations and Quintuple Helix Model. *Technological Forecasting and Social Change*, *160*, 120246.

Dybikowska, A., & Graczyk, M. (2019). Technological eco-innovations related to res–opportunities and barriers. *Zagadnienia Ekonomiki Rolnej/Problems of Agricultural Economics*, (1).

Gidey, M. T., Gebretekle, G. B., Hogan, M. E., & Fenta, T. G. (2019). Willingness to pay for social health insurance and its determinants among public servants in Mekelle City, Northern Ethiopia: a mixed methods study. *Cost Effectiveness and Resource Allocation*, *17*, 1-11.

Illu, A.R., Muhaimin, A.W., & Setiawan, B.(2021).Farmers' livelihoods strategy based on asset in Pandansari village post eruption of Mount Kelud. *Agricultural Socio-Economics Journal*, 21(4), 277-284

Jigawa State Government (JSG), (2017). Accessed from www.jigawastate.gov.ng/

Jigawa State Government (JSG), (2021). *Jigawa Research Report.* Retrieved on 14/3/2021 from www.citeseerx.ist.psu.edu

Leszek, W., & Grzegorz, W. (2021). Eco-innovations as a factor of sustainable development of agriculture and food processing. *Zagadnienia Ekonomiki Rolnej/Problems of Agricultural Economics*, (1).

Morris, M., Butterworth, J., Lamboll, R., Lazaro, E., Maganga, F., & Marsland, N. (2001). Household livelihood strategies in semi-arid Tanzania: synthesis of findings. Annex A of the final technical report of project R7805. DFID Project. *Natural Resource Institute, University of Greenwich, Chattam*, 94.

*National Population Commission (NPC),(2017).PHC Priority Tables- National Population Commission. Available at www.*population.gov.ng

Nazir, H., Kharkwal, S., Bardhan, D., Tripathi, S. C., & Kumar, A. (2017). Sustainability assessment of dairy production systems in Uttarakhand hills of India. *International Journal of Pure and Applied Biosciences*, *5*(2), 215-229.

Njie, H., Wangen, K. R., Chola, L., Gopinathan, U., Mdala, I., Sundby, J. S., & Ilboudo, P. G. (2023). Willingness to pay for a National Health Insurance Scheme in The Gambia: a contingent valuation study. *Health Policy and Planning*, 38(1), 61-73.

Ogundeji, Y. K., Akomolafe, B., Ohiri, K., & Butawa, N. N. (2019). Factors influencing willingness and ability to pay for social health insurance in Nigeria. *PloS one*, 14(8), e0220558.

Ranasinghe, R. D. A. K., Ginigaddara, G. A. S., & Gunawardena, U. A. D. P. (2021). Sustainability assessment of paddy farming system in Kaduwela wetland ecosystem in Sri Lanka. *Thai Journal of Agricultural Science*, *54*(1), 64-78.

Sadiq, M.S. & Sani, B.S.(2022).Lıvelıhood status of paddy rıce agro-processors that benefıtted from mıcrofınance credıt in Jıgawa State of Nıgerıa. *Bozok Journal of Agriculture and Natural Sciences*, 1(2), 71-94.

Sadiq, M.S., Singh, I.P., Ahmad, M.M., & Bala, U.M.(2023).Food insecurity resilience capacity of rural households in the face of induced-weather extremities in Bauchi State of Nigeria. *Problems of World Agriculture*, 23(XXXVIII), Scientific Journal Warsaw University of Life Sciences, 3, 20-44

Shamsudin, M. N., Chiew, E. F. C., Mohamed, Z. A., Mohayidin, M. G., & Taylor, D. C. (1994). Farmers' production practices and sustainable development: The case of English cabbage production in Cameron Highlands. *Malaysian Journal of Agricultural Economics (Jurnal Ekonomi Pertanian Malaysia)(Malaysia)*.

Sultana, R., Humayun, K., Hasan, K., Al Imran, S., & Ayatullah, M. (2021). Assessing sustainability of paddy farmers in peri-urban Khulna: an application of farmer sustainability index. *International Journal*, *8*(4), 222-233.

Todorova, K. (2022). Attitudes of Bulgarian farmers for adopting eco-innovations. *Scientific Papers: Management, Economic Engineering in Agriculture & Rural Development*, *22*(1).

Tretiak, N., Hebryn-Baidy, L., Sakal, O., Kovalenko, A., Shtohryn, H., Kovalyshyn, O., & Vrublevska, O. (2021). Cultivation of niche crops and prospects of eco-innovative agricultural production in Ukraine. *Acta Scientiarum Polonorum: Formatio Circumiectus*, *20*.

Yordanova, Z. (2023). Technology in the development of eco-innovations. In *International Congress on Information and Communication Technology* (pp. 705-713). Singapore: Springer Nature Singapore.

Appendix A: Economic, social and environmental dimensions

Dimensions	Sub-dimensions	Measurement
Economic stability	Seasonal yield	Wheat output divided by operational holding per season
	Seasonal farm income per hectare	Total wheat farm income divided by operational holding per season
	Ratio of season farm return per hectare	Wheat profit per hectare divided by the total cost per hectare per season
Social stability	Ratio of seasonal farm income from total income	Income earned from wheat farming divided by the total household's income per season
	Frequency of extension services per season	Number of contact(s) with extension agent per season
	Ratio of women's participation in wheat farm per season (woman hour/woman-day)	Working hours of women on wheat farm per season divided by the total work hours(s) on the wheat farm
	Educational level (year(s))	Number of education years spent by the farmers
	Household size (number)	Total household size of the farmer
Environmental stability	NPK fertilizer used per season per hectare	Quantity of NPK fertilizer (kg)used per hectare per season
	Urea fertilizer used per season per hecatre	Quantity of urea fertilizer (kg) used per hectare per season
	Herbicides used per season per hectare	Quantity of pesticide (litre) used per hectare per season
	Fuel used per season per hectare	Quantity of fuel (litre) used per hectare per season
	Irrigation water per season per hectare	Volume of irrigation water per hectare per season
	Level of adoption of IPM	Number of IPM used by a farmer per season
	Level of adoption of GAP	Number of GAP used by a farmer per season
	Level of adoption of TAP	Number of TAP used by a farmer per season

Source: Modified from Ranasinghe *et al*., 2021

IPM = Integrated pest management practices; GAP = Good agricultural practices; TAP = Traditional practices

Appendix B: Selected practices

Strategies	Practices
IPM	Use of natural enemies, predators and biological agents in the season to prevent diseases and pest attacks
	Changes in frequency of irrigation
	Seasonal application of adequate nutrients for wheat cultivation
	Continuous maintenance of field sanitation throughout the season
	Use of mixed cropping practices in the season
	Usage of trap crops/ traps in the season
	Usage of pheromones seasonally
	Use of bio-pesticides seasonally (e.g., neem leaves or seeds, hot pepper, tobacco, wood ash, and soap)
	Usage of barriers to protect the crop in the season
	Selection of the most effective sowing date avoiding drought, pests and diseases occurrences
GAP	Performing minimum tillage
	Availability of biodegradables and non-biodegradables in the paddy fields
	Use of improved and resistant seeds to the most frequent diseases
	Use of correct crop protection chemicals, fertilizer and compost according to the directions in the labels
	Use of good quality water for irrigation
	Sowing at an adequate distance
	Using clean garden tools
	Practicing monthly weeding
	Consulting agricultural instructor when needed during the cropping season
	Use of proper amount of organic and inorganic fertilizers
TAP	Using traditional practices and rituals in the season
	Use of traditional manual land preparation methods in the season
	Performing season fetish festival before harvesting
	Use of traditional weed control methods
	Practicing traditional manure application techniques in the season
	Using traditional methods in the season to safeguard the field
	Use of traditional bio pesticides in the season
	Use of traditional water management techniques
	Use of traditional seed treatment methods
	Selection of paddy varieties in the season based on the traditional weather forecasting

Source: Modified from Ranasinghe *et al*., 2021

VEKTÖRLERLE TAŞINAN ÖNEMLİ VİRAL HASTALIKLAR VE VEKTÖRLERİN BULAŞMADAKİ ROLÜ

Dr. Ömer Faruk GÖKCECİK (ORCID: 0000-0002-5070-6656)
Izmir/Bornova Veterinary Control Institute, Department of Parasitology, Izmir-Türkiye
Email: omerfaruk.gokcecik@tarimorman.gov.tr

Doç. Dr. A. Anıl ÇAĞIRGAN (ORCID: 0000-0001-7766-3150)
Izmir/Bornova Veterinary Control Institute, Department of Rabies Diagnostic, Izmir-Türkiye
Email: anil.cagirgan@tarimorman.gov.tr

ÖZET
Vektörler ve vektörlerle bulaşan hastalıkların önemi 21. yüzyılda, artan plansız kentleşme, kontrolsüz insan ve hayvan göçleri, ormanların yok edilmesi, kaynakların azalması, patojenlerin mutasyonu ve ilaçlara karşı direnç gelişmesi gibi iklimsel, demografik ve sosyal değişiklikler ile daha da artmıştır. Vektörler viral, bakteriyel ve paraziter enfeksiyon hastalık etkenlerini üzerlerinde veya içlerinde taşıyan ve tüm dünyada bilinen hayvan türlerinin %80'ninden fazlasını oluşturan canlılardır. Genellikle eklembacaklılardan oluşan bu canlılar, biyolojik topluluklar ve ekosistemlerin temelinde rol alırlar. Dünya sağlık örgütü dünya nüfusunun %80'den fazlasının vektörlerle bulaşan hastalıklarla risk altında olduğunu ve vektörlerle bulaşan hastalıkların enfeksiyöz hastalıkların %17'sinden fazlasını oluşturduğunu bildirmiştir. Öte yandan çoğunluğu gelişmiş ülkelerden oluşan Avrupa'da insanların her yıl ortalama 77000'i vektörlerden kaynaklanan hastalıklara yakalandığı fakat bu sayının yeni vektör türleri ortaya çıktıkça daha da artacağı tahmin edilmektedir. Arthropod vektörler aracılığıyla konağa nakledilen ve arthropodta replike olan virüsler (arbovirüsler) günümüz dünyasının gelişmelerine paralel olarak her geçen gün halk sağlığını çok daha tehdit eder hale gelmiştir. Bugün dünyada 545 civarı tanımlanmış arbovirüs bulunmaktadır. Bu arbovirüslerden yaklaşık 134'ü insanlarda ateşli, kanamalı ve nöropatik etkiler bırakarak hastalık oluşturmaktadır. Yedi familyadan oluşan arboviral hastalıklardan yaklaşık 40'ı dünya genelinde önemli salgınlara ve yüksek mortalitelere sebep olmuş, günümüzde de halk sağlığını ciddi boyutlarda tehdit etmektedir. Bu derlemede dünya genelinde arbovirüslerin sebep olduğu önemli viral hastalıklar ve vektörleri hakkında kapsamlı bilgi verilmiştir.
Anahtar Kelimeler: Arbovirüsler, Eklembacaklılar, Vektörler, Viral Hastalıklar

THE MAJOR VIRAL DISEASES TRANSMITTED BY THE VECTORS AND THE ROLE OF THE VECTORS IN THE TRANSMISSION

ABSTRACT

The importance of vectors and vector-borne diseases has increased in the 21st century with climatic, demographic and social changes such as increasing unplanned urbanization, uncontrolled human and animal migration, deforestation, depletion of resources, mutation of pathogens and development of resistance to drugs. Vectors carry viral, bacterial and parasitic infectious disease agents on or inside themselves and constitute more than 80% of the known animal species all over the world. These organisms, which mainly consist of arthropods, play roles in the establishment of the biological communities and ecosystems. The World Health Organization (WHO) reported that more than 80% of the world's population is at risk from vector-borne diseases, and vector-borne diseases account for more than 17% of all infectious diseases. On the other hand, it is estimated that in Europe, which consists of mostly developed countries, an average of 77,000 people get diseases caused by vectors every year and this number will increase as new vector species emerge. Viruses (arboviruses), which are transmitted to the host via arthropod vectors and replicate in the arthropods, have become more and more threatening to public health day by day in parallel with the developments in today's world. 545 arbovirus species have been identified in the world so far. About 134 of these arboviruses cause illness in humans by leaving feverish, hemorrhagic and neuropathic effects. About 40 of the seven families of arboviral diseases have caused significant epidemics and high mortality throughout the world and are still seriously threatening public health today. In this review, comprehensive information was given about arboviruses that cause important viral diseases worldwide.

Keywords: Arboviruses, Arthropods, Vectors, Viral diseases

Giriş

Vektörler parazitler de dahil enfeksiyon hastalık etkenlerinin üzerlerinde veya içlerinde taşınmasında rol oynayan canlılardır. Omurgasız canlıların şaşırtıcı çeşitlilikteki çoğunluğu olan ve tüm dünyada bilinen hayvan türlerinin % 80'ninden fazlasını oluşturan bu canlılar genellikle eklembacaklılardan (artropodlar) oluşmaktadır. Göz kamaştırıcı güzellikte, davranışsal olarak karmaşık ve ekolojik açıdan önemli olan bu canlılar hemen hemen tüm biyolojik topluluklar ve ekosistemlerin temelinde rol oynarlar (İnci & Düzlü, 2009; Wall & Shearer, 2011).

Vektörler ve vektörlerle bulaşan hastalıklar; 20. yüzyılın sonlarında artan iklimsel, demografik ve sosyal değişiklikler ile bunlara bağlı olarak azalan kaynaklar, ağaçların yok edilmesi, ilaçlara karşı direnç gelişmesi, patojenlerin mutasyonu, kontrolsüz insan ve hayvan hareketleri, plansız ve düzensiz kentleşme gibi sebeplerden dolayı tekrar önem kazanmaya başlamıştır (İnci & Düzlü, 2009). Özellikle çevresel olarak bozulmuş ortamlar ve elverişsiz barınma koşullarında yaşayan fakir nüfusları etkileyen vektör kaynaklı hastalıklar yüzünden her yıl 1 milyondan fazla kişi hayatını kaybetmektedir (Álvarez-Hernández & Rivera, 2017).

Şu anda Avrupa'da yaşayan insanların her yıl ortalama 77000' i vektörlerden kaynaklanan hastalıklara yakalandığı fakat yeni vektör türleri ortaya çıktıkça ya da bazı türler yeniden görüldükçe bu sayının artacağı tahmin edilmektedir. Ayrıca vektörlerle bulaşan hastalıklar tıbbi maliyetlerle direkt, üretim kaybı ve turizm gibi dolaylı maliyetlerle de indirekt olarak ekonomik kalkınmayı engellemektedir (Müller & ark, 2019).

1. Vektörlerin Genel Özellikleri ve Vektörel Bulaşma Şekilleri

Vektörlerin parazit yaşamları nedeniyle yararlanabilecekleri farklı bir organizma aramaları, yaşam döngülerini tamamlamak için farklı organizmalara ihtiyaç duymaları ve genellikle karmaşık davranış kalıpları sergilemeleri bu canlıların vektör olmalarının temelini oluşturur. Vektörlerin önemli çoğunluğunu bir milyondan daha fazla tanımlanmış türleriyle eklembacaklılar oluşturur. Sivrisinekler, keneler, tatarcıklar, triatomin böcekleri, çeçe sinekleri, bitler, pireler, karasinekler ve su salyangozları gibi türler, organizmaya çeşitli yollarla girerek veya insanlara ısırma, sokma ve kan emme

gibi zarar vererek veya sadece temas yoluyla hastalık etkenlerini bulaştırırlar (Wall & Shearer, 2011; Müller & ark, 2019).

Vertikal Nakil

Vertikal bulaşma transstadial, transgenerational, venereal ve co-feeding bulaşma olmak üzere dört şekilde gerçekleşir. Vektörün **y**aşam siklusunun bir döneminde enfekte bir konaktan aldığı hastalık etkenini sonraki gelişme döneminde kan emdiği yeni bir konağa taşıması transstadial bulaşma olarak adlandırılır (İnci & Düzlü, 2009). Dişi vektörlerin, patojenleri doğrudan kendi yumurtalarına nakletmesiyle oluşan bulaşma şekli ise transgenerational bulaşmadır ve genelde transovarial bulaşma ile gerçekleşen bu bulaşmada etkenin nakli enfekte gamet hücreler aracılığıyla germinal dokuyla ya da plasenta aracılığıyla yeni nesillere nakledilir. Dolayısıyla bu yolla patojenler sonraki nesillere nakledilir. Bazı etkenler transgenerational olarak yeni nesillere aktarılarak korunabilir (İnci & Düzlü, 2009; Reisen, 2017). Dişi ve erkek vektör türlerinin çiftleşmesi sırasında, enfekte erkek vektörün spermi enfekte olmayan dişi vektörün yumurtalarını döllediğinde meydana gelen bulaşmaya ‘’venereal bulaşma’’ denir. Nispeten nadir görülen bu bulaşma biçiminde, enfekte dişiler tarafından üretilen yumurtalar, transovarial olarak enfekte olur (Reisen, 2017). Diğer bulaşma şekli olan ‘’co-feeding’’ ise, en az iki eklembacaklı (artropod) vektörün bir konakçıdan kan emerken, enfekte vektörün sistemik olmayan bir patojeni tükürük sekresyonlarıyla diğer enfekte olmayan vektöre aktarmasıdır (Reisen, 2017).

Horizontal Nakil

Horizontal bulaşma, artropodlar tarafından konakçıdan kan emerek, patojenlerin tükürük (salivarian), dışkı (stercorarian), sindirim sisteminde patojenlerin kusması (yetersizliği) veya vektörün yutulması yoluyla aktif veya pasif olarak meydana gelebilir. Bu bulaşma şekilleri mekanik ya da biyolojik yolla gerçekleşebilir (İnci & Düzlü, 2009).

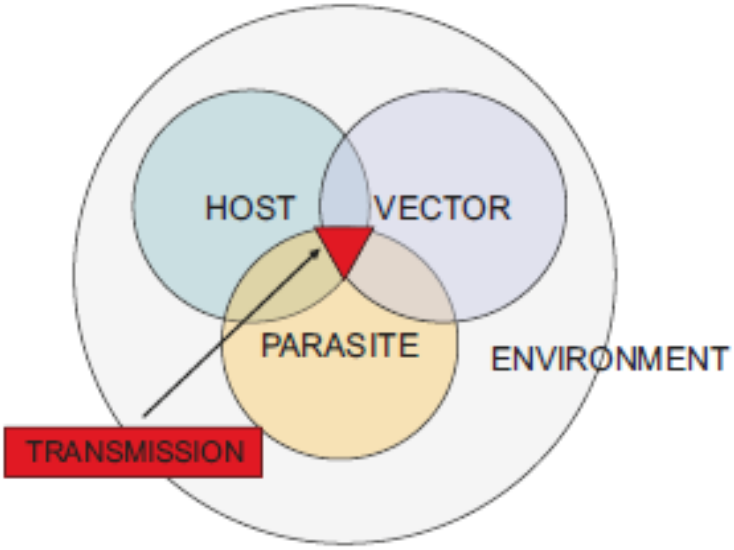
Mekanik vektörlükte hastalık etkeni, vektörün vücudunda herhangi bir çoğalma, gelişme ve değişme göstermez. Vektör, hastalık etkenini bir süre taşır ve asıl konağa nakleder. Konakları ile yakında ilişkili olan ve sık aralıklarla beslenen eklembacaklıların etkenleri mekanik olarak iletme olasılıkları oldukça yüksektir (Contigiani & ark, 2017). Kan emen (blood-borne) sinekler bu tip vektörlere en güzel örnektir. Eklembacaklıların oral organelleri, kanla beslenerek mekanik taşımada hipodermik bir enjektör görevi görür ve enfekte konakçıdan sonra başka bir konakçıda beslenmeye devam eder. Bu şekilde

patojenler herhangi bir çoğalma olmaksızın başka bir konakçıya aktarılır (İnci & Düzlü, 2009; Contigiani & ark, 2017). Günümüzdeki önemli viral hastalıklarından biri olan AIDS'in (HIV) sivrisinekler tarafından taşınmadığına dair birçok çalışma olsa da, dünya çapında yapılan bir çalışmada sivrisinekler ile HIV arasında tutarlı bir ilişki olduğunu gösteren ve mekanik bulaşmada sivrisineklerin önemli bir risk faktörü olduğunu öne süren bir çalışma bulunmaktadır (Jiman 2021; Bockarie & Paru, 1996). Bu çalışma birçok ülkede ve birçok sivrisinek türünde çalışılmış olsa da en geniş coğrafi dağılıma sahip *Aedes aegypti* ve *Aedes albopictus* üzerinde yoğunlaşmıştır (Jiman 2021). Dünyada ve ülkemizde çok sayıda ölüme neden olan Covid 19 pandemisinin etkeni olan SARS CoV-2 'nin bulaşmasında ise sivrisineklerin mekanik olarak vektör görevi görmediği belirtildi (Fortuna & ark, 2021).

Biyolojik vektörlükte patojenlerin büyük çoğunluğu, yaşam döngülerinin bir bölümünü, bu döngüyü tamamlamak için çoğaldıkları veya enfektif aşamaya geldikleri eklembacaklılarda geçirmek zorundadır. Biyolojik nakil de patojen etken vektörde aktif bir replikasyonla çoğalarak bir gelişme aşaması geçirmelidir. Genel olarak, vektör kaynaklı ajanlar, bulaşıcı hale geldikten sonra, vektörün bir sonraki beslenmesinde bulaşmaya hazır olarak, vektörlerin tükürük bezlerine veya ağız kısımlarına göç eder ve böylece vektörün bir sonraki beslenmesinde bulaşmaya hazır hale gelirler. Patojen ajanlar eklembacaklıların sonraki beslenmelerinde konak vücuduna girerek konağı enfekte ederler (Contigiani & ark, 2017).

2. Artropod Vektörlerin Biyolojisi ve Konak ilişkisi

Vektör ve konakçı arasındaki temasın derecesi büyük ölçüde değişebilir. Vektör genellikle konakçıdan gelen kan veya diğer dokularla beslenirken aynı zamanda konakçı vektör için bir yaşam alanı sağlar. Vektörün bulaşmada kanla beslenmesi önemlidir çünkü beslenme sırasında etken, vektör ve konak aynı anda ve ortamda bir araya gelerek etkenleri konakçıya aktarır (Reisen, 2017) (Şekil 1). Vektör eklembacaklıların ajanı taşıyabilmeleri için genellikle ömürleri boyunca en az iki kez beslenmeleri gerekir. İkinci beslemede vektör ne kadar sık ve uzun süre beslenirse enfeksiyon riski o kadar artacaktır (Contigiani & ark, 2017).



Şekil 1 Vektör kaynaklı bulaşma döngüsünün gerekli dört bileşeni (Reisen, 2017).

Eklembacaklılar üremeleri için gerekli yapı malzemelerini elde etmek, metabolizmalarının devamlılığını sağlamak ve metamorfozlarını gerçekleştirmek için kan besinlerini alırlar. Gonotrofik döngü, eklembacaklıların konak arama, beslenme, sindirim, yumurta olgunlaşması ve yumurtlama gibi aşamalardan oluşmaktadır. Parous (doğurmuş) dişiler, bir veya daha fazla gonotropik döngüyü tamamlamıştır ve bu nedenle, üremeyen, ilk kez konaklayan veya ilk kez beslenen nuliparous dişilere göre etkenleri bulaştırma olasılığı çok daha yüksektir. Havayla, temasla veya damlacıkla doğrudan konaktan konağa bulaşan etkenlerin aksine, eklembacaklılar tarafından bulaştırılan etkenler serbest yaşam veya çevreye dirençli aşamalar yerine eklembacaklı içinde çoğalıp, gelişir ve kanla beslenme sırasında bulaşabilir (Wall & Shearer, 2011; Reisen, 2017). Eklembacaklı tarafından alınan virüsler eklembacaklının orta bağırsak hücrelerini enfekte ederek burada çoğalırlar. Daha sonra virüsler hemolenf ve diğer organlardaki nöronlar aracılığıyla yayılarak sonunda tükürük bezlerine ulaşırlar ve burada çoğalarak enfeksiyon oluştururlar. Virüsler, artropodun bir sonraki beslenmesinde tükürük yoluyla duyarlı yeni bir konakçıya aktarılabilir ve bu aktarım döngüsü yeniden başlar. Bir arbovirüsü taşıma yeteneği, vektör yetkinliği olarak bilinen genetik bir özelliktir. Etkili bir artropod vektör, konak seçen, enfektif olan ve hastalık etkenini bulaştırabilen dolayısıyla konağa çeşitli biyolojik zararlar veren vektördür (Contigiani & ark, 2017).

3. Vektör Kaynaklı Viral Hastalıklar ve Artropodların Bulaşmadaki Rolü

Arbovirüsler

Bazı viral etkenlerin epidemiyolojisinde culicoidesler, tahtakuruları, sivrisinekler, tatarcıklar ve keneler gibi kan emen eklembacaklı vektörlerin önemli yeri vardır (Contigiani & ark, 2017). Eklembacaklı vektörler aracılığıyla konağa nakledilen ve replike olan virüslere ise arbovirüsler denir (Knowles, 2011a).

Arbovirüs ailesi *Asfarviridae, Bunyaviridae, Reoviridae, Rhabdoviridae, Flaviviridae, Orthomyxoviridae* ve *Togaviridae* olmak üzere yedi familyayı içerir (Contigiani & ark, 2017). Ayrıca arbovirüs ailesi içinde sayılmayan *Retroviridae* familyasının üyesi HIV ve ataların enfeksiyöz anemisi virüsü (EIA) ile *Poxviridae* familyasının üyesi sığırların nodüler ekzentemi virüsü (LSD) artropodlar aracılığıyla mekanik olarak taşınırlar. Arbovirüsler kuşlar, kemirgenler, atlar, maymunlar ve insanlar dâhil olmak üzere çeşitli omurgalılarda çoğalabilir. Günümüzde tanımlanmış olan 545 civarı arbovirüs bulunmaktadır. Bunlardan yaklaşık 134'ünün insanlarda, 40'ının ise hayvanlarda hastalık oluşturduğu bildirilmiştir (Gubler, 2001). Omurgalı konaklarda genellikle ateşli, kanamalı ve nöropatik etkileri olan bu virüsler konağa nakledildikten sonra akut enfeksiyona yol açarlar ve genellikle konakta uzun süreli immünite oluşturur (İnci & Düzlü, 2009). Ekolojileri ve bir artropodda replike olma özellikleri ile birleşen arbovirüsler üzerine yapılan epidemiyolojik çalışmalarda bazı virüslerin vektör jenerasyonları arasında persiste olabileceğini de ortaya koymuştur (Müller & ark, 2019).

- ***Asfarviridae***

African Swine Fever Virüsü (ASFV)

Asfarviridae ailesindeki tek cins olan *Asfivirüsler* içerisindeki Afrika Domuz Gribi Virüsü (ASFV) domuzların oldukça bulaşıcı, kusma, ishal ve hemorajilerle karakterize ölümcül bir hastalığıdır. Afrika domuz gribi virüsleri lipid solventlere karşı oldukça duyarlı olmalarına karşın dışkıda 11 gün, domuz etinde üç ay ve domuz pastırmasında bir yıl canlı kaldığı saptanmıştır (Knowles, 2011a; Yeşilbağ, 2017). Hastalık etkeninin bulaşmasında *Ornithodoros* cinsi keneler önemli rol oynamaktadır. *Ornithodoros* cinsi virüsü transovarial ve venereal yolla nakledilebilir. Ayrıca virüs transstadial yolla da diğer kenelere nakledilebilir. Kene tükürüğü, idrar sıvısı ve dışkısı ile virüsü diğer domuzlara bulaştırırlar (Contigiani & ark, 2017, Knowles, 2011).

- ***Bunyaviridae***

Bunyaviridae ailesi bitki virüsleri de dahil olmak üzere beş cinste toplam 350 virüsle en büyük ailedir. İnsan ve hayvanlarda enfeksiyon oluşturan önemli virüsler ve vektörleri Tablo 1'de gösterilmiştir. Familya içerisindeki virüsler, kemirgenlerle bulaşan *Hantavirüsler* hariç hemen bütün virüsler arbovirüslerdir. Bu viral hastalıklardan Rift Vadisi Ateşi, Kırım-Kongo Kanamalı Ateşi ve Nairobi Koyun Hastalığı uluslararası hastalık kontrol merkezleri tarafından takip edilen ve referans laboratuvarlar tarafından araştırmaları yapılan önemli hastalıklardır (Yeşilbağ, 2017; Bowen, 2011a).

Tablo 3 *Bunyaviridae* familyasında bulunan başlıca arbovirüsler ve vektörleri.

Genus	**Virüs**	**Vektör**
Nairovirus	Crimean-Congo hemorrahagic fever virüs	*Hyalomma spp.(H.marginatum)*
Nairovirus	Nairobi sheep disease	*Rhipicephalus appendiculatus, Haemaphysalis intermedia*
Bunyavirus	Oropouche virüs	Sivrisinekler, *Culicoides paraensis*
Bunyavirus	Akabane virüs	*Culex spp., Aedes spp.* ve *Culicoides spp.*
Bunyavirus	Bunyamwera virüs	*Aedes spp.*
Bunyavirus	California encephalitis virüs	Sivrisinekler *(Oc. Dorsalis, Cx. tarsalis)*
Bunyavirus	La crosse virüs	Sivrisinekler *(Oc. Triseriatus)*
Phlebovirus	Rift Valley fever virüs	Sivrisinekler *(Aedes spp., Culex spp.)*
Phlebovirus	Sandfly fever naples virüs	*Phlebotomus perniciosus ve Ph. perfiliewi*

Kırım-Kongo kanamalı ateşi (CCHF) familyanın önemli zoonoz patojenlerinden olup uzun yıllardır Asya, Avrupa ve Afrika'da birçok ülkede bildirilmiştir (Bowen, 2011a). Kırım Kongo kanamalı ateşi virüsü vektör keneler tarafından transstadial, transovarial ve venereal nakledilir. Hastalığın insanlara bulaşmasında, özellikle *Hyalomma* türleri önemli bir yer tutmaktadır. Akdeniz *Hyalommas*ı olarak bilinen *H. marginatum* Avrupa'da CCHF'nin ana vektörü olarak bilinmektedir. Hastalığın keneler vasıtası ile insanlara bulaşmasında temel yol, enfekte kenenin konaktan kan emmesi esnasında tükürük salgısı ile birlikte virüsü konağa vermesi şeklindedir. Ayrıca enfekte bir kişinin kanı veya dokuları ile doğrudan temas yoluyla da iletilir (Contigiani & ark, 2017).

- ***Flaviviridae***

Familya içerisinde genomik ve fizyokimyasal özellikleri birbirine benzeyen fakat biyolojik olarak birbirinden farklı üç cins (*Flavivirüs*, *Pestivirüs* ve *Hepacivirüs*) bulunur.

Bu cinslerden sadece flavivirüs cinsinde en az 70 virüs bulunur, bunlardan 30 kadarı artropodlarla insanlara bulaşan hemorajik ateş, ensefalit ve hepatit gibi yaşamı tehdit eden zoonotik enfeksiyonlara neden olurlar. Familyadaki cinsler içindeki önemli arbovirüsler ve vektörleri Tablo 2'de gösterilmiştir (Contigiani & ark, 2017; Bowen, 2011b).

Tablo 4 *Flaviviridae* familyasında bulunan başlıca arboviral etkenler ve vektörleri.

Genus	Virüs	Vektör
Flavivirus	Dengue virüsü	Sivrisinekler (*Aedes aegypti, Aedes spp.)*
Flavivirus	Japanese encephalitis virüs	Sivrisinekler (*Culex tritaeniorhynchus, Culex spp.)*
Flavivirus	St. Louis encephalitis virüs	Sivrisinekler *(Culex tarsalis, C. pipiens, Culex spp.)*
Flavivirus	West Nile virüs	Sivrisinekler *(Culex spp.* nadiren *Aedes spp.)* ve keneler
Flavivirus	Kyasanur Forest disease virüs	*Haemaphysalis spinginera*
Flavivirus	Louping ill virüs	*Ixodes ricinus*
Flavivirus	Murray Valley encephalitis virüs	Sivrisinekler *(Culex annulirostris)*
Flavivirus	Omsk hemorrhagic fever virüs	*Dermacentor reticulatus, Dermacentor spp.*
Flavivirus	Powassan virüs	*Ixodes spp.* ve diğer keneler
Flavivirus	Tick-borne encephalitis virüs	*Ixodes spp.* ve diğer keneler
Flavivirus	Wesselsbron virüs	Sivrisinekler *(Aedes spp.* ve diğer sivrisinekler*)*
Flavivirus	Yellow fever virüs	Sivrisinekler *(Aedes, Haemagogus* ve *Sabethes spp.)*

- ***Orthomyxoviridae***

Thogoto Virüs (THOV)

Orthomyxoviridae familyasında tek cins olan *Thogotovirus* içerisindeki bulunan Thogoto virüs (THOV) Afrika, Güney Avrupa ve Asya'da bulunan ilk olarak sığır, deve ve koyun gibi çiftlik hayvanlarını enfekte eden tek sarmallı bir RNA virüsüdür. Bu virüs omurgalılar arasında *İxodid* cinsi keneler yoluyla bulaşır ve küresel bir dağılıma sahip olduğu düşünülmektedir. Thogoto virüsü ilk 1960 yılında Nairobi Kenya'da Thogoto ormanlarındaki sığırlardan toplanan *Rhipicephalus (Boophilus) decoloratus ve Rh. evertsii kenelerinden izole edilmiştir.* Daha sonra Afrika'da birçok ülkede insan, sığır, deve ve kenelerden izole edildi. Thogoto virüs mide bulantısı, kusma, zayıflık, ishal, ateş, papüler döküntü ve lenfadenopati gibi spesifik olmayan semptomlar gösterebildiği bildirilmiştir (MacLachlan & Dubovi, 2011; Lvov & ark, 2015).

- ***Reoviridae***

Zarfsız, kübik şekilli, virion yapıda olan çift iplikçikli RNA virüsü en karmaşık yapıya sahip ailedir. *Reoviridae* familyasındaki virüsler dış etkilere dayanıklı olup 12 cins

içermektedir. Familyadaki cinsler içindeki önemli arbovirüsler ve vektörleri Tablo 3'de gösterilmiştir. Çevre koşullarına oldukça dayanıklı olan bu familyanın virüsleri ısıya, organik çözücülere ve iyonik olmayan deterjanlara orta derecede dirençlidir (Andrew & ark, 2012; Saif, 2011). *Reoviridae* ailesine ait ilk virüsler insan ve hayvanların solunum ve sindirim sistemlerinden izole edilmiştir (Saif, 2011).

Tablo 5 *Reoviridae* familyasında bulunan başlıca arboviral etkenler ve vektörleri.

Genus	Virüs	Vektör
Orbivirus	African horse sickness virüs	*Culicoides imicola, C. bolitinos, C. variipennis,* sivrisinekler ve keneler
Orbivirus	Bluetongue virüs	*Culex spp. (C. imicola)*
Orbivirus	Epizootic hemorrhagic disease virüs	*Culex spp. (C. sonorensis)*
Seadorna	Banna virüs	Sivrisinekler *(Culex spp.)*
Coltivirus	Colorado tick fever virüs	*Dermacentor andersoni*

- ***Rhabdoviridae***

Ephemeral Ateş Virüsü (Üç Gün Hastalığı) ve Veziküler Stomatitis Virüsü

Rhabdoviridae familyası omurgalı, omurgasız ve bitkilerde enfeksiyonlara neden olan ve 175 den fazla virüs içeren büyük bir familyadır. İnsan, hayvan ve çeşitli bitkilerde hastalık oluşturan toplam altı cins bulunmaktadır. Tarihte bilinen ve tanımlanan en eski ve en öldürücü virüs olan kuduz virüsü bu aile içerisindedir. *Ephemerovirus* genusundaki Sığırların Üç Gün Hastalığı ve *Vesiculovirus* genusunda bulunan veziküler stomatit virüsü *Rhabdoviridae* ailesine ait Afrika, Avustralya, Orta Doğu ve Asya'nın tropikal, subtropikal bölgelerinde ekonomik önemi olan arboviral enfeksiyonlardır. Bu enfeksiyonların vektörlerinin çeşitli sivrisinek türleri olduğu bildirilmiştir (Walker & Klement, 2015, Bowen, 2011c).

Togaviridae

Togaviridae ailesi içerisinde *Alphavirus* ve *Rubivirus* olmak üzere 2 genus bulunmaktadır.

Alphaviruslar'da insan ve hayvanlarda önemli enfeksiyonlara neden olan virüsleri de içeren toplam 31 tür bulunmaktadır. Bazı önemli arbovirüsler ve vektörleri Tablo 4'de gösterilmiştir (Contigiani & Diaz, 2017).

Tablo 6 *Togaviridae* familyasında bulunan başlıca arboviral etkenler ve vektörleri.

Genus	Virüs	Vektör
Alphavirus	Chikungunya virüsü	*Aedes spp.*
Alphavirus	O'nyong-nyong virüs	*Anophel spp. (An. funestus)*
Alphavirus	Eastern equine encephalitis virüsü	Sivrisinekler *(C. sonorensis)*
Alphavirus	Western equine encephalitis virüsü	Sivrisinekler *(Culiseta melanura, Aedes spp.* ve *Culex spp.)*
Alphavirus	Venezuelan equine encephalitis virüsü	Sivrisinekler *(Psorophora spp., Aedes spp.ve Culex spp.)*
Alphavirus	Sindbis virüs	Sivrisinekler *(Culex spp.)*

- ***Retroviridae***

Human Immunodeficiency Virüs (HIV)

Human immunodeficiency virüs, *Retroviridae* ailesi *Lentivirus* genusunda yer alan insanlarda immün yetmezliğe (Acquired Immunodeficiency Syndrome-AIDS) neden olan dünya genelinde salgınlar oluşturmuş önemli bir virüstür (Kızılkoca & ark, 2021). İlk olarak 1981'de Amerika'da tanımlanmış olan HIV, vücudun bütün sistemlerini etkileyebilen, günümüzde etkin güvenilir bir tedavi için çalışmaları devam eden ve ölümle sonuçlanabilen bir enfeksiyondur (Ağlarcı & ark, 2011; Muccini & ark, 2022). Damar içi uyuşturucu kullanımı ve cinsel yolla bulaşma HIV hastalığının yayılımında önde gelen nedenler olsa da sivrisinekler aracılığıyla bulaşmanın yayılımda önemli olduğu bildirilmiştir. Human immunodeficiency virüsü konakçı dışında uzun süre yaşayamadığı için mekanik bulaşmada konakçıların birbirine yakın olması önemlidir (Jiman 2021).

Equine Infectious Anemia Virüs (EIAV)

Retroviridae ailesi *lentivirus* genusundaki equine infectious anemia virüsü atların akut, subakut ve kronik seyirli, dünya genelinde hastalık oluşturan yüksek mortaliteye sahip viral bir enfeksiyonudur. Hastalık ilk kez 1843 yılında Fransa'da tanımlandı ve 1904 yılında viral etiyolojisi verilen ilk hayvan hastalıklarından biri oldu. Yalnızca at, eşek ve katırlarda görülen hastalıkta tabanid sinekleri ve kara sinekler (*Stomoxys* spp.) mekanik vektörlerdir (Lairmore, 2011). Taşınma tamamen mekaniktir virüs vektörde replike olmaz. Etkenin bulaşma şansı sineğin beslenmeden sonra ağzında tuttuğu kan hacmi ile doğru orantılıdır (Cook & ark, 2013). Atların İnfeksiyöz Anemisinin

bulaşmasında artropod vektörler dışında birçok mekanik bulaşma yolları da vardır (Issel & Foi, 1984).

- ***Poxviridae***

Lumpy Skin Disease Virüs (LSDV)

Poxviridae familyası *Capripox* genusunda yer alan, Afrika'da sık görülen sığır ve mandaların ateşli deri hastalığıdır. Lumpy Skin Disease Virüsü ilk kez 1929 yılında Zambiya'da tespit edilmiş ve 1943 yılında enfeksiyöz bir hastalık olarak tanımlanmıştır (Knowles, 2011b). Ateşli seyir gösteren hastalık lenf yumrularında büyüme, iç organ ve mukozal nodüller, zayıflama ve bazen de ölümle karakterizedir (Gazioğlu, 2016). Virüs esas olarak mekanik yolla kan emici artropod vektörler tarafından bulaştırılır. Esas vektör olarak şüphelenilen kara sineklerin (*Stomoxys calcitrans),* yapılan deneylerde LSDV'yi taşıdığı belirtilmiştir (Muller & ark, 2011). Bazı salgınlarda *Aedes* ve *Culex* türü sivrisineklerin vektörlük yaptığı belirtilmektedir. Afrika'da yapılan bir çalışmada *Rhipicephalus (Boophilus) decoloratus* (mavi kene), *Rhipicephalus appendiculatus* (kahverengi kulak kenesi) ve *Amblyomma hebraeum* (bont kene) türü keneler hastalığın vektörleri olarak tespit edilmiştir (Lubinga & ark, 2014). Vektör kenelerde viral replikasyon olmadığı bilinse de venereal bulaşma olduğuna dair kanıtlar da vardır (Gazioğlu, 2016).

Kaynaklar

Wall R, Shearer D. The İmportance Of Diversity Of Arthropod Ectoparasites. Veterinary Ectoparasites Biology, Pathology and Control. 2nd ed. *London: Blackwell Science;* 2001. p.1-22.

İnci A, Düzlü Ö. Vektörler ve Vektörlerle Bulaşan Hastalıklar. *Erciyes Üniversitesi Veteriner Fakültesi Dergisi.* 2009; 6(1): 53-63.

Álvarez-Hernández DA, S-Rivera A. An Introduction to Vector-Borne Diseases. *Austin Journal of Vector Borne Diseases: Open Access.* 2017, 1(1): 1001.

Müller R, Reuss F, Kendrovski V, Montag D. Vector-Borne Diseases. In: Marselle MR, Stadler J, Korn H, Irvine KN, Bonn A, eds. Biodiversity and Health in the Face of Climate Change. *Cham: Springer Open*; 2019. p.67-90.

Reisen WK. Epidemiology. In: Marcondes CB, eds. Arthropod Borne Diseases. *Springer International Publishing; Cham:* 2017. p.7-32.

Contigiani MS, Diaz LA, Spinsanti LI. General Aspects on Arboviruses. In: Marcondes CB, eds. Arthropod Borne Diseases. *Springer International Publishing; Cham*: 2017. p.61-86.

Jiman H. An Opinion on Mosquitoes' Role in HIV Transmission. *Asian Journal of Research in Infectious Diseases.* 2021; 8(4): 37-42.

Bockarie MJ, Paru R. Can mosquiteoes transmit AIDS? *P N G Med J*. 1996 Sep; 39(3): 205-7.

Fortuna C, Montarsi F, Severini F, Marsili G, Toma L, Amendola A, et al. The common European mosquitoes *Culex pipiens* and *Aedes albopictus* are unable to transmit SARS-CoV-2 after a natural-mimicking challenge with infected blood. *Parasites & Vectors*. 2021 Jan 22; 14(1): 76.

Knowles DP. Asfarviridae and Iridoviridae. In: MacLachlan NJ, Dubovi EJ, eds. Fenner's Veterinary Virology. 4st ed. *Chennai: Academic Press is an imprint of Elsevier*; 2011a. p.167-172.

Gubler DJ. Human Arbovirus Infections Worldwide. *Annals of the New York Academy of Sciences. 2001; 951(1): 13-24.*

Yeşilbağ K. Genel Viroloji, 2. baskı, Bursa, *Medyay kitapevi*, 2017; 213-220.

Bowen RA. Bunyaviridae. In: MacLachlan NJ, Dubovi EJ, eds. Fenner's Veterinary Virology. 4st ed. *Chennai: Academic Press is an imprint of Elsevier*; 2011a. p.371-381.

Bowen RA. Flaviviridae. In: MacLachlan NJ, Dubovi EJ, eds. Fenner's Veterinary Virology. 4st ed. *Chennai: Academic Press is an imprint of Elsevier*; 2011b. p.467-481.

MacLachlan NJ, Dubovi EJ. Orthomyxoviridae. Fenner's Veterinary Virology. 4st ed. *Chennai: Academic Press is an imprint of Elsevier;* 2011. p.370.

Lvov DK, Shchelkanov MY, Alkhovsky SV, Deryabin PG. Single-Stranded RNA Viruses. Zoonotic Viruses of Northern Eurasia Taxonomy and Ecology, 1st ed. *Chennai: Academic Press is an imprint of Elsevier*, 2015. p.135-392.

Andrew MQK, Michael JA, Eric BC, Elliot JL. Family-Reoviridae. Virus Taxonomy Ninth Report of the International Committee on Taxonomy of Viruses. *Academic Press is an imprint of Elsevier;* 2012. p.541-634.

Saif LJ. Reoviridae. In: MacLachlan NJ, Dubovi EJ, eds. Fenner's Veterinary Virology. 4st ed. *Chennai: Academic Press is an imprint of Elsevier*; 2011. p.275-291.

Walker PJ, Klement E. Epidemiology and control of bovine ephemeral fever. *Veterinary Research.* 2015 Oct 28; 46: 124.

Bowen RA. Rhabdoviridae. In: MacLachlan NJ, Dubovi EJ, eds. Fenner's Veterinary Virology. 4st ed. *Chennai: Academic Press is an imprint of Elsevier*; 2011c. p.327-341.

Contigiani MS, Diaz LA. Togaviridae. In: Marcondes CB, eds. Arthropod Borne Diseases. *Springer International Publishing; Cham*: 2017. p.115-135.

Kızılkoca SN, Koç BT, Tan MT. Viruslarda Genetik Değişiklere Bağlı Konakçı Değişimleri. *Dicle Üniv Vet Fak Derg.* 2021; 14(1): 77-82.

Ağlarcı O, Erturan İ, Yılmaz H. HIV ile enfekte kişilerde sıklıkla gözlenen oral mukoza bulguları. *Süleyman Demirel Üniversitesi Sağlık Bilimleri Dergisi.* 2011; 1(2): 119-124.

Muccini C, Canetti D, Castagna A, Spagnuolo V. Efficacy and Safety Profile of Fostemsavir for the Treatment of People with Human Immunodeficiency Virus-1 (HIV-1): Current Evidence and Place in Therapy. *Drug Des Devel Ther*. 2022 Jan 25; 16: 297-304.

Lairmore MD. Retroviridae. In: MacLachlan NJ, Dubovi EJ, eds. Fenner's Veterinary Virology. 4st ed. *Chennai: Academic Press is an imprint of Elsevier*; 2011. p.269-270.

Cook RF, Leroux C, Issel CJ. Equine infectious anemia and equine infectious anemia virus in 2013: a review. *Vet Microbiol.* 2013 Nov 29; 167(1-2): 181-204.

Issel CJ, Foil LD. Studies on equine infectious anemia virus transmission by insects. J Am Vet *Med Assoc*. 1984 Feb 1; 184(3): 293-7.

Knowles DP. Poxviridae. In: MacLachlan NJ, Dubovi EJ, eds. Fenner's Veterinary Virology. 4st ed. *Chennai: Academic Press is an imprint of Elsevier;* 2011b. p.157-160.

Gazioğlu A. Sığırların Nodüler Ekzantemi (Lumpy Skin Disease). *Türk Tarım ve Doğa Bilimleri Dergisi.* 2016; 3(1): 1–7.

Muller GC, Hogsette JA, Kravchenko VD, Revay EE, Schlein Y. New records and ecological remarks regarding the tribe Stomoxyini (Diptera: Muscidae) from Israel. *Journal of Vector Ecology*, 2011; 36(2): 468-470.

Lubinga JC, Clift SJ, Tuppurainen ES, Stoltsz VH, Babiuk S, Coetzar JA, et al. Demonstration of lumpy skin disease virus infection in *Amblyomma hebraeum* and *Rhipicephalus appendiculatus* ticks using immunohistochemistry. *Ticks Tick Borne Dis.* 2014 Mar; 5(2): 113-20.

KÜÇÜK HAYVAN VETERİNER HEKİMLERİNİN EL HİJYENİNE DİKKATLERİNİN ARAŞTIRILMASI

Murat ARIKAN (ORCID: 0009-0003-7560-7157)
Mehmet Akif Ersoy University, Faculty of Veterinary, Department of Internal Medicine, Burdur-Türkiye
Email: murat.arikan@tarimorman.gov.tr

Doç. Dr. Ramazan YILDIZ (ORCID: 0000-0001-5772-0891)
Mehmet Akif Ersoy University, Faculty of Veterinary, Department of Internal Medicine, Burdur-Türkiye
Email: ramazanyildiz@mehmetakif.edu.tr

ÖZET
Microsoft Forms aracılığıyla Türkiye'nin çeşitli bölgelerindeki küçük hayvan klinikleri ve hastanelerinde çalışmakta olan veteriner hekimler üzerinde biyogüvenlik uygulamaları ile ilgili bir anket çalışması yürütülmüştür. Anket sonucunda veteriner hekimlerin ne ölçüde biyogüvenlik protokollerine dikkat ettikleri ve el hijyenine ne ölçüde önem verdikleri araştırılmıştır. Sağlık kuruluşlarında enfeksiyonların yayılmasının önlenmesinde el hijyeni çoğunlukla en önemli tedbir olarak görülmektedir. Veteriner kliniği çalışanları, hastayla temastan önce ve sonra ve bulaşmaya sebep olabilecek her türlü faaliyetten sonra mutlaka el hijyeni sağlamalıdır. Usulüne uygun el hijyeni, cildin bütünlüğünü bozmaksızın birçok patojeni tamamen elimine eder ve yok eder. Gözle görülür kirlenme olması halinde, hastaların vücut sıvıları, sekresyonlar, dışkı ve yaralarla temas sonrası, tuvaleti kullandıktan sonra, yeme veya içmeden önce hangi sıklıkla el yıkama uygulaması yaptıklarına ilişkin sorular yöneltilmiştir. Bu sunum, 06.09.2023 tarihli, GO 2023/449 karar numaralı 10595912 referans numaralı "Küçük Hayvan Kliniklerinde Biyogüvenlik" başlıklı yüksek lisans tezinin bir bölümünden oluşmaktadır.
Anahtar Kelimeler: Biyogüvenlik, Dezenfeksiyon, El Hijyeni, Veteriner

INVESTIGATION OF SMALL ANIMAL VETERINARY SURGEONS' ATTENTION TO HAND HYGIENE

ABSTRACT
A survey on biosecurity practices was conducted on veterinarians working in small animal clinics and hospitals in various regions of Turkey using Microsoft Forms. As a result of the survey, it was investigated to what extent veterinarians pay attention to biosecurity protocols and to what extent they attach importance to hand hygiene. Hand hygiene is often seen as the most important measure in preventing the spread of infections in health institutions. Veterinary clinic staff should ensure hand hygiene before and after patient contact and after any activity that may cause transmission. Proper hand hygiene completely eliminates and destroys many pathogens without compromising the integrity of the skin. In case of visible contamination, questions were asked about the frequency with which patients practiced hand washing after contact with body fluids, secretions, feces and wounds, after using the toilet, and before eating or drinking. This presentation consists of a part of the master's thesis titled "Biosafety in Small Animal Clinics" dated 06.09.2023, decision number GO 2023/449, reference number 10595912.
Keywords: Biosecurity, Disinfection, Hand Hygiene, Veterinary

Giriş

Hastane enfeksiyonları, bir hasta tarafından hastanede yatış sırasında edinilen enfeksiyonlardır (Burke 2003). Sağlık çalışanlarının elleri, insanlarda nozokomiyal enfeksiyonların birincil bulaşma yoludur; el hijyeni, insan tıbbında nozokomiyal enfeksiyonların önlenmesinde kritik öneme sahiptir (Larson 1999). Sağlık çalışanları, bir hastayı kaldırmak veya hastanın nabzını, tansiyonunu veya ateşini ölçmek gibi "temiz prosedürler" olarak adlandırılan işlemleri gerçekleştirirken veya hastanede yatan bir hastanın cildinin sağlam bölgelerine dokunurken bile ellerini kontamine edebilir (Sanderson ve Weissler 1992, Duckro ve diğerleri 2005, Riggs ve diğerleri 2007).

Sağlık çalışanları hasta odalarındaki cansız nesnelere dokunduktan sonra da ellerini kontamine edebilir (Boyce ve diğerleri 1997, Pessoa-Silva ve diğerleri 2004,Duckro ve diğerleri 2005). İnsanlarda görülen çok sayıda hastane enfeksiyonu salgını kontamine olmuş ellerle ilişkilendirilmiştir (Boyce ve diğerleri 1990, El Shafie ve diğerleri 2004, Zawacki ve diğerleri 2004)

El hijyeni, el yıkama veya el dezenfeksiyonu yoluyla, mikroorganizmaların çapraz bulaşmasını önler ve insan tıbbında hastane enfeksiyonlarını önlemek için en önemli önlem olmaya devam etmektedir (Fridkin ve Gaynes 1999, Pittet 2000, Kim ve diğerleri 2001, Tenorio ve diğerleri 2001). El hijyeninin önemine ve prosedürün göreceli basitliğine dair yapılan tutarlı raporlara rağmen, insan hastanelerinde iyi el hijyeni uygulamalarına bağlılık düşük kalmaktadır (Pittet 2000, Tenorio ve diğerleri 2001).

Bu nedenle, hastane enfeksiyonu riskini sınırlandırmak için veteriner hekimler arasında iyi el hijyeni zorunludur. Ancak, Türkiye'de veteriner hekimlere el hijyeni uygulamaları daha önce incelenmemiştir. Bu çalışmanın amacı, küçük hayvan muayenehanelerinde çalışan veteriner hekimlerinin el hijyeni uygulamalarını değerlendirmektir.

Materyal ve Yöntemler

Bu çalışma, Türkiye'de gerçekleştirilmiştir. Türkiye'nin farklı bölgelerinde görev yapan küçük hayvan veteriner hekimlerine elektronik ortamda anket gönderilerek cevaplar alınmıştır. Ankete katılım gönüllülük esasına bağlı olup veteriner hekimler anketi reddetmekte özgürdü ve katılımcılardan ankete katılım öncesi bilgilendirilmiş gönüllü onam formu onayı alınmıştır. Katılımcıların çalışmaya dahil edilebilmeleri için küçük hayvanlarla çalışmış olmaları ve iş günlerinde düzenli olarak hayvanlarla ilgilenmeleri gerekmiştir. Katılımcıların anonimliğini sağlamak ve açık sözlü cevapları teşvik etmek

amacıyla ankette isim veya çalıştıkları yeri yazmaları istenmemiştir. Anketi cevaplandırma süresi 10 ile 15 dakikaydı. Veriler veri tabanına girerek uygun istatistiksel yöntemlerle analiz yapılmıştır. Veri kaybı olmaması açısından anketteki bütün soruları cevaplamak zorunlu tutulmuştur.

Sonuç ve Tartışma

Beşeri hekimlikte iyi el hijyenine uyum oranlarının düşük olması, küçük hayvan klinisyenlerinin yaklaşık %50'sinin ve at klinisyenlerinin %25'inin hastalar arasında düzenli olarak ellerini yıkadığını bildiren bir veteriner hekimliği çalışmasının sonuçları birbirini desteklemektedir (Wright ve diğerleri 2008). Fakat yürütmüş olduğumuz çalışmada bu çalışmaların aksine küçük hayvan muayenehanelerinde çalışan veteriner hekimler arasında el hijyeni uygulamalarının iyi olduğu ve katılımcıların %80'inden fazlasının hastalarla ilgilenirken her seferinde düzenli olarak ellerini yıkadığı tespit edilmiştir.

Bu ankette katılımcıların sıvı sabun mu yoksa katı sabun mu veya alkol bazlı el losyonu kullanıp kullanılmadığı araştırılmamıştır. Fakat bazı çalışmalar göstermektedir ki sıradan el sabunu, Gram-pozitif ve negatif bakterilere ve çeşitli mantarlara karşı mükemmel in vitro aktiviteye sahip alkol bazlı temizleyicilerin aksine hiçbir antimikrobiyal aktivite içermemektedir (Harrington ve Walker 1903, Price 1939). Bu nedenle, insan tıbbındaki ilk fikir birliği bildirileri, alkol bazlı el losyonlarını sağlık hizmeti ortamlarında el hijyeni için standart bakım olarak tanımlamıştır (Boyce ve diğerleri 2002). Son zamanlarda, eller kir ve organik maddelerle gözle görülür şekilde kontamine olmadıkça, alkol bazlı el losyonları beşeri tıpta el hijyeni için ilk tercih olmaya devam etmektedir, aksi durumlarda sıvı sabun ve su önerilmektedir (Pratt ve diğerleri 2007). Bu durum özellikle veteriner hekimler için önemlidir, çünkü ellerinin insan meslektaşlarına kıyasla kalıntılarla kirlenme olasılığı daha yüksektir ve bu nedenle veterinerlik uygulamalarında sabunlar alkol bazlı el ovmalarına tercih edilebilir. Veterinerlik uygulamalarında hangi el dezenfekte edici maddenin daha etkili olduğunu belirlemek için daha fazla çalışma yapılması gerekmektedir. İnsanlarda yapılan çalışmalar, alkol bazlı el yıkayıcıların sabun veya diğer antiseptikler ve su ile el yıkamaya kıyasla daha fazla organizmayı daha etkili bir şekilde uzaklaştırdığını, daha az zaman gerektirdiğini ve cildi daha az tahriş ettiğini bildirmiştir (Picheansathian 2004).

Hangi el dekontaminasyon ajanı seçilirse seçilsin, bunların kolaylıkla bulunabilmesi, en olası kullanım alanının 3 adım yakınında olması veya hastane çalışanları tarafından kendi kişisel kullanımları için küçük şişelerde taşınması tavsiye edilmektedir (Pittet ve diğerleri 2000).

Veteriner hastaneleri, sadece olası nozokomiyal enfeksiyon olasılığını sınırlamak için değil, aynı zamanda veteriner hekimlerin el hijyeni oranlarını iyileştirmek için her türlü fırsatı sağlamak amacıyla çalışanları için el dezenfekte edici maddelerin hazır bulunmasını sağlamak için her türlü çabayı göstermelidir.

Katılımcıların yaklaşık %60'ından fazlası hastanelerinde/kliniklerinde el hijyeninin önemi konusunda eğitim düzenlenmediğini bildirmiştir. Bu durum, veteriner hekimlerin eğitim sisteminin hastane enfeksiyonu potansiyelini sınırlamada el hijyeninin önemini vurgulamada başarısız olduğunu göstermektedir. Bu nedenle veteriner hekimler hem kendilerini hem de çalışanlarına eğitim sağlamazsa, el hijyeninin önemini vurgulamazsa el hijyeni ihmal edilir ve bunun sonucunda hastane enfeksiyonu olasılığı artar.

El hijyeninin veteriner hekimlikteki hastane enfeksiyonu oranları üzerindeki etkisini araştırmak için daha fazla çalışma yapılması gerekmektedir, çünkü verilerin çoğu beşeri hekimlikten elde edilmiştir. Veteriner hekimlerin ellerinden en sık üreyen bakteri türleri hala tanımlanamamıştır. Yüzük takmanın veterinerlik alanında nozokomiyal organizmalarla el kontaminasyonu riskini artırıp artırmadığı henüz belirlenmemiştir.

Bu çalışma küçük hayvan muayenehanelerindeki veteriner hekimliği ile sınırlı olduğundan, büyük ve egzotik hayvan muayenehaneleri ile akademik sağlık tesislerindeki el hijyeni uygulamalarının araştırılması için daha fazla çalışma yapılması gerekmektedir. Bununla birlikte, bu çalışma daha önce incelenmemiş bir sorunu tanımlamakta ve el hijyeni oranlarının iyileştirilmesi gerektiğini ve bunun bir yolunun da veteriner hekimlere el hijyeninin önemi konusundaki eğitimlerin iyileştirmesi olduğunu göstermektedir.

Kaynaklar

Archibald, L.K., Corl, A., Shah, B., Schulte, M ve ark. (1997). Serratia marcescens outbreak associated with extrinsic contamination of 1% chlorxylenol soap. Infection Control and Hospital Epidemiology vol. 18, pp. 704-709.

Barry, M.A., Craven, D.E., Goularte, T.A. & Lichtenberg D.A. (1984). Serratia marcescens contamination of antiseptic soap containing triclosan: implications for nosocomial infection. Infection Control 5:427-430.

Boyce, J.M. & Pittet, D. (2002). Guideline for Hand Hygiene in Health-Care Settings. MMWR Recomm Rep. 2002 Oct 25;51(RR-16):1-45.

Boyce, J.M., Potter-Bynoe, G., Chenevert, C., King, T. (1997). Environmental contamination due to methicillin-resistant *Staphylococcus aureus*: possible infection control implications. *Infection Control and Hospital Epidemiology* 18, 622-627

Boyce, JM., Potter-Bynoe, G., Opal, SM., Dziobek, L., Medeiros, AA. (1990). A common source outbreak of *Staphylococcus epidermidis* infections among patients undergoing cardiac surgery. *Journal of Infectious Diseases* 161, 493-499

Burke, J.P. (2003). Infection control – a problem for patient safety. *New England Journal of Medicine* 348, 651-656

Duckro, A.N., Blom, D.W., Lyle, E.A., Weinstein, R.A., Hayden, MK. (2005). Transfer of vancomycin-resistant enterococci via health care worker hands. *Archives of Internal Medicine* 165, 302-307

El Shafie, S.S., Alishaq, M. & Leni Garcia, M. (2004). Investigation of an outbreak of multidrug-resistant *Acinetobacter baumannii* in trauma intensive care unit. *Journal of Hospital Infection* 56, 101-105

Fridkin, S.K., Gaynes, R.P. (1999). Antimicrobial resistance in intensive care units. *Clinics in Chest Medicine* 20, 303-316

Harrington, C., Walker, H. (1903). The germicidal action of alcohol. *Boston Medical and Surgical Journal* 148, 548-552

Kikuchi-Numagami, K., Saishu, T., Fukaya, M. ve ark. (1999). Irritancy of scrubbing up for surgery with or without a brush. Acta Dermato-venereologica vol.79 pp. 230-232.

Kim, T., Oh, P.I., Simor, A.E. (2001). The economic impact of methicillinresistant *Staphylococcus aureus* in Canadian hospitals. *Infection Control and Hospital Epidemiology* 22, 99-104

Larson, E. (1996). Handwashing and skin preparation for invasive procedures. APIC infection control and applied epidemiology: principles and practice, Mosby, St Lois, pp. 107-111

Larson, E. (1999). Skin hygiene and infection prevention: more of the same or different approaches? *Clinical Infectious Diseases* 29, 1287-1294

Longtin, Y., Sax, H., Allegranzi, B., Schneider, F., Pittet, D. (2011). Videos in clinical medicine. Hand hygiene. *New England Journal of Medicine* 364, e24

Pessoa-Silva, C.L., Dharan, S., Hugonnet, S., Touveneau, S., Posfay-Barbe, K., Pfister, R., Pittet, D. (2004). Dynamics of bacterial hand contamination during routine neonatal care. *Infection Control and Hospital Epidemiology* 25, 192-197

Picheansathian, W. (2004). A systematic review on effectiveness of alcohol based solutions for hand hygiene. *International Journal of Nursing Practice* 10, 3-9

Pittet, D. (2000). Improving compliance with hand hygiene in hospitals. *Infection Control and Hospital Epidemiology* 21, 381-387

Pittet, D., Allegranzi, B., Boyce, J. (2009). The World Health Organization Guidelines on Hand Hygiene in Health Care and their consensus recommendations. Infect Control Hosp Epidemiol. 2009 Jul;30(7):611-22. doi: 10.1086/600379

Pratt, R.J., Pellowe, C.M., Wilson, J.A., Loveday, H.P., Harper, P.J., Jones, S.R., Mcdougall, C., Wilcox, M.H. (2007). epic2: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *Journal of Hospital Infection* 65S, S1-S64

Price, P.B. (1939). Ethyl alcohol as a germicide. *Archives of Surgery* 38, 528-542

Riggs, M.M., Sethi, A.K., Zabarsky, T.F., Eckstein, E.C., Jump, R.L., Donskey, C.J. (2007). Asymptomatic carriers are a potential source for transmission of epidemic and nonepidemic Clostridium difficile strains among long-term care facility residents. *Clinical Infectious Diseases* 45, 992-998

Sanderson, P.J., Weissler, S. (1992). Recovery of coliforms from the hands of nurses and patients: activities lead to contamination. *Journal of Hospital Infection* 21, 85-93

Sartor, C., Jacomo, V., Durvivier C., ve ark. (2000). Nosocomial Serratia marcescens infections associated with extrinsic contamination of a liquid nonmedicated soap. Infection Control and Hospital Epidemiology, vol. 21, pp.196-199.

Tenorio, A.R., Badri, S.M., Sahgal, N.B., Hota, B., Matushek, M., Hayden, M.K., Tenholme, G.M., Weinstein, R.A. (2001). Effectiveness of gloves in prevention of hand carriage of vancomycin-resistant Enterococcus species by health care workers after patient care. *Clinical Infectious Diseases* 32, 826-829

Trick, W.E., Vernon, M.O., Hayes, R.A., Nathan, C., Rice, T.W., Peterson, B.J., Segreti, J., Welbel, S.F., Solomon, S.L., Weinstein, R.A. (2003). Impact of ring wearing on hand contamination and comparison of hand hygiene agents in a hospital. *Clinical Infectious Diseases* 36, 1383-1390

Wright, J.G., Jung, S., Holman, R.C., Marano, N.N., Mcquiston, J.H. (2008). Infection control practices and zoonotic disease risks among veterinarians in the United States. *Journal of the American Veterinary Medical Association* 232, 1863-1872

Zawacki, A., Orourke, E., Potter-Bynoe, G., Macone, A., Harbarth, S., Goldmann, D. (2004). An outbreak of *Pseudomonas aeruginosa* pneumonia and bloodstream infection associated with intermittent otitis externa in a healthcare worker. *Infection Control and Hospital Epidemiology* 25, 1083-1089

KÜÇÜK HAYVAN KLİNİKLERİNDE UYGUN KİŞİSEL KORUYUCU EKİPMAN (KKE) KULLANIMININ ÖNEMİ

Murat ARIKAN (ORCID: 0009-0003-7560-7157)
Mehmet Akif Ersoy University, Faculty of Veterinary, Department of Internal Medicine, Burdur-Türkiye
Email: murat.arikan@tarimorman.gov.tr

Doç. Dr. Ramazan YILDIZ (ORCID: 0000-0001-5772-0891)
Mehmet Akif Ersoy University, Faculty of Veterinary, Department of Internal Medicine, Burdur-Türkiye
Email: ramazanyildiz@mehmetakif.edu.tr

ÖZET
Kişisel koruyucu ekipman (KKE) veteriner hekimlikte enfeksiyon kontrolünde önemli bir rutin uygulamadır. KKE kullanımı, kişisel kıyafetlerin kontaminasyon tehlikesini azaltmak, cilt ve mukoza zarlarının kontaminasyonunu önlemek ve veterinerlik personeli aracılığıyla patojenlerin hastalar arasında taşınmasını önlemek için tasarlanmıştır. KKE, cildi, kıyafetleri, mukoza zarlarını ve solunum yollarını enfeksiyöz etkenlerden korumak için engel oluşturmak amacıyla kullanılan eldivenler, önlükler, maskeler, solunum maskeleri, gözlükler ve yüz siperleri gibi ekipmanları içermektedir. Kullanılmak üzere seçilen materyaller bulaşıcı ajana, temas türüne ve mikroorganizma iletim yöntemine göre değişmektedir. İşverenlerin çalışma ortamında tehlikelere maruz kalan personele KKE sağlamaları, KKE'nin uygun şekilde kullanımı konusunda personele eğitim vermeleri ve KKE'yi gerektiği şekilde muhafaza etmeleri, saklamaları ve uygun şekilde imha etmeleri gerekmektedir. Koruyucu dış giysiler ve eldivenler, dermatolojik semptomlar, solunum belirtileri, kusma veya ishal, nörolojik semptomlar veya kanamalı bir hayvanı tedavi etmek için kullanılması uygun olan giysilerdir. Dışkı veya idrar numunelerinin alınması, kan örneklerinin alınması ve oral veya rektal muayene sırasında da asgari düzeyde koruyucu dış giysi ve eldiven kullanılması tavsiye edilmektedir. Bu çalışmanın hedefi, Türkiye'deki veteriner hekimler arasında KKE kullanımı ve biyogüvenlik konularında bilinç oluşturmaktır.
Anahtar Kelimeler: Biyogüvenlik, Kişisel Koruyucu Ekipman, Veteriner Hekim

IMPORTANCE OF THE USE OF PERSONAL APPROPRIATE PROTECTIVE EQUIPMENT (PPE) IN SMALL ANIMAL CLINICS

Abstract
Personal protective equipment (PPE) is an important routine practice in infection control in veterinary medicine. The use of PPE is designed to reduce the hazard of contamination of personal clothing, prevent contamination of skin and mucous membranes and prevent the transmission of pathogens between patients via veterinary personnel. PPE includes equipment such as gloves, aprons, masks, respirators, goggles and face shields, which are used as barriers to protect the skin, clothing, mucous membranes and respiratory tract from infectious agents. The materials selected for use vary according to the infectious agent, the type of contact and the method of microorganism transmission. Employers are required to provide PPE to personnel exposed to hazards in the workplace, train personnel in the proper use of PPE, and maintain, store and properly dispose of PPE as required. Protective outer clothing and gloves are appropriate for dermatological symptoms, respiratory symptoms, vomiting or diarrhea, neurological symptoms or for treating an animal with bleeding. A minimum level of protective outer clothing and gloves is also recommended for fecal or urine sampling, blood sampling and oral or rectal examination. The aim of this study was to raise awareness about PPE use and biosecurity among veterinarians in Turkey.
Keywords: Biosafety, Personal Protective Equipment, Veterinary Medicine

Giriş

Kişisel koruyucu ekipman (KKE) koruyucu gözlük, eldiven, koruyucu giysi, kulak koruması, solunum koruması ve koruyucu ayakkabı gibi ekipmanları içermektedir. KKE genellikle iş yerinde kullanıcıyla olası zararlı bir tehdit karşısında koruyucu bir engel yaratmak için kullanılır (Weese J., 2004). Kullanılmak amacıyla seçilecek araçlar enfeksiyon etkenine, etkileşim türüne ve mikroorganizma iletim metoduna göre değişmektedir.

KKE rutin enfeksiyon kontrolünde çok önemli bir araçtır. KKE'nin kullanılması, kişisel giysilerin kontaminasyon riskini azaltmak, deri ve mukoza zarlarının kontaminasyonunu azaltmak ve patojenlerin veteriner hekimler tarafından hastalar arasında bulaşmasını önlemek için tasarlanmıştır.

Hayvanlar ve çevreleriyle her türlü temas da dahil olmak üzere tüm klinik durumlarda genel çalışma prensibi olarak standart önlemler benimsenmelidir.

- Her zaman el hijyeni sağlanmalıdır
- Kan/vücut maddeleri, sağlıklı deri ve mukoza zarları ile temas için eldiven giyilmelidir
- Eğer kan veya vücut maddelerinin bulaşması veya sıçraması olasılığı bulunuyorsa kıyafetler muhafaza edilmelidir
- Gözlere veya yüze sıçrama riski olan sıvı veya vücut maddeleri söz konusuysa mukoza zarları kesinlikle korunmalıdır.Bu, mesleki yargıya dayanmaktan ziyade rutin bir uygulama olarak gerçekleşmelidir.

KKE'ler aşağıdaki sırayla giyilmelidir (Honda H, Iwata K., 2016):

1. Önlük
2. Maske veya solunum cihazı
3. Gözlük veya yüz siperi
4. Eldivenler

Eğer cildin veya kıyafetlerin vücut sıvılarına veya kana maruz kalma olasılığı bulunuyorsa koruyucu önlük giyilmelidir. Düzgün bir şekilde giyilen önlükler gövdeyi boyundan dizlere kadar, kolları ise bileklerin bitimine ve sırtı kapsayacak şekilde tamamen kapatmalıdır. Önlükler enseden ve bel hizasından sıkıca bağlanmalıdır. Kan veya vücut sıvısının ağza veya buruna sıçrama olasılığı bulunuyorsa Veteriner Hekim ekip üyeleri tıbbi maske/solunum cihazı ve koruyucu gözlük/yüz siperi kullanmalıdır.

Doğru şekilde takılan bir maskenin başın ve boynun ortasında bağları ya da sabitlenmiş esnek şeritleri bulunmalıdır. Esnek şerit burun köprüsüne uyacak şekilde ayarlanmalı ve maske yüzün üzerine ve çenenin altına tam olarak yerleşmelidir. Koruyucu gözlükler/yüz siperleri gözlerin/yüzün üzerine tam oturması için ayarlanmalıdır. Eldivenler kan, vücut sıvıları, deri, mukoza zarları ve kontamine olmuş malzemelerle çalışırken giyilmelidir. Damar içi ve idrar yolu ile ilgili işlemler esnasında da her zaman eldiven giyilmelidir. Eldivenler önlüğün bilek bölümünü kapatmalıdır.

KKE kullanıldıktan sonra hemen çıkarılmalıdır ve cilde veya kıyafetlere bulaşmayı engellemek amacıyla doğru sırada çıkarılmalıdır. KKE'nin çıkartılması için tavsiye edilen sıralama ilk olarak önlük, ardından galoş, daha sonra eldiven ve en son olarak maske/solunum cihazı ve koruyucu gözlük/yüz siperliğidir (Honda H, Iwata K., 2016). Kan veya vücut sıvılarıyla ıslanan, sıvıların sıçrayabileceği, sızabileceği veya akabileceği tüm KKE'ler veya diğer kullan-at ekipmanlar bir biyolojik atık torbasına atılmalıdır. Islanmamış KKE direkt olarak atık çöp kutusuna atılabilir.

Çalışanlar KKE'nin uygun şekilde kullanımı, ekipmanların doğru şekilde giyilip çıkarılması ve bunlarla bağlantılı el hijyeni hususlarında eğitim almalıdır.

Personele, tam olarak oturmasını sağlamak amacıyla uygun beden ölçülerinde KKE temin edilmelidir. Veteriner hekime destek verirken ve bulaşma tehlikesi bulunan hallerde danışanlara da KKE temin edilmelidir.

Kişisel Koruyucu Ekipman Nasıl Seçilir?

Çalışma alanındaki KKE ihtiyacı, çalışma alanındaki tehlikelerin risk değerlendirmesine dayanarak tespit edilir (Ryan D, Jacobsen E,. 2009). İşverenler, çalışma ortamındaki riskleri belirlemek, bunları değerlendirmek ve denetlemekle yükümlüdür.

Veterinerlik kuruluşlarındaki riskler kimyasal (örn. anestezikler, kemoterapi ilaçları, dezenfektanlar, formalin), biyolojik (örn. zoonotik ajanlar), fiziksel (örn. radyasyon, gürültü) ya da emniyet (örn. ısırık, kesik, çizik, tekme ya da ezilme) şeklinde kategorize edilebilir. KKE seçimi sırasında var olan risklerin türü göz önünde bulundurulmalıdır (Epp T, Waldner C,. 2012). Aşağıdaki faktörler, veterinerlik faaliyetlerinin yürütüldüğü alanlarda bulunabilecek olan riskler değerlendirilirken dikkate alınmalıdır:

- Hastanın mizacı ve genel sağlık durumu
- Şüpheli enfeksiyon hastalığı ve bulaşma yolları
- Tesis, görev ya da iş ortamındaki riskler

- Ürünlerin veya kullanılan maddelerin kimyasal özellikleri
- Yüze ya da vücuda sıçrayan vücut sıvıları tehlikesi
- Kesik, ısırılma, çizilme, tekmelenme veya ezilme riski
- Havadaki kimyasalların, patojenlerin veya alerjen maddelerin varlığı
- Sürekli havlama, miyavlama vb. gürültüler.

Pek çok veteriner hekim için KKE günlük olarak kullanılan pamuklu/polyester laboratuvar önlükleri, koruyucu tulumlar veya önlükler, burnu kapalı ayakkabılar veya lastik çizmeler, kullan-at eldivenler ve koruyucu gözlükleri kapsayabilir. Fakat bazı özel koşullar ve yeni tehlikeler ek KKE kullanılmasını zorunlu kılabilir.

Sonuç ve Değerlendirme

Sonuç itibariyle, KKE kullanımının iş kazaları, hastalıklar ve bunların yol açtığı ölümleri önlemek için son savunma seviyesi olarak kullanılması önerilmektedir. KKE kullanımının işyerinde istenmeyen yaralanmaları önlemek, çalışanların aşırı düzeyde kimyasala maruz kalmasını engellemek, işyerlerinin kanuni şartlara uymasına destek olmak ve personel üretkenliğini ve verimliliğini yükseltmek gibi yararları bulunmaktadır. Koruyucu dış kıyafetler, klinik personelini korumak ve hastalara, hayvan sahiplerine, klinik personeline ve halka kıyafet yoluyla patojen bulaşma riskini azaltmak için kullanılır. Bir hayvanla temas ihtimali bulunan her yerde ya da bir klinik ortamında çalışırken (temizlik dahil) kişisel koruyucu dış giyim giyilmelidir.

Koruyucu dış kıyafetler ve eldivenler, dermatolojik belirtiler, solunum belirtileri, kusma veya ishal, nörolojik semptomlar veya kanaması bulunan bir hayvanı muayene ederken kullanılması gereken uygun ekipmanlardır. Dışkı veya idrar numunelerinin alınması, kan örneklerinin alınması ve oral veya rektal muayene esnasında da koruyucu dış kıyafet ve eldivenler asgari olarak kullanılması uygun görülen KKE'lerdir. Gebe hayvanların muayenesi veya doğum yapmasına yardımcı olunması, ameliyat veya nekropsi yapılması için koruyucu dış giysi ve eldivenlere ek olarak cerrahi maske veya koruyucu gözlük kullanılması uygun görülmüştür (Bolyard EA, Tablan OC, Williams WW, ve ark., 1998).

Kaynaklar

Bolyard, EA. & Tablan OC. & Williams WW. ve ark. (1998). Guideline for infection control in healthcare personnel. Hospital Infection Control Practices Advisory Committee. Infect Control Hosp Epidemiol 1998;19:407-463.

Epp, T. & Waldner, C. (2012). Occupational health hazards in veterinary medicine: Physical, psychological, and chemical hazards. Can Vet J. 2012 Feb;53(2): 151-157

Honda, H. & Iwata, K. (2016). Personal protective uquioment and improving compliance among healthcare workers in high-risk settings. Curr Opin Infect Dis, Aug;29(4):400-6. doi: 10.1097/QCO. 0000000000000280

Ryan, D. & Jacobsen, E. (2009). Biosecurity in practice: protecting you and your clients. A practical workshop for veterinarians and their staff.

Weese, J. (2004). Barrier precautions, isolation protocols and personal hygiene in veterinary hospitals. Vet Clin North Am Equine Pract, vol20, pp. 543-559.

Staphylococcus aureus İZOLATLARINDA BİYOFİLM OLUŞUMUNUN FENOTİPİK VE GENOTİPİK KARAKTERİZASYONU

Dr. Öğr. Üyesi Muazzez YEŞİLYURT* (ORCID: 0000-0003-4195-6335)
Siirt Üniversitesi, Veteriner Fakültesi, Mikrobiyoloji AD, Siirt/Türkiye
Email: muazzez.yesilyurt@siirt.edu.tr

Doç. Dr. Özgül GÜLAYDIN (ORCID: 0000-0001-8376-2008)
Siirt Üniversitesi, Veteriner Fakültesi, Mikrobiyoloji AD, Siirt/Türkiye
Email: ozgul.gulaydin@siirt.edu.tr

ÖZET
Staphylococcus aureus, büyük ruminantlarda görülen mastitis vakalarından sıklıkla izole edilmektedir. Etken, biyofilm oluşturma yeteneği sayesinde tedavide kullanılan birçok antimikrobiyal maddeye karşı direnç geliştirebilmektedir. Bu çalışmada mastitisli sığır sütlerinden izole edilen *S. aureus* suşlarında biyofilm oluşumu fenotipik ve genotipik yöntemlerle araştırıldı. Çalışma kapsamında Siirt Üniversitesi Veteriner Fakültesi Mikrobiyoloji Anabilim Dalı kültür koleksiyonunda bulunan 30 adet *S. aureus* izolatı kullanıldı. İzolatlarda biyofilm oluşumu fenotipik olarak Congo-Red agar yöntemiyle belirlendi. *S. aureus* suşlarında biyofilm oluşumundan sorumlu *icaAB, AtlE, aap, icaA* ve *icaD* genlerinin varlığı PCR ile araştırıldı. Congo-red agarda izolatların 12 (%40)'sinin biyofilm oluşturduğu belirlendi. İzolatların 24'ünde (%80) *icaA*, tamamında ise *icaD* geni tespit edildi. Diğer taraftan izolatların tamamının *icaAB, AtlE* ve *aap* genleri yönünden negatif olduğu görüldü. Fenotipik olarak biyofilm oluşturduğu belirlenen 12 izolatın tamamında *icaD*; 8'inde (%66.6) ise *icaA* geni pozitif olarak tespit edildi. PCR ile *icaA* geni pozitif olan izolatların %66.6'sının, *icaD* geni pozitif izolatların ise %60'ının Congo-Red agarda biyofilm oluşturmadığı belirlendi. Sonuç olarak; biofilm oluşturma özelliğine sahip *S. aureus* izolatlarının sığırlarda mastitis vakalarına neden olabileceği tespit edilerek, bu durumun mastitis tedavisinde zorluk yaratabileceği kanısına varıldı. *S. aureus* izolatlarında biyofilm oluşturma özelliğinin değerlendirilmesinde Congo-Red agar dışındaki fenotipik yöntemlerin de ileriki çalışmalarda değerlendirilmesi gerektiği belirlendi.
Anahtar Kelimeler: *S. aureus*, Biyofilm, Congo-Red agar, *icaA, icaD*

PHENOTYPIC AND GENOTYPIC CHARACTERIZATION OF BIOFILM FORMATION IN *Staphylococcus aureus* ISOLATES

ABSTRACT

Staphylococcus aureus is frequently isolated from cases of mastitis in large ruminants. Thanks to its ability to form biofilms, the agent can develop resistance to many antimicrobial agents used in treatment. In this study, biofilm formation in *S. aureus* strains isolated from mastitis bovine milk was investigated using phenotypic and genotypic methods. Within the scope of the study, 30 *S. aureus* isolates in the culture collection of Siirt University Faculty of Veterinary Medicine, Department of Microbiology were used. Biofilm formation in the isolates was determined phenotypically by the Congo-Red agar method. The presence of *icaAB*, *AtlE*, *aap*, *icaA* and *icaD* genes responsible for biofilm formation in *S. aureus* strains was investigated by PCR. It was determined that 12 (40%) of the isolates formed biofilms on Congor-red agar. The *icaA* gene was detected in 24 (80%) of the isolates, and the *icaD* gene was detected in all of them. On the other hand, all of the isolates were found to be negative for *icaAB*, *AtlE* and *aap* genes. *icaD* in all 12 isolates that were phenotypically determined to form biofilm; The *icaA* gene was detected positive in 8 (66.6%). It was determined by PCR that 66.6% of the *icaA* gene positive isolates and 60% of the *icaD* gene positive isolates did not form biofilms on Congo-Red agar. In conclusion; It was determined that *S. aureus* isolates with biofilm-forming properties could cause mastitis cases in cattle, and it was concluded that this situation may cause difficulties in the treatment of mastitis. It was determined that phenotypic methods other than Congo-Red agar should be evaluated in future studies in evaluating the biofilm formation feature of *S. aureus* isolates.

Keywords: *S. aureus*, Biofilm, Congo-Red agar, *icaA*, *icaD*

Giriş

Mastitis, süt sığırı yetiştiriciliği yapılan sürülerde kalite ve verimde azalmalara neden olarak önemli ekonomik kayıpların meydana gelmesine yol açmaktadır (Kot ve ark., 2016, Gurler ve ark., 2022). Mastitis olguları, özellikle meme başından içeri doğru bakteriyel etkenlerin girmesi ile meydana gelmektedir (Käppeli ve ark., 2019). Mastitise neden olan bakteriyel etkenler arasında *Staphylococcus aureus* (*S. aureus*), *S. epidermidis*, koagulaz negatif stafilokoklar, *Escherichia coli*, *Streptococcus agalactiae*, *Mycoplasma* spp., *Klebsiella* spp., *Streptococcus disgalactiae* ve *Streptococcus uberis* yer almaktadır (Frebourg ve ark., 2000, Dalanezi ve ark., 2020, Ahmed ve ark., 2020, Ferreira ve ark., 2022).

Süt işletmelerinde büyük verim kayıplarına neden olan ve *Staphylococcaceae* familyasında yer alan *S. aureus*, Gram pozitif, sporsuz, hareketsiz, oksidaz negatif, koagulaz ve katalaz pozitif, fakültatif anaerob, kok morfolojisine sahip mikroorganizmadır (Sears ve McCarthy, 2003, Vaughn ve ark., 2020).

Sığırlarda meydana gelen mastitis olgularında özellikle *S. aureus* kaynaklı enfeksiyon tabloları daha ciddi bir seyir göstermektedir (Tegegne ve ark., 2021). *S. aureus*'un neden olduğu mastitislerde tablonun şiddetli bir seyir göstermesinde bazı virulens faktörleri etkin rol oynamaktadır (Kot ve ark., 2016). Bu virulens faktörleri arasında özellikle biyofilm oluşumu, toksik şok sendromu toksini-1 (Tsst-1), fibronektin bağlayıcı proteinler (*FnbA* ve *FnbB*) ve hemolizinler (*Hla* ve *Hlb*) yer almaktadır (Watkins ve Unnikrishnan, 2020). *Staphylococcus* spp. izolatlarında biyofilm oluşumu, *icaA*, *icaB*, *icaC* ve *icaD* genleri tarafından indüklenmektedir (Arciola ve ark., 2015). Ayrıca *Staphylococcus* spp. tarafından oluşturulan biyofilmlerde adezin türleri de rol oynamaktadır. Adezin proteinleri arasında yer alan AtlE (otolizin E) biyofilmin yapışma, birikme, olgunlaşma ve dağılma aşamalarına aracılık etmektedir. Biyofilmin birikim aşamasında ise hücre yüzeyi ile ilişkili olan aap proteini önemli rol oynamaktadır (Soumya ve ark., 2017).

Özellikle kronikleşmiş enfeksiyon olgularında meydana gelen biyofilm oluşum mekanizması etkenin hem antibiyotiklere hem de makrofajlar aracılığı ile gerçekleştirilen fagozitoza karşı direnç geliştirmesine neden olmaktadır (Watkins ve Unnikrishnan, 2020, Gurler ve ark., 2022). Bu durum *S. aureus*'un meme içerisinde canlı kalmasına ve

üremesine olanak sağlayarak şiddetli mastitis vakalarının meydana gelmesine neden olmaktadır (Pereyra ve ark., 2016).

Bu çalışmada; mastitisli sığır sütlerinden izole edilen *S. aureus* suşlarının biyofilm oluşturma özelliği fenotipik ve genotipik yöntemlerle araştırılması amaçlandı.

Materyal ve Metot

Çalışmada Siirt Üniversitesi Veteriner Fakültesi Mikrobiyoloji Anabilim Dalı kültür koleksiyonunda bulunan ve mastitisli sığır sütlerinden elde edilen 30 adet *S. aureus* izolatı kullanıldı. İzolatlar kovansiyonel bakteriyolojik yöntemler ile izole edilip Schmitz ve ark. (1997)'nın bildirdiği PCR ile identifiye edildi.

Metot

Biyofilm Oluşumunun Fenotipik Karakterizasyonu

S. aureus izolatlarında biyofilm oluşumunu fenotipik olarak belirlemek amacıyla Congo Red agara ekimleri yapılarak 37°C'de inkübe edildi. İnkübasyon sonucunda siyah renkli koloniler oluşturan izolatlar pozitif, renksiz ve/veya kırmızı koloniler oluşturan izolatlar da negatif olarak değerlendirildi (Gurler ve ark., 2022).

Biyofilm Oluşumunun Genotipik Karakterizasyon

İzolatların biyofilm oluşturma yeteneğinin genotipik olarak belirlenmesinde ise Çizelge 1'de belirtilen genlerin varlığı PCR ile araştırıldı. Bu amaçla izolatlardan kaynatma yöntemi ile genomik DNA elde edildi. PCR karışımın hazırlanmasında 12.5 µl mastermikse (Hibrigen 2X Taq Master Mix, Türkiye), 5 µl genomik DNA, 1.5'şer µl primerlerden ilave edilerek toplam hacim PCR suyu ile 25 µl'ye tamamlandı. Karışımın ön denatürasyonu için 94°C'de 10 dk bekletildi ve toplam 35 siklusluk amplifikasyon döngüsü 94°C'de 1 dk. denatürasyon, ve 72°C'de 1 dk. uzama aşaması uygulandı. Final uzaması için karışım 72°C'de 10 dk bekletildi. Bağlanma aşaması 1 dk olarak uygulandı ve sıcaklığın ayarlanmasında primelerin sentez ettirildiği firma önerileri dikkate alındı. Amplifikasyon sonucu elde edilen ürünler jel-red ile boyanmış %1'lik agaroz jelde 80 Voltta 1.5 saat elektroforeze tabi tutuldu. Amplikonlar DNA marker (Hibrigen, 100 bp DNA Ladder Plus, Türkiye) ile karşılaştırılarak jel görüntüleme sisteminde görüntülendi.

Çizelge 1: *S. aureus*'un suşlarının PCR ile biyofilm oluşumunu tespit etmek amacıyla kullanılan primer dizilimleri ve hedef genleri.

Gen	Oligonukleotid (5'-3')	Amplikon Büyüklüğü (bp)	Bağlanma Sıcaklığı (°C)	Kaynak
aap	**F:** ATACAACTGGTGCAGATGGTTG **R:** GTAGCCGTCCAAGTTTTACCAG	399 bp	53.90°C	Vandecasteele ve ark., 2003
AtlE	**F:** CAACTGCTCAACCGAGAACA **R:** TTTGTAGATGTTGTGCCCCA	682 bp	50.75°C	Frebourg ve ark., 2000
icaAB	**F:** TTATCAATGCCGCAGTTGTC **R:** GTTTAACGCGAGTGCGCTAT	546 bp	50.75°C	Frebourg ve ark., 2000
icaA	**F:** CCTAACTAACGAAAGGTAG **R:** AAGATATAGCGATAAGTGC	1315 bp	51°C	Vasudevan ve ark., 2003
icaD	**F:** AAACGTAAGAGAGGTGG **R:** GGCAATATGATCAAGATAC	381 bp	51°C	Vasudevan ve ark., 2003

Bulgular ve Tartışma

Süt sığırı işletmelerinde önemli verim kayıplarına neden olan mastitis olguları, tedavi masrafları ve memenin körelmesi sonucu hayvanların elden çıkarılması nedeni ile büyük ekonomik kayıplara yol açmaktadır (Khan ve Khan, 2006; Kot ve ark., 2016, Gurler ve ark., 2022). *S. aureus* izolatları sığırlarda görülen mastitis olgularının en önemli etiyolojik etkenidir. Biyofilm oluşturma yeteneğine sahip olan izolatlar fagositozdan kaçabilme ve antimikrobiyal direnç geliştirebilme özellikleri ile mastitis vakalarının klinik olarak ağır seyretmesine neden olmaktadır (Arciola ve ark., 2015, Kot ve ark., 2016, Soumya ve ark., 2017, Watkins ve Unnikrishnan, 2020, Gurler ve ark., 2022).

Bu kullanılan 30 adet *S. aureus* izolatının 12'sinin (%40) Congo Red Agarda siyah renkte koloni oluşturduğu belirlendi (Şekil 1). PCR ile izolatların tamamında *icaD* geni tespit edilirken, 24'ünde (%80) ise *icaA* geni tespit edildi (Şekil 2). İzolatlarda PCR ile *icaAB, aap* ve *AtlE* virulens genlerinin varlığı tespit edilmedi (Şekil 3). Biyofilm oluşumu gözlemlenen 12 izolatın tamamında *icaD*, 8'inde (%66.6) ise *icaA* geni pozitif olarak tespit edildi. *İcaA* geni pozitif izolatların %66.6'sının, *icaD* geni pozitif izolatların ise %60'ının Congo-Red agarda biyofilm oluşturmadığı gözlemlendi (Şekil 3).

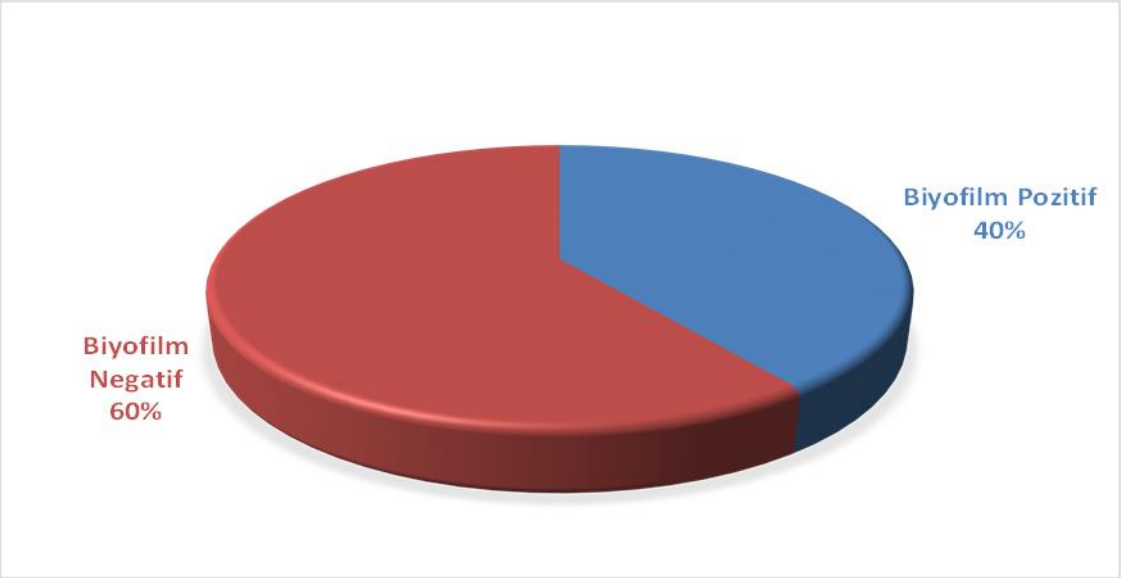
Konu ile ilgili uluslararası alanda birtakım çalışmaların yapıldığı görülmektedir. Bu kapsamda; Vasudevan ve ark. (2003), yapmış oldukları çalışmada 35 *S. aureus* izolatının 24 (%68.57)'ünde biyofilm oluşumunu fenotipik olarak belirlediklerini bildirmişlerdir. Çalışmada izolatların tamamında *icaA* ve *icaD* geni tespit edilmiştir. Zaatout ve ark. (2019), biyofilm oluşumunun fenotipik olarak gözlemlendiği 9 *S. aureus* izolatının tamamında *icaA, icaC* ve *icaD* genini tespit ettiklerini rapor etmişlerdir.

Liu ve arkadaşlarının 2020 yılında mastitisli ineklerden elde ettikleri 62 *S. aureus* izolatının tümünde biyofilm oluşumu tespit ettiklerini ve yapılan genotipik analizler sonucunda da izolatların tamamında *icaA* ve *icaD* geni yönünden pozitif sonuç elde ettiklerini bildirmişlerdir. Gajewska ve Chajecka-Wierzchowska (2020), yaptıkları bir araştırma doğrultusunda 30 adet sığır sütünden toplamda 54 *Staphylococcus* spp. izole ettiklerini, bu izolatların 42 (%77.7)'sinin koagulaz negatif stafilokok, 12 (%22.2)'sinin de *S. aureus* olarak identifiye edildiğini bildirmişlerdir. Araştırmacılar elde edilen bütün izolatların biyofilm oluşturduğunu, ancak *S. aureus* izolatlarında *icaA, aap, AtlE* geni tespit edilemediğini bildirmişlerdir. Bunun yanı sıra *icaD* geni ise *S. aureus* izolatlarının tamamında pozitif bulunmuştur. Buna karşın koagulaz negatif stafilokokların %28.6'sında *aap* , %23.8'inde *AtlE*, %21.4'ünde *icaD* geni tespit ettiklerini rapor etmişlerdir. Marques ve ark. (2017), yapmış oldukları bir çalışmada, subklinik mastitis belirtileri gösteren sığırların sütünden elde ettikleri 20 *S. aureus* izolatını biyofilm oluşumu yönünden fenotipik ve genotipik olarak incelemişlerdir. Araştırmacılar 20 *S. aureus* izolatının tamamında biyofilm oluşumunu gözlemlediklerini, PCR ile ise 17 (%85) izolattta *icaA*, 19 (%95) izolatta *icaD* gen varlığını belirlediklerini bildirmişlerdir. Wang ve ark. (2018) yapmış oldukları bir çalışma doğrultusunda süt sığırı işletmesinden aldıkları 195 çiğ süt örneğinden toplam 96 *S. aureus* izolatı elde ettiklerini bildirmişlerdir. Araştırmacılar yapılan fenotipik ve genotipik incelemeler sonucunda 96 *S. aureus*

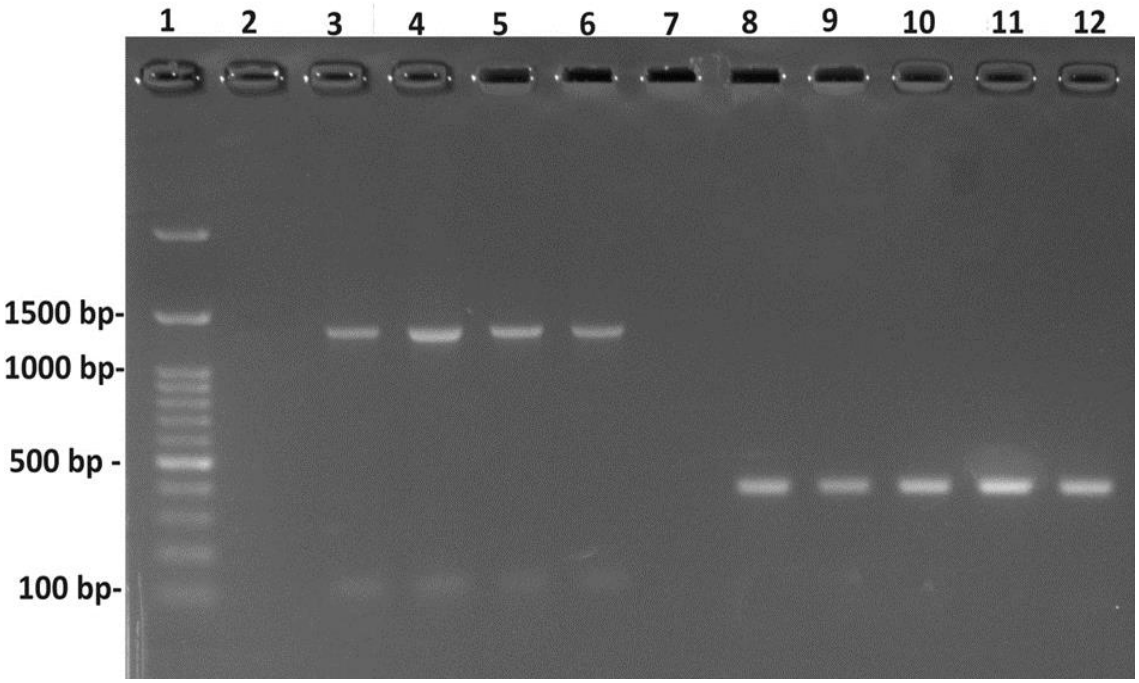
izolatının tamamında hem biyofilm oluşumunu gözlemlediklerini hem de biyofilm oluşumunda önemli rol oynayan *icaA* ve *icaD* genini tespit ettiklerini rapor etmişlerdir. Konu ile ilgili ulusal alanda yapılan çalışma sayısı oldukça azdır. Ciftci ve ark. (2009), mastitis belirtisi gösteren 161 sığırdan aldıkları süt örneklerini incelediklerini ve 59 (%36.64) *S. aureus* izolatı elde ettiklerini belirtmişlerdir. Araştırmacılar elde edilen izolatlardan 22 (%37)'sinin biyofilm oluşturduğunu bildirmişlerdir. Yapılan bu çalışmada 59 izolatın 16 (%27.11)'sında *icaA*, 38 (%64.4)'inde *icaD* genine rastladıklarını, ancak fenotipik olarak biyofilm oluşturduğu tespit edilen 22 izolattan sadece 15 (%68)'inde hem *icaA* hem de *icaD* geni tespit ettiklerini rapor etmişlerdir. Gurler ve arkadaşlarının 2022 yılında yapmış oldukları bir çalışmada subklinik mastitis belirtisi gözlemlenen toplam 36 adet mandadan aldıkları sütleri incelediklerini belirtmişlerdir. Yapılan çalışmada 22 adet koagulaz negatif stafilokok izolatı elde edilmiş ve bu izolatların sadece 3 (%13.6)'ünde fenotipik olarak biyofilm oluşumu gözlemlendiği belirtilmiştir. Ayrıca araştırmacılar *icaA* ve *icaD* genini her 3 izolatta da tespit ettiklerini rapor etmişlerdir.

Sunulan çalışmada biyofilm oluşumu 12 (%40) izolatta pozitif olarak değerlendirildi. Elde edilen sonucun Ciftci ve ark. (2009)'nın yapmış olduğu çalışma ile Gurler ve ark. (2022)'nın yapmış olduğu çalışma sonuçlarına göre daha yüksek olduğu; Vasudevan ve ark. (2003), Zaatout ve ark. (2019), Wang ve ark. (2018), Liu ve ark. (2020) ile Gajewska ve Chajecka- Wierzchowska (2020)'nın yapmış oldukları çalışma sonuçlarına göre ise daha düşük olduğu belirlendi.

Çalışmada PCR ile *icaAB*, *aap* ve *AtlE* geni hiçbir izolatta tespit edilemezken, *icaA* geni 24 (%80) izolatta, *icaD* geni ise izolatların tamamında belirlendi. Bu çalışmadan elde edilen verilerin Gajewska ve Chajecka-Wierzchowska (2020) ile Ciftci ve ark. (2020)'nın elde ettikleri verilere göre daha yüksek olduğu ancak, Vasudevan ve ark. (2003), Marques ve ark. (2017), Wang ve ark. (2018), Zaatout ve ark. (2019), Liu ve ark. (2020), Gurler ve ark. (2022)'nın yapmış oldukları çalışma sonuçları ile paralellik gösterdiği belirlendi.



Şekil 1: *S. aureus* izolatlarının Congo-Red agardaki biyofilm oluşumunun dağılımı (%).



Şekil 2. PCR ile *icaA* ve *icaD* geni belirlenen izolatlardan elde edilen amplikonların agaroz jel görüntüsü [1: 100 bp DNA marker, 2: *icaD* geni negatif kontrol, 3-6: *icaD* geni pozitif izolatlar (1315 bp); 7: *icaA* geni negatif control, 8-12: *icaA* geni pozitif izolatlar (381 bp)].

Şekil 3: *S. aureus* izolatlarında PCR sonuçlarına göre elde edilen virulens genlerinin dağılımı.

Sonuç

Sonuç olarak bu çalışmada mastitisli sığır sütlerinde biyofilm oluşturma yeteneğine sahip *S. aureus* izolasyon oranının yüksek olabileceği ve bu durumun mastitis tedavisinde zorluklara neden olabileceği düşünüldü. İzolatlarda *icaA* ve *icaD* genlerinin biyofilm oluşumunda rol oynadığı belirlenirken, *S. aureus* izolatlarında biyofilm oluşturma özelliğinin değerlendirilmesinde Congo-Red agar dışındaki fenotipik yöntemlerin de ileriki çalışmalarda değerlendirilmesi gerektiği belirlendi.

Kaynaklar

Abebe, R., Hatiya, H., Abera, M., Megersa, B. & Asmare, K. (2016). Bovine mastitis: prevalence, risk factors and isolation of *Staphylococcus aureus* in dairy herds at Hawassa milk shed, South Ethiopia. *BMC Vet Res*, 12, 270. doi: 10.1186/s12917-016-0905-3.

Ahmed, W., Neubauer, H., Tomaso, H., El Hofy, F. I., Monecke, S., Ashraf Awad Abdeltawab, A. A. & Hotzel, H. (2020). Characterization of *Staphylococci* and *Streptococci* isolated from milk of bovides with mastitis in Egypt. *Pathogens*, 9, 381. doi:10.3390/pathogens9050381.

Alghariba, S. A., Dawood, A. & Xie, S. (2020). Nanoparticles for treatment of bovine Staphylococcus aureus mastitis: *Drug Delıvery*, 27(1), 292–308. https://doi.org/10.1080/10717544.2020.1724209.

Arciola, C. R., Campoccia, D., Ravaioli, S. & Montanaro, L. (2015). Polysaccharide intercellular adhesin in biofilm: Structural and regulatory aspects. *Front. Cell. Infect. Microbiol*, 5, 7.

Ashraf, A. & Imran, M. (2018). Diagnosis of bovine mastitis: from laboratory to farm. *Tropical Animal Health and Production*, 50, 1193–1202.

Åvall-Jääskeläinen, S., Koort, J., Simojoki, H. & Taponen, S. (2021). Genomic analysis of *Staphylococcus aureus* isolates associated with peracute non-gangrenous or gangrenous mastitis and comparison with other mastitis-associated *Staphylococcus aureus* isolates. *Front. Microbiol*, 12, 688819.

Ciftci, A., Findik, A., Onuk, E.E. & Savasan, S. (2009). Detection of methicillin resistance and slime factor production of *Staphylococcus aureus* in bovine mastitis. *Brazilian Journal of Microbiology*. 40, 254-261.

Dalanezi, F.M., Joaquim, S.F., Guimarães, F.F., Guerra, S.T., Lopes, B.C., Schmidt, E.M.S., Cerri, R.L.A. & Langoni, H. (2020). Influence of pathogens causing clinical mastitis on reproductive variables of dairy cows. *Journal of Dairy Science*, 103(4), 3648-3655.

Ferreira, E. M., Romero, L. C., Cunha, M.L.R.S., Junior, W. M., Camargo, C. H., Junior, W. B. & Zafalon, L. F. (2022). Persistence of *Staphylococcus* spp. in milk from cows undergoing homeopathy to control subclinical mastitis. *BMC Veterinary Research*, 18, 273. https://doi.org/10.1186/s12917-022-03364-8.

Frebourg, N. B., Lefebvre, S., Baert, S. & Lemeland, J-F. (2000). PCR-Based Assay for discrimination between invasive and contaminating *Staphylococcus epidermidis* strains. *Journal of Clinical Microbiology*, 38 (2), 877-880.

Gajewska, J. & Chajecka-Wierzchowska, W. (2020). Biofilm formation ability and presence of adhesion genes among coagulase-negative and coagulase-positive *Staphylococci* isolates from raw cow's milk. *Pathogens*, 9, 654. doi:10.3390/pathogens9080654.

Gurler, H., Findik, A. & Sezener, M.G. (2022). Determination of antibiotic resistance profiles and biofilm production of *Staphylococcus* spp. isolated from Anatolian water buffalo milk with subclinical mastitis. *Polish Journal of Veterinary Sciences*, 25 (1), 51–59.

Jung, H.-R. & Lee, Y.J. (2022). Characterization of virulence factors in enterotoxin-producing *Staphylococcus aureus* from bulk tank milk. *Animals*, 12, 301. https://doi.org/10.3390/ani12030301.

Käppeli, N., Morach, M., Corti, S., Eicher, C., Stephan, R. & Johler, S. (2019). *Staphylococcus aureus* related to bovine mastitis in Switzerland: Clonal diversity, virulence gene profiles, and antimicrobial resistance of isolates collected throughout 2017. *J Dairy Sci*, 102, 3274-3281. https://doi.org/10.3168/jds.2018-15317.

Khan, M.Z. & Khan, A. (2006). Basic facts of mastitis in dairy animals: A review. *Pakistan Vet. J*, 26(4), 204-208.

Kibebew, K. (2017). Bovine mastitis: A review of causes and epidemiological point of view. *J Biol Agric Healthc*, 7, 1–14.

Kot, B., Szweda, P., Frankowska-Maciejewska, A., Piechota, M. & Wolska, K. (2016). Virulence gene profiles in *Staphylococcus aureus* isolated from cows with subclinical mastitis in eastern Poland. *Journal of Dairy Research*, 83, 228–235.

Liu, K., Tao, L., Li, J., Fang, L., Cui, L., Li, J., Meng, X., Zhu, G., Bi, C. & Wang, H. (2020) Characterization of *Staphylococcus aureus* ısolates from cases of clinical bovine mastitis on large-scale Chinese dairy farms. *Front. Vet. Sci*, 7, 580129. doi: 10.3389/fvets.2020.580129.

Marques, V.F., Couto da Motta, C., da Silva Soares, B., de Melo, D.A., de Oliveira Coelho, S.M., Coelho, I.S., Barbosa, H.S., Soares de Souza, M.M. (2017). Biofilm

production and beta-lactamic resistance in Brazilian *Staphylococcus aureus* isolates from bovine mastitis. *Brazilian Journal of Microbiology*, 48(1), 118-124.

Pereyra, E.A.L., Picech, F., Renna, M.S., Baravalle, C., Andreotti, C.S., Russi, R., Calvinho, L.F., Diez, C. & Dallard, B.E. (2016). Detection of *Staphylococcus aureus* adhesion and biofilm-producing genes and their expression during internalization in bovine mammary epithelial cells. *Veterinary Microbiology*, 183, 69-77.

Pumipuntu, N., Kulpeanprasit, S., Santajit, S., Tunyong, W., Kong-ngoen, T., Hinthong, W. & Indrawattana, N. (2017). Screening method for *Staphylococcus aureus* identification in subclinical bovine mastitis from dairy farms. *Vet World*, 10(7), 721–726.

Pyörälä, S. (2009). Treatment of mastitis during lactation. *Irish Veterinary Journal*, 62, 40-44.

Romero, J., Benavides, E. & Meza, C. (2018). Assessing financial impacts of subclinical mastitis on colombian dairy farms. *Front Vet Sci*, 5, 273. doi: 10.3389/fvets.2018.00273.

Sears, P.M. & McCarthy, K.K. (2003). Diagnosis of mastitis for therapy decisions. *Vet Clin Food Anim*, 19, 93–-108.

Schmitz, F.J., Mackenzie, C.R., Hofmann, B., Verhoef, J., Finken-Eigen, M., Heinz, H.P. & Köhrer, K. (1997). Specific information concerning taxonomy, pathogenicity and methicillin resistance of staphylococci obtained by a multiplex PCR. *J Med Microbiol*, 46(9), 773-778.

Soumya, K.R., Philip, S., Sugathan, S., Mathew, J. & Radhakrishnan, E.K. (2017). Virulence factors associated with coagulase negative *staphylococci* isolated from human infections. *3 Biotech*, 7(2), 140. Available from: https:// DOİ. org/ 10. 1007/ s13205- 017- 0753-2.

Tegegne, D. T., Mamo, G., Waktole, H. & Messele, Y. E. (2021). Molecular characterization of virulence factors in *Staphylococcus aureus* isolated from bovine subclinical mastitis in central Ethiopia. *Ann. Microbiol*, 71, 28.

Vandecasteele, S.J., Peetermans, W.E., Merckx, R. & Johan Van Eldere, J.V. (2003). Expression of biofilm-associated genes in *Staphylococcus epidermidis* during in

Vitro and in vivo foreign body infections. *The Journal of Infectious Diseases*, 188, 730-7.

Vasudevan, P., Nair, M.K.M. Annamalai, T. & Kumar S. Venkitanarayanan, K.S. (2003). Phenotypic and genotypic characterization of bovine mastitis isolates of *Staphylococcus aureus* for biofilm formation. *Veterinary Microbiology*, 92, 179–185.

Vaughna, J.M., Abdia, R.D., Gillespiea,B.E. & Dego, O.K. (2020). Genetic diversity and virulence characteristics of *Staphylococcus aureus* isolates from cases of bovine mastitis. *Microbial Pathogenesis*, 144, 104171.

Wang, W., Lin, X., Jiang, T., Peng, Z., Xu, J., Yi, L., Li, F., Fanning, S. & Baloch, Z. (2018). Prevalence and characterization of *Staphylococcus aureus* cultured from raw milk taken from dairy cows with mastitis in Beijing, China. *Front. Microbiol*, 9, 1123. doi: 10.3389/fmicb.2018.01123.

Watkins, K. E. & Unnikrishnan, M. (2020). Evasion of host defenses by intracellular *Staphylococcus aureus*. *Adv Appl Microbiol*, 112, 105–41. doi: 10.1016/bs.aambs.2020.05.001.

Zaatout, N., Ayachi, A., Kecha, M. & K. Kadlec, K. (2019). Identification of staphylococci causing mastitis in dairy cattle from Algeria and characterization of *Staphylococcus aureus*. *Journal of Applied Microbiology*, 127, 1305-1314.

Zhao, X. & Lacasse, P. (2008). Mammary tissue damage during bovine mastitis: causes and control. *J Anim Sci*, 86:57–65. doi: 10.2527/jas.2007-0302.

HAMDANİ MELEZİ KOYUNLARDA (*Ovis Aries*) 2. VE 3. TRİMESTERDE DALAK GELİŞİMİNİN MAKROSKOBİK VE MİKROSKOBİK TANIMI

Dr. Öğr. Üyesi Fatma İŞBİLİR (ORCID: 0000-0002-6110-1302)
Siirt University, Faculty of Veterinary Medicine, Department of Anatomy, Siirt-Türkiye
Email: fatmaisbilir42@gmail.com

ÖZET
Dalak, dolaşım sistemine ait bir organdır. Embriyolojik dönemde eritrosit üretimi sağlayan bu organ olgun dönemde lenfosit üretimi ve eritrositlerin yok edilmesini sağlar. Ayrıca kan ve hemosiderin (demir) depolanmasını sağlar. Sonuç olarak vücudun korunma mekanizmasına katkısı retiküloendoteliyal sistem ile sıkı bir ilişki içerisinde olmasından kaynaklıdır. Bu organın, vücuttaki rolünün anlaşılması için farklı memelilerde çeşitli çalışmalar yürütülmüştür. Dalağın boyutu, gelişimsel faktörlere bağlı olarak türden türe, hatta bireyden bireye değişiklik göstermektedir. Özellikle gebelik dönemlerinde dalak gelişimine ilişkin çalışmalar organın bu dönemlerdeki değişikliklerini anlamak için gereklidir. Bu amaçla gebeliğin son iki döneminde (2. ve 3. Trimester) her grupta 7 erkek 7 dişi olmak üzere toplamda 28 adet Hamdani melezi koyununa ait fetüs dalağı kullanıldı. Fetüslerden dalak dikkatli bir şekilde diseke edilerek topografik, makroskobik ve morfometrik özellikleri belirlendi. CRL (crown- rump length) parametresi, fetal ağırlık, dalak ağırlığı, dalak uzunluğu ve genişliği gibi morfometrik parametreler ölçüldü. Aynı zamanda toplanan dalak dokuları rutin histolojik prosedür ile takip edilerek Hematoksilen & Eozin ve Masson Trichrome boyamaları ile mikroskobik düzeyde incelendi. Çalışma sonucunda 2. trimesterde fetal ağırlık, dalak ağırlığı, dalak uzunluk ve genişlik parametreleri sırasıyla, 300.35±260.39 g, 0.43±0.56 g, 1.30±0.77 cm ve 0.96±0.44 cm olarak belirlendi. Aynı değerler 3. Trimesterde sırasıyla 2241.42±541.32 g, 2.50±0.70 g, 4.11±0.80 cm ve 2.75±0.45 cm olarak ölçüldü. Mikroskobik incelemede ise beyaz pulpa, germinal merkez ve trabeküler septum yapılarının gelişimsel değişimleri izlendi. Elde edilen veriler, anatomi ve histoloji literatürüne katkı sağlamasının yanı sıra, insan ve memeli hayvanlarda yapılan gelişimsel çalışmalara temel bilgi oluşturacak niteliktedir.
Anahtar kelimeler: dalak, dalak histolojisi, Hamdani koyunu, morfometri, trimester

MACROSCOPIC AND MICROSCOPIC DESCRIPTION OF SPLEEN DEVELOPMENT IN THE 2ND AND 3RD TRIMESTER IN HAMDANI CROSSBREED SHEEP (*Ovis Aries*)

ABSTRACT

The spleen is an organ belonging to the circulatory system. This organ, which provides erythrocyte production in the embryological period, ensures lymphocyte production and destruction of erythrocytes in the mature period. It also provides storage of blood and hemosiderin (iron). As a result, its contribution to the body's protection mechanism is due to its close relationship with the reticuloendothelial system. Various studies have been conducted in different mammals to understand the role of this organ in the body. The size of the spleen varies from species to species and even from individual to individual, depending on developmental factors. Studies on spleen development, especially during pregnancy, are necessary to understand the changes in the organ during these periods. For this purpose, fetal spleens from 28 Hamdani crossbreed sheep, 7 males and 7 females in each group, were used in the last two periods of pregnancy (2nd and 3rd trimester). The spleen from the fetuses was carefully dissected and its topographic, macroscopic, and morphometric characteristics were determined. Morphometric parameters such as CRL (crown-rump length) parameter, fetal weight, spleen weight, spleen length and width were measured. At the same time, the collected spleen tissues were followed by a routine histological procedure and examined microscopically with Hematoxylin & Eosin and Masson Trichrome staining. As a result of the study, fetal weight, spleen weight, spleen length, and width parameters in the second trimester were determined as 300.35±260.39 g, 0.43±0.56 g, 1.30±0.77 cm and 0.96±0.44 cm, respectively. The same values were measured as 2241.42±541.32 g, 2.50±0.70 g, 4.11±0.80 cm, and 2.75±0.45 cm in the 3rd Trimester, respectively. In microscopic examination, developmental changes of the white pulp, germinal center, and trabecular septum structures were observed. In addition to contributing to the anatomy and histology literature, the data obtained will provide basic information for developmental studies in humans and mammals.

Keywords: Hamdani sheep, morphometry, spleen, spleen histology, trimester.

Introduction

Sheep stands out with its role in organic production in developing sustainability in small livestock breeding and meeting sustainability demands (Koyuncu & Taşkın, 2016). Hamdani sheep breed comes from the Rizaiye region of Iraq. Fat-tailed is a breed with good meat, milk, and fleece yield (Al Barzinji, 2022). Türkiye is an important country in sheep breeding. Hamdani sheep are generally raised in the southeastern regions of Turkey due to their productivity ability (Turgut et al., 2023).

Lymphoid tissue plays an important role in defense against microorganisms. One of the lymphoid organs is the spleen, which is considered the largest lymphoid of immunological defense (Khalel, 2010). The spleen is an important organ that acts as a filter for blood and preserves iron for use in hemoglobin synthesis (Samuelson, 2007). This organ, which produces erythrocytes in the embryological period, ensures lymphocyte production and destruction of erythrocytes in the mature period and ensures the storage of blood and hemosiderin (iron) (Mebius & Kraal, 2005). The spleen is located behind the diaphragm, in the left anterior part of the abdominal cavity, adjacent to the stomach (Liebich & König, 2022).

The size of the spleen varies from species to species and even from individual to individual, depending on developmental factors. Macroscopic and microscopic studies on spleen development, especially during pregnancy, are necessary to understand the changes in the organ during these periods. Studies on the spleen in the fetal period in sheep are limited. Morphometric measurement studies of the spleens of sheep and goats in the Jammu region were carried out by Suri et al., (2017). Khaksary-Mahabady et al., (2018) carried out morphometric measurements on fetal sheep spleens. In our study, macroscopic, morphometric, and microscopic features were determined in the spleen of the 2nd and 3rd-trimester fetuses of Hamdani crossbreed sheep raised in Siirt province. The information obtained will contribute to studies on organ development and morphological literature.

Materials and Methods

In the presented study, fetuses of pregnant Hamdani crossbred sheep slaughtered in the Siirt province slaughterhouse were used. A total of 28 Hamdani crossbred sheep fetuses, 7 males, and 7 females, from each trimester, including the 2nd and 3rd trimesters, were

used. No clinical findings were observed in the kidneys used in the study. Fetal weights were determined. In a study conducted by Noakes et al. (2009), the gestational days of the fetuses were determined with the A= 2.1(B+17) formulation. The length expressed as B = Crown-rump length (Figure 1) was measured separately in the fetuses and the gestational days (A) were determined. Additionally, biparietal length was measured. The topographic positions of the spleen in the 2nd and 3rd trimesters were determined by simultaneous dissection of the fetuses. The spleen removed from the abdominal cavity was weighed and photographed. Morphometric measurements were performed by transferring the images to the Image J program. Spleen length and spleen width were measured. Spleen measurement parameters are shown in Figure 2.

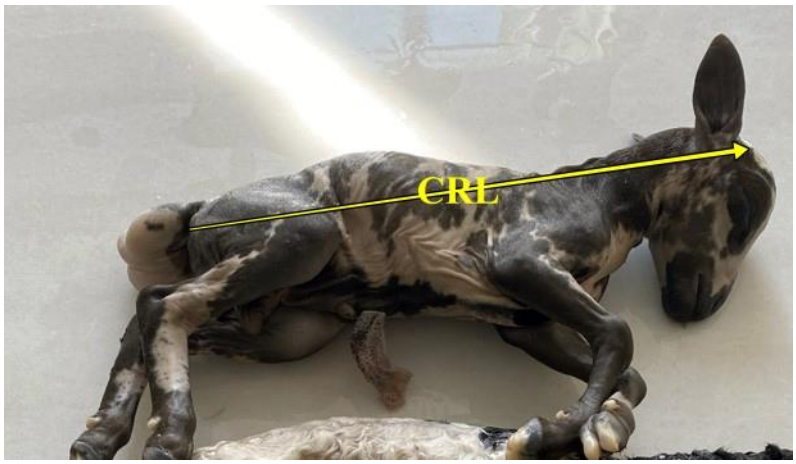


Figure 1. CRL (Crown-rump) length measurement.

Figure 2. Morphometric measurements on the spleen.

For microscopic examination, the collected spleen tissues were followed by a routine histological procedure and embedded in paraffin wax. 5 μm thick sections were taken from the blocks with a microtome and stained with Hematoxylin & Eosin (H&E) and Masson Trichrome stains. The sections were examined under a light microscope and photographed.

IBM SPSS 23 program was used for statistical analysis. Descriptive statistics were determined in the 2nd and 3rd trimesters. In addition, since the pregnancy days were close, spleen measurements taken from male and female animals between the same trimesters were compared with parametric and nonparametric tests.

Findings and Discussion

Hamdani sheep, which are similar to Morkaraman sheep, differ from this sheep breed with their long-eared structure (Güzel & İşbilir, 2023). In addition to being an important breed in the world due to its high milk yield, it is also a breed grown in Turkey, especially in the eastern regions (Dayan et al., 2023). Over the years, the people of the region have tried to crossbreed Hamdani sheep to obtain more productivity, and the breeding of Hamdani hybrid sheep has increased in Siirt province. In our study, it was aimed to determine the macroscopic and microscopic characteristics of the fetal spleen in Hamdani crossbred sheep in the 2nd and 3rd trimesters and to reveal the similarities and differences. In our study, it was determined that the average age of 2nd Trimester fetuses was between 56-86 days and the age of 3rd Trimester fetuses was between 109-135 days.

We observed that the spleen was located behind the diaphragm and adjacent to the rumen in the 2nd and 3rd trimesters. In general, spleen location was determined as dorsal to the rumen and caudal to the diaphragm. In a study conducted on adult sheep, the topographic position of the spleen was determined between the 10th and 13th ribs (Mehta et al., 2016). In our study, It was determined that the spleen was found in fetuses between the 11th and 13th ribs and passed towards the caudal side of the 13th rib (Figure 3-A, B, C).

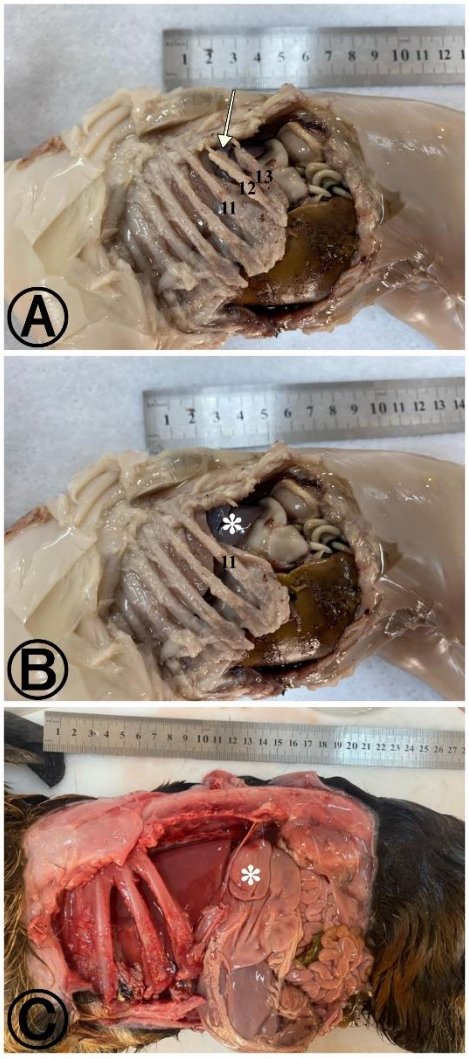


Figure 3. A: 2nd trimester (view of the spleen between the ribs, arrow: spleen). B: 2nd trimester (view of the spleen with the ribs removed). C: 3rd trimester view of the spleen, *: spleen

In the presented study, the spleen weights of the fetuses were weighed with a precision scale, and as a result, the average spleen weight in the 2nd trimester was 0.43 g, while this weight was measured as 2.50 g in the 3rd trimester. Descriptive statistics values for the two trimesters are stated in Table 1. While the descriptive statistics and P values of the 2nd trimester are presented in Table 2, the descriptive statistics and P values of the 3rd trimester are shown in Table 3. As a result of statistical analysis, no difference was observed in spleen sizes between male and female animals in the 2nd and 3rd trimesters.

Table 1. In 2nd and 3rd trimester descriptive statistics values of morphometric measurements of Hamdani crossbreed sheep fetal spleen.

	Trimester	N	Mean	Min.	Max.	Std. Deviation
Crown-rump uzunluğu (cm)	2	14	15.68	9.97	24.26	4.71
	3	14	40.10	35.13	47.50	4.16
Biparietal Uzunluk (cm)	2	14	4.24	2.18	6.42	1.47
	3	14	15.00	10.16	22.14	3.30
Fötal ağırlık (g)	2	14	300.35	80.00	835.00	260.39
	3	14	2241.42	1385.00	3400.00	541.32
Dalak ağırlığı (g)	2	14	0.43	0.02	1.62	0.56
	3	14	2.50	1.09	3.57	0.70
Dalak uzunluğu (cm)	2	14	1.30	0.50	2.64	0.77
	3	14	4.11	2.44	5.15	0.80
Dalak genişliği (cm)	2	14	0.96	0.43	1.99	0.54
	3	14	2.75	1.80	3.57	0.45

Table 2. Descriptive statistics and P values of 2nd-trimester sheep fetal spleen measurements.

	Cinsiyet	N	Mean	Min.	Max.	Std. Deviation	P
Crown-rump uzunluğu (cm)	Dişi	7	14.30	9.97	21.38	4.09	0.29
	Erkek	7	17.07	11.56	24.26	5.19	
Biparietal Uzunluk (cm)	Dişi	7	4.17	2.60	6.37	1.32	0.85
	Erkek	7	4.32	2.18	6.42	1.70	
Fötal ağırlık (g)	Dişi	7	286.42	80.00	835.00	267.67	0.71
	Erkek	7	314.28	90.00	745.00	273.51	
Dalak ağırlığı (g)	Dişi	7	0.36	0.04	1.56	0.53	0.80
	Erkek	7	0.50	0.02	1.62	0.61	
Dalak uzunluğu (cm)	Dişi	7	1.25	0.65	2.62	0.67	0.82
	Erkek	7	1.35	0.50	2.64	0.91	
Dalak genişliği (cm)	Dişi	7	0.93	0.53	1.99	0.51	0.84
	Erkek	7	0.99	0.43	1.81	0.60	

Table 3. Descriptive statistics and P values of 3rd-trimester sheep fetal spleen measurements.

	Cinsiyet	N	Mean	Min.	Max.	Std. Deviation	P
Crown-rump uzunluğu (cm)	Dişi	7	39.35	35.13	47.50	5.25	0.31
	Erkek	7	40.85	37.27	45.18	2.95	
Biparietal Uzunluk (cm)	Dişi	7	15.48	10.79	22.14	3.64	0.60
	Erkek	7	14.52	10.16	18.67	3.14	
Fötal ağırlık (g)	Dişi	7	2327.14	1785.00	3400.00	551.05	0.57
	Erkek	7	2155.71	1385.00	3050.00	560.44	
Dalak ağırlığı (g)	Dişi	7	2.51	1.73	3.57	0.68	0.96
	Erkek	7	2.49	1.09	3.51	0.77	
Dalak uzunluğu (cm)	Dişi	7	4.15	3.29	4.96	0.70	0.86
	Erkek	7	4.07	2.44	5.15	0.94	
Dalak genişliği (cm)	Dişi	7	2.72	2.15	3.14	0.33	0.81
	Erkek	7	2.78	1.80	3.57	0.58	

In a study conducted on the spleens of 18 sheep fetuses, it was observed that values such as spleen length, width, and weight increased in all prenatal periods. In the second trimester, spleen length was measured as 7.66 cm, and spleen width was measured as 4.88 cm in a sheep fetus with a gestational day of 60 and an average fetus weight of 46 g. In another sheep fetus in the second trimester with an average gestation day of 81 g and a fetal weight of 310 g, the spleen length was reported as 14.72 cm and the spleen width as 10.65 cm. In the same study, in the fetus with gestational day 103, fetal weight was 793 g, spleen length was 26.3 cm and spleen width was 17.66 cm (Bhagyalakshmi and Balasundaram, 2021).

In their study in 2019, Chaurasia et al. measured the weight, length, and width of the spleen in 30 goat fetuses between 44-144 days of pregnancy. It is consistent with our study that the spleen is located close to the stomach in a 44-day-old fetus. The spleen structure, which is reported to be quadrangular in goat fetuses, was roughly triangular in sheep fetuses examined in our study. In the 2nd trimester, the spleen length was measured as 3.60 ± 0.46 cm and its width was 3.00 ± 0.35 cm, while in the 3rd trimester, these values were measured as 13.54 ± 1.14 cm and 10.14 ± 1.16 cm, respectively. In another study conducted on goat fetuses, the average length, width, and thickness values of the spleen in the fetuses divided into groups were 20.29±1.5 mm, 14.76±0.97 mm, and

5.07±0.17 mm in the 2nd group fetuses. It was reported as 7.55±1.34 mm, 5.81±0.93 mm, and 1.82±0.48 mm in the 3rd group fetuses, respectively (Nishant et al., 2018). In our study, the average spleen length in the 2nd trimester was measured as 1.30±0.77 cm and 0.96±0.5 cm, respectively, while in the 3rd trimester, these values were measured as 4.11±0.80 cm and 2.75±0.45 cm, respectively. In the statistical evaluation, no statistical difference was determined between female and male sheep fetuses in different trimesters. In their study, Gautam and Mishra (2015) identified capillary endothelium in the trabecular artery, white pulp, and red pulp in the 94-day-old goat fetus spleen. While thin cytoplasmic protrusions and compact chromatin structures in indented nuclei were detected in the 99-day-old fetus, nuclear hypertrophy, chromatin condensation, and vacuolization were reported in the 106-day-old fetus. In another study conducted on goat fetuses, it was stated that hematopoietic and reticular cells began to be observed in the organ in the third month, and cellular hematopoietic areas masked the red and white pulps. While the number and size of these areas decreased towards the final stages of pregnancy, on the 93rd day the splenic parenchyma was observed to be similar to that of the mature animal with distinct red and white pulps. It has been reported that trabeculae extend from the capsule to the interior of the organ (Asha Antony et al., (2011). In our study, consistent with the literature, it was observed that although some of the white pulps were oval-shaped in the splenic parenchyma in the second trimester, some of them were diffuse or irregular. It was detected that the germinal center started to mature and the central arteries completed their maturation. It was determined that the splenic capsule had matured and extended its trabeculae into the tissue (Figure 4- A,B). In the 3rd trimester, it was observed that the white pulp had largely completed its maturation. The central arteries were functional and erythrocyte accumulation was intense in their cavities. It was observed that the trabecular septum gave deep and tortuous extensions to the splenic parenchyma (Figure 5- A,B).

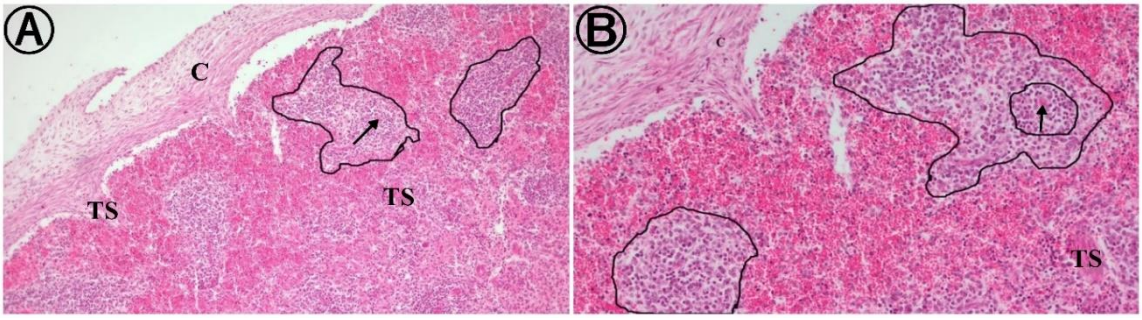


Figure 4. 2nd trimester transversal section of the spleen in sheep foetus (A: H&EX4; B: H&EX10). C: capsule; TS: trabecular septum; demarcated areas: white pulp; inner demarcated area: germinal centre; arrow: central artery.

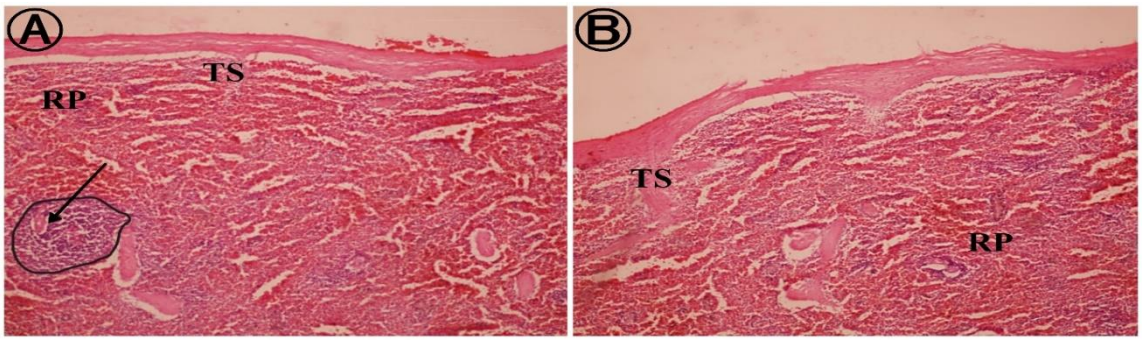


Figure 5. 3rd trimester transversal section of the spleen in sheep foetus (A-B: Masson trichrome X10). RP: red pulp; TS: trabecular septum; demarcated area: white pulp; arrow: central artery.

Conclusion and Recommendations

According to the study results, it was determined that, in line with the literature, the morphometric properties of the spleen increased with the increasing age of the animal during the fetal period (Bhagyalakshmi & Balasundaram, 2021). Additionally, it was determined that the histological features of the spleen continued to develop in the 2nd trimester, while in the 3rd trimester, they were almost similar to those of mature animals (Asha Antony et al., 2011). In the study results, the differences observed in fetal growth and spleen sizes were considered significant. As expected, there were increases in macroscopic and morphometric features along with organ growth. It was normal that there were no statistical differences between male and female fetuses at the same period. It was also noteworthy that microscopically, the organ showed similar characteristics to a mature spleen in the 3rd trimester.

References

Al-Barzinji, Y. M. (2022). Molecular analysis of fecgh gene in hamdani sheep breed in iraqi kurdistan region. *Iraqi Journal of Agricultural Sciences*, *53*(1), 1-8.

Asha Antony, S., Maya, K. R., & Chungath, J. J. (2011). Comparative development of thymus and spleen in foetal goat. *Journal of Indian Veterinary Association*, *9*(2), 21-23.

Bhagyalakshmi, J., & Balasundaram, K. (2021). Gross morphometrical studies on spleen (*Ovis aries*) at various age groups of prenatal sheep. *The Pharma Innovation*, *10*(11), 2572-2575.

Chaurasia, S., Menaka, R., Rao, T. K. S., & Tyagi, K. K. (2019). Prenatal gross morphometrical studies on spleen with special reference to prediction of foetal age in Surti goat (Capra hircus). *Indian Journal of Animal Research*, *53*(12), 1619-1623.

Dayan, M. O., Demircioğlu, İ., Koçyiğit, A., Güzel, B. C., & Karaavci, F. A. (2023). Morphometric analysis of the skull of Hamdani sheep via Three-Dimensional modelling. *Anatomia, Histologia, Embryologia*, *52*(2), 215-222.

Gautam, A. K., & Mishra, U. K. (2015). Histochemical and transmission electron microscopic studies of spleen in prenatal stages of goat. *Indian Journal of Animal Research*, *49*(1), 59-62.

Güzel, B. C., & Işbilir, F. (2023). Radiological examination of the skull of Siirt-coloured mohair goat, Romanov and Hamdani sheep. *Anatomia, histologia, embryologia*, *52*(6), 967–974. https://doi.org/10.1111/ahe.12956

Khaksary-Mahabady, M., Khazaeel, K., Borujeni, M. P., & Yazdanjoo, B. (2018). Morphometric development of sheep (Ovis aries) lymph nodes in fetal period. *Vet Res Forum*, *9*(2), 121-128. doi: 10.30466/VRF.2018.30833.

Khalel, E. (2010). Anatomical and histological study of the spleen in Iraqi sheep (Awasi sheep). *Basrah Journal of Veterinary Research*, *9*(2), 163-171.

Koyuncu, M., & TAŞKIN, T. (2016). Ekolojik koyun ve keçi yetiştiriciliği. *Hayvansal Üretim*, *57*(1), 56-62.

Liebich, H. G., Sotonyi, P., & König, H. E., (2022). *Evcil hayvanlar veteriner anatomi konu anlatım ve renkli atlas. (İ. Türkmenoğlu, Çeviri).* Malatya: Medipres Matbaacılık.

Mebius, R. E., & Kraal, G. (2005). Structure and function of the spleen. *Nature reviews immunology*, *5*(8), 606-616.

Mehta, S., Deshmukh, S.K., Minj, A.P., Kumar, K., Kumari, L. & Shahi, J.K. (2016). Gross morphometrical postnatal developmental studies on spleen of Chotanagpuri sheep (Capra ovis). *Veterinary Science Research Journal*, *7*(2), 83-86.

Nishant, N., Ajay Prakash, A. P., Farooqui, M. M., & Prabhakar Kumar, P. K. (2018). Topography and biometric studies of prenatal goat spleen at different gestational age. *Indian Journal of Veterinary Anatomy*, *30* (2), 80-82.

Noakes, D.E., Parkinson, T.J., England, G.C.W., (2009). *Arthuts' Veterinary reproduction and obstetrics*. 9th edition, DE Noakes, TJ Parkinson, GCW England (eds), Saunders, Edinburg, London

Samuelson, D.A. (2007). *Textbook of Veterinary Histology.* Missouri: Saunders Elsevier, p.261-268

Suri, S., Sasan, J. S., Sarma, K., & Chakraborty, D. (2017). Comparative gross and histomorphological studies on the spleen of sheep and goat of Jammu region of India. *Explor. Anim. Med. Res*, *7*(2), 179-183.

Turgut, A. O., Gülendağ, E., Koca, D & Üner, S. (2023). Milk Composition Traits of Hamdani Crossbreed Sheep Raised Under Extensive Management. *ISPEC Journal of Agricultural Sciences*, *7*(2), 271-279.

DETERMINATION OF THE PREVALENCE OF IBR AND BVD IN A DAIRY HERD

Dr. Berat Selim TOKGÖZ (ORCID: 0000-0002-7940-5371)
Adana Veteriner Kontrol Enstitüsü, Virology Laboratory, Adana- Türkiye
Email: bselimtokgoz@hotmail.com

ABSTRACT
This study was carried out to investigate the presence of IBR and BVDV in a dairy herd in Gaziantep in 2023. Blood serum samples (410) taken from the animals in the herd were examined serologically with IBR gB Blocking ELISA (Enzyme Linked Immunosorbent Assay) for the presence of IBR antibodies, and leukocyte samples (410) were examined with real time PCR for the presence of Bovine Herpesvirus-1 antigen. Serum samples (410) were investigated for the presence of BVDV antibody by Indirect ELISA and for the presence of BVDV antigen by Direct ELISA. All tested samples were negative for the presence of IBR antigen. IBR gB was 22.68% (93/410). While no positive samples were detected for BVDV antigen, seropositivity for BVDV spesific antibody was 4.87% (20/410). The positivity obtained in both infections was attributed to infection as the sampled animals were not vaccinated. As a result, it can be stated that periodically examining the animals in dairy herds for IBR and BVD and removing the detected latent and/or persitent infected animals from the herd can be applied as a protective measure to prevent economic losses in the farms.
Keywords: IBR, BVDV, ELISA, Real time PCR

Introduction

Infectious Bovine Rhinotracheitis/Infectious Pustular Vulvovaginitis/Infectious Pustular Balanoposthitis (IBR/IPV/IPB) is a difficult to fight viral infection called BHV-1 (Bovine Herpesvirus-1), which affects the respiratory and genital system of cattle and causes high economic losses (Hacıoğlu 2011, Duman et al 2013, Yadav et al 2018). BHV-1 is located in the Alphaherpesvirinae subfamily of the herpesviridae family in the Varicelovirus genus (Patil et al 2016, Yadav et al 2018). Once infected with IBR, animals become latently infected and transmit the infection to the herd for lifelong (Bulut and Yavru 2004, Maresca et al 2018, Yadav et al 2018). There are subtypes such as BHV 1, 1.1,1.2a and 1.2b. morbidity is stated as 100% and mortality is 10% (Hacıoğlu 2011).

BHV-1 is infected by genital, respiratory, ocular secretions and direct animal-to-animal contact. Infection can also be transmitted through the semen of bulls. The virus can remain latent in neurons throughout the host's life. Because the stress factors can reactivate the virus in latently infected animals and so healthy animals can be infected (Maresca et al 2018) latently infected animals should be identified and removed from the herd (Yadav et al 2018). BHV-1 is currently a major obstacle to live animal exports to European countries where the disease has been eradicated (Maresca et al 2018).

Bovine Viral Diarrhea Virus (BVDV) causes economic losses by affecting respiratory, digestive and reproductive systems (Su et al 2023). BVDV was first detected in the United States of America by Olafson et al. (1946) and named as Viral Diarrhea. Later, Ramsey and Chivers (1953) identified Mucosal Disease, a disease with mucosal lesions with similar symptoms. When it was determined that the causative agent of these diseases, which were previously described as two separate diseases, was the same virus, the disease was named Bovine Viral Diarrhea/Mucosal Disease (BVD-MD) (Uyanık 1992). The virus is a RNA virus in the pestivirus subfamily of the Flaviviridae family. BVDV is reported to have two biotypes, cytopathic and non-cytopathic (Pellerin et al 1994).

The BVDV control program emphasizes the protection of susceptible and incompletely protected animals from persistently infected animals (Moennig and Becher 2018). Persistently infected animals seem healthy but play a major role in the spread of the virus. Many studies have reported that BVDV infection is widespread in many countries (Burgu et al 2003).

Material and Method

Material

In this study, blood serum and EDTA defibrinated blood samples obtained from 410 cattle in a dairy farm in Gaziantep in 2023 were used.

Method

Preparation of blood sera

Blood samples taken in sterile kaolin tubes were centrifuged at 2000 rpm for 10 minutes at +4°C. The serum remaining on the top was taken and transferred to eppendorf tubes. Stored at -20 °C until testing.

ELISA

Blood serum samples were tested and evaluated with IBR gB (glycoprotein B) Ab (Antibody), BVDV Ab commercial indirect ELISA kit, BVDV Ag (Antigen) commercial direct ELISA kit (Idexx, United States of America) according to the manufacturer's instructions .

Extraction

Whole blood samples with EDTA were performed according to the DNA extraction kit (Indispin Pathogen Kit, INDICAL, Germany) procedure. Nucleik acids were stored at -80°C until the study.

PCR

IBR was performed according to the Real Time Polymerase Chain Reaction (Real Time PCR) kit (Lightcycler Taqman Master Kit, Roche Germany) protocol. For each sample, 4 µl Taqman Mix, 0.5 µl each of Primer 10 pmol Primer F and R, 1 µl of 5 pmol Probe, 9 µl water and 5 µl extract were used to make a final volume of 20 µl.

Primer and probe sequences were used Primer gB-F: (5'-TGTGGACCTAAACCTCACGGT-3') Primer gB-R: (5'-GTAGTCGAGCAGCAGACCCGTGTC-3') Taqman Probe: (5'-FAM AGGACCGCGAGTTCTTGCCGCTAMRA -3') (Chandranaik et al 2010).

Activation was performed at 95°C for 10 min, 1 cycle, later denaturation at 95°C for 15 s, annealing at 60°C for 30 s and extension at 72°C for 1 s and 40 cycles (Roche Lightcycler 480). Positive control was supplied from Etlik Veterinary Control Central Research Institute. DNase and RNase free water were used as negative control. Positive and negative control were used in each PCR test.

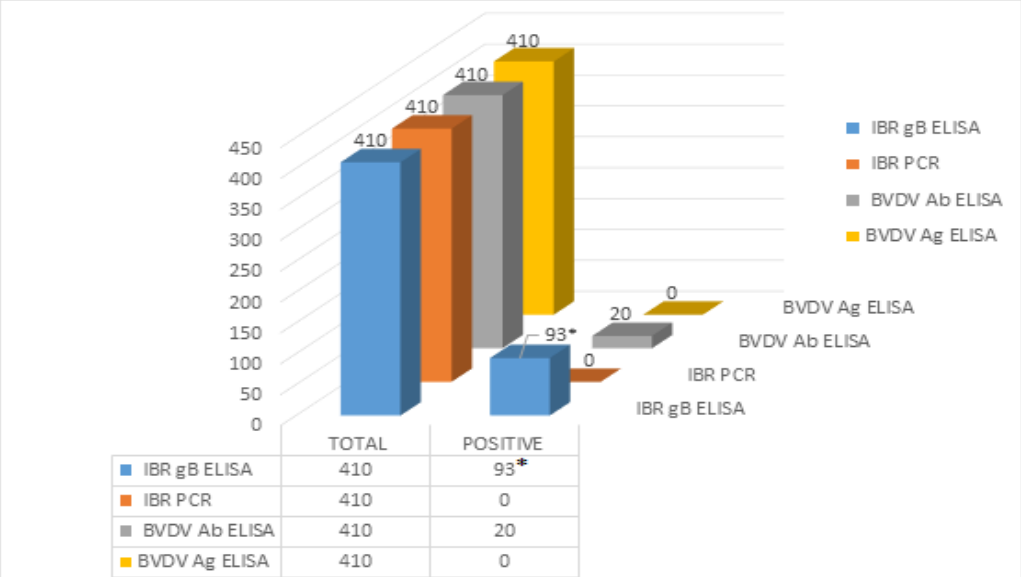
Statistics

Statistically obtained results obtained were compared by chi-square test (SPSS 22.0) and P<0.05 was considered statistically significant.

Results

The test results of the examined 410 samples are shown in graphic 1.

Graphic 1: Distribution of ELISA and PCR results.



	TOTAL	POSITIVE
IBR gB ELISA	410	93*
IBR PCR	410	0
BVDV Ab ELISA	410	20
BVDV Ag ELISA	410	0

*:Values in the same column are statistically different (P<0.05).

Discussion

As in the world, IBR and BVDV infections cause serious economic problems in our country. Many European countries have planned BHV-1 eradication programmes due to disease and trade restrictions (Maresca et al 2018). In eradication programmes, control strategies have been determined by removing seropositive animals from infected herds and using marker vaccines. For example, in Slovakia, while they culled <15% seroprevalence, they also reported the use of marker vaccination along with culling in those with >15 %. In this way, they were able to eradicate 60.2% of the herds from IBR in 2020 (Iscaro et al 2021).

Researchers (Bulut and Yavru 2004) emphasised that ELISA is more sensitive than microneutralisation test (mNT) in Indirect diagnosis of IBR, PCR is more sensitive than ELISA and Virus Isolation (VI) in Direct diagnosis of IBR. ELISA is preferred over the mNT because it gives results in a short time and is easy to work with a large number of samples (Xingnian and Kirkland 2008).

IBR was revealed serologically for the first time in Turkey by Erhan et al (1971). It has been reported to be very common according to studies conducted in our country [(Kabaklı and Çarlı (1996), Yavru et al (1998), Bilge- Dağalp et al (2001), Bulut and Yavru, (2004), Güler et al (2004), Yıldırım and Burgu (2005), Yıldırım et al (2009), Hacıoğlu, (2011), Avcı and Yavru, (2013), Özgünlük and Yıldırım, (2017)].

The prevalence of IBR in our country, Bulut and Yavru, (2004) 23% (23/100) with both direct PCR and indirect Ab ELISA, Avcı and Yavru (2013) 72.88% with indirect ELISA, Güler et al, (2004) 35% (42/120) with Ab ELISA, Hacıoğlu, (2011) 28.7% (42/146) with ELISA, Yıldırım et al (2009) in total 61.50% in the sampled provinces between 44.04% and 76.47% with Ab gB ELISA, Özgünlük and Yıldırım (2017) 40.11% with mNT, Bilge- Dağalp et al (2001) 60.1-70.7% by mNT, Yavru et al (1998) 41.66% (125/300) by mNT, Yıldırım and Burgu (2005) 59.48% (301/506) by mNT, Kabaklı and Çarlı (1996) 52.53% (354/670) by neutralisation test was found in the rate of Ab presence.

The prevalence of IBR in the world Noordegraaf et al (1998) 42% in the Netherland, Iscaro et al (2021) in 2010 28-42% in Ireland, in two artificial insemination stations of the bulls 49.3% and 48.9% in 1991 in Hungary was reported. Maresca et al (2018) determined 55.49% (8014/25141) the seroprevalence in Italy. Seroprevalence in India Trangadia ve ark (2010) %60.84, Saravanajayam ve ark. (2015) %65.88, BoHV-1 seroprevalence in Ireland Barret et al (2018) found 90 % at herd level and 40% within the herd. Yitagesu ve ark (2021) reported that 882 animals 349 households were negative Ag Capture-ELISA in Ethopia. In this study, IBR seroprevalence was found 22.68% (93/410) (Graphic 1), which was lower than IBR prevalence studies determined both in Turkey and rest of the world. The rate of 22.68% was found to be statistically significant.The fact that the sampled animals were in one herd, the animals sampled were not in the viremia period during the sampling period, the viral load in the animals may be low, and it was thought to be low due to the sampling period.

In studies on BVDV epidemiology in Turkey, Burgu et al (2003) determined 24.8% Ab (3086/12413) with mNT and virus presence with virus isolation in 38.4% (10/26) in herds and 0.32% (40/12413) in animals. Cabalar and Karaoglu (1999) determined 96.8% (456/471) in neutralisation immunperoxidase test. Yıldırım and Burgu (2005) 81.62% (413/506), Yıldırım et al (2009) 58.86%, Özgunluk and Yıldırım (2017) 48.05% reported antibody presence by mNT. Güler et al (2004) found 39.6% (46/120)

BVDV seropositive by Ab ELISA. İnce (2020) determined 40.83% (98/240) by Indirect ELISA. Avcı and Yavru (2013) found 46.22% positive by indirect ELISA in serum and BVDV antigen negative by direct ELISA in leucocyte samples.

In addition, Özgünlük and Yıldırım (2017), attributed the different prevalence of BVDV infections in turkey to use of diferent test methods in the studies, animal movements in the sampled area,the number of animals in the herd, the presence of persistent infection and protective measures.

The prevalence of BVDV in the World, Su et al (2023) reported BVDV Ag prevalence of 15.74% and Ab prevalence of 42.77% between 2010 and 2021 in China. Billinis et al (2005) reported 1.3-14% by Ag ELISA in herds in Greece. Velasova et al (2017) found BVDV in Bulk milk tank Ab 66%, Ag 5% in Great Britain, Barret et al (2018) found seroprevalence as 100% at herd level and 77.7% within the herd in Ireland. Scharnböck et al (2018) reported seroprevalence 53.47% in herds, 45.51% in animals ve 9.72% in herds, 10.78% in animals in North America in 325 studies conducted in 73 different countries between 1961-2016.

There has been no animal entry to the sampled herd for a long time and this situation has negatively affected the virus circulation. The hygiene conditions, care and feeding conditions of the animals are good. Sampling was carried out from only one farm. For these reasons, it is thought that 4.87% (20/410) (Graphic 1) positivity is lower than the studies in Turkey and rest of the world.

As a result, IBR and BVDV infections cause high economic losses to herd. Animal movements are very important in the spread of IBR and BVDV infections in herd. For these reasons, it is recommended that the animals to be included in the herd are added after being tested for the presence of viral factors. Latently and persistently infected animals should be separated from herds. It is thought that more prevalence studies should be carried out and control measures should be complied with in order to ensure that herds are free from IBR and BVDV.

References

Avcı O, Yavru S. (2013). Investigation of Bovine Herpesvirus-1, Bovine Viral Diarrhea Virus and Bovine Herpesvirus-4 in a dairy herd with naturally infected in Konya. Eurasian J Vet Sci, 2013, 29, 2, 82-86.

Barret D, Parr M, Fagan J, Johnson A, Tratalos J, Lively F, Diskin M, Kenny D. (2018). Prevalence of Bovine Viral Diarrhoea Virus (BVDV), Bovine Herpes Virus 1 (BHV!), Leptospirosis and Neosporosis, adn associated risk factors in 161Irish beef herds. Veterinary Research 14:8

Bilge- Dağalp S, Yıldırım Y, Alkan F. (2001). Detection of Maternal Antibody Levels against BHV-1 in Calves. Ankara Üniv Vet Fak Derg. 48:117-122.

Billinis C, Leontides l, Amiridis GS, Spyrou V, Kostoulas P, Sofia m. (2005). Prevalance of BVDV infection in Greek dairy herds. Preventive Veterinary Medicine. 72:75-79.

Bulut O, Yavru S. (2004). Seroepidemiology and Comparative Diagnosis of Bovine Herpesvirus Type-1 (BHV-1) in Bulls using enzyme- Linked Immunosorbent Assay (ELISA), Polymerase Chain Reaktion (PCR) and Virus Isolation (VI).Vet Bil Derg. 20(4):61-70.

Burgu İ, Alkan F, Özkul A, Yeşilbağ K. Karaoğlu T, Güngör B. (2003). Control and Epidemiology of Bovine Viral Diarrhea Virus (BVDV) Infection for Dairy Herds in Turkey. Ankara Üniv Vet Fak Derg. 50:127-133

Cabalar M, Karaoglu T. (1999). Comparison of Neutralization Peroxidase- Linked Antibody (NPLA) Assay and Serum Neutralization (SN) Test for Detecttion of Antibodies to Bovine Viral Diarrhea (BVD) Virus in cattle Sera. Ankara Üniv Vet Fak Derg. 46:249-255.

Chandranaik BM, Shivaraj C, Kumar S, Renukaprasad C. (2010). Isolation of BHV-1 from bovine semen and application of real time PCR for diagnosis of IBR/IPV from clinical samples. Veterinary Arhiv. 80(4):467-475.

Duman R, Yavru S, Bulut O, Avcı O. (2013). Comparative Detection of Bovine Herpesvirus-1 Infection in Cattle by Enzyme-Linked Immunosorbent Assay and Micro neutralisation Test.Atatürk Üniveristesi Vet bil derg. 8(2):129-136.

Erhan M, Onar B, Csontos L, Hopkins IG. (1971). Serological survey on some virus and bedsonia diseases of cattle. Pendik Vet Kont Arş Derg. 4:55-58.

Güler L, Yavru S, Ekik M, Ok Ü, Şimşek A, Gündüz K, Gülcü Y. (2004). Investigation of Some Important Pathogens in Bulls. 20(4):71-78.

Hacıoğlu S, (2011). Molecular and Serological Diagnosis of Bovine Parainfluenza 3 (BPI-3) and Infectious Bovine Rhinotracheitis (IBR) in Respiratory Tract of Cattle. Ankara Üniversitesi Sağlık Bilimleri Enstitüsü Yüksek Lisans Tezi. Ankara.

Iscaro C, Cambiotti V, Petrini S, Feliziani F. (2021). Conrol programs for infectious bovine rhinotracheitis (IBR) in European countries: an overview. Animal Health Research Reviews. 22:136-146.

İnce ÖB.(2020). Investigation of Bovine Viral Diarrhoea Virus (BVDV) Infection Epidemiology at Dairies in the Province of Afyonkarahisar. Van Vet J. 31(3):122-126

Kabaklı Ö, Çarlı KT. (1996). Infectious Bovine Rhinotracheitis- Infectious Pustular Vulvovaginitis (IBR/IPV): Detection of Neutralization Antibodies and Isolation of the Virus in MDBK abd Primary Calf Kidney Cell Culture. Etlik Vet Mikrob Derg. 8(4)

Maresca C, Scoccia E, Dettori A, Felici A, Guarcini R, Petrini S, Quaglia A,Filippini G. -(2018). National surveilance plan for infectious bovine rhinotracheitis (IBR) in autochthonous Italian cattle breeds:results of first year of activity. Veterinary Microbiology. 219:150-153.

Moennig V, Becher P. (2018). Control of Bovine Viral Diarrhea. Pathogen. 7(1)29. https://doi.org/10.3390/pathogens7010029.

Noordegraaf AV, Buijtels JAAM, Dijhuizen AA, Franken P, Stegeman JA, Verhoeff J. (1998). An Epidemiological and Economic Simulation Model to Evaluate the Sğread and Control of Infectious Bovine Rhinotracheitis in the Netherlands. Preventive Veterinary Medicine. 36:219-238.

Özgünlük İ, YıldırımY. (2017). A Serological Investigation on Bovine Herpes Virus Type 1 (BHV-1) and Bovine Viral Diarrhea Virus (BVDV) Infections in Cattle in Southeast Region of Turkey. Harran Üniv Vet Fak Derg. 6(2):152-157.

Patil SS, Prajapati A, Hemadri D, Suresh KP, Desai GS, Manjunatha Reddy GB, Chandranaik BM, Ranganatha S, Rahman H. (2016). Phylogenetic analysis of glycoprotein B gene sequences of bovine herpesvirus 1 isolates from India reveals the predominance of subtype1.1. Vet World. 9: 1364-1369.

Pellerin C,Van den Hurk J, Lecomte J, Tijssen P. (1994). Identification a new group bovine viral diarrhea virus strains associated with severe outbreaks and high mortalities. Virol. 203:260-269.

Saravanajayam M, Kumanan K, Balasubramaniam A. (2015), Seroepidemiology of infectious bovine rhinotracheitis infection in unvaccinated cattle. Vet World. 8(12):1416-1419.

Scharnböck B, Roch F-F, Richter V, FunkeC,Firth CL, Obritzhauser W, Baumgartner W, Kasbohrer A, Pinior B. (2018). A meta-analysis of bovine viral diarrhoea virus (BVDV) prevalences in the global cattle population. Scientific Reports 8:14120.

Su N, Wnag Q, Liu HY, Li LM, Tian T, Yin JY, Zheng W, Ma QX, Wang TT, Li T, Yang TL, Li JM, Diao NC, Shi K, Du R. (2023). Prevalence of bovine viral diarrhea virus incattle between 2010 and 2021: a global systematic review and meta-analysis. Front Vet Sci. doi: 10.3389/fvets.2022.1086180

Trangadia B, Rana SK, Mukherjee F, Srinivasan VA. (2010). Prevalence of brucellosis and infectious bovine rhinotracheitis in organized dairy farms in India. Trop Anim Health Prod. 42:203-207.

Uyanık F. (1992). Bovine Viral Diarrhea/Mucosal Disease (BVD/MD). Etlik Vet Mikrob Derg. 7(3):65-76.

Velasova M, Damaso A, Prakashbabu BC, Gibbons J, Wheelhouse N, Longbottom D, Winden SV, Green M, Guitian j. (2017). Herd-level prevalence of selected endemic infectious diseases of dairy cows in Great Britain. J Dairy Sci. 100: 9215-9233.

Xingnian G, Kirkland PD. (2008). Infectious Bovine Rhinotracheitis. Australia and New Zealand Standart Diagnostic Procedures. Part 2: Diagnostic Test Methods. 1-18.

Yadav V, Singh SP, Kumar R, Diwakar RP, Kumar P. (2018).A Review Current Status of Infectious Bovine Rhinotracheitis in India. Int J Curr Microbiol App Sci. 7:411-426.

Yavru S, Şimşek A, Öztürk F. (1998). Investigation of Bovine Herpes Virus Type 1 (BHV-1) Infection by Serologic and Virologic Methods in Bulls. Vet Bil Derg. 14(2):101-110.

Yıldırım Y. Burgu İ. (2005). The Seroprevalnce of Bloetongue(BT), IBR,PI-3,EBLand BVD Infections in Cattle in Northeastern Anatolia. Ankara Üniv Vet Fak Derg. 52:113-117.

Yıldırım Y, Yılmaz V, Majarashın ARF. (2009). Seroprevalence of Viral Respiratory System Infections in Catttle in the Border Provinces of North-East Turkey. Kafkas Univ Vet Fak Derg. 15(4):601-606.

Yitagesu E, Jackson W, Kebede N, smith W, Fentie T. (2021). Prevalence of bovine abortion, calf mortality, and bovine viral diarrhea virus (BVDV) persistently infected calves among pastoral, peri-urban, and mixed-crop livestock farms in central and Northwest Ethiopia. BMC Veterinary research. 17:87.

HAMDANİ MELEZİ KOYUN (*Ovis Aries*) FETÜSLERİNDE BÖBREKLERİN MORFOLOJİK VE HİSTOLOJİK YAPISININ İNCELENMESİ

Arş. Gör. Muhammed Zahid ATLI (ORCID: 0009-0007-3139-1453)
Siirt University, Faculty of Veterinary Medicine, Department of Anatomy, Siirt-Turkey.
Email: mzahid.atli@siirt.edu.tr

ÖZET
Böbrekler, normal vücudun fizyolojisini sürdürmesi için önemli olan hayati organlardan biridir. Retroperitoneal olarak yerleşmiş, dorsal abdominal duvar ve columna vertebralis arasında kalan bir çift organdır. Temel görevi vücut sıvılarının içeriğinin belirli sınırlar arasında kalmasını sağlamaktır. Böbrek boyut olarak, çevresel faktörlerde dahil olmak üzere çeşitli sebeplerle türden türe değişkenlik göstermektedir. Özellikle gebelik dönemlerinde böbrek üzerine yapılan detaylı çalışmalar, bu dönemlerde meydana gelen farklılıkları açığa çıkarmak için gereklidir. Bu amaçla gebeliğin son iki döneminde (2. ve 3. trimester) her grupta 7 erkek 7 dişi olacak şekilde toplam 28 adet Hamdani melezi koyun fetüsü kullanıldı. Fetüslerden, böbrek dikkatli bir şekilde disseke edilerek topografik, makroskobik ve morfometrik özellikleri belirlendi. Fetal ağırlık, böbrek ağırlığı, total böbrek uzunluk ve genişliği, medulla, korteks uzunlukları gibi morfometrik parametreler ölçüldü. Ayrıca toplanan böbrek dokuları rutin histolojik prosedür ile takip edilerek Hematoksilen & Eozin ve Masson Trichrome boyamaları ile mikroskobik düzeyde incelendi. Çalışma sonucunda 2.trimester ölçümlerinde ortalama CRL (crown-rump length) parametresi 15.68 ± 4.71 cm, ortalama fetal ağırlık 300.35 ± 260.39 g, ortalama böbrek uzunluğu 1.36 ± 0.57 cm, ortalama korteks uzunluğu 0.20 ± 0.11 cm, ortalama pelvis renalis uzunluğu 0.46 ± 0.21 cm olarak belirlenirken, 3.trimesterde bu ölçümler ortalama CRL (crown-rump length) parametresi 40.10 ± 4.16 cm, ortalama fetal ağırlık 2241.42 ± 541.32 g, ortalama uzunluk 3.13 ± 0.30 cm, ortalama korteks uzunluğu 0.32 ± 0.12 cm, ortalama pelvis renalis uzunluğu 1.15 ± 0.24 cm olarak belirlendi. Histolojik inceleme ile 2. ve 3. trimesterde mikroskobik benzerlik ve farklılıklar tespit edildi. 2.trimesterde glomerül, proksimal ve distal tübüllerin olgunlaşmasını tamamladığı, 3.trimesterde toplama tübüllerinin iyi gelişmiş olduğu görüldü. Elde edilen bilgiler anatomi ve histoloji literatürüne katkı sağlamasının yanı sıra, insan ve hayvan sağlığında yapılan, bilimsel araştırmalar için temel teşkil edecek niteliktedir.
Anahtar Kelimeler: Böbrek histolojisi, böbrek morfometrisi, Hamdani koyunu, koyun fetüs.

INVESTIGATION of the MORPHOLOGICAL and HISTOLOGICAL STRUCTURE of the KIDNEYS in HAMDANI CROSSBREED (*Ovis Aries*) SHEEP FETUS

ABSTRACT

Kidneys are one of the vital organs important for maintaining normal body physiology, they are a pair of organs located retroperitoneally, between the dorsal abdominal wall and the columna vertebralis. Its main function is to ensure that the content of body fluids remains within certain limits. The kidney varies in size from species to species, including various environmental factors. Detailed studies on the kidney, especially in the early stages of pregnancy, are necessary to reveal differences in pregnancy periods. For this purpose, 28 Hamdani crossbreed sheep fetuses, 7 males and 7 females in each group, were used in the last two periods of pregnancy (2. and 3. trimesters). The kidney was carefully dissected and its topographic, macroscopic, and morphometric features were determined. Morphometric parameters such as fetal weight, kidney weight, total kidney length and width, medulla and cortex lengths were measured. In addition, the collected kidney tissues were followed by a routine histological procedure and examined microscopically with Hematoxylin & Eosin and Masson Trichrome staining. As a result of the study, in the second-trimester measurements, the average CRL (crown-rump length) parameter was 15.68 ± 4.71 cm, the average fetal weight was 300.35 ± 260.39 g, the average kidney length was 1.36 ± 0.57 cm, the average cortex length was 0.20 ± 0.11 cm, the average pelvis renalis length was 0.46 ± 0.46 ± 0.46 cm. While it was determined as 0.21 cm, in the 3rd trimester these measurements showed an average CRL (crown-rump length) parameter of 40.10 ± 4.16 cm, average fetal weight 2241.42 ± 541.32 g, average length 3.13 ± 0.30 cm, average cortex length 0.32 ± 0.12 cm, average pelvis renalis. Its length was determined as 1.15 ± 0.24 cm. By histological examination, microscopic similarities and differences were determined in the 2. and 3. trimesters. It was observed that the glomerulus, proximal, and distal tubules completed their maturation in the 2. trimester, and the collecting tubules were well developed in the 3. trimester. In addition to contributing to the anatomy and histology literature, the information obtained will form the basis for scientific research in human and animal health.

Keywords: Hamdani sheep, kidney histology, kidney morphometry, sheep fetus.

Introduction

Sheep breeding has played an important role in our country from past to present. Turkey ranks first in the world in terms of sheep population (Kaymakçı, 2010). Hamdani sheep come from the Rizaiye region of Iran and are raised in the eastern region of Turkey (Aziz & Oramary, 2005; Al–Doori, 2006; Güzel & İşbilir, 2023). Fat-tailed is a breed that is used for its meat, milk and fleece. It matures quickly and is well adapted to local conditions (Magid et al., 2013).

Kidneys play an important role in removing waste products from the body in mammals. Water and many electrolytes are preserved by the kidney and excreted from the body when necessary (Finco, 1997). The kidneys are retroperitoneal and topographically, they are a pair of organs located between the last dorsal vertebrae and the first lumbar vertebrae, stuck between the dorsal abdominal wall and the columna vertebralis (Liebich & König, 2022). The renal parenchyma is divided into two parts, cortex and medulla renis. The part where the ureter extends to the renal sinus in the kidney medulla and covers it is the pelvis renalis (Wallace, 1998; Bahadır & Yıldız, 2016).

The kidney varies in size for various reasons, including environmental factors. Measurement studies, especially during pregnancy, are necessary to reveal the differences that occur during this period. Studies on the kidney in the fetal period in sheep are limited. In a study conducted in 2016, histomorphometric measurements were made on the fetuses of Yankasa sheep and the results were compared (Bello et al., 2016). In our study, macroscopic, morphometric and microscopic features were determined in the kidneys of the 2nd and 3rd trimester fetuses of Hamdani crossbreed sheep raised in Siirt province. In addition to contributing to the anatomy and histology literature, the information obtained will form the basis for scientific research in human and animal health.

Material and Method

In the presented study, fetuses of pregnant Hamdani crossbred sheep slaughtered in the Siirt province slaughterhouse were used. A total of 28 Hamdani crossbred sheep fetuses, 7 males and 7 females, from each trimester, including the 2nd and 3rd trimesters, were used. No clinical findings were observed in the kidneys used in the study. Fetal weights were determined. Noakes et al., (2009) used in the study A= 2.1(B+17) (B=CRL). The length expressed as B = Crown-rump length was measured separately in the fetuses and the gestational days (A) were determined. Additionally, biparietal length was measured.

The topographic positions of the kidneys in the 2nd and 3rd trimesters were determined by simultaneous dissection of the fetuses. The kidneys removed from the abdominal cavity were weighed and photographed. Morphometric measurements were performed by transferring the images to the Image J program. Kidney weight, total kidney length, total kidney width, medulla renal width, cortex renal width and renal pelvis lengths were measured. Kidney measurement parameters are shown in Figure 1.

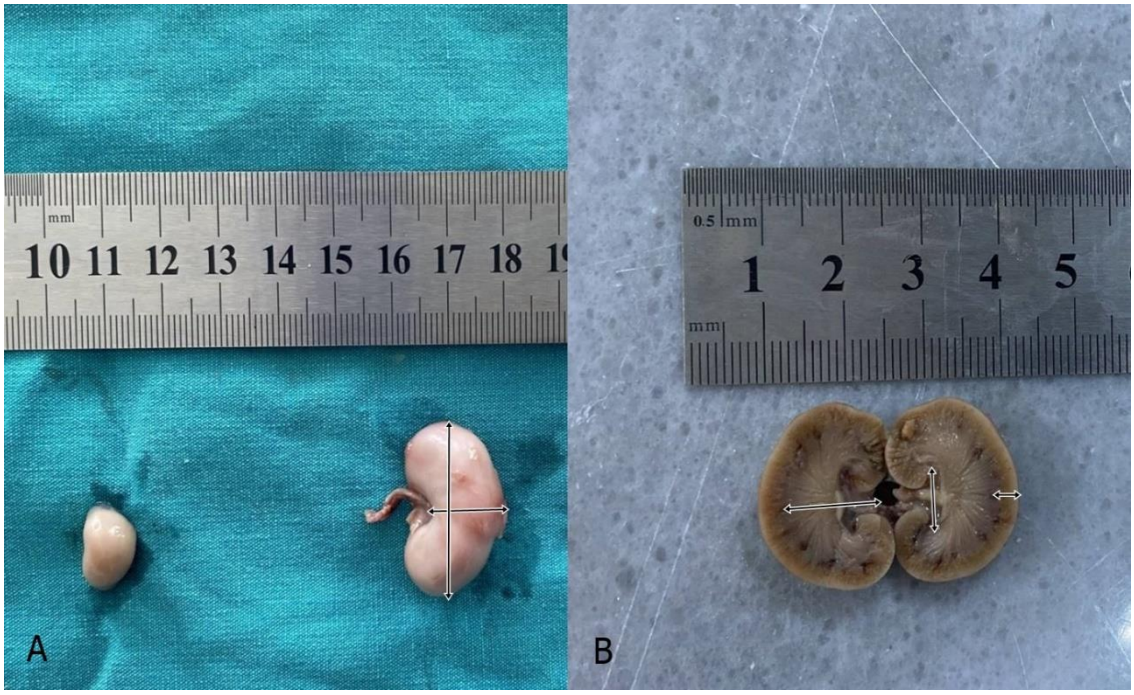


Figure 1. A: Lateral view of the right kidney in the 2nd and 3rd trimesters (kidney width and length measurement). B: Right kidney sectioned from the median line, 3rd trimester (Cortex width, medulla width, and pelvis renalis length measurements).

In microscopic examination, the kidney tissues taken were stained with Hematoxylin & Eosin and Masson Trichrome stains, following the routine histological procedure. Sections were examined under a light microscope and photographed.

IBM SPSS 23 program was used for statistical analysis. Descriptive statistics were determined in the 2nd and 3rd trimesters. In addition, since the pregnancy days were close, kidney measurements taken from male and female animals between the same trimesters were compared with parametric and nonparametric tests.

Findings and Discussion

The detailed definition of the morphological characteristics of Hamdani sheep remains unclear due to the lack of studies. Hamdani sheep is a breed that is produced in the world and especially in the Eastern regions of Turkey due to its significant productivity (Dayan

et al., 2023). In our study, it was aimed to determine the morphometric characteristics of the fetal kidney of Hamdani sheep in the 2nd and 3rd trimester gestation days and to reveal the similarities and differences between genders. In the 2nd trimester, the left kidney was observed almost symmetrically with the right kidney. Generally, kidney location is in the 2nd-5th stage. It was determined to be below the lumbar vertebrae. In the 3rd trimester, it was determined that the left kidney shifted to the right due to the growth of the rumen and was located behind the right kidney, in the median line it was observed that it resembled a bean in both trimesters. In our study, the average CRL (Crown-rump length) length was measured as 14.30 cm in females and 17.07 cm in males in the second trimester. In the 3rd trimester, it was measured as 39.35 cm in females and 40.85 cm in males. Accordingly, the gestational days of the fetuses used in the study were determined. Pregnancy days were calculated as 56-80 days in 2nd trimester females, 60-86 days in 2nd trimester males, 109-135 days in 3rd trimester females, and 113-130 days in 3rd trimester males. Descriptive statistics values for the 2nd and 3rd trimesters are shown in Table 1. As a result of statistical analysis, a difference was observed between male and female animals in the width of the medulla and cortex in the 2nd trimester ($P<0.05$). No differences were observed between males and females in the 3rd trimester. The results of morphometric measurements and P values in male and female animals within the same trimester are presented in Tables 2 and 3. While the average 2nd trimester medulla width was 0.45 cm, the 3rd trimester medulla width was measured as 1.17 cm. The 2nd trimester medulla width was measured as 0.60 cm in the female fetus and 0.31 cm in the male fetus.

Table 1. Descriptive statistical values of kidneys in 2nd and 3rd trimester sheep fetuses.

	Trimester	N	Mean	Min.	Max.	Std. Deviation
Crown-rump lenght (cm)	2	14	15.68	9.97	24.26	4.71
	3	14	40.10	35.13	47.50	4.16
Biparietal lenght (cm)	2	14	4.24	2.18	6.42	1.47
	3	14	15.00	10.16	22.14	3.30
Fetal weight (g)	2	14	300.35	80.00	835.00	260.39
	3	14	2241.42	1385.00	3400.00	541.32
Kidney weight (g)	2	14	1.56	0.51	3.77	1.22
	3	14	5.34	3.50	7.71	1.48
Kidney lenght (cm)	2	14	1.36	0.54	2.39	0.57
	3	14	3.13	2.47	3.63	0.30
Kidney width (cm)	2	14	0.88	0.00	1.41	0.35
	3	14	1.68	0.00	2.29	0.53
Cortex width (cm)	2	14	0.20	0.09	0.51	0.11
	3	14	0.32	0.20	0.62	0.12
Medulla width (cm)	2	14	0.45	0.13	1.17	0.27
	3	14	1.17	0.68	1.80	0.32
Renal pelvis lenght (cm)	2	14	0.46	0.21	0.86	0.21
	3	14	1.15	0.74	1.72	0.24

Table 2. Descriptive statistics and P values of 2nd trimester fetal kidney measurements.

	Gender	N	Mean	Min.	Max.	Std. Deviation	P
Crown-rump lenght (cm)	Female	7	14.30	9.97	21.38	4.09	0.29
	Male	7	17.07	11.56	24.26	5.19	
Biparietal lenght (cm)	Female	7	4.17	2.60	6.37	1.32	0.85
	Male	7	4.32	2.18	6.42	1.70	
Fetal weight (g)	Female	7	286.42	80.00	835.00	267.7	0.71
	Male	7	314.28	90.00	745.00	273.51	
Kidney weight (g)	Female	7	1.45	0.51	2.93	1.005	0.62
	Male	7	1.68	0.53	3.77	1.48	
Kidney lenght (cm)	Female	7	1.40	0.87	2.03	0.49	0.83
	Male	7	1.33	0.54	2.39	0.68	
Kidney widht (cm)	Female	7	0.75	0.00	1.16	0.37	0.38
	Male	7	1.01	0.72	1.41	0.31	
Cortex lenght (cm)	Female	7	0.29	0.18	0.51	0.10	0.004*
	Male	7	0.11	0.09	0.14	0.01	
Medulla lenght (cm)	Female	7	0.60	0.31	1.17	0.29	0.04*
	Male	7	0.31	0.13	0.53	0.16	
Renal pelvis lenght (cm)	Female	7	0.63	0.43	0.86	0.17	0.001*
	Male	7	0.29	0.21	0.43	0.07	

*:<0.05

Table 3. Descriptive statistics and P values of 3rd trimester fetal kidney measurements.

	Gender	N	Mean	Min.	Max.	Std. Deviation	P
Crown-rump lenght (cm)	Female	7	39.35	35.13	47.50	5.25	0.31
	Male	7	40.85	37.27	45.18	2.95	
Biparietal lenght (cm)	Female	7	15.48	10.79	22.14	3.64	0.60
	Male	7	14.52	10.16	18.67	3.14	
Fetal weight (g)	Female	7	2327.14	1785.00	3400.00	551.05	0.57
	Male	7	2155.71	1385.00	3050.00	560.44	
Kidney weight (g)	Female	7	5.25	3.50	7.21	1.60	0.82
	Male	7	5.43	3.85	7.71	1.47	
Kidney lenght (cm)	Female	7	3.10	2.47	3.63	0.39	0.73
	Male	7	3.16	2.95	3.47	0.19	
Kidney widht (cm)	Female	7	1.52	0.00	2.19	0.70	0.45
	Male	7	1.84	1.53	2.29	0.24	
Cortex lenght (cm)	Female	7	0.38	0.20	0.62	0.16	0.09
	Male	7	0.26	0.21	0.33	0.04	
Medulla lenght (cm)	Female	7	1.15	0.68	1.80	0.39	0.90
	Male	7	1.19	0.95	1.51	0.26	
Renal pelvis lenght (cm)	Female	7	1.05	0.79	1.24	0.14	0.13
	Male	7	1.25	0.74	1.72	0.29	

Microscopic examination showed that sheep fetuses in the second trimester had completed the maturation of the glomeruli and proximal and distal convoluted tubules in the renal parenchyma, the collecting tubules showed radial alignment to form the renal lobules, and the filtration space and collecting tubule lumens had largely completed their development and matured (Figure 2). In sheep kidneys in the 3rd trimester, it was determined that the kidney parenchyma, which developed in the second trimester, as well as the corticomedullary and the base sections of the collecting tubules in the medulla, were well developed (Figure 3).

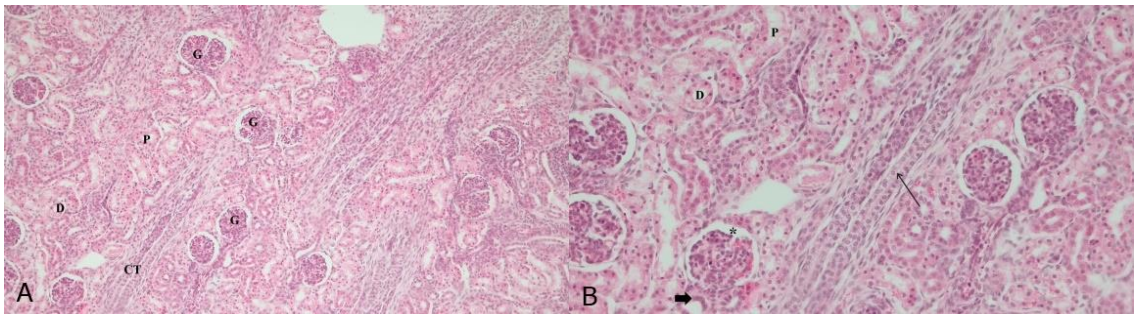


Figure 2. Transversal section of 2nd trimester kidney tissue (A: H&E X4; B: H&E X10). G: glomeruli, P: proximal tubules, D: distal tubules, CT: collecting tubules, *: filtration space, Arrows: collecting tubule lumens.

Bello et al. (2016) performed weight, width and volume measurements of the right and left kidneys in 17 fetuses (2nd and 3rd trimester). These measurements showed that in the 2nd trimester, kidney lengths were measured as 2.36 ± 0.11 cm for the right kidney and 2.48 ± 0.05 cm for the left kidney. In the 3rd trimester, kidney lengths for the right kidney were measured as 2.86 ± 0.04 cm and the left kidney was measured as 3.88 ± 0.30 cm. The average kidney widths were measured as 1.44 ± 0.10 cm in the right kidney and 1.48 ± 0.08 cm in the left kidney in the 2nd trimester. In the 3rd trimester, it was measured as 1.66 ± 0.08 cm in the right kidney and 1.68 ± 0.08 cm in the left kidney. In the study conducted with 40 Holstein fetuses, the average kidney length in the early period (65-90 days) was reported as 10.28 ± 5.56 cm in the right kidney and 9.78 ± 5.27 cm in the left kidney. In the middle period (98-168 days), kidney lengths were reported as 38.28 ± 12.56 cm in the right kidney and 34.23 ± 10.50 cm in the left kidney (Erdoğan & Kılınç, 2011). In our study, in the 2nd and 3rd trimesters, on average, kidney length and width values were determined as 1.36 and 0.88 cm in the 2nd trimester and 3.13 and 1.68 cm in the 3rd trimester, respectively.

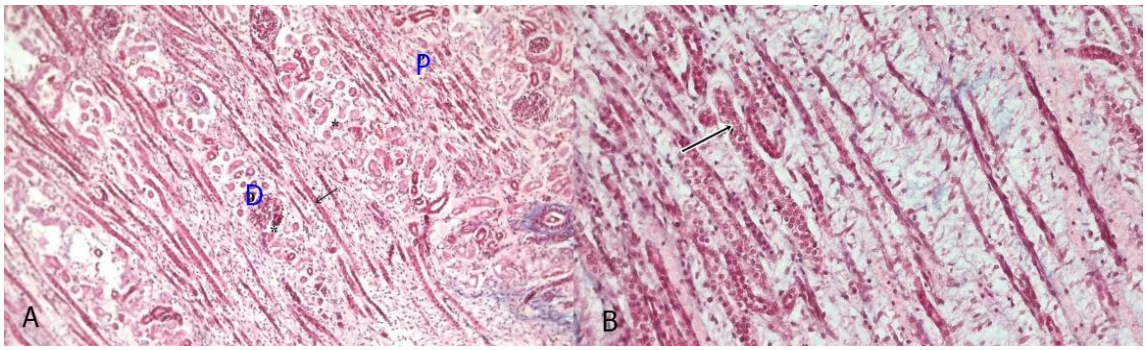


Figure 3. Transversal section of 3rd trimester kidney tissue (A:). Arrows: Base sections of collecting tubules, P: proximal tubules, D: distal tubules.

While in our study, kidney weights were measured as 1.56 g on average in the 2nd trimester and 5.34 g in the 3rd trimester, Goodarzi made morphometric measurements of the cortex, medulla and renal pelvis in 12 Angora goats in 2015 and found the average weight of. the kidneys to be 66 g for the right kidney. she reported 62 ± 0.2 g and 64.45 ± 0.12 g for the left kidney. The average volumes of the medulla, cortex and renal pelvis were measured as 64.67, 32.72, 2.61 mm3, respectively.

In our study, the average medulla and cortex width values in the 2nd and 3rd trimesters were determined as 0.45 and 0.20 cm, respectively, in the 2nd trimester and 1.17 and 0.32 cm in the 3rd trimester. Sadeghinezhad & Nyengaard, (2021) Sudan evaluated kidney morphometric parameters in Saanen goats in . The average length of the right kidney is 7.04±0.6 cm, width is 3.81±0.50 cm, cortex width is 1.05±0.3 cm and medulla width is 1.74±0.3, while the left kidney is 6.91±0.6 cm determined it as. (Abdelghafar & Almubarak, 2020) determined these values as 3.81 ± 0.5, 1.01 ± 0.2 and 1.79 ± 0.4 cm, respectively. In the same study, using the left kidneys, 9-11, 12-14, 15-17, 18-20. provided information about the kidney volumes of 16 sheep fetuses at gestational weeks. It was reported that the kidney volume increased from 0.94±0.22 cm3 to 8.6±0.88 cm3 and the cortex volume increased from 406±85 mm3 to 5151±309 mm3 during development. Statistically significant differences were determined.

In our study, statistical differences were determined between female and male fetuses in terms of medulla, cortex width and renal pelvis length values in the 2nd trimester, while no differences were determined in the 3rd trimester. It is thought that this difference observed between male and female fetuses is individual.

In the study conducted on Yankasa sheep (Bello et al., 2016), microscopic examination showed that the glomerulus matured in the 2nd trimester, blood vessels became evident and the connective tissue differentiated. It has been reported that in the 3rd trimester, connective tissues are well developed and blood vessels are clearly observed. In the study conducted on rat fetuses, it was reported that a developed glomerular structure was not observed in the kidneys, which contain dense mesenchymal tissue and tubules in the early period of development. It was stated that during this period, the tubules, whose lumens are closed and covered with multilayered epithelium, turn into a structure similar to the tubules seen in adults, starting from the 18th day. Also prenatal 16-19 It has been reported that immature glomeruli develop in the following days (Onarlıoğlu et al. 1997). In their study, Sadeghinezhad & Nyengaard (2021) stated that glomeruli do not mature microscopically between the 9th and 17th weeks of pregnancy, and that the glomeruli mature between the 18th and 20th weeks of pregnancy. It was determined that only mature glomeruli were recorded in the cortex during the gestational weeks. In our study, it is observed that glomeruli, proximal and distal tubules mature in the 2nd trimester. It is

information consistent with the literature that collecting tubules mature well in the 3rd trimester.

Conclusion and Recommendations

As a result, it was determined that the kidneys of Hamdani crossbred sheep fetuses grew macroscopically in the 2nd and 3rd trimesters, and their biometric properties continued to increase along with morphometric fetal growth. In addition, microscopic examination revealed that the tubule structures, which continued to develop in the 2nd trimester, matured in the 3rd trimester. It is thought that the results of the study will contribute to studies on organ development in the fetal period.

References

Abdelghafar, R. M., & Almubarak, A. M. (2016). Sonographic morphometry of the kidneys in healthy female Saanen goats. *Ruminant Science*, *5*(1), 103-106

Al-Doori, Z. T. O. A. (2006). *Effect of fattening system in growth features and carcass for Awassi lamb* (Doctoral dissertation, Ph. D. Thesis, College of Agriculture, University of Baghdad).

Bahadır, A., & Yıldız, H. (2010). Veteriner Anatomi. *Hareket Sistemi ve İç Organlar, Ezgi Kitabevi, Bursa*.

Bello, A., Dabai, D. I., Umaru, M. A., Shehu, S. A., & Jimoh, M. I. (2016). Prenatal development of Yankasa sheep (Ovis aries) kidney: a histomorphometric study. *J Kidney*, *2*(126), 2472-1220. http://dx.doi.org/10.4172/2472-1220.1000126

Dayan, M. O., Demircioğlu, İ., Koçyiğit, A., Güzel, B. C., & Karaavci, F. A. (2023). Morphometric analysis of the skull of Hamdani sheep via Three-Dimensional modelling. *Anatomia, Histologia, Embryologia*, *52*(2), 215-222. https://doi.org/10.1111/ahe.12873

Erdogan, S., & Kilinc, M. (2011). The morphometric development and arterial vascularization of bovine fetal kidneys in the prenatal period. *Annals of anatomy-anatomischer Anzeiger*, *193*(6), 530-538. https://doi.org/10.1016/j.aanat.2011.08.007

Finco, D. R. (1997). Kidney function. In *Clinical biochemistry of domestic animals* (pp. 441-484). Academic Press. https://doi.org/10.1016/B978-012396305-5/50018-X

Güzel, B. C., & Işbilir, F. (2023). Radiological examination of the skull of Siirt-coloured mohair goat, Romanov and Hamdani sheep. *Anatomia, histologia, embryologia*, *52*(6), 967-974. https://doi.org/10.1111/ahe.12956

Kaymakçı, M. (2010). İleri Koyun Yetiştiriciliği Kitabı. Genişletilmiş 3. *Baskı. İzmir*, *359*.

Liebich, H. G., Sotonyi, P., & König, H. E., (2022). *Evcil hayvanlar veteriner anatomi konu anlatım ve renkli atlas. (İ. Türkmenoğlu, Çeviri). Malatya: Medipres Matbaacılık.* p.419-425

Magid, S. A., Al-Murrani, W. K., & Alkas, J. I. (2003). Iraq country report animal genetic resources. *Ministry Agric*, 18-21.

Noakes, D.E., Parkinson, T.J., England, G.C.W., 2009. Arthuts' Veterinary reproduction and obstetrics, 9th edition, DE Noakes, TJ Parkinson, GCW England (eds), Saunders, Edinburg, London

O Aziz, K. (2005). A study on fleece characterization of Hamadani sheep in Erbil plain. *Mesopotamia Journal of Agriculture*, *33*(1), 3-12.

Onarlıoğlu, B., Gürsoy, E., & Kaloğlu, C. (1997). Renal Morphogenesis of rat fetus. *Turkish Journal of Veterinary & Animal Sciences*, *21*(6), 493-496.

Sadeghinezhad, J., & Nyengaard, J. R. (2021). Stereological study of the kidney during prenatal development in sheep. *Microscopy Research and Technique*, *84*(12), 2915-2921. https://doi.org/10.1002/jemt.23849

Wallace, M. A. (1998). Anatomy and physiology of the kidney. *AORN journal*, *68*(5), 799-820. https://doi.org/10.1016/S0001-2092(06)62377-6

MOLECULAR CHARACTERIZATION OF POTATO CYST NEMATODES FROM THE PROVINCE OF BÉCHAR, SOUTH-WESTERN ALGERIA

Mezerket AMINA
LESN, Ecole Normale Supérieure (ENS) Kouba, Algiers, Algeria.
Email: amina.mezerket@g.ens-kouba.dz

Hammache MILOUD
National High School of Agronomy (ENSA), El Harrach, Algiers, Algeria.
Email: m.hammache@ensa.dz

Cantalapiedra-Navarrete CAROLINA
Instituto de Agricultura Sostenible (IAS), Consejo Superior de Investigaciones Científicas (CSIC), Menéndez Pidal s/n, 14004 Córdoba, Spain.
Email: carocantalapiedra@hotmail.com

Castillo PABLO
Instituto de Agricultura Sostenible (IAS), Consejo Superior de Investigaciones Científicas (CSIC), Menéndez Pidal s/n, 14004 Córdoba, Spain.
Email: p.castillo@csic.es

Palomares-Rius JUAN EMILIO
Instituto de Agricultura Sostenible (IAS), Consejo Superior de Investigaciones Científicas (CSIC), Menéndez Pidal s/n, 14004 Córdoba, Spain.
Email: palomaresje@ias.csic.es

ABSTRACT

Potato cyst nematodes (PCNs) *Globodera pallida* and *G. rostochiensis* have spread quickly to become a major limiting factor in several important potato production localities in Algeria. Production of potatoes (*Solanum tuberosum* L.) occupies an important place in the economy of Algeria. It is cultivated on about 149,463 ha, with a production of 4,659,482 tons, and a yearly yield of 31,170 kg ha-1 on average. In Algeria, nematode management is usually based on chemical control that threats the human health, and the environment. In addition, they are not economically justified in some cases. Molecular identification plays a crucial role in nematology; it prevents damage to potato crops that could be caused by these nematodes. The objective of this research was to determine the infestation degree, the density of cysts, and the molecular identification of PCNs from the locality of Béchar "El Abadella" region in south west of Algeria. Soil samples were collected from different potato production areas in this location using a zig zag pattern. The collected samples were placed in a plastic bag, mixed, and dried. They were divided into 12 subsamples of 500 g, and kept in a refrigerator at 4°C until nematode extraction. Cysts filled with eggs, and Juveniles were extracted by using the Fenwick method, and separated from soil debris and other organic materials. They were counted and stored dry in tubes at 4°C for molecular identification (Specific PCR., ITS-rDNA, *cytb* gene mtDNA and sequencing). A significant average density of cysts was detected in El Abadella region with 6.4 cysts/100 cm^3 of soil and with an important infestation degree of PCNs 72.83 juveniles and eggs/g of soil. Molecular identification revealed that *G. rostochiensis*

occurred mainly in the surveyed area. The Algerian populations of PCN were probably introduced from Europe by infested seed-potato because of the phylogenetic association with the European populations.

Keywords: *Globodera rostochiensis*, specific PCR, ITS rDNA, *cytb* gene mtDNA, sequencing.

INTRODUCTION

First introduced to Algeria by the Andalusian Moors in the 16th century, potatoes (*Solanum tuberosum* L.) play an important role in the country's economy (Meziane, 1991; Ministry of Agriculture and Rural Development, 2022). From 1970 to 2009, Algerian potato consumption increased substantially from 20 to 75 kg per capita per year (Chehat, 2008). In Algeria, There are 3 main potato-producing areas: the coastal region, the Tellian Atlas and the High Plains, and the Southern region. These regions produce about 61%, 17% and 8.2% of national potato production respectively (Institut Technique des Cultures Maraichères et Industrielles, 2010 and 2013).

However, this crop is exposed to many diseases: fungal among them downy mildew (*Phytophthora infestans*) and alternaria (*Altenaria solani*), viral (potato leafroll virus PLRV and potato yellow mosaic virus PYMV), and bacterial (potato brown rot caused by *Ralstonia solanacearum* and blackleg caused by *Erwinia carotovora*) (Swiezynski, 1994; Umaerus and Umaerus, 1994; Valkonen, 2007; Van der Wolf and De Boer, 2007; Olanya et al. , 2012; Valkonen et al., 2015). Added to these diseases caused by pests. These include the potato moth (*Phthorimaea operculella*), wireworms of the genus Agriotes, white grubs (*Rhizotrogus* spp.) and nematodes, in particular the cyst nematodes known as potato cyst nematodes (PCNs) *Globodera pallida* (Stone, 1973) Behrens, 1975 and *G. rostochiensis* (Wollenweber, 1923) Behrens, 1975 (Raman et al, 1994; Holliday, 1998; Weber, 2013). The latters are defined as quarantine pests because of the extent of the damage caused to potato crops, mainly in temperate zones (Winslow and Willis, 1972; Mugnièry, 1984). It is difficult to put a figure on the damage caused by this pest, particularly as it frequently interacts with other pathogens (Philips, 1994). Worldwide, they are responsible for more than 12% of agricultural losses (Bates et al., 2002).

Potato cyst nematodes (PCN) were first introduced into Algeria with infested British potato tubers around 1953. They were reported in many regions of Algeria (Frezal, 1954, Scotto La Massesse, 1961). Since that time, these nematodes have spread rapidly to become a major limiting factor in several important potato-producing areas (Institut National de Protection des Végétaux, 2009). It is very difficult to control these pests, given their extreme resistance to adverse climatic conditions (cold and drought), their great physiological variability and the fact that they are telluric. Several molecular techniques have been developed for the rapid and accurate identification of potato golden

nematodes. These include polymerase chain reaction (PCR), the ITS region and mitochondrial DNA (Vrain et al., 1992; Wendt et al., 1993; Zijlstra et al., 1995; Subbotin et al., 2001). In this study, we have chosen to carry out a survey of *Globodera* in potato-growing region 'Al Abadella' in Béchar province situated in south west of Algeria, and to define the prevalence, the density of cysts, and the degree of infestation of PCNs. Finally, we evaluated the molecular identification among the populations of potato cyst nematode introduced into Béchar province using ITS, cytb and sequencing for geographical associations.

MATERIALS AND METHODS

Nematode extraction

The collected soil samples were divided in 12 subsamples of 500 g. They were placed in a plastic bag, mixed, dried in laboratory, and kept in a refrigerator at 4°C. Cysts were extracted by using the Fenwick method. They were counted and stored dry in tubes at 4°C for molecular identification (Specific PCR., ITS-rDNA, *cytb* gene mtDNA and sequencing).

DNA extraction

DNA was extracted from individual cysts. At least 5 cysts per sampling were molecularly identified. Each cyst was crushed and juveniles were cut with scalpel blade under the stereomicroscope.

RESULTS AND DISCUSSION

Frequency of infestation by *Globodera* spp.

All the sub-samples (12 sub-samples) analysed in Al Abadella region showed a percentage infestation of 100%.

Count and percentage of full and empty cysts of *Globodera* spp.

Results showed that they were 53.34% empty cysts and 46.66% full cysts in Al Abadella region.

The density of full *Globodera* spp. cysts in infested areas.

A significant average density of cysts was detected in El Abadella region with 6.4 cysts/100 cm^3 of soil (Table 1).

Degree of infestation by *Globodera* spp.

The results indicated an important infestation degree of PCNs in Al Abadella region with 72.83 juveniles and eggs/g of soil (Table 1).

Nematode Molecular Identification and Phylogenetic Analysis

Molecular identification revealed that *G. rostochiensis* occurred mainly in the surveyed area (Table 1), and the Algerian populations of PCN were probably introduced from Europe by infested seed-potato because of the phylogenetic association with the European populations.

Table 1. Results of potato cyst nematode study

Simpling province	Locality	Attitude (m)	Cultivar	Infestation degree (juveniles/g of soil)	Full cysts per 100 cm^3 of soil	Nematode species
Béchar	Al Abadella	780	désirée	72.83	6.4	*G.rostochiensis*

DISCUSSION

This research showed a clear geographical distribution of *G. rostochiensis*, which is more prevalent in the southern part of the country, in particular Al Abadella region in Béchar province. This distribution could be explain by the major tolerance of *G. rostochiensis* to higher temperatures (Kaczmarek et *al.*, 2014). Also, the use of cultivar sensitive to *G. rostochiensis* (Desirée) in this southern region. This locality have shown a significant level of infestation, which could be the result of the monoculture of potato in the south. Finally, the low molecular diversity and their association with the European populations of PCNs suggest the close relationship with those populations, probably by infested-seed potato.

CONCLUSION

In Algeria, the absence of a complete map of nematode distribution throughout the country, and the lack of molecular research into the various existing species make this parasite an essential constraint for farmers. Future management of golden potato nematodes will therefore involve rigorous regulatory programmes and ongoing surveys to identify the various sources of infestation. The areas detected need to be quarantined for effective control. Finally, the future studies should be accompanied by improvements in molecular techniques (molecular markers) to identify these species more quickly, correctly and easily. They can also be used to highlight their phylogenetic relationships with other *Globodera* species.

BIBLIOGRAPHY

Bates, J.A., Taylor E.J., Gans P.T., Thomas J.E. 2002. Determination of Relative Proportions of *Globodera* Species in mixed Populations of Potato Cyst Nematode Using PCR Product Melting peak Analysis. *Mol. Plant Pathol.* Vol.3, pp.153-161.

Chehat, F. 2008. *La Filière Pomme de terre Algérienne : Une Situation Précaire*. Journée d'étude sur la filière pomme de terre : Situation Actuelle et perspective. El Harrach. Algérie. pp. 1-13.

Frezal, P. 1954. Importance et Répercussions de la Contamination de l'Algérie par le nématode Doré *Heterodera rostochiensis* Wooll. [Woll.]. *Comptes Rendus des Séances de l'Académie d'Agriculture,* France. Vol. 40, pp. 71-74.

Holliday, P.1998. *A Dictionary of Plant Pathology.* Cambridge University Press. U.K. 536 p.

Institut National de Protection des végétaux (INPV), 2009. *Nématode à kystes de la Pomme de Terre Globodera rostochiensis et G. pallida*, Algérie, 4p.

Institut Technique des Cultures Maraichères et Industrielles (ITCMI), 2010. Fiche techniques valorisée des cultures maraîchères et Industrielles. *La culture de la pomme de terre.* Ed. ITCMI. Algérie, 10 p.

Institut Technique des Cultures Maraichères et Industrielles (ITCMI), 2013. *La Culture de la Pomme de Terre: Production et Possibilités de Transformation.* Journée de la pomme de terre C. C. I. Dahra, Mostaganem, Algérie. 04 Décembre 2013, 10 p.

Kaczmarek ,A., MacKenzie K., Kettle, H., Blok, V.C. 2014. Influence of soil temperature on *Globodera rostochiensis* and *Globodera pallida*. Phytopathol. Mediterr. Vol. 53, pp.396-405.

Meziane, D.1991. *Histoire de la pomme de terre.* Detitique, n. 25, 29 p.

Ministry of Agriculture and Rural Development, 2022

Mugnièry, D. 1984. Les Nématodes de la Pomme de Terre. *J.Agronomy*. Vol. 3, pp. 45 –50.

Olanya, M., Nyankanga, R., Ojiambo, P., Lemaga, B., Kakuhenzire, R., Fontem, D.,2012. *Optimization of late Blight and Bacterial Wilt Management in Potato Production Systems in the Highland Tropics of Africa in Sustainable potato production: global case studies.* Ed. Springer .USA. Pp. 509-531.

Philips, M.S. 1994. Inheritance of Resistance to Nematodes in *Potato Genetics* Ed. J.E. Bradshaw and G.R.Mackay. CAB International .UK. pp. 319-337.

Raman, K.V., Golmirzaie, A. M, Palacios, M., Tenorio J. 1994. Inhiritance of resistance to insects and mites in *Potato Genetics.* Ed. J.E. Bradshaw and G.R.Mackay. CAB. International.UK. Pp. 447-463.

Scotto, La Massesse 1961. *Aperçu sur les Problèmes Posés par les Nématodes Phytoparasites en Algérie.* Journée d'Étude et d'Information. Association de Coordination Technique Agricole, F. N. G. P. C., Paris, pp. 1-27.

Stone, A.R. 1973. *CIH Descriptions of Plant-Parasitic Nematodes No 15 and 16 Globodera pallida and Globodera rostochiensis.* CAB International, Wallingford (GB).

Subbotin, S.A, Vierstraete, A., De Ley, P., Rowe, J., Waeyenberge, L., Moens, M., Vanfleteren, J. R. 2001. Phylogenetic Relationships within the Cyst Forming Nematodes (Nematoda, *Heteroderidae*) based on analysis of sequences from the ITS region of ribosomal DNA. *Mol. Phylogenet. Evol.* Vol. 21, pp. 1-16.

Swiezynski, K.M. 1994. *Inheritance of Resistance to Viruses in Potato Genetics,Ed. J.E. Bradshaw and G.R.Mackay.* CAB International.UK. Pp: 339-363.

Umaerus, V., Umaerus, M. 1994. *Inheritance of Resistance to Late Blight in Potato Genetics Ed . J.E. Bradshaw and G.R.Mackay.* CAB International .UK. Pp. 365-401.

Valkonen, JP.T. 2007. Viruses: Economical Losses and Biotechnological Potentiel In *Potato Biology and Biotechnology: Advances and perspectives*. Ed. Elsevier. Italy,pp. 619- 641.

Valkonen, JP.T, Kreuze, J.F., Ndunguru J. 2015. Disease Management, Especially Viruses In *Potato and Sweet Potato in Africa « Transforming the Value Chaine for Food and Nutrition Security ».* Ed .CAB International .UK. Pp. 339-349.

Van der Wolf, JM., De Boer SH. 2007. *Bacterial Pathogens of Potato in Potato Biology and Biotechnology: Advances and perspectives.* Ed. Elsevier. Italy, pp. 595-600.

Vrain, T.C., Wakarchuk, D.A., Levesque, A.C., Hamilton, R.I. 1992. Intraspecific rDNA Restriction Fragment Length Polymorphisms in the *Xiphinema americanum* group. *Fund. Appl. Nematol.* Vol. 15, pp.563-573.

Weber, D.C. 2013. *Biological control of Potato insect pests in Insect Pests of Potato: Global Perspectives on Biology and Management.* Elsevier, USA, pp. 399-437.

Wendt, K.R., Vrain, T.C., Webster, J. M. 1993. Separation of Three Species of *Ditylenchus* and Some Host Races of *D. dipsaci* by Restriction Fragment Length Polymorphism. *J. Nematol.* Vol. 25, pp. 555-563.

Winslow, R.D., Willis, R.J. 1972. *Nematode Diseases of Potato in Economic Nematology*. Edited by John M. Webster. Academic press I. N. C., London, pp. 17-48.

Wollenweber, H.W. 1923. Krankheiten und Beschädigungen der Kartoffel. Arb. Forschungsinst. *Kartoffelbau*. Vol. 7, pp.1-56.

Zijlstra, C., Lever, A.E.M., Uenk, B.J., Van Silfhout , C.H. 1995. Differences between ITS regions of isolates of root-knot nematodes *Meloidogyne chitwoodi* and *M.hapla*. *Phytopathology*, vol. 85, pp.1231-1237.

ALFA AMİNİTİNİN AKCİĞER KANSER HÜCRE HATTINDA SİTOTOKSİK DÜZEYİNİN BELİRLENMESİ

Dr. Öğr. Gör. İlhan SABANCILAR (ORCID: 0000-0002-0773-2752)
Bitlis Eren University, School of Health Services Vocational College, Department of Medical Services and Techniques, Bitlis-Türkiye
Email: isabancilar@beu.edu.tr

Dr. Öğr. Üyesi Murat YOLCU (ORCID: 0000-0003-3067-8755)
Dicle University, Faculty of Pharmacy, Department of Pharmacy Basic Sciences, Diyarbakır-Türkiye
Email: muratyolcu21@gmail.com

ÖZET

Amanita phalloides mantarındaki alfa amanitin ekstraksiyon yapılarak elde edildikten sonra Sitotoksik yöntemlerden olan; sulforhodamin B (SRB) ve 3-[4,5-dimetiltiyazol-2-il]-2,5-difenil-tetrazolyum bromür (MTT) testi ile Akciğer kanser hücresinde (A549) sitotoksik düzeyinin belirlenmesi amaçlandı. Mantarlar oda sıcaklığında kurutuldu, öğütülerek toz haline getirildi. 20 gramlık 6 ayrı sokslet filtresi içine alındı, 6 farklı kanalda 150 mL %50 metanolde 3 saat sokslet aparatında ekstraksiyonu yapıldı. Elde edilen eksraktlar vakum evaporatörde tam kuru oluşuna kadar 50ºC'de buharlaştırıldı. Kalan materyal üzerine metanolden 10 mL eklenerek iyice çözüldü, 10 dakika 5000 rpm'de santrifüj edildi, üstteki süpernatant alındı. Elde edilen süpernatanlara 50 ug/ml, 25 ug/ml, 12.5 ug/ml, 6.25 ug/ml ve 3.125 ug/ml farklı konsantrasyonlarda SRB ve MTT yöntemleriyle invitro ortamda sitotoksisite çalışıldı. Pozitif kontrol grubu olarak Dimetil sülfoksit (DMSO) çalışıldı. Çalışma sonrası elde edilen veriler Graphpad prism 8 programıyla istatistik olarak analiz edilerek kanser hücrelerin canlılık oranları analiz edildi. Alfa Aminitin ekstraktı farklı konsantrasyonlarda hazırlanarak A549 Akciğer kanser hücresine (her bir kuyucuğa 10.000 tümörlü hücre) SRB ve MTT yöntemleri ile uygulandı. MTT yönteminde; 25 ug/ml konsantrasyonda tümörlü hücrelerin %62.11, en yüksek konsantrasyonumuz olan 50 ug/ml'de tümörlü hücrelerin %83.39 oranında öldürmüştü. SRB yönteminde ise; 25 ug/ml konsantrasyonda tümörlü hücrelerin %56.46, en yüksek konsantrasyonumuz olan 50 ug/ml'de tümörlü hücrelerin %87.28 oranında öldürmüştü. Sitotoksik maddeler, hücreye toksik şekilde etki edip hücreyi öldüren ya da fonksiyonunu durduran maddelerdir. Sonuç olarak; Sitotoksik hücre kültürü kolorimetrik yöntemlerden olan SRB ve MTT kullanılarak, Alfa Aminitin ekstraktının A549 kanser hücresine yüksek dozlarda etki ettiği gözlemlendi. Ayrıca kullanılan SRB ve MTT yöntemlerinde hücre canlılık oranlarının yakın olması dolayısıyla SRB ve MTT'nin kolorimetrik yöntem olarak tercih edilebileceği düşünülmektedir.

Anahtar Kelimeler: Alfa Aminitin, SRB, MTT, A549 ve Sitotoksisite

DETERMINATION OF CYTOTOXIC LEVEL OF ALPHA AMANITIN IN LUNG CANCER CELL LINE

ABSTRACT

After extraction of alpha amanitin from Amanita phalloides mushroom, the aim was to determine the cytotoxic level in Lung cancer cells (A549) using cytotoxic methods; sulforhodamine B (SRB) and 3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyltetrazolium bromide (MTT) test. The mushrooms were dried at room temperature and ground into powder. 20 grams were taken into 6 separate Soxhlet filters, and extraction was performed in a Soxhlet apparatus for 3 hours with 150 mL of 50% methanol in 6 different channels. The obtained extracts were evaporated at 50°C until completely dry using a vacuum evaporator. To the remaining material, 10 mL of methanol was added and dissolved thoroughly, then centrifuged at 5000 rpm for 10 minutes, and the supernatant was collected. The obtained supernatants were tested for cytotoxicity in vitro with different concentrations of 50 ug/ml, 25 ug/ml, 12.5 ug/ml, 6.25 ug/ml, and 3.125 ug/ml using SRB and MTT methods. Dimethyl sulfoxide (DMSO) was used as the positive control group. The data obtained after the study were statistically analyzed using GraphPad Prism 8 program to analyze the viability rates of cancer cells. Alpha Amanitin extract was prepared at different concentrations and applied to A549 Lung cancer cells (10,000 tumor cells per well) using SRB and MTT methods. In the MTT method; at a concentration of 25 ug/ml, tumor cells killed 62.11%, and at the highest concentration of 50 ug/ml, tumor cells were killed by 83.39%. In the SRB method; at a concentration of 25 ug/ml, tumor cells killed 56.46%, and at the highest concentration of 50 ug/ml, tumor cells were killed by 87.28%. Cytotoxic substances are those that act toxic to the cell, killing or stopping its function. In conclusion; using cytotoxic cell culture with colorimetric methods such as SRB and MTT, it was observed that Alpha Amanitin extract had a high impact on A549 cancer cells at high doses. Additionally, due to the close cell viability rates in the SRB and MTT methods, it is considered that they can be preferred as colorimetric methods..

Keywords: Alpha Amanitin, SRB, MTT, A549, and Cytotoxicity

Introduction

Amanita mushrooms are a genus of mushrooms commonly found growing in many regions of our country. Among these mushrooms, there are some very delicious varieties that can be consumed on a daily basis. However, there are also some species that can cause serious poisoning if not handled carefully. Among the poisonous species are Amanita verna, Amanita virosa, and Amanita muscaria, which are among the deadly mushroom species. (Mat, 2020). One of the species that causes deadly poisoning is Amanita phalloides. (French et al., 2011).

Figure 1. Amanita phalloides mushrooms analyzed in the study.

The toxins responsible for death are amatoxins, also known as amanitins. These toxins include alpha, beta, gamma, and epsilon amanitins as groups causing death. Due to its high absorption rate compared to other toxins, the alpha amanitin is the primary toxin responsible for toxicity. (Letschert et al., 2006). After being absorbed in the liver, alpha amanitin enters hepatocytes and specifically binds to RNA Polymerase II enzyme in the cell nucleus, inhibiting this enzyme (Gong et al., 2004). When poisoning occurs in the body, protein synthesis stops. Previously synthesized proteins enable cells to remain alive for a while longer. As a result, deaths due to liver failure can occur within a week (Buku et al., 1971). If the toxin has been ingested at low levels, the liver can regenerate itself and recover.

There is no known specific inhibitor of alpha-amanitin, but in treatment, certain agents such as penicillin and thioctic acid (silibinin) can be used (Tong Mcknight). Literature studies have revealed that the levels of alpha-amanitin in Amanita phalloides mushrooms grown in different regions of our country vary. It is known that toxin levels differ in different parts of the same mushroom. The highest toxin levels have been measured in the cap and gill sections (Mcknight et al., 2010).

Figure 2. Amanita phalloides (Death Cap) mushroom.

Materials and Methods

Three specimens of Amanita phalloides mushrooms were collected from the forested area in the Muradiye district of Van (Figure 2). Their taxonomic classification was done based on microscopic and macroscopic characteristics (Bresinsky et al., 1990). The mushrooms were dried under a continuous airflow at 50°C until they reached a constant weight, then ground into powder. The extraction process was carried out by boiling the whole mushrooms in 50% methanol for 30 minutes After centrifugation at 5000 rpm for 5 minutes, the supernatant was passed through a 0.22 µm (Millipore) filter. The concentrated supernatant was added to sterile Falcon tubes in 20 ml aliquots, with each tube containing 50 cc. The tops of the Falcon tubes were covered with filter paper and left overnight at -80°C.

The frozen samples brought to the Analytical Chemistry Laboratory of Dicle University Faculty of Pharmacy were dried using a lyophilizer device branded as Christ Freezone. After the 96-hour lyophilization process, the completely powdered extraction was stored at -80ºC until the time of analysis. The obtained supernatants were subjected to cytotoxicity studies in vitro using the SRB (Sulforhodamine B) and MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) methods at different concentrations: 50 ug/ml, 25 ug/ml, 12.5 ug/ml, 6.25 ug/ml, and 3.125 ug/ml. Dimethyl sulfoxide (DMSO) was used as the positive control group. Following the study, the obtained data were statistically analyzed using GraphPad Prism 8 software to analyze the viability rates of cancer cells. Alpha-amanitin extract was prepared at different

concentrations and applied to A549 lung cancer cells (10,000 tumor cells per well) using the SRB and MTT methods.

Statistical Analysis

The groups involved in this study were conducted in three repetitions, and the averages of the data after the study were shown in graphs and displayed together with standard deviations. The quantitative data obtained in the study were expressed as mean ± standard deviation through post-hoc analysis. The results of the graphs related to the study were obtained using GraphPad Prism 8 software (GraphPad Software, http://www.graphpad.com). Statistical analysis of the MTT assay was performed on the computer using SPSS 22 software. Twoway ANOVA test was conducted to determine the differences between the groups studied in the MTT method. The level of significance in different groups was determined according to $p < 0.05$.

Findings and Discussion

The most important toxicological studies have been conducted with α- and β-amanitin. The bicyclic structure of the compound (Figure 3) indicates the formation of an outer and an inner ring in the structure, consisting of eight amino acids. The outer ring of this structure is formed by peptide bonds between the C and N termini of the amino acids (*Yao* et al., 2022).

Analysis of materials containing Amanita phalloides spores has documented high similarity to lipid droplets and/or other cellular structures found in biological samples. According to opinions s the absence of death cap spores in the tested samples does not rule out the possibility of poisoning, and a type of instrumental analysis is recommended. In the MTT method, tumor cells were killed by 62.11% at a concentration of 25 ug/ml and by 83.39% at the highest concentration, which was 50 ug/ml. In the SRB method, tumor cells were killed by 56.46% at a concentration of 25 ug/ml and by 87.28% at the highest concentration, which was also 50 ug/ml. Cytotoxic substances are those that act toxic to the cell, killing or stopping its function.

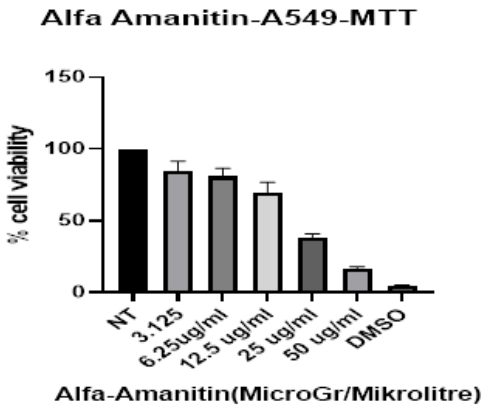


Figure 3. Cell viability rates of Alpha Amanitin determined by MTT in A549 cells.

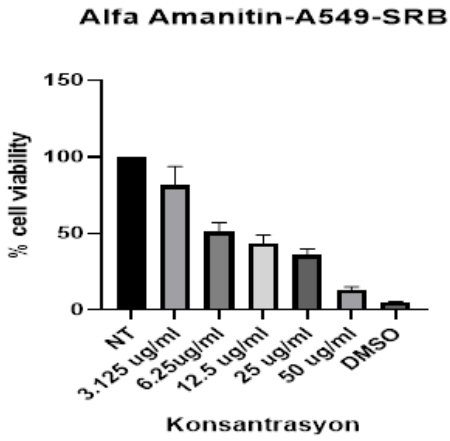


Figure 4. Cell viability rates of Alpha Amanitin determined by MTT in A549 cells.

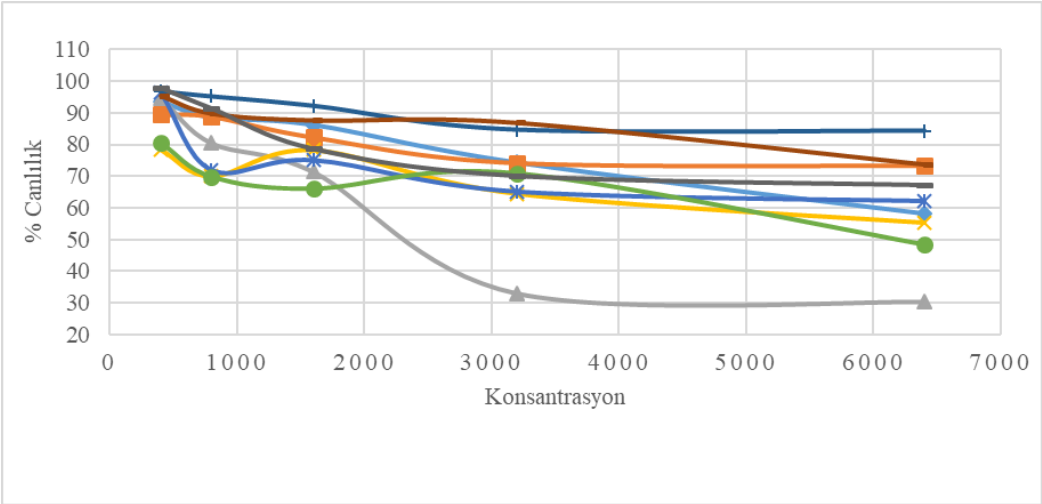


Figure 5. MTT results of Alpha Amanitin in A549 cells on different days.

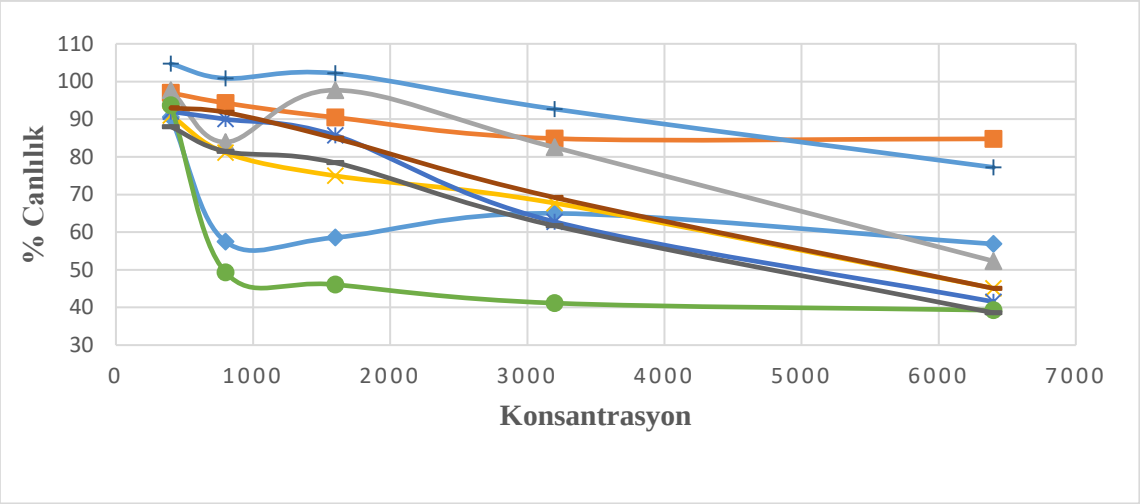


Figure 6. SRB results of Alpha Amanitin in A549 cells on different days.

Conclusion and Recommendations

As a result; Amatoxins are thermostable octapeptides. They inhibit RNA Polymerase II enzyme, thereby halting protein synthesis. Among oral poisonings, alpha-amanitin is the most toxic species.

Cytotoxic cell culture using colorimetric methods SRB and MTT revealed that Alpha Amanitin extract had a high impact on A549 cancer cells at high doses. Additionally, due to the close cell viability rates observed with the SRB and MTT methods, it is considered that SRB and MTT could be preferred as colorimetric methods.

The in vitro study we conducted is planned to be further extended to in vivo experiments with the necessary ethical approval obtained from the animal ethics committee. This extension to in vivo experiments is expected to enhance the quality of our study and provide insights for future research endeavors.

Thanks and Information Note

This study was supported by Dicle University Scientific Research Project Coordinator, ECZACILIK 23.004.

References

Mat, A. (2000). Mushroom Poisoning and Poisonous Mushrooms in Turkey. Istanbul: Nobel Publications,14(2), p.12-22.

French, L.K., Hendrickson, R.G. (2011). Horowitz, B.Z. Amanita phalloides poisoning. Clin Toxicol (Phila), 49(2):128-9.

Letschert, K., Faulstich, H., Keller, D., Keppler, D. (2006). Molecular characterization and inhibition of amanitin uptake into human hepatocytes, Toxicol Sci. 91(1);140-9.

Gong, X.Q., Nedialkov, Y.A., Burton, Z.F. (2004). Alpha-amanitin blocks translocation by human RNA polymerase, II. J Biol Chem. 25;279(26);27422-7.

Buku, A., Campadelli-Fiume, G., Fiume, L., Wieland, T. (1971). Inhibitory effect of naturally occurring and chemically modified amatoxins on RNA polymerase of rat liver nuclei, FEBS Lett.14(1);42-4.

Tong, T.C., Hernandez, M., Richardson, W.H, et al. (2007). Comparative treatment of alpha-amanitin poisoning with N-acetylcysteine, benzylpenicillin, cimetidine, thioctic acid, and silybin in a murine model, Ann Emerg Med. 50(3);282-8.

Mcknight, T.A., Mcknight, K.B., Skeels, M.C. (2010). Amatoxin and phallotoxin concentration in amanita bisporigera spores, Mycologia, 102(4):763-5.

Bresinsky, A., Besl, H., A Colour. (1990). Atlas of Poisonous Fungi. London: Wolf Publishing, 142: 2166–2174.

*Yao, G., Kosol, S., Wenz, H.T., Irran, E., Keller, B.G., Trapp, O., Süssmuth, R.D. (*2022*). The occurrence of ansamers in the synthesis of cyclic peptide. Nat. Commun. 13, 6488.*

Wierzycki, S., Skowron, M., Ucinski, J., Sacharczuk, K., Wojciechowska, A., Potocka-Banas, B. (2022). Microscopic diagnostic difficulties, and the role of amanitin determination caused by Amanita phalloides. Pomeranian Life Sci. 68, 20–24.

ROLE OF KEAP1/Nrf2/HO-1 PATHWAY IN LIPOPOLYSACCHARIDE-INDUCED SEPTIC LUNG INJURYIN RATS

Burak Batuhan LAÇİN* (ORCID 0000-0002-5701-3684)
Department of Veterinary Physiology, Atatürk University, Faculty of Veterinary Medicine, Erzurum, Turkey.
Email: bblacin@hotmail.com

Prof. Dr. Ali ÇINAR (ORCID 0000-0002-3928-320X)
Department of Veterinary Physiology, Atatürk University, Faculty of Veterinary Medicine,Erzurum, Turkey.
Email: d.cinar@atauni.edu.tr,

ABSTRACT
Sepsis is a systemic inflammatory syndrome caused by infection that usually causes damage to more than one organ and system. The lungs are one of the organs affected by this damage. Acute inflammatory diseases such as acute lung injury (ALI) and sepsis resulting from local or systemic inflammation continue to be the most common cause of death in intensive care units worldwide. The aim of this study was to discuss the role of Keap1/Nrf2/HO-1 pathway in oxidative stress and inflammation in lipopolysaccharide (LPS)-induced septic lung injury. LPS is the leading bacterial endotoxin used to induce septic lung injury experimentally. LPS causes a severe inflammatory signaling and lung injury characterized by leukocyte infiltration. The severity of pneumonia depends on neutrophil accumulation, increased production of reactive oxygen species (ROS) and the production of proinflammatory cytokines such as tumor necrosis factor (TNF-α), interleukin-1β (IL-1β) and IL-6, which cause secondary diffuse lung parenchymal damage in the alveoli and exacerbate inflammation. Excessive production of these cytokines causes lung tissue damage and the increased amount of ROS triggers the formation of oxidative stress. Oxidative stress-induced damage plays an important role in lung failure. Nrf2 is an inducible protein with cytoprotective and antioxidant properties. When there is a redox imbalance in the cell, Nrf2 dissociates from keap1. Free Nrf2 binds antioxidant response elements in the nucleus and thus activates detoxification gene expression. Nrf2 increases the expression of HO-1 gene in the nucleus. HO-1 inhibits neutrophil, macrophage and lymphocyte-mediated inflammatory responses by catalyzing hemin cleavage. Oxidative stress and some proinflammatory mediators can induce Nrf2 activation and HO-1 expression. HO-1 is a cytoprotective protein produced through the Keap1/Nrf2/HO-1 axis and thus can reduce the cytotoxicity of various oxidative stress sources and inflammatory reactions.In the literature reviews, it has been observed that some antioxidants inhibit LPS-induced inflammation and oxidative stress in vivo and in vitro, and the Keap1-Nrf2/HO-1 pathway significantly attenuates the regulation of LPS-induced inflammation.
Keywords: Lung sepsis, lps, inflammation.

Introduction

Sepsis is a systemic inflammatory syndrome caused by infection that usually causes damage to multiple organs and systems. It has been reported that almost half of the annual number of patients hospitalised in the intensive care unit of hospitals is due to sepsis (Keely et al, 2017; Honeyford et al.2020). The lungs are the leading organs affected by sepsis. Acute lung injury resulting from local or systemic inflammation and acute inflammatory diseases such as sepsis remain the most common cause of death worldwide (Opal et al. 2013). Studies have shown that the main reason for the easier development of sepsis in the lungs is that a large number of inflammatory mediators and lipid metabolites enter the bloodstream in sepsis, stimulating the accumulation and activation of inflammatory cells in the lung tissue of patients and producing more chemokines and cytokines. Lung injury, usually with alveolar oedema, has led to high mortality and morbidity rates worldwide (Park et al. 2019; Lefrançais et al. 2018).

Lipopolysaccharide (LPS): Bacterial endotoxins are frequently used to induce septic lung injury experimentally. Lipopolysaccharide (LPS) is one of these endotoxins. LPS is the basic structural substance that forms the outer membrane of gram-negative bacteria. LPS is a highly toxic endotoxin that causes oxidative stress, inflammation, apoptosis and DNA damage in tissues (Niu et al. 2014). LPS causes severe inflammatory signalling and lung injury characterised by leukocyte infiltration. The severity of pneumonia depends on neutrophil accumulation, increased production of reactive oxygen species (ROS) and the production of proinflammatory cytokines such as tumour necrosis factor (TNF-α), interleukin-1β (IL-1β) and IL-6, which cause secondary diffuse lung parenchymal damage in the alveoli and exacerbate inflammation (Takahashi et al. 2012). Excessive production of these cytokines causes lung tissue damage and the increased amount of ROS triggers the formation of oxidative stress. Oxidative stress is a condition that occurs when the balance between ROS and antioxidant defence is disturbed. This condition suppresses the antioxidative defence of the organism by affecting the regulation of cellular functions. As a result, tissue damage and accelerated cellular death are observed (Sindhi et al. 2013).

Keap1-Nrf2/HO-1 Pathway: Kelch-like ECH-associated protein (Keap1) is a protein that regulates Nrf2 activity. Nrf2 is a transcription factor that regulates important antioxidant and phase II detoxification genes. Inhibition of Nrf2 migration to the nucleus

to activate multiple genes depends on a conserved glycine. When the amount of ROS increases, Nrf2 separates from Keap1 and begins its translocation to the nucleus. Expression of endogenous antioxidants is mainly regulated by the nuclear factor erythroid 2-related factor 2 (Nrf2)-kelch-like ECH-related protein 1 (Keap 1) pathway. This pathway mediates the transcription of antioxidants through the antioxidant response element (ARE) located in the promoter region of genes encoding antioxidants. While Nrf2 is inactivated by the Keap 1 protein in the absence of oxidative stress, in the case of oxidative stress, Nrf2 separates from the Keap 1 protein and binds to the ARE region in the nucleus, stimulating the expression of genes that produce antioxidants. Due to this important feature, Nrf2 is being investigated as a potential therapeutic target in the treatment of oxidative stress. It has been thought that Nrf2 could be used as a potential treatment target in chronic obstructive pulmonary disease, liver diseases, neurodegenerative diseases and other oxidative stress-related diseases. It has been thought that Nrf2 could be used as a potential treatment target in chronic obstructive pulmonary disease, liver diseases, neurodegenerative diseases and other oxidative stress-related diseases.

NRF2 is expressed mainly in alveolar macrophages and epithelial cells in the lungs. KEAP1 has a highly reactive sulfhydryl content of 27 cysteines and is considered both electrophilic and a sensor for oxidants. It is also the main analysis of NRF2 stability and NRF2-induced transcriptional activity in response to endogenous, pharmacological, and pharmacological electrophiles. In contrast, DJ-1 protein stabilizes NRF2 by preventing its association with KEAP1 (Ohta et al. 2008). When exposed to various stresses or inducers, NRF2 is released from KEAP1 and translocates to the nucleus (Hayes et al. 2014; Sporn &Liby 2012). In the nucleus, NRF2 forms heterodimers with other bZIP transcription factors, including small Maf proteins, c-Jun, activating transcription factor-4, c-Fos, and Fra-1 (growth antigen-1 with Fos) and binds to a cis-element of the ARE are involved in target gene promotions to up-regulate their expression (Singh et al. 2006). Recently, several, potentially compatible mechanisms by which NRF2 is activated and subsequently turned off have been described (Campell et al. 2016). (Figure 1). KEAP1, NRF2, small Maf proteins, BACH1 and the abundance of these proteins in the circulation, where they are directed to exchange, also work more healthily against oxidative stress.

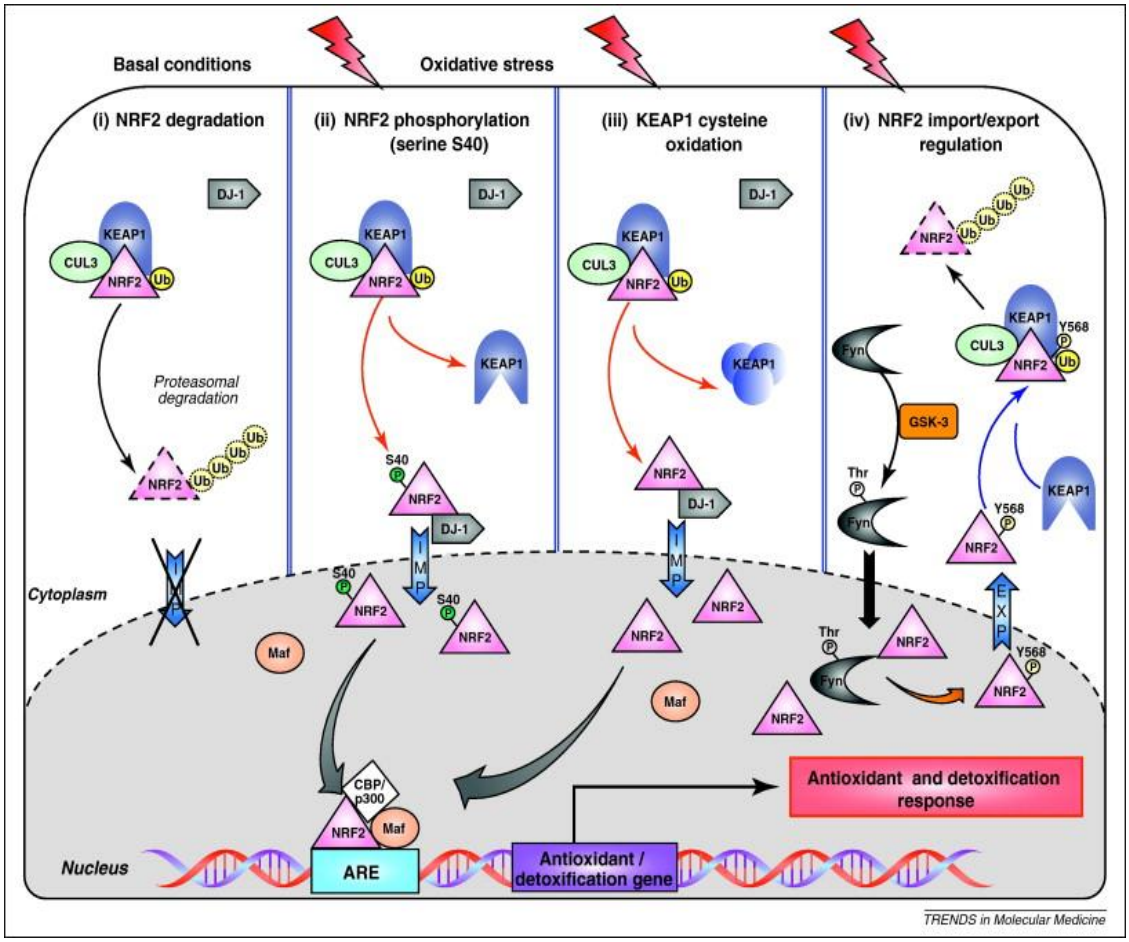


Figure 1. NRF2 targeting: a promising therapeutic strategy in chronic obstructive pulmonary disease Bouttenet al. 2011

The antioxidant defense system against moderate oxidative stress works using the Nrf2 / Keap 1 /ARE pathway. Nrf2 is usually found in the cytosol in complex with the Keap-1 protein. Due to mild oxidative stress, Nrf2 is released from this complex and transported to the nucleus. Transported Nrf2 forms a new complex with the Maf protein and initiates the transcription of various antioxidant enzymes by binding to the antioxidant response element (ARE) on DNA. Specific antioxidant enzymes activated include SOD, catalase, GSH-reductase, Glutathione peroxidase and phase II enzymes. These enzymes are thought to cause antineoplastic effects.

The Nrf2/Keap1/ARE pathway is involved in oxidative stress, such as direct antioxidant proteins, phase I and II electrophile detoxification enzymes, toxic solvent transporters, free radical metabolism, inhibition of inflammation, glutathione homeostasis, proteasome

function, recognition of DNA damage, expression of various growth factors and transcription factors. More than 100 related genes and their functions are regulated (Figure 2).

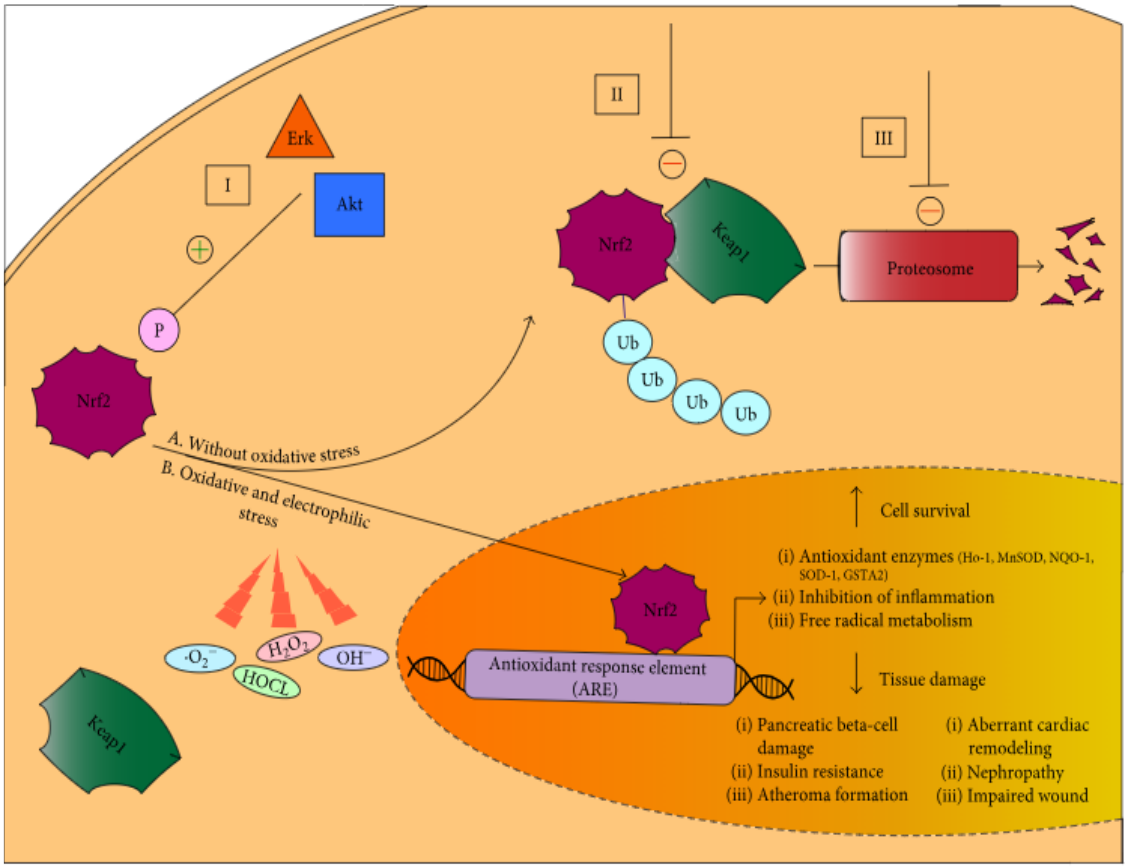


Figure 2: Nrf2 / Keap1 / ARE pathwway David et al. 2017

A study conducted in 2009 revealed that sulfasalazine induces the transcription of antioxidant enzyme genes such as HO - 1 by activating Nrf2, thus reducing oxidative stress in vascular walls by scavenging reactive oxygen radicals. Sulfasalazine showed this effect by separating Nrf2 from Keap 1. Nrf2, which is activated in the presence of oxidative stress, induces the transcription of many detoxification enzymes by binding to the antioxidant response element (ARE) sequence (Itoh et al. 1997). In the physiological state, Nrf2 activity is suppressed by the endogenous inhibitor Keap 1 through interaction with the C terminus of the Nrf2-ECH homologous domain (Neh2) phosphorylation site on Nrf2. Keap1 is the adapter protein of the Cullin3-E3-ligase complex associated with the cytoplasmic actin cytoskeleton (Kensler et al. 2007).

The Nrf2 pathway serves as the main cellular defense mechanism against oxidative stress in both physiological and pathological situations. Nrf2 is a member of the capin'collar family of both constitutive and inducible ARE gene expression, first isolated in cloning studies in 1994 (Moi et al. 1994). The interaction mechanisms of Nrf2 and Keap1 have not been fully elucidated, especially due to the different intracellular locations of these two molecules. Nrf2 and Keap1, which interact with each other under physiological conditions, exhibit a different behavior in the presence of oxidative stress. In response to oxidative stress, Keap1 dissociates from Nrf2, freeing Nrf2 to heterodimerize with Maf family transcription factors (Kensler ve ark. 2007). With the help of a nuclear localization sequence, the Nrf2 heterodimer rapidly translocates to the nucleus and binds to the ARE. Thus, transcriptional activation of various genes such as NQO-1, SOD-1 and HO-1 and glutathione S-transferase A2 (GSTA2) begins.

These antioxidant enzymes aim to inactivate free radicals by four main mechanisms. These; Oxidation and reduction reactions to which functional groups on hydrophobic molecules are exposed, Nucleophilic capture processes, removal of toxic metabolites through transporters and maintenance of reduction by molecules containing thiol. Reactive oxygen radicals activate the Nrf2 pathway by phosphorylating the ERK and p38 pathways within the cell. Phosphorylated ERK and p38 pathways separate Nrf2 from Keap1, allowing Nrf2 to pass into the nucleus and express antioxidant genes via ARE. Additionally, another study showed that ROS causes Nrf2 activation through the JNK pathway in addition to ERK and p38. It has also been reported that any region on this pathway can be induced by drugs and that the primary production of these pathways is Heme oxygenase - 1, synthesized from the nucleus.

Conclusion and Recommendations

The respiratory system is constantly exposed to multiple inhaled oxidants. The lungs protect themselves against these oxidants through cellular and extracellular antioxidant defense mechanisms throughout the epithelial lining fluid and tissues. Oxidative stress resulting from oxidative load and antioxidant imbalance is involved in cellular and tissue damage associated with the pathogenesis of many acute and chronic respiratory diseases, including COPD. NRF2, a transcription factor that controls the expression of antioxidant response element (ARE)-regulated antioxidant and cytoprotective genes, has an important protective role against oxidative airway diseases in the lungs. The antioxidant and anti-

inflammatory role of NRF2 is evident from studies in animal models as well as human studies of cigarette smoke (CS)-induced COPD. Therefore, NRF2 is thought to have an attractive therapeutic effect for intervention and prevention strategies in COPD.

References

Boutten, A., Goven, D., Artaud-Macari, E., Boczkowski, J., & Bonay, M. (2011). NRF2 targeting: a promising therapeutic strategy in chronic obstructive pulmonary disease. *Trends in molecular medicine*, 17(7), 363-371.

Campbell JD, Alexandrov A, Kim J, et al (2016). Distinctpatterns of somatic genome alterations in lung adenocarcinomasand squamous cell carcinomas. *Nat Genet.;*48:607–616.

David, J. A., Rifkin, W. J., Rabbani, P. S., & Ceradini, D. J. (2017). The Nrf2/Keap1/ARE pathway and oxidative stress as a therapeutic target in type II diabetes mellitus. *Journal of diabetes research*.

Habtemariam, S. (2019). The Nrf2/HO-1 axis as targets for flavanones: neuroprotection by pinocembrin, naringenin, and eriodictyol. Oxidative medicine and cellular longevity,

Hayes JD & Dinkova-Kostova AT. (2019) The Nrf2 regulatorynetwork provides an interface between redox andintermediary metabolism. *Trends Biochem Sci.*2014;39:199–218.

Honeyford, K., Cooke, G. S., Kinderlerer, A., Williamson, E., Gilchrist, M., Holmes, A., ... & Costelloe, C. (2020). Evaluating a digital sepsis alert in a London multisite hospital network: a natural experiment using electronic health record data. *Journal of the American Medical Informatics Association*, 27(2), 274-283.

Itoh, K., Chiba, T., Takahashi, S., Ishii, T., Igarashi, K., Katoh, Y. ve ark. (1997). An Nrf2/small Maf heterodimer mediates the induction of phase II detoxifying enzyme genes through antioxidant response elements. *Biochem Biophys Res Commun*, 236, 313–322.

Keeley, A., Hine, P., & Nsutebu, E. (2017). The recognition and management of sepsis and septic shock: a guide for non-intensivists. *Postgraduate medical journal*, 93(1104), 626-634.

Kensler, T.W., Wakabayashi, N. & Biswal, S. (2007). Cell survival responses to environmental stresses via the Keap1-Nrf2-ARE pathway. *Annu Rev Pharmacol Toxicol*, 47, 89–116.

Lefrançais, E., Mallavia, B., Zhuo, H., Calfee, C. S., & Looney, M. R. (2018). Maladaptive role of neutrophil extracellular traps in pathogen-induced lung injury. *JCI insight*, 3(3).

Moi, P., Chan, K., Asunis, I., Cao, A. & Kan, Y.W. (1994). Isolation of NF-E2-related factor 2 (Nrf2), a NF-E2-like basic leucine zipper transcriptional activator that binds to the tandem NF-E2/AP1 repeat of the beta-globin locus control region. *Proc Natl Acad Sci* U S A, 91, 9926–9930.

Niu, X., Mu, Q., Li, W., Huang, H., Yao, H., & Li, H. (2014). Protective effects of chelerythrine against lipopolysaccharide-induced endotoxic shock in mice. *Inflammation*, 37, 1968-1975.

Ohta T, Iijima K, Miyamoto M, et al. (2008). Loss of Keap1function activates Nrf2 and provides advantages forlung cancer cell growth. *Cancer Res.* 2008;68:1303–1309.

Opal, S. M., Laterre, P. F., Francois, B., LaRosa, S. P., Angus, D. C., Mira, J. P., ... & ACCESS Study Group, F. T. (2013). Effect of eritoran, an antagonist of MD2-TLR4, on mortality in patients with severe sepsis: the ACCESS randomized trial. *Jama*, 309(11), 1154-1162.

Park, I., Kim, M., Choe, K., Song, E., Seo, H., Hwang, Y., ... & Kim, P. (2019). Neutrophils disturb pulmonary microcirculation in sepsis-induced acute lung injury. *European Respiratory Journal*, 53(3).

Sindhi, V., Gupta, V., Sharma, K., Bhatnagar, S., Kumari, R., & Dhaka, N. (2013). Potential applications of antioxidants–A review. *Journal of pharmacy research*, 7(9), 828-835.

Singh A, Misra V, Thimmulappa RK, et al. (2006). DysfunctionalKEAP1-NRF2 interaction in non-small-cell lung cancer. *PLoS Med.* 3:e420.

Sporn MB & Liby KT. (2012). NRF2 and cancer: the good, thebad and the importance of context. *Nat Rev Cancer*, 12:564.

Takahashi, K., Mizukami, H., Kamata, K., Inaba, W., Kato, N., Hibi, C., & Yagihashi, S. (2012). Amelioration of acute kidney injury in lipopolysaccharide-induced systemic inflammatory response syndrome by an aldose reductase inhibitor, fidarestat. *PloS one*, 7(1), e30134.

Zhao, F., Li, K., Zhao, L., Liu, J., Suo, Q., Zhao, J., ... & Zhao, S. (2014). Effect of Nrf2 on rat ovarian tissues against atrazine-induced anti-oxidative response. *International journal of clinical and experimental pathology*, 7(6), 2780.

MELANOM HAYVAN MODELLERİ

Dr. Esra BİLİCİ (ORCID: 0000-0001-6636-5975)
Uşak Üniversitesi, Eşme Meslek Yüksek Okulu, Laborant ve Veteriner Sağlık Programı
Email: esra.bilici@usak.edu.tr

ÖZET
Dünyada ve ülkemizde en sık karşılaşılan tümörler arasında hayvanlarda deri tümörleri yer almaktadır. İnsanlarda evcil hayvan besleme oranı her geçen gün hayat standartlarının artmasına paralel olarak daha da arttığı görülmektedir. Bununla beraber; sanayileşmenin getirmiş olduğu birçok çevresel kirlenmeye bağlı olarak bu türlerde tümör görülme sıklığının arttığı dikkati çekmektedir. Bundan dolayı tümörlerde tanı ve tedavi süreci önem kazanmaktadır. Son yıllarda, melanositik tümörler hayvanlarda en yaygın habis tümörlerden bazıları haline gelmiştir. Değişken hücre mimarileri ve pigmentasyon durumu nedeniyle, çeşitli hayvan türlerindeki melanositik tümörlerin kesin olarak teşhis edilmesi zor olabilmektedir. Bu tümörler, lenfoma, sarkomlar ve karsinomlar gibi yuvarlak hücreli kötü diferansiye maligniteler ile histolojik benzerlikler paylaşabilmektedir. Şu anda, pigmentasyonu olmayan amelanotik tümörleri tanımlamak ve melanomları diğer kanserlerden ayırmak için çeşitli teknikler kullanılmaktadır. Bu agresif ve kötü huylu tümörlerin mümkün olan en kısa sürede teşhis ve tedavi edilmesi hastalığın seyri açısından çok önemlidir. Köpekler ve kediler bir bütün olarak ele alındığında tümör görülme sıklığının en yüksek olduğu hayvanlardır. Melanosit kökenli neoplazmalar vücudun herhangi bir yerinde görülebilen ancak en sık göz kapağı, tırnak altı bölgesi, deri ve ağız boşluğunda görülen kanser türleridir. Tipik olarak kötü huyludurlar ve korkunç bir prognozları vardır. Bu makalede çok sayıda hayvan türünde bulunan malign melanoma hakkında kısa ve genel bilgiler verilmektedir.
Anahtar Kelimeler: Melanom, Köpek, Kedi, Sığır, At

ANIMAL MODELS OF MELANOMA

ABSTRACT
Animal skin cancers are among the most prevalent tumors both globally and domestically. It is evident that the rate of pet feeding is rising daily in tandem with the improvement in human living standards. Additionally, it is interesting that these species have developed more cancers due to the numerous environmental contamination caused by urbanization. The procedure of tumor identification and treatment, therefore, becomes crucial. In recent years, melanocytic tumors have become some of the most prevalent malignant tumors in animals. Due to the varying cell architectures and pigmentation state, melanocytic tumors in various animal species can be challenging to definitively diagnose. These tumors may share histological similarities with round cell poorly differentiated malignancies such lymphoma, sarcomas, and carcinomas. Currently, a variety of techniques are employed to identify amelanotic tumors, which lack pigmentation, and to distinguish melanomas from other cancers. It is crucial for the course of the disease that these aggressive and malignant tumors are diagnosed and treated as soon as feasible. When considered as a whole, dogs and cats are the animals with the highest frequency of tumors. Neoplasms of melanocytic origin are cancer types that can appear anywhere on the body, but are most common in the eyelid, subungual region, skin, and oral cavity. They are typically malignant and have a terrible prognosis. Brief and general information regarding malignant melanoma found in numerous animal species is provided in this article.
Keywords: Melanoma, Dog, Cat, Cattle, Horse

INTRODUCTION

The unchecked growth of melanocytes leads to the tumor known as melanoma. It is regarded as the deadliest variety of skin cancer (Montal et al, 2023). Over the past 50 years, there has been a sharp rise in the incidence of melanoma due to chemical carcinogens that produce reactive oxygen species and elevated UV radiation levels at the earth's surface as a result of ozone depletion (Matsumura and Ananthaswamy 2004). The majority of skin cancer fatalities are caused by melanoma because of its propensity to spread. Although melanoma often affects the skin, it can also damage the mucosal surfaces of the mouth, eyes, and brain. It comes from skin-derived melanocytes or neural crest progenitors. Adipocytes are one of the cell types that the melanoma encounters as it penetrates the epidermis further. By providing fatty acids as a source of energy for proliferation, these adipocytes aid in the invasion of melanoma (Zhang et al., 2018). Malignant melanoma and squamous cell carcinoma are just two of the many different kinds of skin cancer (Gloster and Brodland, 1996).

In rare cases, melanoma can also develop in internal organs including the colon (Hussein 2008). A typical form of skin cancer that arises from squamous cells is squamous cell carcinoma. Squamous cell carcinoma can grow or spread to other areas of the body if left untreated, which can result in life-threatening problems (Hawrot et al. 2003). Although cutaneous melanomas are the most frequent type, melanocytes on the eye, leptomeninges, and mucosal surfaces can also produce them. A deeper comprehension of the genetic environment, signaling pathways, and interactions between the tumor and its microenvironment is necessary for the development of new treatments. Although the exact causes of melanocytic tumors are unknown, a number of predisposing variables, including genetic predispositions, gray horses, dogs with deeply pigmented skin, and red, gray, or black skinned cattle varieties, have been found to be effective (Erer and Kran, 2005). Although the exact cause is unknown, some researchers have found that environmental factors, particularly prolonged exposure to sunshine and ultraviolet light, are important in the development of melanocytic tumors (Koç et al., 2006).

MELANOM RISK FACTORS

According to sun exposure, the World Health Organization (WHO) makes three distinctions between skin melanocytic tumors: melanoma that develops on skin that is shielded from the sun, melanoma that develops on skin that is exposed to the sun

intermittently, and melanoma that develops on skin that is chronically exposed to the sun. The key factor contributing to the development of melanoma in skin exposed to the sun is chronic and irregular ultraviolet (UV) radiation exposure (Bastian, 2014). Due to its aggressive nature and propensity to spread, cutaneous melanoma—which makes up less than 5% of all skin malignancies—causes the bulk of skin cancer mortality (Linos et al., 2009). Although there is no doubt that the outlook for patients with advanced melanoma has improved recently, the 5-year survival rate is still 52% (Larkin et al., 2019). Acral melanoma, vaginal and mucosal melanoma, ocular melanoma, and leptomeningeal melanoma are the melanomas that form on sun-protected skin. Spitz melanoma, melanoma in blue nevi, and melanoma in congenital nevi are additional uncommon melanoma subtypes that develop independently of UV light exposure (Weyden et al., 2020). Genetic risk factors also have a significant role in the development and spread of melanoma, in addition to environmental risk factors. Approximately 60% of melanomas have somatic mutations in genes important for the control of pathways relating to cell proliferation, differentiation, and survival (Palmieri et al., 2018; Garman et al., 2017; Miraflor et al., 2017; Rabbie et al., 2019).

ANIMAL MODELS

CAT

Domestic animal pigment tissue tumors are a group of neoplastic growths made of melanin-producing cells. The two types of these cancers are benign and malignant melanoma. These tumors typically start in the head area. All of the ear buds were described as benign in one study, however all eyelid protrusions were described as cancerous (Croix, 2017). In dogs, diffuse iris melanoma destroys the eye but has a low risk of metastasis (Chandler et al., 2008; Plummer et al., 2008). In cats, diffuse iris melanoma is often benign intraocular tumor with a high potential for metastasis (Pigatto et al., 2010; Plummer et al., 2008). Tumors in other locations have different malignancies. The prevalence of benign and malignant cutaneous melanomas is often close to equal. Typically, the mass has a considerable nodular look, with 80% of it being black colored (Goldschmidt et al., 1992). Cats experience intraocular melanoma more commonly than cutaneous melanoma, in contrast to other domesticated species like dogs and horses (Patnaik et al, 1988). Regardless of race or gender, it affects adult cats of all ages, but it

is recognized as a lesion that generally appears at or after the age of nine (Ionaşcu et al., 2012).

DOG

Dogs can develop melanocytic tumors, which are often malignant and rather common (Gillard et al., 2014). According to Prrouteau and Andre (2019), the most common anatomical locations are oral (62%), cutaneous (27%), finger (6%), ungual (4%), and ocular (1%). It's interesting to note that the association between malignancy with each site differs; between 84 and 100% of oral, finger, and ungual melanocytic tumors are cancerous.

Oral melanomas are one of the most prevalent cancers in dogs and have a bad prognosis in veterinary medicine (Munday, 2017). According to Gillard et al. (2014), mucosal melanoma typically develops in the gingiva but can also occur in the lips, tongue, tonsils, palate, and oropharynx. Although they have been described, spontaneous anal sac, intestinal, and intranasal melanomas are uncommon (Prouteau and Andre, 2019). According to D'Angelo et al. (2017), canine oral melanomas are aggressive tumors that have a high propensity for local invasion and lung and lymph node metastasis. Chemotherapy and radiation therapy are ineffective against canine melanoma (Bergman and Wolchok, 2008).

Since most canine cutaneous melanocytic tumors are benign and develop on hairy skin, they are not thought to be caused by UV radiation exposure (Bastian, 2014). This shows that these tumors have a unique origin.

HORSE

Horse melanocytic tumor terminology and categorization have historically been inconsistent, as they are in other species, which has confused pathologists and physicians (Smith et al, 2002). The clinical syndromes melanocytic naevi (also known as melanocytoma), dermal melanomas, dermal melanomatosis, and anaplastic malignant melanoma are currently recognized in horses (Valentine, 1995). Both gray and non-grey horses can develop melanocytic nevi, some of which resemble human nevi and are typically found on the legs, torso, or neck rather than the perineum (Schöniger and Summers, 2009).

Melanocyte-based tumors typically have a deep origin in horses. According to reports, it is also shaped in various areas, including the ear, neck, legs, and sexual organ, in addition

to the perineum, perianal, and under the tail root (Schott et al., 1990). The most prevalent neoplasm in horses is skin cancer, and up to 15% of all equine skin cancers are melanocytic (Johnson, 1998). Despite the fact that more than 90% of them are benign at first appearance, two-thirds of them have the potential to develop into cancer and spread widely if untreated (Levene, 1971; Schott et al, 1990; Johnson, 1998).

The perianal region, lips, and eyelids are the areas where melanomas nodules are most frequently found, along with the tail and at high rates (Seltenhammer et al., 2003; Kansal et al., 2016). According to a study, the tumor began to grow as nodular masses from the base of the tail to the anus (Köküuslul et al., 1990).

CATTLE

According to studies (Crispin, 2005; Dubielzig, 2002; Gelatt, 2005; Gharagozlou et al., 2007; Hirsbrunner et al., 1998; Martins et al. Barros, 2014; Robert, 2002; Schulz and Anderson, 2010), lymphosarcoma and squamous cell carcinoma are the most frequent tumors found in the ocular and periocular tissues of cattle. Melanoma, lymphoma, benign and malignant hemangioendotheliomas, squamous papillomas, sebaceous gland carcinoma, fibromas, mastocytomas, and optic nerve neuroepitheliomas are more infrequently found (Gharagozlou et al., 2007; Martins and Barros, 2014; Robert, 2002; Schulz and Anderson, 2010; Wilcock, 1993).

The causes of squamous cell cancers are multifaceted and include inheritance, exposure to sunshine, diet, pigmentation of the eyelids, and environmental factors. Tumor growth is accelerated by UV exposure and high-energy diets (Al-Asadi, 2012; Crispin, 2005; Dubielzig, 2002; Gelatt, 2005). According to Ceylan et al. (2011), high altitude, proximity to the equator, high average temperatures, and prolonged exposure to the sun's powerful radiation put animals at risk for developing ocular and periocular cancers.

All domestic animal species have been linked to skin tumors. Melanoma is one of these and has been observed in a variety of animal species. Melanoma is said to make up 3% of all neoplasms in dogs, 7% of malignant neoplasms in horses, and 15% of skin neoplasms in horses. More than 90% of these neoplasms begin as benign conditions, but with time, roughly 2/3 develop into malignant conditions (Smith et al., 2002). Melanoma distribution on the skin is said to provide a general indication of whether the tumor is benign or malignant. According to reports, the majority of melanomas that develop in the

hairy regions of the skin are benign, whereas the majority of those that appear in the hairless regions are malignant (Galdschmidt and Hendrick, 2002).

CONCLUSION

These tumors have a high likelihood of metastasizing, an insidious onset, a slow course, and a clinical appearance that make them difficult to distinguish from other diseases. It has been stated that early diagnosis and treatment of these tumors will be crucial for patient quality, life expectancy, and early diagnosis. Cytopathology is a highly useful diagnostic approach for the early diagnosis of these tumors, despite the fact that it has not yet attained the due significance in our medical system for research in the diagnosis of skin malignancies.

With the lesions being accessible, the application being simple, and the cytological material frequently being in the necessary amount, it offers significant advantages in the identification of skin malignancies. It is also a quicker, significantly less expensive, and least hazardous diagnostic procedure.

REFERENCES

Bastian BC. The molecular pathology of melanoma: an integrated taxonomy of melanocytic neoplasia. Annu Rev Pathol. 2014; 9:239–271.

Bergman P, Wolchok J. Of mice and men (and dogs): development of a xenogeneic DNA vaccine for canine oral malignant melanoma. Cancer Ther 2008; 6:817–826.

Chandler HL, Barden CA, Newkirk KM, Kusewitt DF, Colitz CMH, Dubielzig RR. İmmunohistochemical analysis of uveal melanoma in cats and dogs. Invest Ophth Vis Sci 2008; 49(13): 70.

Crispin S, 2005: Farm Animal Ophtalmology. In ‘‘Notes on Veterinary Ophtalmology’’, First Ed, Blackwell Science Ltd, Oxford, pp. 239-264.

Croix NL. “Ocular melanoma” Veterinary Medical Center of Long Island. http://www.vmcli.com/veterinary-articles-ocular-melanoma.htm. Erişim tarihi:16.07.2017.

D'Angelo SP, Larkin J, Sosman JA, et al Efficacy and safety of nivolumab alone or in combination with ipilimumab in patients with mucosal melanoma: a pooled analysis. J Clin Oncol 2017; 35:226–235.

Dubielzig RR, 2002: Tumors of the eye. In ‘‘Tumors in Domestic Animals’’, Ed; Meuten DJ, Fourth Ed. Iowa State Press, Iowa USA, pp 739-754.

Elder DE, Massi D, Scolyer R, et al (eds). Melanocytic tumors In WHO Classification of Skin Tumors (Vol. 11, 4th edn). International Agency for Research on Cancer: Lyon, 2018; Ch 2.

Erer H, Kırar MM, 2005, Veteriner Onkoloji, 3. Basım.

Garman B., Anastopoulos I.N., Krepler C., Brafford P., Sproesser K., Jiang Y., Wubbenhorst B., Amaravadi R., Bennett J., Beqiri M., et al. Genetic and Genomic Characterization of 462 Melanoma Patient-Derived Xenografts, Tumor Biopsies, and Cell Lines. Cell Rep. 2017;21:1936–1952.

Gelatt KN, 2005: Neoplasia of the eye and associated structures. Eye and ear. In ‘‘The Merck Veterinary Manual’’, Ed; Kahn CM, Ninth Ed, Merck&Co., Inc, Philadelphia, pp. 413-416.

Gharagozlou MJ, Hekmati P, Ashrafihelan J, 2007: A clinical and histopathological study of ocular neoplasms in dairy cattle. Vet Arhiv, 77, 5, 409-426.

Gillard M, Cadieu E, De Brito C, et al Naturally occurring melanomas in dogs as models for non-UV pathways of human melanomas. Pigment Cell Melanoma Res 2014; 27:90–102.

Gloster HM, Brodland DG. The epidemiology of skin cancer. Dermatol Surg. 1996;22:217–226.

Hawrot A, Alam M, Ratner D. Squamous cell carcinoma. Curr Probl Dermatol. 2003;15:91–133.

Heilmann, S., Ratnakumar, K., Langdon, E., Kansler, E., Kim, I., Campbell, N. R., Perry, E., Mcmahon, A., Kaufman, C., Van Rooijen, E.et al. (2015). A quantitative system for studying metastasis using transparent zebrafish. Cancer Res. 75, 4272-4282.

Hirsbrunner G, Ebeid M, Eicher R, 1998: Cancer eye in cattle: 21 cases (1990-1996). Schweizer Archiv fur Tierheilkunde, 140, 4, 149-155.

Hussein MR. Extracutaneous malignant melanomas. Cancer Invest. 2008;26:516–534.

Johnson PJ. Dermatologic tumors (excluding sarcoids). Vet Clin North Am Equine Pract 1998; 14:625–658.

Kansal RG, McCravy MS, Basham JH, et al Inhibition of melanocortin 1 receptor slows melanoma growth, reduces tumor heterogeneity and increases survival. Oncotarget 2016;7: 26331–26345.

Koç Y, Özdemir Ö, Alkan F, Çiftçi MK, Erol M, 2006. Bir İnekte Melanom Olgusu, Vet. Bil. Derg. 22. 3·4: 91·96

Köküuslul C, Kutsal O, Özdemir A T, 1990, Bir Doru Atta Malıngn Melanom Olgusu, Ankara Üniversitesi Veteriner Fakültesi Dergisi, Cilt: 37 Sayı: 03.

Larkin J, Chiarion-Sileni V, Gonzalez R, et al Five-year survival with combined nivolumab and ipilimumab in advanced melanoma. N Engl J Med 2019; 381:1535–1546.

Levene A. Equine melanotic disease. Tumori 1971; 57:133–168.

Ionaşcu I, Dinescu G, Anca CC. Iris melanoma in cats. Scientific Works-University of Agronomical Sciences and Veterinary Medicine, Bucharest Series C, Vet Med 2012; 58(4): 81 8.

Linos E, Swetter SM, Cockburn MG, et al Increasing burden of melanoma in the United States. J Invest Dermatol 2009; 129:1666–1674.

Martins TB, Barros CSL, 2014: Fifty years in the blink of an eye: a retrospective study of ocular and periocular lesions in domestic animals. Pesq Vet Bras, 34, 12, 1215-1222.

Matsumura Y, Ananthaswamy HN. Toxic effects of ultraviolet radiation on the skin. Toxicol Appl Pharmacol. 2004;195:298–308.

Miraflor A.P., de Abreu F.B., Peterson J.D., Turner S.A., Amos C.I., Tsongalis G.J., Yan S. Somatic mutation analysis in melanoma using targeted next generation sequencing. Exp. Mol. Pathol. 2017;103:172–177.

Montal E, Lumaquin D, Ma Y, Suresh S, White RM, 2023, Modeling the effects of genetic- and diet-induced obesity on melanoma progression in zebrafish. Dis Model Mech. 2023 Jan 1; 16(1): dmm049671.

Munday JS, Löhr CV, Kiupel M. 2017. Tumors of the alimentary tract. Meuten DJ. ed. In: Neoplasms in Domestic Animals. Fifth Edition. Iowa: Iowa State University Press. pp. 499-601.

Palmieri G., Colombino M., Casula M., Manca A., Mandala M., Cossu A., Italian Melanoma I. Molecular Pathways in Melanomagenesis: What We Learned from Next-Generation Sequencing Approaches. Curr. Oncol. Rep. 2018;20:86.

Patnaik AK, Liu SK, Hurvitz AI, et al Nonhematopoietic neoplasms in cats. J Natl Cancer Inst 1975; 54:855–860.

Patnaik AK, Mooney S. Feline melanoma: a comparative study of ocular, oral, and dermal neoplasms. Vet Pathol 1988; 25:105–112.

Patton, E. E., Zon, L. I. and Langenau, D. M. (2021). Zebrafish disease models in drug discovery: from preclinical modelling to clinical trials. Nat. Rev. Drug Discov. 20, 611-628.

Pigatto JAT, Hünning PS, Almedia ACVR, Pereira FQ, Freitas LVRP, Gomes C, Scihiochet F, Rigon GM, Driemeier D. Diffuse iris melanoma in a cat. Acta Sci Vet 2010; 38 (4): 429-32.

Plummer CE, Kallberg ME, Olliver FJ, Gelatt KN, Brooks DE. Use of biosynthetic material torepair the surgical defect following excision of an epibulbar melanoma in a cat. Vet Ophthalmol 2008; 11(4): 250-4.

Prouteau A, Andre C. Canine melanomas as models for human melanomas: clinical, histological, and genetic comparison. Genes 2019; 10:501.

Rabbie R., Ferguson P., Molina-Aguilar C., Adams D.J., Robles-Espinoza C.D. Melanoma subtypes: Genomic profiles, prognostic molecular markers and therapeutic possibilities. J. Pathol. 2019;247:539–551.

Schott HC, Major MD, Grant BD, et al Melanoma as a cause of spinal cord compression in two horses. J Am Vet Med Assoc 1990; 196:1820–1822.

Schott, H.C, Major, O.M., Grant, B,O., Bayly, W.M. (1990). Melanoma as a cause ol spiııal cord compression iıı tıvO horses. J.A.Y.M.A., 196: 1820-1822.

Schöniger S, Summers BA. Equine skin tumours in 20 horses resembling three variants of human melanocytic naevi. Vet Dermatol 2009; 20: 165–173.

Schulz KL, Anderson DE, 2010: Bovine Enuclation: A retrospective study of 53 cases (1998-2006). Can Vet J, 51, 611-614.

Seltenhammer MH, Simhofer H, Scherzer S, et al Equine melanoma in a population of 296 grey Lipizzaner horses. Equine Vet J 2003; 35:153–157.

Smith SH, Goldschmidt MH, McManus PM. A comparative review of melanocytic neoplasms. Vet Pathol 2002; 39: 651–678.

Valentine BA. Equine melanocytic tumors: a retrospective study of 53 horses (1988 to 1991). J Vet Intern Med 1995; 9: 291–297.

VandeBerg JL, Robinson ES. The laboratory opossum (Monodelphis domestica) in laboratory research. ILAR J 1997; 38:4–12.

Weyden L, Brenn T, Patton EE, Wood GA, Adams DJ, 2020, Spontaneously occurring melanoma in animals and their relevance to human melanoma, J Pathol. 252(1): e5505.

Zhang, L., Alt, C., Li, P., White, R. M., Zon, L. I., Wei, X. and Lin, C. P. (2012). An optical platform for cell tracking in adult zebrafish. Cytometry A 81, 176-182.

Zhang, M., Di Martino, J. S., Bowman, R. L., Campbell, N. R., Baksh, S. C., Simon-Vermot, T., Kim, I. S., Haldeman, P., Mondal, C., Yong-Gonzales, V.et al. (2018). Adipocyte-derived lipids mediate melanoma progression via FATP proteins. Cancer Discov. 8, 1006-1025.

UTILIZATION OF TOASTED VELVET BEANS (*MUCUNA PRURIENS*) SEED MEAL AS A PROTEIN SOURCE FOR *CLARIAS GARIEPINUS* FINGERLINGS

Alatise S. P.
Department of Fisheries Technology, Federal College of Freshwater Fisheries Technology, P.M.B 1500, New Bussa, Niger State, Nigeria
Email: segunpeter13@gmail.com

R. Ibrahim
Department of Fisheries Technology, Federal College of Freshwater Fisheries Technology, P.M.B 1500, New Bussa, Niger State, Nigeria

M. J. Abubakar
Department of Fisheries Technology, Federal College of Freshwater Fisheries Technology, P.M.B 1500, New Bussa, Niger State, Nigeria

ABSTRACT
A feeding trial was conducted to investigate the effect of toasted velvet beans seed meal (TVBM), *Mucuna pruriens* on growth performance, nutrient utilization and survival of *Clarias gariepinus* fingerlings. One hundred and fifty (150) fingerlings of *C. gariepinus* of average weight of 5.39±0.20 g were stocked and fed at 5% body weight per day for 56 days. Five iso-nitrogenous diets containing 40% crude protein in which soyabean meal was replaced by toasted velvet beans seed meal at 0% (TVBM0), 25% (TVBM25), 50% (TVBM50), 75% (TVBM75) and 100% (TVBM100) were formulated and prepared. Mean weight gain (MWG) and feed conversion ratio (FCR) were significantly different from 22.04±0.20 g and 1.87±0.02 respectively in fish fed diet TVBM25 while fish fed diet TVBM25 was no significantly different from the TVBM0. Protein efficiency ratio (PER) was not significantly different from fish fed diets TVBM0 (1.32±0.01) and TVBM25 (1.33±0.02) respectively. Then, protein efficiency ratio (PER) decreased as toasted velvet beans seed meal (TVBM) increased in the diet. From the above results, soyabean meal could therefore be replaced by toasted velvet beans seed meal at 25% level without affecting growth and nutrient utilization in the diet of African mud catfish, *C. gariepinus* fingerlings.
Keywords: Toasted velvet beans seed meal, Protein source, *Clarias gariepinus* and Growth

Introduction

With the rapid growth in the aquaculture sector in the recent years, the demand for quality fish feed is continuously increasing. Providing quality fish feed became a prime aim of every Aquaculturist. Though fish feed devours around 50% of the production cost, yet it plays the essential role in the production and yield outcome (Mzengereza *et al.*, 2014). With the increase in demand, the price of feed increased simultaneously. One main reason for the rise in the cost price of fish feed is due to the rise in demand of fish meal which remains the core of the protein supply of the feed. The demand for fish meal is not just increasing but the supply of it is also declining with stagnating marine catches and alternative use of it for livestock and human consumption (Fasakin *et al.*, 1999). So, the search for possible alternative protein sources to replace (complete/partial) fish meal in the feed became paramount (Magouz *et al.*, 2008). As animal protein sources are mostly expensive and not easily available, plant sources are considered to be one possible alternative that can be used in fish feed without compromising the nutritional quality of the feed (El-Sayed, 1999; Francis *et al.*, 2012). Moreover, use of cheaper and locally available plant sources to substitute the expensive fish meals would mean reduction in the production cost and thereby enhance the profit (Osman *et al.*, 1996, Munguti *et al.*, 2006). The experiment is designed to assess the effect of toasted velvet beans (*Mucuna pruriens*) seed meal-based diet on growth and nutrient utilization of African mud catfish (*Clarias gariepinus*) fingerlings reared in plastic bowls.

Materials and Methods

Experimental Site

The experiment was carried out at the Feed mill Unit of the Federal College of Freshwater Fisheries Technology, New Bussa, Niger State, Nigeria. Latitude 9° 53"N and Longitude 4° 33"E.

Experimental Fish

One hundred and fifty (150) fingerlings of catfish (*Clarias gariepinus*) with average weight of 5.39±0.20 g were obtained from the A and B Fish Hatchery Complex, New Bussa, Niger State. The fish were acclimatized for three (3) days in the bowls during which they were fed 40% crude protein feed before the commencement of the experiment.

Experimental Diets Preparation

The feedstuff, Velvet beans (*Mucuna pruriens*) seeds (VBS) were harvested from the wild at Iye-mero Ekiti, Ekiti State. The other ingredients which include soyabean meal, fish meal, groundnut cake meal, yellow maize, vitamin premix, vegetable oil, bone meal, methionine, lysine and salt were bought locally from Jasope Feed Depot, Ibadan Way, New Bussa, Niger State, Nigeria. The velvet beans seeds were prepared by toasting traditionally by constant stirring the seeds to prevent charring in a dry pot until browned and grind into fine powder with hammer mill. Five isocaloric and isonitrogenous diets were formulated to provide 40% crude protein. The soyabean meal was substituted with the toasted velvet beans seed meal at 0%, 25%, 50%, 75% and 100% respectively. The various feed ingredients were thoroughly mixed together in a bowl. The resultant mixture was made into dough and pelleted with Flat-die pelletizers (APF 150 model) of 40-60kg/hr capacity and then sun-dried for 8 hours. The diets were properly packed, labelled accordingly and stored in polyethylene bags at room temperature.

Experimental Design

Fifteen (15) cylindrical plastic bowls each measuring 25-Litres was used for this study. The experimental design consists of five (5) treatments and three replicates in a completely randomized design (CRD). Ten (10) fingerlings of *Clarias gariepinus* of equal size were stocked in each bowl. The fish were weighed with an electronic sensitive weighing balance (OHAUS 400g model). The plastic bowls were washed, thoroughly rinsed and filled with water 16 cm high.

Results and Discussion

The percentage composition of toasted velvet beans seed meal based diets is presented in Table 1.

Table 1: Percentage Composition of toasted velvet beans seed meal based diets

Ingredients	Diet 1 (0%TVBM)	Diet 2 (25%TVBM)	Diet 3 (50%TVBM)	Diet 4 (75%TVBM)	Diet 5 (100%TVBM)
TVBM	0.00	6.74	13.48	20.22	26.96
Soyabean meal	26.96	20.22	13.48	6.74	0.00
Fish meal	26.95	26.95	26.95	26.95	26.95
Groundnut cake meal	26.95	26.95	26.95	26.95	26.95
Maize meal	9.64	9.64	9.64	9.64	9.64
Vitamin premix	2.00	2.00	2.00	2.00	2.00
Vegetable oil	2.50	2.50	2.50	2.50	2.50
Bone meal	1.50	1.50	1.50	1.50	1.50
Methionine	1.50	1.50	1.50	1.50	1.50
Lysine	1.50	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50	0.50
	100.00	**100.00**	**100.00**	**100.00**	**100.00**

The proximate composition of the toasted velvet beans seed meal-based diets is presented in Table 2.

Table 2: Proximate Composition of the toasted velvet beans seed meal-based diets

Parameters	Diet 1 (Control)	Diet 2 (25% TVBM)	Diet 3 (50% TVBM)	Diet 4 (75% TVBM)	Diet 5 (100% TVBM)
Moisture content	11.23 ± 0.06^{a}	11.53 ± 0.06^{b}	11.47 ± 0.12^{b}	11.77 ± 0.03^{a}	11.83 ± 0.03^{a}
Crude protein	39.63 ± 0.25^{d}	40.23 ± 0.06^{b}	40.47 ± 0.12^{ab}	40.67 ± 0.12^{a}	39.90 ± 0.10^{c}
Crude fat	8.47 ± 0.12^{bc}	8.67 ± 0.12^{a}	8.37 ± 0.03^{c}	8.53 ± 0.02^{ab}	8.67 ± 0.06^{a}
Crude ash	5.73 ± 0.12^{a}	5.40 ± 0.17^{b}	5.13 ± 0.06^{c}	5.23 ± 0.06^{bc}	5.13 ± 0.06^{c}
Crude fibre	3.59 ± 0.01^{d}	3.61 ± 0.01^{c}	3.72 ± 0.01^{b}	3.75 ± 0.01^{a}	3.75 ± 0.01^{a}
NFE	32.54 ± 1.88^{a}	30.55 ± 0.39^{b}	33.85 ± 0.30^{b}	30.05 ± 0.24^{b}	30.71 ± 0.07^{b}
Gross energy (kcl/g)	437.36	433.88	446.55	433.61	433.28
Metabolizable energy (kcl/g)	364.91	361.15	372.61	359.65	360.47
Energy/protein ratio	9.20	9.00	9.20	8.84	9.03

Values in each row having the same superscripts are not significantly difference ($p<0.05$)

NFE (Nitrogen Free Extract) = 100 – (Moisture content + Crude protein + Crude fat + Crude fibre + Crude ash).

Gross energy = Caloric value of protein 5.65, NFE 4.1 and fat 9.45 kcal/g (NRC, 1993). Metabolizable energy = Caloric value of protein 4.0, NFE 4.0 and fat 9 kcal/g (Atwater's calculation as described by Foster and Smith (1997).

The growth performance and nutrient utilization of *Clarias gariepinus* fingerlings fed toasted velvet beans seed meal-based diets is presented in Table 3.

Table 3: Growth performance and nutrient utilization of *Clarias gariepinus* fingerlings fed toasted velvet beans seed meal-based diets

Parameters	Diet 1 (Control)	Diet 2 (25% TVBM)	Diet 3 (50% TVBM)	Diet 4 (75% TVBM)	Diet 5 (100% TVBM)
Mean initial weight (g)	5.47±0.15^{a}	5.63±0.15^{a}	5.33±0.15^{b}	5.23±0.06^{b}	5.27±0.21^{b}
Mean final weight (g)	24.64±0.33^{b}	27.68±0.25^{a}	24.00±0.26^{b}	21.11±1.18^{c}	17.63±0.69^{d}
Mean weight gain (g)	19.18±0.37^{b}	22.04±0.20^{a}	18.57±0.06^{b}	15.88±1.14^{c}	12.36±0.49^{d}
Relative eight gain (g)	351.03±13.96^{b}	391.49±11.15^{a}	350.15±8.1^{b}	303.31±20.22^{c}	234.70±2.87^{d}
Daily growth rate (g/day)	0.34±0.01^{b}	0.39±0.01^{a}	0.33±0.01^{b}	0.28±0.02^{c}	0.22±0.01^{d}
Specific growth rate (%/day)	2.69±0.06^{b}	2.85±0.04^{a}	2.69±0.04^{b}	2.49±0.10^{c}	2.16±0.02^{d}
Mean feed intake (g)	36.38±0.83^{b}	41.28±0.55^{a}	37.80±0.99^{b}	33.43±3.01^{c}	29.02±1.34^{d}
Food conversion ratio (FCR)	1.90±0.02^{c}	1.87±0.02^{c}	2.03±0.06^{b}	2.10±0.08^{b}	2.34±0.03^{a}
Protein intake (%)	14.55±0.33^{b}	16.51±0.22^{a}	15.12±0.39^{b}	13.37±1.21^{c}	11.61±0.54^{d}
Protein efficiency ratio (PER)	1.32±0.01^{a}	1.33±0.02^{a}	1.23±0.04^{b}	1.19±0.04^{b}	1.07±0.01^{c}
Survival rate (%)	95.33±0.58^{ab}	96.67±2.89^{a}	91.67±2.89^{bc}	88.33±2.89^{cd}	86.67±2.89^{d}
Total fish production (kg/m^{3})	2.35±0.04^{b}	2.68±0.06^{a}	2.20±0.10^{b}	1.87±0.16^{c}	1.53±0.11^{d}
Culture period (days)	56	56	56	56	56

Values in each row having the same superscripts are not significantly different ($p<0.05$)

The result is similar to other workers; Fasakin *et al.*, 1999; Obasa *et al*., (2013) and Nawwar *et al*., (2017).

Fish fed diets containing 25% velvet beans seed meal with 75% soyabean meal were observed to have the best result among the treatments, with final weight gain of 27.68 g, specific growth rate of 2.85 %/day and daily growth rate of 0.39 g/day daily. The survival rate was also 96.67% as in the diet 2.

Results of the feeding trial revealed that inclusion of graded levels of toasted velvet beans seed meal affected the growth patterns of the experimental fish. There was a trend of differences in growth and nutrient utilization parameters. The 25% TVBM ration gave the best results in terms of growth and survival rates. Diets with high inclusion levels (Diets 3, 4 and 5) resulted in reduced growth of *Clarias gariepinus* fingerlings. However, velvet beans seed is locally available at a very low cost and its inclusion in animal

especially fish feeds will reduce the competition for soyabean by man and animal, a research into effective and efficient usage in fish, livestock and poultry feeds and effective processing methods is recommended. The result is in line with those of other workers e.g. Obasa *et al*., (2013) and Nawwar *et al*., (2017).

Conclusion

In view of the proximate composition profile of toasted velvet beans seed meal and their wide and ready availability throughout the tropics and sub-tropics. It could be concluded that soyabean meal can be replaced at 25% level by toasted velvet beans seed meal without affecting the growth and nutrient utilization in practical diet of *Clarias gariepinus* fingerlings.

References

El-Sayed, A. F., (1999). Alternative dietary protein sources for farmed tilapia, *Oreochromis spp*. *Aquaculture*, *179*(1):149-168.

Fasakin, E. A., Balogun, A. M. and Fasuru, B. E., (1999). Use of duckweed, Spirodela polyrrhiza L. Schleiden, as a protein feedstuff in practical diets for tilapia, *Oreochromis niloticus* L. *Aquaculture Research*, *30*(5): 313-318.

Foster, D. N. and Smith E. J. (1997).Determination of true metabolizable energy and Caloric Density of food items. www.drsfostersmith.com/pic/article.cfm

Francis, G., Makkar, H. P. and Becker, K. (2012). Products from little researched plants as aquaculture feed ingredients. *Agrippa–FAO online Journal (www. fao. org/Agrippa*).

Magdi, A. O., (2004). Chemical and nutrient analysis of Baobab (*Adansonia digitata*) Fruit and Seed protein solubility. Plant. Food. Hum. Nutr., 59: 29-33.

Magouz, F. I., El-Gendi, M. O., Salem, M. F. I. and Elazab, A. A., (2008), October. Use of cucumber, squash and broad bean leaves as non-conventional plant protein sources in Nile tilapia (*Oreochromis niloticus*) diet. In *8th International Symposium on Tilapia in Aquaculture*. pp. 847-859.

Munguti, J. M., Liti, D. M., Waidbacher, H., Straif, M. and Zollitsch, W., (2006). Proximate composition of selected potential feedstuffs for Nile tilapia (*Oreochromis niloticus Linnaeus*) production in Kenya.

Mzengereza, K., Msiska, O. V., Kapute, F., Kang'ombe, J., Singini, W. and Kamangira, A., (2014). Nutritional Value of Locally Available Plants with Potential for Diets of Tilapia Rendalli in Pond Aquaculture in NkhataBay, Malawi. *Journal of Aquaculture Research and Development*, *5*(6), pp.1.

Nawwar Z. M., Izzaah S. M. A. and Seri N. A. N. (2017). Replacement of fish meal by white lead tree meal in the diets for juveniles of Giant River Prawn, *Macrobranchium rosenbergii* (De Man, 1879). Livestock Research for Rural Development 25 (6) 2013.

NRC- National Research Council (1993). Nutrient Requirements of fish. National Academy Press, Washington DC, USA. 114.

Obasa, S. O., W. O. Alegbeleye, A. A. Akinyemi, A. A. Idowu, N. A. Bamidele and A. N. Adesanya (2013). Replacement of maize meal by toasted African breadfruit

(*Treculia africana*) seed meal in the diet of *Clarias gariepinus* (Burchell 1822) fingerlings. Livestock Research for Rural Development 25 (6) 2013.

Osman, M. F., Omar, A. E. and Nour, A. M., (1996). The use of leucaena leaf meal in feeding Nile tilapia. *Aquaculture international*, *4*(1): 9-18.

METABOLİZMADA APOPTOZ, OTOFAJİ VE İNFLAMASYON

Dr. Öğr. Üyesi Serpil AYGÖRMEZ (ORCID: 0000-0002-5675-5096)
Kafkas University, Faculty of Veterinary Medicine, Department of Biochemistry, Kars-Turkiye
Email: serpilaygormez@hotmail.com

Araş. Gör. Aydın GENÇ (ORCID: 0000-0001-5367-0743)
Bingol University, Faculty of Veterinary Medicine, Department of Biochemistry, Bingol-Turkiye
Email: agenc@bingol.edu.tr

ÖZET
Her hücre, doğar, çoğalır (proliferasyon), farklılaşır (diferansiasyon) ve ölür (apoptozis). Bütün bu olaylar doğal bir denge halinde sürer gider. Apoptozis, organizmada hasar görmüş veya organizma için tehlikeli olabilecek hücrelerin yok edilmesinde görev alarak hücrenin yaşam çemberi boyunca yapım-yıkım dengesinin sürdürülmesini sağlar. Doku homeostazisi yani yeniden yapım ve yıkımın bir düzen içinde oluşu, apoptozis/proliferasyon dengesinin sağlıklı bir şekilde sürdürülmesine bağlıdır. Bir kalite kontrol sistemi olarak görev yapan otofaji mekanizması, uzun ömürlü proteinlerin, işlevsiz organellerin, sitozolik bileşenlerin, hasarlı makromoleküllerin ve patojenlerin yok edilmesinden sorumlu olan fizyolojik bir süreçtir. Otofajinin disfonksiyonu birçok hastalığın başlamasına ve ilerlemesine neden olmaktadır. Hücresel içeriğe bağlı olarak apoptozisin yetersiz kaldığı koşullarda otofaji ile hücre ölümü gerçekleşmektedir. Konu üzerine yapılan çalışmalar, klasik apoptoz ile otofaji arasında doğrudan bir bağlantı olduğunu doğrular nitelik taşımaktadır ve bu bağlantı moleküler düzeyde aydınlatılmaya başlanmıştır. İnflamasyon (yangı); kısaca dokularda fiziksel, kimyasal veya patojenler tarafından meydana getirilen hasar, yara veya yıkıma karşı gelişen fizyolojik bir yanıttır. Vücuttaki birçok iyileşme sürecinin temelinde inflamasyon oluşması yer alır. Apoptoz, otofajide görevli yolaklar ve inflamasyonu düzenleyen hücresel elemanlar arasındaki karşılıklı etkileşim oldukça karışık gibi gözükmektedir. Fakat bu alandaki araştırmalar kanser, çeşitli toksikasyonlar, enfeksiyonlar ve nörodejenaratif hastalıklar gibi sağlık problemleri için yeni tanı, takip ve tedavi yöntemlerine yol açma potansiyeli nedeniyle çok büyük önem arz etmektedir.
Anahtar Kelimeler: Apoptoz, Otofaji, İnflamasyon

APOPTOSIS, AUTOPHAGY AND INFLAMMATION IN METABOLISM

ABSTRACT

Each cell is born, multiplies (proliferation), differentiates (differentiation) and dies (apoptosis). All these events continue in a natural balance. Apoptosis ensures the maintenance of the balance of production and destruction throughout the life cycle of the cell by taking part in the destruction of cells that are damaged in the organism or that may be dangerous for the organism. Tissue homeostasis, that is, the regularity of reconstruction and destruction, depends on the healthy maintenance of the apoptosis/proliferation balance. Serving as a quality control system, the autophagy mechanism is a physiological process responsible for the elimination of long-lived proteins, dysfunctional organelles, cytosolic components, damaged macromolecules and pathogens. Dysfunction of autophagy causes the onset and progression of many diseases. In conditions where apoptosis is insufficient depending on the cellular content, cell death occurs through autophagy. Studies on the subject confirm that there is a direct connection between classical apoptosis and autophagy, and this connection has begun to be elucidated at the molecular level. Inflammation (fire); In short, it is a physiological response to damage, wound or destruction caused by physical, chemical or pathogens in tissues. Inflammation is at the basis of many healing processes in the body. The interaction between pathways involved in apoptosis, autophagy, and cellular elements regulating inflammation seems to be quite complex. However, research in this field is of great importance due to its potential to lead to new diagnosis, monitoring and treatment methods for health problems such as cancer, various toxications, infections and neurodegenerative diseases.

Keywords: Apoptosis, Autophagy, Inflammation

Giriş

1. Apoptoz

Apoptoz ilk olarak 1972 yılında Kerr, Wyllie ve Currie tarafından tanımlanmış ve nekrozdan farklı özellikler taşıyan bir hücre ölüm şekli olarak literatürlere girmiştir. Apoptoz hücrenin kendi otonom mekanizması tarafından düzenlenen yaşlanmış, zararlı, bakteri ve virüslerle infekte veya istenmeyen hücrelerin bir ahenk ve düzen içinde enerji (ATP) kullanımlı ve zaman endeksli iz bırakmadan öldürülmesi sürecidir. Başka bir deyişle apoptoz, yaşam boyu devam eden programlı bir şekilde bir hücrenin genetik olarak düzenlenen sistematik yok oluş serüvenidir (Coşkun & Özgür, 2011).

1.1. Apoptozun Temel Amaçları

Canlı hücrelere zarar vermeden ve iz bırakmadan düzenlenen apoptozun bazı temel amaçları vardır. Bunlar; Metamorfoz, embriyo gelişimi ve doku atrofisi sırasında olduğu gibi organizmaya hassas bir mimariyle şekil verilir. Organizmadaki toplam hücre sayısı düzenlenir. Tümör hücreleri, virüsle kontamine olmuş hücreler, otoimmun hastalıklara yol açan kendine zarar veren hücreler, kısacası istenmeyen ve zararlı hücreler ortadan kaldırılır ve bunlara karşı savunma oluşturulur (Elmore, 2007).

1.2. Apoptozu Uyaran Sinyal ve Uyarıcılar

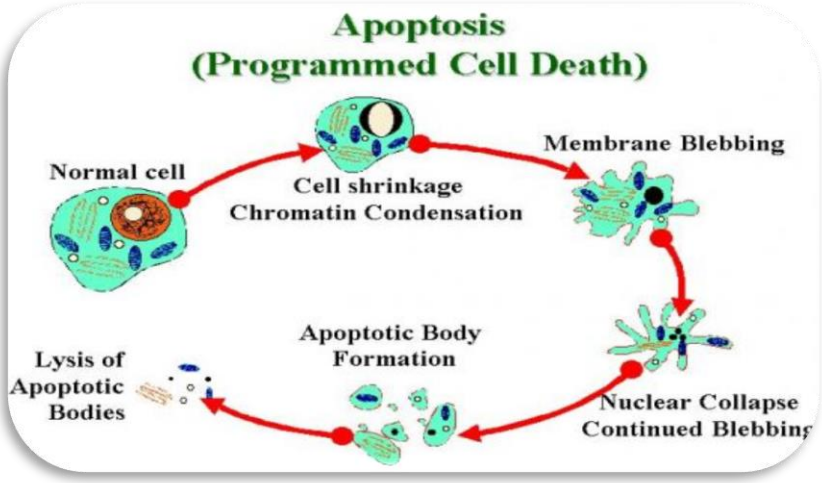
Apoptoz uyarıcıları; genetik kontrol, İyonize radyasyon, ilaçlar ve çevresel faktörler (kemoterapi, steroid tedavisi, insektisitler vb.), travmalar, viremi, bakteriyemi, sepsis ve septik şok gibi etkenler ile tanımlanmaktadır.

Apoptoz uyarıcı sinyallar, hücre içi ve hücre dışı sinyaller olmak üzere iki ana grupta sınıflandırılır. Hücre içi apoptoz sinyalleri; iyonize radyasyon, viral enfeksiyonlar, serbest radikaller sebebiyle oluşan oksidatif stres iken; hücre dışı apoptoz sinyalleri ise hormonlar, büyüme faktörü gibi sağkalım sinyalinde eksiklikler, bitişik hücreler ile temas olarak literatüre geçmiştir (Coşkun & Özgür, 2011).

1.3. Apoptoz Aşamaları

Apoptoz sırasıyla ölüm sinyali, kromatinde sıkışma, hücrede parçalanma, yutulma (fagositoz) şeklinde özetlenebilir. Eksternal olarak; hücreler hacim kaybeder ve büzüşür. Hücre yüzeylerinde küresel kabarcıklar oluşur. Phospatidylserine isimli fosfolipid, hücrelerden dışarı çıkar. İnternal olarak; Stoplazma yoğunlaşır Mitokondriyum sitokrom-c gibi apoptozu uyaran faktörleri serbestleştirerek bütünlüğünü kaybeder ve parçalanır. Kaspazlar aktive olur. Kromozal DNA'lar parçalanır. Moleküler ağırlığı 100 daltonun

üzerinde olan ve metabolizmada çok önemli rollere sahip birçok protein de benzer şekilde parçalanır (Gültekin et al., 2008).



Şekil 1.1. Hücresel Apoptoz Süreci (Gültekin et al., 2008).

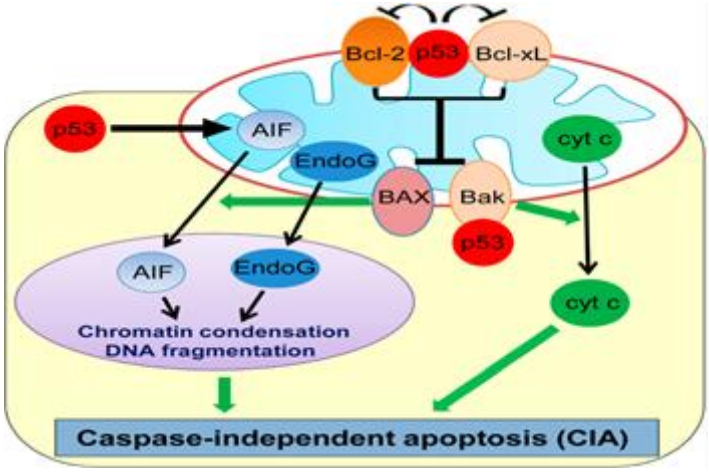
1.4. Apoptozu Baskılayan ve Uyaran Genler

Tablo 1.1. Apoptozun Düzenlenmesinde Görevli Genler (Hasan & Bildik, 2008).

Apoptozu Baskılayan Genler	Apoptozu Uyaran Genler
Bcl-2	Bax
Bcl-XL	Bak
Bcl-W	Bcl-xs
Mcl-1 A1	Bad
Nr-13	Bik
Ced-9	Bid
	Bim
	Noxa

1.5. Apoptozun Düzenlenmesi

Memelilerde apoptozun düzenlenmesi p53 proteini ile başlayan ve kaspazlara kadar devam eden bir süreçtir. Bir tümör süpressör gen olarak çalışan p53 mutasyona uğradığı ya da bulunmadığı zaman hücre yaşam süresi uzar. Genotoksik olaylarla oluşan hücre hasarı p53'ü aktive eder ve p53 protein ürünü DNA'ya doğrudan bağlanarak hasarı tanıdıktan sonra, ya G1' de hücre siklusunun durmasını uyararak tamir yapar ya da hasar fazlaysa apoptoza yönlendirir. Ayrıca p53ün apoptozda görevli genler olan Bax/Bax, Bax/Bcl–2, Bcl-2/Bcl-2 gruplarının oranlarını düzenlediği düşünülmektedir (Elmore, 2007).



Şekil 1.2. Apoptozun Düzenlenmesi (Ranjan & Iwakuma, 2016).

1.6. Apoptoz Mekanizmaları

Hücre içi ve hücre dışı faktörlerin uyarımı sonucunda hücreyi ölüme götüren 3 farklı apoptoz mekanizmasından söz edilir. Bunlar mitokondri yolu, TNF ve Fas ligand (ölüm reseptörleri) yolu, AIF (Apoptozu başlatan faktör) yolu olarak sınıflandırılmaktadır.

1.6.1. Mitokondri Yolu

Apoptozun regülasyonu Bcl–2/Bax gen ailesi ile sağlanır. Bu ailenin 20 üyesi vardır; bunlardan bazıları apoptoz inhibitörüdür (antiapoptotik), bazıları ise apoptozu uyarır ve proapopitotik genler olarak tanımlanır.

Hücrenin yaşayabilirlik durumu bu ailenin proapoptotik ve antiapoptotik üyelerinin oranına bağlıdır.

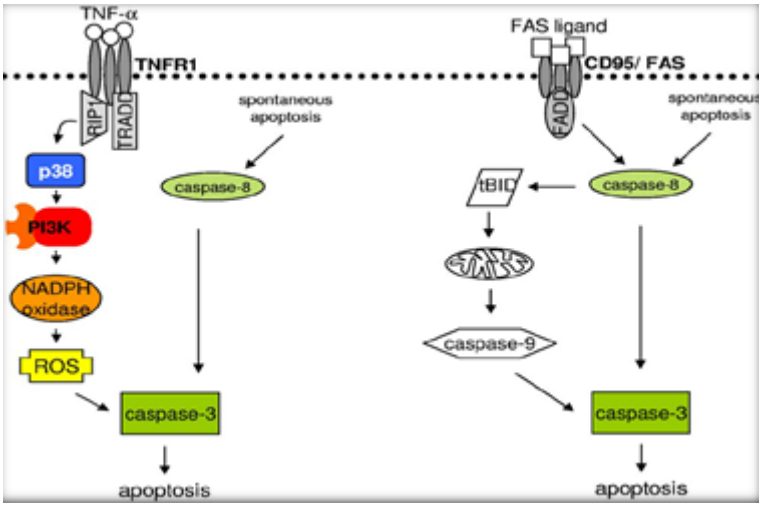
Bcl–2/Bax gen ailesinin ürünleri, mitokondri ve çekirdek zarlarının yanı sıra endoplazmik retikulum zarının üzerinde de yer alırlar.

Mitokondri yolunun uyarımı DNA hasarı, oksidanlar, seramid, büyüme faktörü eksikliği, radyasyon, kemoterapötikler gibi etkenler ile gerçekleşir (Savitskaya & Onishchenko, 2015).

1.6.2. TNF ve Fas Ligand (ölüm reseptörleri) Yolu

Fas ve TNF alfa reseptörleri hücre zarında bulunurlar ve uygun ligandlar ile bağlandıklarında normal şartlarda inaktif konumda olan prokaspaz 8'i aktifleştirerek kaspazların aktivasyonunu başlatarak, hücreyi ölüme götürürler.

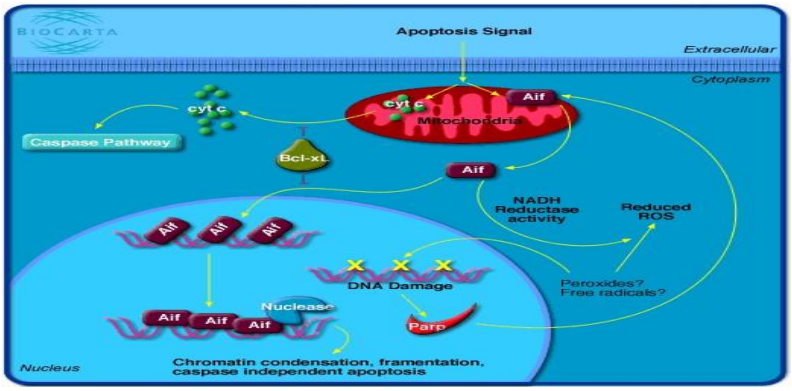
Bu yol daha çok immün cevap reaksiyonlarında ve infeksiyonlarda kullanılan bir yoldur (Savitskaya & Onishchenko, 2015).



Şekil 1.3. TNF ve Fas Ligand (ölüm reseptörleri) Yolu (Geering et al., 2011).

1.6.3. Apoptoz İndükleyici Faktör (AIF) Yolu

AIF yolu aşırı stres koşullarına maruz kalan hücrelerin kaspaz bağımlı diğer 2 apoptoz mekanizmasından farklı olarak kaspaz yoluna alternatif biçimde AIF yolunu kullandığı bir apoptoz türüdür. Normal koşullarda mitokondri zarları arasındaki ara bölgede yer alan AIF proteini, hücrenin ölmesi gerektiğini belirten bir sinyal ile sitokrom-c ile mitokondriden dışarı çıkarak çekirdekte DNA'ya bağlanır. DNA'ya bağlanınca nükleaz aktivitesine yol açarak DNA fragmentasyonunu uyarır (Savitskaya & Onishchenko, 2015).



Şekil 1.4. Apoptoz İndükleyici Faktör (AIF) Yolu (Polster, 2013).

2. Otofaji

Otofaji evrimsel olarak korunmuş, hücresel içeriği autophagosome olarak adlandırılan çift zarlı vezikül tarafından saklanan ve degredasyonu lizozomal olarak yapılan, protein degredasyonu ve organel turnover gibi homeostatik fonksiyonları sürdüren katabolik bir

süreçtir. Geleneksel olarak, otofaji hücresel strese yanıt olarak hücre kalite kontrolü için, hayatta kalma mekanizması olarak düşünülmektedir. Bazal otofaji, zarar görmüş organeller, uzun ömürlü proteinler ve protein agregatlarını uzaklaştırmak, besin ve büyüme faktörü eksikliği gibi hücresel strese yol açan durumlarda hızla aktive olmaktadır. Hücre içi yapılar için alternatif kaynak ve hücre yaşamının devamı için enerji üretimine substrat sağlamaktır. Hücrenin gerekli besini bulunduğu ortamdan alamaması durumunda, kendini içten yiyerek varlığını sürdürmesidir. Ayrıca otofaji patojen enfeksiyonu, hipoksi, besin azalması ya da reaktif oksijen türleri (ROS) gibi hücresel stres ile tetiklenebilir. Hücrenin zor koşullara uyumunu sağlayan bu özelliği ile yaşamsal organları tüketerek ölüme yol açmaktadır. Kontrolü bozulduğunda kanser, erken bunama, bazı kalıtsal hastalıklar, Alzheimer ve enfeksiyonların oluşmasına sebep olmaktadır (Karadag, 2016).

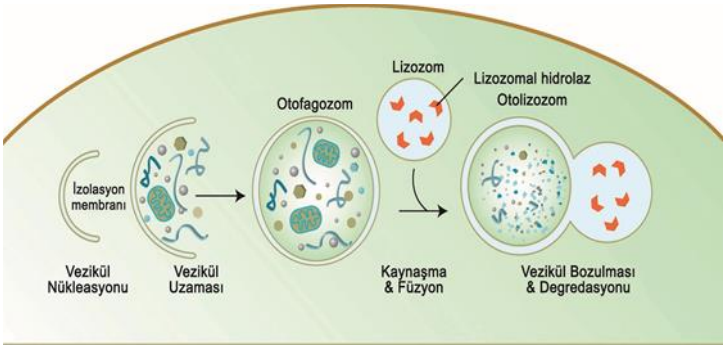
Çalışmaların çoğu açlık tarafından tetiklenen, hücre sağkalımında otofajinin fonksiyonu üzerine odaklanmıştır. Bununla birlikte, otofaji, apoptoz ya da diğer hücre ölüm yolları veya bağımsız bir şekilde ölüm süreçleri ile sıkı bir şekilde bağlantılıdır. Nomenklatür Komitesi (NCCD), hücre ölümü araştırma alanında önde gelen araştırmacılardan oluşan bir grup, otofaji ilişkili hücre ölümü ile "otofajik hücre ölümü" olarak adlandırılmıştır (Karadag, 2016).

Otofaji, hücrelerin hücre içi besin ve enerji üretimine ihtiyacı olduğunda hızla aktive edilir. Dolayısıyla hücre yoğunluğu, oksijen konsantrasyonu, sıcaklık, hormonal faktörler ve besin durumu otofajinin kontrolünde önemlidir. Hücre ve dokuların morfolojik analizleri birçok organizmada gelişimsel hücre ölümü sırasında otofajik aktivitenin arttığını göstermiştir. İnsect metamorfozu, kuşlardaki kol kanat morfogenezi, memelilerdeki damak kapanması sırasındaki hücre ölümleri buna örnek verilebilir. Her ne kadar otofajik aktivite ve hücre ölümü arasındaki rastlantısal ilişki tespit edilememiş olsa da ve sadece gözlemleme seviyesinde kalınsa da bu çalışmalar otofajik aktivitenin hücre ölümü üzerine etkisini dikkatle incelenmesine yol açmıştır (Kuma & Mizushima, 2010).

Otofajide, otofagozom veya otofajik vakuol olarak bilinen çift veya daha fazla membran yapıları oluşur. Memelilerde otofagozomun dış membranı lizozomla, maya ve bitkilerde ise vakuolle kaynaşır. Yapılan çalışmalarda özel koşullar altında uyaranın özelliğine bağlı olarak, büyüklüğü ve süresi otofajinin uzatılması hücreyi ölüme

götürebilir. Kromatin kondensasyonu gibi nükleer değişiklikler otofajik hücre ölümünde apoptoziste olduğundan sonra gözlenmektedir ve DNA fragmentasyonu ve apoptotik cisimciklerin oluşumu yoktur. Fagositoz tarafından ölü hücrelerin temizlenmesi apoptoziste görülenden daha geç ve oldukça düzensiz olarak meydana gelebilmektedir (Dunn, 1990).

Otofajik hücre ölümü Tip II hücre ölümü olarak tanımlanmış olup bu hücre ölüm tipindeki en büyük morfolojik değişiklik mitokondri ve endoplazmik retikulum gibi organeller ve/veya sitoplazmanın bir kısmının çift veya çok membranlı veziküller içine alınmasıdır. Bu veziküller lizozomlarla kaynaşırlar ve aynı hücrenin lizozomal enzimleri tarafından degredasyonu yapılmaktadır. Bu işlem Yunanca'da *'self-eating'* anlamına gelen *'kendi kendini yeme'* terimi olan otofaji olarak adlandırılmaktadır. Hücrenin açlıkla karşı karşıya kaldığı koşullarda besin ve enerji elde etmek için hücre içindeki yapıları parçaladığını ifade etmek için kullanılmıştır (Karadag, 2016).



Şekil 2.1. Otofaji Aşamalarının Şematik Gösterimi (Melendez & Levine, 2009).

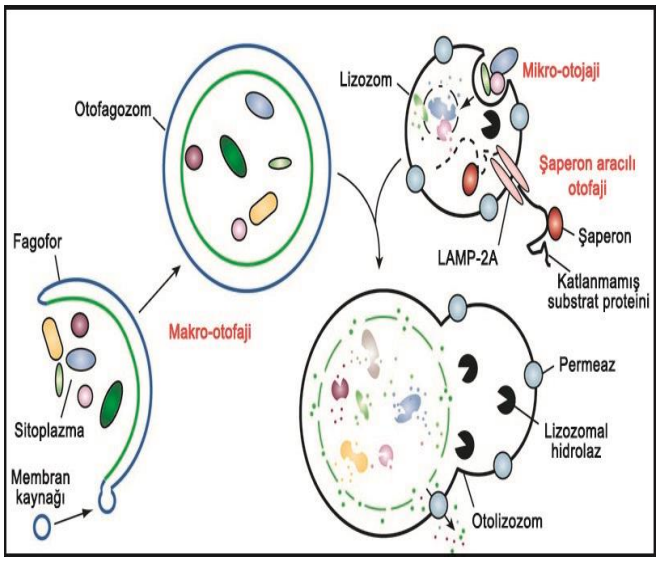
2.1. Otofajinin Farklı Tipleri

Otofaji üç farklı şekilde gerçekleşebilir. Bunlar mikro otofaji, makro otofaji ve şapheron aracılı otofaji olarak sınıflandırılmaktadır. AIF yolu aşırı stres koşullarına maruz kalan hücrelerin kaspaz bağımlı diğer 2 apoptoz mekanizmasından farklı olarak kaspaz yoluna alternatif biçimde AIF yolunu kullandığı bir apoptoz türüdür (Yamamoto & Matsui, 2023).

Mikro otofaji: Küçük parçacıkların membranda oluşan girintiyle lizozom içine alınıp degredasyonunun yapılmasıdır.

Makro otofaji: Otofajik hücre ölümünü oluşturan temel mekanizmadır. Daha büyük parçacıkların, organellerin otofagozom içine alınıp daha sonra lizozomlarla birleşerek meydana gelen degredasyondur.

Şapheron aracılı otofaji: Belli bir peptid sekanslı sitozolik proteinlerin moleküler şapheronlarla kompleks olan Hsp73 tarafından tanınması ve lizozomlara taşınmasıdır. Bu tip protein degredasyon yolağında veziküler bir trafiğe gerek yoktur.



Şekil 2.2. Otofajinin Farklı Tipleri (Mizushima et al., 2008).

2.2. Otofajik Hücre Ölümünün Düzenleyici Mekanizmaları

PI3 kinaz tip I insülin benzeri büyüme faktörleri tarafından aktive edilir ve mTOR'un düzenleyicisi olan PDK 1 ve AKT üzerinden otofajiyi inhibe eder. Otofajiyi nasıl inhibe ettiği bilinmemekle beraber bir serin/treonin kinaz olan Atg 1 ile komplex oluşturan bir protein olan Atg 13'ün fosforilasyonuyla yaptığı düşünülmektedir. Tümör hücresini ölüme götüren rapamycin, tamoxifen, arsenic trioxide ve radyasyon gibi birçok anti kanser ajanlar otofajiyi indükleyebilirler. PTEN, p53 ve p19ARF gibi birçok tümör baskılayıcı gen, otofajiyi aktive ederken AKT, c-Myc, PI3K ve Ras gibi birçok onkoprotein de otofajiyi baskılamaktadır. Otofaji tümör baskılama mekanizması; genotoksik stresin azaltılması, hücre ölümünün başlatılması, nekroz ve enflamasyonun durdurulması, degrade ve modüle edici sinyal proteinlerinin düzenlenmesi gibi mekanizmalarda temel rol alır. Aminoasit ve/veya büyüme faktörü yokluğunda otofajiyi regüle eden p53 ve mTOR yolağı arasında ise bir ilişki ortaya konmuştur. Antiapoptotik

bir sinyal yolağında etkili olan mTOR aktivitesinin inhibe edilmesiyle, p53 aktivasyonu otofajiyi uyarır (Fukushima et al., 2012).

Mayada mitokondri dış membran proteini olan Uth1p mitokondrial otofaji için gereklidir ve bunun genlerinin inaktivasyonu Bax veya rafamisinle indüklenen hücre ölümüne direnç meydana getirmektedir. Açlık olmayan koşullar altında mayada mitokondrial bozukluklara neden olan mutasyonlar, mitokondrial membran potansiyelinin kaybı, mitokondrial biyogenezisteki defektler, mitokondrial otofajik hücre ölümünü uyardığı gösterilmiştir. Otofajide mitokondrinin eliminasyonunun artmasıyla hücre içinde ATP konsantrasyonunun da arttığı gözlenmiştir. Memeli hücrelerinde dış mitokondriyal membranda bulunan Bcl-2 ailesi üyeleri otofajiye etki eder. Bcl-2 downregülasyonu, insan lösemi hücrelerinde kaspaz bağımsız bir yolda otofajiyi artırır. Bcl-2, belcin-1 gibi anahtar otofajik proteinlerle direk ilişkiye girerek otofajinin regülesyonunda rol oynar Bcl-2, bir otofaji proteini olan Beclin-1 ile direk bir interaksiyon yoluyla otofajiyi inhibe eder. Fakat mitokondride Bcl-2 proteinlerinin otofajiyi regüle edici işlevleri henüz tam olarak açıklanamamıştır. Bcl-2 ve Bcl-XL gibi anti-ölüm üyelerinin fazla ekspresyonu otofajik hücre ölümünden hücreleri korurken, BH3 domaini içeren ölüme indükleyici üyeleri olan Bax ve BNIP3 otofajik hücre ölümüne neden olmaktadır. Bax, reaktif oksijen türlerinin birikmesine, lipit peroksidasyonuna ve plazma membran değişiklerine neden olarak hücreyi ölüme götürmektedir. Yine BNIP3 ekspesyonunun artmasıyla, BNIP3'ün dimerizasyonla aktif hale geçmesi de seramid ve arsenik trioxidle otofajik hücre ölümünü uyarmaktadır (Camougrand et al., 2004; Marinkovic et al., 2021).

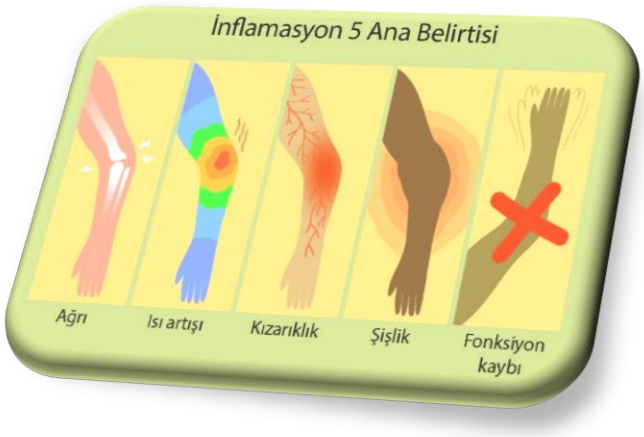
2.3. Apoptotik ve Otofajik Hücre Ölümü Arasındaki İlişkiler

Apoptotik ve otofajik hücre ölümü arasında karşılıklı ilişkiler bulunmaktadır. Örneğin, bazı proapoptotik sinyaller (Dışsal apoptoz yolağı bileşenleri olan TRAIL, TNF ve FADD, seramid, kalsiyum-kalmodulinle regüle edilen serin-treonin kinazlar olarak bilinen DRP-1 ve DAPK1) otofajiyi indükler. Buna karşın, Sınıf I PI3K/AKT/TOR sinyalizasyonu gibi antiapoptotik sinyaller otofajiyi baskılamaktadır. Apoptozun mitokondriyal regülasyonunu sağlayan genler, otofaji yolağıyla birbirini etkileyebilir. Bu yüzden mitokondrinin, otofaji ve apoptoz yolaklarının birbirini etkilemesine neden olan bir bağlantı noktası özelliği gösterdiği düşünülmektedir. Hücrelerin enerji üreten motorlarında (mitokondriler) yaşlanma sürecinde oluşan bozuklukların, kanserde, beyin,

sinir sistemi harabiyeti, kas ve güç kaybında rol oynadığı gösterilmektedir. Bozulup hücreye zarar vermeye başlayan mitokondriler otofaji mekanizması sayesinde yok edilir. Yaşlandıkça bu sistem yavaşlamaktadır. Bozuk mitokondri birikimi artmakta, genetik yapısı zedelenen hücreler çeşitli hastalıkları tetikleyebilmektedir (Gump & Thorburn, 2011).

3. İnflamasyon

İnflamasyon, enflamasyon, yangı veya halk arasında bilinen adı ile iltihaplanma, kan damarları ile beslenen dokuların, her türdeki hasar karşısında (canlı, cansız yabancı etkene veya içsel/dışsal doku hasarına) verdikleri fizyolojik yanıtların bütünüdür. Latince olarak "ateşe vermek" teriminden köken almıştır ve amaç, bağışıklık sistemine ait hücrelerin saldırının olduğu bölgeye çekilip saldırganı yok etmesine imkân vermektir. Fiziksel ajanlar, Kimyasal maddeler ve bağışıklık reaksiyonları inflamasyonun başlıca oluşma sebepleridir (Abdulkhaleq et al., 2018).



Şekil 3.1. İnflamasyonun 5 Ana Belirtisi (Germolec et al., 2018).

3.1. İnflamasyon Çeşitleri

İnflamasyonun akut ve kronik şekilde seyreden tipleri vardır. Akut inflamasyon hızlı bir şekilde başlar ve kısa sürede şekillenir (birkaç saat ile bir gün arasında). Hızlıca oluştukları için yangılı alana sayıca hakim hücreler nötrofil ve lökositlerdir. Bunun yanında makrofajlar da sıkça görülür. Sayıca az da olsa lenfositler görülebilir. Erken başlar ve kısa süreli yangılardır. Damar içindeki sıvı dokuya sızar ve Polimorfonükleer yapılı lökositler zedelenen dokuya gelirler.

Kronik yangılar uzun sürede (3-4 hafta ve daha fazla) gelişirler. Akut yangılara nispeten ağrı duyusu daha azdır. Mikroskopik incelemede yangılı alanda sayıca lenfositlerin üstün olduğu görülür. Genellikle bu tür yangılarda fibrinleşme görülür. Bunun yanında akut yangılar zamanla kronik hale de gelebilirler. Geç başlar ve uzun süreli yangılardır. Lenfositler, makrofajlar ve kan damarları çoğalır, skar dokusu gelişir (Ward, 2010).

3.2. İnflamasyonda Rol Oynayan Kimyasal Aracılar

Bir yangısal reaksiyonda belirli süreçleri tetikleyen kimyasal maddelerdir. Kompleks olmayan bir inflamasyonda bu maddeler birbirlerini karşılıklı olarak aktive ederler veya baskılarlar; böylece, inflamasyondaki bireysel adımlar koordineli bir defansif (savunmacı) reaksiyon oluştururlar. Bunlar (kininlerde olduğu gibi) ölü dokulardan elde edilebilir ya da canlı dokulardan oluşturulabilir (Juhn et al., 2008).

3.3. Hücrelerden Elde Edilen Mediatörler

Bunlar ya bunları aktive biçimde salgılayan belirli hücreler içinde depolanmış mediatörlerdir ya da hücreler tarafından özellikle sentezlenen mediatörlerdir. Histamin mast hücre ve bazofil granüllerinde depolanır. Bu inflamasyonun alerjik formlarında kilit bir rol oynar. Histamin; Antijen-antikor kompleksleri tarafından salgılanır ve hücrelerin membrana bağlı IgM molekülleri tarafından önceden duyarlılığı gerektirir. Serotonin trombositlerden ve ince bağırsaktaki enretokromoffin hücrelerden gelir. Etkileri histamininkine benzer. Damar geçirgenliğinde artışa neden olur (Abdulkhaleq et al., 2018).

3.3.1. ICAM-3 Proteini

İnterselüler adhezyon molekülü-3 olarak da bilinir. Lökositlerin hücre yüzeyinde bulunan bu molekül, antijen sunan hücreler ile T-lenfositlerin etkileşiminde son derece önemli rol oynar. Bu etkileşim, hem ICAM-1, ICAM-2 ve ICAM-3'ün LFA-1 molekülleri ile etkileşime girmesi hem de T hücre yüzeyinde bulunan CD2 molekülü ve APC'nin sunduğu LFA-3'ün etkileşime girmesi sayesinde gerçekleşir (Fougerolles et al., 1994).

3.3.2. Sitokinler

Yangının patobiyokimyasında önemli rol üstlenen komplementler hücre membranında bulunan protein yapıda mediatörlerdir.

Sitokinler (lenfokinler) hücresel düzenleyici proteinlerdir. Çeşitli uyarılara karşı cevap olarak özel hücreler (T Lenfositler) tarafından salgılanır ve hedeflenen hücrelerin

davranışını etkilerler. Belli bir sitokin çeşitli hücreler tarafından farklı dokularda salgılanır ancak aynı benzeri biyolojik etkinliği gösterir. Sitokinlerin etkileri sistemik veya lokaldir.

Lenfosit kaynaklı sitokinler; IL-2, IL-4, IL-5, IL-12, IL-15, TGF-β (transforming growth factor). IL-10 ve TGF-β immun yanıtı azaltırken, IL-2, IL-4 lenfosit gelişimini indüklerler. Yangısal olaylarda genel olarak stimulan (proinflamatuvar) veya depresif (antiinflamatuvar) etki gösterirler. Sitokinlerin temel görevleri arasında makfrojlarda kemotaksisinin başlatılması, damar permeabilitesinde (geçirgenlik) artış ve immunite (bağışıklık) sayılabilir.

Makrofaj/monosit kaynaklı sitokinler ise IL-1α ve β, TNF-α'dır. Bazı sitokinler tedavi amacıyla ilaç olarak kullanılmaktadır; IFN'ların kanser (IFN-α), hepatitis (IFN-α), kronik granülomatoz hastalık (IFN-γ) ve multiple skleroz (IFN-β) ve IL-2'nin renal kanser ve melanoma tedavisinde yer edinmiştir. Th2 hücreleri (Tip-2 Yardımcı T Lenfosit), bağışıklık sisteminde T-hücre reseptörleri aracılığıyla hem allerjen peptitleri doğrudan tanıyan hem de interlöykinlerin (IL) salınımı sağlayan tek hücre sistemidir ve bu da alerjik yangıda IgE antikoru üreten B hücreleri (IL-4, IL-13), mast hücreleri (IL-4, IL-10), ve eozinofil'ler (IL-5) ile ilişkisini ortaya koyar. Lökosit kemotaksis'i ve kemokinezis'ini etkileyen sitokinler arasında; IL-8, eotaksin ve makrofaj enflamatuvar protein-1α bulunmaktadır (Opal & DePalo, 2000).

Sonuç

Metabolizmada apoptoz, otofaji ve inflamasyonun düzenlenmesindeki temel moleküler mekanizmalar ve bu mekanizmaların kanser, hastalıklar ve diğer patolojik durumlarla ilişkileri tam olarak açıklanamamaktadır. Bununla birlikte apoptoz, otofaji ve inflamasyonun farmakolojik olarak düzenlenmesi hastalıklara yönelik yeni tedavi stratejileri için önemli klinik potansiyele sahiptir. Otofajinin uyarılması, özellikle apoptoz mekanizması hasar görmüş olan kanser hücrelerinin alternatif hücre ölüm mekanizması olarak ya da normal hücrelerde kanser gelişiminin önlenmesinde faydalı olabilir. Gelecekte klinik örneklerde programlı hücre ölümleri ve inflamasyon düzeylerini değerlendirmek amacıyla yeni moleküler yöntemler geliştirilmeli ve bu süreçleri değerlendirmek amacıyla yeni biyolojik belirteçler araştırılmalıdır.

Kaynaklar

1) Coşkun, G., & Özgür, H. (2011). Apoptoz ve nekrozun moleküler mekanizması. *Arşiv Kaynak Tarama Dergisi*, *20*(3), 145-158.

2) Elmore, S. (2007). Apoptosis: a review of programmed cell death. *Toxicologic pathology*, *35*(4), 495-516.

3) Gültekin, N., Karaoglu, K., & Küçükate, E. Hücrede apoptoz ve sağkalım mekanizmalarının keşfedilmesi ve yeni potansiyel tedavi stratejileri.

4) Akşit, H., & BİLDİK, A. (2008). Apoptozis. *Yüzüncü Yıl Üniversitesi Veteriner Fakültesi Dergisi*, *19*(1), 55-63.

5) Ranjan, A., & Iwakuma, T. (2016). Non-canonical cell death induced by p53. *International journal of molecular sciences*, *17*(12), 2068.

6) Savitskaya, M. A., & Onishchenko, G. E. (2015). Mechanisms of apoptosis. *Biochemistry (Moscow)*, *80*, 1393-1405.

7) Geering, B., Gurzeler, U., Federzoni, E., Kaufmann, T., & Simon, H. U. (2011). A novel TNFR1-triggered apoptosis pathway mediated by class IA PI3Ks in neutrophils. *Blood, The Journal of the American Society of Hematology*, *117*(22), 5953-5962..

8) Polster, B. M. (2013). AIF, reactive oxygen species, and neurodegeneration: a "complex" problem. *Neurochemistry international*, *62*(5), 695-702.

9) Karadağ, A. (2016). Otofaji: programlı hücre ölümü. *Ankara Sağlık Hizmetleri Dergisi*, *15*(2), 19-26.

10) Kuma, A., & Mizushima, N. (2010, September). Physiological role of autophagy as an intracellular recycling system: with an emphasis on nutrient metabolism. In Seminars in cell & developmental biology (Vol. 21, No. 7, pp. 683-690). Academic Press.

11) Dunn Jr, W. A. (1990). Studies on the mechanisms of autophagy: maturation of the autophagic vacuole. *The Journal of cell biology*, *110*(6), 1935-1945.

12) Meléndez, A. Levine, B. Autophagy İn C. Elegans (2009), Wormbook, Ed. The C. Elegans. Research Community, Wormbook, Doi/10.1895/Wormbook.1.147.1.

13) Yamamoto, H., & Matsui, T. (2023). Molecular mechanisms of macroautophagy, microautophagy, and chaperone-mediated autophagy. *Journal of Nippon Medical School*, JNMS-2024_91.

14) Mizushima, N., Levine, B., Cuervo, A.M., Klionsky, D.J. (2008) Autophagy Fights Disease Through Cellular Self-Digestion. Nature 451, 1069-1075.

15) Fukushima, T., Nakamura, Y., Yamanaka, D., Shibano, T., Chida, K., Minami, S., ... & Takahashi, S. I. (2012). Phosphatidylinositol 3-kinase (PI3K) activity bound to insulin-like growth factor-I (IGF-I) receptor, which is continuously sustained by IGF-I stimulation, is required for IGF-I-induced cell proliferation. *Journal of Biological Chemistry*, *287*(35), 29713-29721.

16) Camougrand, N., Kiššová, I., Velours, G., & Manon, S. (2004). Uth1p: a yeast mitochondrial protein at the crossroads of stress, degradation and cell death. *FEMS yeast research*, *5*(2), 133-140.

17) Marinković, M., Šprung, M., & Novak, I. (2021). Dimerization of mitophagy receptor BNIP3L/NIX is essential for recruitment of autophagic machinery. *Autophagy*, *17*(5), 1232-1243.

18) Gump, J. M., & Thorburn, A. (2011). Autophagy and apoptosis: what is the connection?. *Trends in cell biology*, *21*(7), 387-392.

19) Abdulkhaleq, L. A., Assi, M. A., Abdullah, R., Zamri-Saad, M., Taufiq-Yap, Y. H., & Hezmee, M. N. M. (2018). The crucial roles of inflammatory mediators in inflammation: A review. *Veterinary world*, *11*(5), 627.

20) Ward, P. A. (2010). Acute and chronic inflammation. *Fundamentals of inflammation*, *3*, 1-16.

21) Juhn, S. K., Jung, M. K., Hoffman, M. D., Drew, B. R., Preciado, D. A., Sausen, N. J., ... & Huang, T. (2008). The role of inflammatory mediators in the pathogenesis of otitis media and sequelae. *Clinical and experimental otorhinolaryngology*, *1*(3), 117-138.

22) De Fougerolles, A. R., Qin, X., & Springer, T. A. (1994). Characterization of the function of intercellular adhesion molecule (ICAM)-3 and comparison with ICAM-1 and ICAM-2 in immune responses. The Journal of experimental medicine, 179(2), 619-629.

23) Opal, S. M., & DePalo, V. A. (2000). Anti-inflammatory cytokines. *Chest*, *117*(4), 1162-1172.

BAZI BALIK TÜRLERİNİN KAS VE KARACİĞERİNDEKİ MİKROPLASTİKLERE GENEL BİR BAKIŞ

Çiğdem KIRSÜLEYMANOĞLU (ORCID):0000-0001-7262-1349)
Ondokuz Mayıs Üniversitesi, Lisansüstü Eğitim Enstitüsü, Samsun
Email: cigdem-_-20@hotmail.com

Prof. Dr. Dilek ÇELİKLER (ORCID):0000-0002-9945-7195)
Ondokuz Mayıs Üniversitesi, Eğitim Fakültesi, Samsun
Email: dilekc@omu.edu.tr

ÖZET
Günümüzde en önemli çevresel problemlerden biri deniz atıklarıdır. Deniz atıkları yoğun nüfuslu bölgelerde olduğu kadar, insanların yoğun yaşamadığı alanlarda ve tüm sucul ekosistemlerde de bulunmaktadır. Zamanla az nüfuslu şehirlerin kıyısal alanlarında bile deniz atıkları ciddi bir problem haline gelmiştir. Gelişen teknoloji ile birlikte dayanıklı ve düşük maliyetli olmaları sebebiyle plastik kullanımının artması, deniz atıkları içerisinde plastik atıkların oranını da arttırmıştır. Karada ve denizde gerçekleşen faaliyetler sonucu oluşan plastik atıklar doğaya bırakıldığında hava olayları ve yüzey sularıyla sucul ekosistemlere ulaşabilmektedir. Plastikler, doğada parçalanmasının uzun zaman alması ve küçük parçacığa bölünerek doğada kaybolmaması nedeniyle önemli bir tehdit haline gelmiştir. Deniz atıkları arasında önemli bir yer tutan plastikler, fiziksel ve kimyasal değişimlerle parçalanarak küçük boyutlara dönüştüğünde mikroplastik olarak adlandırılmaktadır. Mikroplastikler denizel ortamlardan kolaylıkla besin zincirine katılarak sucul ortamda yaşayan canlılara zarar verebilmektedir. Sucul ekosistemde yaşayan canlılar denizdeki mikroplastik parçaları yiyecek sanmaları nedeniyle özellikle balıkların sindirim sisteminde, kaslarda ve karaciğerde birikebilmektedir. Deniz biyotasında yutulan mikroplastikler dışkıyla dışarı atılabildiği gibi mide bağırsak yolunda kalabilmekte, bu da balık midesinde hasara ya da yanlış bir dolgunluk hissine neden olabilmektedir. Bazı durumlarda mikroplastikler daha küçük boyutlara ayrılarak bağırsak duvarından kas ve karaciğerlere geçerek dokulara zarar verebilmektedir. Plastiklere eklenen katkı maddeleri balıklar tarafında yutulduğunda kas ve karaciğer dokularında iltihaplanma, yaralanma gibi olumsuz etkilere sebep olabilmektedir. Bu nedenle insanlar için önemli bir besin kaynağı olan balıklar mikroplastik çalışmalarında en çok araştırılan grup olmuştur. Fourier Dönüşümlü Kızılötesi Spektroskopisi ile balık türlerinin karaciğer ve kas dokularında yapılan analiz incelemelerinde en çok karşılaşılan mikroplastik türlerinin polipropilen ve polietilen polimerleri olduğu tespit edilmiştir.
Anahtar Kelimeler: Mikroplastik, Karaciğer, Kas, Polietilen, Polipropilen.

A GENERAL OVERVIEW OF MICROPLASTIC IN THE MUSCLE AND LIVER OF SOME FISH SPECIES

ABSTRACT

One of the most important environmental problems today is marine waste. Marine debris is found in densely populated areas as well as in areas where people do not live densely and in all aquatic ecosystems. Over time, marine debris has become a serious problem even in coastal areas of sparsely populated cities. The increase in the use of plastic due to its durability and low cost along with developing technology has also increased the proportion of plastic waste in marine waste. When plastic waste generated as a result of activities on land and at sea is released into nature, it can reach aquatic ecosystems through weather events and surface waters. Plastics have become a significant threat because they take a long time to break down in nature and do not break down into small particles and disappear in nature. Plastics, which have an important place among marine waste, are called microplastics when they are broken down into small sizes by physical and chemical changes. Microplastics can easily enter the food chain from marine environments and harm aquatic creatures. Creatures living in the aquatic ecosystem mistake microplastic pieces in the sea for food, which can accumulate in the digestive system, muscles and liver of fish. Microplastics ingested in marine biota can be excreted in feces or remain in the gastrointestinal tract, causing damage to the fish stomach or a false feeling of fullness. In some cases, microplastics can break down into smaller sizes and pass through the intestinal wall to the muscles and liver, damaging tissues. When the additives added to plastics are swallowed by fish, they can cause negative effects such as inflammation and injury in muscle and liver tissues. For this reason, fish, which are an important food source for humans, have been the most researched group in microplastic studies. In the analysis of liver and muscle tissues of fish species using Fourier Transform Infrared Spectroscopy, it was determined that the most common microplastic types were polypropylene and polyethylene polymers.

Keywords: Microplastic, Liver, Muscle, Polyethylene, Polypropylene

1. Giriş

Deniz kirliliği, ekosisteme doğrudan veya dolaylı olarak giren madde veya enerjinin, canlı kaynaklara ve insan sağlığına zarar vermesi, denizel kalitenin bozulması ve bu nedenle denizel kaynakların kullanımının sınırlanması ve balıkçılığı da içeren tüm denizel aktivitelerin engellenmesi olarak tanımlanmaktadır (GESAMP, 1969). Kirliliğe neden olan kirletici maddeler bazen canlı organizmaların özellikle de insanların yaşamsal aktivitelerinin sonucunda, bazen de örneğin toksik metallerin kayalardan ve yer altı sularından denizlere karışması gibi çeşitli doğal süreçlerle de oluşabilirler (Pepper ve ark., 2006). Ancak denizel ortamlara kirleticilerin girişinin en büyük sorumlusu doğal süreçlerden daha çok insanlar oluşturmaktadır. Sanayi, balıkçılık, tarım ve su ürünleri yetiştiriciliği, kıyıların hatalı kullanımı ve kontrolsüz deniz taşımacılığı gibi pek çok etken nedeniyle nanopartiküller, bakteriler, virüsler, besinler ve pek çok kimyasal atık karışımı denizel ortamlara girmekte ve birikim düzeyleri giderek artmaktadır (Hester ve Harrison, 2019). İnsan kaynaklı atıkların birçoğu akarsular, rüzgarlar, yağmur suyu dalgalar veya kanalizasyonlar aracılığıyla denizlere ve kıyılara ulaşmakta ve bu kirleticiler genel olarak deniz atığı olarak tanımlanmaktadırlar (UNEP, 2021). Deniz atıkları genellikle cam, metal, tekstil, ahşap, kâğıt, kauçuk ve plastikler olarak gruplandırılmaktadır (UNEP, 2009). Bu atıkların bir kısmı doğada biyolojik olarak parçalanabilir olmasına karşın birçoğu denizel ortamda bozulmadan yıllarca kalabilmektedir. Deniz atıklarının %62.31'ini ise plastikler oluşturmaktadır (Hahladakis, 2020). Günümüzde varlıkları, ekvatordan kutuplara kadar tüm denizlerin kıyılarından en derin noktalarına kadar bilinen plastikler, biyolojik olarak parçalanmadıklarından çevrede birikip kirliliğe sebep olurlar (Barnes ve ark., 2009). Bu nedenle de birikimlerine yönelik çalışmalar son yıllarda kirlilik izleme çalışmalarının odak noktası haline gelmiştir (Dąbrowska ve ark., 2021). Plastik atıklar ise büyüklüklerine göre megaplastik (>100 mm), makroplastik (>20 mm), mezoplastik (5-20 mm) ve mikroplastik (>5 mm) olarak isimlendirilmektedir (Arthur ve ark., 2009). Sulardaki plastik atıkların %92'sininde mikroplastik formu olduğu düşünülmektedir (Greenpeace, 2019). Mikroplastikler şekil ve yoğunluklarına göre sularda yüzeyde, su sütununda veya diplerde birikmektedirler (Cole ve ark., 2011). Bu nedenle sucul ekosistemlerde mikroplastik içerikleri en çok araştırılan organizma grupları balıklar olmuştur (Futter ark., 2018). Yapılan araştırmalarda bentik zonda yaşayan balıklar başta olmak üzere filtrasyonla beslenen

birçok canlılarda mikroplastik parçacıklara rastlanmıştır (Avio ve ark., 2015; Prokic ve ark., 2019). Deniz ortamında bulunan mikroplastikler hareketsiz ve renkli olmaları nedeniyle birçok deniz canlısı tarafından yem olarak yanlışlıkla tüketilmekte ve böylece besin zincirine karışmaktadır. Mikroplastikler canlılar tarafından tüketildiğinde sindirim organlarında tıkanmalara neden olmakta ve besin alınımını azaltmaktadır (Foekema ve ark., 2013). Yapılan araştırmalarda mikroplastikler ile beslenen hayvanların midesinde plastiğin yer kapladığı ve sahte bir doyma hissi yaratarak canlının karnı dolu olduğu halde açlıktan öldüğü, sulardaki plastiklerin canlıların yüzgeç vb. takılarak fiziksel yaralanmalara yol açtığı rapor edilmiştir (Rummel ve ark., 2016). Daha sonra mikroplastiklerin özellikle balık gastrointestinal sisteminde kaslarda ve karaciğerde biriktiği rapor edilmiştir (Toussaint et al., 2019). Balıkların kaslarında ve karaciğerinde bulunan plastik filmde 5 mm'ye kadar mikroplastiklerin biriktiğini yapılan araştırmalarda öne sürülmüştür (Löder ve Gerdts, 2015). Son zamanlarda sularda yaşayan birçok canlı ve su kuşları ile ilgili yapılan araştırmalarda plastik atıklara dolaşmış olan hayvanların boğulabildiğini, dış yaralanmalara uğrayabildiğini, besine ulaşabilme ve avcı hayvanlardan kaçabilme kabiliyetini kaybedebildiğini, dolu bir mide ve tokluk hissi sonucu zamanla zayıflayarak formunu yitirebildiğini ve ölebildiğini göstermektedir (Lattin ve ark., 2004). Birkaç deneysel araştırma, bir kez alındığında mikroplastiklerin bağırsak lümeni ve sindirim tübülleri gibi çift kabuklu Mytilus edulis'in farklı bölümlerinde tutulabileceğini ve hatta bağırsak duvarını geçip diğer vücut dokularına yer değiştirebileceğini ileri sürmüştür (Kor ve Mehdinia, 2020). Besin değeri olmayan mikroplastiklerin yutulması, fiziksel, kimyasal toksisiteye neden olabilir, sindirim sistemini bloke edebilir veya zarar verebilir ve bireysel uygunluğu azaltarak sonuçta ölümle sonuçlanabilir (Zhang ve ark., 2020). Ayrıca, deneysel araştırmalar mikroplastiklerin yumurtalık gelişimini geciktirerek, dişi balıkların doğurganlığını azaltarak, seks hormonu dengesini bozarak, gonadotropin salgılatıcı hormon, koryojeninin aşağı regülasyonunu bozarak balık karaciğeri hasarına ve ayrıca üreme bozukluklarına yol açabileceğini bildirmiştir (Schirinzi ve ark., 2017). Örneğin Laboratuvar koşullarında yapılan bir araştırmada, zebra balığı karaciğeri ve solungaçlarında polistiren alımı ve birikmesi, iltihaplanma ve lipid birikimine neden olabileceği görülmüştür. Mikroplastiklerin ve kimyasal kirleticilerin biyolojik olarak birikmesi ve biyolojik olarak büyütülmesi, cilt hassasiyetine, solunum hastalıklarına,

kardiyovasküler risklere, gastrointestinal sorunlara, üreme etkilerine ve insan vücudunda kansere yol açmaktadır (Löder ve Gerdts, 2015).

Yapılan bu literatür araştırmasında, konu ile ilgili son yıllarda yayınlanmış makaleler göz önüne alınarak mikroplastiklerin, sucul ortamına geçişi ile birlikte deniz habitatında bulunan balıkların kas ve karaciğer dokularının mikroplastiklere maruziyetinin mevcut durumunun belirlenmesi amaçlanmıştır. Ayrıca besin zinciri yoluyla balıkların kas ve karaciğerlerinde mikroplastik birikimini, balıklar üzerindeki etkilerini ortaya koyan çalışmalar irdelenerek en fazla bulunan mikroplastik türleri ile ilgili araştırmalar incelenmiştir.

2. Mikroplastikler

Plastikler hafif oluşları, kolay işlenebilirlikleri, her alana uygulanabilirlikleri, dayanıklılıkları ve düşük maliyetli olmaları sebebi ile 20. yüzyılda günlük yaşamın her alanında kullanılmaya başlanmıştır (Derraik, 2002). Üretilen plastik atıkların yalnızca %9'u geri dönüştürülebilmektedir. Yaklaşık %12'si yakılırken, geri kalanı %79'u çöplüklerde veya doğal ortamda birikmiştir (Derraik, 2002; OSPAR, 2007). Plastik atıklar doğada çeşitli fiziksel, kimyasal ve biyolojik süreçler sonucunda her geçen gün daha ufak parçalara ayrılarak mikro ve nanoplastiklere dönüşmektedirler (Hidalgo-Ruz ve ark., 2012). 2004 yılında Thomson ve arkadaşları, 1 mm ile 5 mm arasındaki plastik parçalarını mikroplastik olarak tanımlarken, 2007 yılında Browne ve arkadaşları 1 mm'den küçük parçaları da mikroplastik olarak kabul etmişlerdir. Araştırmalarda yer alan mikroplastik tanımları genelde boyut dikkate alınarak yapılmıştır. Yapılan diğer mikroplastik araştırması sonucunda mikroplastiği daha açıklayıcı şu tanım önerilmiştir: Mikroplastikler, birincil veya ikincil kaynaklı, suda çözünmeyen, boyutu 5 mm' den küçük, düzenli veya düzensiz şekilli olan herhangi bir sentetik katı parçacık veya polimerik matrikslerdir. Bu, mikroplastiklerin yapısı, özellikleri, kaynakları, boyutları ve şekillerinin de belirtildiği kapsamlı bir ifadedir. Kaynaklarına göre mikroplastikler birincil (primer) ve ikincil (sekonder) olarak adlandırılmaktadır (Frias ve Nash, 2019). Birincil mikroplastikler deodorantlar, cilt soyucuları, göz maskarası, losyon, ojeler gibi kişisel bakım ürünlerindeki mikroboncuklar, bebek ürünleri, temizlik ürünlerindeki aşındırıcılar, sondaj sıvıları ve hava basma işlemlerinde kullanılan nanopartiküller şeklinde çok çeşitli tüketim ürünlerinde karşımıza çıkmaktadır. Bununla birlikte mikroplastikler günümüzde ilaçlarda da kullanılmaktadır. Bir diğer birincil üretim alanı

da plastik ürünlerin yapımında kullanılan hammaddeyi oluşturan 5 mm'den küçük plastik peletlerdir. Birincil mikroplastikler ayrıca üretim, kullanım veya bakım esnasında büyük boyutlu plastiklerin aşınmasından da kaynaklanabilirler, örneğin sürüş sırasında lastiklerin veya yıkama sırasında sentetik tekstillerin aşınması gibi. Sentetik tekstillerin yıkama işlemlerinden kaynaklanan mikroplastikler son zamanlarda okyanus ve denizlerdeki birincil mikroplastiklerin ana kaynağı olarak değerlendirilmektedir (De Falco ve ark., 2019). İkincil mikroplastikler daha büyük boyutlu plastiklerin aşınması ve parçalanması sonucu oluşur. Bozunma plastik polimerin yapısının bir dizi kimyasal reaksiyonla kırılması ile gerçekleşir ve parçalanmalar; foto bozunma, ısıl bozunma, biyobozunma ve termo oksidatif bozunma şeklinde sınıflandırılır. Bu bozunmalar büyük boyutlu plastiklerin parçalanmasına ve doğada ikincil mikroplastiklere dönüşmesine neden olur. Güneş ışığına ve dalgalara maruz kalma denizel ortamlardaki parçalanmanın birincil nedenleridir. Plastikler UV radyasyonu ve yüksek sıcaklıklar altında kimyasal değişime uğrar ve bu da onları daha kırılgan ve parçalanmaya uygun hale getirir. Karasal ortamlardaki plastiklerin parçalanmasının; karasal yüzeyde direk güneş ışığına maruz kalma ve sıcaklık değişikliklerinin yardımı ile deniz suyunda olan parçalanmadan daha büyük olduğu söylenebilir (Horton ve ark., 2017).

Denizel ortamda bulunan birincil ve ikincil mikroplastiklerde meydana gelen bozunmalar onların renk, yüzey morfolojisi, tanecik büyüklüğü, özgül ağırlığı, kristallik derecesi gibi kimyasal ve fiziksel özelliklerini değiştirir (Xuan ve Jianlong, 2019). Denizel ortamda en çok rastlanan mikroplastik polimer tipleri günlük hayatta sıklıkla kullanılan polietilen, polipropilen, polistiren, polivinil klorür, poliamid ve polietilen terefitalattır Mikroplastiklerin yapıları ve yoğunlukları çevresel koşullarda değişikliğe uğrar ve her tip mikroplastik denizel ekosistemin tümünde gözlenir (GESAMP, 2015; Xuan ve Jianlong, 2019). Plastikler denizlere metreden mikrometreye kadar çok değişik boyutlarda girerler; ayrışmaları uzun zaman aldığı için deniz ve okyanus ortamlarında uzun süre kalma olasılıkları yüksektir (Hidalgo-Ruz ve ark., 2012). Deniz ortamında bulunan mikroplastikler hareketsiz ve renkli olmaları sebebiyle birçok deniz canlısı tarafından besin olarak yanlışlıkla tüketilmekte ve böylece besin zincirine karışmaktadır (Bouwmeester ve ark., 2015; Rist ve ark., 2018; Smith ve ark., 2018). Mikroplastikler canlılar tarafından tüketildiğinde sindirim organlarında tıkanmalara neden olmakta ve besin alınımını azaltmaktadır (Kershaw, 2016; Rist ve ark., 2018). Mikroplastik

birikimlerinin sonucu karaciğerde ve kaslarda inflamatuar tepkiye neden olan oksidatif stres belirtileri ortaya çıkmaktadır. Bu gözlem mikroplastiklerin canlı vücudunda enfeksiyon oluşturabileceğini göstermektedir (Deng ve ark., 2017). Mikroplastiklerin sucul canlılar tarafından yutulması canlıların doku ve organlarına fiziksel olarak zararlar da vermektedir (FAO, 2016; GESAMP, 2016).

3. Mikroplastiklerin Bazı Balık Türlerindeki Kas ve Karaciğer Üzerine Etkileri

Sucul çevrede çeşitli habitatlarda çok sayıda balık türü mikroplastiğe maruz kalmaktadır (Wang ve ark., 2020). Ryan ve arkadaşlarının 2016 yılında mikroplastik bulaşan balık türü sayısını 93 olarak bildirirken bu rakam bir yıl sonra yapılan araştırmada 150'ye çıkmıştır (Ryan ve ark., 2016; Jabeen ve ark., 2017,). Markic ve arkadaşları 1972'den beri yapılan mikroplastik araştırmalarını incelemişler ve %81'i ticari öneme sahip 323 deniz balığı türünün plastik yuttuğu sonucunu çıkarmışlardır. Bu konuda çalışmalar arttıkça mikroplastik bulaşan tür sayısı da katlanarak artmaktadır. Balıklar boyut ve şekil olarak planktona benzettiği mikroplastiği kasıtlı veya kafa karışıklığı ile yutma veya filtreleme ile beslenme sırasında almaktadır (Besseling ve ark., 2015, Markic ve ark., 2020). Genellikle, deniz biyotasında, yutulan mikroplastikler ya dışkıyla dışarı atılır ya da bazen mide-bağırsak yolunda kalır, bu da balık midesinde hasara ya da yanlış bir dolgunluk hissine neden olur. Yapılan araştırmalarda mikroplastiklerin daha küçük boyutlara ayrılarak bağırsak duvarından dolaşım sistemine girdiği de tespit edilmiştir (Hossain ve ark., 2019; Zakeri ve ark., 2020; Wang ve ark., 2021). Mikroplastiklerin özellikle balık gastrointestinal sisteminde (Neves ve ark., 2015) kaslarda, (Akhbarizadeh ve ark., 2018; Abbasi ve ark., 2018; Barboza ve ark., 2020) ve karaciğerde biriktiği yapılan araştırmalarda rapor edilmiştir (Collard ve ark., 2017). Solungaçlardaki ve karaciğerdeki kirleticilerin konsantrasyonunun sırasıyla sudaki kirletici seviyesini ve balıkta biriken kirletici seviyesini yansıttığı da iyi bilinmektedir (Hosseini ve ark., 2015).

Son yıllarda, poligenik hastalık, kardiyovasküler hastalık, kanser ve Alzheimer riskini azaltmak gibi yararlı etkileri konusunda artan farkındalık nedeniyle deniz ürünleri tüketimi önemli ölçüde artmıştır (Kühn ve ark., 2015). Ayrıca deniz ürünleri, sağlık yararları ile ünlü güçlü enerji, protein, omega-3 çoklu doymamış yağ asitleri (u3-PUFA'lar), vitamin ve mineral kaynakları olarak tüketilmektedir (Schirinzi ve ark., 2017). Ancak deniz ürünlerinde kirleticilerin (yani ağır metaller ve mikroplastikler) varlığı,

organlara zararlı olabilecekleri ve kanserojen, mutajenik, teratojenik etkilere de neden olabilecekleri için faydalarını azaltmaktadır (Zhang ve ark., 2020). Kirleticinin sudaki biyoyararlanımı ve konsantrasyonu, organizmanın fizyolojisi, beslenme davranışı, çevresel faktörler ve maruz kalma süresi, kirleticilerin balıklarda biyobirikim derecesini kontrol eden ana faktörlerdir (Laist, 1997). Balıkların farklı dokularında (kas, solungaç ve karaciğer) kirleticilerin birikimi aynı değildir. Solungaçlardaki ve karaciğerdeki kirleticilerin konsantrasyonunun sırasıyla sudaki kirletici seviyesini ve balıkta biriken kirletici seviyesini yansıttığı iyi bilinmektedir (Seltenrich, 2015). Kas, balıkların en yenilebilir kısmı olduğundan ve kaslardaki potansiyel kirletici riskleri insanlar için büyük endişe kaynağı olduğundan, karaciğer ve solungaç ile karşılaştırıldığında daha düşük birikme potansiyellerine rağmen balık kasındaki kirleticilerin araştırılması çok önemlidir (Abdolahpur ve ark., 2013; Neves ve ark., 2015; Mziray ve Kimirei, 2016). Bununla birlikte, son zamanlarda bazı araştırmalar balık kasında ve karaciğerinde tespit edilen mikroplastiklerin dış veya arka plan kontaminasyonundan kaynaklanabileceğini göstererek balık organı değerlendirmesinde kalite kontrol ve kalite güvencesinin önemini vurgulamaktadır (Santos ve Duarte, 2015).

Kashiwada yaptığı bir araştırmada *Oryzias lapites* balık türünde sindirim sistemindeki mikroplastiklerin balık kaslarına ulaşması için deri, solungaç, mide ve bağırsak kaslarını kullandığını belirtmiştir. Mikroplastiklerin bağırsak epitelyumlarından karaciğere dağılmasının ve burada hasara neden olmasının olası olduğunu; karaciğer ve kanda nanopartiküller bulunduğu sonucuna ulaşmıştır (Kashiwada, 2006).

Lu ve arkadaşlarının zebra balığının karaciğerinde yaptığı bir araştırmada, FTIR Spektroskopisi ile mikroplastiklerin balık dokuları incelenmiştir. Yapılan bu araştırmada balıklardaki mikroplastik birikiminin balık karaciğerinde iltihaplanma ve lipit birikimine neden olduğu, oksidatif stresi indüklediği ve enerji metabolizmasını bozduğu sonucuna varılmıştır. Çeşitli balık türleri tarafından tüketilen mikroplastiklerin karaciğere translokasyonu gözlemlenmiştir (Avio ve ark., 2015; Lu ve ark., 2016; Rochman ve ark., 2013).

Collard ve arkadaşlarının yaptığı bir araştırmada, Akdeniz sularında yaşayan Avrupa hamsisinin (*Engraulis encrasicolus*) karaciğerinde Raman spektroskopisi ile mikroplastik konsantrasyonu incelenmiştir. Analizler sonucunda Avrupa hamsisinin

karaciğerlerinin %80'inin nispeten büyük mikroplastikler içerdiği ve bu mikroplastik türünün polietilen olduğu tespit edilmiştir (Collard ve ark., 2015).

Basra Körfezi'nin kuzeydoğusundaki *(P. indicus, E. coioides, A. djedaba ve S. Jello)* balık kaslarında yapılan bir araştırmada mikroplastik tespiti yapılmıştır. Mikroskop ile yapılan analizler sonucunda kaslarda lif, parça ve pelet şeklinde mikroplastikler olduğu sonucuna varılmıştır (Akhbarizadeh ve ark., 2017).

Karami ve arkadaşlarının yaptığı bir araştırmada, Avrupa hamsisinin karaciğerindeki mikroplastikleri araştırmışlardır. Mikroplastiklerin balık kaslarına ulaşması için doğrudan yolların deri, solungaçlar ve gastrointestinal sistemler olduğunu öne sürmüşlerdir (Karami ve ark., 2017).

Alomar ve arkadaşlarının 417 çizgili barbunya (*Mullus surmuletus*) balığının karaciğerinde yaptıkları bir araştırmada mikroplastik varlığı analiz edilmiştir. Analizler sonucunda bireylerin neredeyse üçte birinin (%27.30) mikroplastik tükettiği belirlenmiştir. Mikroplastik tüketen balığın karaciğerinde glutatyon S-transferaz aktivitesinde küçük bir artışa neden olduğu; bu, detoksifikasyon sistemlerinin indüklendiğini tespit etmişlerdir. Fourier Dönüşümü Kızılötesi Spektroskopisi ile yapılan analizler sonucunda, mikroplastiklerin büyük çoğunluğunun filaman tipi olduğunu ve tanımlanan ana bileşenin polietilen tereftalat olduğunu belirlemişlerdir (Alomar ve ark., 2017).

Abbasi ve arkadaşlarının Basra Körfezi Musa Halici'nden topladıkları demersal ve pelajik balıkların (*Platycephalus indicus, Saurida tumbil, Sillago sihama, Cynoglossus abbreviatus*) bağırsak, deri, kas, solungaç ve karaciğerlerinde mikroplastik konsantrasyonunu tespit etmişlerdir. İncelenen dokularda 828 adet mikroplastik tespit edilmiş ve bu parçacıkların çoğunlukla lifli yapıda olduğu belirlenmiştir (Abbasi ve ark., 2018).

İskenderun Teknik Üniversitesi Deniz Ürünleri Üretim Uygulama ve Araştırma Merkezinde Nil Tilapia *(Oreochromis niloticus)* balığında yapılan bir araştırmada, polipropilen mikroplastiklerinin günlük olarak tüketilmesinin balığın sağlığı üzerindeki etkisi araştırılmıştır. 30 günlük beslenmenin ardından hayvanlar hemogram ve biyokimyasal araştırma için kan toplama işlemine tabi tutulmuş ve daha sonra bağırsak mikrobiyolojik analizi, karaciğer, dalak, kalp, böbrek, mide ve bağırsak somatik indeksi yapılmıştır. Somatik araştırmanın sonuçları, polimerle beslenen balıkların midesinde,

karaciğerinde ve kalbinde önemli bir artış olduğunu ortaya çıkarmıştır. Bu analizlerde, polimere maruz bırakılan balığın bağırsağında gram-negatif mikroorganizmaların sayısında artış ve mezofilik aerobik mikroorganizmaların sayısında azalma gözlendiğini bildirmiştir. Bu nedenle, art arda 30 gün boyunca polipropilen içeren diyetlerle günlük olarak beslenen balıklar, karaciğer fonksiyonlarını, lökosit profilini ve organ morfometrisinin yanı sıra bağırsak mikrobiyotasındaki değişiklikleri değiştirerek sistemik inflamatuar rahatsızlıklara yol açan zararlı etkiler gösterdiği rapor edilmiştir (Souza ve ark., 2019).

Avio ve arkadaşlarının yapmış olduğu bir araştırmada plastiğe maruz kalan balıkların karaciğerlerinde mikroplastiklerin varlığını tespit etmişlerdir (Avio ve ark., 2015).

Yapılan bir araştırmada tatlı su balığı kırmızı tilapia'da (Oreochromis niloticus) mikroplastiklerin birikimi ve doku dağılımının yanı sıra mikroplastiklerinlerin *O.niloticus üzerindeki biyokimyasal etkilerini* değerlendirmişlerdir. Dokular polistiren mikroplastiklere 14 gün boyunca maruz bırakılmış, *O.niloticus'un* balıklarının çeşitli dokularındaki mikroplastik konsantrasyonları genellikle bağırsak>solungaçlar>karaciğer≈beyin sırasını izleyerek zamanla arttığını belirlemişlerdir. Ayrıca, balık beynindeki asetilkolinesteraz aktivitesi, mikroplastiklere maruz kalma nedeniyle maksimum %37.7'lik bir engelleme oranıyla inhibe edildiği; bu, mikroplastiklerin tatlı su balıklarına karşı potansiyel nörotoksisitesini ortaya koyduğu sonucuna varılmıştır. Balık karaciğerindeki antioksidatif enzim süperoksit dismutazı aktivitesi, maruz kalma süresi boyunca önemli ölçüde indüklendiği, malondialdehit içeriği mikroplastiklere maruz kalma ile değişmediği; bu, *O.niloticus'taki antioksidatif enzimatik sistemin* oksidatif hasarı önleyebileceğini rapor etmişlerdir (Ding ve ark., 2019).

Hindistan'daki Mannar Körfezi kıyısındaki ticari açıdan önemli beş balık türünün (ör.*Sufflamen fraenatus, Heniochus acuminatus, Atropus atropos, Pseudotriacanthus* ve *Leiognathus brevirostris*) kas ve bağırsaklarındaki mikroplastik bolluğu(boyut, şekil ve doku), mikro-Fourier Dönüşümü Kızılötesi Spektroskopisi ve atomik kuvvet mikroskobu ile araştırılmıştır. 100-250 µm boyutunda ve beyaz renkli parçacıklarının baskın olduğu ve toplam mikroplastiklerin ortalama bolluğu (adet/100 g) *Heniochus acuminatus'a* (kas:9,6; bağırsak:15) kıyasla *Pseudotriacanthus'ta* (kas:51,2; bağırsak:50,1) daha fazla

olduğu, *Leiognathus brevirostris* (kas:12; bağırsak:13,2) ve *Atropus atropus* (kas:15,2; bağırsak: 44,1) belirlenmiştir. Polietilen (%35,3), polipropilen (%27,2), poliamid (naylon) (%22,2) ve lif (%15,3) kaslarda bulunan mikroplastikleri temsil ederken, poliamid (naylon) (%30,2), polietilen (%28,1), polipropilen (%25,9) ve lif (%15,8) bağırsak mikroplastiklerini oluşturduğunu tespit etmişlerdir (Selvam ve ark., 2021).

Kanada'daki Simcoe Gölü'nde yapılan bir araştırmada yedi spor balığı türünün gastrointestinal kanalında, filetosunda ve karaciğerlerinde mikroplastiklerin ve diğer antropojenik mikropartiküllerin varlığı ile ilgili yapılan bir araştırmada dokularda mikroplastik tespit edilmiştir. Şekil ve malzeme türlerinin bir araya gelmesinin dokular arasında farklılık gösterdiği; bu da parçacık özelliklerinin biyolojik kaderi tahmin edebileceğini saptamışlardır. Analizler sonucunda mikroplastik translokasyon ve atılım mekanizmalarını ve gıda ağlarında ve insanların maruziyetinde mikroplastik birikiminin dinamikleri üzerinde etkileri olduğunu belirtmişlerdir (McIlwraith ve ark., 2021).

Kılıç kuyruk balığının karaciğeri üzerinde mikroplastiklerle ilgili yapılan bir araştırmada, balıklar 72 saat boyunca yüksek konsantrasyonlu polistiren mikroküreler (1 μm) ile muamele edilmiştir. Metabolomik analiz, mikroplastiklere maruz kalmanın kılıç kuyruk balıklarında metabolik profillerde değişikliklere neden olduğunu göstermiş, metabolitler oksidatif stres, bağışıklık fonksiyonu, enerji metabolizması, şeker metabolizması, lipit metabolizması, molekül taşınması ve zayıflamış yem kullanımı, büyüme performansı, besin metabolizması ve hayvan büyümesinde etkili olduğu saptamışlardır (Zhang ve ark., 2022).

İran'da Karasu Nehir balıklarının bağırsak ve kas dokusunda mikroplastikleri belirlemek için yapılan bir araştırmada tüm balıkların bağırsaklarında ve kaslarında mikroplastik bulunduğu tespit edilmiştir. Analizler sonucunda balıkların kas ve bağırsaklarında en çok polietilen, polipropilen, polistiren ve poliamid plastik türleri olduğu belirlenmiştir (Makhdoumi ve ark., 2022).

Doğu Pasifik Okyanusunda doğadan avlanan ticari öneme sahip 15 yunus balığının dokularında yapılan bir araştırmada mikroplastik kontaminasyonları ve etkileri araştırılmıştır. *Balıkların* (*C. hippurus)* solungaçlarında, yemek borusunda, mide, bağırsak ve kasında 1741 şüpheli parçacık tespit edilmiştir. Mikroskobik incelemeler ve mikro-Raman spektroskopik analiziyle *C. hippurus'ta moleküler yerleştirme sonuçları, dört baskın mikroplastik polimerin polyester,* polietilen tereftalat polipropilen, polietilen-

polipropilen mikroplastik olduğu belirlenmiştir. Moleküler yerleştirme sonuçları, dört baskın mikroplastik ile etkileşiminin üreme fonksiyonunun bozulmasına yol açacağını rapor etmişlerdir (Zang ve ark., 2022).

Çin'de yapılan bir araştırmada, mikroplastiklerin havuz balığının büyümesi, karaciğer hasarı ve bağırsak mikrobiyom bileşimi üzerine etkilerini incelemek amacıyla omnivor bir tatlı su balığı türü olan havuz sazanı (*Carassius carassius*) 30 günlük mikroplastik içeren balık yemi ile gıdaya maruz bırakılmıştır. Düşük polietilen mikroplastikli turpgiller grubunun karaciğer dokuları temelde normal olduğu, orta ve yüksek polietilen mikroplastikli gruptaki havuz balıklarında değişen derecelerde karaciğer hasarı olduğu ve yüksek polietilen mikroplastikli gruptaki havuz balıklarında en ciddi karaciğer hasarı belirlenmiştir (Hu ve ark., 2022).

Balear Adaları'nda yapılan bir araştırmada yırtıcı pelajik balığın (*Seriola dumerili*) gastrointestinal kanalında ve karaciğerinde mikroplastiklerin varlığı ve oksidatif stres ile ilişkisi incelenmiştir. Analizler sonucunda ortalama 12,2 ± 1,3 mikroplastik/birey ile incelenen toplam örneklerin %98'inde (n = 52) mikroplastik parçacıklar tespit edilmiştir. Parçalara kıyasla daha fazla lif benzeri parçacık izole edildiği belirlenmiştir. Antioksidan enzimler (süperoksit dismutaz ve katalaz) ve faz II detoksifikasyon enzimi glutatyon-S-transferaz, daha yüksek mikroplastik yükü olan balıklarda artan aktivite gösterdiği saptanmıştır (Solomando ve ark., 2022).

Atlantik morina balığında (*Gadus morhua*) yapılan bir araştırmada, balık yemlerine mevcut haliyle (Virgin PE) veya PCB-126 katkılı (Çivili PE) %1 oranında polietilen mikroplastikler (150-300 µm) eklenerek yapılan bir araştırmada, yemler 4 haftalık bir süre boyunca yavru morinalara verilerek mikroplastik birikimi incelenmiştir. Polietilen ile beslenen morina balığı, kontrol ve işlenmemiş polietilen tüketen balıklarla karşılaştırıldığında karaciğer ve kas numunelerinde önemli ölçüde daha yüksek bir çivili polietilen konsantrasyonu gösterdiği tespit edilmiştir. Polietilenin karaciğerde birikmesine bağlı olarak hepatik cyp1a ekspresyonu, morina balığı ile beslenen polietilen daha yüksek olduğu, özellikle katkılı polietilenin yanı sıra işlenmemiş polietilenin de cilt üzerinde bir etkisi olduğunu gözlemlenmiştir. Genel değişiklikler, polietilen içeren bir diyetle beslenen balıklarda cilt bariyerinin azaldığını göstermekte ve polietilenin bağırsak dokusuyla etkileşimi yoluyla balıklarda cilt sağlığını etkileyebileceği belirlenmiştir (Bogevik ve ark., 2022).

Kore'deki mikroplastik toksisitesini değerlendirmek için yapılan bir araştırmada 96 saat (0 mg/L), 100, 200, 5000 ve 10.000 mg/L mikroplastiklere (Polietilen: beyaz yüzeyli ve küresel şekilli polietilen mikroplastikler) maruz bırakılan *juvenil P. fulvidraco'nun* dokularında mikroplastik birikimi ve fizyolojik etkileri araştırılmıştır. Mikroplastik birikiminin bağırsak> solungaçlar>karaciğer şeklinde olduğu rapor edilmiştir. Bu araştırmanın sonuçları, polietilen mikroplastiklere akut maruz kalmanın, konsantrasyona bağlı bir şekilde tüm fizyolojik değişiklikleri tetiklediğini ve bunun, spesifik dokularda birikimden sonra genç *P. fulvidraco'nun* hematolojik parametrelerini, plazma bileşenlerini ve antioksidan tepkisini etkilediğini göstermektedir (Lee ve ark., 2023).

Harbin Su Ürünleri Araştırma Enstitüsü'nden rastgele yakalanan 50 sazan deney hayvanın kaslarında yapılan bir araştırmada, balıklar 21 gün boyunca polietilene maruz bırakılmıştır. Analizler sonucunda polietilen birikiminin kas liflerinde yapısal anormalliklere ve düzensizliğe neden olabileceğini ve kaslarda oksidatif stresi artırabileceğini rapor etmişlerdir (Liu ve ark., 2024).

4. Sonuçlar

Dünya genelinde son zamanlarda yapılan araştırmaların tümü, bölgesel veya ülke bazlı sularda mikroplastik kirliliğini ve canlı organizmalarda birikimini belirlemeye yöneliktir. Mikroplastiklerin besin zincirinde transfer edilebileceğine dair artan kanıtlar da bulunmaktadır. Küçük boyutları nedeniyle mikroplastikler, insanlar tarafından tüketilen plankton, çift kabuklular ve balık gibi farklı trofik seviyelerde bulunabilir. Bu nedenle farklı kaynaklardan gelen mikroplastiklerin su ortamlarına karışması, sudaki organizmalar ve muhtemelen balık ve deniz ürünleri tüketen insanlar için de bir tehdit oluşturmaktadır. Bu durum, bir trofik seviyeden diğerine biyobirikim için zararlı etkiler hakkında artan endişeleri beraberinde getirmektedir.

İncelenen araştırmalar sonucunda;

1. Birçok bölgede plastik atıkların düzgün bir şekilde ayrıştırılmaması veya geri dönüştürülmemesi nedeniyle plastik atıklar denizlere, nehirlere ve diğer doğal ortamlara sızabilmektedir. Yanlış atık yönetimi, plastik kirliliğini arttırmakta ve çevresel ortamdan besin zinciri ile canlı bünyesine geçerek doku ve organlarında birikmelere sebep olmaktadır.

2. Yapılan araştırmalar özellikle sucul ekosistemlerde yaşayan canlıların yüksek oranda mikroplastiklere maruz kaldığını ortaya koymaktadır. Balıkların vücutlarındaki mikroplastik birikimi, iltihaplanma neden olabildiği ve dokularında hasara yol açabildiği yapılan araştırmalarda rapor edilmiştir. Bu durumun, balık tüketen insanların sağlığını da etkileyebileceği belirlenmiştir.

3. Sucul ekosistemlerindeki incelenen balık türlerinde en çok tespit edilen polimer mikroplastik türlerinin polipropilen ve polietilen olduğu saptanmıştır.

4. Balıkların kas ve karaciğer dokularında tespit edilmiş mikroplastik verileri birlikte değerlendirildiğinde özellikle polietilen, polipropilen gibi polimerlerin yüksek oranda bulunduğu diğer yandan naylon, lif, suni ipek gibi parçacıklarında bazı türlerin dokularında tespit edildiği görülmektedir**.**

5. Mikroplastiklerin tespiti için çeşitli balık türlerinde balığın kas ve karaciğer dokularında diğer dokulara göre sınırlı sayıda araştırma olduğu belirlenmiştir. Bu konudaki araştırmalar henüz tam olarak netleşmemiştir ve bu etkilerin ne kadarının insan sağlığına doğrudan zarar verebileceği konusunda daha fazla bilgiye ihtiyaç vardır. Bu nedenle, sucul ekosistemlere ve deniz ürünlerine olan mikroplastik maruziyeti konusunda daha fazla araştırma yapılması ve sürdürülebilir çözümler bulunması açısından önem taşımaktadır.

Kaynakça

Abbasi, S., Soltani, N., Keshavarzi, B., Moore, F., Turner, A., and Hassanaghaei, M. (2018). "Microplastics in different tissues of fish and prawn from the Musa Estuary, Persian Gulf". Chemosphere. 205. 80–87. doi: 10.1016/j.chemosphere.2018.04.076. Epub 2018 Apr 18.

Abdolahpur, M.F., Safahieh, A., Savari, A., Ronagh, M.T., Doraghi, A. (2013). The relationship between heavy metal (Cd, Co, Cu, Ni and Pb) levels and the size of benthic, benthopelagic and pelagic fish species, Persian Gulf. Bull. Environ. Contam. Toxicol. 90, 691e696. doi: 10.1007/s00128-013-0986-7.

Akhbarizadeh, R., Moore, F., Keshavarzi, B., Moeinpour, A. (2017). Microplastics and potentially toxic elements in coastal sediments of Iran's main oil terminal (Khark Island). Environ. Pollut. 220, 720e731.

Akhbarizadeh, R., Moore, F., Keshavarzi, B. (2018). Investigating a probable relationship 319 between microplastics and potentially toxic elements in fish muscles from northeast of 320 Persian Gulf. Environmental Pollution 232, 154–163.

Akoueson, F., Sheldon, L.M., Danopoulos, E., Morris, S., Hotten, J., Chapman, E., Li, J., Rotchell, J.M. (2020). A preliminary analysis of microplastics in edible versus non-edible tissues from seafood samples. Environ. Pollut. 114452. https://doi.org/ 10.1016/j.envpol.2020.114452. doi: 10.1016/j.envpol.2020.114452. Epub 2020 Mar 27.

Alomar C, Sureda A, Capco C, Guijarro B, Tejada S, Deudero S (2017). Microplastic ingestion by *Mullus surmuletus* Linnaeus, 1758 fish and its potential for causing oxidative stress. Environmental Research 159: 135–142. doi: 10.1016/j.envres.2017.07.043. Epub 2017 Aug 8.

Arthur, C., Baker, J and Bamford H. (eds) (2009). "Proceedings of the international research workshop on the occurrence. Effects and Fate of Microplastic Marine Debris". NOAA Technical Memorandum NOS-OR&R-30. The Center for Urban Waters Univerrsity of Washington Tacoma, Tacoma.

Avio, C. G., Gorbi, S., Milan, M., Benedetti, M., Fattorini, D., d'Errico, G., Pauletto, M., Bargelloni, L. & Regoli, F. (2015). Pollutants bioavailability and toxicological risk from microplastics to marine mussels, Environmental Pollution, 198, 211-222. doi: 10.1016/j.envpol.2014.12.021. Epub 2015 Jan 28

Barboza, L.G.A., Lopes, C., Oliveira, P., Bessa, F., Otero, V., Henriques, B., Raimundo, J., Caetano, M., Vale, C., Guilhermino, L. (2020). Microplastics in wild fish from North East Atlantic Ocean and its potential for causing neurotoxic effects, lipid oxidative damage, and human health risks associated with ingestion exposure. Sci. Total Environ. 717, 134625. https://doi.org/10.1016/j.scitotenv.2019.134625.

Barnes, D.K.A., Galgani, F., Thompson, R.C., Barlaz, M. (2009). Accumulation and fragmentation of plastic debris in global environments, Philosophical Transactions of the Royal Society, (B2) 364, 1985-1998. doi: 10.1098/rstb.2008.0205.

Besseling, E., Foekema, E.M., Van Franeker, J.A., Leopold, M.F., Kühn, S., Rebolledo, E.B. and Koelmans, A.A. (2015). "Microplastic in a macro filter feeder: humpback whale Megaptera novaeangliae". Mar. Pollut. Bull. 95 (1). 248–252. doi: 10.1016/j.marpolbul.2015.04.007. Epub 2015 Apr 24.

Bogevik, A.S., Elisabeth Ytteborg, Alexander K.M., Ann-Elise Olderbakk Jordal, Odd Andr´e Karlsen, Ivar Rønnestad (2023). PCB-126 spiked to polyethylene microplastic ingested by juvenile Atlantic cod (*Gadus morhua*) accumulates in liver and muscle tissues Marine Pollution Bulletin 187 (2023) 114528. https://doi.org/10.1021/acs.est.9b05312

Bouwmeester, H., Hollman, P. C. H., & Peters, R. J. B. (2015). Potential Health Impact of Environmentally Released Micro- and Nanoplastics in the Human Food Production Chain: Experiences from Nanotoxicology. Environmental Science & Technology, 49 (15), 8932-8947. doi.org/10.1021/acs.est.5b01090

Browne, M.A., Galloway, T.S., Thompson, R., (2007). "Microplastic – an emerging contaminant of potential concern?" Integr. Environ. Assess. Manag. 3. 559–561. doi:10.1897/IEAM_2007-048.

Cole, M., Lindeque, P., Halsband, C., Galloway, T.S. (2011). Microplastics as contaminants in the marine environment: A review, Marine Pollution Bulletin, 62, 2588–2597. doi.org/10.1016/j.marpolbul.2011.09.025.

Collard, F., Gilbert, B., Compère, P., Eppe, G., Das, K., Jauniaux, T., & Parmentier, E. (2017). Microplastics in livers of European anchovies (Engraulis encrasicolus, L.). Environmental Pollution, *229*, 1000–1005. https://doi.org/10.1016/J.ENVPOL.2017.07.089.

Collard, F., Gilbert, B., Eppe, G., Parmentier, E., Das, K., 2015. Detection of anthro-pogenic particles in fish stomachs: an isolation method adapted to identifica-tion by Raman spectroscopy. Arch. Environ. Contam. Toxicol. 69, 331e339.

Dąbrowska, J., Sobota, M., Swiader, M., Borowski, P., Morly, A., Stodolak, R., Kucharczak, E., Zieba, Z., Kazak, J.K. (2021). Marine Waste Sources, Fate, Risks, Challenges and Research Needs, Environmental Research and Public Health, 18, 433. doi: 10.1016/j.envpol.2017.07.089. Epub 2017 Jul 30.

De Falco, F., Di Pace, E., Cocca, M.C., & Avella, M. (2019). The contribution of washing processes of synthetic clothes to microplastic pollution. Scientific Reports volume 9, Article number: 6633. doi: 10.1038/s41598-019-43023-x.

Deng, Y., Zhang, Y., Lemos, B., Ren, H. (2017). Tissue accumulation of microplastics in mice and biomarker responses suggest widespread health risks of exposure, Scientific Reports,7,466-487. doi: 10.1038/srep46687.

Derraik, J.G.B., (2002). "The pollution of the marine environment by plastic debris: a review". Marine Pollution Bulletin, Volume. doi:10.1016/S0025-326X(02)00220-5.

Ding, J.; Jiang, F.; Li, J.; Wang, Z.; Sun, C.; Wang, Z.; Fu, L.; Ding, N.X.; He, C. Microplastics in the Coral Reef Systems from Xisha Islands of South China Sea. Environ. Sci. Technol. 2019, 53, 8036–8046.

FAO. (2016). The state of the worlds fisheries and aquaculture 4–10.

Foekema, E. M., De Gruijter, C., Mergia, M. T., Van Franeker, J. A., Murk, A. J., & Koelmans, A. A. (2013). Plastic in north sea fish. Environmental Science and Technology, *47*(15), 8818–8824. doi.org/10.1021/es400931b.

Frias, J. P. G. L., Nash, R. (2019). Microplastics: Finding a consensus on the definition. Marine Pollution Bulletin, 138, 145-147. doi.org/10.1016/j.marpolbul.2018.11.022

Futter, M. N., Carlos de Sá, L., Oliveira, M., Ribeiro, F. and Lopes Rocha, T. (2018). "Studies of the effects of microplastics on aquatic organisms: What do we know and where should we focus our efforts in the future?". Science of the Total Environment. 645. 1029–1039. doi.org/10.1016/j.scitotenv.2018.07.207.

GESAMP. 1969. (The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection), 1969, Report of the First Session, London, 17-21 Mart.

GESAMP. (2015). "Sources, fate and effects of microplastics in the marine environment: a global assessment" (Kershaw, P. J., ed.). (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/ UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 90, 96 p.

GESAMP. (2016). Sources, fate and effects of microplastics in the marine environment: part two of a global assessment. (Kershaw, P.J. & Rochman, C.M., eds). (IMO/FAO/ UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 93, 220 pp.

Greenpeace. (2019). "Türkiye'de deniz canlılarında mikroplastik kirliliği" roporu. Erişim 10 Ekim 2021.

Hahladakis, J.N. (2020). Delineating the global plastic marine litter challenge: clarifying the misconceptions, Environmental Monitoring and Assessment, 192; 267.

Hester, R.E. ve Harrison, R.M. (2019). Plastics and the Environment, Croydon, UK, ISBN:978-1-78801-241-6.

Hidalgo-Ruz, V., Gutow, L., Thompson, R. C., & Thiel, M. (2012). 'Microplastics in the marine environment: a review of the methods used for identification and quantification'. Environmental science & technology, 46(6), 3060-3075.

Horton, A.A., Walton A., Spurgeon D.J., Lahive E., Svendsen C. (2017). "Microplastics in freshwater and terrestrial environments: Evaluating the current understanding to identify the knowledge gaps and future research priorities". Sci Total Environ.; 586:127-141. doi: 10.1016/j.scitotenv.2017.01.190. Epub 2017 Feb 4. PMID: 28169032.

Hossain, M.S., Rahman, M.S., Uddin, M.N., Sharifuzzaman S.M., Chowdhury, S.R., Sarker, S., Chowdhury, S.H. (2020). Microplastic contamination in Penaeid shrimp from the Northern Bay of Bengal, Chemosphere, 238, 1-9.

Jabeen, K., Su, L., Li, J., Yang, D., Tong, C., Mu, J., Shi, H. (2017). Microplastics and mesoplastics in fish from coastal and fresh waters of China'. Environmental Pollution 221: 141–149.

Jia-Min, Hu, Jian-E Zuo , Jin-Bo Li , Yan-Yan Zhang , Xiang Ai , Da-Hui Gong , Ji-Wen Zhang , Ding-Ming Sun. (2022). Effects of Microplastic Exposure on Crucian

Growth, Liver Damage, and Gut Microbiome Composition Jul 8;43(7):3664-3671. doi: 10.13227/j.hjkx.202108002.

Karami, A., Golieskardi, A., Choo, C.K., Romanoc, N., Ho, Y. B. and Salamatinia B. (2017). "A high-performance protocol for extraction of microplastics in fish". Science of the Total Environment. 578. 485–494.

Kashiwada, S., 2006. Distribution of nanoparticles in the see-through medaka (Oryzias latipes). Environmental Health Perspectives, 114, 1697–1702.

Kershaw, D. (2016). Marine plastic debris and microplastics – Global lessons and research to inspire action and guide policy change. Technical Report. United Nations Environment Programme (UNEP).

Kor, K., & Mehdinia, A. (2020). Neustonic microplastic pollution in the Persian Gulf. *Marine Pollution Bulletin*, *150*, 110665. https://doi.org/10.1016/J.MARPOLBUL.2019.110665.

Kühn, S., Bravo Rebolledo, E. L., & Van Franeker, J. A. (2015). Deleterious effects of litter on marine life. Marine Anthropogenic Litter, 75–116. https://doi.org/10.1007/978-3-319-16510-3_4/TABLES/5.

Laist, D. W. (1997). Impacts of Marine Debris: Entanglement of Marine Life in Marine Debris Including a Comprehensive List of Species with Entanglement and Ingestion Records. 99–139. https://doi.org/10.1007/978-1-4613-8486-1_10.

Lattin, G. L., Moore, C. J., Zellers, A. F., Moore, S. L., & Weisberg, S. B. (2004). A comparison of neustonic plastic and zooplankton at different depths near the southern California shore. Marine Pollution.

Lee, J.H., Ju-Chan Kang, Jun-Hwan Kim. (2023). Toxic effects of microplastic (Polyethylene) on fish: Accumulation, hematological parameters and antioxidant responses in Korean Bullhead, Pseudobagrus fulvidraco Science of The Total Environment Volume 877, 15 June,162874.

Liu, T.J., Jie Yang, Jia-wei Wu, Xiao-ran Sun, Xue-jiao Gao .(2024). Polyethylene microplastics induced inflammation via the miR-21/IRAK4/ NF-κB axis resulting to endoplasmic reticulum stress and apoptosis in muscle of carp. Fish & Shellfish Immunology Volume 145, February, 109375.

Löder, M. G. J., & Gerdts, G. (2015). Methodology used for the detection and identification of microplastics a critical appraisal. Marine Anthropogenic Litter,

201–227. https://doi.org/10.1007/978-3-319-16510-3_8/FIGURES/7 Mar. Pollut. Bull. 2020, 160, 111598.

Lu, Y., Zhang, Y., Deng, Y., Jiang, W., Zhao, Y., Geng, J., Ren, H., 2016. Uptake and accumulation of polystyrene microplastics in zebrafish (Danio rerio) and toxic effects in liver. Environ. Sci. Technol. 50 (7), 4054–4060. https://doi.org/10.1021/acs. est.6b00183.

Makhdoumi, P., Hossini, H., Nazmara, Z., Mansouri, K., Pirsaheb, M. (2021). Corrigendum to "Occurrence and exposure analysis of microplastic in the gut and muscle tissue of riverine fish in Kermanshah province of Iran" [Mar. Pollut. Bull. 173. 112915] Marine Pollution Bulletin Volume 181, August 2022, 113950.

Markic, A., Gaertner, J.C., Gaertner N., Koelmans M., and Albert A. (2020). "Plastic ingestion by marine fish in the wild, Critical Reviews in Environmental". Science and Technology. 50 (7). 657-697.

McIlwraith, H.K., Kim, J., Helm, P., Bhavsar, S.P., Metzger, J.S., Rochman, C.M. (2021). Evidence of microplastic translocation in wild-caught fish and implications for microplastic accumulation dynamics in food webs. Environ. Sci. Technol. 55, 12372–12382. https://doi.org/10.1021/ACS.EST.1C02922.

Mziray, P., Kimirei, I.A. (2016). Bioaccumulation of heavy metals in marine fishes (Siganus sutor, Lethrinus harak, and Rastrelliger kanagurta) from Dar es Salaam Tanzania. Regional Stud. Mar. Sci. 7, 72e80.

Neves, D., Sobral, P., Ferreira, J.L., Pereira, T. (2015). Ingestion of microplastics by commercial fish off the Portuguese coast. Mar. Pollut. Bull. 101, 119–126.

OSPAR Commission (2007). "OSPAR Pilot Project on Monitoring Marine Beach Litter. Monitoring of marine litter in the OSPAR region". ISBN 978-1-905859-45-0.

particles in fish stomachs: an isolation method adapted to identification by Raman spectroscopy. Arch. Environ. Contam. Toxicol. 69, 331e339.

Pepper, I.L., Gerba, C.P, Brusseau, M.L. (2006). The Extent of Global Pollution, The extent of global pollution, Brusseau, M.L, Gerba, C.P, Pepper, I.L.

Prokic, M.D, Radovanovic, T.B, Gavric, J.P, Faggio, C. (2019). Ecotoxicological effects of microplastics: Examination of biomarkers, current state and future perpectives. Trends in Analytical Chemistry 111: 37–46.

Rist, S., Almroth, B. C., Hartmann, N. B., & Karlsson, T. M. (2018). A critical perspective on early communications concerning human health aspects of microplastics. Science of The Total Environment, 626, 720-726.

Rochman CM, Hoh E, Hentschel BT, Kaye S. (2013a). "Long-Term Field Measurement of Sorption of Organic Contaminants to Five Types of Plastic Pellets: Implications for Plastic Marine Debris". Environmental Science&Technology. 47 (3). 1646-1654.

Rummel, C. D., Löder, M. G. J., Fricke, N. F., Lang, T., Griebeler, E. M., Janke, M., & Gerdts, G. (2016). Plastic ingestion by pelagic and demersal fish from the North Sea and Baltic Sea. Marine Pollution Bulletin, *102*(1), 134–141. https://doi.org/10.1016/J.MARPOLBUL.2015.11.043.

Ryan, P.G. (2016). Hazardous chemicals associated with plastics in the marine environment H. Takada and H. K. Karapanagioti (Eds.). "Ingestion of plastics by marine organisms". (s. 235–266). Cham, Switzerland. Springer International Publishing.

Santos, R.T., & Duarte, A. C. (2015). A critical overview of the analytical approaches to the occurrence, the fate and the behavior of microplastics in the environment. TrAC Trends in Analytical Chemistry, *65*, 47–53. https://doi.org/10.1016/J.TRAC.2014.10.011.

Schirinzi, G. F., Pérez-Pomeda, I., Sanchís, J., Rossini, C., Farré, M., & Barceló, D. (2017). Cytotoxic effects of commonly used nanomaterials and microplastics on cerebral and epithelial human cells. Environmental Research, *159*, 579–587. https://doi.org/10.1016/J.ENVRES.2017.08.043.

Seltenrich, N. (2015). New link in the food chain? Marine plastic pollution and seafood safety. *Environmental Health Perspectives*, *123*(2), A34–A41. https://doi.org/10.1289/EHP.123-A34/ASSET/4CB6D5B0-B80B-40EA-8E4B-178E13B09DFC/ASSETS/GRAPHIC/EHP.123-A34.G008.JPG.

Selvam, S., Jesuraja, K., Venkatramanan, S., Roy, P.D., Jeyanthi Kumar, V., 2021. Hazardous microplastic characteristics and its role as a vector of heavy metal in groundwater and surface water of coastal south India. J. Hazard Mater. 402, 123786 https://doi.org/10.1016/j.jhazmat.2020.123786.

Smith, M., Love, D. C., Rochman, C. M., & Neff, R. A. (2018). "Microplastics in seafood and the implications for human health", Current Environmental Health Reports, 5(3), 375-386.

Solomando, A , Sánchez, A.C., Kutusu, A ., Montero I., Pinya, S., Sureda , S., (2022). Microplastic presence in the pelagic fish, Seriola dumerili, from Balearic Islands (Western Mediterranean), and assessment of oxidative stress and detoxification biomarkers in liver. 212(Pt C):113369. doi: 10.1016/j.envres.2022.113369.

Souza, R. L. De, Cesar, E., Lima, R. De, Melo, F. P. De, Padilha, M. G. & Correia, E. D. S. (2019). The culture of Nile tilapia at different salinities using a biofloc system Revista Ciencia Agronomicancia, 50(2), 267–275.

Thompson, R. C., Olsen, Y., Mitchell, R. P., Davis, A., Rowland, S. J., John, A. W. ve Russell, A. E. (2004). "Lost at sea: where is all the plastic*?"* Scielnce, 304(5672), 838-838.

Toussaint, B., Raffael, B., Angers-Loustau, A., Gilliland, D., Kestens, V., Petrillo, M., Rio-Echevarria, I. M., & Van den Eede, G. (2019). Review of micro- and nanoplastic contamination in the food chain. Food Additives & Contaminants: Part A, 36(5), 639–673. https://doi.org/10.1080/19440049.2019.1583381.

UNEP (United Nations Environment Programme). (2009). Marine Litter: A Global Challenge, Nairobi: UNEP, 232 p.

UNEP (United Nations Environment Programme). (2021). From Pollution to Solution, A global assessment of marine litter and plastic pollution, Nairobi.

Wang, C., Zhao, J., Xing, B. (2021). Environmental source, fate, and toxicity of microplastics, Journal of Hazardous Materials, 407,124357.

Wang, W., Ge, J. and Yu, X. (2020). "*Bioavailability and toxicity of microplastics to fish species: A Review*" Ecotoxicology and Environmental Safety. 189. 109913.

Xuan, G., Jianlong, W., (2019). "The chemical behaviors of microplastics in marine environment: A review". Marine Pollution Bulletin, Volume 142, Pages 1-14, ISSN 0025-326X, https://doi.org/10.1016/j. marpolbul.2019.03.019.

Zhang, D., Liu, X., Huang, W., Li, J., Wang, C., Zhang, D., & Zhang, C. (2020). Microplastic pollution in deep-sea sediments and organisms of the Western Pacific Ocean.

Zhang, Y.K., Yang, B.K., Zhang, C.N., Xu, S.X., Sun, P. (2022). Effects of polystyrene microplastics acute exposure in the liver of swordtail fish (Xiphophorus helleri) revealed by LC-MS metabolomics Sci Total Environ2022 Dec 1:850:157772. doi: 10.1016/j.scitotenv.2022.157772. Epub Aug 5.

Zakeri, M.; Naji, A.; Akbarzadeh, A.; Uddin, S. (2020). Microplastic ingestion in important commercial fish in the southern Caspian Sea.Environmental Pollution, 259, 113948. https://doi.org/10.1016/J.ENVPOL.2020.113948.

INTEGRATION OF AUTOMATED SYSTEMS IN THE AGRICULTURAL SECTOR: PROCESS MANAGEMENT OPTIMIZATION

Vadym SOLOVEI (ORCID: 0000-0001-9820-1780)
National Scientific Center «Institute for Soil Science and Agrochemistry Research named after O.N. Sokolovsky» Department of Soil Resources, Kharkiv, Ukraine
Email: gruntpokrov@ukr.net

Elena TROTSENKO (ORCID: 0009-0007-0317-2907)
National Scientific Center «Institute for Soil Science and Agrochemistry Research named after O.N. Sokolovsky» Department of Soil Resources, Kharkiv, Ukraine
Email: trea140981@gmail.com

ABSTRACT
The significance of measuring soil temperature at various depths in real-time for assessing its condition in the context of agriculture is indicated. The development of a convenient, economically accessible, and efficient soil temperature measurement system intended for use in both research and applied spheres is described. The system developed by the authors consists of a thermosensor based on an Arduino controller, housed in a polypropylene pipe with a diameter of 3.2 cm and a length of 200 cm, as well as in a plastic case for housing the microcontroller, lithium-ion batteries, flash card, and other components. The system is equipped with DS18B20 digital sensors that provide temperature measurement with an accuracy of +/- 0.5 °C in the range from -55 °C to +125 °C. Sensors are placed every 10 cm vertically on the device and are connected via a 1-Wire interface, allowing for temperature measurement at depths from 10 to 120 cm. A sensor on a flexible cord for measuring soil surface temperature is also provided. Measurement intervals can be adjusted from 1 minute to several hours, and data is transmitted in real-time through the GSM network of a local operator to a specialized website and database. On the website, data on soil temperatures at various depths are reflected immediately after they are received from the devices. Long-term data storage provides the possibility for analysis thanks to functionality that offers extensive options for information display customization. The authors note that the installation of the thermosensor causes minimal disruption to soil integrity - 0.0011 m^3, for a borehole 120 cm deep and 3.5 cm in diameter, allowing its natural state to be preserved. The thermosensor finds application in agriculture for optimizing agronomic practices, including determining the optimal timing for sowing, fertilizing, regulating irrigation, and preventing crop losses through timely detection of plant stress and diseases due to temperature fluctuations. Additionally, the device is used for monitoring soil freezing depth, which is important for predicting moisture infiltration processes. The use of thermosensors is noted to contribute to more efficient resource use. The authors emphasize the possibility of using thermosensors in parks, gardens, and urban green areas.
Keywords: soil temperature, thermosensor, agriculture automation.

In the modern agro-industrial complex, the use of digital automated robotic systems is becoming an increasingly significant factor in improving management processes and optimizing production. In the context of digital technology use in the agro-industrial sector, enhancing soil monitoring techniques, especially its temperature regimes, is important. This involves moving from manual measurements in the fields to choosing real-time data acquisition technologies. Research aimed at studying soil temperature parameters can significantly improve the efficiency of agricultural production by optimizing processes such as sowing, irrigation, and fertilization.

The use of digital automated systems, such as the device/system proposed by the authors, for measuring soil temperature is implemented based on an Arduino controller. A polypropylene pipe with a diameter of 3.2 cm and a length of 150 or 200 cm (two length options exist, but the length can be adjusted as needed) and a plastic housing for placing the microcontroller, batteries, flash cards, and other components are used as the housing. Soil temperature measurement is provided by DS18B20 digital sensors, vertically arranged on the device every 10 cm (placement can be with any step, as needed) and connected via 1-Wire technology. Each device is equipped with 12 temperature sensors, which conduct measurements at soil depths from 0 to 120 cm, and one temperature sensor on a flexible wire for the soil surface. The device is powered by a lithium-ion battery. The Arduino microcontroller serves as a platform for creating software and hardware systems capable of automating the process of managing and collecting data about soil temperature. Within this system, the Arduino microcontroller receives data from the DS18B20 thermal sensors. The use of selected microcontrollers allows adjusting the frequency of temperature measurements from 1 minute to several hours (currently, temperature data collection is performed in 30-minute intervals). A system that includes a website and a database on a specialized web server, which receives data in real-time through the GSM network of the local operator and stores them in a database, has been developed for storing the obtained data. This approach to data transmission and storage ensures the long-term preservation of information obtained from devices located at research sites (as needed on agricultural fields, gardens, parks).

Therefore, the proposed system has the following advantages/functionality:

1. The accuracy of measurements is +/- 0.5 °C, in the range from -55°C to +125°C, which allows obtaining current thermodynamic indicators of soil at various

depths, with minimal soil disturbance during the device installation (0.0011 m^3 of soil, at a borehole with a diameter of 3.2-3.5 cm and a depth of 120 cm).

2. Flexible adjustment of the measurement interval, as the device/system is set up to respond/request specific research/usage requirements.
3. Convenient data storage and analysis, as the system allows quick access to data with the possibility of further analysis.
4. Efficient use of energy – on a single charge of the lithium-ion battery (as a power source), the device operates throughout the vegetation period.
5. Scalability of the device as needed. The flexible structure allows changing the number of sensors or their placement depending on the specific needs of research/use.
6. Automated data collection system, which allows obtaining data in real-time, enabling response to changes in soil parameters.
7. Long-term data preservation, allowing trends in soil temperature parameters to be identified over time and space.

The proposed device can be used to implement various approaches to optimizing agricultural practices:

1. Increasing yield by determining the optimal soil temperature for choosing the most favorable time for planting/seeding plants/seeds.
2. Effective fertilization, taking into account temperature limits within which a particular plant will most efficiently absorb nutrients.
3. Optimizing plant irrigation, based on determining the best time for watering, to avoid moisture deficit or excess, which also helps reduce water and energy consumption by irrigation systems.
4. Preventing crop losses by timely detecting early signs of stress and diseases in plants caused by temperature deviations, and applying appropriate measures such as soil treatment and maintaining optimal moisture levels.
5. Preventing plant diseases by controlling air and soil temperature fluctuations, with additional determination of moisture levels, to prevent the development of fungal diseases, root rot, and leaf diseases.

6. Monitoring soil freezing depth to predict moisture infiltration processes and the risk of water erosion during snowmelt, as well as to assess the scale of river flooding.

Additionally, monitoring soil temperature regimes allows gaining new fundamental knowledge, such as climate changes (seasonal variations and long-term trends); characteristics of soil aridity on slopes of various exposures, forms, and degrees of steepness are interesting and promising directions within the framework of monitoring observations of soil temperature regimes.

Thus, the practical aspects considered demonstrate the potential of using digital technologies to increase productivity and sustainability of agricultural processes, creating promising opportunities for further development of agriculture digitalization.

YUMURTACI TAVUKLARIN DAVRANIŞSAL İHTİYAÇLARI

Dr. Öğr. Üyesi Uğur ÖZENTÜRK* (ORCID: 0000-0002-2037-9340)
Atatürk Üniversitesi Veteriner Fakültesi Zootekni Ana Bilim Dalı Erzurum-Türkiye
Email: uozenturk@gmail.com

Doç. Dr. Murat GENÇ (ORCID: 0000-0002-9565-0887)
Atatürk Üniversitesi Veteriner Fakültesi Zootekni Ana Bilim Dalı Erzurum-Türkiye
Email: vet.murat.genc@gmail.com

ÖZET
Tavuk yetiştiriciliği geçmişte evlerin bahçesinde ve çevresinde yapılan yetiştiricilikten günümüzde büyük ölçekli ticari yetiştiriciliğe evrilmiştir. Bu süreç yumurta tavuklarının barındırılma ve yönetilme biçiminde değişikliklere yol açmıştır. Tavukların doğal davranışlarının belirli koşullar altında sergilenmesi etogram olarak adlandırılır. Hayvan refahı açısından etogram, bir tavuğun ticari yetiştirme koşullarında kabul edilebilir bir refaha sahip olması için sergilemesi beklenen davranışların bütünüdür. Yumurta tavuklarının davranışsal ihtiyaçlarını anlamak, hem refahı artırmak hem de uygun üretim sistemleri tasarlamak için çok önemlidir. Bu derlemede yumurtacı tavukların bazı doğal davranış kalıplarının nedenselliğin ve işlevselliğinin incelenmesi ve ticari yetiştirme sistemlerinde bu davranışları gerçekleştirmenin önemine vurgu yaparak davranışları etkileyen faktörlerin değerlendirilmesi amaçlanmıştır. Ticari yetiştirme koşullarında tavuklar tarafından sergilenen bazı davranışların gerçekleştirilmesi bakımından bir engel yoktur. Fakat bazı davranışlar için fiziksel bir nesneye ve yeterli alana ihtiyaç vardır. Bu kapsamda bu inceleme tavukların yiyecek arama, yuva yapma, tüneme ve toz banyosu gibi doğal davranış ihtiyaçlarını içermektedir. Ayrıca tavuklar arasındaki sosyal etkileşim de ele alınmıştır. Tavukların davranışlara yönelik motivasyonları ve davranışlardan mahrum bırakıldıklarında gösterdikleri fizyolojik tepkiler değerlendirilmiştir. Davranış ihtiyaçlarının belirlenmesi hayvan refahının sağlanması ve üretim performanslarının artırılması bakımından potansiyel ipuçları barındırıyor; bu da endüstriyel yetiştiricilikte optimum çevresel şartların sağlanmasına ve istenmeyen davranışların önlenmesine yardımcı olabilir.

Anahtar Kelimeler: Yumurtacı Tavuk, Hayvan Davranışı, Yiyecek Arama, Yuva Yapma, Tüneme, Toz Banyosu

BEHAVIOURAL NEEDS OF LAYING HENS

ABSTRACT
Poultry farming has evolved from small-scale operations around home gardens to large-scale commercial enterprises. This transformation has brought about significant changes in the rearing and management practices of laying hens. The study of natural behaviour in chickens under specific conditions is referred to as an ethogram. In the context of animal welfare, an ethogram represents the range of behaviours that are considered essential for a chicken to exhibit acceptable welfare within commercial rearing environments. Understanding the behavioural requirements of laying hens is crucial for enhancing welfare and designing appropriate production systems. This review aims to investigate the causality and functionality of natural behavioural patterns in laying hens, as well as to evaluate the factors influencing these behaviours, with an emphasis on their significance in commercial breeding systems. While some behaviours exhibited by hens in commercial farming face no obstacle, others necessitate the presence of physical objects and adequate space. Therefore, this review addresses the natural behavioural needs of laying hens, including foraging, nesting, perching, and dust bathing. Additionally, social behaviours among hens are also discussed. The review explores hens' motivation for behaviours and their physiological responses when deprived of these behaviours. Understanding these behavioural needs can provide valuable insights into ensuring animal welfare and enhancing production performance. This understanding can help in establishing optimal environmental conditions and mitigating undesirable behaviours in industrial poultry farming.
Keywords: Laying Hens, Animal Behaviour, Foraging, Nesting, Perching, Dust Bathing

Giriş

Doğal davranışlarının belirli koşullar altında sergilenmesi etogram olarak adlandırılır. Tavuk yetiştiriciliğinde hayvan refahı açısından etogram, bir tavuğun ticari yetiştirme koşullarında kabul edilebilir bir refaha sahip olması için sergilemesi beklenen davranışların bütünüdür (Bhadauria & Bhanja, 2017; Ferreira et al., 2022). Tavukçuluk ailelerin yumurta ve tavuk eti ihtiyacını karşılamak için evlerin bahçesinde ve çevresinde serbestçe dolaşan 5-10 tavukluk bir yetiştiricilikten yüzbinlerce tavuğun bir arada yetiştirildiği büyük ölçekli ticari işletmelere doğru evrim geçirmiştir (Castro et al., 2023). Bu süreç yumurta tavukçuluğu barınma ve yönetim sistemlerinde değişikliklere yol açmıştır. Yumurta tavuklarının davranışsal ihtiyaçlarını anlamak, hem refahı artırmak hem de uygun üretim sistemleri tasarlamak için çok önemlidir (Emine & Yenilmez, 2017; Hocking, 2016; Sulimova et al., 2020). Örneğin, geleneksel kafeslerden zenginleştirilmiş veya kafessiz sistemlere geçiş, bu değişikliklerin tavuk davranışını ve refahını nasıl etkilediğinin anlaşılmasını gerektirir (Hartcher & Jones, 2017; He et al., 2022; Nicol, 2015).

Hayvan refahına yönelik artan farkındalıkla birlikte tüketiciler, gıdalarının nasıl üretildiği konusunda daha fazla endişe duymaktadır (Korver, 2023). Geleneksel kafesler gibi üretim sistemleri, tavukların doğal davranışlarını kısıtlayarak refahın kötü olmasına yol açtığı için eleştirilmektedir (Hartcher & Jones, 2017). Tavuk davranışını anlamak, tavuğun refahı için önemli olan tüneme, toz banyosu ve yiyecek arama gibi doğal davranışlara izin veren sistemlerin tasarlanmasına yardımcı olur. Davranışsal ihtiyaçlarını karşılayan ortamlar sağlayarak tüm üretim sistemlerinde tavukların refahı artırılabilir (Hocking, 2016; Nicol, 2015; Nicol et al., 2017).

Yumurta tavuklarının davranışsal ihtiyaçlarının karşılanması, üretim performansını da olumlu yönde etkileyebilir. Doğal davranışlar sergileyebilen tavukların daha az stres yaşaması muhtemeldir, bu da yumurta üretiminin ve kalitesinin artmasını sağlayabilir. Davranışların sergilenmesine imkan veren bir ortam sağlamak, yumurta üretimini ve genel sürü sağlığını etkileyebilecek zararlı davranışların ortaya çıkmasını azaltabilir (Hocking, 2016; Nicol, 2015; Nicol et al., 2017).

Ticari yetiştirme koşullarında tavuklar tarafından sergilenen bazı davranışların gerçekleştirilmesi bakımından bir engel yoktur. Tavuklara yiyecek ve su sağlanması gerektiği açıktır ve bu nedenle yemleme ve içme davranışının önemini tartışmaya gerek

yoktur. Gerinme ve vücut sallama gibi davranışlar fiziksel bir nesneye yönelik değildir ve herhangi bir zamanda herhangi bir yerde gerçekleştirilebilir, bu nedenle çalışmada bu davranışlar ele alınmamıştır. Ancak tüneme, yiyecek arama, yuvalama, toz banyosu gibi bazı davranışların gerçekleşmesi için folluk, tünek ve altlık gibi kaynaklara ihtiyaç vardır. Günümüzde dünyada kullanılan çoğu tavuk yetiştirme sistemi, tavukların doğal davranışlarını gerçekleştirmeleri için ihtiyaç duydukları bu tür donanımları tam olarak karşılamamaktadır (Welfare (AHAW) et al., 2023). Bu çalışmanın amacı, tavuk yetiştiriciliği için bazı davranış kalıplarını incelemektir. Ayrıca, kanatlılar için ticari yetiştirme sistemlerinde bu davranışları gerçekleştirmenin önemine vurgu yaparak davranışları etkileyen faktörler değerlendirilmiştir.

Yiyecek Arama Davranışı

Tavuklar, doğal ortamlarında yerde bulunan yiyecekleri tespit etmek için gagalama ve ayaklarıyla hızlı kazımalar yaparak yiyecek arama davranışı sergilerler (Bhadauria & Bhanja, 2017; Nicol, 2015). Tavukların yiyecek arama davranışı genellikle gündüz saatlerinde gerçekleşir. Ticari sistemlerde yem gece boyunca sürekli olarak mevcut olsa da, tavuklar genellikle aydınlatmanın açık olduğu saatlerde yemlenirler. Tavuklara istenildiği kadar yem sağlansa da bu, tavukların doğal yiyecek arama davranışını ortadan kaldırmaz (Nicol et al., 2017). Doğal hayatta, tavuklar gün içinde zamanın yaklaşık %60'ında yiyecek arama davranışı gerçekleştirirken, evcilleştirme ve ıslah sürecinde hem genetik hem de çevresel etkilerle bu davranışın zaman içinde azaldığı ve gün içindeki aktivitelerinin yaklaşık %40'ını aldığı bildirilmiştir (Lindqvist & Jensen, 2008, 2009). Özellikle çevresel etkilerin bu davranışta önemli olduğu belirtilmektedir (Nicol, 2015). Yiyecek arama davranışı için harcanan sürenin yüksek olması, tüy gagalama riskini azaltır. Mevcut yetiştirme sistemlerinde yiyecek arama konusundaki kısıtlamalar ise kuşların birbirlerini gagalamasına ve kanibalizmin artmasına neden olabilir (Nicol et al., 2017).

Kafeste yetiştirilen tavukların genellikle mevcut yem materyali ve kafes telleri üzerinde yiyecek arama davranışı sergilediği; yerde yetiştirme sistemlerinde ise daha çok altlık materyaline karşı bu davranışı gösterdikleri gözlenmiştir (Nicol, 2015). Yerde yetiştirilen tavuklarda, altlık materyali olarak kullanılan torf, kum, talaş, saman gibi materyallerde yiyecek arama davranışları incelenmiştir (Weeks & Nicol, 2006). Davranışın kum ve

samanda daha fazla gözlendiği belirtilse de, yiyecek arama davranışı için çoğu altlık materyalinin uygun olduğu değerlendirilmiştir (Nicol, 2015).

Tavuklar içindeki sosyal yapı, davranışın geliştirilmesinde önemli rol oynar (Ogura & Matsushima, 2011). Yetişkin tavuklar genellikle toplu halde beslenir ve bir tavuğun yiyecek arama davranışları diğer tavukları çeker. Bu durum, tavukların sosyal öğrenme yoluyla yiyecek arama davranışını geliştirebileceğini göstermektedir (Hocking, 2016; Nicol, 2015).

Yiyecek arama davranışının hayvanlardaki fizyolojik etkileri üzerine yapılan araştırmalar sınırlı olup, bu araştırmalarda tavukların besin maddesini ararken kalp atış hızı ve kafa hareketlerinin gözlendiği (Davies et al., 2014), besin maddesinin bulunduğu ortamların uzun vadede stres hormonu kortikosteron seviyesini düşürdüğü bildirilmiştir (Nicol et al., 2011). Dolayısıyla, tavuklar için yiyecek aramanın önemi, aynı zamanda davranış ve refah sorunlarını azaltmada oynadığı rol ve tavukların yiyecek arama malzemeleri ve ortamları konusunda yaptığı olumlu seçimlerle de gösterilmektedir (Nicol, 2015; Nicol et al., 2011).

Yuvalama Davranışı

Tavuklarda yuva yapma veya yuvalama olarak ifade edilen davranış, korunaklı bir yuva alanının seçilmesini ve uygun bir yuva inşa edilmesini içerir ve yumurtlama süreci etkisinde gerçekleşir (Bécot et al., 2023; Bhadauria & Bhanja, 2017; Hemsworth & Edwards, 2020). Yumurtlama sürecindeki hormonal değişimler, farklı davranışları tetikler. Örneğin, yumurtlamadan yaklaşık 1 saat önce artan aktivite ve huzursuzluk gibi davranışlar görülür. Işık uyarımıyla başlayan süreçte, hipotalamus ön hipofizden lüteinizan hormon (LH) ve folikül uyarıcı hormonlarını (FSH) salgılar. Yumurtlamadan yaklaşık 7 saat önce bir LH dalgalanması gerçekleşir. Yuvalama davranışı, yumurtlama ile tetiklenir. Yumurtlama sonrası folikülden salınan östrojen ve progesteron, yuva yeri seçimi ve yuva yapımını başlatır (Nicol, 2015).

Yumurtlama öncesinde gözlenen huzursuzluk, tavuğun yuvalama davranış ihtiyacını ve yuva arama aşamasının başladığını gösterir. Tavuk, seçilen alanda oturma, dönme, zemini tırmalama ve saman gibi malzemeleri toplama gibi faaliyetlerle yuva yapma davranışına başlar (Hemsworth & Edwards, 2020; Hocking, 2016). Tavuk yetiştiriciliği uygulamaları genetik ve çevresel etkenler nedeniyle değişse de, tavukların her zaman belirli oranda yuva yapma davranışı göstereceği bildirilmiştir (Perry, 2004). Örneğin kafes

sistemlerinde yetiştirilen tavukların vücut çevresine dışkı parçacıklarını ve kafes tellerini gagalayarak altlık toplama davranışı sergileyebileceği belirtilmiştir. Bu davranışın yumurtlamadan yaklaşık 2 saat önce başlayabileceği bildirilmiştir. Tavukların yumurtlamadan yaklaşık 40 dakika öncesinde ise oturma davranışı gösterdiği tespit edilmiştir (Heinrich et al., 2014; Hunniford & Widowski, 2017).

Tavukların yuva alanı tercihlerinde çevresinde bulunan yuvalama için kullanacağı altlık malzemeleri etkili olabilir. Örneğin, saman, yuvalama davranışı için odun talaşı ve torftan daha çok tercih edilir (Clausen & Riber, 2012). Kafeste yetiştirilen tavuklarda ise suni çimle kapanan alanın çıplak tel zemine tercih edildiği bildirilmiştir (Struelens et al., 2008). Folluk kullanım tercihini etkileyen bir diğer faktör, tavukların daha erken yaşlarında maruz kaldığı yetiştirme şartlarıdır. Örneğin, altlıklı bir sistemde yetiştirilen yarkalar, kafeste yetiştirilenlere göre daha farklı folluk tercihi gösterebilir (Nicol, 2015). Doğrudan erişim mümkün olmasa bile, altlık malzemesinin sadece görülmesi bile yuva yeri seçimi üzerinde olumlu bir etki oluşturduğu bildirilmiştir (Nicol, 2015). Tavukların yuva yeri seçiminde daha çok kapalı alanları tercih ettikleri gözlenmiştir (Cooper & Appleby, 2003). Başka bir araştırma, folluk renginin tavukların tercihinde etkili olabileceğini belirlemiş, kırmızı, mavi veya yeşil renkli kümeslere yetiştirilen tavukların sarı yuvaları tercih ettiğini bulmuştur(Zupan et al., 2007). Folluk taban eğimleri üzerine yapılan araştırmada tavukların daha sığ ve yüzeysel taban eğimine sahip folluklara oturmayı tercih ettiği belirtilmiştir (Stämpfli et al., 2011).

Yoğun yetiştiricilikte tavuklar, yumurtlama için aynı folluları tercih edebilir (Cronin & Hemsworth, 2012). Ticari yetiştiricilik şartlarında tavuklar genellikle köşelerde ve sıranın sonundaki folluklara yumurtlamayı tercih eder. Bunlar en akılda kalıcı alanlar olabilir. Ayrıca, köşelerdeki folluklara yönelik bu tercih, daha az avlanma veya rahatsız edilme riski sundukları algısından kaynaklanıyor olabilir (Bécot et al., 2023; Heinrich et al., 2014; Hunniford & Widowski, 2017).

Tavuklarda sosyal yapı ele alındığında, tavukların sıklıkla toplu yuvalama eğiliminde olduğu görülmüştür. Bu durum, yaralanma ve boğulma gibi bazı dezavantajlar olsa da, diğer tavuklarla birlikte yuvalama yırtıcı hayvanların tehdidi ve altlık, renk ve konum gibi yuvalama tercihlerinin benzer olmasından kaynaklanabilir (Hocking, 2016; Nicol, 2015). Yine de tavuklar, birbirlerini gagalama gibi agresif davranışlar sergileyebilecekleri için yoğun yetiştiricilikte daha fazla folluk alanı sağlanması tavsiye

edilmektedir(Papageorgiou et al., 2023; Welfare (AHAW) et al., 2023) Farklı yetiştirme sistemleri için yerleşim sıklıkları baz alınarak hayvan başına düşen folluk sayısı belirlenebilir. Yeterli folluk sağlanmayan işletmelerde, yere yumurtlama gibi üretim kayıplarına neden olacak istenmeyen davranışların şekillendiği bildirilmiştir (Welfare (AHAW) et al., 2023).

Bazı araştırmalar, tavukların folluk alanına erişiminin engellenmesi sonucu gösterdiği fizyolojik stres tepkisine odaklanmıştır. Sherwin ve arkadaşlarının (2010) folluklu kafeslerdeki tavukların kabuklarında, geleneksel kafeslerindeki tavukların yumurtalarına kıyasla strese bağlı daha düşük kalsiyum birikimi tespit etmiştir (Sherwin et al., 2010). Alm ve arkadaşları (2016) (3) mobilyalı kafeslerdeki folluklardan uzaklaştırılmanın dışkı kortikosteron metabolitlerinde ve heterofil:lenfosit oranında belirgin bir artışla ilişkili olduğunu bulmuştur (Alm et al., 2016). Buna karşın Cronin ve arkadaşları (2012) folluklara erişim engellendiğinde yumurta kabuklarında stresle ilişkili kalsiyum birikiminde belirgin bir artış olmadığını bildirmiştir (Cronin & Hemsworth, 2012). Stres seviyesi ölçüm zamanı ve sürelerinin sonuçlardaki tutarsızlığın sebebi olabileceği değerlendirilmiş, folluğa erişimin engellenmesinden kaynaklanan fizyolojik değişimin kısa süreli olabileceği nedeniyle yumurtlamadan sonra en fazla 20 dakika içinde stres ölçümlerinin yapılması tavsiye edilmektedir (Nicol, 2015). Sonuç olarak, literatürde tavukların yumurtalarını uygun bir yuva alanına bırakabilmelerinin önemli olduğuna dair ikna edici kanıtlar bulunmaktadır (Alm et al., 2016; Bécot et al., 2023).

Tüneme Davranışı

Tavuklar, gün boyunca tünemek ve geceleri dinlenmek ve uyumak için çevrelerindeki yüksek yapıları kullanırlar(Bhanja & Bhadauria, 2018; Campbell et al., 2016; Malchow et al., 2022). Gün içinde yüksek yerlerde tüneme davranışı, tavukların çevrelerini izlemesine ve yerde bulunan tehditlere karşı güvenliğini sağlar. Evcil tavukların köken aldığı kırmızı orman tavukları, evcil tavuklardan daha sık ve daha senkronize tüneme davranışı gösterse de, evcil tavukların da tünemeyi kolayca öğrendiği bildirilmiştir (Eklund & Jensen, 2011). Yabani tavuklar, ışığa daha duyarlı oldukları için akşamın erken saatlerinde ışık seviyesinin düşmesiyle tünemek için yüksek ağaç dalları ararlar. Gece vakti yüksek yerlerde tüneme davranışı kendilerini güvende hissetmeleri için önemlidir (Bist et al., 2023; Nicol, 2015).

Yaşamsal süreç içinde tüneme davranışı incelendiğinde, civcivlerin yaklaşık 2 haftalık yaşta tünemeye başladığını göstermektedir. Bu durum, anneleriyle birlikte yetişen civcivlerde daha erken yaşta görülebilir. Gündüz tüneme davranışının, 6 haftalık yaşa kadar artma eğilimde olduğu gözlenmiştir. Bu dönemde gece tüneme davranışı da başlamaktadır(Bist et al., 2023; Hocking, 2016; Nicol, 2015).

Doğal şartlarda yetiştirilen tavuklarla karşılaştırıldığında, ticari sistemlerde tüneksiz yetiştirilen yarkalar, kas tonusu, mekansal farkındalık ve dengenin azalması nedeniyle yetişkin yaşamlarında tünekleri daha az kullanabilmektedir (Nicol, 2015). Tüneklerin sağlandığı ticari sistemlerde ise tavukların tüneklerden ne ölçüde yararlandıkları konusunda önemli farklılıklar vardır. Zenginleştirilmiş kafeslerde gündüz tünek kullanımı yaklaşık %25 ile %40 arasında değişmektedir. Buna karşın gece vakti tavukların yaklaşık %90 oranında büyük bir çoğunluğunun tünediği bildirilmiştir (Nicol, 2015). Geceleri tüneme davranışının yüksek olması, tünemenin tavuklarda yüksek motivasyonlu bir davranış ihtiyacı olduğunu göstermektedir (Bist et al., 2023; Perry, 2004).

Tünek yüksekliklerini inceleyen araştırmalarda, tavukların daha yüksek bir tüneği tercih etmeye daha motive oldukları belirlenmiştir (Schrader & Malchow, 2020). Kafesli sistemlerde ise tünek yüksekliği tercihinin kafes yüksekliğinden etkilendiği, tavukların çatıya yakın alanlara tüneme konusunda isteksiz olduğu bildirilmiştir(Nicol, 2015; Struelens et al., 2008). Chen ve arkadaşları (2014), 65 cm yüksekliğindeki kafeslerdeki tavukların, 30 veya 40 cm yüksekliğindeki tüneklere göre 10 veya 20 cm yüksekliğindeki tünekleri tercih ettiğini bulmuşlardır (Chen et al., 2014).

Tünek genişliği ve çapına ilişkin tüneme tercihleri, tünek yüksekliğine göre daha değişken sonuçlar vermektedir. Struelens ve ark (2009) tavukların 1.5 cm çapındaki dar tüneklere tünemekten kaçındığını bildirmiştir (Struelens et al., 2009). Pickel ve arkadaşları (2010) ise 4.5 cm ve daha düşük çaptaki tüneklerin denge konusundaki zorluklar nedeniyle tavuklar tarafından daha az tercih edildiğini bildirmiştir (Pickel et al., 2010). Buna karşın başka bir çalışmada tavukların 3 cm çapındaki tünekleri 5 cm'e göre daha fazla tercih ettiği bildirilmiştir (Chen et al., 2014). Tünek uzunlukları bakımından ise zenginleştirilmiş kafeslerde çoğu tavuğun aynı anda tünemesini sağlamak için tavuk başına minimum uzunluğun 15 cm olması gerektiği bildirilmiştir (Nicol, 2015; Nicol et al., 2017). Tavuklar genel olarak küçük çaplı, tamamen yuvarlak tünekler yerine belki de

kavranması daha kolay olan oval şekilli tünekleri tercih ediyor. Tavukların dikdörtgen veya kare şeklindeki tünekleri tercih ettikleri de bildirilmiştir (Chen et al., 2014). Ancak Avrupa Gıda Güvenliği Otoritesi (EFSA), bu tür tüneklerin yaralanmayı önlemek için en azından yuvarlak kenarlara sahip olması gerektiğini öne sürmüştür (Schrader & Malchow, 2020; Welfare (AHAW) et al., 2023).

Tavukların kafes sistemlerinde tüneklere ne ölçüde ihtiyaç duyulduğu tartışılmaya devam ediyor. Tüneme ihtiyacının kafes sistemlerinde hayvanların yüksekte bulunmaya mı yoksa ayaklarını kavrama poziyonuna getirmeye mi daha motive oldukları belirsizliğini koruyor (Bist et al., 2023; Nicol et al., 2017). Bazı çalışmalarda tünek bulunan kafeslerde bulunan tavukların tüneksizlere göre heterofil lenfosit değerlerinin daha düşük olduğunu gösterse de (Campo et al., 2005), bu konuda herhangi bir farklılığın olmadığını bildiren çalışmalar da mevcuttur (Yan et al., 2013, 2014). Kafessiz sistemlerde ise tüneklerin etkileri daha açık olarak bildirilmiştir. Tavukların büyük bir kümeste dinlenmek ve saldırgan tavuklardan uzaklaşmak için tüneklerden yararlandığı bildirilmiştir (Nicol et al., 2017). Ayrıca tünekli kümeslerdeki tavukların daha az saldırgan oldukları ve insanlardan daha az korktukları bildirilmiştir (Bist et al., 2023; Nicol, 2015). Genel olarak araştırmalar, tüneklerin kuş sağlığı açısından bazı faydaları olduğunu, daha güçlü kemikleri teşvik ettiğini ve bazı ayak rahatsızlığı türlerinin riskini azalttığını göstermektedir. Bununla birlikte, aynı zamanda artan bir çarpışma nedeniyle kemik hasarlarına ilişkin riskler vardır ve bu nedenle tünek sağlamanın maliyet ve faydaları dikkatle tartışılmalıdır (Bist et al., 2023; Schrader & Malchow, 2020).

Toz Banyosu Davranışı

Toz banyosunun aşırı lipitleri ve ektoparazitleri ortadan kaldırma işlevi gördüğü belirlenmiştir. Ayrıca tüy temizleme davranışı ile birlikte tüylerin iyi durumda tutulmasına yardımcı olduğu bildirilmiştir (Bhanja & Bhadauria, 2018; Grebey et al., 2020; Wang et al., 2022). Toz banyosunu kullanan tavuklar, kullanmayanlara kıyasla bir hafta içinde akar ve bit istilasını %80-100 oranında azalttığı bildirilmiştir (Martin & Mullens, 2012). Toz banyosu ihtiyacının tavuklarda düzenli olduğu ve uygun şartlarda tavukların her 2 günde bir toz banyosu yaptığı bildirilmiştir (Castro et al., 2023; Grebey et al., 2020; Nicol et al., 2017; Wang et al., 2022). Tam bir toz banyosu sıralı birkaç unsurdan oluşur. İlk olarak tavuk, gagasıyla altlığı tırmıklar, kazıma davranışı gösterir. Sonra tüyleri kalkık olarak hafifçe yan döner. Daha sonra, dikey kanat sallama ve baş

sürtünme ile daha fazla tırmıklama ve kazıma ile toz banyosu başlar. Bu hareketli aşama tamamlandıktan sonra tavuk, ayağa kalkmadan vücuduna serpiştirdiği altlık materyali çıkarmak için vücudunu iyice sallamadan önce, ara sıra sürtünme veya kaşıma hareketleri yaparak bir süre daha yatmaya devam edebilir (Bhanja & Bhadauria, 2018; Hocking, 2016; Nicol, 2015). Tüm bu olası unsurları içeren uzun süreli toz banyosu, olumlu refahın iyi bir göstergesidir (Bhanja & Bhadauria, 2018; Hemsworth & Edwards, 2020).

Yiyecek arama davranışlarında olduğu gibi toz banyosu davranışları için de uygun altlık materyalin belirlenmesi gerekir. Bu kapsamda kum, torf, odun talaşı, saman gibi altlık materyalleri üzerine çalışmalar yürütülmüş olup tavukların talaş ve samana nazaran kum ve torf gibi ince yapılı ve düşük lipit içeriğine sahip altlıkları tercih ettikleri bildirilmiştir (Scholz et al., 2010, 2011).

Altlıklı yetiştirme sistemlerinde tavuklar altlık materyalini toz banyosu davranışında kullanabilir, fakat bu durum uzun sürede altlığın ıslanarak ve topaklaşması durumunda toz banyosu için uygun olmayan bir yapıya gelebilir (Jong & Blokhuis, 2006). Kafes yetiştiriciliğinde son zamanlarda hayvan refahının iyileştirilmesi amacıyla kullanılan zenginleştirilmiş kafes sistemleri gagalama ve tırmalama alanına sahip olsa da çoğu toz banyosu davranışı için donanım içermemektedir. Dolayısıyla bu sistemlerde yetiştirilen tavuklarda toz banyosu davranışını gerçekleştirme motivasyonunu tatmin edecek şekilde pratik olarak nasıl sağlanacağı belirsizdir (Castro et al., 2023; Wang et al., 2022). Çekme kat sistemleri ise toz banyosu davranış ihtiyacının karşılanması için kafesli sistemlere nazaran daha fazla fırsat sunmaktadır. Serbest yetiştirme sistemlerinde toz banyosu davranışının sıklıkla öğlen saatlerinde gerçekleşse de yumurtlamanın yoğun olduğu saatlerde dış alana yumurtalamanın önüne geçmek için hayvanların iç alandaki folluklara yönelmesi istenir. Bu durumda toz banyosu ve dışarıya erişim öğleden sonraki vakitlerde gerçekleştirilebilir. Bu da toz banyosu için olumsuz sonuçlara yol açabilir (Jong & Blokhuis, 2006; Perry, 2004).

Toz banyosuna davranışı engellenen tavuklarda sesli çağrılarında artış gözlenmiş, bu da toz banyosuna erişim engellendiğinde tavukların hayal kırıklığına uğradığını ve bu mahrumiyetin strese neden olduğu bildirilmiştir (Olsson et al., 2002). Tozdan mahrum kalan tavukların toz banyosu yapan tavuklara bile yöneldiği bildirilmiştir (Olsson et al., 2002). Tavuklarda toz banyosunun önemine ilişkin kanıtlar güçlü olsa da diğer davranış ihtiyaçlara göre düşük bir davranış gibi görünmektedir (Nicol, 2015).

Sosyal Davranış

Doğal koşullar altında tavuklar, diğer bireyleri tanıdıkları ve onlara farklı tepkiler verdikleri sosyal gruplar halinde yaşarlar. Grubun yapısı hayvanların yaşı, bulundukları çevreye göre değişkenlik gösterebilir. Doğal koşullarda tipik bir tavuk grubu büyüklüğü genellikle 3 ila 30 tavuktan oluşan gruplardır. Tanıdık olanlar bireysel olarak öncelikle görsel ipuçları ile diğerlerinden ayırt edilebilse de (Abeyesinghe et al., 2009) grup büyüklüğü yaklaşık 100 tavuğu aştığında, tavuklar tanıdık ve yabancı tavukları ayırt edemezler (Nicol et al., 2017). Küçük gruplardaki tanıdık tavuklar, başlangıçta tehdit ve saldırganlık kullanarak baskınlık hiyerarşileri kurar. Hiyerarşi kurulduktan sonra, ast tavuklar daha baskın bireylerin yakınında hareket edebilir ve toz banyosu gibi normal davranışlar sergileyebilir (Shimmura et al., 2010). Küçük grup büyüklüklerinde yetiştirilen tavuklar tanıdık tavukları diğerlerine tercih eder ve saldırma eğilimi göstermez. Artan grup büyüklüklerinde davranış stratejileri gelişir. Daha büyük gruplarda kavgalar, kurulan ilişkileri hatırlamak yerine basit ipuçlarına dikkat ederek (örneğin daha ağır tavuklardan kaçınarak) önlenir. Tavuklarda saldırganlık davranışının sosyal hiyerarşilerin tam olarak kurulmadığı orta büyüklükteki tavuk gruplarında (yaklaşık 100 ila yaklaşık 500) ortaya çıkma olasılığı daha yüksektir. Daha büyük ticari kafes dışı tavuk sürülerinde saldırganlık genellikle düşük seviyelerde görülür (Nicol et al., 2017).

Yemleme, toz banyosu gibi davranışların sergilenmesinde tavuklar belirli bir senkronizasyon gösterebilir. Senkronizasyon, her tavuğun bağımsız olarak ancak mevcut ortama aynı şekilde tepki vermesi nedeniyle ortaya çıkabilir. Bu nedenle, tavukların çoğu otomatik yemliğin her çalışmasında birlikte beslenir ve yumurtlayan tavukların çoğu ışıklar söndüğünde bir kümes içindeki tüneklere uçar. Tavukların senkronize davranışları büyük ölçüde çevrenin bireyleri aynı şekilde etkileyen sirkadiyen veya diğer ipuçları sağlaması nedeniyle ortaya çıkmaktadır. Tavuklar ayrıca arkadaşlarının eylemlerine de katılabilir ve senkronize olabilir (Nicol et al., 2017). Hoppitt ve arkadaşları (2007) aynı kümeste barındırılan tavuk gruplarında, grup içi davranış biçimlerinin senkronizasyonunu gruplar arası olduğundan daha fazla bulmuştur (Hoppitt et al., 2007).

Diğer Davranışlar

Tüy temizleme ya da tüy tarama davranışı gaga, ayaklar ve kuyruğun tabanında bulunan yağ bezleri kullanılarak tüylerin temizlenmesi, bakımını içerir (Nicol, 2015). Tavukların kuyruğunun tabanında yer alan ve aynı zamanda kuyruk kökü yağ bezi olarak da bilinen

üropigal bezi vardır. Gagalarını kullanarak bu bezden yağ toplar ve bunu tüylerine yayarlar. Bu yağ, tüylerin su geçirmez hale gelmesine yardımcı olarak tavuğu kuru tutar ve tüylerin vücut sıcaklığının düzenlenmesinde önemli olan yalıtım özelliklerin korunmasına yardımcı olur. Temizleme süreci tavuğun tüylerinde kir, parazit veya hasarlı tüyleri aramasıyla başlar. Daha sonra gagasını kullanarak her bir tüyü dikkatlice temizleyip düzeltir ve mevcut olabilecek kalıntıları veya parazitleri ortadan kaldırır. Bu, tüylerin temiz kalmasına ve tahrişe ve enfeksiyonlara neden olabilecek zararlılardan uzak tutulmasına yardımcı olur. Ayrıca tüylerin temizlenmesi, tüy sağlığının ve büyümesinin korunması için önemli olan deriye ve tüylere kan akışının uyarılmasına yardımcı olur (Sandilands, 2001). Tavuklarda tüylerin gagayla temizlenmesi 1 günlük yaşta başlar ancak yağlama davranışı civcivler yaklaşık 1 aylık olana kadar gözlemlenmez (Williams & Strungis, 1979). Bu davranışın sosyal bir davranış olduğu ve tavukların birbirlerinin tüylerini de temizlediği gözlenmiştir. Yüksek sıklıkta tüy tarama davranışı (muhtemelen kısa süreli) tavuklarda olumsuz tepkilerle de ilişkilendirilmiştir. Ancak tüyleri temizlemek için harcanan süre ve sıklık çevresel etkenlere göre değişkenlik gösterebilir (Bhanja & Bhadauria, 2018; Hocking, 2016; Nicol, 2015). Tavuklar, daha rahat ve sağlıklı civcivleri gözlemlediğinde, hafif sıkıntılı civcivleri gözlemledikleri zamana göre daha uzun tüy tarama süreleri kaydedilmiştir (Edgar et al., 2011). Bu yüzden davranışa ilişkin gelecekteki çalışmaların davranışın biçimini, yapısını ve süre uzunluğunu belirtmesi gerekmektedir.

Tavuklarda gözlenen bir diğer davranış keşif davranışıdır. Keşif çevrenin yeni veya değiştirilmiş özellikleri hakkında bilgi edinmeyi kolaylaştıran bir davranıştır. Tavukların, çevrelerindeki yeni nesneleri veya özellikleri keşfetme konusunda güçlü ve son derece gelişmiş bir dürtüleri vardır (Meuser et al., 2021). Newberry (1999), tavukların keşfetme eğilimlerini test etmek için yaptığı araştırmada tavukların yeni malzemelerin bulunduğu ortamda harcadıklarını sürenin sadece temel kaynakları (yiyecek, su ve ısıtma gibi) içeren ortama göre daha fazla olduğunu bildirmiştir (Newberry, 1999). Tavukların yenilik arama motivasyonunun anlaşılması çevresel zenginleştirme konusunda son derece önemlidir. Tavuk barınaklarının zenginleştirilmesine yönelik çalışmalar öncelikle yiyecek arama, yuvalama, tüneme gibi davranış ihtiyaçların karşılanmasına odaklanmalıdır. Bununla birlikte, sınırlı kanıtlara göre tavuklar için tehdit edici ve yaralayıcı olmayan oyuncak ve

uyaranların, tavukları etkili bir şekilde meşgul edebilir ve birbirlerini gagalama gibi agresif davranışları engelleyebilir (Meuser et al., 2021; Nicol, 2015).

Oyun davranışı ise tavuklarda daha düşük dirençli bir davranış olup, çevredeki değişikliklere göre hızlı bir şekilde sonlanabilir (Baxter et al., 2019; Lundén, 2020). Araştırmalar tavukların yaşamın ilk döneminde oyun davranışı gösterdiğini, civcivlerin yaklaşık 1 haftalıkken kanatları kaldırarak rastgele koşmayı içeren oyun oynama aktivitesi sergilediğini ve 2 haftalıkken civcivlerin zıplama, kovalama ve kanat çırpma gibi aktiviteler sergilediği bildirilmiştir (Held & Špinka, 2011; Lundén, 2020). Buna karşın civcivlerin birbirlerine tepki verdiği sosyal oyunların zamanla azaldığı ve memeli hayvanlarda olduğu gibi belirgin ve yaygın bir sosyal davranış olmadığı bildirilmiştir (Nicol, 2015).

Sonuç ve Öneriler

Yumurta tavuklarının davranışsal ihtiyaçlarını anlamak, refahı ve üretkenliği artırmak için çok önemlidir. Hayvan davranışlarının izlenmesi ticari yetiştirme şartlarında refahın değerlendirilmesi açısından önemli ipuçları sağlar. Tavukçuluk endüstrisinin gelişmesiyle birlikte barınma ve yönetim uygulamaları değişiyor. Yumurta tavuğu yetiştiriciliğinde geleneksel kafes sistemlerinden zenginleştirilmiş veya kafessiz sistemlere geçiş sürecinde, bu değişikliklerin tavuk davranışını ve refahını nasıl etkilediğinin dikkatli bir şekilde değerlendirilmesini gerekiyor.

Yetiştirme sistemlerinde su içme ve beslenme gibi bazı davranışsal ihtiyaçların sağlanması kolay olsa da yiyecek arama, yuvalama, tüneme, toz banyosu ve sosyalleşme gibi doğal davranışların sergilenmesi için belirli çevresel şartlar sağlanmalıdır. Bu nedenle ticari yetiştirme sistemlerinin, tavukların doğal davranışlarını sergilemesine olanak tanıyan zenginleştirilmiş ortamlara daha uyumlu olması gerekmektedir. Uygun üretim sistemlerinin tasarımı için ise tavukların davranış kalıplarının ve davranışsal ihtiyaçlarının bilinmesi önemlidir.

Tavuklardaki yiyecek arama davranışı, çoğunlukla gündüz saatlerinde gerçekleşen ve çevresel faktörlerden etkilenen, kısıtlama durumunda tavukların birbirlerini gagalamasına neden olan bir davranıştır. Tavukların yiyecek arama davranışlarını destekleyecek uygun altlık materyalinin sağlanması, doğal davranışlarını gerçekleştirmelerine yardımcı olabilir. Tavuklarda yuvalama davranışı yumurtlama için önemlidir. Yumurtlama öncesi hormonal değişiklikler yuvalama davranışını tetikler.

Tavuklar, yumurtlamadan önce uygun bir yuva alanı bulma konusunda güçlü bir iç motivasyon sergilerler ve uygun yuvalama koşullarının sağlanması, tavuklarda stres ve hayal kırıklığını önlemek için çok önemlidir. Tavuklarda tüneme davranışı güvenlik ve rahatlık ihtiyacını yansıtır; tavuklar genellikle güvenlik ve dinlenme için yüksek yerleri tercih ederler. Uygun yükseklik, genişlik ve uzunlukta tüneklerin sağlanması davranışın sergilenmesi için önemlidir. Tavuklarda toz banyosu davranışı, tüy sağlığını korumak ve ektoparazitleri önlemek için çok önemlidir, bu da onların hijyen ihtiyaçlarını ve genel refahını yansıtır. Tavukların toz banyosu davranışının sergilenmesinde, altlık materyaline yönelik tercihlerini anlamak uygun ortamların sağlanması bakımından önemli ipuçları sağlar. Tavuklar grup büyüklüğüne bağlı olarak hiyerarşiler ve sosyal ilişkiler oluşturan sosyal hayvanlar olduğundan, sosyal etkileşim ve keşif fırsatları sağlamak stresi azaltabilir ve refahı artırabilir. Tavuklarda gözlenen tüy tarama-temizleme, keşif ve oyun gibi diğer doğal davranışların da önemli olduğu görülmüştür.

Doğal davranışları sergileyebilen tavukların daha az stres yaşaması muhtemeldir, bu da yumurta üretiminin ve kalitesinin artmasına yol açar. Ayrıca doğal davranışların sergilenmesine imkan sağlayan ortamlar, yumurta üretimini ve sürünün genel sağlığını olumsuz yönde etkileyebilecek zararlı davranışların gösterilmesini azaltabilir.

Sonuç olarak, tavukların doğal davranışlarını anlamak ve desteklemek, tavuk yetiştiriciliğinde daha iyi bir refah standardına yol açabilir. Tavuk davranışını incelemek ve uygun yetiştirme koşullarını belirlemek, tavuk refahını iyileştirmede önemli adımlardır. Gelecekteki araştırmalar, daha etkili çevresel zenginleştirme stratejileri geliştirmek için tavukların davranış kalıplarını ve motivasyonlarını daha fazla incelemelidir.

Kaynakça

Abeyesinghe, S. M., McLeman, M. A., Owen, R. C., McMahon, C. E., & Wathes, C. M. (2009). Investigating social discrimination of group members by laying hens. *Behavioural Processes*, *81*(1), 1–13.

Alm, M., Tauson, R., Holm, L., Wichman, A., Kalliokoski, O., & Wall, H. (2016). Welfare indicators in laying hens in relation to nest exclusion. *Poultry Science*, *95*(6), 1238–1247.

Baxter, M., Bailie, C. L., & O'connell, N. E. (2019). Play behaviour, fear responses and activity levels in commercial broiler chickens provided with preferred environmental enrichments. *Animal*, *13*(1), 171–179.

Bécot, L., Bédère, N., Ferry, A., Burlot, T., & Le Roy, P. (2023). Egg production in nests and nesting behaviour: Genetic correlations with egg quality and BW for laying hens on the floor. *Animal*, *17*(10), 100958.

Bhadauria, P., & Bhanja, S. K. (2017). *Practicing behavioural observations for assessment of welfare in poultry*. ICAR-CARI, Izzatnagar. https://www.researchgate.net/profile/Pragya-Bhadauria-3/publication/322021405_Practicing_behavioral_observations_for_assessment_of_welfare_in_poultry/links/5c6256c1299bf1d14cbf893d/Practicing-behavioral-observations-for-assessment-of-welfare-in-poultry.pdf

Bhanja, S. K., & Bhadauria, P. (2018). *Behaviour and welfare concepts in laying hens and their association with housing systems*.

Bist, R. B., Subedi, S., Chai, L., Regmi, P., Ritz, C. W., Kim, W. K., & Yang, X. (2023). Effects of perching on poultry welfare and production: A review. *Poultry*, *2*(2), 134–157.

Campbell, D. L. M., Makagon, M. M., Swanson, J. C., & Siegford, J. M. (2016). Perch use by laying hens in a commercial aviary1 1Research support provided in part by a grant from the Coalition for a Sustainable Egg Supply (Kansas City, MO). *Poultry Science*, *95*(8), 1736–1742. https://doi.org/10.3382/ps/pew111

Campo, J. L., Gil, M. G., Dávila, S. G., & Muñoz, I. (2005). Influence of perches and footpad dermatitis on tonic immobility and heterophil to lymphocyte ratio of chickens. *Poultry Science*, *84*(7), 1004–1009.

Castro, F. L. S., Chai, L., Arango, J., Owens, C. M., Smith, P. A., Reichelt, S., DuBois, C., & Menconi, A. (2023). Poultry industry paradigms: Connecting the dots. *Journal of Applied Poultry Research*, *32*(1), 100310.

Chen, D., Bao, J., Meng, F., & Wei, C. (2014). Choice of perch characteristics by laying hens in cages with different group size and perching behaviours. *Applied Animal Behaviour Science*, *150*, 37–43.

Clausen, T., & Riber, A. B. (2012). Effect of heterogeneity of nest boxes on occurrence of gregarious nesting in laying hens. *Applied Animal Behaviour Science*, *142*(3–4), 168–175.

Cooper, J. J., & Appleby, M. C. (2003). The value of environmental resources to domestic hens: A comparison of the work-rate for food and for nests as a function of time. *Animal Welfare*, *12*(1), 39–52.

Cronin, G. M., & Hemsworth, P. H. (2012). The importance of pre-laying behaviour and nest boxes for laying hen welfare: A review. *Animal Production Science*, *52*(7), 398–405.

Davies, A. C., Radford, A. N., & Nicol, C. J. (2014). Behavioural and physiological expression of arousal during decision-making in laying hens. *Physiology & Behavior*, *123*, 93–99.

Edgar, J. L., Lowe, J. C., Paul, E. S., & Nicol, C. J. (2011). Avian maternal response to chick distress. *Proceedings of the Royal Society B: Biological Sciences*, *278*(1721), 3129–3134. https://doi.org/10.1098/rspb.2010.2701

Eklund, B., & Jensen, P. (2011). Domestication effects on behavioural synchronization and individual distances in chickens (Gallus gallus). *Behavioural Processes*, *86*(2), 250–256.

Emine, U., & Yenilmez, F. (2017). Tavukçulukta Davranış-Refah İlişkisi ve Hayvan Refahı Uygulamaları. *Çukurova Tarım ve Gıda Bilimleri Dergisi*, *32*(2), 69–76.

Ferreira, J. A., Valentim, J. K., Machado, L. C., & de Oliveira, H. F. (2022). *Preparation of ethogram for laying hens reared in cages.* https://www.cabidigitallibrary.org/doi/full/10.5555/20220296572

Grebey, T. C., Ali, A. B., Swanson, J. C., Widowski, T. M., & Siegford, J. M. (2020). Dust bathing in laying hens: Strain, proximity to, and number of conspecifics matter. *Poultry Science*, *99*(9), 4103–4112.

Hartcher, K. M., & Jones, B. (2017). The welfare of layer hens in cage and cage-free housing systems. *World's Poultry Science Journal*, *73*(4), 767–782.

He, S., Lin, J., Jin, Q., Ma, X., Liu, Z., Chen, H., Ma, J., Zhang, H., Descovich, K., Phillips, C. J. C., Hartcher, K., & Wu, Z. (2022). The Relationship between Animal Welfare and Farm Profitability in Cage and Free-Range Housing Systems for Laying Hens in China. *Animals*, *12*(16), Article 16. https://doi.org/10.3390/ani12162090

Heinrich, A., Icken, W., Thurner, S., Wendl, G., Bernhardt, H., & Preisinger, R. (2014). Nesting behaviour-a comparison of single nest boxes and family nests. *European Poultry Science/Archiv Für Geflügelkunde*, *78*. https://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=00039098&AN=100969487&h=UZpG%2BIOvVJ%2FMruHIA0ZhVKYFz5NFNPqwyoKD41ZNT9vOk5dinlny7Mzj6xERyJRu1nOjlvgIltviDQy0Tn%2FLpA%3D%3D&crl=c

Held, S. D., & Špinka, M. (2011). Animal play and animal welfare. *Animal Behaviour*, *81*(5), 891–899.

Hemsworth, P. H., & Edwards, L. E. (2020). Natural behaviours, their drivers and their implications for laying hen welfare. *Animal Production Science*, *61*(10), 915–930.

Hocking, P. M. (2016). The Behavioural Biology of Chickens. *British Poultry Science*, *57*(4), 581–581. https://doi.org/10.1080/00071668.2016.1200799

Hoppitt, W., Blackburn, L., & Laland, K. N. (2007). Response facilitation in the domestic fowl. *Animal Behaviour*, *73*(2), 229–238.

Hunniford, M. E., & Widowski, T. M. (2017). Nest alternatives: Adding a wire partition to the scratch area affects nest use and nesting behaviour of laying hens in furnished cages. *Applied Animal Behaviour Science*, *186*, 29–34. https://doi.org/10.1016/j.applanim.2016.10.018

Jong, I. de, & Blokhuis, H. J. (2006). *The welfare of laying hens.* https://www.cabidigitallibrary.org/doi/full/10.5555/20093210217

Korver, D. R. (2023). Current challenges in poultry nutrition, health, and welfare. *Animal*, *17*, 100755.

Lindqvist, C., & Jensen, P. (2008). Effects of age, sex and social isolation on contrafreeloading in red junglefowl (Gallus gallus) and White Leghorn fowl. *Applied Animal Behaviour Science*, *114*(3–4), 419–428.

Lindqvist, C., & Jensen, P. (2009). Domestication and stress effects on contrafreeloading and spatial learning performance in red jungle fowl (Gallus gallus) and White Leghorn layers. *Behavioural Processes*, *81*(1), 80–84.

Lundén, G. (2020). *Play Behavior and its Importance for Welfare in Chickens and Other Farm Animals.* https://www.diva-portal.org/smash/record.jsf?pid=diva2:1456443

Malchow, J., Eusemann, B. K., Petow, S., Krause, E. T., & Schrader, L. (2022). Productive performance, perching behavior, keel bone and other health aspects in dual-purpose compared to conventional laying hens. *Poultry Science*, *101*(11), 102095. https://doi.org/10.1016/j.psj.2022.102095

Martin, C. D., & Mullens, B. A. (2012). Housing and dustbathing effects on northern fowl mites (*Ornithonyssus sylviarum*) and chicken body lice (*Menacanthus stramineus*) on hens. *Medical and Veterinary Entomology*, *26*(3), 323–333. https://doi.org/10.1111/j.1365-2915.2011.00997.x

Meuser, V., Weinhold, L., Hillemacher, S., & Tiemann, I. (2021). Welfare-related behaviors in chickens: Characterization of fear and exploration in local and commercial chicken strains. *Animals*, *11*(3), 679.

Newberry, R. C. (1999). Exploratory behaviour of young domestic fowl. *Applied Animal Behaviour Science*, *63*(4), 311–321.

Nicol, C. J. (2015). *The behavioural biology of chickens*. CABI.

Nicol, C. J., Bouwsema, J., Caplen, G., Davies, A. C., Hockenhull, J., Lambton, S. L., Mullan, S., & Weeks, C. A. (2017). *Farmed bird welfare science review*. Department of Economic Development, Jobs, Transport and Resources Melbourne.

Nicol, C. J., Caplen, G., Statham, P., & Browne, W. J. (2011). Decisions about foraging and risk trade-offs in chickens are associated with individual somatic response profiles. *Animal Behaviour*, *82*(2), 255–262.

Ogura, Y., & Matsushima, T. (2011). Social facilitation revisited: Increase in foraging efforts and synchronization of running in domestic chicks. *Frontiers in Neuroscience*, *5*, 11069.

Olsson, I. A. S., Duncan, I. J., Keeling, L. J., & Widowski, T. M. (2002). How important is social facilitation for dustbathing in laying hens? *Applied Animal Behaviour Science*, *79*(4), 285–297.

Papageorgiou, M., Goliomytis, M., Tzamaloukas, O., Miltiadou, D., & Simitzis, P. (2023). Positive Welfare Indicators and Their Association with Sustainable Management Systems in Poultry. *Sustainability*, *15*(14), Article 14. https://doi.org/10.3390/su151410890

Perry, G. C. (2004). *Welfare of the laying hen* (Vol. 27). CABI. https://books.google.com/books?hl=tr&lr=&id=44S7TRL2lk0C&oi=fnd&pg=PR9&dq=WELFARE+OF+THE+LAYING+HEN+Poultry+Science+Symposium+Series+Volume+Twenty-seven&ots=j_VwVwqOwN&sig=WKPE2l9C8Y_kHt4v9uPJzAg88tw

Pickel, T., Scholz, B., & Schrader, L. (2010). Perch material and diameter affects particular perching behaviours in laying hens. *Applied Animal Behaviour Science*, *127*(1–2), 37–42.

Sandilands, V. (2001). *Preening behaviour in laying hens: Its control and association with other behaviors*. University of Glasgow (United Kingdom). https://search.proquest.com/openview/fc0c6e19e675254ecb4ecf631b4bedc9/1?pq-origsite=gscholar&cbl=51922&diss=y

Scholz, B., Kjaer, J. B., Urselmans, S., & Schrader, L. (2011). Litter lipid content affects dustbathing behavior in laying hens. *Poultry Science*, *90*(11), 2433–2439.

Scholz, B., Urselmans, S., Kjaer, J. B., & Schrader, L. (2010). Food, wood, or plastic as substrates for dustbathing and foraging in laying hens: A preference test. *Poultry Science*, *89*(8), 1584–1589.

Schrader, L., & Malchow, J. (2020). The role of perches in chicken welfare. In *Understanding the behaviour and improving the welfare of chickens* (pp. 375–416). Burleigh Dodds Science Publishing. https://api.taylorfrancis.com/content/chapters/edit/download?identifierName=doi&identifierValue=10.1201/9781003048039-13&type=chapterpdf

Sherwin, C. M., Richards, G. J., & Nicol, C. J. (2010). Comparison of the welfare of layer hens in 4 housing systems in the UK. *British Poultry Science*, *51*(4), 488–499. https://doi.org/10.1080/00071668.2010.502518

Shimmura, T., Hirahara, S., Azuma, T., Suzuki, T., Eguchi, Y., Uetake, K., & Tanaka, T. (2010). Multi-factorial investigation of various housing systems for laying hens. *British Poultry Science*, *51*(1), 31–42. https://doi.org/10.1080/00071660903421167

Stämpfli, K., Roth, B. A., Buchwalder, T., & Fröhlich, E. K. (2011). Influence of nest-floor slope on the nest choice of laying hens. *Applied Animal Behaviour Science*, *135*(4), 286–292.

Struelens, E., Tuyttens, F. A. M., Ampe, B., Ödberg, F., Sonck, B., & Duchateau, L. (2009). Perch width preferences of laying hens. *British Poultry Science*, *50*(4), 418–423. https://doi.org/10.1080/00071660903110885

Struelens, E., Van Nuffel, A., Tuyttens, F. A., Audoorn, L., Vranken, E., Zoons, J., Berckmans, D., Ödberg, F., Van Dongen, S., & Sonck, B. (2008). Influence of nest seclusion and nesting material on pre-laying behaviour of laying hens. *Applied Animal Behaviour Science*, *112*(1–2), 106–119.

Sulimova, L. I., Zhuchaev, K. V., & Kochneva, M. L. (2020). *Poultry behavior reactions and welfare*. https://www.cabidigitallibrary.org/doi/full/10.5555/20203453447

Wang, Y., Zhang, R., Wang, L., Li, J., Su, Y., Li, X., & Bao, J. (2022). Effect of social order, perch, and dust-bath allocation on behavior in laying hens. *Animal Bioscience*, *35*(2), 299.

Weeks, C. A., & Nicol, C. J. (2006). Behavioural needs, priorities and preferences of laying hens. *World's Poultry Science Journal*, *62*(2), 296–307.

Welfare (AHAW), E. P. on A. H. and A., Nielsen, S. S., Alvarez, J., Bicout, D. J., Calistri, P., Canali, E., Drewe, J. A., Garin-Bastuji, B., Gonzales Rojas, J. L., & Gortázar Schmidt, C. (2023). Welfare of laying hens on farm. *EFSA Journal*, *21*(2), e07789.

Williams N. S., & Strungis, J. C. (1979). The development of grooming behavior in the domestic chicken,(Gallus gallus domesticus). *Poultry Science*, *58*(2), 469–472.

Yan, F. F., Hester, P. Y., & Cheng, H. W. (2014). The effect of perch access during pullet rearing and egg laying on physiological measures of stress in White Leghorns at 71 weeks of age. *Poultry Science*, *93*(6), 1318–1326.

Yan, F. F., Hester, P. Y., Enneking, S. A., & Cheng, H. W. (2013). Effects of perch access and age on physiological measures of stress in caged White Leghorn pullets. *Poultry Science*, *92*(11), 2853–2859.

Zupan, M., Kruschwitz, A., & Huber-Eicher, B. (2007). The influence of light intensity during early exposure to colours on the choice of nest colours by laying hens. *Applied Animal Behaviour Science*, *105*(1–3), 154–164.

SIĞIR NAKİLLERİNDE REFAH VE NAKİL KOŞULLARININ ETKİLERİ

Doç. Dr. Murat GENÇ (ORCID: 0000-0002-9565-0887)
Atatürk Üniversitesi Veteriner Fakültesi Zootekni Ana Bilim Dalı Erzurum-Türkiye
Email: vet.murat.genc@gmail.com

Dr. Öğr. Üyesi Uğur ÖZENTÜRK (ORCID: 0000-0002-9565-0887)
Atatürk Üniversitesi Veteriner Fakültesi Zootekni Ana Bilim Dalı Erzurum-Türkiye
Email: vet.murat.genc@gmail.com

ÖZET
Sığırlarda alım, satım, kesim, sergi, fuar gösterileri, otlatma, tedavi, vb amaçlarla kara, tren, deniz ve hava yoluyla gerçekleşebilen nakil işlemi, son yıllarda rutin bir yönetim uygulaması halini almıştır. Günümüzde kara yolu nakilleri diğer yöntemlere kıyasla daha cazip hale gelmiş olup, modern bir sığırcılık işletmesinde yetiştirilen hayvanların büyük bir çoğunluğunun bu yöntemle en az bir kez bir yerden başka bir yere nakledildiği bilinmektedir. Hayvanların doğasında olmayan bu işlem, onları alışık olmadıkları çevre ve popülasyonlara maruz bıraktığı için korku ve stres oluşturur. Sığırlarda kara yolu nakliyesi sırasında oluşabilecek stres kaynakları arasında araç dizaynı, sürücünün deneyimi, yükleme yoğunluğu, yol durumu ve mesafesi, mola verilme zamanı, hayvanların su ve gıda ihtiyaçlarının karşılanması, iklim, yaş ve cinsiyet gibi çeşitli faktörler ön plana çıkmaktadır. Uygun olmayan koşullarda yapılan nakiller, bir takım fizyolojik ve morfolojik değişiklikler oluşturarak hem hayvan refahını, hem de sağlığını olumsuz olarak etkiler. Bu da karkas kalitesinin düşmesine, canlı ağırlık kayıplarına ve hatta ölümlere sebep olur. Nakil işlemleri sırasında oluşacak stresin tamamen ortadan kaldırılması mümkün olmamakla birlikte; kural, tedbir ve kısıtlamaları ülkeden ülkeye değişebilen bir takım yasal düzenlemeler getirilmiştir. Bu düzenlemelerin tamamında temel amaç nakil işlemlerinde hayvan refahını artırmaktır. Nakil işlemleri ile ilgili yönetim koşullarını iyileştirerek oluşacak stresi minimum düzeye indirmek, mevcut yasa ve yönetmeliklere göre gerekli önlemleri almak, refah ve et kalitesinin iyileşmesi ve ekonomik kayıpların azaltılması bakımından önemlidir.
Anahtar Kelimeler: Sığır, Nakil, Stres, Refah

WELFARE IN CATTLE TRANSPORTATION AND EFFECTS OF TRANSPORTATION CONDITIONS

ABSTRACT

The transportation of cattle, which can be carried out by land, train, sea and air for the purposes of buying, selling, slaughtering, exhibitions, fair shows, grazing, treatment, etc., has become a routine management practice in recent years. Nowadays, road transportation has become more attractive compared to other methods, and it is known that the majority of animals raised in a modern cattle enterprise are transported from one place to another at least once by this method. This process, which is not in the nature of animals, creates fear and stress because it exposes them to environments and populations they are not accustomed to. Various factors such as vehicle design, driver's experience, loading density, road condition and distance, break time, meeting the water and food needs of the animals, climate, age and gender stand out among the stress sources that may occur during road transportation of cattle. Transports performed under inappropriate conditions create a number of physiological and morphological changes, negatively affecting both animal welfare and health. This causes a decrease in carcass quality, live weight loss and even death. Although it is not possible to completely eliminate the stress that will occur during transportation procedures; a number of legal regulations have been introduced, the rules, measures and restrictions of which may vary from country to country. The main purpose of all these regulations is to increase animal welfare in transportation procedures. It is important to minimize the stress that will occur by improving the management conditions related to transportation operations, to take the necessary precautions in accordance with current laws and regulations, to improve welfare and meat quality and to reduce economic losses.

Keywords: Cattle, Transport, Stress, Welfare

1. Giriş

1.1. Hayvan Nakilleri ve Nakillerin Tarihsel Süreci

Geleneksel olarak, bir buzağı doğumundan ölümüne kadar aynı çiftlikte yaşamaktaydı. Günümüzde ise canlı hayvan ithalat ve ihracatının yaygınlaşması ile birlikte hayvan refahı, hayvan-insan sağlığı ve hayvancılık ekonomisi bakımından oldukça önemli bir aktivite olan nakliye, sıklıkla yapılan rutin bir yönetim uygulaması halini almıştır (Tarrant, 1990; Cockram et al., 1996; Grigor et al., 2004; Fazio et al., 2005).

Hem ülkemizde, hem de dünya genelinde düşük nüfuslu kırsal yerleşmelerde yaşayan halkın temel geçim kaynağı tarım ve hayvancılıktır. Kalabalık yerleşim merkezlerindeki insanların hayvansal besin ihtiyaçları, kırsalda yetiştirilen hayvanlardan sağlanmaktadır. Bu da hayvan nakliyesinin zorunlu hale geldiğini göstermektedir. Dolayısıyla sığırların bir işletmeden başka bir işletmeye ya da kesimhaneye taşınması tüm dünya ülkelerinde sıkça gerçekleştirilen bir durum haline gelmiştir (Altınçekiç & Koyuncu, 2010).

Tarihsel sürece bakıldığında hayvan nakillerinin ilk olarak deniz yoluyla gerçekleştirildiği bilgisine ulaşılmaktadır. Tarihte kaydedilen ilk hayvan taşınması 1607 yılında, Amerika'nın ilk kalıcı İngiliz sömürgecilerini taşıyan bir İngiliz gemisi olan Susan Constant ile Jamestown'a (Virginia) gerçekleştirilmiştir (Swanson & Morrow, 2001). Amerika'da 1850 yılında demiryolu ağının Chicago'nun merkezinden doğu, batı, kuzey ve güney yönlerine doğru yayılmasıyla demir yolu ulaşımı cazip hale gelmiş ve 5 Eylül 1867 yılında canlı sığırların trenle ilk nakliyesi Chicago'ya gerçekleşmiştir (Wade, 2002). Ancak demir yolu nakliyesi hem yüksek maliyet, hem de seyahat süresinin uzunluğundan dolayı çok fazla tercih edilmemiştir (Erzurum & Yılmaz, 2016). İlerleyen süreçte kara yolu ile yapılan taşımaların, deniz ve demir yoluna göre ölüm riskini azaltması nedeniyle bu yöntemi daha cazip kılmıştır (Hutchings & Martin, 1983). Önceleri deniz yolu ile başlayan, daha sonra demiryolu ve kara yolu ile devam eden canlı hayvan nakilleri en son olarak hava yoluyla gerçekleştirilmiştir. Ancak günümüzde canlı hayvanların kara yolu ile taşınması halen en çok kullanılan seçenek olup, özellikle Avrupa Birliği Ülkelerinde en önemli nakliye biçimidir (Anonim, 2020).

Nakil işlemi; hayvanların başka bir yere taşınmaları amacıyla yakalanmaları, araca konulmaları, gidecekleri yere götürülmeleri, araçtan indirilmeleri ve yeni yerlerine yerleştirilmelerini kapsayan bir süreçtir. Sığırcılık işletmelerindeki önemli aktivitelerden biri olan bu işlem, hayvanların refahını etkileyen ve onlarda stres yaratan önemli

etmenlerden biridir. Nakliye sırasında hayvan refahını ve sağlığını doğrudan etkileyen çok sayıda faktör, karkas ve et kalitesi üzerinde de etkilidir (Tarrant & Grandin, 2000; Grigor et al., 2004). Uygun şartlarda yapılmayan nakiller hayvanların hafif yaralanmalarından ölümlerine kadar değişebilen ciddi ekonomik kayıplara yol açmaktadır. Dolayısıyla hayvan nakillerinde refahı olumsuz etkileyen bazı faktörleri ve bu faktörlerin hayvan ve ürün üzerindeki olumsuz etkilerini en aza indirmek için alınması gereken tedbirler ya da konuyla ilgili belirlenen standartlar çerçevesinde uyulması gereken kurallara dikkat edilmesi çok önemlidir (Tarrant, 1990; Tarrant & Grandin, 2000; Anonim, 2005; Erzurum & Yılmaz, 2016)

1.2. Hayvanlar Nakledilmeden Önce Dikkat Edilecek Noktalar

1.2.1. Nakil için hayvanların hazırlanması

Hayvan Sağlığı Zabıtası Kanunu (HSZK) (3275) ve Hayvan Sağlığı Zabıtası Yönetmeliğinde (89/13838) hayvan nakillerinde, hayvan pazarlarında hastalıkların yayılmasının önlenmesi için alınacak önlemler hususunda canlı hayvan nakillerinde nakil öncesi hayvanların muayenelerinin yapılması ve sağlık raporlarının düzenlenmesi gerektiği bildirilmiştir. Hayvan pazarında satışı yapılan ve başka il veya ilçelere nakledilecek hayvanlar için, varsa o yerdeki hükümet veteriner hekimi, yoksa en yakın il veya ilçe hükümet veteriner hekimi menşe şahadetnamesinde yazılı hayvanları muayene ederek veteriner sağlık raporu düzenlemesi gereklidir Küpelenmemiş, kayıt altına alınmamış ve pasaportsuz sığır cinsi hayvanların sevkleri yasaktır (Anonim, 1989; Yıldız & Hayırlı, 2005).

Zorunlu kesimler dışında fiziksel ve sağlık şartları uygun olmayan hayvanların sevklerine müsaade edilmemelidir. İleri gebe (gebeliğinin son %10'unda), yeni doğum yapmış (48 saat), 14 günlük yaştan küçük buzağılar, ayağı kalkamayan, kırık nedeniyle şiddetli ağrı çeken, kanamalı, geniş ve derin yaraya sahip, sistemik hastalıklı, aç, zayıf, güçsüz, ayağı sakat, uterusu prolobe olmuş, görülebilir solunum ve dolaşım sistemi hastalıklı, koordinasyon bozukluğu olan, çevreye karşı aşırı reaksiyon gösteren, boynuzu kopmuş veya kör hayvanların nakilleri yasaktır (Anonim, 1989; Anonim 2002a, Anonim 2002b).

1.2.2. Naklin hangi ulaşım aracı ile yapılacağına karar verilmesi

Hayvanların nakillerinde, yüklemeden boşaltmaya kadar maruz kaldıkları stres faktörlerinin etkisini en aza indirmek için uygun araçların kullanılması gerekli ve önemlidir. Hayvanları taşımak için kullanılan tüm araçların, taşıma sırasında hayvan

refahına yönelik Avrupa Birliği mevzuatına göre temel standartlara sahip olması gerekmektedir (Jarvis et al., 1996; Anonim 2002a, Anonim, 2005). Canlı hayvanların taşınması genellikle kamyon, tren veya kısa mesafelerde yürütülerek yapılır. Yürütülerek nakil yapılması kanunen yasaktır. Kara yolu taşımacılığında çeşitli avantajlarından dolayı en çok kamyonlar tercih edilmektedir. Bu avantajlar; hayvanların satın alındığı yerden yüklemelerinin yapılabilmesi, hareket saatlerinin istenildiği gibi ayarlanabilmesi, taşıma maliyetlerinin düşük olması, taşıma firesinin daha az olması, daha hızlı ulaşım imkânı sağlaması, her yerde bulunabilmesi ve kapasitesinin değişik olmasıdır (Anonim, 2002b; Yıldız & Hayırlı, 2005).

1.2.3. Nakil araçların özellikleri

Hayvan nakleden araç ve konteynerlere dışarıdan görülecek şekilde, hayvan nakledildiğini belirten levhalar asılmalıdır. Nakil araçları hayvanların güvenliğini sağlamalı, yaralanmalarını ve acı çekmelerini engellemelidir. Hayvanların muayene ve bakımlarının yapılabilmesi için, gerektiğinde hayvanlara erişim imkânı sağlamalıdır. Hayvanların kaçmasını, dışarı düşmesini önlemeli ve hareketliliğin yarattığı zorlamalara karşı koyabilmelidir. Hayvanları sert hava, aşırı ısı ve iklim koşullarındaki olumsuz değişikliklere karşı korumalı ve yeterli aydınlatma imkânı sağlamalıdır. Döşeme yüzeyi; idrar ve dışkı sızıntısını asgariye indirecek, temizlenecek ve dezenfekte edilecek özellikte tasarlanmalı ve imal edilmiş olmalıdır (Anonim, 1989; Anonim, 2002b; Yıldız & Hayırlı, 2005).

1.2.4. Nakil aracının hazırlanması ve bakımı

Nakil araçlarına yükleme yapılmadan önce temizlik ve dezenfeksiyonu yapılmalıdır (Hall et al., 1998). Ek olarak hayvan Sağlığı Zabıtası Kanunu (HSZK) yönetmeliğine göre hayvanları veya hayvan maddelerini nakleden tüm kara, deniz ve hava vasıtalarının nakil sonunda da temizlenmesi ve dezenfekte edilmesi zorunludur. Bu gibi vasıtaların nakliyattan sonra temizlenip temizlenmediği sorumlu veteriner hekim tarafından denetlenerek rapor edilmelidir. İlaçlanmış her türlü vasıtaya dezenfekte edildiğine dair bir etiket yapıştırılır ve sahibine veteriner hekimce bir belge verilir. Bu belgesi bulunmayan vasıtalarla yeni bir hayvan nakline müsaade edilmemelidir (Anonim, 1989; Yıldız & Hayırlı, 2005).

Nakil araçlarına normalden fazla hayvan yüklenmemeli, değişik türlerden hayvan yüklenmesi durumunda araçlar içinde ayrı bölmeler oluşturulmalıdır (Hall et al., 1998).

Nakil aracının taban döşemeleri üzerine en az 2 cm kalınlığında yataklık, sap, saman veya talaş vs. maddeler serilmelidir (Hall et al., 1998). Nakliyecilerin nakil araçlarında yem-su yönünden tedarikli olup olmadıkları ve yeteri miktarda urgan, yular vs. ile ilk yardım çantası bulundurup bulundurmadıkları kontrol edilmelidir (Anonim, 2002a).

1.2.5. Hayvanların yüklenmesi ve boşaltılması

Taşıma sırasında en önemli stres faktörü canlı hayvanların araca yüklenmesidir (Ninomiya, 2014). Hayvanların gereksiz yere yaralanmalarına veya acı çekmelerine neden olmamak için yükleme, taşıma ve boşaltma işlemleri uygun rampalar kullanılarak yapılmalıdır (Hall et al., 1998; Anonim, 2005). Bir hayvanın araca yükleme veya boşaltma sırasında yaşadığı stres, tamamen bakıcının o andaki tutumuna göre şekillenir. Yükleme koşulları özellikle de yükleme elemanları (yükleme rampası ve iskelesi) hayvanlarda fiziksel efor ve psikolojik stres seviyesini büyük ölçüde etkileyebilen faktörlerdir. Kaygan zeminler, keskin köşeler veya metal yapılar hayvanları yaralayabilir, psikolojik ve fiziksel strese neden olabilir. Eğer meyilli bir yüzey kullanılacaksa yüzeyin yeteri derecede geniş olması, kaygan olmaması ve hayvanların vücutlarını çarpıp zedelememeleri için yan kısımların çıkıntılı olmaması gerekir. Hayvanlar yüklenirken yönlendirilme veya hareket ettirilmesi amacıyla sopa ya da elektrikli övendire kullanılmamalı, kuyruk veya kulakları bükülmemelidir. Yükleme ve boşaltma sırasında hayvanları rahatsız edeceğinden kapı ve kilitlerin aşırı gürültülü açılıp kapanması da engellenmelidir (Trunkfield et al., 1991; Anonim, 2014).

Yükleme genellikle kamyon kasasının arka kapağı açılarak yapılmaktadır (Anonim, 2002b). Yükleme ve boşaltma sırasında kullanılan rampanın yerle maksimum 20-25° açı oluşturması gerekmektedir (Anonim, 2002b; Ünal et al., 2008). Pazar yerinde uygun rampalar olmadığından yükleme işlemi sırasında birçok zorluklarla karşılaşılmaktadır. Hayvanlar taşıma aracına yüklerirken kayma veya kapağa takılma nedeniyle yaralanma riski artmaktadır. Aynı şekilde indirme esnasında da rampaların olmamasından dolayı bazen hayvanlar kamyondan atlatılarak indirilmektedir (Anonim, 2002b; Yıldız & Hayırlı, 2005).

1.2.6. Hayvan nakleden araç şoförlerinin eğitimi

Hayvanların sağlıklı bir şekilde taşınması için sürücülerin hayvan refahı konusunda eğitimli olması ve bu meslekte sertifikalı sürücüler çalıştırması önemlidir. Hızlı araç

kullanan, sık fren yapan, ani hızlanan ve virajlara sert giren sürücüler, hayvanın yaralanmasına, hatta ölümüne yol açabilir (Anonim, 2002b).

1.3. Nakil Esnasında Dikkat Edilecek Noktalar

1.3.1. Nakil araçlarında yerleşim sıklığı, yükseklik ve çevre şartları

Sığırlar soğuk ve yağışlı kış günlerinde üstü branda ile kaplı, yaz döneminde ise üstü açık araçlarla nakledilmelidir. Bu hayvanların taşınmasında tek ve iki katlı araçlardan yararlanılmasına rağmen, genelde araçların tek katlı olması tercih edilir. Kapalı nakil araçlarında hayvanların ihtiyaç duyduğu havanın karşılanması ve normal pozisyonlarında ayakta durabilecekleri koşullar sağlanması için plânlanan yolculuğa ve hayvanların hacimlerine uygun yükseklik ayarlaması yapılmalıdır (Broom, 2005). Sığırlarda normal pozisyonda vücudun en yüksek noktası başın tepe noktasıdır. Bu bağlamda sığır nakil araçlarında tavan yüksekliğinin baş seviyesinden en az 20 cm yukarıda olması gerekmektedir (Trunkfield et al., 1991; Yıldız & Hayırlı, 2005). Taşıma koşulları hayvanların dinlenmesine izin verecek şekilde düzenlenirse, ergin sığırlar nakil başladıktan 2-4 saat sonra yatma eğilimi gösterirler. Araçta denge kaybı ve düşmelerin beklenmedik yaralanma ve ezilmelere neden olmasından dolayı ergin sığırların, seyehat yönüne dik veya paralel durmaları tercih edilmektedir (Tarrant, & Grandin, 2000; Swanson & Morrow, 2001; Altınçekiç & Koyuncu, 2010).

Taşıma sırasında sığır başına düşen alan, hayvanların sağlığı ve refahı bakımından oldukça önemlidir. Nakli gerçekleştiren kişiler taşıma maliyetlerini düşürmek için dar alanda daha fazla sayıda hayvan nakletmek isteyebilir. Uzun mesafeli taşımalarda hayvanların yatma ihtiyacını karşılayacak, yiyecek ve su sağlayacak alanların hesaplanması gereklidir (Ali et al., 2006; Anonim, 2002b). Nakil araçlarına seyrek olarak yerleştirilen sığırlar da aracın hızlı kullanılması, ani frenleme, virajlara hızlı girilmesi gibi durumlarda zarar görebilir. Ayrıca özellikle erkek sığırlar düşük yerleşim sıklıklarında kendi aralarında dövüşebilir veya birbirlerinin üzerlerine atlayabilir (Anonim, 2002b; Erzurum & Yılmaz, 2016).

Taşınacak hayvanların canlı ağırlığı değişkenlik gösterdiğinden hayvan başına alan hesabı yapılırken m^2 alana düşen hayvan sayısı veya 100 kg için gerekli alanın m^2 cinsinden belirlenmesi doğru değildir. İngiltere Çiftlik Hayvanları Refahı Konseyi (FAWC) tarafından tüm hayvan türleri için kabul edilen minimum alan ihtiyacını belirlemek için 12 saate kadar süren ayakta nakledilen sığırlarda $A = 0.21 \times W^{0.67}$

denkleminin kullanılması önerilmektedir. Bu eşitlikte "A" m^2 olarak hayvan başına düşen minimum alanı, "W" kg olarak hayvanın canlı ağırlığını, "0.021 sabiti" hayvanın vücut yapısına bağlı olarak vücut uzunluğunun vücut genişliğine oranını temsil eder. Buna göre 300, 400, 500 kg canlı ağırlıktaki her bir sığır için sırasıyla en az 0.96, 1.16, 1.35 m^2 alan düşmelidir. Uzun süreli nakillerde (>12 saat) birim alana düşen hayvan sayısı %50 oranında azaltılmalıdır ($A = 0.0315 \times W^{0.67}$). Boynuzlu sığırlar için %5-7 daha azaltma yapılmalıdır (Anonim, 2002b).

Avrupa Birliği standartlarına göre sığırlarda farklı canlı ağırlıklar için, nakil esnasında hayvan sayısı ve aracın kapasitesine göre araç içerisinde hayvan başına ayrılacak alanlarla ilgili sınırlar Tablo 1'de verilmiştir (Anonim, 2005).

Tablo 1. AB standartlarına göre nakil anında bir hayvan için ayrılan alan (Anonim, 2005).

Sınıf	Tahmini ağırlık (kg)	Gereken alan (m^2/hayvan)
Küçük buzağılar	50	0.30-0.40
Orta yapılı buzağılar	110	0.40-0.70
Ağır yapılı buzağılar	200	0.70-0.95
Orta yapılı inekler	325	0.95-1.30
Ağır yapılı inekler	550	1.30-1.60
Çok ağır yapılı inekler	>700	>1.60

1.3.2. Nakil ve mola süreleri

Nakiller; nakliyeci, üretici ya da kesimhane arasında planlanmalıdır (Anonim, 2005; Yıldız & Hayırlı, 2005). Yükleme ve nakliyeye alışık olmayan hayvanlar, yüklemeden sonraki ilk saatlerde yoğun stres yaşarlar. Daha sonra taşıma koşullarına göre belirli seviyelerde adaptasyon meydana gelebilir. Ancak, taşıma süresi uzadıkça stres artmakta ve refah olumsuz etkilenmektedir. Nakil süresi, ilk hayvanın yüklenmesinden son hayvanın boşaltılmasına kadar geçen zamandır. Deniz taşımacılığı araçlarında geçirilen süre taşıma süresinden sayılır ve bu süreye dâhil edilir. Havayolu ulaşımının kullanılması durumunda, uçakta geçirilen süre toplam seyahat süresinden sayılmaz (Akman, 1998; Anonim, 2005). Nakil süresinin uzaması hayvanlarda yorgunluğa, enerji yetersizliğine ve hastalıklara karşı duyarlılığın artmasına neden olur. Bu nedenlerden dolayı hedefe ulaşım gecikmeden yapılmalı ve nakil süreleri mümkün olduğu kadar kısa tutulmalıdır. Sığır ve buzağılar için standart nakliye süresi 8 saattir (Anonim 2002b; Anonim, 2005; Yıldız &

Hayırlı, 2005). Gerektiğinde su, yem ve dinlenme sağlanmalıdır. Buzağısı ile birlikte nakli yapılacak inekler için de nakil süresi 8 saatten daha uzun olmamalı ve taşıma süresi boyunca belirli aralıklarla mutlaka su verilmelidir (Trunkfield et al, 1991; Yıldız & Hayırlı, 2005; Akbaş, 2013). Sığırlar için standart ve maksimum taşıma süreleri Tablo 2'de verilmiştir (Anonim, 2005).

Tablo 2. Sığırlar için standart ve maksimum taşıma ve dinlenme süreleri (saat) (Anonim, 2005).

	Standart Araçta Kalma Süresi	Maksimum Araçta Kalma Süresi		
		Seyahat	Dinlenme	Seyahat
İnek	8	14	1	14
Sütten kesilmiş buzağı	8	14	1	14

1.4. Nakilden Sonra Dikkat Edilecek Hususlar

İndirilen hayvanlara; indirildikleri yeni alanı tanıma fırsatı verilmelidir. Bu amaçla 1-2 saat boyunca hayvanların yanına girilmemeli ve her türlü müdahaleden kaçınılmalıdır. Dinlenip yeni ortamı tanıyan hayvanlara kontrollü olarak su verilebilir. Getirilen hayvanlar, ayrı bir ahırda karantinaya alınarak sağlık statüsü eşitlenene kadar bir araya konulmamalıdır. Karantina süresince araç ve gereçler ortak kullanılmamalıdır. Nakliye sonrası şekillenebilen öksürüğe karşı barınak içi havalandırma kapatılmamalı, içeride hava cereyanı oluşturmadan sürekli temiz hava sağlanmalıdır. Ayrıca hayvanların nakil stresinden çıkarak yeni yaşam alanlarına uyum sağlayabilmesi için elektrolit tedavisi, vitamin ve aşı uygulamaları yapıldıktan sonra birkaç gün yüksek enerjili diyetlerle beslenmesi de fayda sağlar (Tarrant & Grandin, 2000; Anonim, 2005; Anonim, 2020).

2. Sığırların Nakliyesi Esnasında Meydana Gelen Fizyolojik ve Morfolojik Değişiklikler

2.1.1. Taşıma esnasında oluşan fizyolojik değişiklikler

2.1.1.1. Kortizol seviyesindeki değişim

Nakil sırasında hayvanlar üzerinde yoğun stres yaratarak refahı olumsuz yönde etkileyebilen faktörler hayvanlarda zorlanım (stres) oluşturur ve bu zorlanıma karşı hayvanlar bir takım tepkilerle ortama uyum sağlamaya çalışır. Stresörler hayvanlarda homeostasinin ve metabolizma değerlerinin değişmesine neden olur. Akut strese yanıt olarak kandaki kortizol gibi kan glukokortikoidlerinin artması hayvanların çevredeki

değişimlere tepkisinin göstergesi olarak kabul edilebilmektedir (Cockram & Corley, 1991; Yıldız & Hayırlı, 2005). Yapılan bir çalışmada taşıma esnasında belirli periyotlarla alınan kan örnekleri kortizol seviyesindeki değişimleri ortaya koymuştur (Ali et al., 2006). Benzer şekilde planlanan bir diğer araştırmada Tarrant et al. (1992) düşük, orta ve yüksek yoğunlukta stoklama yapılarak kara yolu ile 24 saatlik sürede nakledilen sığırların plazma kortizol seviyelerinin sırasıyla 0.1, 0.5 ve 1.1 ng/ml olduğunu ve aradaki farkın istatistiksel olarak önemli ($P<0.05$) bulunduğunu tespit etmişlerdir. Gebresenbet & Eriksson (1998) farklı yaş ve cinsiyetteki toplam 540 baş sığırın kısa, orta ve uzun süreli nakliyesine bağlı fizyolojik değişimlerini araştırdıkları çalışmada, buzağıların nakillerden daha fazla etkilendiğini ve bu hayvanlarda plazma kortizol konsantrasyonunun erişkin erkek ve dişi sığırlara göre daha fazla değiştiğini belirlemişlerdir. Nanda et al. (1990) nakillerin Holstayn ırkı sığırlarda serum kortizol miktarı üzerine etkisini araştırdıkları çalışma sonucunda, yolculuğun başlamasından 15 dakika sonra bu değerin arttığını ($P<0.01$) tespit etmişlerdir. Ek olarak en yüksek değere seyahatin başlamasından 30 dakika sonra rastlandığı ve kortizol seviyesinin seyahat öncesinin 8 katına kadar yükseldiği bildirilmiştir.

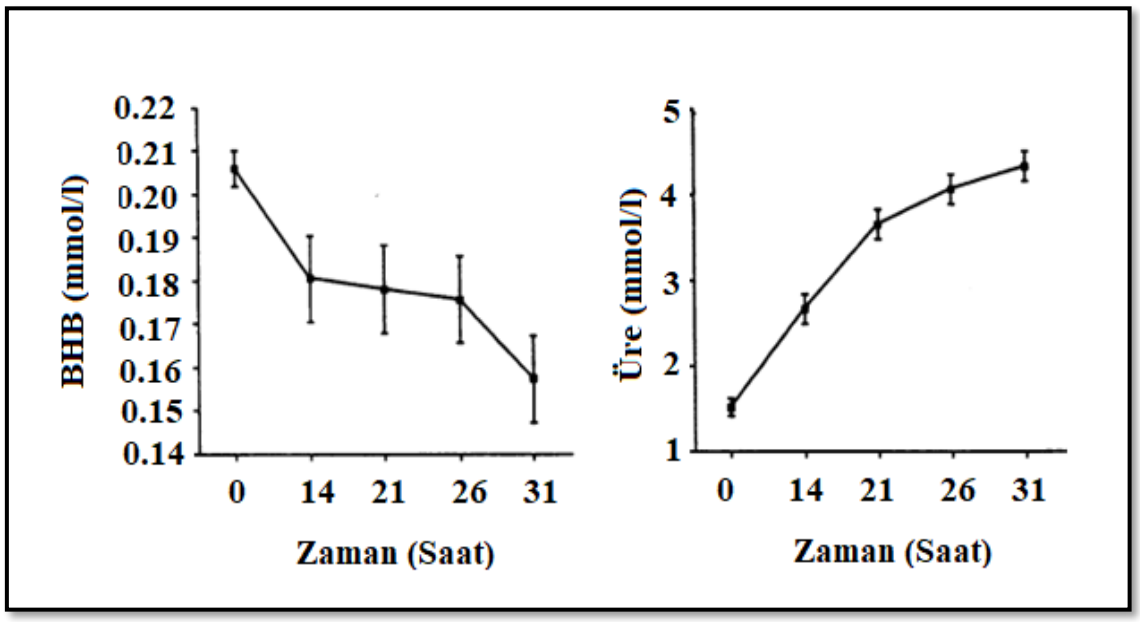
2.1.1.2. Kreatin kinaz seviyesindeki değişim

Kreatin kinaz (CK) aktivitesi taşıma ile oluşan akut strese bağlı olarak değişiklik göstermektedir. Konu ile ilgili olarak yapılan bir çalışmada, nakliye sırasında yükleme yoğunluğuna bağlı olarak CK aktivitesinin farklılık gösterdiği tespit edilmiştir (Tarrant et al., 1992). Farklı bir çalışmada Knowles (1999) sığır nakillerinde fiziksel yorgunluğun göstergesi olan plazma CK miktarının önemli derecede arttığı sonucuna varmıştır. Knowles et al. (1999) 14, 21 ve 31 saat süren yolculuklardan sonra plazma CK aktivitesinde benzer oranda artışlar tespit etmişlerdir. Lensink et al. (2001) sığır nakillerinde yükleme esnasındaki fiziksel çaba ve akut psikolojik stresin bir sonucu olarak CK seviyesinin nakliyenin ilk döneminde oldukça yüksek seviyelere çıktığını ve daha sonra yolculuk ilerledikçe azaldığını tespit etmişlerdir. Öte yandan dengeyi sağlama çabası ve uzanma zorluğu gibi fiziksel eforun bir sonucu olarak CK enzimi yolculuk sırasında sürekli normal seviyenin üzerinde seyretmiştir.

2.1.1.3. Beta-hidroksibutirat ve üre seviyesindeki değişimler

Knowles et al. (1999) kara yolu ile 14, 21, 26 ve 31 saat nakledilen sığırların plazma beta-hidroksibutirat düzeylerinde azalma ($P<0.001$) meydana geldiğini saptamışlardır (Şekil

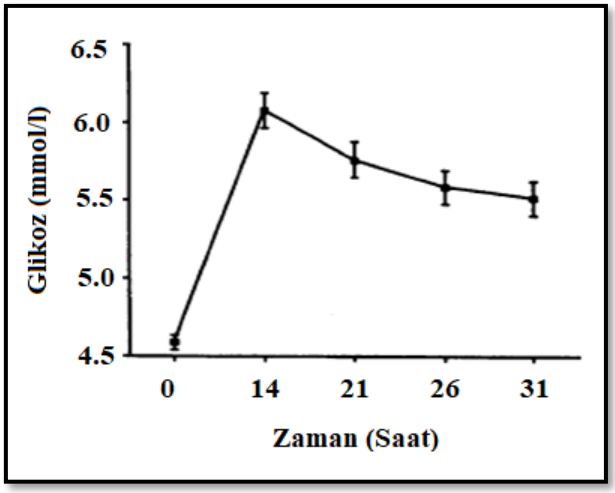
1). Aynı çalışmada plazma üre düzeylerinin de yolculuk süresiyle birlikte yükseldiği ($P<0.001$) ve daha kısa yolculuklarda artış oranının arttığı sonucuna varılmıştır.



Şekil 1: Kara yolu ile 31 saat nakledilen sığırların plazma beta-hidroksibutirat ve üre seviyelerinin değişimi (Knowles et al., 1999).

2.1.1.4. Plazma glikoz miktarındaki değişim

Nakliye esnasında ortaya çıkan stres faktörleri hayvanlarda homeostazın ve devamında metabolizmanın bozulmasına neden olmaktadır. Buna bağlı olarak da kan glikoz miktarının yükseldiği bilinmektedir (Averós et al, 2008). Knowles et al. (1999) plazma glikoz konsantrasyonunun nakliyenin ilk 14 saatinde düzenli bir artış gösterdiğini, daha sonra düşmeye başladığını belirlemişlerdir. Tarrant et al. (1992) düşük, orta ve yüksek yükleme yoğunluğunda nakledilen sığırların plazma glikoz konsantrasyonlarını sırasıyla 0.81, 0.93 ve 1.12 mmol/l olarak hesaplayarak, bu parametrenin araçtaki hayvan yoğunluğunun artmasına bağlı olarak yükseldiğini ifade etmişlerdir. Bulitta et al. (2015), taşıma süresinin serum glikoz konsantrasyonu üzerindeki etkisinin hem dişi, hem de erkek sığırlar için anlamlı bir değişime sebep olduğunu belirlemişlerdir.



Şekil 2. Kara yolu ile 31 saat nakledilen sığırların plazma glukoz seviyesinin değişimi (22)

2.1.1.5. Kas glikojen ve pH düzeyindeki değişimler

Tarrant (1981), kesim öncesi stres koşullarının bir sonucu olarak kas glikojen depolarının tükendiğini ve et pH'ının yükseldiğini belirterek, kaliteli sığır etinin nihai pH değerinin 5.5'e yakın olduğunu ve 5.8'den büyük pH değerlerinde taze soğutulmuş etin hem yumuşaklığının, hem de muhafaza kalitesinin olumsuz etkilendiğini ifade etmiştir. Kuzmanović & Cvrtila (2000), kesim için mezbahaya nakledilen sığırların gracilis kasındaki pH değerinin yol stresine bağlı olarak yükselttiğini belirlemişlerdir. Gebresenbet & Eriksson (1998) nakil stresinin et pH' ını artırdığını belirterek, engebeli ve virajlı yollarda taşınan hayvanlarda bu değerin 5.8'in üzerine çıktığını saptamışlardır.

2.1.1.6. Diğer değişimler

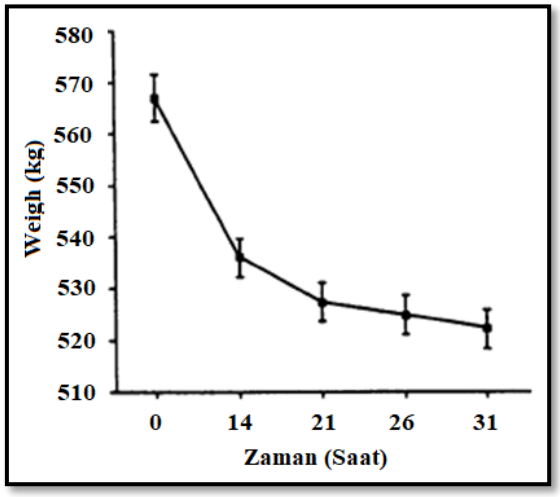
Nakil esnasında değişen çevre ve nakliyenin stresine maruz kalan hayvanlarda kalp ve solunum sayısında artış ve adrenal bez salgılarında değişimler görülür. Ayrıca hayvanların su alımının kısıtlanması, solunum sayısının artması, üriner ve ruminal su kaybı ile aşırı terleme gibi sebeplerin yol açtığı dehidrasyon derecesine bağlı olarak hematokrit düzeyinin de arttığı bildirilmektedir (Yıldız & Hayırlı, 2005).

2.1.2. taşıma esnasında oluşan morfolojik değişiklikler

2.1.2.1. Canlı ağırlık kaybı (Nakil firesi)

Nakliyat sırasında görülen değişimlerin en önemlilerinden birisi yem ve su kısıtlamasına bağlı olarak yağ rezevlerinin mobilize olması ve vücut ağırlığında meydana gelen kayıplardır. Nakil firesi, hayvan nakilleri sırasında oluşan fizyolojik bir durumdur. Nakil firesinin düzeyi naklin optimum hayvan refahı koşullarında yapılıp yapılmadığını

gösteren önemli bir parametredir. Hayvan nakillerine bağlı ağırlık kaybı, yolculuğun süresi ve koşullarına bağlı olarak değişebilir. 24 saatlik bir seyahatten sonra normal beslenen sığırların vücut ağırlığında %2-4, 24-36 saatlik seyahatten sonra %3.5-5.5'luk bir kayıp görülür (Tarrant & Grandin, 2000; Altınçekiç & Koyuncu, 2010; Marques et al., 2012; Teke, 2014; Erzurum & Yılmaz, 2016). Knowles et al. (1999) kara yolu ile her 14 saatlik seyahat sonunda mola verilerek toplam 31 saat süre transport yapılan sığırlarda %7'lik bir canlı ağırlık kaybı belirlemişlerdir.



Şekil 3. Kara yolu ile 31 saat nakledilen sığırların canlı ağırlıklarının değişimi (Knowles et al., 1999)

Nakliyeye bağlı olarak hayvanların maruz kaldığı stres koşulları sindirim sisteminde baskılanmalara yol açabildiği gibi, dolaşım sistemini de olumsuz etkilediği için mikro elementlerin akut yetmezliğine bağlı olarak hassas doku ve organlarda hücresel faaliyetler aksar. Buna bağlı olarak hayvanların yemden yararlanma ve yaşamsal faaliyetleri kısa bir süreliğine yeni çevreye adaptasyon için değişir. Canlı ağırlık artışı psikolojik olarak yaşanan travma son buluncaya kadar işletmenin ön gördüğü düzeyde olmayacaktır (Marques et al., 2012; Hughes et al., 2014).

2.1.2.2. Et kalitesi ve rengi

Kesim öncesindeki koşullara bağlı olarak hayvanın oluşturduğu cevaplar kasta biyokimyasal değişikliklere (özellikle glikojen metabolizmasında) neden olmaktadır. Bu durum özellikle hızlı glikolizis olduğunda ortaya çıkar, ardından da laktik asit üretiminde artış ve pH düşüşü şekillenir. Kas proteinlerinin su bağlama kapasitesi azalır ve suyun etin dışına sızmasına bağlı olarak et solgun ve gri bir renge dönüşür. Ette oluşabilecek diğer bir bozukluk da onun koyu, sıkı ve kuru bir hal almasıdır. Kastaki depolanmış

glikojenin ölüm öncesi yer değiştirmesi ve ölüm sonrasında az miktarda laktik asit üretimine karşılık pH' nın yüksek kalması sonucu şekillenir (Schaefer et al., 1988; Tarrant et al., 1992; Yıldız & Hayırlı, 2005; Yıbar & Çetin, 2013).

Hayvanların et kalitesini etkileyen bir diğer etmen de, nakil sırasında hayvanların insanlar tarafından gördüğü kötü muamele ya da kendi aralarındaki kavgadır ki bu durum karkasta sıyrık, morartı ve yaralanmalara neden olup ekonomik yönden kayıplara yol açar (Schaefer et al., 1988; Tarrant et al., 1992; Broom, 2005).

2.1.2.3. Hastalık ve ölüm

Sığırların uygun olmayan şartlarda nakledilmelerine bağlı olarak yaşadıkları çoklu stres faktörleri nedeniyle bağışıklık sistemleri baskılanmakta, böylelikle birçok metabolik ve sistemik hastalığa predispozisyon oluşmaktadır. Yüksek stres altında taşınan bu hayvanlarda hareketsizlik, iştahsızlık, çevreye karşı duyarsızlık, diş gıcırdatma ve birbirlerine saldırma gibi istenmeyen davranışlar da gelişmektedir (Knowles et al., 1999; Eicher, 2001; Yıldız & Hayırlı, 2005; Akbaş, 2013). Nakledilen sığırlarda yeni yaşam alanında bulunan mikroorganizmalara karşı yeterli direnç geliştirilemediğinden, vücutları çok sayıda fırsatçı patojen tarafından istila edilir. Bu durum özellikle 4 haftalık yaştan küçük buzağılar için daha da kritiktir. Çünkü genç hayvanlar taşıma stresini, erişkinler kadar kolay tolere edemezler. Taşıma sırasındaki refah seviyesinin düşmesine bağlı oluşan stresin süresi ve şiddetine göre ölümler de görülebilir (Anonim, 2002b; Earley et al, 2017).

3. Sonuç ve Öneriler

Hayvan nakillerinin oluşturduğu stresi sıfırlamak neredeyse imkansızdır. Ancak alınacak bir takım tedbirlerle taşıma stresine bağlı olumsuzlukların minimum düzeye indirilmesi ve nakillerin en az zararla atlatılabilmesi mümkündür. Bu tedbirlerden en önemlileri uygun yükleme yoğunluğunun hesaplanması, nakil esnasında erkek ve dişi hayvanların ve farklı ağırlıkta olan hayvanların ayrı taşınmaları veya nakil araçlarında ayrı bölmelerde bulundurulmaları, nakillerin mümkün olduğunca kısa sürdürülmesi, uzun yolculuklarda yeterli sayı ve sürede istirahat verilmesi, molalarda yem ve su desteğinin sağlanması, nakillerin termonötral sıcaklık aralığında yapılması, düşünceli sürüş tekniği, doğru tasarlanmış kamyon kasaları ve yükleme rampalarının kullanılmasıdır.

Kaynaklar

Akbaş, A. A. (2013). Çiftlik hayvanlarında davranış ve refah ilişkisi. *Mehmet Akif Ersoy Üniversitesi Sağlık Bilimleri Enstitüsü Dergisi*, 1(1), 42-49.

Akman N.,1998. Pratik sığır yetiştiriciliği. Ankara Üniversitesi Zootekni Bölümü, Ankara, Türk Ziraat Mühendisleri Birliği Vakfı.

Ali, B. H., Al-Qarawi, A. A. & Mousa, H.M. (2006). Stress associated with road transportation in desert sheep and goats, and the effect of pretreatment with xylazine or sodium betaine. *Research in Veterinary Science*, 80, 343–348. https://doi.org/10.1016/j.rvsc.2005.07.012

Altınçekiç, Ş. & Koyuncu, M. (2010). Effect of transport conditions on animal welfare. *Journal of Animal Production*, 51(1), 48-56.

Anonim, 1989. Hayvan sağlığı ve zabıtası yönetmeliği. https://www.mevzuat.gov.tr/MevzuatMetin/3.5.8913838.pdf

Anonim, 2002a. Farm animal welfare. Current research hand future directions. European commission. ISBN 92-894-3817-7.

Anonim, 2002b. Report on european commission proposals on transport of animals. London:MAFF publications, https://food.ec.europa.eu/system/files/2023-12/aw_in-transit_reg-proposal_2023-770_0.pdf

Anonim, 2005. Council regulation 1/2005/ec on the protection of animals during transport and related operations. https://eur-lex.europa.eu/eli/reg/2005/1/oj

Anonim, 2014. Çiftlik hayvanlarının refahına ilişkin genel hükümler hakkında yönetmelik, Resmi Gazete, 22.11.2014. http://www.resmigazete.gov.tr/eskiler/2014/11/20141122-6.htm

Anonim, 2020. EU trade and transport of live animals. https://www. https://www.europarl.europa.eu/RegData/etudes/ATAG/2020/646170/EPRS_ATA(2020)646170_EN.pdf

Averós, X., Martin, S., Riu, M., Serratosa, J. & Gosalvez, L. F. (2008). Stress response of extensively reared young bulls being transported to growing-finishing farms under Spanish summer commercial conditions. *Livestock Science*, 119(1-3), 174-182. https://doi.org/10.1016/j.livsci.2008.04.002

Broom D. M. (2005). The effects of land transport on animal welfare. *Revue scientifique et technique - Office international des épizooties*, 24 (2), 683-691.

Bulitta, F. S., Aradom, S. & Gebresenbet, G. (2015). Effect of transport time of up to 12 hours on welfare of cows and bulls. *Journal of Service Science and Management*, 8(02), 161-182. http://dx.doi.org/10.4236/jssm.2015.82019

Cockram, M. S. & Corley, K. T. T. (1991). Effect of preslaughter handling on the behavior and blood composition of beef cattle. *British Veterinary Journal*, 147(5), 444-454.

Cockram, M. S., Kent, J. E., Goddard, P. J., Waran, N. K., McGilp, I. M., Jackson, R. E., Muwanga, G. M. & Prytherch, S. (1996). Effect of space allowance during transport on the behavioural and physiological responses of lambs during and after transport. *Animal Science*, 62: 461–477. http://dx.doi.org/10.1016/0007-1935(91)90087-4

Earley, B., Sporer, K. B., & Gupta, S. (2017). Invited review: Relationship between cattle transport, immunity and respiratory disease. *Animal*, 11(3), 486-492. http://dx.doi.org/10.1017/S1751731116001622

Eicher, S. D. (2001). Transportation of cattle in the dairy industry: current research and future directions. *Journal of Dairy Science*, 84, E19-E23. https://doi.org/10.3168/jds.S0022-0302(01)70192-0

Erzurum, O. & Yılmaz, A. (2016). Relationship between cattle welfare and behaviour during transportation. *Kocatepe Veterinary Journal*, 9(4), 357-362.

Fazio, E., Medica D. & Cavaleri, A. S. (2005). Effect of long distance road transport on thyroid and adrenal function and haematocrit values in limousin cattle: influence of body weight decresase. *Veterinary research communications*, 29(8), 713-719. https://doi.org/10.1007/s11259-005-3866-8

Gebresenbet, G., & Eriksson, B. (1998). Effects of transport and handling on animal welfare, meat quality and environment with special emphasis on tied cows. Swedish University of Agricultural Sciences Department of Agricultural Engineering, Report 233. ISSN 00283-0086.

Grigor, P. N., Cockram, M. S., Steele, W. B., McIntyre, J., Williams, C. L., Leushuis, I. E. & Van Reenen, C. G. (2004). A comparison of the welfare and meat quality of veal calves slaughtered on the farm with those subjected to transportation and lairage. *Livestock Production Science*, 91, 219–228. https://doi.org/10.1016/j.livprodsci.2004.08.005

Hall, S. J. G.., Broom, D. M. & Kiddy, G. N. S. (1998). Effect of transportation on plasma cortisol and packed cell volume in different genotypes of sheep. *Small Ruminant Research*, 29(2), 233-237. https://doi.org/10.1016/S0921-4488(97)00114-4

Hughes, H. D., Carroll, J. A., Sanchez, N. C. B. & Richeson, J. T. (2014): Natural variations in the stress and acute phase responses of cattle. *Innate immunity*, 20(8), 888-896. https://doi.org/10.1177/1753425913508993

Hutchings, D. & Martin, S. (1983). A mail survey of factors associated with morbidity and mortality in feedlot calves in Southwestern Ontario. *Canadian Journal of Comparative Medicine*, 47(2), 101-107.

Knowles, T. G. (1999). A review of the road transport of cattle. *The Veterinary Record*, 144(8), 197-201. https://doi.org/10.1136/vr.144.8.197

Knowles, T. G., Warriss, P. D., Brown S.N. & Edwards, J. E. (1999). Effects on cattle of transportation by road for upto 31 hours. *The Veterinary Record*, 145(20), 575-582. https://doi.org/10.1136/vr.145.20.575

Kuzmanović, Ž., & Cvrtila, Ž. (2000). Influence of transport on pH value in gracilis muscle of cattle of different age, sex and breeding conditions. *Veterinarski Arhiv*, 70, 41-46.

Lensink, B. J., Fernandez, X., Cozzi, G., Florand, L. & Veissier, I. (2001). The influence of farmers' behavior on calves' reactions to transport and quality of veal meat. *Journal of Animal Science*, 79, 642-652. https://doi.org/10.2527/2001.793642x

Marques, R. S., Cooke, R. F., Francisco, C. L. & Bohnert, D. W. (2012). Effects of twenty–four hour transport or twenty–four hour feed and water deprivation on physiologic and performance responses of feeder cattle. *Journal of Animal Science*, 90, 5040–5046. https://doi.org/10.2527/jas.2012-5425

Nanda, A. S., Dobson, H. & Ward, W. R. (1990). Relationship between an increase in plasma cortisol during transport-induced stress and failure of oestradiol to induce a luteinising hormone surge in dairy cows. *Research in Veterinary Science.* 49 (1), 25-28.

Ninomiya, S. (2014). Satisfaction of farm animal behavioral needs in behaviorally restricted systems: Reducing stressors and environmental enrichment. *Animal Science Journal.*, 85(6), 634-638. https://doi.org/10.1111/asj.12213

Schaefer, A. L., Jones, S. D. M., Tong, A. K. W. & Vincent, B. C. (1988). The effects of fasting and transportation on beef cattle. 1. Acid-base-electrolyte balance and infrared heat loss of beef cattle. *Livestock Production Science,* 20(1), 15-24. https://doi.org/10.1016/0301-6226(88)90050-4

Swanson, J. &, Morrow, T. J. (2001). Cattle transport: Historical, research, and future perspectives. *Journal of Animal Science*, 79: E102-E109. https://doi.org/10.2527/jas2001.79E-SupplE102x

Tarrant, P. V. (1990). Transportation of cattle by road. *Applied Animal Behaviour Science,* 28(1-2), 153-170. https://doi.org/10.1016/0168-1591(90)90051-E

Tarrant, P. V., Kenny, F. J., Harrington, D. & Murphy M. (1992). Long distance transportation of steers to slaughter: effect of stocking density on physiology, behavior and carcass quality. *Livestock Production Science,* 30(3), 223-238. https://doi.org/10.1016/S0301-6226(06)80012-6

Tarrant, P. V. (1981) The occurrence, causes and economic consequences of dark-cutting in beef – A survey of current information. In: Hood, D.E. and Tarrant, P.V. (eds) The Problem of Dark Cutting in Beef. Martinus Nijhoff, The Hague, pp. 3–36

Tarrant, V. & Grandin, T. (2000). Cattle transport. CAB International 2000. Livestock Handling and Transport, 2nd edn (ed. T. Grandin).

Teke, B. (2014). Sığırlarda nakil firesi ve etkili faktörler. *Erciyes Üniversitesi Veteriner Fakültesi Dergisi*, 11(1), 63-67.

Trunkfield, H. R., Broom, D. M., Maatje, K., Wierenga, H. K., Lambooij, E. & Kooijman, J. (1991). Effects of housing on responses of veal calves to handling and transport. In New trends in veal calf production (Metz, J. H. M. & Groenestein, C. M. eds). Pudoc., Wageningen, p: 40-43.

Wade, L. C. (2002). Chicago's Pride: The stockyards, packingtown, and environs in the nineteenth century, University of Illinois Press, p. 47, Chicago-USA.

Yıbar, A. & Çetin, E. (2013). Hayvan refahının et kalitesi üzerine etkileri. *Uludağ Üniversitesi Veteriner Fakültesi Dergisi,* 32(2), 31-37.

Yıldız, A. & Hayırlı, A. (2005). Kuzeydoğu Anadolu Bölgesinden Canlı Hayvan Nakilleri ve Hayvan Refahı. Türkiye'de Birinci Hayvan Refahı ve Veteriner Hekimliği Eğitimi Konferansı Bildiri Kitabı (9-10 Haziran 2005), ISBN: 975-407-192-6.

EFFECTS OF GALLIC ACID ON Nrf-2 AND HO-1 LEVELS ON ACR-INDUCED KIDNEY DAMAGE IN RATS

Doç. Dr. Emin ŞENGÜL (ORCID: 0000-0003-1566-1816)
Atatürk University, Faculty of Veterinary Medicine, Department of Physiology, Erzurum-Türkiye
Email: emin.sengul@atauni.edu.tr

Dr. Öğr. Üyesi Samet TEKİN (ORCID: 0000-0003-4116-6720)
Atatürk University, Faculty of Veterinary Medicine, Department of Physiology, Erzurum-Türkiye

ABSTRACT
Acrylamide (ACR) is a chemical that is widely used in many areas and can cause damage to many tissues and organs. It occurs as a result of heat treatment of foods containing mainly carbohydrates and proteins. In this study, the effects of gallic acid (GA) on kidney damage induced by ACR in rats were investigated. A total of 40 male Sprague Dawley rats were used in our study and the rats were divided into five experimental groups which Control, ACR, ACR+GA50, ACR+GA100 and GA100. In the experiment, ACR was applied to the ACR groups at a dose of 50 mg/kg, while Gallic acid (GA) was applied to the GA groups at doses of 50 and 100mg/kg. At the end of the 14-day experiment, the rats were euthanized and their kidney tissues were removed. In order to determine whether oxidative stress developed in kidney tissues taken from rats, the nuclear factor erythroid 2–related factor 2 (Nrf-2) and heme oxygenase-1 (HO-1) levels were determined by using the ELISA method. While both Nrf-2 and HO-1 levels decreased significantly in the groups treated with ACR, there was an increase in the kidney tissues of the treated rats with GA. As a result, in this study was determined that GA had a protective effect against ACR-induced renal oxidative stress and this protective effect was achieved especially with high doses of GA.
Keywords: Acrylamide, Gallic Acid, HO-1, Oxidative Stress, Nrf-2.

1. INTRODUCTION

Acrylamide (ACR) is a substance known for its significant side effects in many tissues and organs. Because of this feature and its widespread use in the industrial field, research on it has increased. ACR occurs especially with the heat treatment of carbohydrate-rich foods. Exposure to these foods causes damage to many organs and tissues (1-3).

After ACR exposure, it rapidly dissolves in body tissues and reaches the liver and kidney tissues. After ACR enters the body, its metabolites are formed. These metabolites also cause damage to many tissues and organs. One of the tissues damaged is the kidneys. The damage that occurs in the kidneys is caused by ROS and oxidative damage occurs (4-6). This damage is caused by the proteins the nuclear factor erythroid 2–related factor 2 (Nrf-2) and Heme Oxygenase-1 (HO-1), which are responsible for protecting the cell against oxidative damage. ACR damage significantly reduces the levels of these proteins in kidney tissue and leaves the cell vulnerable to protection (7,8).

There are many polyphenols that may have protective effects against this damage caused by ACR. One of these polyphenols is Gallic acid (GA) and GA is a powerful antioxidant substance. GA also has anti-bacterial and antioxidant roles. GA has protective effects against damage to tissues and cells caused by many chemical agents. (9,10).

In our study, the roles of GA against oxidative damage occurring in the kidney tissues of ACR administered rats were investigated.

2. MATERIAL METHOD

ACR (≥ 99%) (Cas No: 10236-47-2) and GA (Cas No: 149-91-7) chemicals Sigma Chemical Co. (St. Louis, MO). Nrf-2 and HO-1 ELISA kits were purchased commercially (BT Laboratory, China).

The animals used during the experiment were obtained from Atatürk University Experimental Research and Application Center. A total of 40 rats with an average weight of 200-250 g were used. Rats were housed in ventilated rooms with a room temperature of 25oC, a humidity rate of 60-65%, a 12-hour light/dark cycle. All rats were allowed unlimited food and water intake. The rats were weighed before the experiment and divided into 5 separate groups, with 8 rats in each group. Experimental groups were created as follows.

Control: 1ml physiological saline was given intragastric (i.g) for 14 days.

ACR: ACR was given i.g. at a dose of 50 mg/kg for 14 days.

ACR+GA50: ACR at a dose of 50 mg/kg and GA at a dose of 50 mg/kg were given i.g. for 14 days.

ACR+GA100: ACR at a dose of 50 mg/kg and GA at a dose of 100 mg/kg were given i.g. for 14 days.

GA100: GA was given i.g. at a dose of 100 mg/kg for 14 days.

On the 15th day, all rats were weighed and euthanized under sevoflurane anesthesia. The kidneys of all rats were washed with cold phosphate buffer and then placed in a -20 deep freezer until analysis.

Equally small pieces of kidney tissue were taken and placed in Eppendorf tubes, then phosphate buffer solution adjusted to pH 7.4 was added and homogenized in the MagNA Lyser device. Then, it was centrifuged at 4000 rpm for 10 minutes and the resulting sera were transferred to a different Eppendorf tube. Nrf-2 and HO-1 activities were measured from the obtained supernatants in accordance with the protocol of commercially available ELISA kits.

Statistical Analyzes

After the studies were completed, one-way ANOVA was used in the statistical analysis of more than two independent groups in the SPSS 20.00 statistical data program, and then quantitative values were obtained and evaluated by applying the Tukey test. Obtained values were expressed as mean ± standard error (± SEM), and $p < 0.05$ was considered significant.

3. RESULTS

3.1. Oxidative stress in ACR-induced kidney damage

The effects of GA on Nrf-2 and HO-1 levels in the kidney tissues of rats in the experimental groups are shown in Figure 1. Nrf-2 and HO-1 levels were low in the kidney tissues of the rats in the ACR group, and there was a statistical difference between them and the rats in the control group ($p<0.01$). Although HO-1 and Nrf-2 levels increased slightly in the ACR+GA50 group compared to the ACR group, there was no statistical difference ($p>0.05$). HO-1 and Nrf-2 levels in the ACR+GA100 group were significantly higher ($p<0.05$) than ACR group while lower ($p<0.05$) than control group. It was determined that HO-1 and Nrf-2 levels in the GA100 group were not different ($p>0.05$) from the control group.

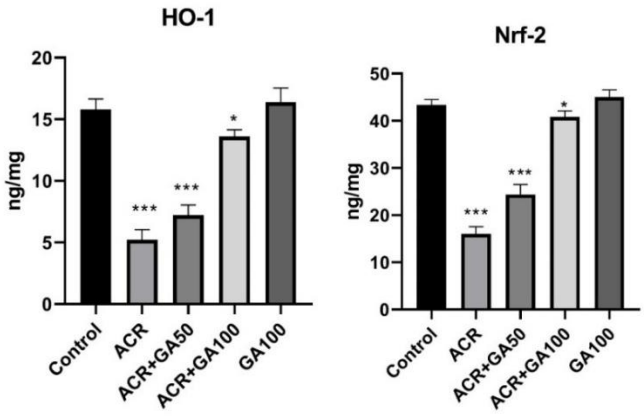


Figure. 1. The effects of ACR and GA administration on renal HO-1 and Nrf-2 levels in the experimental groups (There are statistically significant differences between the values expressed with different symbols between the control group. ***,**$p<0,01$, *$p<0,05$; n =8)

4. DISCUSSION

In this study, the effects of GA on Nrf-2 and HO-1 levels in relation to oxidative stress in kidney tissue due to ACR administration were determined. Nrf-2 and HO-1 levels were especially effective at high doses of GA. It was observed that these levels were very essential for kidney tissue cells and these levels were suppressed due to ACR application. It was observed that GA application together with ACR played an important role in protecting cells by significantly increasing Nrf-2 and HO-1 levels. Nrf-2 plays a key role in the formation of the anti-oxidant response within the cell. In normal situations, Nrf-2 is bound to the Keap1 protein. When it encounters a negative situation within the cell, it becomes free and goes to the nucleus. In this case, it ensures an anti-oxidant defense within the cell. However, the agents prevent this protein from both separating into the Keap1 protein and activating it, thus preventing it from having an anti-oxidant defense within the cell (11). Toxic agents such as cyclosporine and ACR significantly suppress Nrf-2 levels in this way (12,13). In a study, it was determined that oxidative damage occurred in the kidney tissues of rats administered cyclosporine. It was determined that this damage suppressed the level of Nrf-2, which has an important role in anti-oxidant defense within the cell (12). In a study on the level of Nrf-2, which regulates transcription factors by binding to the ARE region on the nucleus, it was observed that it was suppressed in the rat kidney due to cisplatin application (14). In our study, Nrf-2 level was significantly suppressed in kidney damage caused by ACR application. It was

observed that the rats we used as a protector, especially high doses of GA, were important in suppressing these effects. The relationship between Keap1 and Nrf-2 is disrupted during oxidant exposure, resulting in Nrf-2 being exported to the nucleus, where it binds to the antioxidant response element (ARE) and stimulates expression of the antioxidant enzyme hemeoxygenase-1 (HO-1). HO-1 plays an important role in the first step of homeostatic adaptive responses that develop to reduce tissue damage (15). It has been observed that homeostasis is impaired due to toxic agent exposure and anti-oxidant defense plays an important role (16-18). In a study, it was observed that the HO-1 level was suppressed in the heart tissue cells of rats administered doxorubicin (19). In another study, it was observed that the HO-1 level was suppressed in the kidney tissue of rats administered methotrexate (20). In our study, it was observed that oxidative damage occurred in the kidney tissues of rats treated with ACR and the protective HO-1 level was accordingly suppressed. It was observed that GA application together with ACR prevented the anti-oxidant defense system from becoming more fragile in the kidney tissue. It was observed that the protection of kidney tissue, especially at high doses, increased gradually. As a result, it was determined that ACR application caused serious damage to kidney tissue cells and, accordingly, the anti-oxidant defense system was damaged. The role of Nrf-2 and HO-1 proteins, which have an important role in the realization of anti-oxidant defense in cells, was demonstrated. In addition to causing serious damage to the kidney tissue, ACR application also suppressed the anti-oxidant defense system. It was observed that Nrf-2 and HO-1 activity decreased due to ACR application, and the defense system became stronger with GA application. It was determined that especially high doses of GA provided very high protection for kidney tissue.

Author contributions

ES and ST conceived and designed the project. ST acquired the data, analyzed the data, interpreted the data, and wrote the paper. BBL reviewed the paper.

Funding statement

This research received no specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

No conflicts of interest were identified.

REFERENCES

1. Celik, I., & Suzek, H. J. J. o. H. M. (2008). The hematological effects of methyl parathion in rats. *153*, 1117-1121.
2. Ghorbel, I., Elwej, A., Fendri, N., Mnif, H., Jamoussi, K., Boudawara, T., Grati Kamoun, N., & Zeghal, N. J. R. f. (2017). Olive oil abrogates acrylamide induced nephrotoxicity by modulating biochemical and histological changes in rats. 39, 236-245.
3. Pan, X., Zhu, L., Lu, H., Wang, D., Lu, Q., Yan, H. J. O. M., & Longevity, C. (2015). Melatonin attenuates oxidative damage induced by acrylamide in vitro and in vivo. 2015.
4. Amirshahrokhi, K. J. I. J. o. B. M. S. (2021). Acrylamide exposure aggravates the development of ulcerative colitis in mice through activation of NF-κB, inflammatory cytokines, iNOS, and oxidative stress. 24, 312.
5. Jiang, X., Feng, X., Huang, H., Liu, L., Qiao, L., Zhang, B., Yu, W. J. T. m., & methods. (2017). The effects of rotenone-induced toxicity via the NF-κB–iNOS pathway in rat liver. 27, 318-325.
6. Lim, T.-G., Lee, B. K., Kwon, J. Y., Jung, S. K., Lee, K. W. J. F., & toxicology, c. (2011). Acrylamide up-regulates cyclooxygenase-2 expression through the MEK/ERK signaling pathway in mouse epidermal cells. 49, 1249-1254.
7. Zhao, M., Wang, F. S. L., Hu, X., Chen, F., & Chan, H. M. (2017). Acrylamide-induced neurotoxicity in primary astrocytes and microglia: roles of the Nrf-2-ARE and NF-κB pathways. Food and chemical toxicology, 106, 25-35.
8. Soliman, M. M., Alotaibi, S. S., Sayed, S., Hassan, M. M., Althobaiti, F., Aldhahrani, A., ... & El-Shehawi, A. M. (2022). The Protective Impact of Salsola imbricata Leaf Extract From Taif Against Acrylamide-Induced Hepatic Inflammation and Oxidative Damage: The Role of Antioxidants, Cytokines, and Apoptosis-Associated Genes. Frontiers in Veterinary Science, 8, 817183.
9. Kahkeshani, N., Farzaei, F., Fotouhi, M., Alavi, S. S., Bahramsoltani, R., Naseri, R., Momtaz, S., Abbasabadi, Z., Rahimi, R., & Farzaei, M. H. J. I. j. o. b. m. s. (2019). Pharmacological effects of gallic acid in health and diseases: A mechanistic review. 22, 225.

10. Hafner, A., Bulyk, M. L., Jambhekar, A., & Lahav, G. J. N. r. M. c. b. (2019). The multiple mechanisms that regulate p53 activity and cell fate. 20, 199-210.
11. Petri, S., Körner, S., & Kiaei, M. (2012). Nrf-2/ARE signaling pathway: key mediator in oxidative stress and potential therapeutic target in ALS. Neurology research international, 2012.
12. Nouri, A., Ghatreh-Samani, K., Amini-Khoei, H., Mohammadi, A., Heidarian, E., & Najafi, M. (2022). Ferulic acid prevents cyclosporine-induced nephrotoxicity in rats through exerting anti-oxidant and anti-inflammatory effects via activation of Nrf-2/HO-1 signaling and suppression of NF-κB/TNF-α axis. Naunyn-Schmiedeberg's Archives of Pharmacology, 395(4), 387-395.
13. Donmez, D. B., Kacar, S., Bagci, R., & Sahinturk, V. (2020). Protective effect of carnosic acid on acrylamide-induced liver toxicity in rats: Mechanistic approach over Nrf-2-Keap1 pathway. Journal of biochemical and molecular toxicology, 34(9), e22524.
14. Kilic, U., Kilic, E., Tuzcu, Z., Tuzcu, M., Ozercan, I. H., Yilmaz, O., ... & Sahin, K. (2013). Melatonin suppresses cisplatin-induced nephrotoxicity via activation of Nrf-2/HO-1 pathway. Nutrition & metabolism, 10(1), 1-8.
15. Upadhayay, S., & Mehan, S. (2021). Targeting Nrf-2/HO-1 anti-oxidant signaling pathway in the progression of multiple sclerosis and influences on neurological dysfunctions. Brain Disorders, 3, 100019.
16. Wu, T., Li, J., Li, Y., & Song, H. (2017). Antioxidant and hepatoprotective effect of swertiamarin on carbon tetrachloride-induced hepatotoxicity via the Nrf-2/HO-1 pathway. Cellular Physiology and Biochemistry, 41(6), 2242-2254.
17. Barakat, B. M., Ahmed, H. I., Bahr, H. I., & Elbahaie, A. M. (2018). Protective effect of boswellic acids against doxorubicin-induced hepatotoxicity: impact on Nrf-2/HO-1 defense pathway. Oxidative medicine and cellular longevity, 2018.
18. Lv, H., Xiao, Q., Zhou, J., Feng, H., Liu, G., & Ci, X. (2018). Licochalcone A upregulates Nrf-2 antioxidant pathway and thereby alleviates acetaminophen-induced hepatotoxicity. Frontiers in Pharmacology, 9, 147.
19. Bai, Z., & Wang, Z. (2019). Genistein protects against doxorubicin-induced cardiotoxicity through Nrf-2/HO-1 signaling in mice model. Environmental toxicology, 34(5), 645-651.

20. Aladaileh, S. H., Hussein, O. E., Abukhalil, M. H., Saghir, S. A., Bin-Jumah, M., Alfwuaires, M. A., ... & Mahmoud, A. M. (2019). Formononetin upregulates Nrf-2/HO-1 signaling and prevents oxidative stress, inflammation, and kidney injury in methotrexate-induced rats. Antioxidants, 8(10), 430.

MİDE ÜLSERLERİNİN GELİŞİMİNDE COX ENZİMİ VE PROSTAGLANDİNLERİN ROLÜ

Arş. Gör. Merve BOLAT* (ORCID: 0000-0001-5836-5529)
Atatürk University, Faculty of Veterinary Medicine, Department of Physiology, Erzurum, Turkey
Email: mervebolat@atauni.edu.tr

Öğr. Gör. Aslıhan ATASEVER (ORCID: 0000-0002-2983-3343)
Atatürk University, Faculty of Veterinary Medicine, Department of Physiology, Erzurum, Turkey
Email: aslihan.atasever@erzincan.edu.tr

Prof. Dr. Fikret ÇELEBİ (ORCID: 0000-0002-6196-2196)
Atatürk University, Faculty of Veterinary Medicine, Department of Physiology, Erzurum, Turkey
Email: fncelebi@atauni.edu.tr

ÖZET
Gastrik ülser, mide dokusunda mukozasının yapısal bütünlüğünün hasar görmesiyle karakterize sindirim sistemi hastalığıdır. Yaşam kalitesini olumsuz etkileyen bu hastalığın mevcut tedavi protokolleri olmasına rağmen sık sık tekrarlayabilmesi nedeniyle insanlarda görülen en ciddi sağlık sorunlarının başında gelmektedir. Bu hastalık, mide mukozasının hasar görmesiyle ve çeşitli faktörlerin etkisi altında gelişebilir. Son yıllarda yapılan araştırmalar, gastrik ülser gelişiminde Siklooksijenaz (COX) enziminin önemli bir rol oynadığını göstermektedir. COX enzimi, vücutta inflamasyon, ağrı ve doku tamiri gibi birçok biyolojik süreci düzenleyen ve prostaglandinlerin sentezinde anahtar bir rol oynayan bir enzimdir. Ancak, COX enziminin aşırı veya anormal aktivitesi, mide mukozasının koruyucu tabakasının zayıflamasına ve bunun sonucunda gastrik ülser gelişimine yol açabilir. Özellikle COX-2 enziminin, mide mukozasında inflamasyon hücrelerinden ve fibroblastlardan salınması, gastrik ülser oluşumunda önemli bir faktör olarak belirlenmiştir. Bu sebeple yapılan derlemede, gastrik ülser gelişiminde COX enzimi ve prostoglandinlerin rolünün incelemesi amaçlanmaktadır. Ayrıca, COX enziminin ve prostoglandinlerin fizyolojik işlevleri, gastrik mukozanın koruyucu mekanizmaları üzerindeki etkileri, gastrik ülser tedavisindeki rolleri ve gelecekteki araştırmalarda üzerinde durulması gereken noktalar ele alınacaktır.
Anahtar Kelimeler: Gastrik ülser, Prostoglandin, Siklooksijenaz (COX)

THE ROLE OF COX ENZYME AND PROSTAGLANDINS IN THE DEVELOPMENT OF GASTRIC ULCERS

ABSTRACT
Gastric ulcer is a digestive system disease characterized by damage to the structural integrity of the mucosa in the stomach tissue. Despite the availability of current treatment protocols for this condition, its tendency to recur frequently makes it one of the most serious health problems in humans, negatively affecting their quality of life. This disease can develop due to damage to the gastric mucosa and the influence of various factors. Recent research has shown that Cyclooxygenase (COX) enzyme plays a significant role in the development of gastric ulcers. The COX enzyme is a key regulator of many biological processes in the body, including inflammation, pain, and tissue repair, and plays a key role in the synthesis of prostaglandins. However, excessive or abnormal activity of the COX enzyme can weaken the protective layer of the gastric mucosa, leading to the development of gastric ulcers. Particularly, the release of COX-2 enzyme from inflammatory cells and fibroblasts in the gastric mucosa has been identified as a significant factor in the formation of gastric ulcers. Therefore, this review aims to examine the role of COX enzyme and prostaglandins in the development of gastric ulcers. Additionally, it will address the physiological functions of COX enzyme and prostaglandins, their effects on the protective mechanisms of the gastric mucosa, their roles in the treatment of gastric ulcers, and points to be emphasized in future research.
Keywords: Cyclooxygenase (COX, Gastric ulcer, Prostaglandin

Introduction

Gastric ulcer is a digestive system disorder characterized by damage to the mucosal integrity of the stomach tissue. Despite the availability of current treatment protocols for this disease, which negatively affects quality of life, it ranks among the most serious health problems in humans due to its frequent recurrence (Zhou D et al., 2020). The normal gastric mucosa is equipped with various protective mechanisms against high levels of hydrochloric acid and pepsin, which balance protective and aggressive factors. Among the mucosal protective factors that prevent the formation of gastric ulcers are factors that support renewal such as mucus secretion, HCO3- production, and epidermal growth factor (EGF). Additionally, factors such as gastric acid, pepsin, bile acids, Helicobacter pylori, inhibition of prostaglandin synthesis by NSAIDs, stress-induced vasoconstriction, alcohol, and smoking are among the most important causes of ulcer formation in the stomach (Shareef et al., 2022; Shams, SGE et al., 2022). The main reason for the development of gastric ulcers is usually the imbalance between protective and exogenous factors in the stomach. Therefore, measures should be taken against situations that may disrupt the existing balance due to an increase in exogenous factors in the stomach. Symptoms such as stomach pain, nausea, burning sensation, acid reflux, and bloating are commonly observed in individuals with gastric ulcer complaints. If treatment is delayed, more serious complications such as gastric bleeding, perforation of the mucosa, and even gastric cancer can occur. Taking early measures to preserve stomach health is crucial to prevent these potentially fatal outcomes. (Küçükler S. et al., 2022; Longo B et al., 2021; Gong G et al., 2021)

Functions and General Role of the COX Enzyme

Arachidonic acid is found among the components of phospholipids in cell membranes and plays a critical role in cellular signaling. As it is well known, the COX enzyme is highly important in the metabolism of arachidonic acid. When a cell receives a stimulus, arachidonic acid present in the cell membrane is released, and then it is metabolized by cytochrome P-450, lipoxygenase, or COX enzymes. Cytochrome P-450 metabolizes arachidonic acid through derivatives such as epoxides and omegas. Lipoxygenase, on the other hand, metabolizes arachidonic acid into leukotrienes, lipoxins, and hydroxy fatty acids. However, in the case of COX enzymes, the situation is a bit different. COX enzymes convert arachidonic acid to prostaglandin G2 via

cyclooxygenase and peroxidase enzymes, and then metabolize arachidonic acid by reducing PG2 to PGH2. PGH2 is then converted to prostaglandins such as PGE2, PGI2, and PGF2α through enzymes released from the cell. These resulting PGs not only have various biological effects in the body but also actively participate in physiological processes. (Sheng J et al., 2020; Lopez DE et el., 2020; Fitzpatrick FA, 2004). COX enzymes are highly important in regulating biological reactions occurring in the body, such as inflammatory responses, fever, and pain. COX enzymes exist primarily in two main forms, namely COX-1 and COX-2. COX-1 generally plays a role in the body's normal physiological processes, particularly in the activation of platelets, preservation of gastric mucosal layer, and kidney functions. On the other hand, COX-2 becomes active in response to stimuli in the body. They play a crucial role, especially in the body's inflammatory response to inflammatory agents. In this case, COX-2 enzymes actively participate in the synthesis of PGs in cells in response to stimuli, leading to the initiation of the inflammatory response. PGs synthesized by COX-2 not only contribute to the inflammatory response but also play a critical role, particularly in the gastric tissue, in the production of gastric acid and secretion of protective mucus. (Morita I, 2002; Chandrasekharan NV, 2004).

The effects of prostaglandins on gastric tissue

PGs are important in maintaining the structural integrity of gastric tissue and regulating gastric secretions. They play a regulatory role in the secretion of gastric acid and mucus, thereby ensuring the preservation of the gastric mucosal layer. In addition, they contribute to the fastest possible healing of damage in gastric tissue by regulating blood flow in the vessels. (Wallace JL, 2005).

The Relationship Between Gastric Ulcers and the COX Enzyme

In the development of gastric ulcers, particularly the role of COX-1 enzyme, the mechanism of Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) in causing gastric ulcers is crucially important. This is because NSAIDs are known as COX-1 inhibitors. NSAIDs not only inhibit the COX enzyme but also suppress the release of PGs, which have a protective effect on the stomach. Consequently, NSAIDs suppress gastric acid and mucus secretion, making the mucosal layer vulnerable to external factors. Additionally, NSAIDs can increase gastric acid secretion and reduce gastric blood flow, leading to thinning of the gastric mucosal layer and subsequently the formation of ulcers. (Halter F et al., 2001)

Treatment Protocols for Gastric Ulcers

COX-2 Enzyme Inhibitors

In the treatment protocols where the COX enzyme takes precedence, they are generally used in ulcer conditions caused by NSAIDs. The main goal of COX enzyme treatment protocols is to preserve the gastric mucosal layer and promote the healing process of ulcerative tissue. For this purpose, COX-2 inhibitors are widely used in the field. COX-2 inhibitors, which target the COX-2 enzyme and suppress inflammation while not affecting COX-1, are used in ulcer treatment. This is because inhibiting the COX-1 enzyme reduces PG synthesis, leading to thinning of the gastric mucosal layer, decreased mucus quality and quantity, and an increased risk of gastric ulcer formation due to the effect of gastric acid. Therefore, since the main approach in the treatment of gastric ulcers is to protect the gastric mucosa, it is essential not to suppress the COX-1 enzyme. Additionally, long-term and high-dose use of COX-2 inhibitors can contribute to ulcer formation rather than prevention in gastric ulcers. Prolonged and high-dose use of COX-2 inhibitors can also lead to some cardiovascular damage. (Vishwakarma et al., 2020; Houston AM et al., 2004).

Prostaglandin Analogues

In the treatment of gastric ulcers, in addition to COX-2 inhibitors, some PG analogues are also used in the field, which do not have adverse effects on COX-1. These drugs have positive contributions, especially in preserving the gastric mucosa, increasing the quantity and quality of mucus secretion, and promoting ulcer healing. The main mechanism of these drugs is to increase PG secretion in cells, thereby increasing the amount of PG utilization in the stomach. (Yazdanian N et al., 2021).

Conclusion and Recommendations

Gastric ulcer stands as one of the most prevalent diseases in humans. Numerous research studies have been conducted for the treatment of the disease, yielding positive results. However, the efficacy of certain substances that have positive effects on gastric ulcers in different tissues and organs has not been fully determined. Therefore, there are still many alternative treatment methods being investigated for gastric ulcers. In this review, the importance of COX-1 and COX-2 enzymes and PGs in gastric ulcers has been emphasized. Based on literature searches, it has been observed that COX-2 inhibitors and some PG analogues can be used in the treatment of gastric ulcers without significantly

affecting other enzymes in the tissue. This finding suggests that these agents could be considered as alternative and low-risk treatment methods for patients at risk of gastric ulcers. However, it is recommended that further research be conducted at the molecular mechanisms level to enable widespread use of COX-2 enzyme inhibitors and PG analogues in the treatment of gastric ulcers.

Kaynaklar

Zhou, D., Yang, Q., Tian, T., Chang, Y., Li, Y., Duan, L. R., ... & Wang, S. W. (2020). Gastroprotective effect of gallic acid against ethanol-induced gastric ulcer in rats: Involvement of the Nrf2/HO-1 signaling and anti-apoptosis role. *Biomedicine & Pharmacotherapy*, *126*, 110075.

Shareef, S. H., Al-Medhtiy, M. H., Ibrahim, I. A. A., Alzahrani, A. R., Jabbar, A. A., Galali, Y., ... & Abdulla, M. A. (2022). Gastroprophylactic effects of p-cymene in ethanol-induced gastric ulcer in rats. *Processes*, *10*(7), 1314.

Shams, S. G. E., & Eissa, R. G. (2022). Amelioration of ethanol-induced gastric ulcer in rats by quercetin: implication of Nrf2/HO1 and HMGB1/TLR4/NF-κB pathways. *Heliyon*, *8*(10).

Küçükler, S., Kandemir, F. M., & Yıldırım, S. (2022). Protective effect of chrysin on indomethacin induced gastric ulcer in rats: role of multi-pathway regulation. *Biotechnic & Histochemistry*, *97*(7), 490-503.

Longo, B., Sommerfeld, E. P., Dos Santos, A. C., Somensi, L. B., Mariano, L. N. B., Boeing, T., ... & da Silva, L. M. (2021). Dual role of eugenol on chronic gastric ulcer in rats: Low-dose healing efficacy and the worsening gastric lesion in high doses. *Chemico-Biological Interactions*, *333*, 109335.

Gong, G., Zhao, R., Zhu, Y., Yu, J., Wei, B., Xu, Y., ... & Liang, G. (2021). Gastroprotective effect of cirsilineol against hydrochloric acid/ethanol-induced gastric ulcer in rats. *The Korean Journal of Physiology & Pharmacology: Official Journal of the Korean Physiological Society and the Korean Society of Pharmacology*, *25*(5), 403.

Sheng, J., Sun, H., Yu, F. B., Li, B., Zhang, Y., & Zhu, Y. T. (2020). The role of cyclooxygenase-2 in colorectal cancer. *International journal of medical sciences*, *17*(8), 1095.

López, D. E., & Ballaz, S. J. (2020). The role of brain cyclooxygenase-2 (Cox-2) beyond neuroinflammation: neuronal homeostasis in memory and anxiety. *Molecular Neurobiology*, *57*(12), 5167-5176.

Fitzpatrick, F. A. (2004). Cyclooxygenase enzymes: regulation and function. *Current pharmaceutical design*, *10*(6), 577-588.

Morita, I. (2002). Distinct functions of COX-1 and COX-2. *Prostaglandins & other lipid mediators*, *68*, 165-175.

Chandrasekharan, N. V., & Simmons, D. L. (2004). The cyclooxygenases. *Genome biology*, *5*, 1-7.

Wallace, J. L. (2005). Recent advances in gastric ulcer therapeutics. *Current Opinion in Pharmacology*, *5*(6), 573-577.

Khan, A. H., Dar, M. A., & Mir, M. A. (2023). Gastric Ulcer: An overview. *International Journal of Current Research in Physiology and Pharmacology*, 1-7.

Halter, F., Tarnawski, A. S., Schmassmann, A., & Peskar, B. M. (2001). Cyclooxygenase 2—implications on maintenance of gastric mucosal integrity and ulcer healing: controversial issues and perspectives. *Gut*, *49*(3), 443-453.

Vishwakarma, R. K., & Negi, D. S. (2020). The development of COX-1 and COX-2 inhibitors: a review. *Int J Pharm Sci Res*, *11*(8), 3544.

Houston, A. M., & Teach, S. J. (2004). COX-2 inhibitors: a review. *Pediatric emergency care*, *20*(6), 396-399.

Yazdanian, N., Mozafarpoor, S., & Goodarzi, A. (2021). Phosphodiesterase inhibitors and prostaglandin analogues in dermatology: A comprehensive review. *Dermatologic Therapy*, *34*(1), e14669.

OXIDATIVE STRESS AND THE NRF2/HO-1 PATHWAY

Öğr. Gör. Aslıhan ATASEVER (ORCID: 0000-0002-2983-3343)
Atatürk University, Faculty of Veterinary Medicine, Department of Physiology, Erzurum, Turkey
Email: aslihan.atasever@erzincan.edu.tr

Arş. Gör. Merve BOLAT (ORCID: 0000-0001-5836-5529)
Atatürk University, Faculty of Veterinary Medicine, Department of Physiology, Erzurum, Turkey
Email: mervebolat@atauni.edu.tr

Prof. Dr. Fikret ÇELEBİ (ORCID: 0000-0002-6196-2196)
Atatürk University, Faculty of Veterinary Medicine, Department of Physiology, Erzurum, Turkey
Email: fncelebi@atauni.edu.tr

ABSTRACT
Free radicals that react with biomolecules are reactive molecules that form various compounds. Free radicals, divided into ROS and RNS, have negative effects on proteins, carbohydrates, lipids, nucleic acids and DNA. The situation caused by the imbalance between ROS and antioxidant defenses is called oxidative stress. This affects the regulation of cellular functions, suppressing the organism's antioxidative defenses and causing various pathological conditions caused by ROS, leading to tissue damage and accelerated cellular death, which is the basis of many diseases. One of the most important factors to prevent oxidative stress caused by free radicals is antioxidants. Antioxidant enzymes alleviate oxidative damage by combating free radicals. Cellular antioxidant defense mechanisms may lose their effectiveness as a result of excessive accumulation of free radicals within the cell. The Nrf2/HO-1 signaling pathway plays an important role in protecting cells from damage caused by oxidative stress by restoring endogenous antioxidant enzymes. Nrf2 is an important transcription factor that plays a role in cellular defense against oxidant damage. Active Nrf2 stimulates antioxidant response elements and activates antioxidant enzymes such as HO-1 and increases the antioxidant capacity of the cell. It plays an important role in protecting against the harmful effects of ROS. HO-1 is an enzyme found in cells that plays a critical role in protecting cells against oxidative stress, inflammation and other stress factors. HO-1 breaks down equimolar amounts of products such as biliverdin, ferrous iron, and carbon monoxide and is therefore considered an antioxidative and cytoprotective agent. This review aims to summarize oxidant and antioxidant systems, provide information about oxidative stress, and explain how the Nrf2 and HO-1 pathway occurs.
Keywords: Heme oxygenase-1 (HO-1), Nuclear factor erythroid 2-related factor 2 (Nrf2), Oxidative stress

Introduction

Molecules carrying one or more unpaired electrons in their outer orbit are termed free radicals. These molecules are short-lived, unstable, have low molecular weight, and are highly reactive. Those originating from oxygen are referred to as reactive oxygen species (ROS), while those from nitrogen are termed reactive nitrogen species (RNS), presenting as two-sided reactive species. Among ROS are superoxide (O2.-), hydroxyl (OH.), peroxyl (ROO.), lipid peroxyl (LOO.), hydroperoxyl (HO2.), and alkoxyl (RO.) radicals. RNS include nitric oxide (NO.) and nitrogen dioxide (NO2.). ROS are produced as a consequence of the normal cellular metabolism in living organisms. They function in physiological cellular processes at low and moderate concentrations; however, at high concentrations, they induce adverse changes in cellular components such as lipids, proteins, and DNA (Halliwell & Gutteridge, 2015; Valko et al., 2007; Valko et al., 2006). Oxidative stress occurs as a result of the excessive production of reactive oxygen species (ROS) and inadequate antioxidant defense mechanisms (Berg et al., 2004). Under balanced redox conditions, with appropriate ROS levels, ROS are necessary and beneficial for normal physiological function. They can help protect cells from infections by eliminating invasive pathogens at inflammation sites; play a physiological role as secondary messengers in regulating the functions of heart and vascular cells; and are involved in regulating intracellular calcium concentration, protein phosphorylation and dephosphorylation, and transcription factor activation (Halliwell, 2006; Valko et al., 2007).

However, excessive ROS can exert harmful effects by indiscriminately targeting important macromolecules in living systems, such as DNA, proteins, and lipids (Kohen & Nyska, 2002). ROS can disrupt the integrity of normal adenine and pyridine nucleotides, affecting the viability of DNA, triggering mutations, and altering gene expression (Konat, 2003). Protein oxidation by ROS can lead to the loss of sulfhydryl groups and alterations in amino acids, rendering proteins dysfunctional (Lockwood, 2000; Stadtman & Levine, 2003). Additionally, ROS can cause peroxidative damage to lipids, leading to damage not only to the cell membrane but also to cellular organelle membranes (Horton & Fairhurst, 1987). Particularly, polyunsaturated fatty acids (PUFAs), the major components of membrane phospholipids, are highly susceptible to free radical attack and autoxidation. This results in the formation of peroxyl radicals in membranes, leading to

unstable membrane structures and disruptions in membrane fluidity and permeability, impairing signal transduction (Reddy & Yao, 1996).

There are various causes of oxidative stress, including exposure to environmental toxins, alcohol consumption, smoking, excessive UV radiation and exposure to radiation, inadequate nutrition, overexertion, stress, and aging. It is a well-known fact that oxidative stress plays a significant role in the pathogenesis of diseases, and this condition can contribute to the development of many chronic diseases, including cardiovascular diseases, diabetes, cancer, and neurodegenerative diseases. Adopting a healthy lifestyle, avoiding exposure to toxins, and consuming antioxidants are important for reducing the harmful effects of oxidative stress (Poljsak et al., 2013).

One of the most important factors in preventing oxidative stress caused by free radicals is antioxidants. Antioxidants are substances in the body's defense system that prevent the formation of reactive oxygen species (ROS), protect against the damage they cause, and facilitate detoxification. They react with free radicals, inhibiting the progression of autoxidation and peroxidation. Additionally, antioxidants neutralize excess free radicals, protect cells against their toxic effects, and can eliminate cellular damage. Antioxidants act as scavengers of free radicals, enhancing the immune system's effectiveness and reducing the risk of disease (Shinde et al., 2012; Sen et al., 2010).

Antioxidants are classified into two categories: endogenous and exogenous. Endogenous antioxidants are further divided into enzymatic and non-enzymatic groups, while exogenous antioxidants include those used as vitamins and drugs. These antioxidants are used to neutralize free radicals and also protect the body from free radicals to maintain the oxidant/antioxidant balance (Sen & Chakraborty, 2011).

NRF2/HO-1 Pathway: The Nrf2/HO-1 signaling pathway plays a crucial role in protecting cells from oxidative stress-induced damage by restoring endogenous antioxidant enzymes (Yanaka, 2018). Nrf2 is a significant transcription factor involved in cellular defense against oxidative damage. This factor binds to the negative regulator Kelch-like ECH-associated protein 1 (Keap1) in the cytoplasm and remains inactive (Xie et al., 2022). Upon an increase in ROS levels, it becomes activated, dissociating from Keap1. Activated Nrf2 translocates from the cytoplasm to the nucleus, where it binds to Maf proteins, stimulating antioxidant response elements and activating antioxidant enzymes such as HO-1, SOD, CAT, and GPx. This activation and transcription of key

cytoprotective and antioxidant molecules facilitate combating cellular oxidative stress (Kim et al., 2022).

Nrf-2 enhances the cell's antioxidant capacity and plays a significant role in protecting against the harmful effects of ROS. Additionally, it serves a protective function in many diseases associated with inflammation, oxidative stress, toxic substances, and other stress factors (such as cancer, neurodegenerative and cardiovascular diseases, and diabetes). Functioning as a sensor that detects oxidative stress levels within the cell, Nrf-2 increases its activity when ROS levels rise. Active Nrf-2 enhances the cell's antioxidant capacity, providing protection against the adverse effects of ROS (Chowdhury et al., 2022).

HO-1 is an enzyme found in cells that plays a critical role in protecting against oxidative stress, inflammation, and other stress factors. It catalyzes the release of heme groups by breaking down heme-containing proteins. Free heme groups can cause damage to cells during oxidative stress and inflammation conditions. HO-1 converts free heme groups into biliverdin and Fe+2 by reacting with oxygen and carbon monoxide. This prevents the toxic effects associated with heme groups and enhances the cell's antioxidant capacity. HO-1 levels increase in cells exposed to oxidative stress, inflammation, cancer, ischemia, heavy metals, hypoxia, and other stress factors. Additionally, it intervenes in signaling pathways to regulate cell apoptosis and inflammation (Fernandez-Mendivil et al., 2021; Puentes-Pardo et al., 2020).

HO-1 is considered a reliable antioxidative and cytoprotective agent as it breaks down its products, such as biliverdin, ferrous iron, and carbon monoxide, in equimolar amounts (Puentes-Pardo et al., 2020). Among enzymes capable of providing protection against apoptosis by inhibiting ROS, HO-1 is most prominently recognized for its cytoprotective function against oxidative stress (Yanaka, 2018; Rahman et al., 2020). Drugs and other therapeutic interventions that enhance HO-1 activity may hold potential benefits in treating many diseases associated with oxidative stress and inflammation (Albarakati et al., 2020).

Conclusion

Oxidative stress can arise from the excessive production of reactive oxygen species (ROS) due to the overproduction of oxygen-utilizing metabolic reactions, shifting the oxidant/antioxidant balance in favor of oxidants. Significant reductions in antioxidant markers may indicate excessive ROS production and depletion of endogenous

antioxidants, leading to the dissociation and activation of cytoplasmic Nrf2 from Keap1. Nrf2 is a crucial cellular oxidative stress sensor and a nuclear transcription factor. This factor induces the nuclear transcription of cytoprotective genes that protect cells against excessive oxidative stress. When the excessive production of free radicals overwhelms endogenous antioxidant defenses, Nrf2 is phosphorylated by protein kinase B, released by Keap1, and translocated to the nucleus. In the nucleus, it binds to the antioxidant response element (ARE), facilitating the activation and transcription of key cytoprotective and antioxidant molecules necessary to combat cellular oxidative stress.

HO-1 is one of the genes controlled by Nrf2. In other words, Nrf2 activation plays a significant role in the transcription of HO-1, an inducible gene with antioxidant functions. HO-1 facilitates the breakdown of heme into biliverdin, and subsequently, biliverdin is catalyzed by biliverdin reductase to form bilirubin, a compound known for its antioxidant properties. In light of this information, we can say that the Nrf2 signaling pathway plays a critical role in protecting cells from oxidative damage through the activation of endogenous antioxidant enzymes, and HO-1 can provide cytoprotection against oxidative stress. Activation of the Nrf2/HO-1 pathway prevents oxidative damage by reducing ROS production, inflammatory mediators, and cell death.

References

Albarakati, A. J. A., Baty, R. S., Aljoudi, A. M., Habotta, O. A., Elmahallawy, E. K., Kassab, R. B., & Abdel Moneim, A. E. (2020). Luteolin protects against lead acetate-induced nephrotoxicity through antioxidant, anti-inflammatory, anti-apoptotic, and Nrf2/HO-1 signaling pathways. *Molecular Biology Reports*, 47(4), 2591-2603. DOI: 10.1007/s11033-020-05346-1

Berg, D., Youdim, M. B., & Riederer, P. (2004). Redox imbalance. *Cell and tissue research*, 318, 201-213. DOI: 10.1007/s00441-004-0976-5

Chowdhury, F. I., Yasmin, T., Akter, R., Islam, M. N., Hossain, M. M., Khan, F., Aldhahrani, A., Soliman, M. M., Subhan, N., & Haque, M. A. (2022). Resveratrol treatment modulates several antioxidant and anti-inflammatory genes expression and ameliorated oxidative stress mediated fibrosis in the kidneys of high-fat diet-fed rats. *Saudi Pharmaceutical Journal*, 30(10), 1454-1463. DOI: 10.1016/j.jsps.2022.07.006

Fernández-Mendívil, C., Luengo, E., Trigo-Alonso, P., García-Magro, N., Negredo, P., & López, M. G. (2021). Protective role of microglial HO-1 blockade in aging: Implication of iron metabolism. *Redox biology*, 38, 101789. DOI: 10.1016/j.redox.2020.101789

Halliwell, B., & Gutteridge, J. M. (2015). Free radicals in biology and medicine. Oxford university press, USA.

Halliwell, B. (2006). Phagocyte-derived reactive species: salvation or suicide? *Trends in biochemical sciences*, 31(9), 509-515. DOI: 10.1016/j.tibs.2006.07.005

Horton, A. A., Fairhurst, S., & Bus, J. S. (1987). Lipid peroxidation and mechanisms of toxicity. *CRC Critical Reviews in Toxicology*, 18(1), 27-79. DOI: 10.3109/10408448709089856

Kim, H. S., Lim, J. W., & Kim, H. (2022). Korean red ginseng extract inhibits IL-8 expression via Nrf2 activation in Helicobacter pylori-infected gastric epithelial cells. *Nutrients*, 14(5), 1044. DOI: 10.3390/nu14051044

Kohen, R., & Nyska, A. (2002). Invited review: oxidation of biological systems: oxidative stress phenomena, antioxidants, redox reactions, and methods for their quantification. *Toxicologic pathology*, 30(6), 620-650. DOI: 10.1080/01926230290166724

Konat, G. W. (2003). H 2 O 2-induced higher order chromatin degradation: a novel mechanism of oxidative genotoxicity. *Journal of biosciences*, 28, 57-60.

Lockwood, T. D. (2000). Redox control of protein degradation. *Antioxidants & Redox Signaling*, 2(4), 851-878. DOI: 10.1089/ars.2000.2.4-851

Poljsak, B., Suput, D., & Milisav, I. (2013). Achieving the Balance between ROS and Antioxidants: When to Use the Synthetic Antioxidants. *Oxidative Medicine and Cellular Longevity*, 2013. DOI: 10.1155/2013/956792

Puentes-Pardo, J. D., Moreno-SanJuan, S., Carazo, Á., & León, J. (2020). Heme oxygenase-1 in gastrointestinal tract health and disease. *Antioxidants*, 9(12), 1214. DOI: 10.3390/antiox9121214

Rahman, Z., Dwivedi, D., & Jena, G. (2020). Ethanol-induced gastric ulcer in rats and intervention of tert-butylhydroquinone: Involvement of Nrf2/HO-1 signalling pathway. *Human & Experimental Toxicology*, 39(4), 547-562. DOI: 10.1177/0960327119895559

Reddy, R. D., & Yao, J. K. (1996). Free radical pathology in schizophrenia: a review. *Prostaglandins, Leukotrienes and Essential Fatty Acids*, *55*(1-2), 33-43. DOI: 10.1016/S0952-3278(96)90143-X

Sen, S., Chakraborty, R., Sridhar, C., Reddy, Y., & De, B. (2010). Free radicals, antioxidants, diseases and phytomedicines: current status and future prospect. *International Journal of Pharmaceutical Sciences Review and Research*, 3(1), 91-100.

Sen, S., & Chakraborty, R. (2011). The role of antioxidants in human health. In Oxidative stress: diagnostics, prevention, and therapy. *ACS Publications*, 1-37. DOI: 10.1021/bk-2011-1083.ch001

Shinde, A., Ganu, J., & Naik, P. (2012). Effect of free radicals & antioxidants on oxidative stress: a review. *Journal of Dental and Allied Sciences*, 1(2), 63.

Stadtman, E. R., & Levine, R. L. (2003). Free radical-mediated oxidation of free amino acids and amino acid residues in proteins. *Amino acids*, 25, 207-218. DOI 10.1007/s00726-003-0011-2

Xie, L., Luo, M., Li, J., Huang, W., Tian, G., Chen, X., Ai, Y., Zhang, Y., He, H., & He, J. (2022). Gastroprotective mechanism of modified lvdou gancao decoction on ethanol-induced gastric lesions in mice: Involvement of Nrf-2/HO-1/NF-κB

signaling pathway. *Frontiers in Pharmacology*, 13, 953885. DOI: 10.3389/fphar.2022.953885

Valko, M., Leibfritz, D., Moncol, J., Cronin, M. T. D., Mazur, M., & Telser, J. (2007). Free radicals and antioxidants in normal physiological functions and human disease. *International Journal of Biochemistry & Cell Biology*, 39(1), 44-84. DOI: 10.1016/j.biocel.2006.07.001

Valko, M., Rhodes, C. J. B., Moncol, J., Izakovic, M. M., & Mazur, M. (2006). Free radicals, metals and antioxidants in oxidative stress-induced cancer. *Chemico-biological interactions*, 160(1), 1-40. DOI: 10.1016/j.cbi.2005.12.009

Yanaka, A. (2018). Role of NRF2 in protection of the gastrointestinal tract against oxidative stress. *Journal of Clinical Biochemistry and Nutrition*, 63(1), 18-25. DOI: 10.3164/jcbn.17-139

PEUCEDANUM LONGIFOLIUM WALDST & KİT BİTKİSİNİN ANTİHEMOLİTİK ETKİSİNİN DEĞERLENDİRİLMESİ

Doç. Dr. Mahire BAYRAMOĞLU AKKOYUN (ORCID: 0000-0001-5150-5402)
Siirt Üniversitesi, Veteriner Fakültesi, Biyokimya ABD.
Email: mahireakkoyun@siirt.edu.tr

ÖZET

RBC'lerin (Kırmızı Kan Hücreleri) en önemli ve temel görevi, hücrelere oksijen sağlamak için akciğerlerden dokulara oksijen taşımaktır. Bu süreçte kırmızı kan hücreleri sürekli olarak yapılarına zarar verebilecek ve işlevini bozabilecek endojen ve eksojen reaktif oksijen türleri (ROS) ile karşı karşıya kalırlar. Fenil hidrazinin kırmızı kan hücreleriyle (RBC) etkileşimi önemli serbest radikaller arasında yer alan hidrojen peroksit üretimine sebep olur. Hidrojen peroksitin, sülfidril gruplarını oksitlediği ve membran lipitlerinin peroksidasyonunu başlatarak hemolizi tetiklediği, bu sebeple fenil hidrazinin eritrositlerin hemolizine sebep olduğu bilinmektedir. Bitkiler reaktif oksijen türlerinin zararlı etkilerine karşı koruyan antioksidan bileşikler içerir. Peucedanum L., cinsi Apiaceae ailesine ait gıda ve ilaç olarak kullanılan ekonomik açıdan önemli farklı türlerden oluşur. Çalışmada *kullanılan Peucedanum longifolium* Waldst. & Kit bitkisi Peucedanum L., cinsine ait türler arasında yer alır. Yürütülen çalışmada *Peucedanum longifolium* Waldst. & Kit türünün fenil hidrazin ile oluşturulan eritrosit hemolizi üzerine anti-hemolitik etkilerinin incelenmesi amaçlandı. Metanol kullanılarak hazırlanan bitki ekstraktının farklı konsantrasyonlarını içeren örneklere 1 mL fenil hidrazin, 0,1 mL %20 PCV, 1,85 mL pH:7,4 olan tampon ilave edildi. Ardından, 37 °C'de 60 dk süreyle inkübasyona bırakıldı. 10 dakika boyunca 4000 rpm'de santrifüj edildi. Üstteki kısım alınarak 540 nm'deki absorbans kontrol numunesine karşı okundu. Pozitif kontrol olarak sentetik bir antioksidan olan troloks kullanıldı. *Peucedanum longifolium* Waldst. & Kit bitkisi ekstresinin fenil hidrazinin neden olduğu eritrosit hemolizi üzerine inhibisyon yüzdesinin 52,91 ± 0,73; troloksun ise 50,14 ± 0,54 olduğu rapor edildi. *Peucedanum longifolium* Waldst. & Kit bitki ekstresi ve troloksun IC50 değerleri ise sırasıyla 20,64 ± 1,04 µg/mL ve 31,61± 1,08 µg/mL olarak belirlendi. Sonuç olarak; *Peucedanum longifolium* Waldst. & Kit bitkisinin fenil hidrazinin *neden* olduğu hemoliz üzerine inhibisyon etkisi göstermesi, bitkinin anti-hemolitik ajan olarak görev yapabileceğini ortaya koymaktadır.

Anahtar Kelimeler: *Peucedanum longifolium* Waldst. & Kit, fenil hidrazin, hemoliz

EVALUATION OF THE ANTIHEMOLYTIC EFFECT OF *PEUCEDANUM LONGIFOLIUM* WALDST. & KİT PLANT

ABSTRACT

The most important and basic function of RBCs (Red Blood Cells) is to carry oxygen from the lungs to the tissues to supply oxygen to the cells. During this process, red blood cells are constantly exposed to endogenous and exogenous reactive oxygen species (ROS) that can damage their structure and impair their function. The interaction of phenyl hydrazine with red blood cells (RBC) causes the production of hydrogen peroxide, which is among the important free radicals. It is known that hydrogen peroxide oxidizes sulfhydryl groups and triggers hemolysis by initiating peroxidation of membrane lipids, therefore phenyl hydrazine causes hemolysis of erythrocytes. Plants contain antioxidant compounds that protect against the harmful effects of reactive oxygen species. The genus Peucedanum L. consists of different economically important species belonging to the Apiaceae family and used as food and medicine. The Peucedanum longifolium Waldst. & Kit, plant used in the study is among the species belonging to the genus Peucedanum L. The aim of the study was to examine the antihemolytic effects of *Peucedanum longifolium* Waldst.&Kit species on erythrocyte hemolysis caused by phenylhydrazine. 1 mL phenylhydrazine, 0.1 mL 20% PCV, 1.85 mL buffer pH: 7.4 were added to the samples containing different concentrations of the plant extract prepared using methanol. Then, it was incubated at 37 °C for 60 min. It was centrifuged at 4000 rpm for 10 minutes. The supernatant was removed and the absorbance at 540 nm was read against the control sample. Trolox, a synthetic antioxidant, was used as a positive control. *Peucedanum longifolium* Waldst. & Kit. The percentage of inhibition of plant extract on erythrocyte hemolysis caused by phenylhydrazine was 52.91 ± 0.73; trolox was reported to be 50.14 ± 0.54 The IC50 values of *Peucedanum longifolium* Waldst.&Kit, plant extract and trolox were determined as 20.64 ± 1.04 µg/mL and 31.61± 1.08 µg/mL, respectively.

In conclusion; The fact that *Peucedanum longifolium* Waldst. & Kit plant has an inhibitory effect on hemolysis caused by phenyl hydrazine reveals that the plant can act as an anti-hemolytic agent.

Keywords: *Peucedanum longifolium* Waldst. & Kit phenylhydrazine, hemolysis

GİRİŞ

Kırmızı Kan Hücrelerinin (RBC) önemli rolü, tüm hücrelere oksijen sağlamak için akciğerlerden dokulara oksijen taşımaktır. Dolaşım sırasında, RBC'ler sürekli olarak kendilerine zarar verebilecek ve işlevini bozabilecek hem endojen hem de eksojen reaktif oksijen türleri (ROS) kaynaklarına maruz kalır (Ramani ve ark, 2021) Biyolojik bir sistemdeki bu reaktif türlerin zararlı etkileri, sistemin bunları nötralize etme ve ortadan kaldırma kapasitesini aştığında ortaya çıkar (Rahman ve ark., 2012). Farklı sebeplerle eritrositlerin hücre zarının parçalanması sonucu hemoglobin molekülünün dışarı çıkmasına hemoliz denir. Hemoliz hemolitik anemiler, bakteri-hayvan toksinleri, uygunsuz kan transfüzyonları, eritrofagositoz olayları vb. sebeplerle in vivo veya ozmotik parçalanma, fiziksel-mekanik veya kimyasal etkiler gibi in vitro nedenlerle oluşabilir (Türkmen ve ark., 2007). Fenil hidrazinin hem in vitro hem de in vivo hemolize neden olma kapasitesi ile iyi bilinmektedir. Her iki durumda da hidrojen peroksit oluşumunun eritrositler ile etkileşimi ile ilişkili olduğu gösterilmiştir. Hidrojen peroksitin glutatyon peroksidaz yoluyla detoksifikasyonu da tarif edilmiştir. Hidrojen peroksitin kırmızı hücrenin detoksifikasyon kapasitesinin üzerinde birikmesi, membran fosfolipitleri de dahil olmak üzere temel hücresel bileşenlerin oksidasyonuna yol açabilir. Bu tür değişikliklerin muhtemelen etkilenen hücrelerin nihai hemolizine katkıda bulunduğu belirtilmiştir (Jain ve Hochstein, 1979). Apiaceae familyası Türkiye'de 100 cins ve toplam 477 türden oluşur ve taksonların 167'si endemiktir. Peucedanum L. cinsi Apiaceae familyasına ait 100-120 türle temsil edilen ve esas olarak Avrasya ve Afrika'da dağılan bir cinstir (Yıldırım ve Duman 2017). Peucedanum L. cinsi gıda ve ilaç olarak kullanılan ekonomik açıdan önemli türlerden meydana gelir (Ilıc ve ark 2015). *Peucedanum longifolium* Waldst. & Kit bitkisi Peucedanum L., cinsine ait önemli türler arasında yer alır. Peucedanum L. cinsinin bilinen antioksidan özelliklerinden yola çıkılarak sunulan çalışmada *Peucedanum longifolium* Waldst. & Kit türünün fenil hidrazin ile oluşturulan eritrosit hemolizi üzerine inhibisyon etkilerinin incelenmesi amaçlandı.

MATERYAL VE METOD

Peucedanum longifolium Waldst. & Kit Bitki Materyali

Peucedanum longifolium Waldst. & Kit (Apiaceae) B9 Van: Çatak ilçesi, Yukarı Narlıca Mahallesi, step, 21.05.2020, 38^{O} 10’ 42’’ N, 42^{O} 59’ 11’’E, 2608 m, F 15035 toplanarak

Van Yüzünü Yıl Üniversitesi Öğretim Üyesi Prof. Dr. Fevzi Özgökçe tarafından tanımlandı.

Bitki Ekstraktı Hazırlama

Bitkinin, toprak üstü kısımları gölgede kurutularak öğütüldü (Cai ve ark., 2004). 5 g alınarak tartılan örnekler koyu renkli şişelere alındı ve üzerlerine metanol (% 80) ilave edildi. Ardından karıştırıcılı su banyosunda 35 ˚C'de 24 saat boyunca ekstrakte edildi. Örnekler 5000 rpm'de 10 dk. boyunca santrifüje tabi tutuldu ve süzüldü. Süzme işlemi Whatman No.1 süzgeç kağıdı kullanılarak gerçekleştirildi. Metanol süzüntüden rotary evoporator kullanılarak uzaklaştırıldı Elde edilen metanol ekstresi liyofilize edildi ve liyofilizat -20˚C'de saklandı.

Eritrosit Paketi Hazırlama

Kan örnekleri EDTA'lı tüplere alınarak 3000 rpm'de +4ºC'de soğutmalı santrifüjde 15 dakika boyunca santrifüj edildi. Oluşan plazma ortamdan uzaklaştırıldı. İzotonik % 0,9 NaCl soğuk olarak altta kalan hacme eşit oranda eklendi ve böylece eritrositlerin yıkanma işlemi yapıldı. Serum fizyolojik eklenen tüpler 2500 rpm'de +4ºC'de 5 dk. santrifüj edildi. Bu işlem üç kez arka arkaya tekrarlandı. En sonunda elde edilen eritrosit paketi -80ºC muhafaza edildi (Akkoyun ve ark., 2022)

Fenil Hidrazinin Neden Olduğu Eritrosit Hemolizinin Önlenmesi

Hemolizi indüklemek için fenil hidrazin kullanıldı. Karşılaştırma için troloks seçildi.. Bitki ekstraktının farklı konsantrasyonları ile hazırlanan örneklere 1 mL fenil hidrazin, 0,1 mL %20 eritrosit süspansiyonu (PCV) ve 1,85 mL tampon eklendi. Daha sonra, 4000 rpm'de 10 dakika boyunca santrifüj edilmeden önce, 37 °C'de 1 saat süreyle inkübe edildi. Son olarak süpernatan kısım diğer tüplere aktarıldı; 540 nm'deki absorbans değerinde okundu (Akbaş ve ark., 2018; Valenzuela ve ark., 1985). Antihemoliz yüzdesi aşağıdaki denklemle elde edildi.

$$\text{Inhibisyon (\%)} = (1- A_{test}/A_{kontrol})X100$$

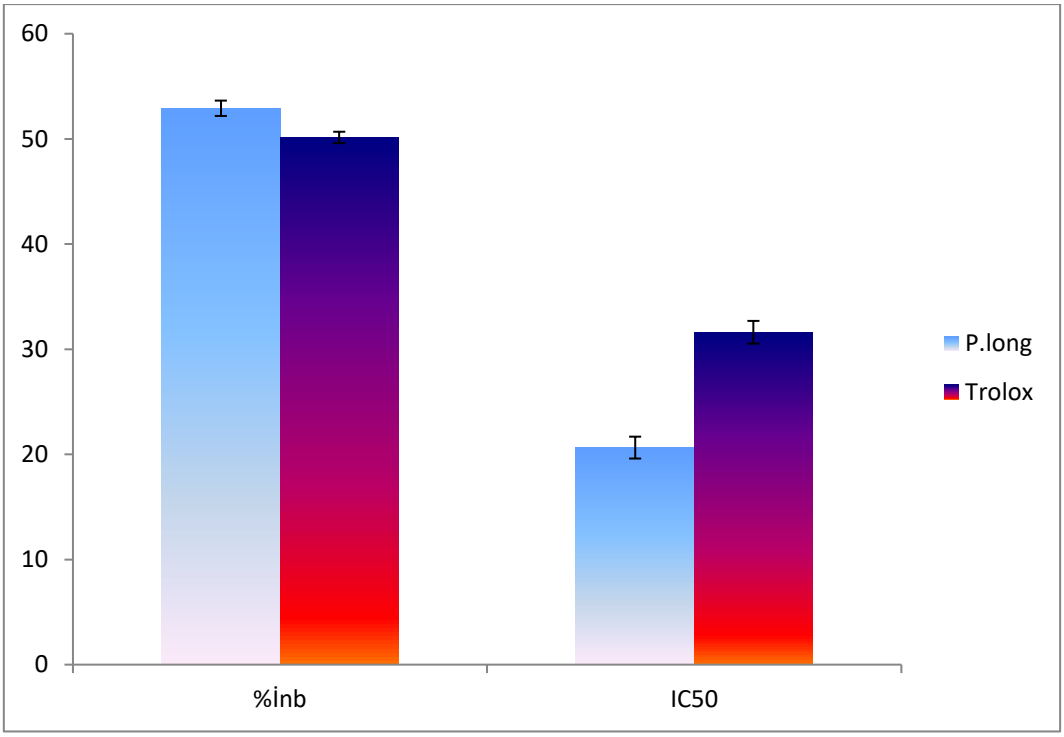
BULGULAR VE TARTIŞMA

Peucedanum longifolium ve karşılaştırma için kullanılan troloksun fenil hidrazin ile gerçekleştirilen hemoliz üzerine % inhisisyonu ve IC_{50} değerleri Tablo. 1 ve Şekil. 1 de verildi.

Tablo 1. *Peucedanum longifolium ve* troloks % inhibisyon ve IC50 değerleri

	% inhibisyon Fenil hidrazine bağlı eritrosit hemolizini önleme	**IC_{50} (µM)** Fenil hidrazine bağlı eritrosit hemolizini önleyen konsantrasyon
Peucedanum longifolium	52.91 ± 0.73	20.64 ± 1.04
Troloks	50,14 ± 0,54	31.61 ± 1.08

Şekil 1. *Peucedanum longifolium ve* troloks % inhibisyon ve IC50 grafiği



Bitkilerin hastalıklardan korunma ve tedavide kullanımı çok uzun yıllara dayanmaktadır. Tarih boyunca kullanılan sağlık materyalinin en eski örneklerini bitkiler, hayvansal ürünler, mantarlar gibi doğal ürünler oluşturmaktadır. Yıllar boyunca çoğu uygarlık bu ürünleri hastalık tedavisi ve ilaç kaynağı olarak kullanmıştır. Dünya Sağlık Örgütünün verilerine göre dünyadaki nüfusun büyük çoğunluğu bitki kaynaklı ilaçları sağlık açısından daha güvenli bulmaktadır (Orçan ve ark., 2023). Avrupa, Asya ve Afrika'da yaygın olarak yetişen Peucedanum L., türlerinin meyveleri ve kökleri, geleneksel Bulgar tıbbında terletici, idrar söktürücü ve antiskorbütik olarak kullanılırken, Sırp geleneksel tıbbında apertatif ve sindirim maddesi olarak kullanıldığı bildirilmiştir. Peucedanum L'.nin farklı bir türünün köklerinin ilaç endüstrisinde kardiyovasküler aktiviteye sahip

olduğu kanıtlanmış bir preparat olarak kullanıldığı raporlanmıştır (Jovanovic 2015). Yapılan farklı literatür taramalarında Peucedanum L., türlerinin antiokisidan, antiradikal ve antimikrobiyal aktivitelere sahip oldukları belirtilmiştir (Matezic 2013). Farklı bir Peucedanum L., türünde 17 aktif bileşen tesbit edilmiş bitkinin antioksidan kapasitesinden bu bileşenlerin sorumlu olduğu belirlenmiştir (Hisamato ve ark., 2004). Önemli bir tür olan *P. pastinacifolium'un* metal şelatlama, radikal süpürme, indirgeme kapasitesinin güçlü olduğu yapılan çalışmada rapor edilmiştir (Movahedian ve ark., 2016). *Peucedanum longifolium* türünün antibakteriyel ve antifungal aktivitelere sahip olduğu yapılan bir çalışmada bildirilmiştir (Matejic ve ark., 2013). *Peucedanum longifolium* yaprak ve çiçeklerinin uçucu yağ içeriği yönünden zengin olduğu belirlenmiştir (Stojanovic ve ark., 2017)

Sunulan çalışmada *Peucedanum longifolium* bitkisinin incelenen ve raporlanan özelliklerinden yola çıkılarak anti-hemolitik aktivitesinin değerlendirilmesi amaçlanmıştır. Yapılan literatür taramalarında fenil hidrazin ile oluşturulan eritrosit hemolizi üzerine *Peucedanum longifolium* bitkisinin etkilerinin incelendiği herhangi bir çalışmaya rastlanmamıştır. Çalışma sonuçları değerlendirildiğinde ise; *Peucedanum longifolium* türünün fenil hidrazine bağlı eritrosit hemolizini %52.91 ± 0.73 oranında önlediği, bu oranın pozitif kontrol olarak kullanılan troloksa göre daha etkili olduğu belirlendi. IC50 değerleri değerlendirildiğinde ise bitkinin troloksa göre daha düşük konsantrasyona sahip olduğu görüldü.

SONUÇ

Sonuç olarak; *Peucedanum longifolium* Waldst. & Kit bitkisinin fenil hidrazinin neden olduğu eritrosit hemolizi üzerine inhibisyon etkisi göstermesi, bitkinin anti-hemolitik ajan olarak görev yapabileceğini fakat bu görüşün farklı çalışmalarla desteklenmesi gerektiği düşünülmektedir.

TEŞEKKÜR

Peucedanum longifolium Waldst. & Kit bitkisinin temin edilmesi ve tanımlanmasında emeği geçen Van Yüzünü Yıl Üniversitesi Öğretim Üyesi Sayın Prof. Dr Fevzi Özgökçe'ye teşekkür ederim.

KAYNAKLAR

Akbas, E., Ekin, S., Ergan, E., & Karakus, Y. (2018). Synthesis, DFT calculations, spectroscopy and in vitro antioxidant activity studies on 4-hydroxyphenyl substituted thiopyrimidine derivatives. *Journal of Molecular Structure*, *1174*, 177-183.

Akkoyun, H., Aydin, S., Akkoyun, M., Bengü, A., Ekin, S., Aslan Erdem S. (2022). Effects of Arbutin on Fatty Acid Levels of Erythrocyte and Serum in Wistar Albino Rats Treated with Potassium Bromate. *INDIAN JOURNAL OF PHARMACEUTICAL EDUCATION AND RESEARCH*, *56*(3).

Cai, Y., Luo, Q., Sun, M., Corke, H., (2004). "Antioxidant activity and phenolic compounds of 112 traditional Chinese medicinal plants associated with anticancer", Life Sciences, 74: 2157-2184.

Hisamoto, M., Kikuzaki, H., Nakatani, N. (2004). Constituents of the leaves of Peucedanum japonicum Thunb. and their biological activity. *Journal of agricultural and food chemistry*, *52*(3), 445-450.

Ilić, B., Miladinović, D., Kocić, B., & Miladinović, M. (2015). Antibacterial profile of Peucedanum longifolium essential oil. *Acta Medica Medianae*, *54*(1), 20-26.

Jain, S. K., Hochstein, P. (1979). Generation of superoxide radicals by hydrazine: Its role in phenylhydrazine-induced hemolytic anemia. *Biochimica et Biophysica Acta (BBA)-General Subjects*, *586*(1), 128-136.

Jovanovic, O. P., Zlatkovic, B. K., Jovanovic, S. C., Petrovic, G., Stojanovic, G. S. (2015). Composition of Peucedanum longifolium Waldst. & Kit. essential oil and volatiles obtained by headspace. *Journal of Essential Oil Research*, *27*(3), 182-185.

Matejic, J. S., Dzamic, A. M., CIRIC, A.D., Krivosej, Z., RANDELOVIC, L. N., Marin, P. D. (2013). antioxidant and antimicrobial activities of extracts of four peucedanum l. species. *Digest Journal of Nanomaterials & Biostructures (DJNB)*, *8*(2).

Movahedian, A., Zolfaghari, B., Mirshekari, M. (2016). Antioxidant effects of hydroalcoholic and polyphenolic extracts of Peucedanum pastinacifolium Boiss. & Hausskn. *Research in pharmaceutical sciences*, *11*(5), 405-411.

Orçan, İ., Bülbül, A. S., & Yakup, K. A. R. A. (2023). Alyssum filiforme Bitkisinin Antimikrobiyal, Antibiyofilm, Antioksidan Aktivitesinin ve Fenolik Profilinin

Belirlenmesi. *Journal of Advanced Research in Natural and Applied Sciences*, *9*(1), 48-55.

Rahman, T., Hosen, I., Islam, M. T., & Shekhar, H. U. (2012). Oxidative stress and human health.

Ramani, S., Basak, S., Puneeth, S., Mahato, K., & Malathi, R. (2021). Anti Hemolytic Activity of Rutin incase of Phenyl Hydrazine induced Hemolysis. *Current Trends in Biotechnology and Pharmacy*, *15*(5), 467-470.

Stojanovic, G., Jovanovic, O., Zlatkovic, B., Jovanovic, S., Zrnzevic, I., Ristic, N. (2017). First insight into the chemical composition of essential oils and head space volatiles obtained from fresh leaves and flowers of Peucedanum longifolium Waldst. & Kit. *Biologica Nyssana*, *8*(1).

Türkmen, Y. H., Serdar, M. A., Haşimi, A., Cihan, M., Kurt, İ., Akman, Ş., Erbil, M. K. (2007). Hemoliz ve lipeminin biyokimyasal testlere etkisi ve lipemik etkinin uzaklaştırılmasında kullanılan yöntemlerin karşılaştırılması. *Gülhane Tıp Dergisi*, *49*, 5-10.

Valenzuela, A., Barría, T., Guerra, R., Garrido, A. (1985). Inhibitory effect of the flavonoid silymarin on the erythrocyte hemolysis induced by phenylhydrazine. *Biochemical and biophysical research communications*, *126*(2), 712-718.

Yildirim, H., Duman, H. (2017). Peucedanum guvenianum (Apiaceae), a new species from West Anatolia, Turkey. *Turkish Journal of Botany*, *41*(6), 600-608.

ENDEMİK KEKİK (*Thymus Haussknechtii Velen*) TÜRÜNÜN BAZI BİYOKİMYASAL İÇERİKLERİNİN ANALİZİ

Doç. Dr. Sevinç AYDIN (ORCID: 0000-0001-8597-8064)
Munzur Üniversitesi, Çemişgezek MYO, Tunceli, Türkiye
Email: sevincaydin2380@gmail.com

ÖZET

Gıda sanayinde yaygın olarak kullanılan kekik en değerli bitkilerden biri olup, Türkiye'de de gıda sanayisinde önemli yer tutmaktadır. Bu çalışmada bilinen beş kekik türünden biri olan, Türkiye'nin Elâzığ-Harput bölgesinden toplanan *Thymus haussknechtii Velen* endemik türü incelenmiştir. Çalışmada, lipit ekstraktı içindeki yağ asitleri metil esterlerine dönüştürüldükten sonra gaz kromatografisi ile, vitamin ve fenolik içeriği ise DAD dedektörünün kullanıldığı, HPLC (yüksek performanslı sıvı kromatografisi) cihazı ile analiz edildi. Çalışmanın sonunda, toplam fenolik bileşikler bakımından karşılaştırıldığında, Gallik asit ve Kafeik asit miktarlarının diğer fenoliklere oranla (Rosmarinik, Vanilik, Ferulik ve Sinnamik asit) daha fazla miktarda olduğu gözlendi ($p<0.001$). Benzer şekilde, vitamin içeriği bakımından ise; β-Sterol ve D2 vitaminlerinin belirgin şekilde fazla olduğu gözlendi ($p<0.001$). Yağ asidi içerikleri incelendiğinde ise, doymuş yağ asitlerinden palmitik asit (16:00) ve stearik asit (18:00) miktarlarının, doymamış yağ asidi içerikleri bakımından ise özellikle linoleik (18:2, n-6t ve 18:2, n-6c) yağ asitlerinin yüksek miktarda olduğu tespit edilmiştir ($p<0.001$). Türkiye'de baharat ihracatında önemli bir yeri olan kekik bitkisinin iyi bir antioksidan özelliğe sahip olması; incelediğimiz ve antioksidan etkiye sahip olduğu bilinen bu biyokimyasal bileşenlerinin oranlarıyla ilişkili olduğunu düşündürmüştür. Ayrıca, literatürdeki diğer bölgesel kekik türlerinin içerik bakımından farklılık göstermesi; alternatif tıpta neden farklı bölgelerde farklı amaçlar için kullanıldığını anlamamız açısından destekleyici bir fikir olabilir.

Anahtar Kelimeler: *Thymus Haussknechtii Velen*, fenolik, yağ asidi, vitamin.

ANALYSIS OF SOME BIOCHEMICAL CONTENTS OF ENDEMIC THYME (*Thymus Haussknechtii Velen*) SPECIES

ABSTRACT

Thyme, which is widely used in the food industry, is one of the most valuable plants and has an important place in the food industry in Turkey. In this study, the endemic species Thymus haussknechtii Velen, one of the five known thyme species collected from the Elâzığ-Harput region of Turkey, was examined. In the study, the fatty acids in the lipid extract were analyzed by gas chromatography after being converted into methyl esters, and the vitamin and phenolic contents were analyzed by HPLC (High-performance liquid chromatography) device using the DAD detector. NAt the end of the study, when compared in terms of total phenolic compounds, it was observed that the amounts of Gallic acid and Caffeic acid were higher than other phenolics (Rosmarinic, Vanillic, Ferulic and Cinnamic acid) ($p<0.001$). Similarly, in terms of vitamin content; it was observed that β-Sterol and vitamin D2 were significantly higher ($p<0.001$). When the fatty acid contents were examined, it was determined that the amounts of saturated fatty acids palmitic acid (16:00) and stearic acid (18:00) were high, and in terms of unsaturated fatty acid content, especially linoleic fatty acids (18:2, n-6t and 18:2, n-6c) ($p<0.001$).NThyme plant, which has an important place in spice exports in Turkey, has good antioxidant properties; this suggested that it was related to the ratios of these biochemical components that we examined and are known to have antioxidant effects. Additionally, other regional thyme types in the literature differ in terms of content; it may be a supporting idea to understand why alternative medicine is used for different purposes in different regions.

Keywords: *Thymus Haussknechtii Velen*, phenolic, fatty acid, vitamin.

Giriş

Kekik, Thymus L. (Lamiaceae) cinsi üyeleri'nin yaygın olarak kullanılan ismidir. Dünya genelinde 300'den fazla türle temsil edilen büyük bir cins olup, Türkiye'de 40 adet türü bulunmaktadır ve bunların 18 türü endemiktir (Ertaş vd., 2015). Çok eski zamanlardan beri geleneksel tıpta önemli bir yeri olan kekik (Thymus L.), günümüzde de halen hem geleneksel hemde resmi tıpta ayrıca ilaç, kozmetik ve gıda sanayinde yaygın olarak kullanılmaktadır. Bitkinin toprak üstü parçalarından (taze ya da kurutulmuş) esansiyel yağı başta olmak üzere tıbbi veya mutfak amaçlı kullanılabilecek yüksek kalitede bir kaynaktır (Jari'c vd., 2015).

Türkiye, baharat ve şifalı bitki endüstrisi için zengin bir kaynak oluşturur. Özellikle iklimin ve ekolojik özelliklerin olumlu etkisiyle, pek çok şifalı bitki ve bitkisel besin Türkiye'de rahatlıkla yetiştirilebilmektedir. Ticari açıdan değerli bitkiler (rezene, biberiye, defne, meyan kökü, nane vb.) arasında kekiğin birçok açıdan özel bir yeri vardır. Baharat ihracatında ilk sırada yer alan kekiğin, Türkiye'de yetişen diğer aromatik bitkilerden daha iyi antioksidan özelliklere sahip olduğu bildirilmiştir (Mevlut vd., 2014).

Farklı Thymus türlerinin bileşenlerinin önemli ölçüde farklılık gösterebildiği, bunun da diğer bitkilerde olduğu gibi, bitkinin hasat zamanı veya olgunluk aşaması, iklim farklılığı, ekstraktların hazırlandığı bitki kısmı, ekstrakt sırasında kullanılan teknikler gibi birçok faktörle ilişkili olduğu bilinmektedir (Kuete, 2017; Lorenzo vd., 2018). Kekiğin geleneksel olarak; bronşit, üst solunum yolu enfeksiyonları ve paraziter hastalıklar gibi enfeksiyonların tedavisinde kullanıldığı, yeni çalışmalarda ise; sadece kekiğin esansiyel yağları değil, kekik ekstraktlarından elde edilen diğer bileşikler de araştırmaların odak noktası olmuştur.

Çalışmalar, kekiğin fitokimyasal bileşiminde fenolik asitler (rosmarinik asit, kafeik asit gibi), flavonoidler (apigenin, naringenin, hesperetin gibi) ve bifenil bileşiklerinin ana bileşenler olduğunu rapor etmiştir. Thymus türlerinin iyi bilinen antioksidan özellikleri bu bileşiklerle ilişkilendirilmiştir (Lorenzo vd., 2018). Diğer taraftan, yine Thymus içeriklerinden olan vitaminler (C ve E)'in de antioksidan aktiviteleri bilinmektedir (Sağlam, 2007; Dauqan vd., 2017). Bu sebeplerle; bitkilerde yer alan fenolik maddelerin biyolojik aktivitelerine (antioksidan, antimikrobiyal, antiviral, enzim inhibitörü, anti-HIV, antikanserojen vb.) ilgi son yıllarda gittikçe artmıştır. Flavonoidler, fenolik maddelerin bu etkilerinin temelini oluşturan en önemli grubudur.

Günümüzde flavonoidleri içeren preparatlar birçok hastalığın iyileştirilmesinde tercih edilmektedir (Spranger vd., 2008; Castañeda-Ovando vd., 2009). Örneğin bu gruptaki fenolik asitler (örneğin elma suyunda bulunan ferulik asit) tek olarak kolayca emilir. Ayrıca, hücre membranlarındaki kolesterol ve doymamış yağ asitlerinin serbest radikaller ile kolayca reaksiyona girerek lipit peroksidasyonunu başlattığı bilinmektedir. (Akkuş, 1995; Gutteridge, 1995).

Gerek yağ asidi değişimlerinin ve gerekse toplam fenolik madde ve vitamin oranlarındaki değişimlerinin antioksidan aktiviteyle ilişkilendirilmesi nedeniyle, Elâzığ/Harput bölgesinde yetişen *Thymus haussknechtii Velen* endemik olan türünün, toprak üstü kısmında bahsi geçen bu içerik dağılımlarını inceleyerek, kekiğin ana tedarikçisi olan Türkiye'deki endemik Thymus türünün farklı içerikleri hakkında yeni veriler sunmayı amaçladık.

Materyal Metot

Bitki Örneklerinin Toplanması

Bu çalışmanın bitki örnekleri Elâzığ/Harput bölgesinden, yaz mevsiminde toplandıktan sonra içerisindeki yabancı maddeler temizlenip toprak üstü kısımları ayrıştırılarak kurutuldu. Kurutulan kısımlar analiz yapılıncaya kadar laboratuvarda hazır halde bekletildi.

HPLC Cihazı ile Bazı Flavonoid Türlerinin Belirlenmesi

Bu analiz, Zu ve arkadaşları tarafından bildirilen yöntem revize edilerek gerçekleştirildi (Zu vd., 2006). 1 gr bitki örneği üzerine 10 ml metanol eklenerek karışım 60 saniye homojenize edildi. Homojenize edilen numuneler daha sonra santrifüj edilerek viallere alındı. Flavonoidlerin kromatografik analizi için, iç çapı 5 µm olan bir PREVAIL C18 (15x4,6 mm) kolonu ve %1 asetik asit içeren bir metanol/su/asetonitril (46/46/8, v/v/v) içeren bir mobil faz asit kullanıldı. Flavonoid analizleri için DAD dedektörü kullanılmış ve bu analizlerde gallik asit için 260 nm, vanilik asit ve rosmarinik asit için 280 nm, sinnamik asit için 312 nm, kafeik ve ferulik asitler için ise 320 nm dalga boyları kullanılmıştır. Tüm kromatografik prosedürler 25°C'de gerçekleştirildi.

Lipid ve Vitaminlerin Ekstraksiyonu

Bitki örneklerinden 1g alınarak lipidlerin ekstraksiyonu yapıldı. Lipidlerin ekstraksiyonu 3:2 (v/v) hekzan/izopropanol karışımının kullanıldığı Hara ve Radin metoduyla yapıldı (1978). Bunun için; 1 g örnek 3:2 (v/v) oranında 10 ml hekzan-izopropanol karışımı

içinde 60 sn süreyle homojenize edildi. Homojenizasyon kabı santrifüj tüplerine alındı. Daha sonra bu homojenat 5000 rpm'de 10 dk süreyle santrifüj edilerek, elde edilen supernatant kısmın yarısı yağ asidi, diğer yarısı da A, D, E, K vitaminleri ve fitosterollerin analizleri için kullanıldı.

A, D, E ve K Vitamin ile Fitosterol Miktarlarının HPLC Cihazı ile Tayini

Bu tayin için ayrılan örneklerin üzerine %10'lik metanolik potasyum hidroksit (KOH) çözeltisi eklendikten sonra vortekslendi. Daha sonra bu karışım 85 ºC'de 15 dk süre ile bekletildi. Bu süre sonunda tüpler oda sıcaklığına soğutularak üzerine saf su ilave edilip karıştırıldı. Lipofilik moleküllerden sabunlaşmayanlar için ise 5 ml hekzan ile ekstraktesi kullanıldı. Bunun için kullanılan hekzan fazı ise azot gazı kullanılarak uçuruldu. Geride kalan tortu 1,0 ml (%60 + % 40v/v) asetonitril/ metanol karışımı ile çözüldükten sonra otosampler viallere alındı. Shimadzu marka HPLC cihazı kullanılarak analizler yapıldı. Bu ölçüm için Asetonitril/metanol (%60+%40, v/v) karışımı mobil faz olarak kullanıldı. Mobil fazın akış hızı ise1 ml/dk olarak ayarlandı. A, D, E ve K vitamin analizleri DAD-UV dedektörü kullanılarak yapıldı. Bunun için kolon olarak Nucleodur LC 18 (15 x 4,6 cm, 5 µm; MN USA) kolonu kullanıldı. Dedeksiyon dalga boyları olarak A vitamini için 326 nm, E, D, K vitaminleri ve fitosteroller için ise 202 nm ayarlandı (Sánchez-Machado vd., 2002; Lopez-Cervantes vd., 2006).

Yağ Asidi Metil Esterlerinin Hazırlanması ve Gaz Kromatografisi ile Analizi

Örneklerin yağ asidi bileşimini tespit için, ayrılan örneklerin üzerine %2'lik metanolik sülfürik asit ilave edilip vortekslenerek örneğin homojen şekilde karışması sağlandı. Sonrasında elde edilen bu karışım 55 ºC'de 15 saat boyunca metilleşmeye bırakıldı. Ve 15 saat sonrasında tüpler oda sıcaklığına soğutulup %5'lik sodyum klorür (NaCl) ilave edilerek iyice karıştırıldı ve bu şekilde tüpler içinde oluşturulan yağ asidi metil esterleri hekzan ile ekstre edildi. Bu işlem sonunda oluşan hekzan fazı ise üsten pipetle alınarak %2'lik potasyum bikarbonat ($KHCO_3$) ile muamele edildi ve faz ayrımı için 4 saat bekletildi. Daha sonra bu metil esterlerini içeren karışımların çözücüleri 45 ºC'deki azot gazı kullanılarak uçuruldu. Bu işlemden sonra tüp içinde kalan kalıntıya 1 ml kloroform eklenip çözülerek, örneğin elde edilen bu son formundaki yağ asidi metil esterleri Shmadzu GC 2010 Plus gaz kromatografisi kullanılarak analiz edildi. Örneklerin yağ asitleri metil esterlerine dönüştürülürken kolon sıcaklığı 138–218 °C, enjeksiyon sıcaklığı 240 °C ve dedektör sıcaklığı 280 °C olarak ayarlandı. Kolon sıcaklık progamı 138 °C''den

218 ℃'ye kadar, sıcaklık artışı ise 200 ℃'ye kadar 5 ℃/dk ve 200 ℃'den 220 ℃ 'ye kadar 4 ℃/dk olarak ayarlandı. 218 ℃'de 7 dakika tutulup, toplam süre olarak 28 dakika ayarlanmıştır. Taşıyıcı gaz olarak Helyum gazı kullanıldı. Analiz aşamasında örneklere ait yağ asidi metil esterlerinin analizinden önce, standart yağ asidi metil esterlerine ait karışımlar ilave edilip, her bir yağ asidinin alıkonma süreleri belirlendi. Bütün bu işlemler bittikten sonra gerekli programlamalar yapılıp örneklerin yağ asidi metil esterleri analiz edilmiştir (Christie, 1990,1992; Tvrzicka vd., 2002).,

İstatistik Analiz

İstatistiksel analiz için SPSS 20.0 programı kullanıldı. Bileşenler arası karşılaştırma Paired-Samples T Testi kullanılarak yapıldı. Sonuçlar ortalama±SEM olarak verildi. Bileşenler arasındaki farklar için $p>0,05$, $p<0,05$, $p<0,01$ ve $p<0,001$ değerleri kullanıldı.

Bulgular

Kekik bitkisindeki fenolik bileşiklerin kompozisyonu Tablo 1 ile gösterildi. Bu kompozisyon içinde başta en fazla miktarda gallik asit olmak üzere, sırasıyla kafeik asit, rosmanirik asit, vanilik asit, ferulik asit ve sinnamik asit bileşenlerinin bulunduğu tespit edildi ($p<0.001$).

Tablo 1. Fenolik bileşik kompozisyonu

Fenolikler bileşikler	**Miktar (µg/g)**
Gallik asit	600,4±0,01 ^{d}
Kafeik asit	193,60±0,01 ^{d}
Rosmanirik asit	102,00±0,02 ^{d}
Vanilik asit	44,00±0,07 ^{d}
Ferulik asit	7,20±0,09 ^{d}
Sinnamik asit	0,40±0,20 ^{a}

$p<0.05$, $p>0.05$, $p<0.01$ ve $p<0.001$

Tablo 2 ile kekik bitkisinin toprak üstü kısımlarındaki gözlenen vitamin ve fitostrerol kompozisyonunu gösterildi. Vitamin bileşimi içinde; K1, K2, D2, α-tokoferol, E-Sterol, β-Sterol ve Retinol tespit edildi. Bu değerler karşılaştırıldığında ise; sırasıyla, β-Sitosterol, D2, K2 ve K1 vitaminlerinin diğerlerine oranla yüksek miktarlarda olduğu gözlendi ($p<0.001$, $p<0.01$, $p>0.05$).

Tablo 2. Vitamin ve fitosterol konsantrasyonları (mg/g)

Vitamin ve steroller	Miktar (mg/g)
K1	14,40±0,02 [b]
K2	17,73±0,01 [c]
D2	21,87±0,01 [d]
α-tokoferol	10,40±0,05 [b]
E-Sterol	11,27±0,03 [b]
β-Sterol	274,67±0,01 [d]
Retinol	0,07±0,15 [a]

p<0.05, p>0.05, p<0.01 ve p<0.001

Tablo 3 ile kekik bitkisinin toprak üstü kısımlarında gözlenen doymuş yağ asidi kompozisyonunu gösterildi. Doymuş yağ asidi bileşimi içinde miristik asit (14:0), palmitik asit (16:0), stearik asit (18:0), Lignoserik asit (24:0) gibi yağ asitlerinin bulunduğu gözlendi. Bu yağ asitleri karşılaştırıldığında, palmitik asit ve stearik asit değerlerinin diğer doymuş yağ asitlerinden daha fazla olduğu gözlendi (p<0.001).

Tablo 3. Doymuş yağ asidi kompozisyonu (%)

Doymuş Yağ asitleri	Miktar (%)
Miristik asit (14:00)	0,40 ±0,05 [a]
Palmitik asit (16:00)	11,62 ±0,01 [d]
Stearik asit (18:00)	3,18 ±0,02 [d]
Lignoserik asit (24:0)	0,49 ±0,05 [a]

p<0.05, p>0.05, p<0.01 ve p<0.001

Kekik bitkisindeki gözlenen doymamış yağ asidi kompozisyonu Tablo 4 ile gösterilmektedir. Tekli yağ asidi bileşimi içinde palmitoleik asit (16:1, n-7), oktadekanoik asit (18:1, n-7) ve oleik asit (18:1, n-9), Linoleik asit (18:2, n-6c), Linoleelaidik asit1(8:2, n-6t), α-linolenik asit (18:3, n3 LNA), Gadoleik asit (20:1), Eikosatrienoik asit (20:3, n-3), Dokosapentaenoik asit (22:5, n-3) ve Dokosahekzaenoik asit (22:5, n-6) gibi yağ asitlerinin bulunduğu gözlendi. Bu yağ asitleri içinde ise sırasıyla; linoleelaidik asit, linoleik asit, oleik asit ve dokosapentaenoik asid doymamış yağ asitlerinin miktarlarının belirgin düzeyde fazla olduğu gözlenmiştir (p<0.001) (Tablo 2).

Tablo 4. Doymamış yağ asidi kompozisyonu (%)

Doymamış Yağ asitleri	**Miktar (%)**
Palmiotelik asit (16:1, n-7)	1,54 ±0,04 [a]
Oktadekanoik asit (18:1, n-7)	1,89 ±0,03 [b]
Oleik asit (18:1, n-9c)	3,18 ±0,02 [d]
Linoleik asit (18:2, n-6c)	12,03±0,01 [d]
Linoleelaidik asit (18:2, n-6t)	21,31 ±0,01 [d]
α-linolenik asit (18:3, n3 LNA)	0,49 ±0,05 [a]
Gadoleik asit (20:1)	1,30±0,06 [a]
Eikosatrienoik asit (20:3, n-3)	1,77±0,05 [a]
Dokosapentaenoik asit (22:5, n-3)	3,16±0,02 [d]
Dokosahekzaenoik asit (22:5, n-6)	0,73±0,06 [a]

$p<0.05$, $p>0.05$, $p<0.01$ ve $p<0.001$

Tartışma

Aromatik ve şifalı bitkiler, güçlü antioksidan özelliklere sahip flavonoidler, hidrolize edilebilir tanenler ve fenolik bileşikler gibi doğal bileşikler açısından zengin kaynaklardır. Bu bitkilerdeki fenolik bileşikler; indirgeyici ajanlar, hidrojen donörler ve singlet oksijen söndürücüler olarak görev yaparak antioksidan etki gösterirler. (Rong-Zhen ve Dao-Wei, 2013; Rice-Evans vd., 1995). Bu bitkilerden biri olan Kekik, güçlü antioksidan ve antimikrobiyal özellikleri sayesinde, yiyecekleri bozulmaktan koruyan, koku ve tadı olumlu yönde artırmasının yanı sıra mutfak sanatında dekoratif yeşil bitki olarak da kullanılması gibi gıda işlemenin neredeyse her aşamasına başarıyla uygulanmıştır (Salehi vd., 2019; Stahl-Biskup ve Venskutonis, 2012).

Thymus türleri ile ilgili temel araştırmalar onların uçucu bileşikleri üzerinde yoğunlaşmıştır, ancak yağ asitleri, vitamin içerikleri ve fenolik bileşikleri yeterince araştırılmamıştır. Bununla birlikte sayıları az olan çalışmaların birinde; T. fallax'ın kök ekstraktlarının oldukça zengin rosmarinik asit içeriğiyle dikkat çektiği, toprak üstü kısımlarında da rosmarinik asitin ikinci sırada yer aldığı rapor edilmiştir (Yilmaz vd., 2018). Rosmarinik asit ve kafeik asidin varlığı daha önce T. serpyllum (Fecka ve Turek; 2008; ve Boros vd., 2010), T. vulgaris gibi farklı kekik türlerinde rapor edilmişti. (Gavari'c vd., 2015; Kosakowska vd., 2020). Çalışmamızda da ilginç özellikler taşıdığı bilinen rosmarinik asitin belirgin bir şekilde mevcut olduğu görülmüştür. Bu anlamda

önceki çalışmayla benzerlik göstermiştir. Yilmaz ve arkadaşları (2018) ayrıca T. kotschyanus türünde kafeik asitinin miktarının tüm ekstraktlarda dikkat çekici olduğunu, özellikle T. hausknetchtii türünün ise kök kısımlarının en yüksek kafeik asit içeriğine sahip olduğu (851,28 µg/g), bununla birlikte T. Kotschyanus'un kök kısımlarının (332,69 µg/g) en düşük miktarda kafeik asit içerdiğini bildirildi. Bu içerikler bakımdan bizim çalışmamız da toprak üstü kısımlarında kafeik asit miktarının 193,60 mg/g ile kayda değer miktarda olduğunu tespit edildi. Farklı bir çalışmada ise T, nummularius ve T. lotocephalus dahil olmak üzere çeşitli Thymus türlerinde kafeik asit, rosmarinik asit ve apigenin belirlendiği bildirildi. Bu çalışmada; T. nummularius'un rosmarinik asit açısından şaşırtıcı derecede zengin bir kaynak (131898,9 µg/g) olduğu ortaya çıkmıştır (Costa vd., 2012; Ertas vd., 2015). Benzer başka bir çalışmada Gökbulut (2015) T. sipyleus'un toprak üstü ve kök kısım ekstraktlarında fenoliklerin incelemiş ve tüm ekstraktlarda rosmarinik asit, klorojenik asit ve kafeik asidin tanımlandığı rapor etmiştir. Rosmarinik asit, birçok bitki türünde bulunan, bol miktarda çözünebilen bir fenolik asit türüdür. (Martins vd., 2015). Güçlü antioksidan aktivitesi, serbest radikal temizleyici ve antiviral özellikleriyle bilinir. Ayrıca gonadotropinlerin, ksantin oksidazın ve adenilat siklazın aktivitelerinin inhibe edilmesinde de rol oynadığı (Kosakowska vd., 2020) düşünüldüğünde bu fenoliğin miktarının kekiğin antioksidan aktivitesine katkısını anlamamızı kolaylaştıracaktır.

Son zamanlarda ise Boga ve arkadaşları (2021), Türkiye'deki beş kekik türünün ana fenolik bileşikleri olarak nikotiflorin, kafeik, kinik, rosmarinik ve fumarik asitlerin varyasyonlarını göstermiştir. Bunlardan ana fenolik bileşikler olarak kafeik, kinik, rosmarinik ve fumarik asitleri rapor edilmiştir. Ayrıca, bu türün 11 popülasyonunun uçucu yağ bileşimi ve ayrıca çok değişkenli analiz kullanılarak fenolik asit profili açısından da araştıran bir çalışma bildirilmiştir. Bu çalışmada, T. daenensis'in fenolik profilinin popülasyonlar arasında farklı konsantrasyonlar gösterdiği rapor edilmiştir (Hassan vd., 2022). Başka bir çalışmada ise T. vulgaris L. 'de sinnamik asit gözlendiği rapor edilmiştir (Roby vd., 2013).

Araştırmalar, fenolik bileşenler dışında, kekik yağının folik asit, beta karoten, A, K, E ve C vitaminler gibi iyi bir vitamin kaynağı olduğunu da ortaya koymuştur (Dauqan vd., 2017) Örneğin bu çalışmalardan birinde *T. serpyllum*'da A vitamini (4,90 mg/100 g) C vitamini (43,8 mg/100 g) ve yüksek miktarda E vitamini (13,7 mg/100 g) içerdiği rapor

edilmiştir. Aynı çalışmada Turcu ve arkadaşları *T. Vulgaris* türünün 11.89 mg/100 g E vitamini içeriği sahip olduğunu rapor etmiştir (Turcu vd., 2020). Çalışmamızdaki E vitamini ve A vitamini değerleri mevcut literatür ile benzerlik göstermektedir. E vitamini çok güçlü bir antioksidandır. Hücre zarındaki çoklu doymamış yağ asitlerini, serbest radikallerden koruyan ilk savunmada görev alır (Banarjee vd., 2003; Yalçın, 1998; Akkus, 1995; Viitala, 2003). Kekik türlerinden elde edilen balın; Güney Avrupa, Yeni Zelanda ve İran'da popüler olan en beğenilen ve en güçlü aromalı ballardan biri olduğu, güçlü antimikrobiyal aktiviteye sahip, temel mineraller ve biyoaktif moleküller açısından zengin bir kaynak olduğu rapor edilmiştir (Leon-Ruiz vd., 2011; Barros vd., 2010).

Hem mevcut literatür ve hemde bizim çalışmamızın sonuçlarına göre, Timus türleri iyi bir vitamin kaynağıdır. Bu içerik, daha az maliyetli besin maddelerinin gıda ürünlerine eklenmesi, mikro besin eksiklikleriyle mücadelede yardımcı olabilir. Vitaminler antioksidan görevi gördüğü için mevcut Thymus türleri bu etkinin arttırılmasına katkıda bulunabilir. Fitosteroller kolesterol düşürücü özelliklere, trigliseritlere ve düşük yoğunluklu lipoprotein kolesterole (LDLC) sahiptir. İnsan deneklerde kolesterol seviyesini %15'e kadar azaltabilir ve kanserin önlenmesinde rol oynayabilir (Borah vd., 2020). Bizde çalışmamızda yüksek miktarda fitosterol (β-Sterol=274,67 mg/g) tespit ettik. Günde 3 gram fitosterol alımının LDL-K'yi yaklaşık %10,7 oranında azaltabildiği gösterilmiştir (Li vd., 2022). Bu sonuçlarla birlikte; kolesterol düşürme yeteneklerini artırmak için fonksiyonel gıdaların hazırlanmasında fitosterol kaynağı olarak, *Thymus Haussknechtii Velen* potansiyel bir kaynak olarak kullanılabilir. Mevcut ve önceki çalışmalar arasında Thymus türlerinin uçucu yağ bileşenlerinin coğrafi çevreye göre büyük ölçüde değiştiğini göstermiştir. Bununla birlikte önceki çalışmalardan farklı olarak analiz ettiğimiz doymuş ve doymamış yağ asidi analizlerinin literatürde kısıtlı olduğunu gördük. Çalışmamızda sırasıyla; 12,03 ve 21,31 oranlarında bulduğumuz Linoleik ve Linoleelaidik yağ asitleri (diğer adıyla; 9,12-oktadekadienoik asit metil ester bileşiği), anti-inflamatuar, antiartritik, antiandrojenik, hipokolesterolemik, nematisit, 5-alfa-redüktaz inhibitörü, antihistaminik, antikoroner, böcek öldürücü, antiekzemik ve antiakne özelliklerine sahiptir (Nishanthini, vd., 2014)

Sonuç ve Öneriler

Bu çalışma ile, Elazığ Harput bölgesindeki yenilebilir endemik kekik türünün biyoaktif bileşenlerinin analizi ile; özellikle antioksidan, antimutajenik, antikarsinojenik

aktiviteler ve anti-inflamatuar gibi koruyucu özellikleriyle potansiyel olarak önemli bir diyet kaynağını temsil eden gallik asit başta olmak üzere fenolik asitler ve yine antioksidan etkisi bilinen β-sitosterol miktarının yüksek oluşu ile zengin bir kaynak olarak kullanılabileceği gösterilmiştir.

Kekiğin gıda işlemedeki değeri göz önüne alındığında, öncelikle antioksidan aktivite ana amaçtır. Bugüne kadar araştırmalar çoğunlukla farklı *Thymus* türlerinin uçucu yağları üzerinde olmuştur. Bu çalışma kapsamında uçucu yağların dışında kalan ama önemli biyolik aktivitelere sahip fenolik içerik, vitamin ve yağ asitleri de incelenmiştir. Bu anlamada çalışılan içerik bakımından *T. Haussknechtii* endemik türünde yapılan ilk çalışmadır. Bu alanda yapılan her çalışma gibi bizim çalışmamız ile elde edilen veriler de hem tıp hem de gıda ve kozmetik sanayinde kullanılacak en değerli Thymus türlerinin seçilmesine katkıda bulunacaktır.

Kaynaklar

Akkuş, İ. **(**1995). Serbest Radikaller ve Fizyopatolojik Etkileri, Mimoza Yayınları, Konya.

Banarjee, A.K., Mandal, A., Chanda, D. &Chakraborti, S. (2003). Oxidant, antioxidant and physical exercise. *Mol. Cell. Biochem*., 253, p. 307-312.

Barros, L., Heleno, S.A., Carvalho, A.M. & Ferreira, I.C. (2010). Lamiaceae often used in Portuguese folk medicine as a source of powerful antioxidants: vitamins and phenolics. *LWT-Food Sci. Technol*. 43 (3), 544–550.

Boga, M., Ozkan, E.E., Ersoy, E., Tuncay, E., Canturk, Y.Y., Cinar, E. & Zengin, G. (2021). Identification and quantification of phenolic and volatile constituents in five different Anatolian Thyme species using LC–MS/MS and GC-MS, with biological activities. *Food Biosci*., 101141.

Borah, P. & Banik, B.K. (2020). Diverse synthesis of medicinally active steroids. *Green Approaches in Medicinal Chemistry for Sustainable Drug Design*, p. 449–490, doi: 10.1016/B978-0-12-817592-7.00012-5.

Christie, W.W. (1990). Gas chromatography and lipids, The Oil Pres, Glaskow.

Christie, W.W. (1992). Preparation of fatty acid methyl esters. Inform. 3, 1031–1034.

Castañeda-Ovando, A., Pacheco-Hernández, M.L., Páez-Hernández, M.E., Rodríguez, J.A. & Galán-Vidal, C.A. **(**2009). Chemical studies of anthocyanins: A review, *Food Chemistry,* 113**,** 859–871.

Costa, P., Gonçalves, S., Valent˜ao, P., Andrade, P. B., Coelho, N. & Romano, A. (2012). *Thymus lotocephalus* wild plants and *in vitro* cultures produce different profiles of phenolic compounds with antioxidant activity. *Food Chemistry, 135*(3), 1253–1260.https://doi.org/10.1016/j.foodchem.2012.05.072

Embuscado, M.E. (2015). Spices and herbs: natural sources ofantioxidants – a mini review. *J. Func. Foods*, 18, p. 811-819.

Ertas, A., Boga, M., Yilmaz, M. A., Yesil, Y., Tel, G., Temel, H., Hasimi, N., Gazioglu, I., Ozturk, M. & Ugurlu, P. (2015). A detailed study on the chemical and biological profiles of essential oil and methanol extract of *Thymus nummularius* (Anzer tea): Rosmarinic acid. *Industrial Crops and Products, 67*, p.336–345. https://doi.org/10.1016/j.indcrop.2015.01.064

Dauqan, E.M. & Abdullah, A. (2017). Medicinal and functional values of thyme (*Thymus vulgaris* L.) herb. *J. Appl. Biol. Biotechnol*, 5 (2), p. 0–2. doi: 10.7324/JABB.2017.50203.

Gokbulut, A. (2015). Validated RP-HPLC method for quantification of phenolic compounds in methanol extracts of aerial parts and roots of *Thymus sipyleus* and evaluation of antioxidant potential. *Tropical Journal of Pharmaceutical Research, 14* (10), p.1871–1877. https://doi.org/10.4314/tjpr.v14i10.19

Gutteridge, J.M.C. **(**1995). Lipid peroxidation and antioxidants as biomarkers of tissue damage, *Clin Chem*, 41, p.1819-1828.

Hara A. & Radin N.S (1978). Lipid extraction of tissues with a low-toxicity solven. *Analytical Biochemistry*, 90, p. 420-426.

Hassan A.A., Farzaneh B., Mehdi M., Hassanali N. B. & Sepideh K.J. (2022). Variability in essential oil composition and phenolic acid profile of *Thymus daenensis* Celak. populations from Iran. *Industrial Crops & Products* 178, 114345

Jari´c, S., Mitrovi´c, M., & Pavlovi´c, P. (2015). Review of ethnobotanical, phytochemical, and pharmacological study of *Thymus serpyllum* L. *Evidence-based Complementary and Alternative Medicine.* https://doi.org/10.1155/2015/101978

Kırmızıbekmez, H., Çalıs, I., Perozzo, R., Brun, R., Donmez, A.A., Linden, A. & Tasdemir, D. (2004). Inhibiting activities of the secondary metabolites of Phlomis brunneogaleata against parasitic protozoa and plasmodial enoyl-ACP reductase, a crucial enzyme in fatty acid biosynthesis, *Planta Med*. 70 (08), p.711–717, https://doi.org/10.1055/s-2004-827200

Kosakowska, O., Bączek, K., Przybył, J.L., Pawełczak, A., Rolewska, K. & Węglarz, Z. (2020). Morphological and chemical traits as quality determinants of common thyme (thymus vulgaris l.), on the example of 'standard winter'cultivar. *Agronomy*, 10 (6), p.909.

Kuete, V. (2017). Thymus vulgaris. *Medicinal spices and vegetables from Africa*, p. 599–609. https://doi.org/10.1016/B978-0-12-809286-6.00028-5

Leon-Ruiz, V., Vera, S., Gonzalez-Porto, A.V. & Andres, M.P.S. (2011). Vitamin C and sugar levels as simple markers for discriminating Spanish honey sources, *J. Food Sci*. 76 (3), C356–C361.

Li, X., Xin, Y., Mo, Y., Marozik, P., He, T. & Guo, H. (2022). The Bioavailability and Biological Activities of Phytosterols as Modulators of Cholesterol Metabolism. *Molecules*, 27 (2). p. 523, doi: 10.3390/molecules27020523.

Lopez-Cervantes, J., Sanchez-Machado, D.I. & Rios-Vazquez, N.J. (2006). High performance liquid chromatography method for the simultaneous quantification of retinol, alpha- tocopherol, and cholesterol in shrimp waste hydrolysate. *Journal of Chromatography A*, 1105, p.135–139.

Lorenzo, J. M., Mousavi Khaneghah, A., Gavahian, M., Marszałek, K., Es¸, I., Munekata, P. E., Ferreira, I. C. F. R., & Barba, F. J. (2019). Understanding the potential benefits of thyme and its derived products for food industry and consumer health: From extraction of value-added compounds to the evaluation of bioaccessibility, bioavailability, anti-inflammatory, and antimicrobial activities.

Martins, N., Barros, L., Henriques, M., Silva, S. & Ferreira, I.C.F.R. (2015) Activity of phenolic compounds from plant origin against Candida species Indus. *Crops Prod.*,74, p. 648-670

Mekkaoui, M., Assaggaf, H., Qasem, A., El-Shemi, A., Abdallah, E.M., Bouidida, E.H., Naceiri Mrabti, H., Cherrah, Y. Z. Alaoui, K. (2022). Ethnopharmacological survey and comparative study of the healing activity of moroccan thyme honey and its mixture with selected essential oils on two types of wounds on albino rabbits. *Foods* 11 (1), p.28.

Mevlut, G., Osman, A., & Sitki, S. B. (2014). Determining the costs, production inputs and profit of thyme production enterprises in denizli province of Turkey. *Journal of Essential Oil Bearing Plants, 17*(4), p.562–569. https://doi.org/10.1080/0972060X.2014.956676

Nishanthini, A., Mohan, V.R. & Jeeva, S. (2014). Phytochemical, FTIR and GCMS analysis of stem and leaf of Tiliacora acuminata (lan.) Hook f & thomas (menispermaceae). *Int. J. Pharm. Sci. Res*. 5 (9), p. 3977–3986. doi: 10.13040/IJPSR.0975-8232.5

Rice-Evans, C.A., Miller, N.J., Bolwell, P.G., Bramley, P.M. & Pridham, J.B. (1995). The relative antioxidant activities ofplant-derived polyphenolic flavonoids. *Free Rad. Res*., 2, p. 375-383.

Roby, M.H.H., Sarhan, M.A., Selim, K.A.H. & Khalel, K.I. (2013). Evaluation of antioxidant activity, total phenols and phenolic compounds in thyme (*Thymus vulgaris* L.), sage (*Salvia officinalis* L.), and marjoram (*Origanum majorana* L.) extracts. *Industrial Crops and Products*, 43, pp. 827–831.

Rong-Zhen, Z. & Dao-Wei, Z. (2013). Oxidative stress and roleof natural plant derived antioxidants in animalreproduction. *J. Integ. Agric*., 12(10), p. 1826-1838.

Turcu, R.P., Olteanu, M., Untea, A.E., Saracila, M., Varzaru Z.I. & Vlaicu, P.A. (2020). Nutritional characterization of some natural plants used in poultry nutrition, Archiva Zootechnica 23 (2), p. 58–72, doi: 10.2478/azibna-2020-0013.

Salehi, B., Abu-Darwish, M. S., Tarawneh, A. H., Cabral, C., Gadetskaya, A. V., Salgueiro, L., Hosseinabad, T., Rajabi, S., Chanda, W., Sharifi-Rad, M., Mulaudzi, R. B., Ayatollahi, S. A., Kobarfard, F., Arserim-Ucar, D. K., Sharifi-Rad, J., Ata, A., Baghalpour, N., & del Mar Contreras, M. (2019). *Thymus* spp. plants-Food applications and phytopharmacy properties. *Trends in Food Science & Technology*, 85, p. 287–306. https://doi.org/10.1016/j.tifs.2019.01.020

Sokovic, M.D., Marin, P.D., Simic, D., Vukcevic, J.K., Vajs, V. & Petrovic, S. (2002). Antimutagenic activity of essential oil and crude extract of *Phlomis fruticosa*. *Pharm. Biol*, 40(4), p. 311- 314.

Sağlam, S. (2007). Antosiyanince Zengin Dut, Kiraz ve Gilaburu Meyvelerindeki Fenolikler ve Antioksidan Kapasitesi Üzerine Reçel Yapım işleminin Etkisi. Selçuk Üniversitesi, Fen Bilimleri Enstitüsü Gıda Mühendisligi Ana Bilim Dalı, *Yüksek Lisans Tezi*, Konya, 2007.

Sánchez-Machado, D.I., López-Hernández, J. & Paseiro-Losada, P. (2002). High performance liquid chromatographic determination of alpha-tocopherol in macro algae. *Journal of Chromatography A*, 976, 277–284.

Spranger, I., Sun, B., Mateus, A. M., Freitas, V. & Ricardo-da-Silva, J.M. (2008). Chemical characterization and antioxidant activities of oligomeric and polymeric procyanidin fractions from grape seeds, *Food Chemistry*, 108, p.519–532.

Stahl-Biskup, E. & Venskutonis, R. P. (2012). Thyme. In *Handbook of herbs and spices* (pp. 499–525). https://doi.org/10.1533/9780857095671.499. Woodhead Publishing.

Turcu, R.P., Olteanu, M., Untea, A.E., Saracila, M., Varzaru, I. & Vlaicu, P.A. (2020). Nutritional characterization of some natural plants used in poultry nutrition, *Archiva Zootechnica* 23 (2), p.58–72, doi: 10.2478/azibna-2020-0013

Tvrzicka, E., Vecka, M., Stankova, B. & Zak, A. (2002). Analysis of fatty acids inplasma lipoproteins by gas chromatography flame ionisation detection Quantative aspects. *Analytica Chimica Acta*, 465, p.337-350.

Viitala, P. (2003). Effects of Antioxidant Vitamin Supplementation on Resistance Exercise Induced Lipid Peroxidation in Trained and Untrained Participants, *MA thesis*, University of Lakehead, Canada.

Yalçın, A. (1998). Antioksidanlar, *Klinik Gelişim*, 11, p. 342-346.

Yalcin, F., Ersöz, T., Bedir, E., Şahpaz, S., Bailleul, F., Khan, I.A. & Çaliş, İ. (2005). Phlinoside F, a new phenylethanoid glycoside from *Phlomis angustissima* Turk. *J. Chem*, 29 (4), p. 417- 423.

Yilmaz, M. A., Ertas, A., Yener, I., Akdeniz, M., Cakir, O., Altun, M., Demirtas, I., Boga, M., & Temel, H. (2018). A comprehensive LC–MS/MS method validation for the quantitative investigation of 37 fingerprint phytochemicals in Achillea species: A detailed examination of *A. coarctata* and *A. monocephala*. *Journal of Pharmaceutical and Biomedical Analysis*, 154, p.413–424. https://doi.org/10.1016/j.jpba.2018.02.059

Zu, Y.G., Fu, Y.J., Liu, W., Hou, C.L. & Kong, Y. (2006). Simultaneous Determination of Four Flavonoids in Pigeonpea [*Cajanus cajan* (L.) Millsp.] Leaves Using RP-LC-DAD. *Chromatographia* 63, p.499–505.

ATRANORİN TEDAVİSİNİN ANTİ-ENFLAMATUVAR ETKİSİNİN ARAŞTIRILMASI

Mesud KAPLAN (ORCID: 0000-0002-6186-9346)
Van Yüzüncü Yıl Üniversitesi, Sağlık Bilimleri Enstitüsü, Temel Eczacılık Bilimleri Anabilim Dalı, Van- Türkiye
Email: msdkpln@gmail.com

Doç. Dr. Mehmet BERKÖZ (ORCID: 0000-0003-4219-8054)
Van Yüzüncü Yıl Üniversitesi, Eczacılık Fakültesi, Biyokimya Anabilim Dalı, Van-Türkiye
Email: mehmet_berkoz@yahoo.com

ÖZET
Liken kaynaklı sekonder metabolitlerin antibakteriyel, antifungal, antioksidan, antiviral, antiinflamatuvar ve antikanser gibi biyolojik etkinlikleri bulunmaktadır. Yapılan çalışmada, liken sekonder metabolitlerinden biri olan atronorinin, lipopolisakkarit ile indüklenen makrofaj hücrelerindeki antienflamatuvar aktivitesi araştırıldı. Bu amaçla, lipopolisakkrit (LPS) (1 µg/mL) indüksiyonu ile RAW264.7 makrofaj hücrelerinde enflamasyon modeli oluşturulmuş ve farklı konsantrasyonlardaki (200 µM, 100 µM, 50 µM, 25 µM ve 12,5 µM) atranorinin antienflamatuvar etkinliği araştırıldı. Atranorin uygulanan ve uygulanmayan hücrelerdeki nitrik oksit, prostaglandin E_2 (PGE_2), tümör nekroz faktör-alfa (TNF-α), interlökin-1 beta (IL-1β), IL-6 ve IL-10 düzeyleri ELISA kit kullanılarak ölçüldü. Yapılan çalışma beş tekrar olarak dizayn edildi. Analizler SPSS for Windows v16.0 paket programında yapıldı. Tüm parametreler için gruplar arasındaki istatistiksel farklılıkların test edilmesinde ANOVA ve alt grup karşılaştırmalarında Tukey çoklu karşılaştırma testleri kullanıldı. Elde edilecek sonuçlarda $p<0,05$ ise fark veya ilişki istatiksel olarak anlamlı kabul edildi. Elde ettiğimiz bulgular, atranorinin, sub-toksik konsantrasyonlarda bile LPS indüksiyonuyla aktive edilen makrofaj hücrelerdeki enflamatuvar yanıtı baskılayabildiğini ve antienflamatuvar etkinlik gösterebileceğini işaret etmektedir. Bu sonuçlar doğrultusunda liken sekonder metabolitlerinin LPS kaynaklı enflamatuvar hastalıkların tedavisinde önemli bir değere sahip olabileceğini söylemek mümkün olabilmektedir. Bu nedenle, zengin bir liken florasına sahip olan ülkemizde liken sekonder metabolitlerinin LPS'nin neden olduğu enflamasyon hastalıklarının tedavilerine yönelik yeni ilaçların geliştirilmesinde daha ileri çalışmalara yön vereceğini ve özellikle antienflamasyon etkisi yüksek olan türlerin biyolojik kökenli ilaç hammaddesi olarak endüstriyel üretimlerinin gerçekleştirilmesi halinde ülke ekonomisine katkı sağlayabileceğini söylemek mümkündür.
Anahtar Kelimeler: Atranorin, lipopolisakkarit, RAW264.7 hücre hattı, makrofaj, enflamasyon

INVESTIGATION OF THE ANTI-INFLAMMATORY EFFECT OF ATRANORIN TREATMENT

ABSTRACT

Lichen-derived secondary metabolites have biological activities such as antibacterial, antifungal, antioxidant, antiviral, anti-inflammatory and anticancer. In this study, the anti-inflammatory activity of atronorin, one of the secondary metabolites of lichen, in lipopolysaccharide-induced macrophage cells was investigated. For this purpose, an inflammation model was established in RAW264.7 macrophage cells by induction of lipopolysaccharide (LPS) (1 µg/mL) and the anti-inflammatory activity of atranorin at different concentrations (200 µM, 100 µM, 50 µM, 25 µM and 12.5 µM) was investigated. Nitric oxide, prostaglandin E_2 (PGE_2), tumour necrosis factor-alpha (TNF-α), interleukin-1 beta (IL-1β), IL-6 and IL-10 levels in atranorin treated and untreated cells were measured using ELISA kit. The study was designed as five replicates. Analyses were performed using SPSS for Windows v16.0 package programme. ANOVA was used to test statistical differences between groups for all parameters and Tukey multiple comparison tests were used for subgroup comparisons. If $p<0.05$ in the results to be obtained, the difference or relationship was considered statistically significant. Our findings indicate that atranorin can suppress the inflammatory response in macrophage cells activated by LPS induction even at sub-toxic concentrations and may show anti-inflammatory activity. In line with these results, it is possible to say that lichen secondary metabolites may have an important value in the treatment of LPS-induced inflammatory diseases. Therefore, in our country, which has a rich lichen flora, it is possible to say that lichen secondary metabolites will guide further studies in the development of new drugs for the treatment of inflammatory diseases caused by LPS and may contribute to the national economy, especially if industrial production of species with high anti-inflammation effect is carried out as biological origin drug raw materials.

Keywords: Atranorin, lipopolysaccharide, RAW264.7 cell line, macrophage, inflammation

Giriş

Akut enflamasyon, çeşitli enflamatuvar uyaranlara karşı yararlı konak yanıt olmasına rağmen kronik enflamasyon süreklidir ve doku hasarına neden olabilir. Kronik enflamasyon romatoid artrit, kronik enflamatuvar bağırsak hastalıkları, nörodejeneratif bozukluklar, septik şok sendromu, kalp krizleri, Alzheimer hastalığı ve kanser gibi birçok hastalığın etiyolojisinde yer almaktadır (Nardin & Abastado, 2008). Kronik enflamasyona bağlı olarak gelişen hastalıkların tedavisi için yeni ilaçların keşfine yönelik çalışmalar, antienflamatuvar potansiyele sahip etkin maddelerin tespiti üzerine yoğunlaşmıştır. Oluşabilecek yan etkinin de en aza indirgenmesini sağlamak adına, bu çalışmalarda yoğun olarak doğal kaynaklı etkin maddeler ele alınmaktadır (de Haas et al., 2008). Likenler, bir mikobiyont ile bir veya daha fazla ekolojik olarak zorunlu biyotrof olarak fotosentez yapan tek hücreli veya filamentöz yapılar arasındaki simbiyotik ilişki ile oluşan kararlı, mutualist yaşam sergileyen ve biyolojik olarak aktif birçok düşük moleküler ağırlıklı sekonder metabolit kaynağı oluşturan mikroorganizmaların kompleks topluluklarıdır (Calcott et al., 2018). Deneysel yöntemlerle liken sekonder metabolitleri hakkında birçok bilgi edinilmesine rağmen simbiyotik yaşamdaki işlevleri hakkında hala net bilgiler elde edilememiştir. Yapısal olarak birbirlerine çok benzer olan metabolitler arasında bile çok farklı biyolojik etkilerin olduğu gözlemlenmiştir. Birçoğunun da çoklu biyolojik aktivite sergilediği bilinen bu metabolitlerin liken talluslarını zararlı otlara, patojenlere, rakiplerine ve yüksek ultraviyole (UV) ışıması gibi dış faktörlere karşı koruduğu düşünülmüştür. Araştırmalar sonucunda ise genel fonksiyonlarının antioksidan aktivite, simbiyoz gelişimi, metal homestazisi ve kirlilik toleransı, fotokoruma, allelopati, antimikrobiyal, antiviral ve antifungal aktivite, antiherbivor ve böcek öldürücü aktivitesi, antikanser aktivitesi, antipiretik ve analjezik etki olduğu belirlenmiştir (Molnár & Farkas, 2010). Yaptığımız çalışmada liken sekonder metabolitlerinden atranorin, diffraktaik asit, evernik asit ve vulpinik asitin lipopolisakkarit ile indüklenen makrofaj hücrelerindeki antienflamatuvar aktiviteleri araştırılmıştır.

Materyal ve Metod

Hücre hattı

Çalışmamızda kullanılan RAW264.7 fare makrofaj hücre hattı Sayın Prof. Dr. Ahmet CUMAOĞLU'nun (Erciyes Üniversitesi, Eczacılık Fakültesi, Biyokimya Anabilim Dalı) hücre kültürü koleksiyonundan temin edildi.

Stok ve çalışma çözeltilerinin hazırlanması

Atranorinin 1 mM konsantrasyonunda stok çözeltisi ve bu stok çözeltiden hareketle farklı konsantrasyonlarda günlük çalışma çözeltileri (12,5, 25, 50, 100 ve 200 µM) hazırlandı (Tanaka et al., 1998).

Atranorinin hücre canlılığı üzerine etkileri

Atranorinin RAW264.7 makrofaj hücrelerinin canlılığı üzerine etkisi 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) testi ile değerlendirilmiştir (Li et al., 2012).

Enzim bağlı immünosorbent analizi (ELISA) çalışmaları

Kontrol, LPS ve LPS ve farklı konsantrasyonlardaki atranorin uygulanan gruplarındaki ortamlar vakum aracılığıyla çekildi. Daha sonra kontrol ve LPS gruplarına FBS içermeyen renksiz deney ortamı konuldu. LPS ve farklı konsantrasyonlardaki atranorin uygulanan gruplara ise kuyucuk başına 100 µl hacminde 12,5, 25, 50, 100 ve 200 µM konsantrasyonlarındaki atranorin çözeltisi eklendi ve 1 saat boyunca bu grup inkübe edildi. Atranorin için ayrı ayrı kontrol ve LPS grupları kullanıldı. 1 saatlik inkübasyon sonrasında, LPS grubundaki ortam çekilerek, kuyucuk başına 150 µl hacminde 1 µg/ml LPS içeren deney ortamı eklendi. Yine LPS ve farklı konsantrasyonlardaki atranorin uygulanan gruplara da kuyucuk başına 50 µl hacminde 3 µg/ml LPS (son konsantrasyon 1 µg/mL olacak şekilde) ve 12,5, 25, 50, 100 ve 200 µM konsantrasyonlarındaki atranorin çözeltileri içeren deney ortamı eklendi ve hücreler 4 saat boyunca inkübe edildi. 4 saatlik inkübasyon sonrasında, LPS grubuna kuyucuk başına 1 µg/ml LPS içeren deney ortamı eklendi.

LPS ve farklı konsantrasyonlardaki atranorin uygulanan gruplara da 1 µg/ml LPS ve 12,5, 25, 50, 100 ve 200 µM konsantrasyonlarındaki atranorin çözeltilerini içeren deney ortamı eklendi ve bu basamakta tüm koşullardaki kuyucukların son hacimleri 200 µL'ye eşitlenmiş oldu. Tüm hücreler 1 saatlik inkübe edildi. Toplam 7 saatlik süreç sonrasında kuyucuklarda ki son hacimleri 200 µl olan plak inkübatörden alındı (González-Guerrero et al., 2013). Sonrasında hücrelerden salınan NOx, PGE2, TNF-α, IL-1β, IL-6 ve IL-10 düzeyleri ELISA kit kullanılarak ve üretici firmanın çalışma protokolüne uygun olarak ölçüldü.

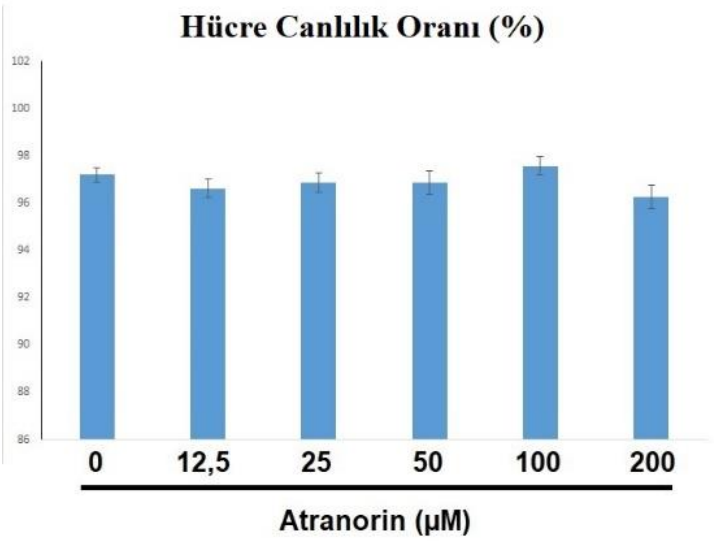
İstatistiksel Analiz

Çalışma sonunda elde edilen gruplara ait tüm veriler SPSS (versiyon 16.0) istatistik paket programı kullanılarak yapıldı. Gruplar arası karşılaştırmalar tekrarlanan ölçümlü varyans analizi (ANOVA) kullanılarak gerçekleştirildi. Varyans analizini takiben farklı grupları belirlemede Tukey çoklu karşılaştırma testi kullanıldı. Tüm analizlerden elde edilen ham değerler, grupların ortalaması ± standart sapma şeklinde sunuldu. Hesaplamalarda istatistik anlamlılık düzeyi $p<0,05$ olarak alındı.

Bulgular

Atranorin Uygulamasının Hücre Canlılığına Etkisi

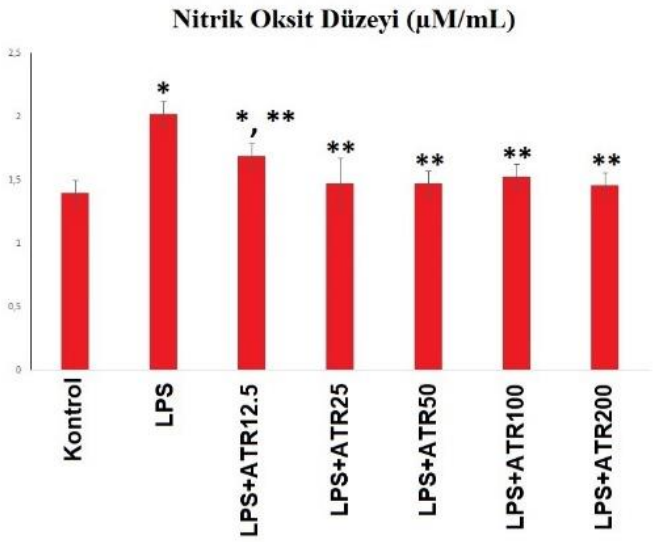
0-200 µM konsantrasyonlarındaki atranorin uygulamaları hücre canlılığında önemli bir düşüşe yol açmamış olup uygulanan tüm atranorin konsantrasyonlarının RAW264.7 makrofaj hücreleri üzerindeki sitotoksisiteleri % 10'un altında bulunmuştur (Şekil 1).



Şekil 1. Atranorin uygulamasının hücre canlılık oranlarına etkileri

Atranorin Uygulamasının Nitrik Oksit Düzeyine Etkisi

LPS grubunun nitrik oksit düzeyi, kontrol grubuna kıyasla istatistiksel olarak anlamlı derecede yüksek bulunmuştur ($p<0,05$). LPS+ATR12.5, LPS+ATR25, LPS+ATR50, LPS+ATR100 ve LPS+ATR200 gruplarının nitrik oksit düzeyleri ise LPS grubuna kıyasla istatistiksel olarak anlamlı derecede düşük bulunmuştur ($p<0,05$) (Şekil 2).



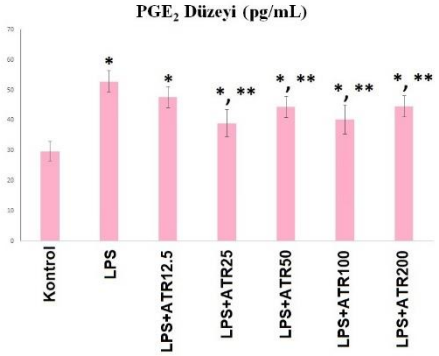
Şekil 2. Atranorin uygulamasının nitrik oksit düzeylerine etkisi.

*Kontrol grubuna kıyasla istatistiksel olarak anlamlı ölçüde yüksek bulunmuştur (p<0,05)

**LPS grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,05)

Atranorin Uygulamasının PGE_2 Düzeyine Etkisi

LPS grubunun PGE_2 düzeyi, kontrol grubuna kıyasla istatistiksel olarak anlamlı derecede yüksek bulunmuştur (p<0,05). LPS+ATR25, LPS+ATR50, LPS+ATR100 ve LPS+ATR200 gruplarının PGE_2 düzeyleri ise LPS grubuna kıyasla istatistiksel olarak anlamlı derecede düşük bulunmuştur (p<0,05) (Şekil 3).



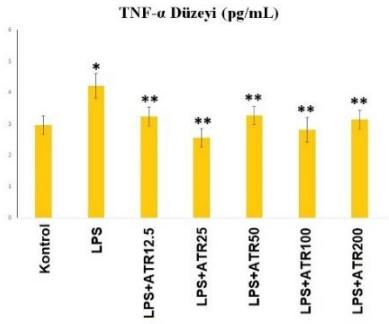
Şekil 3. Atranorin uygulamasının PGE_2 düzeylerine etkisi.

*Kontrol grubuna kıyasla istatistiksel olarak anlamlı ölçüde yüksek bulunmuştur (p<0,05)

**LPS grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,05)

Atranorin Uygulamasının TNF-α Düzeyine Etkisi

LPS grubunun TNF-α düzeyi, kontrol grubuna kıyasla istatistiksel olarak anlamlı derecede yüksek bulunmuştur (p<0,05). LPS+ATR12.5, LPS+ATR25, LPS+ATR50, LPS+ATR100 ve LPS+ATR200 gruplarının TNF-α düzeyleri ise LPS grubuna kıyasla istatistiksel olarak anlamlı derecede düşük bulunmuştur (p<0,05) (Şekil 4).



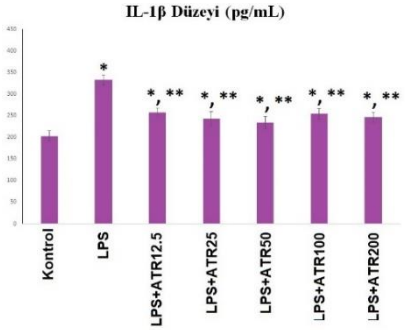
Şekil 4. Atranorin uygulamasının TNF-α düzeylerine etkisi.

*Kontrol grubuna kıyasla istatistiksel olarak anlamlı ölçüde yüksek bulunmuştur (p<0,05)

**LPS grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,05)

Atranorin Uygulamasının IL-1β Düzeyine Etkisi

LPS grubunun IL-1β düzeyi, kontrol grubuna kıyasla istatistiksel olarak anlamlı derecede yüksek bulunmuştur (p<0,05). LPS+ATR12.5, LPS+ATR25, LPS+ATR50, LPS+ATR100 ve LPS+ATR200 gruplarının IL-1β düzeyleri ise LPS grubuna kıyasla istatistiksel olarak anlamlı derecede düşük bulunmuştur (p<0,05) (Şekil 5).



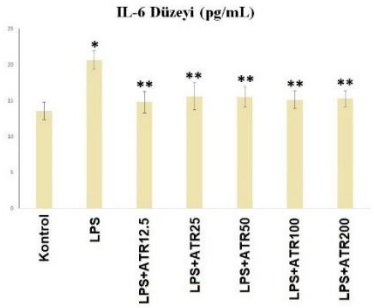
Şekil 5. Atranorin uygulamasının IL-1β düzeylerine etkisi.

*Kontrol grubuna kıyasla istatistiksel olarak anlamlı ölçüde yüksek bulunmuştur (p<0,05)

**LPS grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,05)

Atranorin Uygulamasının IL-6 Düzeyine Etkisi

LPS grubunun IL-6 düzeyi, kontrol grubuna kıyasla istatistiksel olarak anlamlı derecede yüksek bulunmuştur (p<0,05). LPS+ATR12.5, LPS+ATR25, LPS+ATR50, LPS+ATR100 ve LPS+ATR200 gruplarının IL-6 düzeyleri ise LPS grubuna kıyasla istatistiksel olarak anlamlı derecede düşük bulunmuştur (p<0,05) (Şekil 6).



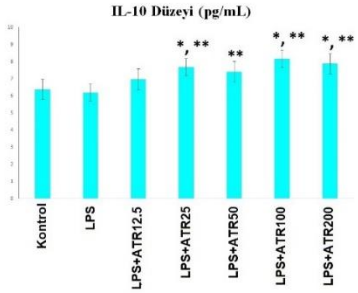
Şekil 6. Atranorin uygulamasının IL-6 düzeylerine etkisi.

*Kontrol grubuna kıyasla istatistiksel olarak anlamlı ölçüde yüksek bulunmuştur (p<0,05)

**LPS grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,05)

Atranorin Uygulamasının IL-10 Düzeyine Etkisi

LPS grubunun IL-10 düzeyi, kontrol grubuna kıyasla yüksek bulunmasına rağmen bu değişim istatitiksel olarak anlamlı derecede önemli bulunamamıştır (p>0,05). Öte yandan LPS+ATR25, LPS+ATR50, LPS+ATR100 ve LPS+ATR200 gruplarının IL-10 düzeyleri ise LPS grubuna kıyasla istatistiksel olarak anlamlı derecede yüksek bulunmuştur (p<0,05) (Şekil 7).



Şekil 7. Atranorin uygulamasının IL-10 düzeylerine etkisi.

*Kontrol grubuna kıyasla istatistiksel olarak anlamlı ölçüde yüksek bulunmuştur (p<0,05)

**LPS grubuna kıyasla istatistiksel olarak anlamlı ölçüde yüksek bulunmuştur (p<0,05)

Tartışma ve Sonuç

Liken sekonder metabolitlerinin antioksidan, antibakteriyel, antifungal, antiviral, antiherbivor, fotoprotektif, antikanser, antipiretik ve analjezik aktiviteye sahip oldukları bildirilmiştir (Mohammadi et al., 2022). Ayrıca son yıllarda liken ekstrelerinin ve liken sekonder metabolitlerinin antienflamatuvar aktivitelerini araştıran çalışmalar gittikçe artmaktadır (Mun et al., 2020). Lobarik asit, stereocalpin A ve ramalinin, TNF-α ile uyarılan fare düz kas hücrelerinde antienflamatuvar aktivite gösterdiği bildirilmiştir (Kwon et al., 2016). Choi et al. (2009) *Ramalina terebrata* ekstresinin makrofajlarda nitrit/nitrat salınımını anlamlı derece azalttığını göstermişlerdir. Jin et al. (2008), usnik asidin fare makrofaj hücrelerinde LPS stimulasyonu ile artan TNF-α ve nitrik oksit düzeylerini anlamlı derecede azalttığını göstermişlerdir. Odabaşoğlu et al. (2006), sıçanlarda indometazin ile oluşturulan gastrik ülser modelinde usnik asidin iNOS aktivitesini azalttığını ortaya koymuştur. Engel et al. (2007), *Usnia barbata* özütünün insan keratinosit hücrelerinde UV-B ile oluşturulan enflamatuvar hasara karşın COX-2 ve PGE_2 üretimini anlamlı derecede azalttığını göstermişlerdir. Ancak literatürde liken sekonder metabolitleri olan atranorinin makrofaj hücreleri üzerindeki antienflamatuvar aktivitesini araştıran bir çalışmaya rastlanılmamıştır. Bu bağlamda, biz de çalışmamızda bu sekonder metabolitlerin LPS ile uyarılan makrofaj hücrelerinde antienflamatuvar etkinlik gösterip göstermediklerini araştırdık.

Çalışmamızda liken sekonder metabolitlerinden atranorinin LPS uyarımı ile RAW264.7 makrofaj hücrelerinde oluşturulan enflamatuvar yanıta karşı antienflamatuvar etkinlikleri araştırılmıştır. Elde ettiğimiz bulgulara göre, bu maddelerin sub-toksik konsantrasyonlarda bile makrofaj hücrelerinde pro-enflamatuvar sitokinlerin ve mediyatörlerin seviyesinde düşüşe, antienflamatuvar sitokin seviyesinde ise artışa neden olarak, meydana gelen enflamasyonu baskıladığı ve antienflamatuvar etkinlik gösterdiği görülmektedir. Bu sonuçlar doğrultusunda liken sekonder metabolitlerinin LPS kaynaklı enflamatuvar hastalıkların tedavisinde önemli bir değere sahip olabileceğini düşündürtmektedir. Bu nedenle, zengin bir liken florasına sahip olan ülkemizde liken sekonder metabolitlerinin LPS'nin neden olduğu enflamasyon hastalıklarının tedavilerine yönelik yeni ilaçların geliştirilmesinde daha ileri çalışmalara yön vereceğini ve özellikle antienflamatuvar etkisi yüksek olan türlerin biyolojik kökenli ilaç hammaddesi olarak

endüstriyel üretimlerinin gerçekleştirilmesi halinde ülke ekonomisine katkı sağlayabileceğini söylemek mümkündür.

Maddi Destek

Bu çalışma Van Yüzüncü Yıl Üniversitesi Bilimsel Araştırma Projeleri Koordinatörlüğü tarafından TYL-2022-9835 numaralı proje olarak desteklenmiştir.

Çıkar Çatışması

Yazarlar arasında herhangi bir çıkar çatışması bulunmamaktadır.

References

Calcott, M. J., , Ackerley, D. F., , Knight, A., , Keyzers, R. A., , & Owen, J. G., (2018). Secondary metabolism in the lichen symbiosis. Chemical Society reviews, 47(5), 1730–1760. https://doi.org/10.1039/c7cs00431a

Choi, H. S., Yim, J. H., Lee, H. K., & Pyo, S. (2009). Immunomodulatory effects of polar lichens on the function of macrophages in vitro. Marine biotechnology (New York, N.Y.), 11(1), 90–98. https://doi.org/10.1007/s10126-008-9121-x

de Haas, A. H., Boddeke, H. W., & Biber, K. (2008). Region-specific expression of immunoregulatory proteins on microglia in the healthy CNS. Glia, 56(8), 888–894. https://doi.org/10.1002/glia.20663

Engel, K., Schmidt, U., Reuter, J., Weckesser, S., Simon-Haarhaus, B., & Schempp, C. M. (2007). Usnea barbata extract prevents ultraviolet-B induced prostaglandin E2 synthesis and COX-2 expression in HaCaT keratinocytes. Journal of photochemistry and photobiology. B, Biology, 89(1), 9–14. https://doi.org/10.1016/j.jphotobiol.2007.08.002

González-Guerrero, C., Ocaña-Salceda, C., Berzal, S., Carrasco, S., Fernández-Fernández, B., Cannata-Ortiz, P., Egido, J., Ortiz, A., & Ramos, A. M. (2013). Calcineurin inhibitors recruit protein kinases JAK2 and JNK, TLR signaling and the UPR to activate NF-κB-mediated inflammatory responses in kidney tubular cells. Toxicology and applied pharmacology, 272(3), 825–841. https://doi.org/10.1016/j.taap.2013.08.011

Jin, J. Q., Li, C. Q., & He, L. C. (2008). Down-regulatory effect of usnic acid on nuclear factor-kappaB-dependent tumor necrosis factor-alpha and inducible nitric oxide synthase expression in lipopolysaccharide-stimulated macrophages RAW 264.7. Phytotherapy research : PTR, 22(12), 1605–1609. https://doi.org/10.1002/ptr.2531

Kwon, I. S., Yim, J. H., Lee, H. K., & Pyo, S. (2016). Lobaric Acid Inhibits VCAM-1 Expression in TNF-α-Stimulated Vascular Smooth Muscle Cells via Modulation of NF-κB and MAPK Signaling Pathways. Biomolecules & therapeutics, 24(1), 25–32. https://doi.org/10.4062/biomolther.2015.084

Li, Z., Chen, J., Lei, T., & Zhang, H. (2012). Tamoxifen induces apoptosis of mouse microglia cell line BV-2 cells via both mitochondrial and death receptor pathways.

Journal of Huazhong University of Science and Technology, 32(2), 221–226. https://doi.org/10.1007/s11596-012-0039-1

Mohammadi, M., Bagheri, L., Badreldin, A., Fatehi, P., Pakzad, L., Suntres, Z., & van Wijnen, A. J. (2022). Biological Effects of Gyrophoric Acid and Other Lichen Derived Metabolites, on Cell Proliferation, Apoptosis and Cell Signaling pathways. Chemico-biological interactions, 351, 109768. https://doi.org/10.1016/j.cbi.2021.109768

Molnár, K., & Farkas, E. (2010). Current results on biological activities of lichen secondary metabolites: a review. Zeitschrift fur Naturforschung. C, Journal of biosciences, 65(3-4), 157–173. https://doi.org/10.1515/znc-2010-3-401

Mun, S. K., Kang, K. Y., Jang, H. Y., Hwang, Y. H., Hong, S. G., Kim, S. J., Cho, H. W., Chang, D. J., Hur, J. S., & Yee, S. T. (2020). Atraric Acid Exhibits Anti-Inflammatory Effect in Lipopolysaccharide-Stimulated RAW264.7 Cells and Mouse Models. International journal of molecular sciences, 21(19), 7070. https://doi.org/10.3390/ijms21197070

Nardin, A., & Abastado, J. P. (2008). Macrophages and cancer. Frontiers in bioscience : a journal and virtual library, 13, 3494–3505. https://doi.org/10.2741/2944

Odabasoglu, F., Cakir, A., Suleyman, H., Aslan, A., Bayir, Y., Halici, M., & Kazaz, C. (2006). Gastroprotective and antioxidant effects of usnic acid on indomethacin-induced gastric ulcer in rats. Journal of ethnopharmacology, 103(1), 59–65. https://doi.org/10.1016/j.jep.2005.06.043

Tanaka, J., Toku, K., Matsuda, S., Sudo, S., Fujita, H., Sakanaka, M., & Maeda, N. (1998). Induction of resting microglia in culture medium devoid of glycine and serine. Glia, 24(2), 198–215.

DİOSMİNİN LARENKS KANSERİ ÜZERİNDEKİ ANTİPROLİFERATİF, ANTIMETASTATİK, APOPTOTİK VE ANTİ-ENFLAMATUAR ETKİNLİKLERİNİN ARAŞTIRILMASI

Recep ERDİL (ORCID: 0000-0001-6904-5002)
Van Yüzüncü Yıl Üniversitesi, Sağlık Bilimleri Enstitüsü, Temel Eczacılık Bilimleri Anabilim Dalı, Van- Türkiye
Email: recep.erdil.4@gmail.com

Doç. Dr. Mehmet BERKÖZ (ORCID: 0000-0003-4219-8054)
Van Yüzüncü Yıl Üniversitesi, Eczacılık Fakültesi, Biyokimya Anabilim Dalı, Van-Türkiye
Email: mehmet_berkoz@yahoo.com

ÖZET
Kanserle savaşmak için diyetsel kaynakların tüketilmesi ve bu sayede yeni kemopreventif ve antitümöral yaklaşımlarının geliştirilmesi son yıllarda oldukça önem kazanmıştır. Fitokimyasalların kemopreventif aktivitesi, hem doğrudan serbest radikal süpürücü hem de demir şelasyon aktivitelerine bağlı olarak gerçekleşmektedir. Enflamasyonun, kanser gelişimine hem neden olması hem de kanser gelişimini hızlandırması, fitokimyasalların anti-enflamatuvar kapasitesinin onların kemopreventif ve antitümöral aktivitelerinin bir başka önemli sebebi olarak nitelendirilmektedir. Üzerinde nispeten en az çalışılan kanser türlerinden birisi olan larinks kanseri, dünyadaki en yaygın altıncı kanser türüdür. Diosminin birçok kanser türünde antitümoral etkinliği gösterilmesine rağmen baş boyun kanserleri özellikle de larinks kanserine karşı antitümoral etkinliği araştırılmamıştır. Yaptığımız çalışamada baş boyun kanserinden larinks kanseri hücre hattı olan Hep-2 hücre hattı kullanılmış olup diosminin Hep-2 hücreleri üzerindeki anti-proliferatif etkisi ile metastatik, apoptotik ve enflamatuar markerlar üzerindeki etkileri incelendi. Uygulanan fitokimyasalların anti-proliferatif etkilerini belirlemek için MTT testi yapıldı, ayrıca anti-metastatik etkinin belirlenebilmesi için vasküler endotelyal büyüme faktörü (VEGF) düzeyine, apoptotik etkinin incelenmesi için kaspaz 3, 8 ve 9 düzeylerine, enflamatuvar yanıtın gözlenmesi için ise interlökin-1 beta (IL-1β), interlökin-6 (IL-6), tümör nekroz faktör alfa (TNF-α), transforme edici büyüme faktör beta (TGF-β) ve granülosit makrofaj koloni uyarıcı faktör (GM-CSF) düzeyleri ELISA kit kullanılarak ölçüldü. Yapılan çalışma beş tekrar olarak dizayn edildi. Analizler SPSS for Windows v16.0 paket programında yapıldı. Tüm parametreler için gruplar arasındaki istatistiksel farklılıkların test edilmesinde ANOVA ve alt grup karşılaştırmalarında Tukey çoklu karşılaştırma testleri kullanıldı. Elde edilecek sonuçlarda $p<0,05$ ise fark veya ilişki istatiksel olarak anlamlı kabul edildi. Elde ettiğimiz bulgular, diosminin Hep-2 hücrelerinin proliferasyonu baskıladığı, enflamasyonu, metastazı ve anjiogeenezi baskıladığı, öte yadan apoptozu ise indüklediği gözlemlendi. Bu sonuçlar neticesinde diosminin umut vaat eden bir terapötik ajan olduğu ve kemoterapide kullanılabileceğine dair destekleyici sonuçlar elde edildi.

Anahtar Kelimeler: Diosmin, larinks kanseri, Hep-2 hücre hattı, anti-proliferasyon, anti-metastaz, apoptoz

INVESTIGATION OF ANTIPROLIFERATIVE, ANTIMETASTATIC, APOPTOTIC AND ANTI-INFLAMMATORY ACTIVITIES OF DIOSMIN ON LARYNGEAL CANCER

ABSTRACT

The consumption of dietary sources to fight cancer and thus the development of new chemopreventive and antitumoural approaches has gained importance in recent years. The chemopreventive activity of phytochemicals is due to both direct free radical scavenging and iron chelation activities. The fact that inflammation both causes and accelerates cancer development is another important reason for the anti-inflammatory capacity of phytochemicals and their chemopreventive and antitumoural activities. Laryngeal cancer, one of the least studied cancer types, is the sixth most common cancer type in the world. Although antitumoural activity of diosmin has been shown in many cancer types, its antitumoural activity against head and neck cancers, especially laryngeal cancer, has not been investigated. In our study, Hep-2 cell line, which is a laryngeal cancer cell line from head and neck cancer, was used and the anti-proliferative effect of diosmin on Hep-2 cells and its effects on metastatic, apoptotic and inflammatory markers were examined. MTT test was performed to determine the anti-proliferative effects of the applied phytochemicals, as well as vascular endothelial growth factor (VEGF) level to determine the anti-metastatic effect and caspase 3, 8 and 9 levels to examine the apoptotic effect, interleukin-1 beta (IL-1β), interleukin-6 (IL-6), tumour necrosis factor alpha (TNF-α), transforming growth factor beta (TGF-β) and granulocyte macrophage colony-stimulating factor (GM-CSF) levels were measured using ELISA kit. The study was designed as five replicates. Analyses were performed using SPSS for Windows v16.0 package programme. ANOVA was used to test statistical differences between groups for all parameters and Tukey multiple comparison tests were used for subgroup comparisons. The difference or relationship was considered statistically significant if $p<0.05$. Our results showed that diosmin suppressed the proliferation, inflammation, metastasis and angiogenesis of Hep-2 cells and induced apoptosis. As a result of these results, supportive results were obtained that diosmin is a promising therapeutic agent and can be used in chemotherapy.

Keywords: Diosmin, laryngeal cancer, Hep-2 cell line, anti-proliferation, anti-metastasis, apoptosis

Giriş

Kanserden korunmak için geliştirilen endojen savunma sistemleri, oksidatif stres ve antioksidan aktivite arasında kurulan dengeye bağlanmaktadır. Bu dengenin artan ROS birikimine doğru kayması başta kanser hastalıkları olmak üzere çeşitli hastalıkların orataya çıkmasına neden olmaktadır. Antioksidanlar ise, serbest lipid radikallerin oluşumunu inhibe ederek, otooksidasyon zincir reaksiyonunun yayılmasını kesintiye uğratarak, tekli oksijen söndürücüler olarak, diğer antioksidanlarla sinerjik etki yaratarak, hiperoksitleri kararlı bileşiklere dönüştüren indirgeyici maddeler olarak, metal prooksidanları kararlı ürüne dönüştüren metal şelatörler ve son olarak prooksidatif enzimlerin inhibitörleri olarak hücreyi oksidatif strese karşı korumada görev almaktadırlar (Pelicano et al., 2004). Bununla birlikte, kanser hücrelerininin artan ROS stresine maruz kalması sonucunda, ROS'un kimyasal olarak aktif bir bileşik olmasından dolayı hücrelerin gördüğü şiddetli hasar ve artan ROS miktarına bağlı olarak hücrelerin daha duyarlı hale gelmesine dayanarak malign hücreleri öldürmek, kanserle mücadele de iyi bir strateji sağlayabilirken antioksidan tedavininde kanserden korumada önemli rol oyanayacağı düşünülmektedir (Cabello et al., 2007).

Kanserle savaşmak için diyetsel kaynakların tüketilmesi ve bu sayede yeni kemopreventif ve antitümöral yaklaşımlarının geliştirilmesi son yıllarda oldukça önem kazanmıştır. Bu doğrultuda, fitokimyasallar son yirmi yılda artan bir ilgi görmüştür (Manach et al., 2009). Fitokimyasaların kemopreventif aktivitesi, hem doğrudan serbest radikal süpürücü hem de demir şelasyon aktivitelerine bağlı olarak gerçekleşmektedir. Enflamasyonun kanser gelişimine hem neden olması hem de kanser gelişimini hızlandırması, fitokimyasalların antienflamatuvar kapasitesinin onların kemopreventif ve antitümöral aktivitelerinin bir başka önemli sebebi olarak nitelendirilmektedir (D'Incalci et al., 2005).

Diosmin, antioksidan ve antienflamatuvar özellikleri iyi bilinen bir fitokimyasaldır (Gerges et al., 2022). Bu fitokimyasalın birçok kanser türünde antitümoral etkinliği gösterilmesine rağmen baş boyun kanserleri özellikle de larinks kanserine karşı antitümoral etkinliği araştırılmamıştır. Yaptığımız çalışamada baş boyun kanserinden larinks kanseri hücre hattı olan Hep-2 hücre hattı kullanılmış olup diosminin Hep-2 hücreleri üzerindeki anti-proliferatif etkisi ile metastatik, apoptotik ve enflamatuar markerlar üzerindeki etkileri araştırılmıştır.

Materyal ve Metod

Hücre hattı

Çalışmamızda kullanılan Hep-2/An-3 insan epidermoid larinks karsinoma hücre hattı T.C. Tarım ve Orman Bakanlığı Türkiye Şap Enstitüsü Hücre Bankası içinde yer alan Hücre kültürü koleksiyonundan (HÜKÜK) temin edildi (HÜKÜK Kayıt No: 92041501).

Stok ve çalışma çözeltilerinin hazırlanması

Diosminin 1 mM konsantrasyonundaki stok çözeltisi ve bu stok çözeltiden hareketle farklı konsantrasyonlarda günlük çalışma çözeltileri hazırlandı (Cardile et al., 2017).

Diosminin hücre canlılığı üzerine etkileri

Diosminin A375 hücrelerinin canlılığı üzerine etkisi 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) testi ile değerlendirilmiştir. Farklı konsantrasyondaki diosmin çözeltisinden (1, 2, 4, 8, 16, 32, 64, 128, 256 ve 512 µM) 200 µL eklenerek 37 °C'de 24 saat inkübe edildi. Kontrol grubuna sadece 200 µL RPMI 1640 eklendi. Diosminin her bir konsantrasyonu için elde edilen absorbans değerinin referans absorbans değerine oranı 100 ile çarpılarak % hücre canlılığı hesaplandı (Li et al., 2011). MTT uygulamaları sonucunda kontrol grubuna göre hücre canlılığını %50 oranında azaltan diosmin dozu IC_{50} dozu olarak kabul edildi. Biyokimyasal analizler için gerekli numunelerin temini için diosmin dozu olarak IC_0 ile birlikte ½xIC_{50}, IC_{50} ve 2xIC_{50} dozları kullanıldı. MTT uygulamaları sonucunda lethal dozlar belirlendikten sonra deney grupları oluşturuldu. A375 hücrelerinde diosminin antimetastatik aktivite ile apoptotik ve enflamatuvar yanıt üzerindeki etkilerini belirleyebilmek amacıyla oluşturulacak deney modelinde, hücrelere her bir maddenin IC_0, ½xIC_{50}, IC_{50} ve 2xIC_{50} dozları ayrı ayrı uygulandı. Her bir grupta ise en az 5 tekrar yapılarak laboratuar analizlerinde kullanılan hücre lizatları hazırlandı.

Enzim bağlı immünosorbent analizi (ELISA) çalışmaları

VEGF, kaspaz 3, kaspaz 8, kaspaz 9, IL-1β, IL-6, TNF-α, TGF-β ve GM-CSF düzeyleri insan spesifik ELISA kitleri kullanılarak ve üretici firmanın direktifleri doğrultusunda mikroplate okuyucuda ölçüldü.

İstatistiksel Analiz

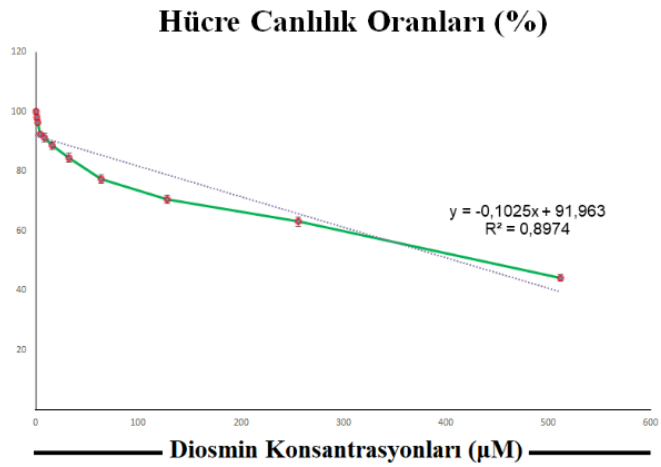
Çalışma sonunda elde edilen gruplara ait tüm veriler SPSS (versiyon 16.0) istatistik paket programı kullanılarak yapıldı. Gruplar arası karşılaştırmalar tekrarlanan ölçümlü varyans analizi (ANOVA) kullanılarak gerçekleştirildi. Varyans analizini takiben farklı grupları

belirlemede Tukey çoklu karşılaştırma testi kullanıldı. Tüm analizlerden elde edilen ham değerler, grupların ortalaması ± standart sapma şeklinde sunuldu. Hesaplamalarda istatistik anlamlılık düzeyi $p<0,05$ olarak alındı.

Bulgular

Diosmin Uygulamasının Hücre Canlılığına Etkisi

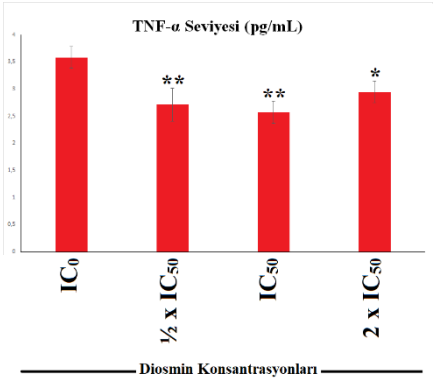
Tüm hücrelere diosminin 0-512 µM konsantrasyonları uygulanmış ve 24 saatlik inkübasyonun sonrasındaki hücre canlılık oranları bulunmuştur. Diosminin Hep-2 hücreleri üzerindeki IC_{50} konsantrasyonu 409,4 µM olarak bulunmuştur. Bu kapsamda çalışmanın daha sonraki aşamaları için IC_0 konsantrasyonu olarak 0 µM diosmin, ½xIC_{50} konsantrasyonu için 204,7 µM diosmin, IC_{50} konsantrasyonu için 409,4 µM diosmin ve 2 x IC_{50} konsantrasyonu için 818,8 µM diosmin Hep-2 hücrelerine uygulanmıştır.



Şekil 1. Diosmin uygulamasının hücre canlılık oranlarına etkileri

Diosmin Uygulamasının TNF-α Seviyesine Etkisi

Diosminin ½xIC_{50}, IC_{50} ve 2xIC_{50} konsantrasyonlarının uygulandığı grupların TNF-α seviyeleri diosminin IC_0 konsantrasyonunun uygulandığı gruba kıyasla istatistiksel olarak anlamlı derecede düşük bulunmuştur ($p<0,01$).



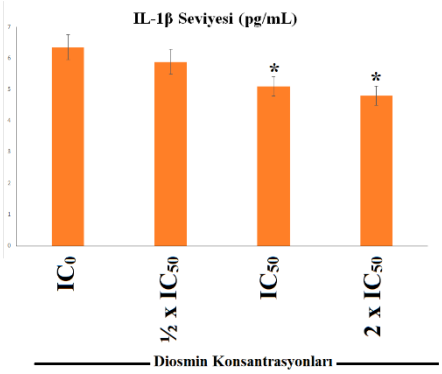
Şekil 2. Diosmin uygulamasının TNF-α seviyesine etkisi.

*IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,05)

**IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,01)

Diosmin Uygulamasının IL-1β Seviyesine Etkisi

Diosminin IC_{50} ve 2xIC_{50} konsantrasyonlarının uygulandığı grubun IL-1β seviyesi diosminin IC_0 konsantrasyonunun uygulandığı gruba kıyasla istatistiksel olarak anlamlı derecede düşük bulunmuştur (p<0,05).

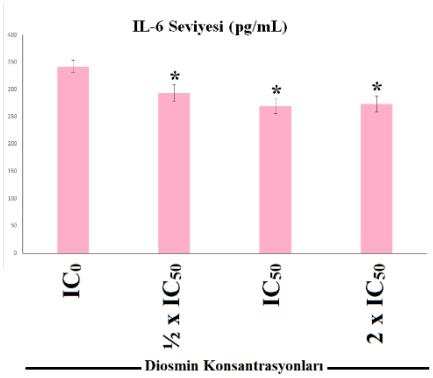


Şekil 3. Diosmin uygulamasının IL-1β seviyesine etkisi.

*IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,01)

Diosmin Uygulamasının IL-6 Seviyesine Etkisi

Diosminin ½xIC_{50}, IC_{50} ve 2xIC_{50} konsantrasyonlarının uygulandığı grupların IL-6 seviyeleri diosminin IC_0 konsantrasyonunun uygulandığı gruba kıyasla istatistiksel olarak anlamlı derecede düşük bulunmuştur (p<0,05).

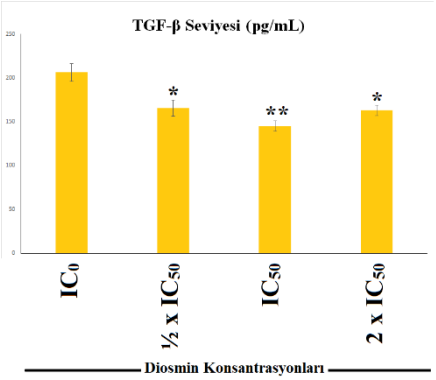


Şekil 4. Diosmin uygulamasının IL-6 seviyesine etkisi.

*IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,05)

Diosmin Uygulamasının TGF-β Seviyesine Etkisi

Diosminin ½xIC_{50}, IC_{50} ve 2xIC_{50} konsantrasyonlarının uygulandığı grupların TGF-β seviyeleri diosminin IC_0 konsantrasyonunun uygulandığı gruba kıyasla istatistiksel olarak anlamlı derecede düşük bulunmuştur (p<0,05).



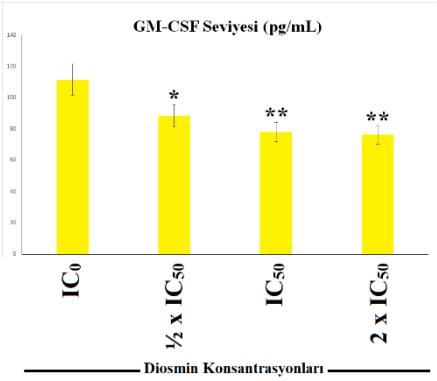
Şekil 5. Diosmin uygulamasının TGF-β seviyesine etkisi.

*IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,05)

**IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,01)

Diosmin Uygulamasının GM-CSF Seviyesine Etkisi

Diosminin ½xIC_{50}, IC_{50} ve 2xIC_{50} konsantrasyonlarının uygulandığı grubun GM-CSF seviyesi diosminin IC_0 konsantrasyonunun uygulandığı gruba kıyasla istatistiksel olarak anlamlı derecede düşük bulunmuştur (p<0,05).



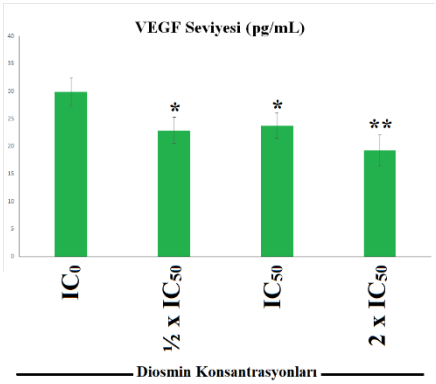
Şekil 6. Diosmin uygulamasının GM-CSF seviyesine etkisi.

*IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,05)

**IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,01)

Diosmin Uygulamasının VEGF Seviyesine Etkisi

Diosminin ½xIC_{50}, IC_{50} ve 2xIC_{50} konsantrasyonlarının uygulandığı grupların VEGF seviyeleri diosminin IC_0 konsantrasyonunun uygulandığı gruba kıyasla istatistiksel olarak anlamlı derecede düşük bulunmuştur (p<0,01).



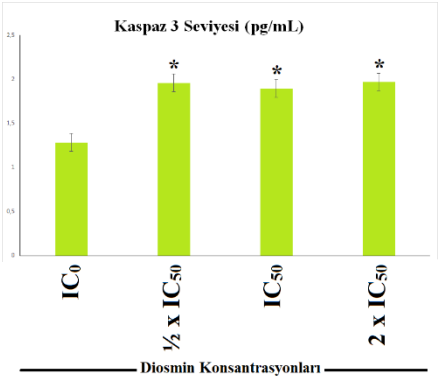
Şekil 7. Diosmin uygulamasının VEGF seviyesine etkisi.

*IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,05)

**IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde düşük bulunmuştur (p<0,01)

Diosmin Uygulamasının Kaspaz 3 Seviyesine Etkisi

Diosminin ½xIC_{50}, IC_{50} ve 2xIC_{50} konsantrasyonlarının uygulandığı grupların kaspaz 3 seviyeleri diosminin IC_0 konsantrasyonunun uygulandığı gruba kıyasla istatistiksel olarak anlamlı derecede yüksek bulunmuştur (p<0,01).

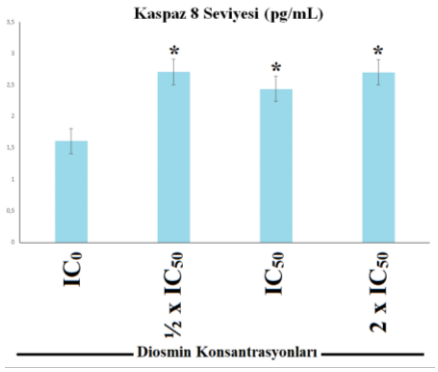


Şekil 8. Diosmin uygulamasının kaspaz 3 seviyesine etkisi.

*IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde yüksek bulunmuştur (p<0,01)

Diosmin Uygulamasının Kaspaz 8 Seviyesine Etkisi

Diosminin ½xIC_{50}, IC_{50} ve 2xIC_{50} konsantrasyonlarının uygulandığı grupların kaspaz 8 seviyeleri diosminin IC_0 konsantrasyonunun uygulandığı gruba kıyasla istatistiksel olarak anlamlı derecede yüksek bulunmuştur (p<0,01).

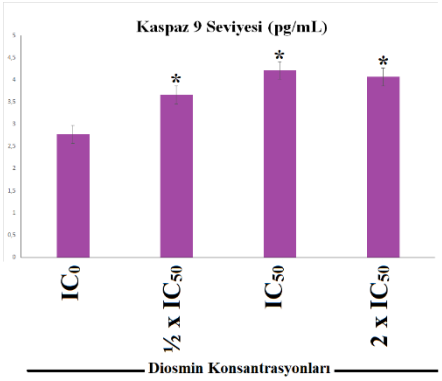


Şekil 9. Diosmin uygulamasının kaspaz 8 seviyesine etkisi.

*IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde yüksek bulunmuştur (p<0,01)

Diosmin Uygulamasının Kaspaz 9 Seviyesine Etkisi

Diosminin ½xIC_{50}, IC_{50} ve 2xIC_{50} konsantrasyonlarının uygulandığı grupların kaspaz 9 seviyeleri diosminin IC_0 konsantrasyonunun uygulandığı gruba kıyasla istatistiksel olarak anlamlı derecede yüksek bulunmuştur (p<0,01).



Şekil 10. Diosmin uygulamasının kaspaz 9 seviyesine etkisi.

*IC_0 grubuna kıyasla istatistiksel olarak anlamlı ölçüde yüksek bulunmuştur (p<0,01)

Tartışma ve Sonuç

Larinks kanseri, özellikle sigara içiciliğinin yüksek olduğu ülkemizde sık olarak görülen baş boyun kanserlerindendirler. Larinks kanseri hastalarda artmış morbidite ve mortaliteye sebep olabilmektedirler. Larinks kanseri evresine uygun olarak cerrahi, radyoterapi ve kemoterapi gibi tedavi seçeneklerinden biri veya birkaçı ile tedavi edilebilmektedir (Wünsch et al., 2004). Artan kanser vakaları ve ölümleri, tedavilerin maliyetli olması ve yan etkilerinin büyük olması yeni tedavi arayışlarına olan ilgiyi arttırmaktadır. Doğal ürünler kanser tedavisi için çok önemli ilaç kaynaklarıdır. Doğal ilaçların seçici olmaları daha az toksisiteye sahip olmaları, moleküler modifikasyonlar ile terapotik potansiyellerinin arttrılması onları kanser tedavi alanlarında önemli hale getirmiştir (Russo, 2007). Doğal ürünler, kanser gibi çeşitli sağlık sorunları için umut verici faydalar göstermektedir. Farmasötik ve tıbbi gelişmeler ilerlemekle birlikte, şifalı otlar ve bunların fitokimyasalları dünya çapında baskın ilaç kaynağı olmaya devam etmektedir. Halihazırda var olan antikanser ilaçlarının %74'ü bitkisel kökenlidir (Russo et al., 2010). Bitkilerden kaynaklanan bu ilaçların küçük yan etkileri, günümüzde klinik deneyler için diğer bitki kökenli bileşiklerin araştırılmasına neden olmuştur. Bitkisel ilaçlar binlerce yıldır dünyanın birçok ülkesinde kanser tedavisinde kullanılmaktadır. Bazıları batı ülkelerinde tamamlayıcı ve alternatif ilaçlar olarak kabul edilmeye başlanmıştır (Manach et al., 2009). Bu çalışmada, diosmin uygulamalarının Hep-2 hücreleri üzerindeki antiproliferatif, antienflamatuvar, antimetastatik ve apoptotik etkileri incelenmiştir. Bu maddelerin antiproliferatif etkisini belirlemek için MTT metodu kullanılmıştır. Anti-metastatik etkinin belirlenebilmesi için VEGF düzeyine, apoptotik

etkinin incelenmesi için Kaspaz 3, Kaspaz 8 ve Kaspaz 9 düzeylerine, enflamatuar yanıtın gözlenmesi için ise IL-1β, IL-6, TNF-α, TGF-β ve GM-CSF düzeylerine bakılmıştır. Literatürde ilk kez diosminin, Hep-2 larinks kanseri hücrelerinde kanser hücre büyümesini, anjiogenezi, metastazı ve enflamasyonu büyük oranda baskıladığı gösterilmiştir. Ek olarak, diosminin intrinsik ve ekstrinsik yolakta yol açan kaspazlar üzerindeki etkileri de araştırılmış ve bu fitokimyasalların kanser hücrelerinin apoptozunu her iki yolak üzerinden de indüklediği görülmüştür. Bu sonuçlar neticesinde diosminin umut vaat eden bir teropatik ajan olduğu ve kemoterapide kullanılabileceğine dair destekleyici sonuçlar elde edilmiştir. Literatürde bu fitokimyasalın Hep-2 hücreleri üzerine etkilerinin araştırılmasına yönelik yapılan ilk çalışma olması nedeniyle özgün bir nitelik taşımaktadır. Çalışmamızda, apoptotik hücrelerin ve gen ürünü olan protein düzeylerinin gösterilememesi temel kısıtlılıklarıdır. İleri ki çalışmalarda, daha ileri yöntemlerle apoptotik hücrelerin tespit edilmesi ve protein ekspresyonunun Western Blot gibi yöntemlerle gösterilmesi planlanmaktadır.

Maddi Destek

Bu çalışma Van Yüzüncü Yıl Üniversitesi Bilimsel Araştırma Projeleri Koordinatörlüğü tarafından TYL-2022-9995 numaralı proje olarak desteklenmiştir.

Çıkar Çatışması

Yazarlar arasında herhangi bir çıkar çatışması bulunmamaktadır.

References

Cabello, C. M., Bair, W. B., 3rd, & Wondrak, G. T. (2007). Experimental therapeutics: targeting the redox Achilles heel of cancer. Current opinion in investigational drugs (London, England : 2000), 8(12), 1022–1037.

Cardile, V., Graziano, A. C. E., Avola, R., Piovano, M., & Russo, A. (2017). Potential anticancer activity of lichen secondary metabolite physodic acid. Chemico-biological interactions, 263, 36–45. https://doi.org/10.1016/j.cbi.2016.12.007

D'Incalci, M., Steward, W. P., & Gescher, A. J. (2005). Use of cancer chemopreventive phytochemicals as antineoplastic agents. The Lancet. Oncology, 6(11), 899–904. https://doi.org/10.1016/S1470-2045(05)70425-3

Gerges, S. H., Wahdan, S. A., Elsherbiny, D. A., & El-Demerdash, E. (2022). Pharmacology of Diosmin, a Citrus Flavone Glycoside: An Updated Review. European journal of drug metabolism and pharmacokinetics, 47(1), 1–18. https://doi.org/10.1007/s13318-021-00731-y

Li, H., Jeong, Y. M., Kim, S. Y., Kim, M. K., & Kim, D. S. (2011). Arbutin inhibits TCCSUP human bladder cancer cell proliferation via up-regulation of p21. Die Pharmazie, 66(4), 306–309.

Manach, C., Hubert, J., Llorach, R., & Scalbert, A. (2009). The complex links between dietary phytochemicals and human health deciphered by metabolomics. Molecular nutrition & food research, 53(10), 1303–1315. https://doi.org/10.1002/mnfr.200800516

Pelicano, H., Carney, D., & Huang, P. (2004). ROS stress in cancer cells and therapeutic implications. Drug resistance updates : reviews and commentaries in antimicrobial and anticancer chemotherapy, 7(2), 97–110. https://doi.org/10.1016/j.drup.2004.01.004

Russo G. L. (2007). Ins and outs of dietary phytochemicals in cancer chemoprevention. Biochemical pharmacology, 74(4), 533–544. https://doi.org/10.1016/j.bcp.2007.02.014

Russo, M., Spagnuolo, C., Tedesco, I., & Russo, G. L. (2010). Phytochemicals in cancer prevention and therapy: truth or dare?. Toxins, 2(4), 517–551. https://doi.org/10.3390/toxins2040517

Wünsch Filho V. (2004). The epidemiology of laryngeal cancer in Brazil. Sao Paulo medical journal = Revista paulista de medicina, 122(5), 188–194. https://doi.org/10.1590/s1516-31802004000500002

YAVRU BİR KEDİDE BİLATERAL BESLENME EKSİKLİĞİNE BAĞLI OLUŞAN EDİNSEL KATARAKT OLGUSU

Dr. Öğr. Üyesi Osman BULUT (ORCID: 0000-0003-2773-8243)
Mugla Sitki Kocman University, Faculty of Milas Veterinary Medicine, Department of Surgery, Milas-Türkiye
Email: obulut@mu.edu.tr

ÖZET
Katarakt lens kapsülasının yada korpusun parsiyel veya total opasifikasyonu ile seyreden ve görüş kaybı ile sonuçlanan bir göz hastalığıdır. Olgunlaşma derecelerine göre insipient, immatür, matür, hipermatür ve morgagnian katarakt olarak sınıflandırılmakta, konjenital ve edinsel olarakta meydana gelmektedir. Olgumuzu Muğla Sıtkı Koçman Üniversitesi, Milas Veteriner Fakültesi Cerrahi Kliniği'ne getirilen 3 aylık, 1.2 kg ağırlığında dişi Calico ırkı yavru kedi oluşturmaktadır. Hasta sahibinin gözlerinde fark ettiği opaklık şikayeti ile kliniğimize getirmesi neticesinde, sahibinden alınan bilgilerde yavru kedinin 1 ay önce bir kardeşi ile çiftlikten sahiplenildiği, henüz bebeklik döneminde annesi tarafından bir süre reddedildiği ve buna bağlı olarak beslenme ve gelişme geriliği gösterdiği bildirildi. Anamnezde hasta sahibinin kedinin görüşü ile ilgili bir problem yaşamadığı bilgisi alındı. Genel durum muayenesinde özellikle sırt tüylerinde belirgin dökülme, kulak ucunda daha önce tedavisine başlanmış olan bir yara olduğu görüldü. Yapilan görüş muayenelerinde kedide görüşün olmasına rağmen, sol gözde belirgin matür, sağ gözde ise başlangıç aşamasında immatür katarakt olgusuna rastlandı. Kediden alınan kan örneklerinde üst sınıra yakın çıkan yüksek platelet seviyesinin iyileşme aşamasında bulunan açık yara ile ilişkisi olabileceği, biyokimyasal parametrelerinde ise kullanılan kortikosteroidlere bağlı ALT (alanin aminotransferaz) seviyesinin referans değerlere göre daha yüksek olduğu gözlendi. Kataraktın etiyolojisinde sıklıkla yer alan diabet için kontrol edilen glikoz değerlerininin ise normal seviyede olduğu saptandı. Gerçekleştirilen klinik muayeneler neticesinde etiyolojide kedide katarakt meydana getirecek herhangi bir bulguya rastlanmadı. Anamnez bilgileri doğrultusunda beslenme eksikliğine bağlı katarakt olgusu olabileceği düşünüldü. Sonuç olarak yavru kedilerde gıda eksikliğine bağlı katarakt oluşabileceği, bu nedenle benzer klinik olgularla karşılaşabileneceği ve olgunun literatüre katkı sağlayacak bir vaka olduğu düşünülmektedir.
Anahtar Kelimeler: göz, immatür, lens opasifikasyonu, matür

ACQUIRED BILATERAL CATARACT CAUSED BY NUTRITIONAL DEFICIENCY IN A KITTEN

ABSTRACT

Cataract is an eye disease that proceeds with partial or total opacification of the lens capsule or corpus and results in vision loss. It is classified as incipient, immature, mature, hypermature, and morgagnian cataract according to the degrees of maturation, and it occurs congenitally and acquired. Our case is a 3-month-old, 1.2 kg female Calico breed kitten brought to Muğla Sıtkı Koçman University, Milas Veterinary Faculty Surgery Clinic. As a result of being brought to our clinic with the complaint of opacity noticed in the eyes by the patient's owner. It was reported that the kitten was adopted from a farm with a sibling a month ago, was rejected by her mother for a while in its infancy, and showed feeding and developmental retardation due to this. In the anamnesis, it was learned that the owner of the patient did not have a problem related to the kitten's vision. In the general condition examination, it was observed that there was a significant shedding in the back feathers, and there was a wound on the ear tip that had been treated before. In the vision examinations performed, despite the existence of vision in the cat, a mature in the left eye and an immature cataract case in the initial stage in the right eye were encountered. In the blood samples taken from the cat, it was observed that the high platelet level close to the upper limit might be related to the open wound in the healing phase, and the ALT (alanine aminotransferase) level in the biochemical parameters was higher than the reference values due to the used corticosteroids. It was determined that the glucose values checked for diabetes, which is often involved in the etiology of cataract, were at normal levels. As a result of the clinical examinations performed, no findings that could cause cataract in the kitten was found in the etiology. It was thought that there could be a case of cataract due to nutritional deficiency in accordance with the anamnesis information. As a result, it is thought that cataract can occur due to nutritional deficiency in kittens, and it can be encountered with similar clinical cases, and it is a case that will contribute to the literature.

Keywords: eye, immature, lens opacification, mature

Introduction

A cataract is an eye disease that progresses with partial or total opacification of the lens capsule or corpus and results in vision loss (Guyonnet et al., 2019). Cataracts are classified as incipient, immature, mature, hypermature, morgagnian cataract according to their degrees of maturity, and named as punctate (pointed), cuneiform (wedge-shaped), diskiform (disk-like), stellate (star), fusiform (thread-like) according to their physical characteristics (Barnett, 1985; Donzel et al., 2017). Depending on the opacities that occur in the lens, it is named as capsular when it is extracapsular, subcapsular when it develops in the epithelial layer under the anterior capsule after trauma, cortical when it forms in the cortical region, and nuclear cataract when it is located in the center (Özgencil, 2005). Congenital, hereditary, aging, nutritional disorders, diabetes and hypocalcemia such as metabolic disorders, uveitis, glaucoma and other eye diseases, drugs and toxins, and traumas are frequently involved in the etiology of cataracts in cats (Guyonnet et al., 2019). Cataract cases in cats are less common than in dogs (Williams & Heath 2006). Cataracts in cats have been reported to be inherited in Persian, Himalayan, Birman and British Short Hair breeds (Tella & Hendrix, 2016). Cataract cases in cats mostly occur acquisitively. Among the acquired causes, reasons such as trauma and uveitis are more common than senile causes (Salgado et al., 2000). Unlike dogs, diabetes-related cataract cases in cats are rarely observed (Thoresen et al., 2002). Metabolic cataracts associated with secondary hyperparathyroidism and hypocalcemia due to nutritional disorders in kittens, diabetes and commercial kitten milk powders have been reported. It has been reported that cataracts can occur in kittens that cannot be adequately and balancedly fed during the kitten period due to amino acid deficiency (Guyonnet et al., 2019). In addition, galactosemic cataracts occur in cats and dogs as a result of the inability to digest galactose and lactose (Maggs et al., 2010).

In this report, a case of acquired bilateral cataract caused by nutritional deficiency in a kitten is presented and the quite uncommon features of the disease in this case are discussed.

Materials and Methods

Our study materiel consist of a 3-month-old, female, 1.2 kg Tabby-Persian mix breed kitten brought to the Muğla Sıtkı Koçman University Milas Veterinary Faculty Practice and Training Hospital on 12.02.2024. It was brought in by its owner with a complaint of

opacity noticed in its left eye for the past week. According to the anamnesis, the kitten was born on a farm, rejected by its mother during infancy, and was not fed for a while. During this period, there is suspicion that it was fed by a mother dog who gave birth in the same area for 1-2 days. It was reported that during this time, it was fed with various milk substitute feeds for about 15 days and showed less development compared to its sibling. The owner stated that it was adopted from the farm with its sibling a month ago and started living at home, and there have been no vision problems. Two weeks ago, treatment was performed for an aural hematoma in its left ear.

Based on the obtained anamnesis information, after the subjective and objective visual examinations of the eye, a direct ophthalmoscopy examination was performed. To facilitate the examination of the lens, alternating applications of Tropicamide and Mydfrin mydriatic drops were applied to both eyes with a 10-minute interval. Subsequently, the ophthalmoscope's diopter disc was adjusted to +8 for examination of the anterior capsule and cortex of the lens, and to +12 for examination of the posterior capsule and cortex. Following the ophthalmoscopic examinations, ultrasonographic examinations of both eyes were performed using the Mindray DP-50 device with a microconvex probe at 9 MHz to determine the condition of the retina in the posterior chamber of the eye and the prognosis of the disease. Blood samples were taken from the cat to investigate diabetes, which is involved in the etiology of cataracts, and complete blood count and full biochemical blood analyses were performed.

Findings and Discussion

An opacity or opacities in the lens or its capsule are called cataracts (Nygren et al., 2018). It is generally acknowledged that cats are less likely than dogs to develop cataracts (Glaze & Gelatt 1999, Romero et al., 2020). Age of onset (embryonal, congenital, juvenile, senile), position within the lens (nuclear, capsular, subcapsular, polar, equatorial, axial), developmental stage (incipient, immature, mature, hypermature), appearance, and consistency are some of the factors that can be used to categorize cataracts (Sapienza 2005). Although rare in domestic cats, congenital cataracts have been reported in several Himalayan kittens, Persian, Birman, and British Shorthair cats (Kucharczyk 2020). In the anamnesis, it was reported that the kitten, which constitutes the material of the study, may have Persian cat ancestry. In the direct ophthalmoscopic examination performed on the

kitten, a distinct mature nuclear cataract was observed in the right eye, while immature suture lines were seen in the left eye (Fig 1).

Figure 1. Mature cataract in the left eye and immature suture lines in the right eye of the kitten.

After the diagnosis of cataracts, examinations were repeated under the operating microscope for the entire lens. In terms of the prognosis of the cataract, ultrasonographic examinations revealed hyperechoic areas in the lens of both eyes, while no abnormalities were observed in the retina and optic nerve (Fig 2a-2b).

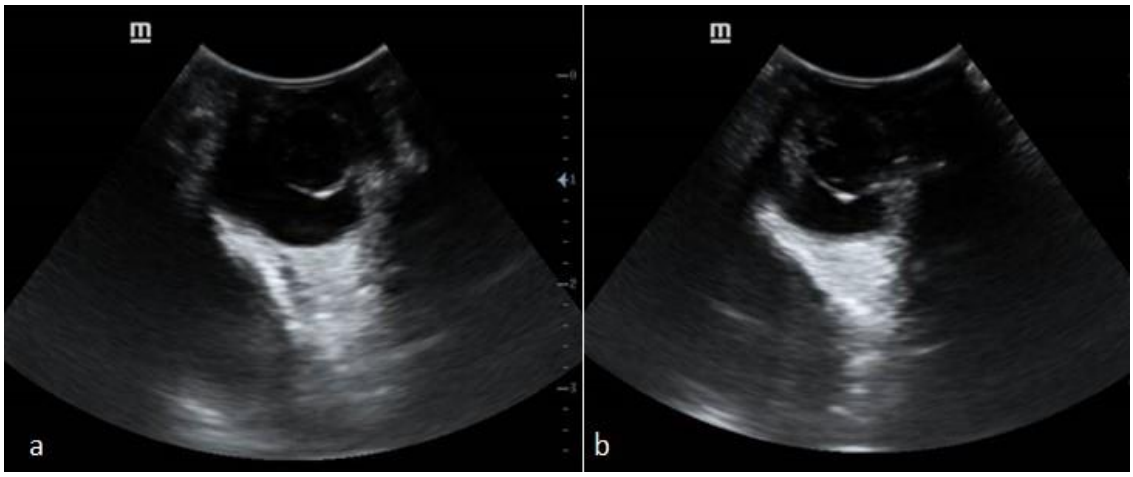


Figure 2a-2b: Hyperechoic areas are clearly visible in the lens of the left eye in 2a and the right eye in 2b on ultrasonography

Cat cataracts typically result from secondary causes such as uveitis, trauma, neoplasia, or nutritional and metabolic issues (Nygren et al., 2018). Metabolic diseases related to diabetes are among the main causes of cataracts in dogs. It has been reported that cataracts occur as a result of metabolic disorders related to diabetes in cats. (Thoresen et al., 2002). Although it has been reported that diabetic cataracts are generally less common in cats than in dogs (Sapienza, 2005) . In the hemogram examination of the kitten, only an

increase in platelets was observed (Table 1). It was considered that this condition might be due to the healing stage of the problem in the kitten's ear.

Table 1: Hemogram results of the kitten.

Test	Results	Reference Range	Unit
WBC	11.90	5.50- 19.50	10^9/L
Neu	7.21	3.12- 12.58	10^9/L
Lym	3.85	0.73- 7.86	10^9/L
Mon	0.23	0.07- 1.36	10^9/L
Eos	0.61	0.06- 1.93	10^9/L
Bas	0.00	0.00- 0.12	10^9/L
HGB	9.1	8.5- 15.3	g/dL
HCT	26.7	26.0- 47.0	%
MCV	39.2	38.0- 54.0	fL
MCHC	341	290- 360	g/L
PLT	558	100-518	10^9/L
MPV	12.0	9.9- 16.3	fL

When looking at the biochemical values, it was observed that the glucose level was within normal range (118 mg/dL), and only the ALT value was elevated (Table 2), which was deemed likely to be due to the medication the kitten was receiving.

Table 2: Biochemical values of the kitten

Test	Results	Reference Range
ALB	3.0 g/dL	2.2-3.9
ALKP	65 U/L	14-192
ALT	509 U/L	12-115
BUN	18 mg/dL	16-33
CREA	0,6 mg/dL	0.6-1.6
GLOB	3,9 g/dL	2.8-4.8
GLU	118 mg/dL	77-153
TP	6,9 g/dL	5.2-8.2
ALB/GLOB	0,8	
BUN/CREA	30	

Kittens with metabolic cataracts linked to feline diabetes, commercially available kitten milk replacer, and nutritional deficiency (Frankel 2001). In the onset of lens opacities in kittens and puppies fed with milk substitutes, deficiencies in amino acids such as arginine, as well as tryptophan, phenylalanine, and histidine, are known to play a role (Wilkie & Colitz, 2008). Galze and Blanchard (1983) reported lens opacities due to amino acid deficiency in inadequately fed puppies and some kitten litters. Maggs et al. (2010) reported the development of galactosemic cataracts in young kangaroos fed with cow's milk due to the inability to digest galactose and lactose. Galactosemic cataracts in cats

and dogs lead to vision loss (Barnett, 1985). In our study, it was reported in the anamnesis that the kitten was rejected by its mother during infancy, and during this period, it was suspected to have been fed by a dog for 1-2 days and received nutritional supplementation with various milk substitutes. It was considered that the cataract occurred in our case of the young kitten due to nutritional deficiency. As the owner of the kitten requested time for cataract treatment, no surgical procedure has been performed yet in our case.

Conclusion and Recommendations

Considering the rarity of cataracts in cats and the fact that our case involves a cat, it is important to raise awareness about cataract disease in cats as well. In our case, it was reported in the anamnesis that the kitten's maternal ancestry could be Persian cat, and it is believed, as suggested in the literature, that such ancestry might create a predisposition to cataracts.

One of the reasons encountered in the etiology of cataracts is old age and diabetes. The absence of both etiologies in our case, along with the fact that our kitten is only 3 months old, suggests the possibility of cataracts caused by nutritional deficiencies and related milk substitute feeds, as indicated in the literature. While galactosemic cataracts have been reported in young kangaroos fed with cow's milk, it has been mentioned that they can also occur in dogs and cats, but such a case has not been reported. Similarly, in our case, it was reported in the anamnesis that the kitten may have nursed from a recently giving birth dog, and it is thought to be related to this suspicion.

In conclusion, cataracts can occur in young kittens due to food deficiency, and therefore, similar clinical cases may be encountered. This case is considered to contribute to the literature and provide insights into such occurrences.

References

Barnett, K. C. (1985). The diagnosis and differential diagnosis of cataract in the dog. *Journal of Small Animal Practice,* 26(3), 305-316.

Donzel, E., Arti, L. & Chahory, S. (2017). Epidemiology and clinical presentation of canine cataracts in France: a retrospective study of 404 cases. *Veterinary ophthalmology,* 20(2), 131-139.

Frankel, D. J. (2001). Malnutrition-induced cataracts in an orphaned kitten. *Can Vet J Volume,* 42.

Galze, M. B & Blanchard G. L. (1983). Nutritional cataracts in samoyed litter. *Journal of the American Animal Hospital Association,* 19, 951-963.

Glaze, M. B. & Gelatt, K. N. (1999). Feline Ophthalmology. In: Veterinary Ophthalmology, 3rd edn. (ed. Gelatt KN) Lippincott/Williams and Wilkins, Philedelphia, 1103–1033.

Guyonnet, A., Donzel, E., Bourguet, A., & Chahory, S. (2019). Epidemiology and clinical presentation of feline cataracts in france: A retrospective study of 268 cases. *Veterinary Ophthalmology,* 22(2), 116-124. https://doi.org/10.1111/vop.12567.

Kucharczyk, N., Pakuluk, A, C., Stefanowicz, P. & Bedford, P. (2020). Hereditary cataract in the Bengal cat in Poland. *BMC Veterinary Research*, 16, 293.

Maggs, D. J., Nasisse, M. P., Marrion, R. M., Priddy, N. H. & Doham, J. R. (2010). Effects of intracameral administration of α – chymotrypsin on intracapsular lens extraction and postoperative outcome in clinically normal dogs. *American Journal of Veterinary Research*, 71(12), 1475-1483.

Nygren, K., Jalomäki, S., Karlstam, L. & Narfström, K. (2018). Hereditary cataracts in Russian Blue cats. *Journal of Feline Medicine and Surgery*, 20(12), 1105–1109.

Özgencil E. (2005). The results of Phacofragmentation and Aspiration Surgery for Cataract Extraction in Dogs. *Turkish Journal of Veterinary Aminal Sciences,* 29, 165-173.

Romero, E. F., Jeanes, E., Freitas, I., Enache, A. E., Lockhart, R., Fleming, L., Knott, T. N. L., Dawson, C., Smith, K. & Bussel, C. (2020). Outcome of phacoemulsification in 71 cats: A multicenter retrospective study (2006-2017). *Veterinary Ophthalmology*, 23, 141–147.

Salgado, D., Reusch, C. & Speiss, B. (2000). Diabetic cataracts: different incidence between dogs and cats. *Schweizer Archiv für Tierheilkunde*, 142, 349–353.

Sapienza, J.S. (2005). Feline Lens Disorders. *Clin Tech Small Anim Pract*, 20, 102-107.

Telle, M. R. & Hendrix, D. (2016). Cataracts in cats: diagnosis. *NAVC Clinician's Brief.*

Thoresen, S. I., Bjerkas, E., Alekandersen, W. & Peiffer, R. L. (2002). Diabetes mellitus and bilateral cataracts in a kitten. *Journal of Feline Medicine and Surgery*, 4, 115–122.

Williams, D. L. & Heath, M. F. (2006). Prevalence of feline cataract: results of a cross-sectional study of 2000 normal animals, 50 cats with diabetes and one hundred cats following dehydrational crises. *Veterinary Ophthalmology*, 9(5), 341–349.

Wilkie, D. A. & Colitz, C. M. (2008). Diseases of the canine lens and cataract formation. In: KN Gelatt (eds), Veterinary Ophthalmology vol. 2 (4 ed), Ames, Iowa, Blackwell Publishing, p.299-344.

MELEZ IRKI BİR KÖPEKTE HEPATOSELLÜLER KARSİNOM

Doç. Dr. İbrahim YURDAKUL (ORCID: 0000-0002-5696-5069)
Sivas Cumhuriyet Universitesi Veteriner Fakültesi Cerrahi Anabilim Dalı, Sivas, Türkiye
Email: iyurdakul@cumhuriyet.edu.tr

ÖZET
Sunulan çalışmada, Sivas Cumhuriyet Üniversitesi Veteriner Fakültesi Hayvan Hastanesi'ne durgunluk, iştahsızlık, abdominal gerginlik ve abdominal bölgede hassasiyet şikâyeti ile getirilen 11 yaşında, 11.5 kg ağırlığında, melez, dişi köpeğin tanı ve tedavi süreci ele alındı. Yapılan radyografik muayenesinde karaciğerin kaudale doğru genişlediği, ultrasonografide ise karaciğerin homojen görünümünü kaybettiği, masif görünümle uyumlu heterojen bir yapının olduğu görüldü. Biyokimyasal ölçümlerde alkalen fosfataz (ALP), aspartat aminotransferaz (AST), alanin aminotransferaz (ALT) ve gama glutamil transferaz (GGT) düzeyinin arttığı ayrıca kreatin (CREA), kan üre azot (BUN) ve fosfor (PHOS) seviyelerinin yükseldiği tespit edildi. Hemogramda kandaki nötrofil yüzdesi artarken lenfosit yüzdesinin düştüğü belirlendi. Karaciğerden alınan numunenin histopatolojik muayenesinde yapılan mikroskobik incelemeler sonucunda kitlenin hepatosellüler karsinom olduğu tespit edildi.
Anahtar Kelimeler: Köpek, karaciğer, hepatosellüler kanser, tümör.

HEPATOCELLULAR CARCINOMA IN A MIXED BREED DOG

ABSTRACT
In the presented study, the diagnosis and treatment process of an 11-year-old, 11.5 kg, mixed-breed female dog, brought to Sivas Cumhuriyet University Veterinary Faculty Animal Hospital with complaints of stagnation, loss of appetite, abdominal tension and tenderness in the abdominal area, was discussed. In the radiographic examination, it was observed that the liver expanded caudally, and in ultrasonography, the liver lost its homogeneous appearance and had a heterogeneous structure compatible with the massive appearance. In biochemical measurements, it was determined that alkaline phosphatase (ALP), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and gamma glutamyl transferase (GGT) and creatine (CREA), blood urea nitrogen (BUN) and phosphorus (PHOS) levels increased. Hemogram showed an increase in the percentage of neutrophils and a decrease in the percentage of lymphocytes. Histopathologic examination of the sample taken from the liver revealed that the mass was hepatocellular carcinoma as a result of microscopic examinations.
Keywords: Dog, liver, hepatocellular carcinoma, tumor

Giriş

Karaciğer; organizmada hayati öneme sahip en önemli organlardan biridir. Karaciğerin, vücutta bütün sistemler ile ilişkisi bulunmaktadır (Abou monsef, 2019). Vücutta karaciğer; safra kesesi ve safra kanallarını içeren sistem içerisinde kan dolaşımının %80'inin geçtiği yer olup çok sayıda sistemik enfeksiyondan etkilenmektedir (Abou monsef, 2019). Karaciğerde meydana gelen hastalık durumunda organizmada birçok organ görevini yapamaz ve sonuçta metabolik denge bozuklukları ortaya çıkar. Karaciğer çok dayanıklı ve yüksek rejenerasyon yeteneğine sahip bir organdır (Abou monsef, 2019). Çeşitli travmalara bağlı olarak şekillenen yaralanma olgularında karaciğer; fizyolojik fonksiyonunu tekrar kazanmak için, rejenerasyon ve reparasyon olmak üzere iki dengeli reaksiyon içeren bir doku onarımı başlatır (Abou monsef, 2019).

Hepatoselluler karsinomun etiyolojisi multifaktöriyeldir. Aflatoksin ve hepatitis B virüsünün hastalığın şekillenmesinde etkili olduğu, ayrıca köpeklerde tedavi amacıyla kullanılan fenobarbitalininde hastalığa sebep olduğu bildirilmiştir (Yener ve ark., 2001). Tümörlerin tanısının konulmasında birçok yöntem kullanılmaktadır. Bu yöntemler hematolojik, immünolojik, sitolojik, histopatolojik, endokronolojik, biyokimyasal, radyoloji ve diğer görüntüleme yöntemleridir (Özer, 1992). Karaciğer hastalıklarının tanısında biyokimyasal, ultrasonografi gibi yöntemlerden faydalanılsa da asıl tanı yöntemi histopatolojik yöntemdir. Tedavide ise önerilen en iyi yöntemin karaciğer lobektomisi olduğu bildirilmektedir (Sarıtaş ve ark., 2014). Lobektomi operasyonu sonrası prognozun iyi olduğu belirtilmekte ve karaciğer yetersizliği şekillenmeksizin birkaç hafta içeresinde karaciğer normal haline dönebilmektedir (Sarıtaş ve ark., 2014; Abou monsef, 2019).

Türkiye'de köpeklerde hepatoselluler karsinom üzerine yapılmış detaylı bir çalışma bulunmamaktadır. Bu tip çalışmaların köpeklerde karaciğer hastalıklarının tanısı ve önlenmesinde çok önemli olacağı düşünülmektedir.

Materyal ve Yöntem

Çalışmaya konu olan olguyu; Sivas Cumhuriyet Üniversitesi Veteriner Fakültesi Hayvan Hastanesi'ne durgunluk, iştahsızlık, abdominal gerginlik ve abdominal bölgede hassasiyet şikayeti ile getirilen 11 yaşında 11.5 kg ağırlığında melez ırkı dişi köpek oluşturdu. Alınan anamnezde köpeğin iki yıl önce piyometraya bağlı olarak ovariohisterektomi operasyonu geçirdiği ve operasyondan sonraki sürecin sıkıntılı geçtiği hayvan sahibi tarafından

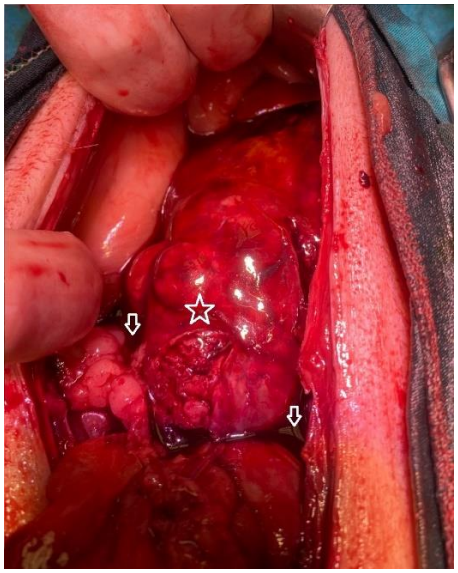
bildirildi. Yapılan klinik muayenede karın bölgesinin gergin ve ağrılı, mukozaların anemik ve hayvanın dehidre olduğu tespit edildi. Hematolojik ve biyokimya için vena cephalica antebrachiden tüplere 2 ml kan örnekleri alınarak ölçümleri yapıldı. Karın bölgesinin V/D pozisyonda grafisi çekildi. Radyografik, ultrasonografik ve biyokimyasal bulgular neoplazi olasılığını işaret ettiğinden hasta sahibinin izni alındıktan sonra laparotomi yapılmasına karar verildi.

Klinik ve laboratuvar muayenesi yapılan olgunun rutin operasyon hazırlıkları tamamlandıktan sonra preoperatif olarak 1 ml Xylazine HCl (Rompun®, Bayer, 23.32 mg/ml) im ve indüksiyon için 1.5 ml Ketamin hidroklorür (15 mg/kg, Ketasol, İnterhas) im uygulandı. İndüksiyonu gerçekleşen olgunun entübasyon işlemi yapıldı. Operasyon masasına dorsal pozisyonda yatırılan olgu yarı kapalı inhalasyon anestezi cihazına bağlandı ve genel anestezisi sevofluran (%3+1 L O2, Sevorane, Baxter) ile gerçekleştirildi. Operasyon süresince damar içi (İV) yolla % 0.9 serum fizyolojik 500 ml verildi.

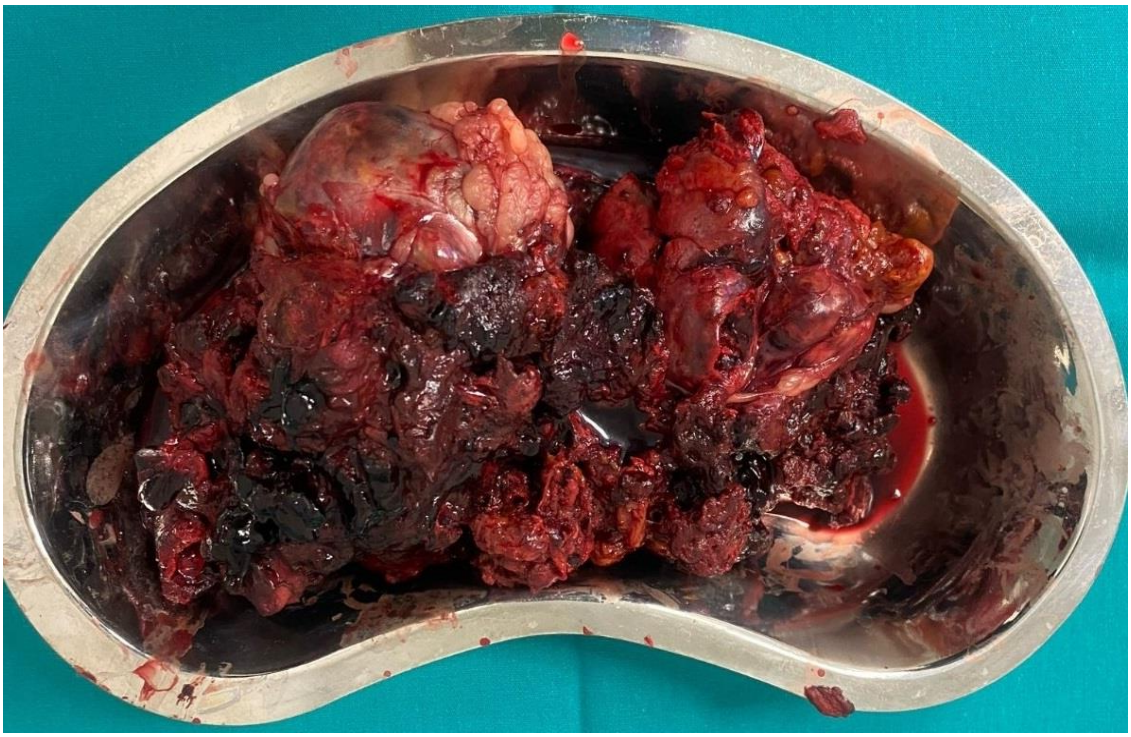
Operasyona radyografik ve ultrasonografik olarak yeri tespit edilen kitlenin olduğu bölgeye yakın olacak şekilde median hattın üstünden deneysel laparatomi amaçlı 5 cm lik deri ensizyonu ile başlandı. Deri altı bağ doku ve kaslar ensize edilip küt olarak diseke edilerek karın boşluğuna girildi. Laparotomi sırasında abdominal boşlukta tümoral kitleden dolayı kan sıvısının olduğu (Şekil 1), karaciğerin genişlediği, sağ ve sol lobda yaygın neoplastik oluşumların varlığı tespit edildi (Şekil 1). Kanamayı kontrol altına almak ve tümoral kitleyi uzaklaştırmak amacı ile tümoral kitle elektro koter yardımı ile dikkatlice uzaklaştırılmaya çalışıldı (Şekil 2, Şekil 3).

Bulgular

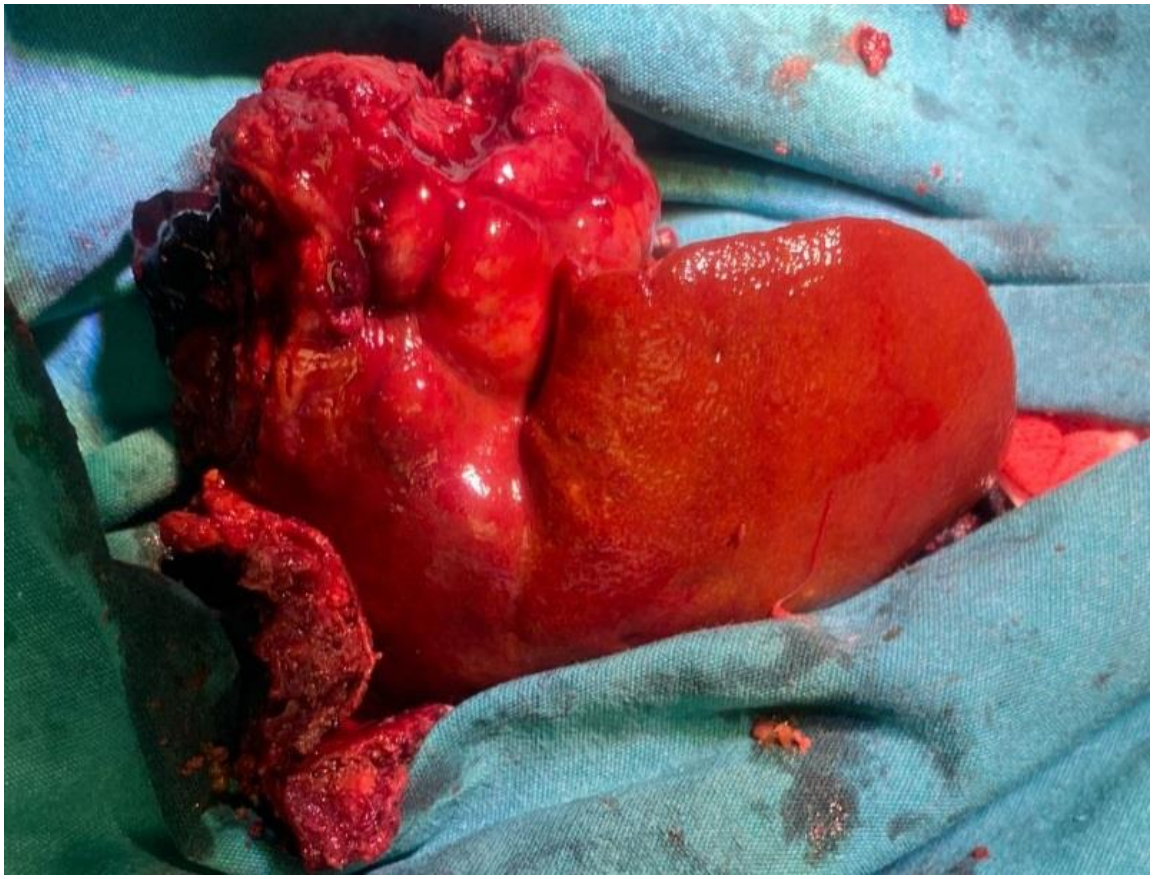
Yapılan klinik muayene sonucunda olguda halsizlik, dehidrasyon, abdominal gerginlik ve abdominal palpasyonda ağrı nedeni ile olgunun ultrasonografik ve radyografik muayenesi yapıldı. Elde edilen radyografik bulguda karaciğerin kaudale doğru genişlediği (Şekil 4), Ultrasonografide ise karaciğerin homojen görünümünü kaybettiği, masif görünümle uyumlu heterojen bir yapının olduğu görüldü.



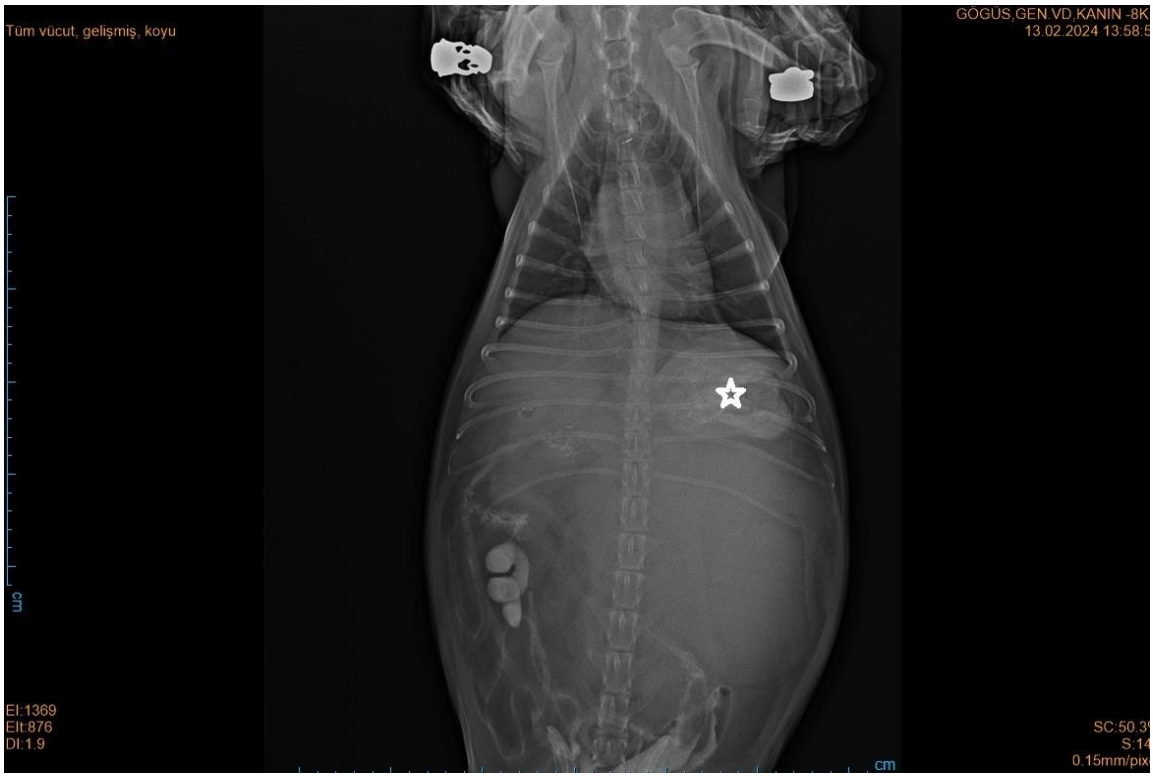
Şekil 1. Karaciğerde neoplastik oluşumlar (*) ve abdominal boşlukta hemorajik sıvı (ok)



Şekil 2. Karaciğerden alınan neoplastik oluşum



Şekil 3. Neoplastik oluşumların alınması esnasında karaciğerin görünümü



Şekil 4. Karaciğerin kaudale genişlemesi ve neoplastik (*) oluşumun görünümü

Biyokimyasal bulgular

Biyokimyasal ölçümlerde alkalen fosfataz (ALP), aspartat aminotransferaz (AST), alanin aminotransferaz (ALT) ve gama glutamil transferaz (GGT) düzeyinin arttığı ayrıca kreatin (CREA), kan üre azot (BUN) ve fosfor (P) seviyelerinin yükseldiği görüldü (Çizelge 1).

Hematolojik muayenede lökositoz tespit edildi. Hematokrit (HCT) düzeyi ile ortalama eritrosit hacmi (MCV) ve ortalama eritrosit hemoglobin (MCH) seviyelerinde azalma görüldü. Hemogramda kandaki nötrofil yüzdesi artarken lenfosit yüzdesinin düştüğü tespit edildi (Çizelge 2).

Çizelge 1. Biyokimyasal kan parametreleri

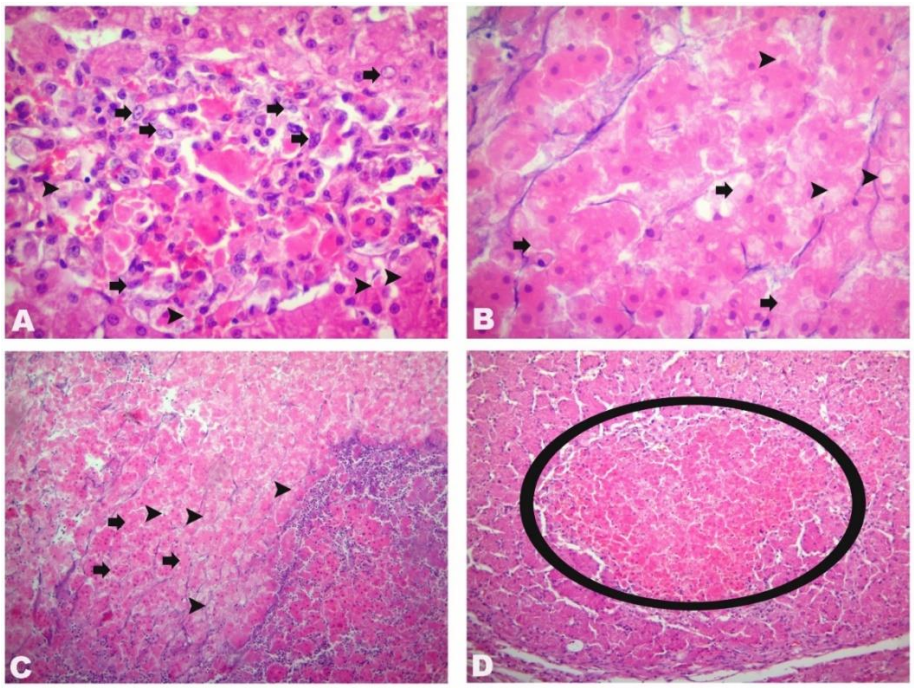
Parametreler	Sonuçlar	Referans Aralığı
CREA	2.55 mg/dl	0.50-1.70
BUN	70 mg/dl	6-25
ALT	405 u/l	10-109
AST	73 u/l	13-15
ALP	186 u/l	1.0-114.0
GGT	14 u/l	1-10
T. BİL	1.46 mg/dl	<0.30
D.BİL	0.34 mg/dl	<0.30
İND. BİL	1.12 mg/dl	<1.00
P	16.19 mg/dl	2.90-5.30
MG	1.86 mg/dl	1.60-2.40
CA	11.27 mg/dl	9.10-11.70

Çizelge 2. Hemogram değerleri

Parametreler	Sonuçlar	Referans Aralığı
WBC	20.94	6.00-17.00 10^3/uL
NEU#	19.72	3.62-12.30 10^3/uL
LYM#	0.49	0.83-4.91 10^3/uL
NEU %	94.2	52.0-81.0
LYM %	2.3	12.0-33.0
RBC	4.91	5.10-8.50 10^6/uL
HGB	10.0	11.0-19.0 g/dl
HCT	28.0	33.0-56.0 %
MCV	57.2	60.0-76.0 fL
MCH	19.5	20.0-27.0 pg
MCHC	35.8	30.0-38.0 g/dl

Histopatolojik bulgular

Operasyon sırasında alınarak formol içerisinde gönderilen karaciğer dokusu örneği %10'luk nötral formalin solüsyonunda 48 saat süreyle bekletilerek tespiti sağlandı. Tespit işlemi tamamlandıktan sonra 8 saat çeşme suyunda yıkandı. Kasetlere alınan dokular rutin alkol ksilol serilerinden geçirildikten sonra parafin bloklara alındı. Bloklardan 5 µm'lik kesitler lam üzerine alınarak deparafinizasyon işlemine tabi tutulmasının akabinde hematoksilen-eosin ile boyandı. Boyama işleminde sonra kesitler ışık mikroskobunda değerlendirildi. Mikroskobik incelemede karaciğer dokusuna ait tümörlü hücrelerde belirgin şekilde pleomorfizm ve anizonükleozis görülürken (Şekil 5 A), sitoplazmalarda ise solgun karakterde eozinofilik inklüzyonlar (Mallory cisimcikleri) (Şekil 5 B) olduğu görüldü. Karaciğer dokusunda psöydoglanduler yapılar oluştuğu görüldü (Şekil 5 C). Oluşan bu yapıların çevresinde hepatositlerin sitoplazmasında çeşitli büyüklüklerde yağ vakuollerine rastlandı. Bununla birlikte incelenen kitlenin bazı bölgelerinde nekrotik odaklar olduğu gözlemlendi (Şekil 5 D). Yapılan incelemeler sonucunda elde edilen bulgular ışığında kitlenin hepatosellüler karsinom olduğu tespit edildi.



Şekil 5. A. Tümöral hücrelerde belirgin pleomorfizm ve anizonükleozis (oklar) ve sitoplazmada eozinofilik inklüzyonlar (Mallory cisimcikleri), (ok başları). 40x **B.** Sitoplazmada eozinofilik inklüzyonlar (Mallory cisimcikleri) (oklar) ve yağ vakuolleri (ok başları). 40x **C.** Psöydoglanduler yapılar (oklar) ve yağ vakuolleri (ok başları). 10x **D.** Nekrotik alan. 10x H&E

Tartışma

Karaciğer vücudun en büyük iç organı olup, kedi ve köpeklerde vücut ağırlığının yaklaşık %3'ünü oluşturur (Brown ve ark., 2017). Evcil hayvanlarda primer hepatoselluler tümörler (Hepatoselüler Karsinom) nadir olarak görülmektedir (Yener ve ark., 2001; Sarıtaş ve ark., 2014). Hepatoselüler Karsinom (HCC) en sık köpek ve sığırlarda, daha az sıklıkla ise domuz ve kedilerde görülmektedir (Yener ve ark., 2001; Sarıtaş ve ark., 2014). Daha çok karaciğerin sağ lobuna yerleşerek gelişim gösteren hepatoselluler karsinom masif, nodüler ve diffüz olmak üzere makroskobik olarak üç morfolojik gruba ayrılmakta olup, en sık görüleni tek karaciğer lobuna yerleşen masif lezyondur (Yener ve ark., 2001; Seki ve ark., 2011; Sarıtaş ve ark., 2014). Sunulan bu olguda tespit edilen hepatosellüler karsinoma ait neoplastik oluşumların karaciğerin sağ ve sol lobuna yerleşerek gelişim gösterdiği ve diffuz lezyonlar şeklinde olduğu belirlendi. Köpeklerde yaş ilerledikçe neoplazi oluşma ihtimalinin büyük bir şekilde arttığı bir çok araştırmacı tarafından belirtilmektedir (Dobson ve ark., 2002; Kashyap ve ark., 2013; Güreşen, 2018). Çalışmayı oluşturan olgumuzun 11 yaşında olması bu görüşü destekler niteliktedir.

Hepatosellüler karsinom tespit ettiğimiz melez ırkı dişi köpekte cinsiyet yönünden ayrım yapmamız olgumuzun sayısı yönünden mümkün olmasada neoplazi yönünden yapılan çalışmalarda erkeklerde dişilere oranla neoplastik oluşumların daha çok görüldüğü bildirilmektedir (Brønden ve ark., 2010; Güreşen , 2013). Biyokimyasal ölçümlerde ALP, AST, ALT ve GGT düzeyinin artması muhtemel karaciğer ve safra kanallarında bir yangı olduğunun göstergesidir. Ayrıca biyokimyasal parametrelerden CREA, P ve BUN seviyelerinin yükselmiş olması muhtemel böbrek hasarının da var olduğunu işaret etmektedir. İnflamasyon, hemoliz ve malignite gibi pek çok durumda nötrofil proliferasyonuna bağlı olarak nötrofil sayısı artmaktadır (Abou monsef, 2019). Olgunun hemogram tablosunda, kandaki nötrofil yüzdesi artarken lenfosit yüzdesinin düştüğü görüldü. Nötrofil artışı malignant karakterdeki tümörlerde görülmektedir (Abou monsef, 2019). Hepatosellüler karsinom tespit ettiğimiz bu olguda da nötrofili belirlenmiştir.

Sonuç

Radyografik, ultrasonografik, biyokimyasal kan parametreleri, hemogram değerleri ve histopatolojik muayeneler neticesinde 11 yaşındaki melez ırkı erkek köpekte hepatosellüler karsinom teşhisi konulan olgunun ülkemizde az görülmesi nedeni ile önemli olduğu sonucuna varılmıştır.

Kaynaklar

Yener, Z., Keleş, İ. & Karaca, M. (2001). Bir Van kedisinde hepatoselluler karsinom. *Veteriner Bilimler Dergisi*. 17(2): 57·63.

Sarıtaş, Z.K., Bozkurt, M.F., Korkmaz, M., Başer, F.D. & Civelek, T. (2014). Hepatocellular Carcinoma in a Dog. *Journal of Faculty of Veterinary Medicine, Erciyes University*. 11(3): 221-225.

Seki, M., Asano, K., Ishikagi, K., Iida, G. & Watari, T. (2011). En block resection of a large hepatocellular carcinoma involving the caudal vena cava in a dog. *Journal of Veterinary Medical Science*. 73(5): 693-696.

Abou monsef, Y. (2019). Köpek ve kedilerde karaciğer bilier sistem hastalıklarının patomorfolojik değerlendirilmesi. Doktora Tezi. Ankara Üniversitesi, Sağlık Bilimleri Enstitüsü, Patoloji Anabilim Dalı. Ankara.

Brown, D.L., Van Wettere, A.J. & Cullen, J.M. (2017). Hepatobiliary System and Exocrine Pancreas. In: Pathologic Basis of Veterinary Disease, 6th Ed., Ed.: Zachary JF, Elsevier, St. Louis, Missouri. 412-470.

Güreşen, G. (2018). Kedi ve Köpeklerde Kanser Prevalansının Retrospektif Araştırılması. Doktora Tezi. Afyon Kocatepe Üniversitesi Sağlık Bilimleri Enstitüsü, Cerrahi Anabilim Dalı, Afyon.

Özer, K. (1992). Kedi ve Köpeklerde Tümörlerin Cerrahi, İmmunoterapi ve Kemoterapi yoluyla sağaltımı Üzerinde Klinik Çalışmalar, Doktora Tezi, İstanbul Üniversitesi Sağlık Bilimleri Enstitüsü, İstanbul.

Dobson, J. M., Samuel, S., Milstein, H., Rogers, K., & Wood, J. L. N. (2002). Canine neoplasia in the UK: estimates of incidence rates from a population of insured dogs. *Journal of Small Animal Practice*, 43(6), 240-246.

Kashyap, D. K., Tiwari, S. K., Giri, D. K., Dewangan, G. & Sinha, B. (2013). Cutaneous and subcutaneous tissue neoplasms in canines: Occurrence and histopathological studies. *African Journal of Agricultural*, 8(49), 6569-6574.

Brønden, L. B., Nielsen, S. S., Toft, N. & Kristensen, A. T. (2010). Data from the Danish veterinary cancer registry on the occurrence and distribution of neoplasms in dogs in Denmark. *The Veterinary Record*, 166(19), 586.

GIDA OLARAK MİKROALGLER

Ceyda DADALI* (ORCID: 0000-0003-2102-8582)
Ege University, Faculty of Engineering, Department of Food Engineering, İzmir-Türkiye
Email: ceyda.dadali@gmail.com

Yeşim ELMACI (ORCID: 0000-0001-7164-838X)
Ege University, Faculty of Engineering, Department of Food Engineering, İzmir-Türkiye
Email: yesim.elmaci@ege.edu.tr

ÖZET
Dünya nüfusunun hızla artması nedeniyle gıda üretimi artan talebe yetişmekte zorlanmakta ve bu da potansiyel bir gıda krizine yol açmaktadır. Ayrıca, artan çevresel kaygılar da gıda tedarik sistemlerinde değişiklik yapılmasını zorlamaktadır. Mikroalgler geleceğin potansiyel gıdaları olarak giderek daha fazla dikkat çekmektedir. Mikroalgler, güçlü karbon tutma kabiliyeti ve yüksek fotosentetik verimlilik gibi bazı avantajlara sahiptir. Gelecekteki gıda tedarik sisteminde ve dünyanın karbon nötral sürecinde önemli bir rol oynamaları beklenmektedir. Mikroalgler, geleneksel hayvancılığa kıyasla önemli ölçüde daha az arazi kullanımı nedeniyle yeni gıda ürünleri için oldukça önemli bir kaynak oluşturmaktadır. Mikroalgler önemli miktarda protein (%11-71), karbonhidrat (%6-57), yağ (%2-77), çoklu doymamış yağ asitleri içermektedir. Mikroalgler, fırınlanmış ürünler (ekmek, kurabiye, bisküvi, hamur işleri ve krakerler), balık ürünleri, süt ürünleri, makarna, içecekler ve atıştırmalıklar gibi çeşitli gıda ürün kategorilerinde kullanılmaktadır. Son çalışmalar, mikroalglerin fizikokimyasal ve besinsel özellikleri iyileştirmek için gıda ürünlerinde yer alabileceğini göstermiştir. Bununla birlikte, mikroalglerin gıda formülasyonlarına dahil edilmesi, özellikle mikroalglerin yoğun rengi veya balık tadı ve kokusu nedeniyle bazı zorluklara neden olmaktadır. Pratik uygulama şu anda yüksek üretim maliyetleri, düşük ürün kabulü ve belirsiz güvenlik ile sınırlanmaktadır. Bu çalışmada mikroalglerin gıda olarak kullanımı hakkında bilgi verilmesi amaçlanmaktadır.
Anahtar Kelimeler: mikroalgler, gıda, alternatif gıda

MICROALGAE AS FOOD

Abstract
Due to the rapid growth of world population, food production is struggling to keep up with increasing demand, leading to a potential food crisis. Also, growing environmental concerns are forcing changes to food supply systems. Microalgae are gaining increasing attention as potential future food. Microalgae have some advantages, including strong carbon sequestration ability and high photosynthetic efficiency. They are expected to play an important role in the future food supply system and the world's carbon neutral process. Microalgae are a highly important source of new food products due to its significantly smaller land use compared to traditional livestock. Microalgae contain significant amounts of protein (11-71%), carbohydrates (6-57%), fat (2-77%), polyunsaturated fatty acids. Microalgae used in several food product category such as baked products (bread, cookies, biscuits, pastries, and crackers), fish products, dairy, pasta, beverages, and snacks. Recent studies have showed that microalgae can take place in food products to improve physicochemical and nutritional properties. However, including microalgae in food formulation causes some challenges mainly due to microalgae's intense colour or fishy taste and odour. The practical application is currently limited by high production costs, lower product acceptance, and uncertain safety. In this study, it is aimed to give information about the use of microalgae as food.
Keywords: microalga, food, alternative food

Introduction

Over past 50 years, advancements in agricultural technology, food production, processing, and supply chains, as well as an increase in income per capita, have caused significant reductions in global hunger. This is even though the world population nearly doubled during the same time. However, population is increasing rapidly and could reach 9.7 billion by 2050. A 70% increase in food production is needed for feeding the increasing population (Bleakley et al., 2017; Godfray et al., 2010). Recent studies indicate that worldwide food production has significant environmental effects on planet and is responsible for generating 30-34% of global greenhouse gas emissions (Tukker et al., 2006; Vermeulen et al., 2012).

Microalgae are a highly important source of new food products due to its significantly smaller land use compared to traditional livestock. The land use of microalgae is only 1.7-5.4 m^2/kg protein meal, while eggs require 26-135 m^2/kg protein, beef requires 76-166 m2/kg protein, and pork requires 40-76 m^2/kg protein (Smetana et al., 2017; Ciani et al., 2021). In comparison to traditional crops, microalgae do not require herbicides or pesticides, are not limited by land conditions or season, and are defined as a source of bioactive compounds in food. It is important to note that microalgae are not only environmentally friendly but also have potential health benefits. In comparison to traditional crops, microalgae are an important source of bioactive compounds in food. Microalgae contain a range of bioactive compounds, including essential amino acids, bioactive peptides, polyunsaturated fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), chlorophylls, carotenoids, phycobiliproteins, polysaccharides, vitamins, polyphenols, and phytosterols (Levasseur et al., 2020).

In recent years, microalgae have become significant crop for global food and beverage industries, aquafarming, animal and human nutrition. Humans have a long history of consuming microalgae, dating back over 2000 years. However, only a few wild microalgae species, such as *Arthrospira platensis* (Spirulina), *Chlorella vulgaris* (Chlorella), and *Aphanizomenon* were grown for human consumption or use (Wang et al., 2021).

Microalgae as Human Food

Algae are living organisms that can be either multicellular or unicellular. They can be classified as macroalgae or microalgae depending on their size. There are over 50,000

microalgal species found in oceans and freshwater bodies such as lakes, ponds, and rivers. However, only 30,000 of these species have been studied (Richmond, 2004). Humans have been consuming microalgae as food for thousands of years (Milledge, 2011). Microalgae used in foods include *Arthrospira platensis, Arthrospira maxima, Chlorella luteoviridis, Chlorella vulgaris, Chlorella protothecoides, Chlorella pyrenoidesa, Dunaliella salina, Dunaliella bardawil, Haematococcus pluvialis, Schizochytrium* sp., *Ulkenia* sp., *Prototheca moriformis, Aphanizomenon flos-aquae, Tetraselmis chui, Euglena gracilis, Crypthecodinium cohnii, Chlamydomonas reinhardtii, Nostoc sphaeroides, Nannochloropsis gaditana* and *Odontella aurita* (Chen et al., 2022).

Microalgae contain significant amounts of protein (11-71%), carbohydrates (6-57%), fat (2-77%), polyunsaturated fatty acids such as arachidonic acid, eicosapentaenoic acid, and docosahexaenoic acid, and vitamins including A, B_1, B_2, B_3, B_6, B_9, B_{12}, C, E, D_3, and K_1. They also serve as a source of secondary metabolites. The health benefits of microalgae are mainly attributed to the presence of secondary metabolites. Microalgae are important sources of various secondary metabolites, such as pigments (phenolics, carotenoids such as β-carotene, lutein, fucoxanthin, astaxanthin, azeaxanthin, and chlorophyll), phytosterols, and mycosporine-like amino acids. These metabolites are known to be valuable for health due to their antioxidant, antimicrobial, antitumor, anti-inflammatory, and anticancer properties. Therefore, due to their renewability and abundance of high-value bioactive compounds, microalgae are considered as a sustainable and healthy food alternative (Ampofo and Abbey, 2022; Hosseinkhani et al., 2022).

Foods containing microalgae are divided into two main groups: those containing microalgae biomass as a colorant and those using microalgae to improve nutritional, physicochemical, and/or sensory attributes of food. Microalgae have been used in baked products (bread, cookies, biscuits, pastries and crackers), fish products, dairy, pasta, beverages and snacks.

Microalgal biomass could be effectively used in bread formulations to obtain high quality products. The protein content of bread samples was increased with microlagae enrichment. Most of the studies published to date reported an increase in the protein content of breads after incorporation of microalgal biomass into their formulations. Furthermore, microalgae concentrations higher than 3% resulted in limitations, such as

reduced loaf volume and negative sensory properties. Microalgae's green colour, which is not typically related with bread, is one of the primary factors limiting its use in baked goods. While the addition of 1-3% *Chlorella vulgaris* to croissants improved their colour, taste, and smell, the use of *Arthrospira platensis, Tetraselmis suecica, Phaeodactylum tricornutum,* and *Chlorella vulgaris* at a ratio of 2-6% negatively affected the colour, smell, taste, and texture of crackers (Shalaby and Yasin, 2013; Batista et al., 2019). In another study, the addition of *Spirulina maxima* to biscuits at a ratio of 20% increased the protein content by 40% without affecting the sensory properties (Paula da Silva et al., 2021).

Microalgae have been used in fish products, especially in fish burgers. *Chlorella minutissima, Isochrysis galbana* and *Picochlorum* sp. were incorporated into the fish burger formulation and an increase in carotenoids, chlorophyll content and an improvement in sensory properties were observed (Ben Atitallah et al., 2019; Barkallah et al., 2019).

Unpleasant colour, odour, taste, and texture occurred when microalgae were used up to 2% in cheese and yoghurt from dairy products. However, probiotic development was supported in these products. Pasta with microalgae has improved nutritional and functional properties, except containing high (20%) concentrations of microalgae. In addition to protein, EPA and DHA content increase, pasta with microalgae determined to have good acceptability scores. On the other hand, fishy taste of microalgae was perceived in pasta samples (Lafarga et al., 2019)

There are studies in which microalgae were added to nectar, kefir, and apple juice from the beverage group. The inclusion of microalgae in beverages had a positive effect on sensory properties and increased carotenoids, chlorophyll and protein content (Wajda et al., 2020; Aljobair et al., 2021; Atik et al., 2021). Microalgae have also been used in the enrichment of snack products. The use of 2.6% *Spirulin*a sp. in the extruded snack product positively affected the protein and mineral content, but unpleasant colour was determined by the consumer.

Conclusion

The products containing microalgae like non-animal proteins, high-value compounds are entering food market. Microalgae were used in baked bread, cookies, biscuits, pastries, crackers, fish products, dairy, pasta, beverages, and snacks. An increase in protein, ash,

mineral, phenolic, dietary fibre, polyunsaturated fatty acids, carotenoid, and chlorophyll content was determined in foods having microalgae. At the same time, an increase in the development of probiotics, antioxidant effect, decrease in moisture loss, increase in water retention and fat retention capacity were determined in foods with microalgae. On the other hand, the future use of microalgae-based foods in the food industry faces several challenges in improvement direction.

References

Aljobair, M. O., Albaridi, N. A., Alkuraieef, A. N., & AlKehayez, N. M. (2021). Physicochemical properties, nutritional value, and sensory attributes of a nectar developed using date palm puree and spirulina. *International Journal of Food Properties, 24*, 845–858.

Ampofo, J., & Abbey, L. (2022). Microalgae: Bioactive Composition, Health Benefits, Safety and Prospects as Potential High-Value Ingredients for the Functional Food Industry. *Foods, 11*(12), 1744.

Atik, D. S., Gurbuz, B., Boluk, E., & Palabiyik, I. (2021). Development of vegan kefir fortified with Spirulina platensis. *Food Bioscience, 42*.

Barkallah, M., Ben Atitallah, A., Hentati, F., Dammak, M., Hadrich, B., Fendri, I., et al. (2019). Effect of spirulina platensis biomass with high polysaccharides content on quality attributes of common carp (Cyprinus carpio) and common barbel (Barbus barbus) fish burgers. *Applied Sciences-Basel, 9*.

Batista, A. P., Niccolai, A., Bursic, I., Sousa, I., Raymundo, A., Rodolfi, L., ... & Tredici, M. R. (2019). Microalgae as functional ingredients in savory food products: Application to wheat crackers. *Foods*, *8*(12), 611.

Ben Atitallah, A., BarkaBah, M., Hentati, F., Dammak, M., Ben Hlima, H., Fendri, I., et al. (2019). Physicochemical, textural, antioxidant and sensory characteristics of microalgae-fortified canned fish burgers prepared from minced flesh of common barbel (Barbus barbus). *Food Bioscience, 30*.

Bleakley, S., & Hayes, M. (2017). Algal proteins: extraction, application, and challenges concerning production. *Foods*, *6*(5), 33.

Chen, C., Tang, T., Shi, Q., Zhou, Z., & Fan, J. (2022). The potential and challenge of microalgae as promising future food sources. *Trends in Food Science & Technology*.

Ciani, M., Lippolis, A., Fava, F., Rodolfi, L., Niccolai, A., & Tredici, M. R. (2021). Microbes: Food for the future. *Foods, 10.*

da Silva, S. P., do Valle, A. F., & Perrone, D. (2021). Microencapsulated Spirulina maxima biomass as an ingredient for the production of nutritionally enriched and sensorially well-accepted vegan biscuits. *Lwt*, *142*, 110997.

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., ... & Toulmin, C. (2010). Food security: the challenge of feeding 9 billion people. *science*, *327*(5967), 812-818.

Hosseinkhani, N., McCauley, J. I., & Ralph, P. J. (2022). Key challenges for the commercial expansion of ingredients from algae into human food products. *Algal Research*, *64*, 102696.

Lafarga, T. (2019). Effect of microalgal biomass incorporation into foods: Nutritional and sensorial attributes of the end products. *Algal Research*, *41*, 101566.

Levasseur, W., Perre, P., & Pozzobon, V. (2020). A review of high value-added molecules production by microalgae in light of the classification. *Biotechnology Advances*, *41*.

Milledge, J. J. (2011). Commercial application of microalgae other than as biofuels: a brief review. *Reviews in Environmental Science and Bio/Technology*, *10*, 31-41.

Richmond, A. (Ed.). (2004). *Handbook of microalgal culture: biotechnology and applied phycology* (Vol. 577). Oxford: Blackwell science.

Shalaby, S. M., & Yasin, N. M. (2013). Quality characteristics of croissant stuffed with imitation processed cheese containing microalgae Chlorella vulgaris biomass. *World J Dairy Food Sci*, *8*(1), 58-66.

Smetana, S., Sandmann, M., Rohn, S., Pleissner, D., & Heinz, V. (2017). Autotrophic and heterotrophic microalgae and cyanobacteria cultivation for food and feed: Life cycle assessment. *Bioresource Technology*, *245*, 162–170.

Tukker, A., & Jansen, B. (2006). Environmental impacts of products: A detailed review of studies. *Journal of Industrial Ecology*, *10*(3), 159-182.

Vermeulen, S. J., Campbell, B. M., & Ingram, J. S. (2012). Climate change and food systems. *Annual review of environment and resources*, *37*, 195-222.

Wajda, L., Rekas, Z., Tarko, T., Duda-Chodak, A., Liebersbach, A., & Makarewicz, M. (2020). Dried biomass of Arthrospira platensis inhibits growth of aureobasidium pullulans LW14 and some bacteria when added to unpasteurised apple juice. *Indian Journal of Microbiology*, *60*, 346–352.

Wang, Y., Tibbetts, S. M., & McGinn, P. J. (2021). Microalgae as sources of high-quality protein for human food and protein supplements. *Foods*, *10*(12), 3002.

BİTKİSEL PROTEİN BAZLI GIDALARIN DUYUSAL KALİTESİ

Ceyda DADALI (ORCID: 0000-0003-2102-8582)
Ege University, Faculty of Engineering, Department of Food Engineering, İzmir-Türkiye
Email: ceyda.dadali@gmail.com

Yeşim ELMACI (ORCID: 0000-0001-7164-838X**)**
Ege University, Faculty of Engineering, Department of Food Engineering, İzmir-Türkiye
Email: yesim.elmaci@ege.edu.tr

ÖZET
Bitki proteinleri, uzun kullanım ve yetiştirme geçmişi, düşük üretim maliyeti ve dünyanın birçok yerinde kolay bulunabilirliği nedeniyle insan beslenmesi için umut verici bir kaynaktır. Ancak bitki proteinlerinin çözünürlük, köpürme, emülsifiye etme ve jelleşme özelliklerinin zayıf olması onların gıda ürünlerinde kullanımını sınırlamaktadır. Bitkisel protein bazlı gıdalar geliştirilirken gıdanın farklı duyusal özelliklerinin belirlenmesi önemlidir. Duyusal özelliklerinin belirlenmesi, kalite özellikleri ve protein içeriği, konsantrasyonu ve diğer ürün parametreleri arasındaki ilişkilere ilişkin temel bir anlayış oluşturacağından, ürünün verimli bir şekilde geliştirilmesine yardımcı olmaktadır. Trendler, sosyal etkiler ve diğer çevresel faktörler nedeniyle tüketici beklentileri değişebileceğinden, yeni ürünler için kalite özelliklerinin belirlenmesini zorlaştırmaktadır. Bu nedenle ürün gruplarının nasıl genişletileceğini ve yeni ürünlerin pazarda nasıl görüntülendiğini öğrenmeye devam etmek önemlidir. Gıdanın tüm duyusal özellikleri, hayvansal proteinlerin bitkisel kökenli proteinlerle değiştirilmesinden etkilenmektedir. Bitkisel proteinin görünüş, koku, tat ve doku üzerindeki etkisi ise bitki bazlı analogların kategorisine göre farklılık göstermektedir. Bu çalışmanın amacı bitkisel protein bazlı gıdaların duyusal kalitesine genel bir bakış sağlamaktır.
Anahtar Kelimeler: bitkisel protein, bitkisel protein bazlı gıda, duyusal kalite

SENSORY QUALITY OF PLANT PROTEIN-BASED FOODS

ABSTRACT
Plant proteins are a promising source to human nutrition because of long usage period and cultivation, low production cost and easy availability around the world. On the other hand, plant proteins have low solubility, foaming, emulsifying and gelling attributes, which limits their use in food products. When developing plant protein-based foods, it is important to determine different sensory properties of the food. Determination of sensory properties helps in the efficient development of the product as it provides a basic understanding of the quality characteristics and the relationships between protein content, concentration, and other product parameters. For this reason, establishing quality attributes for new products can be challenging as consumer expectations can change due to trends, social impacts, and other environmental factors. It is important to keep learning how to extend product lines and how new products are viewed in the market. All sensory properties of food are affected by the replacement of animal proteins with those of plant origin. On the other hand, the effect of plant protein on appearance, odour, taste and texture varied according to the category of plant-based analogues. The aim of this study is to provide an overview of sensory quality of plant protein-based food.
Keywords: plant protein, plant protein-based food, sensory quality

Introduction

There is an increase in the demand for food with an increase in population. Under these conditions, meeting nutritional requirement involves not only sufficient calorie but also adequate macronutrient intake. Proteins are important macronutrients; however, the large-scale production of proteins is important problem. Proteins derived from an animal source has superior quality, however, the resources required to sustain are insufficient (Alcorta et al., 2021). An alternative protein source is necessary to overcome this problem. Plant-based proteins represent an alternative solution because they can be easily cultivated, has low production costs and are sustainable as well (Mistry et al., 2022).

Plant protein sources include grains (wheat, rice, millet, corn, barley, and sorghum), legumes (peas, soybeans, beans, broad beans, lupins, chickpeas, and cowpeas), pseudo cereals (buckwheat, quinoa, and amaranth), nuts (hazelnuts, peanuts, almonds, pistachios, and walnuts) and seeds (chia, pumpkin, sesame and sunflower) (Langyan et al., 2021). Protein contents range from 6-45%, but many plant proteins typically have suboptimal levels of essential amino acids. In legumes such as soybean, pea and lupine, the main protein fraction is globulin. While prolamins constitute the majority of proteins in most grains such as wheat, barley and corn, in oats and rice prolamins constitute approximately 5-10% of the total proteins. The predominant protein fraction in oats is globulin, in rice, glutenin constitutes 80% of the total rice protein and prolamin constitutes 20-30%. Nuts vary significantly in their protein composition, with glutelin being the main protein fraction in walnuts and pecans, whereas globulins are more abundant in almonds, Brazil nuts and pistachios. For oilseeds such as sunflower, the main protein fraction consist of globulins and albumins (Tan et al., 2021). Recently, there has been an increase in plant-based protein products found on markets because of growing interests in vegan and vegetarian diets. These products offer alternatives to animal-derived foods, including meat, dairy, eggs, and seafood (Manickavasagan et al., 2022).

Sensory Quality of Plant Protein Based Products

Plant proteins have been used in human nutrition for long time particularly in vegetarian and vegan diets. However, it has mainly been limited to culinary food services and households. In recent decades, there has been a significant expansion in plant protein-based foods, which has attracted considerable commercial interest (Tan et al., 2021). Within each food category, plant protein-based food products vary significantly in terms

of ingredients. For this reason, each analogue product aims to replicate various quality attributes, resulting in unique sensory experiences for consumers. To expand the use of plant-based protein products in various food applications, it is crucial to establish quality measures that deliver animal protein alternatives that closely resemble the original quality attributes. Product development continues to face challenges as many plant-based materials do not offer the desired sensory attributes of their animal-based equivalents (Manickavasagan et al., 2022).

Soy and pea are common plant proteins used in meat analogues. Plant-based proteins are found in various forms, such as flour, concentrate, isolate, and texturized vegetable proteins. These proteins possess functional properties, namely, water holding, gelling, fat absorption, and emulsification, which make them good for meat analogues. However, some components, including aldehydes, ketones, isoflavones, phenolics, and saponins, can cause beany, bitter, astringent, or metallic flavours, which are defined as off-flavours. To mask these off-flavours and form umami and meaty flavour, flavours and spices are commonly used. Colourants namely, beet extract and betanine are used in meat analogues to mimic meat appearance (Galankis et al., 2019). Meat analogues made from plant proteins lack juiciness and firmness. Hydrocolloids and gums are used as water and fat holder to perform a fibrous texture, enhance emulsion stability and overall sensory quality (Arora et al., 2017; Palanisamy et al., 2018).

Plant-based milk analogues are water-soluble extracts made from cereals, pseudo cereals, legumes, oilseeds, and nuts. These extracts undergo wet milling, filtration, and ingredient addition. Then sterilisation and homogenisation are performed to form stable emulsion which mimics cow's milk (Reyes-Jurado et al., 2021). When it comes to milk analogues, consumers may have a negative reaction to darker or greenish colours. However, the primary factor that drives overall consumer satisfaction is the aroma and flavour of the raw materials used (Appiani et al., 2023).

The texture and mouthfeel of plant-based yoghurts are crucial factors that influence product acceptability by consumers (Grasso et al., 2020; Greis et al., 2020). This is because plant proteins have varying concentrations and properties which typically necessitate the use of gelling agents to replicate the gelation properties of casein (Brückner-Gühmann et al., 2019). While the coconut-based yoghurt has raw odour, taste, and low bitterness and astringency, the soy-based yoghurt has sourness and raw

odour/taste in high intensity. Plant-based yogurts have a uniform, creamy, and thick texture, while plant-based cheeses are expected to have buttery, smooth, and soft attributes (Appiani et al., 2023). Soy-based cheeses have characteristic beany flavour and gritty mouthfeel, likely due to big particle sedimentation (Chumchuere et al., 2000; Li et al., 2013, 2020). Consumers generally dislike bitter off-tastes, sour tastes, and metallic or astringent sensations in dairy products. During production, it is important to control the derivation of raw materials (Appiani et al., 2023).

Conclusion

The replacement of animal proteins with plant-based alternatives affects all sensory properties of food. On the other hand, the importance of appearance, odour, taste, and texture varied depending on the category of plant-based analogues. Mitigating processing strategies were suggested to mask unpleasant sensory properties for each category. Dairy analogues are affected by the odour and flavour of the raw materials, while both meat and dairy analogue face issues with texture. Meat analogues lack juiciness, elasticity and firmness, while dairy analogues need a consistent, creamy and thick texture. Furter studies should be done to improve sensory properties of plant protein-based food.

References

Alcorta, A., Porta, A., Tárrega, A., Alvarez, M. D., & Vaquero, M. P. (2021). Foods for plant-based diets: Challenges and innovations. *Foods*, *10*(2), 293.

Arora, B., Kamal, S., & Sharma, V. P. (2017). Effect of binding agents on quality characteristics of mushroom based sausage analogue. *Journal of Food Processing and Preservation*, *41*(5), e13134.

Brückner-Gühmann, M., Banovic, M., & Drusch, S. (2019). Towards an increased plant protein intake: Rheological properties, sensory perception and consumer acceptability of lactic acid fermented, oat-based gels. *Food Hydrocolloids*, *96*, 201-208.

Chumchuere, S., MacDougall, D. B., & Robinson, R. K. (2000). Production and properties of a semi-hard cheese made from soya milk. *International journal of food science & technology*, *35*(6), 577-581.

Galanakis, C.M. (2019). *Sustainable Meat Production and Processing*. Academic Press: London, United Kingdom,

Grasso, N., Alonso-Miravalles, L., & O'Mahony, J. A. (2020). Composition, physicochemical and sensorial properties of commercial plant-based yogurts. *Foods*, *9*(3), 252.

Greis, M., Sainio, T., Katina, K., Kinchla, A. J., Nolden, A., Partanen, R., & Seppä, L. (2020). Dynamic texture perception in plant-based yogurt alternatives: Identifying temporal drivers of liking by TDS. *Food Quality and Preference*, *86*, 104019.

Langyan, S., Yadava, P., Khan, F. N., Dar, Z. A., Singh, R., & Kumar, A. (2022). Sustaining protein nutrition through plant-based foods. *Frontiers in Nutrition*, *8*.

Li, Q., Xia, Y., Zhou, L., & Xie, J. (2013). Evaluation of the rheological, textural, microstructural and sensory properties of soy cheese spreads. *Food and bioproducts processing*, *91*(4), 429-439.

Manickavasagan, A., Lim, L. T., & Ali, A. (2022). *Plant Protein Foods*. Cham, Switzerland: Springer.

Mistry, K., Sardar, S. D., Alim, H., Patel, N., Thakur, M., Jabbarova, D., & Ali, A. (2022). Plant based proteins: Sustainable alternatives. *Plant Science Today*, *9*(4), 820-828.

Palanisamy, M., Töpfl, S., Aganovic, K., & Berger, R. G. (2018). Influence of iota carrageenan addition on the properties of soya protein meat analogues. *Lwt*, *87*, 546-552.

Reyes-Jurado, F., Soto-Reyes, N., Dávila-Rodríguez, M., Lorenzo-Leal, A. C., Jiménez-Munguía, M. T., Mani-López, E., & López-Malo, A. (2023). Plant-based milk alternatives: Types, processes, benefits, and characteristics. *Food Reviews International*, *39*(4), 2320-2351. Tan, M., Nawaz, M. A., & Buckow, R. (2021). Functional and food application of plant proteins–a review. *Food Reviews International*, 1-29.

ÇEVRE DOSTU TARIMSAL ATIKLARIN GERİ DÖNÜŞÜME KATKILARI

Doç. Dr. Volkan GÜL (ORCID: 0000-0003-4899-2822)
Bayburt Üniversitesi, Aydıntepe Meslek Yüksekokulu, Gıda İşleme Bölümü
Email: volkangul555@gmail.com

Doç. Dr. Fırat SEFAOĞLU (ORCID: 0000-0002-8485-6564)
Kastamonu Üniversitesi Mühendislik ve Mimarlık Fakültesi Genetik ve Biyomühendislik Bölümü
Email: fsefaoglu@kastamonu.edu.tr

ÖZET

Son yıllarda artan dünya nüfusu ve teknolojik gelişmelere bağlı olarak hayat standardındaki artışlar, değişen tüketim alışkanlıkları çevre kirliliğini de beraberine getirmektedir. Özellikle ihtiyaçların karşılanması için yoğun tarımsal üretimler beraberinde yığınla tarımsal atık oluşturmaktadır. Tarımsal atık her türlü bitkisel ve hayvansal üretimlerde elde edilen ürünlerin elde edilmesi sonucu geriye kalan ve kullanılamayan kısımlar olarak ifade edilebilir. Yapılan bu tarımsal faaliyetler günümüzde artan insan nüfusunun gıda ihtiyacını karşılamak için birim alandan daha fazla ürün elde edebilmek amacıyla yapılan birtakım uygulamalar ve tarımsal atık miktarındaki artışlar sınırlı olan doğal kaynakların tüketilmesine ve çevre sorununa neden olmaktadır. Özellikle sürdürülebilir tarım politikaları hedefleri doğrultusunda oluşan aşırı derecede israf, ekonomik maliyet, çevre ve gıda güvenliği açısından büyük zararlar oluşturmaktadır. Enerjiye olan talep yenilenebilir enerji kaynaklarına olan ihtiyacı artırması, çevrede oluşabilecek tahribatın önlenmesi, bu alanda oluşacak istihdam sayesinde işsizlik oranının azaltılması gibi birçok önemli faktör tarımsal atıkların değerlendirilmesini zorunlu kılmaktadır. Bu kapsamda tarımsal atıklar üzerine oluşturulacak önlemler sayesinde doğal kaynakların korunması ve sürdürülebilir tarımın sağlanması için gerekli uygulamalardan bahsedilmiştir. Ayrıca karbonhidrat, yağ, protein ve zengin besin içeriğine sahip tarımsal atıkların katma değeri yüksek ürünlere dönüştürülmesi ve geri dönüşüme kazandırılan ürünlerin kullanım alanları hakkında bilgi verilmeye çalışılmıştır.

Anahtar Kelimeler: Tarımsal Atık, Geri Dönüşüm, Yenilenebilir Enerji, Çevre, Kirlilik

CONTRIBUTION OF ENVIRONMENTALLY FRIENDLY AGRICULTURAL WASTE TO RECYCLING

ABSTRACT

Increases in the standard of living and changing consumption habits due to the increasing world population and technological developments in recent years bring environmental pollution together. In particular, intensive agricultural production to meet the needs creates a lot of agricultural waste. Agricultural waste can be expressed as the remaining and unusable parts as a result of obtaining the products obtained in all kinds of plant and animal production. These agricultural activities today, in order to meet the food needs of the increasing human population, some practices carried out in order to obtain more products from the unit area and increases in the amount of agricultural waste cause the consumption of limited natural resources and environmental problems. Excessive wastage, especially in line with the objectives of sustainable agricultural policies, causes great damage in terms of economic cost, environment and food safety. Many important factors such as the demand for energy increasing the need for renewable energy sources, preventing the destruction of the environment, reducing the unemployment rate thanks to the employment in this field make it compulsory to utilize agricultural wastes. In this context, the necessary applications for the protection of natural resources and sustainable agriculture have been mentioned thanks to the measures to be taken on agricultural wastes. In addition, it was tried to give information about the transformation of agricultural wastes with carbohydrate, fat, protein and rich nutrient content into high value-added products and the usage areas of the recycled products.

Keywords: Agricultural Waste, Recycling, Renewable Energy, Environment, Pollution

GİRİŞ

İnsanoğlu yaşamsal süreci boyunca hayatta kalabilmek için doğanın nimetlerini hiç bitmeyecekmiş gibi kullanmışlardır. Sonraki yıllarda hızlı nüfuz artışı akabinde sanayinin gelişimi çevrenin hızlı bir şekilde tahribatı çevre sorunlarını beraberinde getirmiştir. Bu sorun gelişmiş ülkeler kadar geri kalmış ve gelişmekte olan ülkelerde de ciddi sorun haline gelmiştir. Bunun sebebi ucuz işçilik, hammadde sömürgeciliği gibi birtakım ihtiyaçlardan dolayı gelişmiş ülkelerin sanayilerini geri kalmış ve gelişmekte olan ülkeler taşımasından kaynaklanmıştır. Bu çevre sorunları bir ülke veya bölge değil tüm dünyayı tehdit ettiği için küresel bazda çözümlerin getirilmesi gerektiği anlaşılmıştır. Yapılan birçok araştırma kirliliğin oluşma nedenlerini ve bu kirliliğin önlenmesi için yapılması gereken tedbirlerin yanında doğal kaynakların doğru bir şekilde kullanılması ve oluşan doğal kirliliğin yeniden kullanılabilirliğinin sağlanması büyük önem taşımaktadır. Özellikle artan tüketimle birlikte meydana gelen atıkların yeniden farklı bir alanda kullanılmak üzere dönüştürülmesi çevrede oluşan ve istenmeyen kirliliğin minimize edilmesine olanak sağlamasının yanında ülke ekonomisine katkı, yeni iş kolları ve istihdam alanları oluşturmasına olanak sağlamaktadır (Çolakoğlu, 2018). Atık; tüketim sonucu kullanılmayarak çevreye zarar veren her türlü maddeye verilen isim olarak ifade edilmektedir (Gezer, 2015). Atık yönetimi yönetmeliğine göre ise; üreten, satan ve tüketen gerçek veya tüzel kişiler tarafından ürünlerin kullanılmayan kısımlarının çevreye atılması veya bırakılması gereken madde veya materyallere verilen ad olarak tanımlanmaktadır (Tenikler, 2007).

Dünya genelinde meydana gelen çevre kirliliği tüm canlıların hayatını ve doğal dengeyi tehdit etmektedir (Hasanoğlu, 2012). Tarımsal faaliyetler insanoğlunun yerleşik hayta geçtiği günden bugüne yoğun bir şekilde yapılmaya devem etmektedir. Tarımsal atıklar; tarımsal üretimler sonucu elde edilen here türlü tarımsal ürününü üretilmesi işlenmesi ve sonrası durumlarda oluşan yaprak, sap, saman, çekirdek, gübre, ot gibi atıklara tarımsal atık olarak değerlendirilmektedir (Palabıyık ve Altunbaş, 2004). Bitkisel ve hayvansal faaliyetler sonucu meydana gelen atıklar ilk dönemlerde kendi kendini törele ederken, son yıllarda artan nüfusa bağlı olarak artan gıda talebini karşılamak için konvansiyonel tarım sistemlerinin yoğun bir şekilde kullanılması doğal ortamların bozulmasına ve çevrenin tahribatına neden olan bir sektör olarak ortaya çıkmıştır. Üretim sonucu elde edilen ürünlerin ortalama %30'u kullanılamayan atık ürün olarak ortaya çıkmaktadır

(Gustavsson ve ark., 2011). Tarımsal üretimler sonucu elde edilen ürünlerin gıda olarak tüketimi sırasında meydana gelen israf çevresel, sosyal ve ekonomik yönden değerlendirildiğinde 1 milyon dalar kayıp, Çin'inin yüz ölçümüne eşdeğer oranda tarım arazisi kullanımı ve küresel bazda artan sera gazı emisyonlarının sorumlusu olarak ifade edilmektedir (Craig ve ark., 2016). 2021 yılında yayınlanan Birleşmiş Milletler Gıda İsrafı Endeksi Raporu'na göre maalesef ülkemiz en fazla gıda israfının yapıldığı ülkeler arasında ilk sırada yer almaktadır (Anonim, 2021). Gıda artıkları tarla üretiminden itibaren başlamaktadır. Sera ve arazi artıklarının çevreye olan zararını en aza indirebilmek ve geri dönüşümünü sağlamak için atıklardan kompostlama yapılarak değerlendirilmektedir. Ülkemizde tarımsal atıkları kompost haline getirilmesi işlemi sırasıyla Marmara, Akdeniz, Doğu Anadolu ve Karadeniz Bölgesi'nde yapılmaktadır (Çerçioğlu, 2019).

Son yıllarda çevresel atıklar küresel ölçekte konuşulan konular arasında yer almaktadır. Çevre üzerinde insan ve endüstriyel etkilerin artması çevresel konulara olan ilgi daha yoğun hale gelmiştir (Gelmez, 2020). Artan dünya nüfusu, kentsel alanlarda insan yoğunluğu ve aşırı tüketim çılgınlığı sonucu şehirlerde çöp yığınlarının oluşması hem depo olarak kirlenmesi hem de kaynakların sömürülmesine neden olmaktadır. Oluşan bu kirlilik ilk zamanlar kontrolsüz bir şekilde imha edilmesi insan sağlığı yönünden sıkıntı oluşturmazken zamanla hava, su ve topraklarda oluşan aşırı derecedeki kirlenme sağlık sorunlarını beraberinde getirmiştir. Bunun sonucu olarak çevreye olan zararı minimize etmek için oluşan atıkların geri kazanılması için düzenli katı atık kazanım sistemlerine geçiş yapılmıştır. Doğal kaynakların tükenmesinin önüne geçmek için daha az kaynak kullanımını sağlayacak ve maliyeti düşürecek ger kazanım kavramı ortaya atılmıştır (Aygün ve Yıldız, 2018). Oluşan tarımsal atıkların çevreye zarar vermeden ekonomik anlamda en verimli şekilde değerlendirilebilecek yöntemlerin belirlenmesi gerekmektedir.

Tarımsal atıkların ekonomik ve çevresel olarak katma değer oluşturması için yeniden kullanım, geri dönüşüm ve geri kazanımdan oluşan üç temel yöntem ortaya çıkmamaktadır (Karagözoğlu ve ark., 2009). Geri kazanım insanların aşırı yönde israfı neticesinde bilinçsiz tüketimi alışkanlıkları yerine daha bilinçli ve duyarlı tüketim davranışına dönüştürmek yatmaktadır. Tarımsal atıkların geri dönüşüme kazandırılması ile çevre kirliliğinin azaltılması ile gelecek nesillere temiz bir dünya bırakılması

sağlanacaktır. Çalışmada tarımsal atık ve tarımsal atıkların geri dönüşüme kazandırılması konularına değinilmiştir.

TARIMSAL ATIKLARIN GERİ DÖNÜŞÜME KAZANDIRILMASI

Tarımsal atıklar diğer atıklara göre çevreye verecekleri zararlar daha az olup, doğaya tekrar dönüşümleri kısa sürede olabilen materyallerdir. Tarımsal atıklar genellikle doğaya atılarak veya yakılma yöntemiyle yok edilmektedir. Oysaki tarımsal üretimlerden elde edilen atıkların değerli bir hammadde olabileceği ve değişik amaçlar için kullanılabileceği unutulmalıdır. Bu kapsamda ulusal ve uluslararası uzman kişiler tarafından yapılmış çevre ve tarım politikalarına yönelik plan ve programlar kullanılarak atıkların değerlendirilmesi gerekmektedir. Tarımsal atıkların geri dönüşüm şeklinde değerlendirilmesi çevreye vereceği zararları minimize ederek ekonomik anlamda gelir elde edilmesini sağlayacaktır. Genel atıklarda olduğu gibi tarımsal atıklarda farklılık gösterdiği için değerlendirme esnasında tarımsal atık çeşitlerine göre ayrılarak değerlendirilmektedir (Akırmak, 2010).

Tarımsal atık olarak bir bitkinin hasat işlemi esnasında yaprak, sap, kök, tabla gibi kullanılmayan kısımlarını ifade etmektedir. Hayvansal üretimlerde ise hayvanlara ait gübreleri, kılları, tırnak, kan, boynuz, deri gibi değerlendirmeye alınmayan kısımlarıdır. Tarımsal atıkların tekrardan kullanılmak üzere geri dönüşüme kazandırılması esnasında çevreninde denge unsuru göz önüne alınarak, doğaya zarar vermeden, doğanın ihtiyaç fazlasının geri dönüşümde kullanılmak üzere değerlendirilmesi gerekmektedir. Özellikle erozyona karşı ve besin ihtiyacı için toprak üzerinde kalması gereken bitik artıklarının ve yeterli seviyede hayvan gübresinin hesabı yapılarak geri kalan kısmının kullanılması gerekmektedir. Tarımsal atıkların geri dönüşüm sonucu kullanım amaçları da göz önüne alınarak hasat sonrası nemli, kur gibi faktörlerinde göz önüne alımasın gerekmektedir. Tarımsal atıkların ortaya çıkışı ve miktarı ile ilgili üretimin yapıldığı bölge, tarımsal atıkların sanayi hammaddesi olarak kullanılması, üretim yapılan toplumun gelir düzeyi, o bölgenin eğitim düzeyi, gelenek ve görenekleri, iklim koşulları gibi birçok faktör etkili olmaktadır. Tarımsal atıklar hayvansal, bitkisel ve ürünlerin üretilmesi esnasında ya da sonrasında meydana gelen atıklar şeklinde üç kısma ayrılmaktadır (Çolakoğlu, 2018).

Hayvansal atıklar: Hayvansal üretim ve sonrası elde edilen her türlü hayvan dışkısı, üretim esnasında hayvandan çıkan kıl tüyler, hayvanların yetiştirildikten sonra kesimi esnasında açığa çıkan, kemik, kan, tırnak, deri, iç organları gibi atıkları olarak ifade

edilmektedir. Bu atıkların doğru bir şekilde toplanması ve geri dönüşüme kazandırılması toplum sağlığını da koruma yönünde atılacak önemli adımlardır. Hayvan barınaklarından çıkan sıvı ve katı gübrelerin düzenli ve sağlıklı bir şekilde depolanıp muhafaza edilmesi çevreyi ve gübre kalitesini olumlu yönde etkilemektedir (Öztürk, 2008).

Bitkisel atıklar: Bitkisel üretimin ekim öncesi, ekim, ekim sonrası ve hasat olmak üzere tüm aşamasında meydana gelen atıklar olarak ifade edilmektedir. Bu atıklar çok kapsamlı olmakla birlikte, sap, saman, kabuk, somak, çekirdek, yaprak, budama atığı, kök gibi her türlü kullanılmayan kısımları ifade etmektedir (Eskicioğlu, 2013). Bu atıklar içerisine sera, sebze, meyve orman ürünleri de girmektedir. Atıkların etkin bir şekilde kullanılabilmesi için tarladan toplayacak, depolanacak ve taşıma gibi sistemlerin olması gerekmektedir.

Tarım ürünleri üretim atıkları: Tarım ürünleri üretim atıkları toprağın işlemeye başlamadan önce kurutma, öğütme, ayıklama, işlemleri esnasında açığa çıkan her türlü sap, saman, çekirdek, kabuk gibi atıklardır. Tarımsal üretim faaliyetleri esnasında ve sonrasında meydana gelen her türlü sap, şaman, çekirdek, kök, yaprak gibi atıklarda bu atıklar içerisinde sayılmaktadır (Şanlı, 2014). Tarımsal atıklar tarımsal üretimin yanında inşaat, enerji kimya, mobilya gibi çok geniş sektörler içinde önemli atıklar olarak kullanıldığı için geri kazandırılması son derece önemlidir.

Tarımsal Atıkların Kullanım Alanları

1. Yenilenebilir enerji kaynağı olarak kullanılması

Yenilenebilir enerji; herhangi bir müdahale olmadan doğal çevreden sürekli veya kademeli bir şekilde elde edilen enerji türü olarak ifade edilmektedir (Acaroğlu, 2013). Bu şekilde atıklardan elde edilen enerji sayesinde tarım sektörünün enerji ihtiyacının büyük bir kısmı karşılanabilmektedir. Fosil yakıtların çevreye ve atmosfere vermiş olduğu zararlar göz önüne alındığında çevreye dost yenilenebilir enerjinin ne kadar önemli olduğu ve ekonomik açıdan da avantajlı olmasından bu alana yönelik çalışmalar hız kazanmıştır (Özütemiz, 2017). Tarımsal atıkların yenilenebilir enerji olarak kullanılmasında ilk olarak biokütleden bahsedebiliriz. **Biokütle;** kısaca tarımsal ve orman ürünleri atıkları olarak ifade edilmektedir. Genellikle 100 yıl içerisinde karada ve suda yetişen bitkiler, hayvansal artıklar, besin sanayi orman ürünleri ve kentsel atıklar içeren tüm organik maddeler olarak ifade edilmektedir (Hotunoğlu, 2007). Biokütle katı, sıvı ve gaz şeklinde bulunabilmektedir. Biokütle malzemesi olarak sap, saman, kabuk, küspe,

talaş, ahşap gibi malzemeler örnek verilebilir. Biokütlenin fosil yakıtlara göre çevreye dost yenilenebilir enerji olduğundan üretilen enerjiye biyoenerji denilmektedir. Biokütleden enerji elde etme yöntemi olarak klasik yöntem olan yakarak enerji kaynağı elde etmek iken günümüzde ise çeşitli süreçten geçirilerek ısı, elektrik, yakıt olarak değerlendirilen bir enerji türüne dönüşmüştür (Saraçoğlu, 2010). Benzine alternatif olarak buğday, mısır, patates, pancar gibi ürünlerden etanol elde edilmesi, dizele alternatif olarak ayçiçeği, soya, kolza, aspir gibi yağlı tohumlardan elde edilen atık yağlardan biyodizel üretimi, odun, tarımsal ve endüstriyel atıkların öğütülüp sıkıştırılarak yakacak olarak kullanılan palet gibi ürünler elde edilmektedir. Bir diğer tarımsal atık yenilenebilir enerji olarak biyogazlar kullanılmaktadır.

Biyogazlar: her türlü hayvan dışkısı ve bitkisel atıkların oksijensiz ortamda işlenmesi sonucu elde edilen yanıcı bir gaz olarak tanımlanmaktadır (Öztürk, 2008). Bu şekilde elde edilen biyogazın bileşimde %60-70 metan, %30-40 karbondioksit, %0-2 hidrojen sülfür ile az miktarda azot ve hidrojen bulunmaktadır (Mahdıyan Nasl, 2015). Biyogaz üretiminde kullanılan organik atıklar; hayvan gübresi, kanalizasyon çamuru, tarımsal atıklar, gıda endüstri atıkları, biyolojik su arıtma atıkları, belediye atıkları olarak ifade edilebilir.

2. Tarımsal atıkların kompost olarak kullanılması

Kompost kısaca gübre oluşumu olarak ifade edilmektedir. Geniş bir tanım yapılacak olursak bitkisel ve hayvansal atıkların uygun nem ve sıcaklık altında fermente olması sağlanarak, organik gübreye dönüştürülmesi olayına kompost adı verilmektedir. Kompostlama işlemi sonucu kullanılan maddeler biyolojik parçalanma sonucu bitkiler için oldukça yarayışlı ve faydalı olan humus haline dönüşmektedir (Yıldız ve ark., 2009).

3. Yonga levha olarak değerlendirilmesi

Genellikle tarımsal atık olarak orman atıklarından yapılan yonga levhaların geri dönüşüme kazandırılması mobilya sektörü için oldukça önemli bir materyaldir. Genel olarak yonga levha; odun talaş parçalarından veya keten, kenevir, şeker kamışı gibi lignoselülozik malzemelerin tutkalla karıştırılarak sıcak olarak sıkıştırılması sonucu elde edilen levhalara verilen addır (Arslan, 2008). Bu şekilde kullanılabilecek tarımsal atıkların yoğun olduğu yerlerde iş imkânı ve istihdamının sağlanması açısından oldukça olumlu bir sonuç çıkacağı düşünülebilir.

4. Ağır metal gideriminde tarımsal atık kullanımı

Toprak içerisinde bitkiler için gerekli olan birtakım makro ve mikro elementler bulunmaktadır. Bu elementlerden bazılarının yoğunluğu 5 g/cm^3 fazla olması istenmeyen bir özellik olarak karşımıza çıkmakta olup, ağır metal olarak ifade edilmektedir. Bu elementlere örnek verecek olursak bakır, krom, demir, kobalt, civa, çinko gibi elementler ağır metal olarak belirtilmektedir. Bu elementlerin canlılar üzerinde ciddi sağlık problemleri oluşturduğundan ortamda aşırı derecede bulunması istenmemektedir (Bakar ve Baba, 2009). Ağır metal birikiminin azaltılması için kullanılan fiziksel ve kimyasal metotlar yetersiz ve pahalı olduğu için tarımsal atıkların absorbent olarak kullanılarak su içerisindeki ağır metal yoğunluğu azaltılabilecektir (Doğan, 2005).

5. Biyobozunur plastikler üretiminde tarımsal atıkların kullanımı

Biyobozunma doğaya atılmış bir maddenin belirli bir süre içerisinde mikro organizmalar tarafından ayrışarak tekrardan doğaya kazandırılması olarak tanımlanabilir. Genellikle bu tür maddeler plastik madde içerisine nişasta ve selülozik yapıdaki doğal tarımsal bitki artıklarının katılması ile gerçekleşmektedir. Özellikle hububat sapları, mısır koçanları, saman, talaş gibi nişasta içerikli atıklar katkı maddesi olarak kullanılmaktadır (Bahçegül, 2011).

6. Malç olarak değerlendirme

Malçlama terimini açıklamak gerekirse; bitki gelişimi için uygun koşulları sağlayacak enerji su dengesinin oluşturulması kullanılan yöntemlerden bir tanesidir. Malçlama işleminde genellikle tarımsal atık olarak saman ve kuru ot sapları kullanılmaktadır. Malçlama işlemi toprağın su tutma kapasitesini artırırken erozyon oluşumunun da önüne geçmektedir (Şener, 2015).

7. Mantar üretiminde kullanılması

Mantar yetiştiriciliğinde mantarın yetişme ortamının nemli ve besin değerinin yüksek olması istenmektedir. Bu ortamın sağlanmasında genellikle tarımsal atıklar kullanılmaktadır. Mantar yetiştiriciliğinde kullanılan tarımsal atıklar buğday samanı, mısır koçanı, pirinç kepeği gibi lignoselülezik maddeler mantar üretimi için istenilen koşulları sağalmaktadır (Hong ve ark., 2011). Bu tarımsal atıkların kullanılması hem üretim hem de atık değerlendirilmesi için oldukça değerli materyallerdir.

8. Kâğıt sanayisinde kullanılması

Tarımsal atıkların kâğıt üretiminin hammaddesi olarak değerlendirilmektedir. Üretim şekli odundan üretilen kâğıtta benzerlik göstermektedir. Tarımsal atıklar özellikle lifli bitki artıkları kâğıt yapımının hammaddesini oluşturmaktadır. Bunlara örnek olarak buğday sapı, kenevir, keten lifi, kamış bitkileri verilebilir. Ormanların yok edilmesinin önüne geçmek adına kâğıt üretimine alternatif olarak tarımsal atıkların kullanımı oldukça popüler olmuştur. Özellikle kenevir liflerinin bu alanda değerlendirilmesi ve kısa vadede ormanlardan elde edilecek ham kâğıt hamurundan daha fazla üretim olanağı olduğundan tarımsal atık olarak değerlendirilmesi oldukça önemlidir. Hızlı nüfus artışına bağlı kağıt üretimindeki artış tarımsal atıkların kağıt hamuru olarak değerlendirilmesi hem ekonomik yönden hem de çevre sorunu yönünden oldukça önemlidir (Atchison, 1989).

9. Yalıtım malzemesi olarak değerlendirilmesi

Genellikle yalıtım malzemesi olarak kullanılan malzemelerin petrol türevi ürünlerden elde edilmesi ve kullanılması insan sağlığı ve çevre sorunları açısından büyük problemlere neden olmaktadır. Bu sorunların en aza indirilebilmesi için genellikle lif ve selüloz özelliği olan tarımsal atıkların yalıtım malzemesi olarak kullanılması son derece önemlidir. Bu tür tarımsal atıklardan elde edilen yalıtım malzemeleri hafif olması, ses ve ısı yalıtımını diğer malzemelere göre daha iyi sağlaması tarımsal atıkları cazip hale getirmektedir (Esin ve Yüksek, 2008).

SONUÇ

Canlılığın devamı için gerekli olan temel ihtiyaçların başında beslenme gelmektedir. İnsanlar beslenme ve barınma gibi temel ihtiyaçlarını karşılayabilmek için tarım ve hayvancılıktan yararlanılmak zorundadır. Günümüzde artan dünya nüfusuna bağlı olarak artan beslenme ihtiyacı tarımsal gelişmeleri ve birim alandan daha fazla ürün almak için yoğun tarım uygulamaları ve çevresel etkileri hızlı bir şekilde görülmeye başlamıştır. Bunun sonucu olarak çevresel kirlenme, sera gazı etkisinin artması gibi ciddi problemleri beraberinde getirmiştir. Ayrıca fosil yakıtlarının azalma eğilimi ve enerji ihtiyacının artış göstermesi alternatif enerji ihtiyacını da gün yüzüne çıkarmıştır. Yoğum tarım ve üretim sonucu ortaya çıkan tarımsal atıklar çevreye rast gele atıldığı için çevrede ciddi anlamda kirliliğe sebebiyet vermiştir. Sonrasında oluşan küresel ısınma, enerji ihtiyacı ve çevre kirliliği dünya ülkelerinin bu tarz oluşan atıklara karşı birtakım önlemler alma yolunda çalışmalar yürütmeye başlamıştır. Günümüzde sıfır atık uygulamaları tarımsal atıklarında

geri dönüşüm şeklinde kazanımı ile çevreye olan sorunları minimize edilmiştir. Ayrıca bu şekilde değerlendirilen tarımsal atıklardan elde edilen yenilenebilir enerji sayesinde hem enerji ihtiyacının bir kısmının karşılanması sağlanmış hem de ülke ekonomisine ciddi anlamda gelir kaynağı sağlamıştır. Bu çalışmada tarımsal atıkların önemi, kullanım alanları ve çevreye olumlu etkiler hakkında bilgi verilmeye çalışılmıştır.

KAYNAKÇA

Acaroğlu, M. (2003). *Alternatif enerji kaynakları* (pp. 208-209). Atlas Yayın Dağıtım.

Akırmak, E. (2010). Tarımsal Atık Şeker Pancarı Küspesi İle Sürekli Çalışan Dolgulu Kolonda Teklifi Ve İkili Boyarmadde Ve Metal Gideriminin İncelenmesi. *Hacettepe Üniversitesi, Fen Bilimleri Enstitüsü, Kimya Mühendisliği Anabilim Dalı, Yüksek Lisans Tezi*.

Anonim. (2021). Birleşmiş Milletler Gıda Atıkları Endeksi, https://www.iklimhaber.org/. (Erişim Tarihi: 18.04.2022).

Arslan, M. B. (2008). *Orman ve tarımsal atıklardan üretilen kompozit levhalarda yüzey kimyasal özelliklerinin araştırılması* (Master's thesis, Fen Bilimleri Enstitüsü).

Atchison JE (1989). "New Developmentsin Non-wood Plant Fiber Pulping-A Global Perpective Wood and Pulping Chemistry Symposium", May, New Orleans Tappi Proccecdings pp.451-472.

Aygül, H. H., & Yıldız, D. (2018). Kentsel katı atık yönetimi kapsamında "çevreci komşu kart uygulaması". *Akdeniz İnsani Bilimler Dergisi*, *8*(2), 79-100.

Bahçegül, E. (2011). Tarımsal atıkların çevre dostu plastiklere dönüşümü. *Bilim ve Teknik*, *521*(2), 45-50.

Bakar C, Baba A (2009). "Metaller Ve İnsan Sağlığı: Yirminci Yüzyıldan Bugüne Ve Geleceğe Miras Kalan Çevre Sağlığı Sorunu" 1.Tıbbi Jeoloji Çalıştayı, 30 Ekim–1 Kasım 2009, Ürgüp Bld., Kültür Merkezi, Ürgüp/ NEVŞEHİR.

Craig, H., Lipinski, B., Robertson, K., Dias, D., Gavilan, I., & Gréverath, P. (2016). Food Loss and Waste Accounting and Reporting Standard. Executive summary. FLW Protocol, 160.

Çerçioğlu, M. (2019). Sürdürülebilir atık yönetiminde sera atıklarının kompost olarak değerlendirilmesi. *Bursa Uludağ Üniversitesi Ziraat Fakültesi Dergisi*, *33*(1), 167-178.

Çolakoğlu, B. (2018). Tarımsal atıkların alternatif kullanım alanları konusunda üretici eğilimleri. *Namık Kemal Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi, Tekirdağ-2018*.

Doğan N (2005). Ağır Metal Gideriminde Tarımsal Atık Kullanımı, İnönü Üniversitesi, Fen Bilimleri Enstitüsü, Biyoloji Ana Bilim Dalı, Yüksek Lisans Tezi.

Esin T, Yüksek İ (2008), "A Study on Ecologial Properties of Building Materials Used in Traditional Buildings (In Turkey) Facilities, Volume:26, Issue:5/6,pp. 229-241.

Eskicioğlu, A. V. (2013). *Bitkisel atıklardan kompost gübre üretim sisteminin tasarımı* (Master's thesis, Namık Kemal Üniversitesi).

Gelmez, E. (2020). The mediation role of environmental performance in the effects of green supply chain management practices on business performance. *Avrupa Bilim ve Teknoloji Dergisi*, (19), 606-613.

Gezer, N., 2015. Atık Yönetimi Mevzuatı Uygulamaları: Ankara Örneği. Yüksek Lisans Tezi. Gazi Üniversitesi Fen Bilimleri Enstitüsü. Ankara. 113s.

Gustavsson, U., Eriksson, T., Nemati, H. M., Singerl, P., & Fager, C. (2011). An RF carrier bursting system using partial quantization noise cancellation. *IEEE Transactions on Circuits and Systems I: Regular Papers*, *59*(3), 515-528.

Hasanoğlu, P. (2012). *Düzce evsel ve endüstriyel katı atıklarından geri kazanılabilir maddelerin potansiyelinin araştırılması* (Doctoral dissertation, SDÜ Fen Bilimleri Enstitüsü).

Hong, L. S., Ibrahim, D., & Omar, I. C. (2011). Lignocellulolytic materials-as a raw material for the production of fermentable sugars via solid state fermentation. *Asian Journal of Scientific Research*, *4*(1), 53-61.

Hotunluoğlu, H., & Tekeli, R. (2007). Karbon Vergisinin Ekonomik Analizi ve Etkileri: Karbon Vergisinin Emisyon Azaltıcı Etkisi Var Mı?. *Sosyoekonomi*, *6*(6).

Karagözoğlu, M. B., Özyonar, F., Yılmaz, A., & Atmaca, E. (2009). Katı atıkların yeniden kazanımı ve önemi. *Türkiye'de katı atık yönetimi sempozyumu*, (s 2).

Mahdıyan Nasl, B. (2015). Büyükbaş Hayvan Dışkısından Biyogaz Üreten Bir Reaktöre Peyniraltı Suyu Eklenmesinin Reaktörün Biyogaz Üretim Verimine Etkilerinin İncelenmesi. *Gazi Üniversitesi, Fen Bilimleri Enstitüsü, Çevre Bilimleri Anabilim Dalı, Yüksek Lisans Tezi*.

Öztürk, G. (2008). Edirne-Uzunköprü yöresindeki tarımsal işletmelerde ortaya çıkan hayvansal atıkların oluşturduğu çevresel sorunların belirlenmesi.

Özütemiz, E. (2017). *Avrupa Birliği enerji ihtiyacının karşılanmasında biyoyakıtların rolü* (Master's thesis, Sosyal Bilimler Enstitüsü).

Palabıyık, H., & Altunbaş, D. (2004). Kentsel katı atıklar ve yönetimi. *Çevre sorunlarına çağdaş yaklaşımlar: Ekolojik, ekonomik, politik ve yönetsel perspektifler*, 103-124.

Sabancı, A., Ören, M. N., Yaşar, B., Öztürk, H. H., & Atal, M. (2010). Türkiye'de biyodizel ve biyoetanol üretiminin tarım sektörü açısından değerlendirilmesi. *Ziraat Mühendisliği VII. Teknik Kongresi*, 11-15.

Şanlı, S. K. (2014). Farklı tarımsal artıkların Pleurotus eryngii mantar üretiminde kullanım olanakları. *Ondokuz Mayıs Üniversitesi, Fen Bilimleri Enstitüsü, Bahçe Bitkileri Anabilim Dalı, Yüksek Lisans Tezi*.

Şener, S., & Duran, C. N. (2020). Mikrobiyal İçerikli Bazı Bitki Büyüme Ve Gelişme Düzenleyicilerin Örtüaltı Çilek Yetiştiriciliğinde Bitkilerin Vejetatif Gelişimi Ve Meyve Kalitesi Üzerine Olan Etkileri. *Euroasia Journal of Mathematics, Engineering, Natural & Medical Sciences*, *7*(9), 31-38.

Tenikler, G. (2007). Türkiye'de tehlikeli atık yönetimi ve Avrupa Birliği ülkeleri ile karşılaştırmalı bir analiz. *Yayımlanmamış Doktora Tezi, Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü, İzmir*.

Yıldız, Ş., Ölmez, E., & Kiriş, A. (2009). Kompost teknolojileri ve İstanbul'daki uygulamaları. *Kompostlaştırma Sistemleri ve Kompostun Kullanım Alanları Çalıştayı*, 18-19.

KÜRESEL ISINMAYA BAĞLI İKLİM DEĞİŞİKLİĞİNİN ÜLKEMİZ TARIMINA OLUMSUZ ETKİLERİ

Doç. Dr. Volkan GÜL (ORCID: 0000-0003-4899-2822)
Bayburt Üniversitesi, Aydıntepe Meslek Yüksekokulu, Gıda İşleme Bölümü
Email: volkangul555@gmail.com

Doç. Dr. Fırat SEFAOĞLU (ORCID: 0000-0002-8485-6564)
Kastamonu Üniversitesi Mühendislik ve Mimarlık Fakültesi Genetik ve Biyomühendislik Bölümü
Email: fsefaoglu@kastamonu.edu.tr

ÖZET
İnsanların tüketim çılgınlığına bağlı olarak doğal kaynaklarımızı aşırı derecede sömürmesi ve tahrip etmesi doğanın dengesinin bozulmasına neden olmuştur. Doğanın tahribatı ile birlikte canlı türlerinin nesillerinin yok olması, açlık, toprak ve ormanların tahribata uğraması, susuzluk, çevre kirliliği, ozon tabakasının incelmesine bağlı olarak küresel ısınma ve iklim değişikliği gibi önemli sorunları beraberinde getirmiştir. Bu sorunların oluşmasında en önemli faktör olarak küresel ısınma ve iklim değişikliği gelmektedir. Küresel ısınma sanayi ve teknolojik gelişme ile birlikte atmosfere salınan gazların sera etkisi sonucu dünya atmosferinde meydana gelen tahribata bağlı olarak dünya yüzeyinde sıcaklığın artması olayıdır. Küresel ısınmaya bağlı olarak artan sıcaklıklar ülkesel ve bölgesel olarak iklim değişikliğine sebebiyet vererek ılıman ve yağışlı bölgelerde yağış ve sıcaklığa bağlı olarak taşkın, sel, fırtına gibi doğal afetlerin artmasına, kurak bölgelerde ise aşırı kuraklığa ve susuzluğa neden olmaktadır. Dünya üzerinde büyük sorun haline gelen küresel ısınma ve iklim değişikliği nedeniyle meydana gelen hava değişiklikleri zorunlu ihtiyacımız olan su ve gıdaya ulaşımı güçleştirmeye başlamıştır. Son yıllarda kendisini hızla hissettiren bu olaylar toprak erozyonu, kuraklık, bitki üretim çeşitliliğinin azalması gibi bir takım tarımsal faaliyetleri sekteye uğrattığı için tarım yapmayı güçleştirmektedir. Bu derlemede küresel ısınmanın tarımsal faaliyetlere olumsuz etkileri, iklim değişikliğine bağlı olarak tarım faaliyetleri ve suyun ekonomik kullanımı gibi birçok faktörler üzerinde bilgi verilmeye çalışılacaktır.
Anahtar Kelimeler: Küresel Isınma, İklim Değişikliği, Tarımsal Üretim, Kuraklık

NEGATIVE EFFECTS OF CLIMATE CHANGE DUE TO GLOBAL WARMING ON OUR COUNTRY'S AGRICULTURE

ABSTRACT

Excessive exploitation and destruction of our natural resources due to human consumption frenzy has caused the balance of nature to deteriorate. The destruction of nature has brought along important problems such as the extinction of species, hunger, destruction of soil and forests, thirst, environmental pollution, global warming, and climate change due to ozone depletion. Global warming and climate change are the most important factors in the formation of these problems. Global warming is the phenomenon of increasing temperature on the earth's surface due to the destruction of the earth's atmosphere as a result of the greenhouse effect of gases released into the atmosphere with industrial and technological development. Increasing temperatures due to global warming cause climate change nationally and regionally, leading to an increase in natural disasters such as floods, floods and storms due to precipitation and temperature in temperate and rainy regions, and extreme drought and thirst in arid regions. Weather changes due to global warming and climate change, which have become a major problem in the world, have started to make it difficult to access water and food, which we need. These events, which have made themselves felt rapidly in recent years, make it difficult to do agriculture because they disrupt a number of agricultural activities, such as soil erosion, drought, and a decrease in plant production diversity. In this review, it will be tried to give information on many factors, such as the negative effects of global warming on agricultural activities, agricultural activities due to climate change, and economic use of water.

Keywords: Global Warming, Climate Change, Agricultural Production, Drought

GİRİŞ

Dünyanın varoluşuyla birlikte gerçekleşen yaşam döngüsü içerisinde oluşan birtakım değişimler canlıların yaşayabileceği ve doğanın kendini yenileyebileceği şekilde ilerlemeye devam etmiştir. İnsanlığın yerleşik düzene geçmesi ile birlikte doğanın ve çevrenin tahribatı doğal nedenlerden daha fazla etkisini göstermiştir. Bu tahribatın sebebi olarak günümüzde küresel ısınmaya bağlı olarak meydana gelen iklim değişikliğinin etkisi daha fazla hissedilmeye başlamıştır. Küresel ısınma sadece ülkemizi değil tüm dünya ülkelerini ciddi anlamda etkileten büyük sorun durumundadır. Küresel ısınma sonucu oluşan iklim değişikliğine sebep olan sanayileşme ve teknolojik gelişmelere bağlı olarak yürütülen ekonomik faaliyetlerin atmosferdeki sera gazını artırarak normalin üstüne çıkarması olarak gösterilmektedir. Atmosferde oluşan bu değişimler sıcaklığı artırarak dünyanın dengesi durumdaki buzulların erimesine ve deniz seviyesinin yükselmesine neden olmaktadır. Dünya genelinde meydana gelen iklim değişikliğine bağlı olarak aşırı yağış veya sıcaklık fırtına, kasırga, sel, kuraklık gibi iklim felaketlerine neden olduğundan ekosistemin dengesini bozarak bazı hayvan ve bitki türlerinin yok olmasına neden olmaktadır (Akalın, 2014; Bayraç & Doğan,2016).

İklim değişikliği meteorolojik bir olay olarak değerlendirilse de doğada besin maddesi dönüşümünü ve doğanın ve insanların ihtiyacı olan su dengesini olumsuz yönde tamamıyla değiştiren önemli bir potansiyele sahiptir. Bu yüzden iklim değişikliğinin doğrudan etkilediği alanlar tarım, gıda üretimi, balıkçılık, hayvancılık, ormancılık gibi insanların temel ihtiyaçlarını oluşturan beslenme alanlarıdır. Tarım sektörü istihdam, milli gelir, ihracat, tarıma dayalı sanayi gibi ülkenin ekonomik anlamda büyük gelir kaynaklarını oluşturduğundan önemli bir yere sahiptir. Tarım her ne kadar teknolojik gelişimlere paralele olarak gelişim gösterse de iklim ve çevre faktörleri tarımın sürdürülebilirliği için önemli faktörleri oluşturmaktadır. Tarım ülke ekonomisindeki yeri itibari ile küresel ısınmaya bağlı olarak meydana gelecek değişimler üretimi doğrudan etkileyeceğinden hem ülke ekonomisi hem de uluslararası ticareti önemli derecede etkilemektedir (Başoğlu & Telatar, 2013; Bayraç & Doğan,2016).

Tarım sektörü iklim değişikliğinden önemli derecede etkilendiği kadar iklim değişikliğine eden olan önemli faaliyet alanıdır. Tarımsal faaliyetlerdeki gelişmeler ve yoğun tarım sistemleri toprak işleme, gübreleme, ilaçlama, ürün işleme, aşırı enerji tüketimi, hayvan gübrelerinin kullanımı gibi birtakım faaliyetler karbon emisyonunu artırarak atmosferde sera gazının yoğunluğunun artmasına neden olmaktadır. Bu çalışmada küresel ısınma ve iklim değişikliğinin oluşumu ve önleme çabaları, tarım sektörü üzerindeki olumsuz etkileri incelenmeye çalışılmıştır.

İKLİM DEĞİŞİKLİĞİ, KÜRESEL ISINMA VE ÖNLEME ÇABALARI

Küresel ısınma ve iklim değişikliği tanım olarak birbirinden farklı kavramlardır. Küresel ısınma iklim değişikliğine etki eden sera gazı etkisi ile ilişkilendirilmektedir. İklim değişikliği dünyada meydana gelen her türlü olumsuz etkenlere bağlı olarak ortalama iklim değerlerinin uzun yıllar boyunca değişiklik göstermesi olarak tanımlanır. Birleşmiş Milletlere göre İklim değişikliği, belirli bir sürede gözlemlere dayanarak elde edilen verilere göre iklimin doğal olaylar karşısında değişimine ek olarak insan faaliyetleri nedeniyle atmosfer katmanı içerisindeki bileşimin artması veya azalması sonucu meydana gelen iklim değişikliği olarak tanımlanmaktadır (Unit Nations, 1992). Dünya üzerinde iklim değişikliği okyanus ve hava dolaşımlarında meydana gelen değişimler, güneşten gelen ışınım değişiklikleri, volkanik aktiviteler doğal süreçler adı altında içsel süreçler olarak, insan faaliyetlerine bağlı olarak atmosferde meydana gelen değişimler ise dışa bağlı süreçler olarak ifade edilebilir (Crowley, 2000; Başaoğlu ve Telatar, 2013).

Atmosfer tabakasında çok çeşitli gazlar bulunmamakla birlikte en fazla azot gazı (%78,08), oksijen (%20,95) ve karbondioksit (%0,93) gazı bulunmaktadır. Bu gazlar atmosfer içerisinde homojen bir şekilde dağılım göstermektedir. Normal şartlarda atmosfer bu gaz dengesi içerisinde güneşten gelen dalga boylarını dengeleyerek dünyanın iklim dengesini korumaya çalışır. Nitekim doğal ve yapay etkilere bağlı olarak atmosferde meydana gelen gaz birikimi sera etkisi yaparak dünyanın iklim dengesini bozmaktadır. Sera etkisini örnekle açıklayacak olursak, bitki yetiştiriciliği için kullanılan seralarda güneşten gelen kısa dalga boylu ışınlar geçirgenlik özelliği gösterirken uzun dalga boylu ışınların büyük çoğunluğu sera içerisinde hapsedilerek seranın sınması

sağlanır. Bu şekilde ticari değeri yüksek hassas bitkiler için istenilen yetişme ortamı sağlanmış olmaktadır. Aynı şekilde atmosfer üzerinde açık ve berrak havalarda kısa dalga boylu güneş ışınları atmosferden geçerek yeryüzüne ulaşır ve yer yüzü tarafından emilir. Yer küreden salınan uzun dalga boylu ışınlar ise uzaya kaçmadan bir kısmı atmosfer üzerinde eser miktarda bulunan sera gazları tarafından emilerek yeryüzüne tekrar gönderilir. Sera gazlarının en önemlileri olarak su buharı, karbondioksit, metan, diazotmonoksit ve ozon gazlarıdır. Dünya üzerindeki oluşan faaliyetler sonucu atmosfer içerisindeki eser miktarlardaki gazların artışı yer küreden gelen uzun dalga boylu ışınımları daha az geçirerek bünyesinde hapsetmesi yerkürenin olması gerekenden daha fazla ısınmasına neden olacağından bu sürece sera etkisi denilmektedir (Türkeş ve ark., 2000). Atmosferdeki gazların artışına sanayileşme, fosil yakıtlar, ormansızlaşma, yanlış arazi kullanımı, hatalı tarımsal uygulamalar gibi insan eliyle meydana gelen birçok faktörler sonucu atmosfere salınan CO_2, N_2O, CH_4, CFC, O_3 gibi sera etkisi yapan zehirli gazlar yerkürede ve denizlerde sıcaklık artışına sebep olarak büyük afetlere neden olmaktadır.

Küresel ısınma ise atmosfere salınan ve sera etkisi yapan zehirli gazların atmosfer üzerinde dengeli bir şekilde oluşmuş sera gazı etkisinin bir anda artırarak yerkürenin ve denizlerin normalin üstünde ısınması olayına verilen ad olarak tanımlanmaktadır (Dellal, 2008). Son yıllarda bu gazların atmosfer tabakasında hızla artması sera etkisini hızlandırarak yeryüzünün sıcaklığının giderek yükselmesine neden olmaktadır. Küresel ısınmaya neden olan doğal ve yapay olaylardır. Atmosfere en fazla zarar veren yapay olaylardır. Bunlarda genellikle sanayileşme, tarımsal uygulamalar, deterjan gibi kimyasal maddelerin üretimi, fosil yakıtlar, ormansızlaştırma karbondioksit başta olmak üzere diğer bütün gazların salınımına ve küresel ısınma olayının oluşmasına neden olmaktadır. Küresel ısınmaya neden olan faaliyetleri sıralayacak olursak enerji kullanımı %49, endüstri faaliyetler %24, Ormanların tahribatı %14 ve Tarımsal faaliyetler %13 olarak ifade edilmektedir (Bayraç, 2000; Temur, 2017).

Küresel ısınmaya bağlı oluşan iklim değişikliğine karşı mücadelede azaltım ve uyum politikası şeklinde iki yol uygulanmaktadır. Birinci yol olan azatlımda sera gazı etkisi yapan gazların salınımının mümkün olduğunca minimize edilmesi, ikinci yol olan uyum

politikası ise iklim değişikliği sonucu oluşan olumsuz şartlara göre tedbir alınarak bu şartlar altında yaşamayı öğrenmek olarak ifade edilmektedir. Küresel ısınmayı önleme amacıyla 1992 yılında Birleşmiş Milletler İklim Değişikliği Çerçeve Sözleşmesi kabul edilmiştir. Bu sözleşme çerçevesinde atmosferde oluşan sera gazı etkisini azaltmak için ekosistemlerin iklim değişikliğine doğal haliyle uyum ağlaması, gıda üretimini tehdit etmeyerek ekonomik kalkınmada sürdürülebilirliğin sağlanması şeklinde kararlar alınmıştır. Küresel ısınma ve iklim değişikliği alanında 1997 yılında imzalanan uluslararası Kyoto protokolü ile sanayi alanının öncüleri olan ülkelerde sera gazı salınımını azaltmak için gerekli tedbirleri almalarını yükümlülüğe bağlamamıştır (Bayraç, 2010; Bayraç ve Doğan, 2016).

KÜRESEL ISINMAYA BAĞLI İKLİM DEĞİŞİKLİĞİNİN TARIM ÜZERİNE ETKİSİ

İklimde meydana gelen değişimler gelişmekte olan ve ekonomileri tarıma dayalı ülkelerde yaşayan halkın yaşam koşullarını dezavantajlı hale sokmaktadır. Tarımla uğraşan halkın iklim değişikliğinin yıkıcı etkilerini çok daha fazla hissettiği için insanları bulundukları bölgelerden göçe zorlamaktadır. Tarım sektörünün küresel ısınmayı hem etkileyen hem de etkilenen bir özelliği vardır. İklim değişikliğine bağlı olarak aşırı kuraklık ve su kıtlığının oluşması yoksul halkın sağlığının tehlikeye düşmesine neden olmaktadır. Başta az gelişmiş ve gelişmekte olan ülkelerde tarımsal üretim ve gıda güvenliği iklim değişikliği nedeniyle tehlikeye girdiğinden bu ülkelerden yaşayan insanlar besin kaynaklarına ulaşmakta zorluk çektiklerinden açlıkla karşı karşıya kalmaktadırlar. Tarımsal faaliyetler dünya üzerinde meydana gelen iklim değişikliğinin önemli etkisi olan sera gazının ortalama %20'den sorumludur (Pathak ve Wassmann, 2007). Tarımsal faaliyetler olan ilaçlama, gübreleme, hayvan yetiştiriciliği, enerji tüketimi, bitki atıkları gibi sera gazı açığa çıkaran faaliyetler iklim değişikliğinin sebebi olarak gösterilmektedir (Houghton, 2003). Her ne kadar bu faaliyetler atmosferdeki sera gazı emülsiyonunu artırıcı ekti yaptığı belirtilse de dünya üzerinde yaşamlarının sürdüren insanların sağlıklı bir şekilde yaşamalarına olanak sağladığı da unutulmamalıdır.

Ülkemizde tarım sektöründe bölgesel bazlı yapılan çalışmalar farklı koşullarda yetişebilen çeşitlerin belirlenmesi, ilaçlama, gübre isteklerinin belirlenmesi, sulama ihtiyacı ve sulama sistemleri gibi birçok alanda gelişimler gösterse de tarımsal üretimin iklim ve çevresel faktörlerden direk etkilenmesi hala önemini koruduğu bilinmektedir. Tarımsal üretimde kullanılan gübreleme, tarım makineleri, kimyasal ilaçlar gibi gaz üretimine neden olan tarımsal etkinlikler atmosfere azot ve karbondioksit salınımını sağlamaktadır (Cangir vd., 2005). Son yıllarda küresel ısınmaya bağlı olarak ortaya çıkan iklim değişikliğinin ülkemizde yaratacağı olumsuz etkilerinin hayvansal ve bitkisel üretimlerde doğal yaşam alanlarının kısıtlanması ve su kaynaklarının kuruması gibi büyük sorunlar olarak karşımıza çıkabileceğidir. İklim değişikliğine bağlı olarak ortaya çıkan sıcaklık artışı ve karbondioksit miktarı tarımsal üretimlerde verimin yükselmesi açısından olumlu yönde bir gelişim olarak gözükse de toprak yapısında ve kalitesinde oluşabilecek olumsuzluklar, sıcaklığa bağlı olarak meydana gelen kuraklık ve toprağın nem miktarındaki düşüşler gibi birtakım olumsuzluklar uzun vadede üretimin azalmasına neden olabileceği göz ardı edilmemelidir. Nitekim iklim değişikliğinin sebep olduğu kuraklık, seller, fırtına gibi olayların yoğun bir şekilde yaşanması tarımsal üretimlerde ciddi anlamda azalmalara neden olmaktadır (Akalın, 2014).

Ülkemiz bulunduğu konum itibari ile küresel ısınmadan etkilenme oranı yüksek ülkelerden bir tanesidir. Ülkemizde son yıllarda görülen orman yangınları, kuraklık ve çölleşme ekolojik dengenin bozulmasında büyük etki oluşturabilecektir. Ülkemizin kurak veya yarı kurak bölgelerimizde meydana gelen iklim değişikliği yıllara bağlı olarak su kaynaklarının tamamen kurumasına neden olacağından tarımsal sulama ve içme suyu sıkıntıları baş göstereceği söylenebilir. Ayrıca bu bölgelerde tarım arazilerinde tuzluluk, çoraklaşma, erozyon ve çölleşme gibi olaylar hız kazanacağı düşünülmektedir. Bu gibi sorunlar ürün çeşitliliğini, ürün yetiştirme sezonlarının değişimine neden olabilecektir. İklim değişikliği tarım ve tarımsal faaliyetleri etkilenmesine neden olmaktadır. İklim değişikliğinin tarım üzerine etkileri üretimin yanında ekonomik dengelerinde ciddi anlamda bozulmasına neden olmaktadır (Dellal, 2008). Tarım sektöründe küresel ısınmaya bağlı olarak meydana gelen iklim değişikliğini önlemek amacıyla yapılması gerekenler; arazi toplulaştırması, organik tarım, iyi tarım uygulamaları, çevre amaçlı tarımsal arazilerin korunması (uygun toprak işleme, gübreleme, sulama, erozyonun önlenmesi, kültürel tedbirler alınması, üreticilerin küresel ısınmaya karşı bilinçlenmesi,

çevreyi kirletici uygulamalardan kaçınmak, üreticilere destek), tasarruf amaçlı suluma sistemlerinin belirlenmesi, tarım sigortası uygulaması, ARGE çalışmaları gibi tedbirlerin alınması gerekmektedir (Dellal ve ark., 2015 Temur, 2017).

SONUÇ

Tarım ve Ekonomi birbiri ile paralel bir ilişki içerisinde olduğu için tarım sektöründe meydana gelecek değişimler de ekonomiyi ciddi anlamda etkilemektedir. Dünyada yoğunlaşan sanayileşme ve fosil yakıt kullanımı sera gazı salınımını artırarak küresel ısınmaya neden olmaktadır. Küresel ısınmaya bağlı olarak ortaya çıkan iklim değişikliği geçmişten günümüze etkisini göstermiş, göstermeye de devam etmektedir. Sanayide gelişim ve yeşil devrimle birlikte kimyasal azotlu gübrelerin kullanılmasını ve modern tarımın gelişimi konvansiyonel tarımı artırdığından salınan karbondioksit ve metan gazı iklim değişikliğinde büyük rol oynamaktadır. Artan nüfusa bağlı olarak ihtiyaçlarında artması insanların çevreye ve atmosfere vermiş olduğu tahribatlar nedeniyle de küresel ısınma artışına neden olmuştur. Tarım sektörü küresel ısınmaya sebep olduğu gibi küresel ısınmadan da önemli derecede etkilenmektedir. Tarım sektörü insanların temel besin kaynaklarını karşılayan bir sektör olduğu için küresel ısınma ile ilgili sorunlar için tarım politikalarının geliştirilmesi oldukça önemlidir. Türkiye'de yağış ve karbonhidrat miktarının tarım sektörü için kritik seviyededir.

Küresel ısınmanın azaltılması dünya ülkelerinin birlikteliğinin yanında sanayinin geliştiği ülkelerin bu konuda daha büyük paya sahip olduğu unutulmamalıdır. Ülkemizde tarım politikalarının içerisinde küresel ısınmaya karşı mücadele yöntemleri ve küresel ısınma içerisinde tarımsal faaliyetlerin yürütülmesine yönelik çalışmaların yürütülmesi gerekmektedir. Özellikle iklim değişikliği ile ilgili mücadelede tarım sektörü bazında yenilenebilir enerji kaynaklarının kullanılması gerekmektedir. Bu sayede hava, toprak, su gibi doğal kaynakların korunması ve tarımsal sürdürülebilirliğinin sağlanması için fosil yakıt kullanımının azaltılması çevre üzerine önemli etkiler oluşturacağı düşünülmektedir. Türkiye biyoyakıt gibi yenilenebilir enerji kaynaklarına sahip olup, bu kaynakların kullanılması ve küresel ısınmaya neden olan yöntemler yerine doğaya dost tarım uygulamalarının uygulanması iklim değişikliğini azaltacağı kanaatindeyiz.

KAYNAKÇA

Akalın, M. (2014). İklim değişikliğinin tarım üzerindeki etkileri: Bu etkileri gidermeye yönelik uyum ve azaltım stratejileri. *Hitit Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *7*(2), 351-377.

Başoğlu, A., & Telatar, O. M. (2013). İklim değişikliğinin etkileri: tarım sektörü üzerine ekonometrik bir uygulama. *Karadeniz Teknik Üniversitesi Sosyal Bilimler Dergisi*, *6*, 7-25.

Bayraç, H. N. (2010). Enerji kullaniminin küresel isinmaya etkisi ve önleyici politikalar. *Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi*, *11*(2), 229-259.

Bayraç, N. H., & Doğan, E. (2016). Türkiye'de iklim değişikliğinin tarım sektörü üzerine etkileri.

Cangir, C., Türkeş, M., Boyraz, D., Akça, E., Kapur, B., Kapur, S., Haktanır, K. (2005). Uluslararası Sözleşmelerin Türkiye Tarımına Etkileri.TMMOB Zıraat Mühendisleri Odası 6. Teknik Tarım Kongresi'nde sunulan bildiri.

Crowley, T. J. (2000). Causes of climate change over the past 1000 years. *Science*, *289*(5477), 270-277.

Dellal, İ., Engürülü, B., Ulukan, H., Özevren, A. Ş., & Ünal, M. (2008). İklim Değişikliğinin Tarım Sektörüne Ekonomik Yansımaları. *Türkiye Ziraat Mühendisliği Vıu. Teknik Kongresi Bildiriler Kitabı-1*, 62.

Dellal, İ., Engürülü, B., Ulukan, H., Özevren, A. Ş., & Ünal, M. (2015). İklim Değişikliğinin Tarım Sektörüne Ekonomik Yansımaları. *Türkiye Ziraat Mühendisliği Vıu. Teknik Kongresi Bildiriler Kitabı-1*, 62.

Houghton, R. A. (2003). Why are estimates of the terrestrial carbon balance so different?. *Global change biology*, *9*(4), 500-509.

Pathak, H., & Wassmann, R. (2007). Introducing greenhouse gas mitigation as a development objective in rice-based agriculture: I. Generation of technical coefficients. *Agricultural Systems*, *94*(3), 807-825.

Temur, B. (2017). *Küresel İsınmanın Türkiye'De Tarım Sektörü Üzerine Etkisi: Bir Ardl Modeli Uygulaması* (Doctoral dissertation, Anadolu University (Turkey).

Türkeş, M. (2002). İklim Değişikliği: Türkiye-iklim değişikliği çerçeve sözleşmesi ilişkileri ve iklim değişikliği politikaları. *Çevre ve Sürdürülebilir Kalkınma Paneli Vizyon ve Öngörü Raporu*.

Unıted Natıons (1992), United Nations Framework Convention On Climate Change, New York. https://unfccc.int/resource/docs/convkp/conveng.pdf, (Erşim Tarihi: 03. Mart 2024).

SENOLİTİKLER

Doç. Dr. Kıvanç IRAK (ORCID: 0000-0001-9765-0330)
Siirt Üniversitesi, Veteriner Fakültesi, Biyokimya Anabilim Dalı Siirt -Türkiye
Email: kivancirak@hotmail.com

ÖZET
Yaşlanma, ölüm oranında sürekli bir artışın eşlik ettiği fizyolojik işlevde ilerleyici bir azalma olarak tanımlanmaktadır. Yaşlanma, demans, kanser, kardiyovasküler hastalıklar/ateroskleroz, akciğer hastalıkları, osteoporoz, artrit, diyabet/metabolik sendrom, böbrek yetmezliği gibi birçok ciddi kronik hastalık ve engellilik (körlük, kırılganlık) için önde gelen risk faktörüdür. Aynı zamanda yaşlanma ile birlikte kırılganlık, sarkopeni, hareketsizlik, düşme, depresyon, hafif bilişsel bozukluk, inkontinans ve kilo kaybı gibi geriatrik sendromlara yatkınlık artar. Hücresel yaşlanma, birçok somatik hücre tipini karakterize eden, genetik, epigenetik ve çevresel faktörlerin yönlendirdiği, geri dönüşü olmayan hücre bölünmesi yoluyla çoğalmanın durması ile karakterize bir durumdur. Yaşlanan hücreler yaşam süresi boyunca ortaya çıkabilir ve kalıcı olmaları halinde salgıladıkları birçok protein nedeniyle doku işlevi üzerinde zararlı etkilere sahip olabilir. Birçok yaşlanan hücre proinflamatuar sitokinler, kemokinler, proteazlar, biyoaktif lipitler, inhibitör moleküller, metabolitler, lipitler ve kronik inflamasyonu/doku fonksiyon bozukluğunu teşvik edebilen diğer faktörleri içeren yaşlanmayla ilişkili bir salgı fenotipi geliştirir. Yaşlanan hücreler biriktiğinde kronik, sistemik, düşük dereceli bir iltihaplanma indüklenir. Bu kronik bağışıklık sistemi aktivasyonu, yaşlanan hücre temizliğinin azalmasına neden olur ve böylece iltihaplanmayı körükleyen bir kısır döngü oluşturur. Doku ve organlardaki yaşlanan hücrelerin tanımlanması zor olduğundan, bu hücrelerin hakkındaki mevcut bilgilerin çoğu kültürlenmiş hücrelerdeki deneylere dayanmaktadır. Sağlık süresini ve muhtemelen yaşam süresini iyileştirmeye yönelik bir strateji olarak yaşlanmanın çeşitli özelliklerinin hedeflenmesi önerilmektedir. Klinik öncesi modellerde, kalıcı olan ve doku hasarına neden olan yaşlanan hücreleri hedef alan müdahalelerin birden fazla bozukluğu geciktirdiği, önlediği veya hafiflettiği gösterilmiştir. Bu doğrultuda, yaşlanan hücreleri seçici olarak temizleyen küçük moleküllü senolitik ilaçların keşfi, insanlarda çok sayıda hastalığın ve yaşa bağlı koşulların düzenlenmesi veya tedavisi için umut verici stratejilere yol açmıştır. Bu çalışmada senolitikler ile ilgili olarak güncel bilgiler sunularak, geleceğe yönelik perspektifler değerlendirilmiştir.
Anahtar Kelimeler: Senolitikler, Yaşlanan hücreler, Yaşlanma

SENOLITICS

ABSTRACT
Ageing is defined as a progressive decline in physiological function accompanied by a steady increase in mortality. Ageing is a leading risk factor for many serious chronic diseases and disabilities (blindness, frailty) such as dementia, cancer, cardiovascular disease/atherosclerosis, lung disease, osteoporosis, arthritis, diabetes/metabolic syndrome, renal failure. At the same time, susceptibility to geriatric syndromes such as frailty, sarcopenia, immobility, falls, depression, mild cognitive impairment, incontinence and weight loss increases with ageing. Cellular senescence is a condition characterised by the cessation of proliferation through irreversible cell division, driven by genetic, epigenetic and environmental factors, characterising many somatic cell types. Senescent cells can occur throughout the lifespan and, if persistent, can have detrimental effects on tissue function due to the many proteins they secrete. Many senescent cells develop an age-associated secretory phenotype that includes proinflammatory cytokines, chemokines, proteases, bioactive lipids, inhibitory molecules, metabolites, lipids and other factors that can promote chronic inflammation/tissue dysfunction. When senescent cells accumulate, a chronic, systemic, low-grade inflammation is induced. This chronic immune system activation leads to reduced senescent cell clearance, thus creating a vicious cycle that fuels inflammation. Since senescent cells in tissues and organs are difficult to identify, most of the current knowledge about these cells is based on experiments in cultured cells. Targeting various features of ageing has been proposed as a strategy to improve healthspan and possibly lifespan. In preclinical models, interventions targeting senescent cells that are persistent and cause tissue damage have been shown to delay, prevent or alleviate multiple disorders. Accordingly, the discovery of small molecule senolytic drugs that selectively clear senescent cells has led to promising strategies for the regulation or treatment of numerous diseases and age-related conditions in humans. In this study, current information on senolytics is presented and future perspectives are evaluated.
Keywords: Senolytics, Senescent cells, Ageing

Giriş

Yaşlanma, ölüm oranında sürekli bir artışın eşlik ettiği fizyolojik işlevde ilerleyici bir azalma olarak tanımlanmaktadır (Thoppil & Riabowol, 2020). Yaşlanma, demanslar, kanserler, kardiyovasküler hastalıklar/ateroskleroz, akciğer hastalıkları, osteoporoz, artrit, diyabet/metabolik sendrom, böbrek yetmezliği gibi birçok ciddi kronik hastalık ve engellilik (körlük, kırılganlık) için önde gelen risk faktörüdür (Miller, 2002; Kirkland, 2013). Aynı zamanda yaşlanma ile birlikte kırılganlık, sarkopeni, hareketsizlik, düşme, depresyon, hafif bilişsel bozukluk, inkontinans ve kilo kaybı gibi geriatrik sendromlara yatkınlık artar (Inouye ve ark., 2007).

Hücresel yaşlanma, onkogen kaynaklı stres de dahil olmak üzere farklı stres türleri tarafından yönlendirilen, geri dönüşü olmayan hücre bölünmesi yoluyla çoğalmanın durması ile karekterize bir durumdur (Zhang ve ark., 2023). Hücresel yaşlanmanın yaşa bağlı işlev bozukluklarına ve kronik hastalıklara katkıda bulunduğu öne sürülmüştür (Borghesan ve ark., 2020).

Birçok yaşlanan hücre proinflamatuar sitokinler, kemokinler, proteazlar, biyoaktif lipitler, inhibitör moleküller, metabolitler, lipitler ve kronik inflamasyonu/doku fonksiyon bozukluğunu teşvik edebilen diğer faktörleri içeren yaşlanmayla ilişkili bir salgı fenotipi (SASP) geliştirir (Zhang, ve ark., 2023). Yaşlanan hücreler yaşam süresi boyunca ortaya çıkabilir ve kalıcı olmaları halinde doku işlevi üzerinde zararlı etkilere sahip olabilirler. Yaşlanan hücreler biriktiğinde kronik, sistemik, düşük dereceli bir iltihaplanma indüklenir. Bu kronik bağışıklık sistemi aktivasyonu, yaşlanan hücre temizliğinin azalmasına neden olur ve böylece iltihaplanmayı körükleyen bir kısır döngü oluşturur. Sağlık süresini ve muhtemelen yaşam süresini iyileştirmeye yönelik bir strateji olarak yaşlanmanın çeşitli özelliklerinin hedeflenmesi önerilmektedir (Lagoumtzi & Chondrogianni, 2021). Farelerde yaşlanan hücrelerin seçici olarak ortadan kaldırılmasının (senoliz), ortalama yaşam süresini uzattığı ve yaşla ilişkili hastalıkları önlediği veya hafiflettiği bildirilmektedir (Baker ve ark., 2011; Baker ve ark., 2016). Doku ve organlardaki yaşlanan hücrelerin tanımlanması zor olduğundan, bu hücrelerin hakkındaki mevcut bilgilerin çoğu kültürlenmiş hücrelerdeki deneylere dayanmaktadır. Klinik öncesi modellerde, kalıcı olan ve doku hasarına neden olan yaşlanan hücreleri hedef alan müdahalelerin birden fazla bozukluğu geciktirdiği, önlediği veya hafiflettiği gösterilmiştir. Bu doğrultuda, yaşlanan hücreleri seçici olarak temizleyen küçük

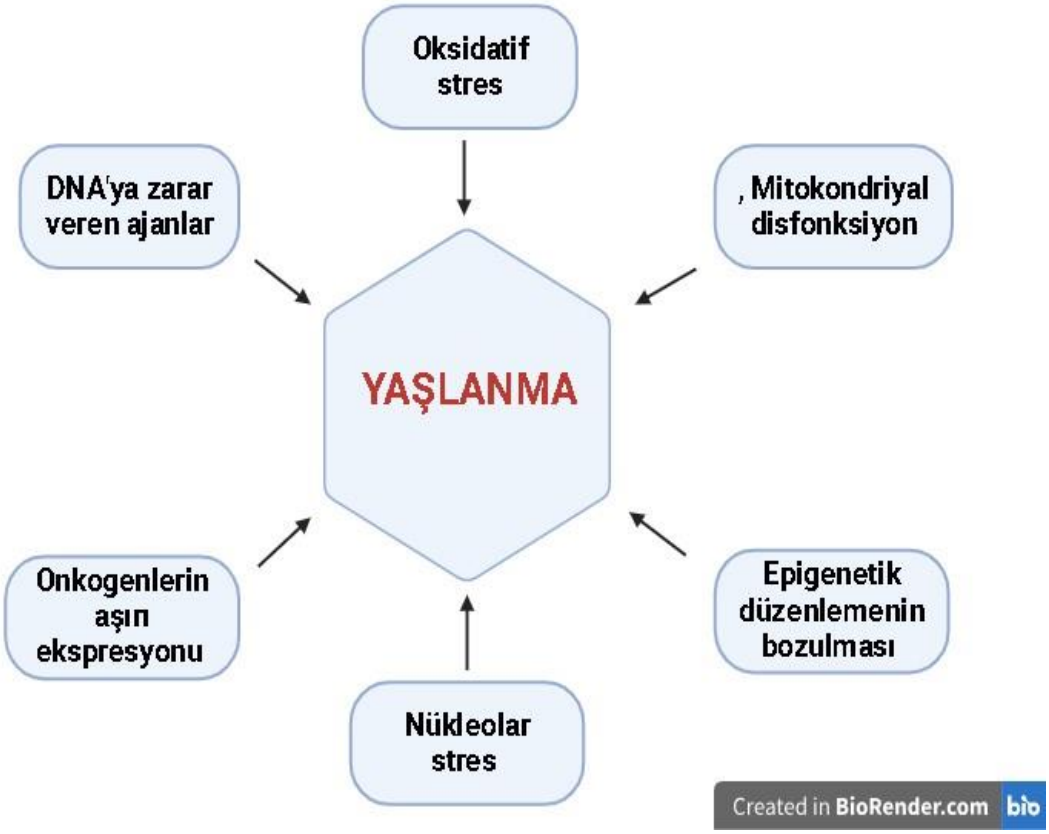
moleküllü senolitik ilaçların keşfi, insanlarda çok sayıda hastalığın ve yaşa bağlı koşulların düzenlenmesi veya tedavisi için umut verici stratejilere yol açmıştır (Chaib ve ark., 2022). Bu çalışmada senolitikler ile ilgili olarak güncel bilgiler sunularak, geleceğe yönelik perspektifler değerlendirilmiştir.

Yaşlanma

Yaşlılık, büyüme faktörlerine ve mitojenlere karşı duyarsızlıkla karakterize edilen, bgeri dönüşü olmayan, kalıcı bir hücre döngüsü durması olarak tanımlanmaktadır (Kuilman ve diğerleri, 2010). Yaşlanma ilk olarak replikasyon kapasitesinin kaybı olarak tanımlanmış (Hayflick & Moorhead, 1961), daha sonrasında replikatif kapasite kaybının, kromozom uçlarını koruyan tandem tekrarlar olan telomerlerin kısalmasından kaynaklandığı bildirilmiştir (Harley ve ark., 1990). Telomerlerin kısalması, telomerlerin ucundaki koruyucu kapakların düzgün yapısının bozulmasına ve dolayısıyla DNA hasar yanıtının aktive edilmesine sebep olur (Fagagna ve ark., 2003).

Hücrelerde DNA'ya zarar veren ajanlar, oksidatif stres, mitokondriyal disfonksiyon, aktive onkogenlerin aşırı ekspresyonu, RNA polimeraz I inhibitörlerinin neden olduğu nükleolar stres ve epigenetik düzenlemenin bozulması gibi çeşitli stres faktörleri de yaşlanmayı indükleyebilmektedir (Şekil 1).Yaşlanan hücrelerin en yaygın özellikleri; genişlemiş ve düzleşmiş bir morfolojiye, daha az düzenli bir şekile, daha büyük bir çekirdeğe, tek ve daha büyük bir nükleolusa, sitoplazmalarında birçok vakuole sahip olmalarıdır (Mária & Ingrid, 2017). Ayrıca yaşlanma ile ilişkili olarak lizozomlarda lipofusin birikiminin yanında (Fang ve ark., 1999), reaktif oksijen türlerinin üretimi (Passos ve ark., 2010) ve β-galaktosidaz aktivitesinin artışı söz konusudur.

Yaşlanan hücreler, ribonükleotid trifosfat seviyelerinde azalma ile karekterize metabolik bir dengesizliğe girer, ATP'nin tükenmesi hücresel AMP (Adenozin monofosfat)'de artışa yol açar, bu da AMP ile aktifleştirilen protein kinazı (AMPK) aktive eder ve yaşlanmanın oluşmasına katkıda bulunur (Zwerschke ve ark., 2003).



Şekil 1. Yaşlanmayı indükleyebilen faktörler (Mária & Ingrid, (2017)'den uyarlanmıştır).

Senolitiklerin Keşfi ve Bazı Senolitikler

Son yıllarda yaşlanan hücre birikimi, yaşa bağlı rahatsızlıklar ile yaşam ve sağlık süresi arasındaki ilişkiler, yaşlanan hücreleri seçici olarak hedef alabilecek terapötik bileşiklerin araştırılmasını teşvik etmiştir (Thoppil & Riabowol, 2020). İlk senolitik ilaçlar, hipoteze dayalı, mekanizmaya dayalı bir ilaç keşif yaklaşımı kullanılarak tanımlanmıştır (Chaib ve ark., 2022).

Bildirilen ilk senolitikler, hipotez odaklı, biyoinformatik tabanlı bir çalışmadan keşfedilen dasatinib ve quercetin ilaç kombinasyonuydu. Hücre proliferasyonunu ve migrasyonunu inhibe edebilen ve apoptozu indükleyebilen bir tirozin kinaz inhibitörü olan dasatinib Amerika Birleşik Devletleri Gıda ve İlaç Dairesi onaylı bir anti-kanser ilacıdır. Quercetin ise çeşitli biyolojik aktivitelere sahip doğal olarak oluşan bir flavonoiddir. Dasatinib + Quercetin kombinasyonu, birçok yaşlanan hücre türünde daha fazla yaşlanan hücre anti-apoptotik yolaklarını hedefleyerek apoptozu indüklemektedir (Zhu ve ark., 2015; Zhang ve ark., 2023). Bu kombinasyonun üzere yaşla ilişkili birçok hastalığı ve bozukluğu (osteoporoz, hepatik steatoz, insülin direnci, nörodejenerasyon,

vazomotor disfonksiyon, pulmoner fibroz, kronik böbrek hastalığı ve iskelet kası disfonksiyonu) gibi iyileştirdiği bildirilmiştir (Wissler Gerdes ve ark., 2020).

B hücreli lenfoma 2 (BCL-2) protein ailesinin üyeleri, pro- ve anti-apoptotik aktivitelere sahip düzenleyici proteinler olup, bu üyeler sağlıklı hücrelerde ince ve hassas bir dengede tutulur (Babacan, 2023). BCL-2, BCL-XL ve BCL-W apoptoza karşı yaşlanan hücre direnci sağlayan temel düzenleyicilerdir (Yosef ve ark., 2016). Kaspaz aktivasyonunu bloke ederek programlanmış hücre ölümünü düzenleyen Bcl-xL gibi pro-survival/anti-apoptotik genlerin ekspresyonunun arttığı yaşlanan hücreler ve çoğalan hücreler arasındaki transkriptomik analiz ile gösterilmiştir (Zhu ve ark., 2016). BCL-W, BCL-XL ve BCL-2'nin bir inhibitörü olan ABT-737 tedavisinin farelerde akciğer ve epidermisteki yaşlanan hücreleri ortadan kaldırdığı bildirilmiştir (Yosef ve ark., 2016).

Isı şok proteini 90 (HSP90), hücresel sinyal iletimi, intraselüler transport, onkogenik proteinlerin katlanması ve stabilizasyonundan görevli, 90 kDa ağırlığa sahip bir proteindir. HSP90'nın görevinin inhibisyonu, kanser kemoterapisi için önemli bir terapötik strateji oluşturmaktadır (Özgür & Gökçe, 2019). HSP90 inhibitörlerinin senolitik etkisinin hücre tipine veya türe özgü olup olmadığını belirlemek için, Ercc1 (Eksizyon Onarımı Çapraz Tamamlama grubu 1) geni eksikliği olan farelerden, insan fetal akciğer (IMR-90) fibroblastlarından ve insan WI38 hücrelerinden izole edilen birincil murin mezenkimal kök hücrelerinin yaşlanan kültürleri üzerinde HSP90 inhibitörlerinden biri olan 17-DMAG (alvespimycin) test edilmiş ve 17-DMAG'nin, yaşlanan insan fibroblastlarının ve fare kök hücrelerinin oranını önemli ölçüde azalttığı bildirilmiştir. Diğer bir HSP90 inhibitörü olan ganetespib, iyonlaştırıcı radyasyonla yaşlanmaya teşvik edilen insan umbilikal ven endotel hücrelerinde senolitik aktivite göstermiştir. Senolitik HSP90 inhibitörleriyle periyodik tedavinin, in vivo yaşlanan hücre belirteçlerini azaltmak ve yaşa bağlı fenotiplerin başlangıcını geciktirmek için yeterli olduğunu ve bu da sağlık süresinin uzamasına işaret ettiğini göstermektedir (Fuhrmann-Stroissnigg ve ark., 2017).

Senolitik stratejilerden biri de, Mouse Double Minute 2 (MDM2) ile p53 arasındaki etkileşimin inhibisyonu olup, bu genellikle p53'ün her yerde bulunması ve proteozomal bozulmasıyla ilişkilidir (Nag ve ark., 2013; Wade ve ark., 2013). MDM2 proteini, bir E3 ubikuitin ligaz görevi görür ve p53 bozunmasını kolaylaştırır (Thoppil & Riabowol, 2020). MDM2 antagonistleri Nutlin-3a ve MI-63'ün, p53 seviyelerini

arttırdığı ve yaşlanan hücrelerin salgı fenotipini (SASP) zayıflattığı gösterilmiştir (Wiley ve ark., 2018). Yaşlanan hücrelerin ortadan kaldırılmasını tetiklemek için, p53 ve FOXO4 etkileşimine müdahale edecek şekilde tasarlanmış bir peptit ilaçla tedavi edilmesi ve böylece apoptozun indüksiyonu için p53'ün mitokondriye yönlendirilmesi de dahil olmak üzere çeşitli başka yaklaşımlar kullanılmıştır. Bu temelde, bu FOXO4-p53 etkileşimini bozan, p53'ün sitozole translokasyonuna izin vererek hücre içi apoptozu indükleyen bir senolitik FOXO4-D-retroinverso (FOXO4-DRI) peptidi tanımlanmıştır (Baar ve ark., 2017). FOXO4-DRI'nin farelerde yaşlanma semptomlarını da hafiflettiği bildirilmiştir (Zhang, ve ark., 2020).

Fisetin birçok meyve, sebze, çiçek ve çayda bulunan, antioksidan, anti-inflamatuar, anti-kanser, antidiyabetik, antibakteriyel, antiviral ve nöroprotektif aktivitelere sahip bir flavonoiddir (Zhang, ve ark., 2023). Bu bileşiğin yaşlanan İnsan Göbek Damarı Endotel Hücreleri (HUVEC) ortadan kaldırdığı (Zhu ve ark., 2017), ayrıca vahşi tip yaşlı farelerde doku homeostazisini iyileştirdiği,yaşa bağlı patolojileri hafiflettiği ve ortalama yaşam süresini uzattığı bildirilmiştir (Yousefzadeh ve ark., 2018).

Kurkumin, anti-inflamatuar, antioksidan, anti-mikrobiyal ve anti-kanser özelliklerine sahip bir bileşiktir. Kurkuminin, yüksek yağlı diyete maruz kalan yaşlı farelerde yaşa bağlı vasküler değişikliklere karşı faydalı olduğu gösterilmiştir. Ayrıca Kurkumin Nuclear factor erythroid 2-related factor 2 (Nrf2) ve Nuclear factor-Kappa B (NF-κB) yollarını aşağı doğru düzenleyerek yaşlanan insan omurlararası disk hücrelerine karşı senolitik aktivite göstermiştir (Cherif ve ark., 2019).

Piperlongumin senolitik aktiviteye sahip doğal bir alkaloid amiddir. Yaşlanan WI38 fibroblastlarının, piperlongumin tedavisinin ardından reaktif oksijen türlerinden bağımsız bir şekilde apoptoza yönlendirildiği bildirilmiştir (Wang ve ark., 2016). Ayrıca piperlonguminin apoptozu baskıladığı, otofajiyi indüklediği gösterilmiştir. Bununla birlikte, senolitik piperlonguminin kesin senolitik etki mekanizmaları hala belirsizdir (Liu ve ark., 2018).

Bir kardiyak glikozit olan Ouabain, Phorbol-12-miristat-13-asetat ile indüklenen protein 1 (NOXA) 'i indükleyen ve böylece senolitik bir aktivite sunan doğal bir bileşiktir. Ouabain replikatif, kemoterapi veya onkogen kaynaklı yaşlanmaya maruz kalan çeşitli yaşlanan hücrelerde geniş spektrumlu bir senolitiktir. İn vivo aralıklı ouabain tedavisinin, ışınlanmış farelerde biriken yaşlanan hücrelerin yükünü azalttığı ve yaşlı farelere

uygulandığında lokal inflamasyon ve immün infiltrasyon seviyesini azalttığı bildirilmiştir (Guerrero ve ark., 2019).

Sonuç

Sonuç olarak, senoterapötikler yaşa bağlı hastalıkların tedavi edilmesi, sağlığın iyileştirilmesi, sağlık süresinin uzatılması ve potansiyel olarak yaşam süresinin uzatılması için umut verici ajanlardır. Senoterapötikler alanının, daha uygun ilaçlar ve ilaç kombinasyonlarının tanımlanması ve klinik çalışmalarda test edilmesiyle genişlemeye devam etmesi beklenmektedir.

Kaynaklar

Baar, M. P., Brandt, R. M., Putavet, D. A., Klein, J. D., Derks, K. W., Bourgeois, B. R., ... & de Keizer, P. L. (2017). Targeted apoptosis of senescent cells restores tissue homeostasis in response to chemotoxicity and aging. *Cell*, 169(1), 132-147.

Babacan, D. (2023). BCL-2 Protein Ailesi ve Kanser. *Yüzüncü Yıl Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, 28(3), 1218-1232.

Baker, D. J., Childs, B. G., Durik, M., Wijers, M. E., Sieben, C. J., Zhong, J., ... & Van Deursen, J. M. (2016). Naturally occurring p16Ink4a-positive cells shorten healthy lifespan. *Nature*, 530(7589), 184-189.

Baker, D. J., Wijshake, T., Tchkonia, T., LeBrasseur, N. K., Childs, B. G., Van De Sluis, B., ... & Van Deursen, J. M. (2011). Clearance of p16Ink4a-positive senescent cells delays ageing-associated disorders. *Nature*, 479(7372), 232-236.

Borghesan, M., Hoogaars, W. M. H., Varela-Eirin, M., Talma, N., & Demaria, M. (2020). A senescence-centric view of aging: implications for longevity and disease. *Trends in cell biology*, 30(10), 777-791.

Chaib, S., Tchkonia, T., & Kirkland, J. L. (2022). Cellular senescence and senolytics: the path to the clinic. *Nature medicine*, 28(8), 1556-1568.

Cherif, H., Bisson, D. G., Jarzem, P., Weber, M., Ouellet, J. A., & Haglund, L. (2019). Curcumin and o-vanillin exhibit evidence of senolytic activity in human IVD cells in vitro. *Journal of clinical medicine*, 8(4), 433.

Fagagna, F. D. A. D., Reaper, P. M., Clay-Farrace, L., Fiegler, H., Carr, P., Von Zglinicki, T., ... & Jackson, S. P. (2003). A DNA damage checkpoint response in telomere-initiated senescence. *Nature*, 426(6963), 194-198.

Fang, L., Igarashi, M., Leung, J., Sugrue, M. M., Lee, S. W., & Aaronson, S. A. (1999). p21Waf1/Cip1/Sdi1 induces permanent growth arrest with markers of replicative senescence in human tumor cells lacking functional p53. *Oncogene*, 18(18), 2789-2797.

Fuhrmann-Stroissnigg, H., Ling, Y. Y., Zhao, J., McGowan, S. J., Zhu, Y. I., Brooks, R. W., ... & Robbins, P. D. (2017). Identification of HSP90 inhibitors as a novel class of senolytics. *Nature communications*, 8(1), 422.

Guerrero, A., Herranz, N., Sun, B., Wagner, V., Gallage, S., Guiho, R., ... & Gil, J. (2019). Cardiac glycosides are broad-spectrum senolytics. *Nature metabolism*, 1(11), 1074-1088.

Harley, C. B., Futcher, A. B., & Greider, C. W. (1990). Telomeres shorten during ageing of human fibroblasts. *Nature*, 345(6274), 458-460.

Hayflick, L., & Moorhead, P. S. (1961). The serial cultivation of human diploid cell strains. *Experimental cell research*, 25(3), 585-621.

Inouye, S. K., Studenski, S., Tinetti, M. E., & Kuchel, G. A. (2007). Geriatric Syndromes: Clinical, Research, and Policy Implications of a Core Geriatric Concept: (See Editorial Comments by Dr. William Hazzard on pp 794–796). *Journal of the American Geriatrics Society*, 55(5), 780-791.

Kirkland, J. L. (2013). Translating advances from the basic biology of aging into clinical application. *Experimental gerontology*, 48(1), 1-5.

Kuilman, T., Michaloglou, C., Mooi, W. J., & Peeper, D. S. (2010). The essence of senescence. *Genes & development*, 24(22), 2463-2479.

Lagoumtzi, S. M., & Chondrogianni, N. (2021). Senolytics and senomorphics: Natural and synthetic therapeutics in the treatment of aging and chronic diseases. *Free Radical Biology and Medicine*, 171, 169-190.

Liu, J., Liu, W., Lu, Y., Tian, H., Duan, C., Lu, L., ... & Yang, H. (2018). Piperlongumine restores the balance of autophagy and apoptosis by increasing BCL2 phosphorylation in rotenone-induced Parkinson disease models. *Autophagy*, 14(5), 845-861.

Mária, J., & Ingrid, Ž. (2017). Effects of bioactive compounds on senescence and components of senescence associated secretory phenotypes in vitro. *Food & function*, 8(7), 2394-2418.

Miller, R. A. (2002). Extending life: scientific prospects and political obstacles. *The Milbank Quarterly*, 80(1), 155-174.

Nag, S., Qin, J., Srivenugopal, K. S., Wang, M., & Zhang, R. (2013). The MDM2-p53 pathway revisited. *Journal of biomedical research*, 27(4), 254.

Özgür, A., & Gökçe, İ. (2019). Hedefe Yönelik Kanser İlaç Dizaynında Isı Şok Proteni 90. *Journal of Biotechnology and Strategic Health Research*, 3(3), 161-169.

Passos, J. F., Nelson, G., Wang, C., Richter, T., Simillion, C., Proctor, C. J., ... & Von Zglinicki, T. (2010). Feedback between p21 and reactive oxygen production is necessary for cell senescence. *Molecular systems biology*, 6(1), 347.

Thoppil, H., & Riabowol, K. (2020). Senolytics: a translational bridge between cellular senescence and organismal aging. *Frontiers in Cell and Developmental Biology*, 7, 367.

Wade, M., Li, Y. C., & Wahl, G. M. (2013). MDM2, MDMX and p53 in oncogenesis and cancer therapy. *Nature Reviews Cancer*, 13(2), 83-96.

Wang, Y., Chang, J., Liu, X., Zhang, X., Zhang, S., Zhang, X., ... & Zheng, G. (2016). Discovery of piperlongumine as a potential novel lead for the development of senolytic agents. *Aging (Albany NY)*, 8(11), 2915.

Wiley, C. D., Schaum, N., Alimirah, F., Lopez-Dominguez, J. A., Orjalo, A. V., Scott, G., ... & Campisi, J. (2018). Small-molecule MDM2 antagonists attenuate the senescence-associated secretory phenotype. *Scientific reports*, 8(1), 2410.

Wissler Gerdes, E. O., Zhu, Y., Tchkonia, T., & Kirkland, J. L. (2020). Discovery, development, and future application of senolytics: theories and predictions. *The FEBS journal*, 287(12), 2418-2427.

Yosef, R., Pilpel, N., Tokarsky-Amiel, R., Biran, A., Ovadya, Y., Cohen, S., ... & Krizhanovsky, V. (2016). Directed elimination of senescent cells by inhibition of BCL-W and BCL-XL. *Nat Commun* 7: 11190.

Yousefzadeh, M. J., Zhu, Y. I., McGowan, S. J., Angelini, L., Fuhrmann-Stroissnigg, H., Xu, M., ... & Niedernhofer, L. J. (2018). Fisetin is a senotherapeutic that extends health and lifespan. *EBioMedicine*, 36, 18-28.

Zhang, C., Xie, Y., Chen, H., Lv, L., Yao, J., Zhang, M., ... & Liu, G. (2020). FOXO4-DRI alleviates age-related testosterone secretion insufficiency by targeting senescent Leydig cells in aged mice. *Aging (Albany NY)*, 12(2), 1272.

Zhang, L., Pitcher, L. E., Prahalad, V., Niedernhofer, L. J., & Robbins, P. D. (2023). Targeting cellular senescence with senotherapeutics: senolytics and senomorphics. *The FEBS Journal*, 290(5), 1362-1383.

Zhu, Y. I., Tchkonia, T., Fuhrmann-Stroissnigg, H., Dai, H. M., Ling, Y. Y., Stout, M. B., ... & Kirkland, J. L. (2016). Identification of a novel senolytic agent, navitoclax, targeting the Bcl-2 family of anti-apoptotic factors. *Aging cell*, 15(3), 428-435.

Zhu, Y. I., Tchkonia, T., Pirtskhalava, T., Gower, A. C., Ding, H., Giorgadze, N., ... & Kirkland, J. L. (2015). The Achilles' heel of senescent cells: from transcriptome to senolytic drugs. *Aging cell*, 14(4), 644-658.

Zhu, Y., Doornebal, E. J., Pirtskhalava, T., Giorgadze, N., Wentworth, M., Fuhrmann-Stroissnigg, H., ... & Kirkland, J. L. (2017). New agents that target senescent cells: the flavone, fisetin, and the BCL-XL inhibitors, A1331852 and A1155463. *Aging (Albany NY)*, 9(3), 955.

Zwerschke, W., Mazurek, S., Stöckl, P., Hütter, E., Eigenbrodt, E., & Jansen-Dürr, P. (2003). Metabolic analysis of senescent human fibroblasts reveals a role for AMP in cellular senescence. *Biochemical journal*, 376(2), 403-411.

LIVING CONDITIONS OF IMMIGRANT WORKERS IN THE AGRICULTURAL SECTOR IN SOUTHERN PORTUGAL

Elsa CAVACO (ORCID: 0009-0003-2933-7395)
Polytechnic University of Beja, Engineering Department, Beja, Portugal.
Email: pagarim@hotmail.com

Prof. Dr. Rui ISIDORO (ORCID: 0000-0002-2475-8591)
Polytechnic University of Beja, Engineering Department, Beja, Portugal.
Email: rui.isidoro@ipbeja.pt

ABSTRACT
This paper is an approach to the living conditions of immigrant workers in the agricultural sector in themunicipality of Odemira, Portugal. The aim is to focus on the measures to be adopted to prevent the risks identified. The topic is approached on the basis of a literature review. This type of population is highly exposed to occupational risks, due to their precarious work and social situation, accentuated by language and communicationdeficits, which in many cases lead to situations of social vulnerability and poverty. Faced with this scenario, most of the measures adopted by the different authors are limited to theavailability of short Portuguese language courses and the integration of these migrants into somecharity-based social policy measures, such as the donation of clothes or foodstuffs, which are ofteninsufficient or inappropriate to their culture of origin.
Keywords: agricultural employment, immigrant workers, living conditions, agriculture

Introduction

This study is an approach to the health and safety conditions of immigrant workers in the agricultural sector in Southern Portugal, in the municipality of Odemira. The theme is approached based on a literature review / state of the art, as well as the methodological procedures adopted, namely the application of an interview survey to immigrants, based on an intentional sample for convenience, and to privileged interlocutors within the scope of the theme. This survey was validated by a panel of judges from the fields of Social Sciences and Education. The data collected was processed using thematic categorical content analysis, with categories defined as follows.

This type of population, mostly made up of individuals whose education does not go beyond secondary school, is urgently exposed to poor health and safety conditions at work, due to their precarious labor situation, accentuated by language and communication deficits, which in many cases lead to situations of social vulnerability and extreme poverty. Faced with this scenario, most of the measures adopted don't reach the immigrants, who close themselves off in their community, where communication flows and they find ways to survive among themselves. However, this situation also leads to a lack of knowledge of their rights, which leads to a worsening of living conditions, particularly regarding housing, labor, health and social conditions and benefits.

Faced with this scenario, most of the measures adopted are limited to the availability of short Portuguese language courses, often subject to volunteering by retired teachers, and the integration of these immigrants into some charity-based social policy measures, such as the donation of clothes or foodstuffs, which are often insufficient or inappropriate to their culture of origin.

The general objective of this study is to identify the measures that should be adopted by the competent authorities so that immigrants are guaranteed their labor, social and human rights.

The specific objectives are to:

- Characterize the immigrant, agriculture worker, population in Southern Portugal (municipality of Odemira) based on the sample identified.
- Understand the perception of these population in the municipality of Odemira about Health and Safety at Work.
- Find out the perspective of the key informants on the phenomenon of immigration.

Portugal is an open door to Europe. Many immigrants from countries where they live on the edge of extreme poverty make their way to Portugal, where they can easily legalize themselves and thus open the doors to Europe.

State-of-the-art

Approved on 25 August 2022, Law no. 18/2022 allows immigrants to enter Portuguese territory, allowing them to stay here in search of work for a period of 120 days, extendable by 60 days. Immigrants can thus enter and remain in the country without any guarantee that they will find work. Without a job and without the means to support themselves, the conditions in which these immigrants stay in Portugal will be questionable. When faced with the cost of living and especially the cost of renting accommodation, they are forced to live in substandard or improvised accommodation in containers. The changes to the legislation on foreigners thus open the door to illegal immigration and labor exploitation. (...) it is important to denounce that the labor exploitation of immigrants continues to exist in Portugal, particularly in the agricultural sector, through forced labor practices as conceptualized by the ILO. Immigrants come to Portugal in search of better living conditions, often duped by international trafficking networks, only to find themselves in deplorable labor conditions that are beyond state regulation. (Dias 2022, p.1)

Given the results presented in Odemira's Municipal Plan for the Integration of Immigrants (2019), it is above all in the initial phase of the migratory cycle that immigrants "present specific social deficits (lack of knowledge of the language, lack of information about access to services, lack of political rights, downward professional integration associated with difficulties in recognizing skills...) that end up causing situations of social disadvantage and exclusion." (Malheiros, 2010, cit. in Plano Municipal para integração dos Imigrantes, Odemira Integra 2019, p.52). In this sense, "the creation of the CLAII Network (Local Support Centre for Immigrant Integration) proved to be fundamental in guaranteeing the existence of a territorially deconcentrated structure that would ensure proximity responses to the specific problems presented by immigrants." (Malheiros, 2010, cit. in Plano Municipal para integração dos Imigrantes, Odemira Integra 2019, p.52).

It is essential to gain a deeper understanding of the situation of immigrants, agriculture workers, in Odemira, to identify solutions to improve their working conditions and guarantee respect for their rights.

References

Agostinho, M. (2022). O impacto da migração laboral em Odemira – O desafio da integração. (Dissertação de Mestrado, não editada) Nova FCSH, Faculdade de Ciências Sociais e Humanas. Universidade Nova de Lisboa. Repositório aberto da Universidade NOVA de Lisboa.

Dias, A. (2019). Avaliação de riscos psicossociais e efeitos na saúde dos trabalhadores na indústria transformadora. (Dissertação de Mestrado não editada, em Marketing e Comunicação, na Especialidade de Gestão de Maketing) Escola Superior de Gestão e Tecnologia de Oliveira do Hospital. Escola Superior de Educação. Instituto Politécnico de Coimbra. Repositório aberto do Instituto Politécnico de Coimbra.

Évora, M. Ricos e Pobres no Sudoeste Alentejano: Os efeitos da Produção Agrícola de Frutos Vermelhos e da Imigração na Freguesia de São Teotónio. (Dissertação de Mestrado não editada, em Estudos Internacionais). ISCTE. Instituto Universitário de Lisboa. Repositório aberto do Instituto Universitário de Lisboa.

Franco, C. (2021). Da Política à Prática: a integração dos trabalhadores agrícolas imigrantes na região Oeste. (Dissertação de Mestrado não editada, em Políticas Públicas) ISCTE, Instituto Universitário de Lisboa. Repositório aberto do Instituto Universitário de Lisboa.

Zaloznik, M. e McCormick, A. (2008). Staff Shortages and Immigration in Agriculture. A Paper Prepared for the Migration Advisory Committee (MAC). Web published by the Migration Advisory Committee. Consultado em Março de 2023. Disponível em: https://www.researchgate.net/publication/239923723_Staff_shortages_and_immigration_in_agriculture

BEÇ TAVUĞU YUMURTALARINDA BAZI ÖZELLİKLER, CİVCİVLERDE BÜYÜME DÖNEMİNDE BAŞ BÖLGESİNDE MORFOLOJİK DEĞİŞİMLER

Öğr. Gör. Mehmet Hanifi YALÇIN* (ORCID: 0000-0002-5117-7653)
Necmettin Erbakan Üniversitesi Konya Ereğli Kemal Akman Meslek Yüksekokulu, Bitkisel ve Hayvansal Üretim Bölümü, Konya-Türkiye
Email: mehmethanifi.yalcin@erbakan.edu.tr

Doç. Dr. Sema ALAŞAHAN (ORCID: 0000-0002-1144-7786)
Hatay Mustafa Kemal Üniversitesi, Veteriner Fakültesi, Zootekni Anabilim Dalı, Hatay-Türkiye
Email: alasahan@mku.edu.tr

ÖZET
Bu çalışma, Beç tavuğuna ait yumurtaların kuluçka işlemi öncesi ve sonrasında bazı dış kalite özelliklerini, civciv çıkışı olan ve çıkışı olmayan yumurtaların ağırlık, kabuk kalınlığı ve ağırlık kaybının belirlenmesi, yumurtadan çıkan civcivlerin baş bölgesindeki morfolojik değişimin görüntülenmesi amaçlanmıştır. Çalışma materyali yumurtalar Hatay Mustafa Kemal Üniversitesi Alternatif Kanatlı Hayvan Yetiştirme Ünitesine getirilen 90 adet Beç tavuğu yumurtası oluşturmaktadır. Bu yumurta temizlikleri kabuk bakımından gözle muayene edilerek kabuğu temiz 59 adet yumurta kuluçka işlemine alınmıştır. Yumurtalar kuluçka makinasına yüklenmeden önce yumurta ağırlıkları belirlenerek tablalara sivri uç aşağı olacak şekilde yerleştirilmiştir. Kuluçka süresi sonunda yumurtadan çıkan civcivlerin ağırlıkları ve görüntüleri alınmıştır. Beç tavuğu yumurtası ile ilgili; ortalama 39.23 g ağırlık, %80.87 şekil indeksi ve 0.28 mm kabuk kalınlığı belirlenmiştir. Kuluçka makinasına yüklenen yumurtalar için; ortalama 37.87 g ağırlık, %80.66 şekil indeksi ve 0.27 mm kabuk kalınlığı saptanmıştır. Yumurta ağırlığının civciv ağırlığına dönüşüm oranı ortalama %62.07 olup civciv çıkışı olan yumurtalarda 37.45 g ağırlık ve 0.27 mm kabuk kalınlığı tespit edilmiştir. Kuluçka sonunda yumurtalar gözle muayene edilerek; Dölsüz ve embriyonik ölümler belirlenmiş, kuluçka sonrası Dölsüz, erken ve orta dönem ölüm olan yumurtalarda yumurta ağırlığı ve kabuk kalınlığı verilen sırayla 32.35 g ve 0.25 mm, 33.27 g ve 0.26 mm, 33.93 g ve 0.26 olarak belirlenmiştir. Kuluçka işlemi sırasında yumurta ağırlık kaybı (%) dölsüz, erken ve orta dönem ölüm olan yumurtalarda verilen sırayla %13.59, %12.96 ve 14.27 olarak bulunmuştur. Ayrıca döllü yumurtalarda civciv çıkış oranı %44.83 olmuştur. Beç tavuğu başındaki beyaz maske ve gaganın altındaki deri parçasındaki renklenme yaklaşık 12 haftalık yaştan sonra başladığı gözlenmiştir. Sonuç olarak, civciv çıkışı olan olmayan yumurtalarda yumurta ağırlığı, şekil indeksi ve kabuk kalınlığı farklı olduğu belirlenmiştir. Beç tavuğu yumurtasının kalite, kuluçka ve bu özelliklerin civciv çıkışı ve kuluçka sonuç değerleri ile ilgili özelliklerin belirlenmesinin yumurta sayısı yüksek olan çalışmaların yapılması ülkemiz adına eksikliklerin giderilmesi adına tavsiye edilebilir.
Anahtar Kelimeler: Dölsüz yumurta, embriyonik ölüm, kabuk kalınlığı, çıkış gücü

DISTINCTIVE FEATURES OF GUINEA FOWL EGGS AND MORPHOLOGICAL TRANSFORMATIONS IN THE CRANIAL REGION THROUGHOUT CHICK DEVELOPMENT

ABSTRACT

This study aimed to assess the external quality traits of guinea fowl eggs pre- and post-incubation, including weight, shell thickness, and weight loss in hatched and unhatched eggs, while also examining the morphological alterations in the cranial region of successfully hatched chicks. The study utilized a total of 90 guinea fowl eggs procured at Hatay Mustafa Kemal University Alternative Poultry Breeding Unit, where visual assessment ensured the cleanliness of the shells, with 59 eggs meeting the criteria and proceeding to the incubation phase. Prior to incubation, egg weights were recorded, and eggs were positioned with the pointed end facing downward on trays within the incubator. Following the incubation period, weights and visual documentation of the hatched chicks were collected. The guinea fowl eggs exhibited an average weight of 39.23 g, a shape index of 80.87%, and a shell thickness of 0.28 mm. Following incubation, the eggs loaded into the incubator showed an average weight of 37.87 g, a shape index of 80.66%, and a shell thickness of 0.27 mm. The conversion rate from egg weight to chick weight averaged at 62.07%, with hatched chicks originating from eggs possessing an average weight of 37.45 g and a shell thickness of 0.27 mm. Following incubation, visual inspection revealed unfertilized and embryonic deaths among the eggs. The unfertilized eggs exhibited an average weight of 32.35 g and a shell thickness of 0.25 mm, while early and mid-term mortality eggs showed weights of 33.27 g and 33.93 g, respectively, with shell thicknesses of 0.26 mm for both. The percentage of egg weight loss during incubation was calculated as 13.59%, 12.96%, and 14.27% for unfertilized, early, and mid-term mortality eggs, respectively. Furthermore, the chick hatching rate was determined to be 44.83% among fertilized eggs. Observations revealed that the development of the guinea fowl's white mask on the head and the pigmentation of the skin under the beak typically initiated around 12 weeks of age. Consequently, disparities in egg weight, shape index, and shell thickness were noted between eggs that hatched chicks and those that did not. It is recommended to conduct further studies with larger sample sizes to comprehensively assess the quality and hatchability of guinea fowl eggs, as well as to investigate the characteristics associated with chick hatching success. Such endeavors could help address existing shortcomings and contribute to the advancement of guinea fowl breeding practices within our country.

Keywords: Fertile egg, embryonic death, shell thickness, hatchability

Giriş

Beç tavuğu yetiştiriciliği diğer kanatlı hayvanlarda olduğu gibi yumurta ve et verimi için dünyanın birçok ülkesinde yapılmaktadır. Beç tavuğunun yoğun olarak yetiştirildiği tropikal ülkelerde, Beç tavukları yumurta kalite özellikleri bakımından önemli farklılık göstermektedir (Rayan ve ark. 2022). Beç tavuğu Afrika kıtası kanatlı hayvan türüdür. Beç tavuğu ülkemizde Tokat tavuğu ya da İran tavuğu olarak adlandırılmaktadır. Ülkemizde Beç tavuklarının gri ve beyaz varyeteleri bulunmaktadır. Beç tavuğu kısa ve ince boyun, tüysüz deri beyaz renkte baş bölgesi ve gaga altına doğru uzanan kırmızı yapı özellikleri ile dikkat çekici bir kanatlı hayvan türüdür.

Beç tavuklarında, yaklaşık 7-8 aylık yaşta yumurta verimi başlamakta, ilk verim yılında düşük olan yumurta sayısı, ikinci yıldan itibaren yaklaşık 180-190 adet olup ortalama verim yılı 7 yıl olarak ifade edilmektedir (Ayorinde, 1990; Islam ve Nishibori, 2009; Gwaza ve Elkanah 2017). Beç tavuğu yumurtasının kabuğu kalınlığı ve sarı oranı yüksektir. Beç tavuğu yumurta ağırlığı 40.10-48.21 g arasında, şekil indeksi %73.00-76.80 ve kabuk kalınlığı 0.28-0.41 mm olarak bildirilmiştir (Ahaotu ve ark 2019; Aysondu ve Özyürek 2021). Beç tavuğu yumurtasının kuluçka süresi yaklaşık 28 gün olarak ifade edilmektedir (Ancel ve ark. 1994). Beç tavuğunun kuluçkalık yumurta ağırlığı 38 g, kabuk kalınlığı 0.41 mm, yumurtadan çıkan civciv ağırlığı 25.8 ve döllülük oranı %80 olduğu bildirilmiştir (Khairunnesa ve ark. 2016). Beç tavuğunun yumurtasının kuluçka özelliğini belirlemek için yapılan çalışmada yumurta ağırlığı 38.43-51.26 g arasında değiştiği tespit edilmiştir. Kouame ve ark. (2019) tarafından farklı depolama koşulu uyguladıkları çalışmada Beç tavuğu yumurta ağırlığını 41.15-42.54 g ve kuluçka makinasındaki ağırlık kaybını ise %11.20-11.42 olarak bildirmişlerdir. Diğer kanatlı hayvan yumurtalarının kuluçka sonuç değerlerini etkileyen faktörler Beç tavuğu yumurtası içinde etki faktörüdür. Ayrıca kurak mevsimlerde yetiştirilen Beç tavuklarının iyi beslenmesi ve doğaçlama su sağlanması kuluçka randımanını artırdığını bildiren çalışma bulunmaktadır (Konlan ve ark. 2011).

Çalışmanın amacı, Beç tavuğuna ait yumurtaların kuluçka işlemi öncesi ve sonrasında bazı dış kalite özellikleri, civciv çıkışı olan ve çıkışı olmayan yumurtaların ağırlığı, kabuk kalınlığı ve yumurta ağırlık kaybının belirlenmesi, yumurtadan çıkan civcivlerin baş bölgesindeki morfolojik değişimin görüntülenmesidir.

Materyal ve Metot

Çalışmanın yumurta materyali, Hatay ili Antakya ilçesinde özel bir sosyal tesiste süs hayvanı olarak yetiştirilen Beç tavuklarından temin edilmiştir. Hatay Mustafa Kemal Üniversitesi Alternatif Kanatlı Hayvan Yetiştirme ünitesine 90 adet yumurta getirilmiştir. Bu 90 adet yumurtalar bireysel olarak tartılmıştır. Yumurtalar göz ile kabuk temizliği bakımından kontrol edilerek 59 adet temiz kabuklu yumurtalar bireysel olarak numaralandırılmış ve tartılarak tablalara sivri üç aşağı gelecek şekilde yerleştirilmiştir. Bu tartım ile kuluçkalık yumurtalar için başlangıç yumurta ağırlığı belirlenmiştir. Kuluçka koşulları; gelişme ve çıkış amaçlı tek makine kullanılmış olup embriyo gelişme döneminde 37.5 °C sıcaklık ve %65 nisbi nem, çıkış döneminde nem sıcaklık 37 °C ve nisbi nem %70 olarak ayarlanmıştır. Yumurtaların çıkış bölümüne aktarımlarında, yumurtalar bireysel olarak tartıldıktan sonra çıkış sepetine yerleştirilmiştir. Üniteye getirilen toplam yumurtaların ortalama ağırlıkları, kuluçkalık yumurta başlangıç ağırlığı ve transfer yumurta ağırlıkları baz alınarak aşağıdaki formüller yardımıyla yumurta boyu, yumurta eni ve kabuk kalınlığı hesaplanmıştır (Rahn ve Paganelli 1989; Alaşahan ve ark 2019);

Yumurta boyu (mm)=13.04938 x (Yumurta ağırlığı)$^{0.373272}$

Yumurta eni (mm)=8.01571 x (Yumurta ağırlığı)$^{0.448338}$

Kabuk kalınlığı (mm) = 0.0546 x (Yumurta ağırlığı)$^{0.441}$

Şekil indeksi (%) = (Yumurta eni / Yumurta boyu) x 100

Elongasyon = (Yumurta boyu / Yumurta eni)

Kuluçka süresinin 26'ıncı gününde civciv çıkışı başladı, kuryan civcivler makine dışına alınarak civciv çıkış ağırlıkları belirlenmiştir. Kuluçka süresi sonunda civciv çıkışı olmayan yumurtalar küt uçtan açılarak gözle döllülük muayenesi yapılmıştır. Bu işlemde dölsüz ve embriyonik ölüm olan yumurta sayıları belirlenmiştir. Civciv çıkış ağırlığı ve civciv çıkışı olan yumurta transfer ağırlıkları kullanılarak kuluçka süresince oluşan yumurta ağırlık kaybı belirlenmiştir. Ayrıca kuluçka sonuçları değerlerinden olan döllülük ve çıkış oranı belirlenmiştir. Formüller;

Civciv dönüşüm oranı (%) = (Civciv çıkış ağırlığı / Başlangıç yumurta ağırlığı) x 100

Yumurta ağırlık kaybı (%) = ((Başlangıç yumurta ağırlığı–Transfer Yumurta Ağırlığı)/Başlangıç yumurta ağırlığı) x 100

Döllülük oranı (%) = (Döllü yumurta sayısı / Toplam yumurta sayısı) x 100

Çıkış gücü (%) = (Çıkan civciv sayısı / Döllü Yumurta sayısı) x 100

İstatistik Analizler

Çalışmada elde edilen ham verilere SPSS paket programı kullanılarak Tanımlayıcı İstatistik Analizi yapılmıştır.

Bulgular

Çalışma için üniteye getirilen Beç tavuğu yumurtalarının bazı kalite özelikleri ve yumurtadan çıkan civciv özellikleri Tablo 1'de sunulmuştur. Beç tavuğu yumurta ağırlığı ortalama 39.23 g, şekil indeksi ortalama %80.87 ve kabuk kalınlığı ortalama 0.28 mm olduğu saptanmıştır. Aynı zamanda, kuluçka makinasına yüklenen yumurtaların ortalama ağırlığı 37.87 g, ortalama %80.66 ve kabuk kalınlığı ortalama 0.27 mm olarak belirlenmiştir. Civciv çıkışı olan yumurta ağırlığı 37.45 g olurken civciv dönüşüm oranı %62.07 olarak gerçekleşmiştir.

Tablo 1. Beç Tavuğu yumurta özelliği (n = 90 adet)

Özellikler	n (Adet)	Ortalama	Minimum	Maximum
Üniteye Getirilen Toplam Yumurtaların Özellikleri				
Yumurta Ağırlığı (g)	90	39.23±4.17	28.37	48.59
Yumurta Boyu (mm)	90	51.27±0.22	45.49	55.61
Yumurta Eni (mm)	90	41.48±0.21	35.92	41.48
Şekil İndeksi (%)	90	80.87±0.07	78.96	82.22
Elongasyon	90	1.237±0.00	1.22	1.27
Kabuk Kalınlığı (mm)	90	0.28±0.00	0.24	0.30
Kuluçka Makinasına Yüklenen Yumurta Özellikleri				
Yumurta Ağırlığı (g)	59	37.87±0.50	28.37	44.55
Yumurta Boyu (mm)	59	50.61±0.26	45.49	53.83
Yumurta Eni (mm)	59	40.83±0.25	35.92	43.97
Şekil İndeksi (%)	59	80.66±0.08	78.96	81.68
Elongasyon	59	1.240±0.00	1.22	1.27
Kabuk Kalınlığı (mm)	59	0.27±0.00	0.24	0.29
Yumurtadan Çıkan Civciv Özelliği				
Civciv çıkışı olan yumurta ağırlığı (g)	13	37.45±1.24	28.37	42.22
Civciv çıkışı olan yumurta kabuk kalınlığı (mm)	13	0.27±0.00	0.24	0.28
Civciv Çıkış Ağırlığı (g)	13	23.27±1.20	16.83	30.28
Civciv Dönüşüm Oranı (%)	13	62.07±2.31	49.79	77.50

Kuluçka işlemi sonrasında civciv çıkışı olmayan yumurtalar için belirlenen özellikler Tablo 2'de verilmiştir. Dölsüz, erken ve orta embriyonik ölüm olan yumurtalarda

başlangıç ve transfer ağırlıkları verilen sırayla 37.43 g – 32.35 g, 38.24 g – 33.27 g ve 39.54 g – 33.93 g olarak saptanmıştır. Kuluçka süresince yumurtada gerçekleşen ağırlık kaybı en fazla orta dönem emriyonik ölüm olan yumurtalarda (%14.27) gerçekleşirken, en düşük erken dönem embriyonik ölüm olan yumurtalarda (%12.96) bulunmuştur. Kuluçka sonuçlarını değerlendirmede kullanılan döllülük oranı %49.15 ve çıkış gücü %44.83 olarak tespit edilmiştir.

Tablo 2. Civciv Çıkışı olmayan Beç Tavuğu yumurtalarının bazı özellikleri

	n (Adet)	Ortalama	Minimum	Maximum
Kuluçka Makinasına Yüklenen yumurta Özellikleri				
Dölsüz yumurta ağırlığı (g)	30	37.43±0.64	28.83	43.02
Dölsüz yumurta kabuk kalınlığı (mm)	30	0.27±0.00	0.24	0.29
Erken embriyonik ölüm olan yumurta ağırlığı (g)	6	38.24±1.30	32.41	40.69
Erken embriyonik ölüm olan yumurta kabuk kalınlığı (mm)	6	0.27±0.00	0.25	0.28
Orta embriyonik ölüm olan yumurta ağırlığı (g)	10	39.54±1.34	30.20	44.55
Orta embriyonik ölüm olan yumurta kabuk kalınlığı (mm)	10	0.28±0.00	0.25	0.29
***Kuluçka süresi sonunda belirlenen yumurta özellikleri (g)**				
Dölsüz olan yumurta ağırlığı (g)	30	32.35±0.59	23.37	37.74
Dölsüz olan yumurta kabuk kalınlığı (mm)	30	0.25±0.00	0.22	0.27
Erken embriyonik ölüm olan yumurta ağırlığı (g)	6	33.27±1.10	28.68	35.91
Erken embriyonik ölüm olan yumurta kabuk kalınlığı (mm)	6	0.26±0.00	0.24	0.26
Orta embriyonik ölüm olan yumurta ağırlığı (g)	10	33.93±1.28	25.76	38.56
Orta embriyonik ölüm olan yumurta kabuk kalınlığı (mm)	10	0.26±0.00	0.23	0.27
Kuluçka sürecinde yumurta ağırlık kaybı (%)				
Dölsüz yumurtalarda ağırlık kaybı	30	13.59±0.50	6.49	18.94
Erken embriyonik ölüm olan yumurtalarda ağırlık kaybı	6	12.96±0.47	11.51	14.25
Orta embriyonik ölüm olan yumurtalarda ağırlık kaybı	10	14.27±0.67	11.97	19.50
Kuluçka Sonuç Değerleri				
Döllülük Oranı (%)		49.15		
Çıkış Gücü (%)		44.83		

*: Döllülük muayenesi sırasında alınan yumurta ağırlık değerleri baz alınarak hesaplanmış kabuk kalınlıkları

Beyaz tüylü Beç tavuğu yumurtasından kuluçka sonrasında çıkan civcivlerin ayak ve gaga yapısı pembe, beden tüyler beyaz ve gagadan başlayarak göz çukurlarını içine alarak boyuna ve sırta kadar uzanan koyu beyaz şeritler gözlenmiştir (Resim 1). Civcivlerde

yaşla birlikte baş bölgesinde yüzdeki renklenme yaklaşık 12-14 hafta arası yaşta gözle görülebilecek düzeye gelmiş ve yeşile çalan açık mavi renkte (turkuaz) olmuştur (Resim 2).

Resim 1. Beç tavuğu civcivlerinin 1 günlük -7 haftalık yaştaki baş bölgesi görüntüsü

Resim 2. Beç tavuğu yavrusunun 12-14 haftalık yaşta baş görüntüsü

Tartışma

Çalışmada üniteye getirilen toplam yumurtalarda ve kuluçka makinasına yüklenen yumurtalarda verilen sırayla yumurta ağırlığı 39.23 g ve 37.87 g, şekil indeksi %80.87 ve %80.66 ve kabuk kalınlığı 0.28 mm ve 0.27 mm olarak saptanmıştır (Tablo 1). Aynı zamanda civciv çıkışı olan yumurta ağırlığı 37.45 g, civciv çıkış ağırlığı 23.27 g, kabuk kalınlığı 0.27 ve civciv dönüşüm oranı %62.04 olarak bulunmuştur. Kanatlı türü, yaş, ırk, mevsim, bakım besleme vb faktörler yumurta ağırlığı ve kabuk kalınlığını etkilemektedir. Alkan ve ark. (2016) tarafından 40 haftalık Beç tavuklarından iki günde toplanan yumurtalarda ortalama 39.58-41.42 g yumurta ağırlığı ve 0.54-0.56 mm kabuk kalınlığı bildirilmiştir. Aysondu ve Özyürek (2021) 42 haftalık yaştaki Beç tavuklarından Mart-Temmuz ayları arasında toplanan yumurtalarda ortalama yumurta ağırlığı 40.10 g, şekil

indeksi %73.00 ve kabuk kalınlığı 0.28 mm olarak ifade edilmiştir. Rayan ve ark (2022) tarafından farklı tropik bölgelerde yetiştirilen Beç tavuklarında yumurta ağırlığı, kabuk kalınlığı, kabuk yüzdesi, ak ağırlığı, haugh birimi, sarı yüksekliği ve yumurta sarısı rengi bakımından önemli farklılığın olduğu bildirilmiştir. Çalışma sonucumuz yumurta ağırlığı bakımından benzer, kabuk kalınlığı için bazı kaynaklardan daha düşük olduğu görülmektedir. Çalışmada Beç tavuklarında, civciv çıkışı olan yumurta ağırlığı 37.45 g, kabuk kalınlığı 0.27 mm, civciv çıkış ağırlığı 23.27 g ve civciv dönüşüm oranı %62.07 olarak belirlenmiştir (Tablo 1). Çalışmada döllülük oranı %49.15 ve çıkış gücü %44.83 olarak saptanmıştır (Tablo 2). Kanatlı hayvanlarda döllü yumurta sürü devamlılığında önemli bir materyaldir. Yumurta ağırlığı ve kabuk kalınlığı gibi yumurta kalite özellikleri kuluçka süresince meydana gelen yumurta ağırlık kaybına ve civciv ağırlığına önemli etkisi bulunmaktadır. Bernacki ve ark. (2013) beyaz ve gri Beç tavuğu yumurtalarında yumurta ağırlığı, kabuk kalınlığı ve döllülük oranı verilen sırayla 40.7 g ve 40.8 g, 0.450 mm ve 0440 mm ve %85.2 ve %91.7 olarak ifade edilmiştir. Khairınnesa ve ark. (2016) tarafından kuluçkalık yumurta ağırlığı 38 g, kabuk kalınlığı 0.52 mm ve civciv çıkış ağırlığı 25.8 g olup döllülük oranı %80 olarak bildirmişlerdir. Ancel ve ark. (1994) tarafından kuluçka süresince Beç tavuğu yumurtasında kulaçka süresince yumurtada %13.3 su kaybı bildirmişlerdir. Kuluçka süresince yumurta ağırlığındaki su kaybına depolama koşulları, depolama süresi ve kabuk özelliğinin etkisinin olduğunu tavuk ve bıldırcın yumurtaları için yapılan çalışmalarda ifade etmektedir.

Sonuç

Çalışmanın sonucunda, kuluçka işlemine tabi tutulan Beç tavuğuna ait döllü ve dölsüz yumurtalarda başlangıç yumurta ağırlığı, transfer yumurta ağırlığı, kabuk kalınlığı, şekil indeksi, civciv çıkış ağırlığı, yumurta ağırlık kaybı, döllülük oranı ve çıkış gücü değerleri tespit edilmiştir. Ayrıca, kuluçka süresince oluşan ağırlık kaybı en yüksek orta dönem embriyonik olan yumurtalarda, en düşük ise erken dönem embriyonik ölüm olan yumurtalarda saptanmıştır. Beç tavuğu yumurta kabuk kalınlık değişimi dölsüz yumurtalarda daha yüksek olmuştur. Ancak Beç tavuğu yumurtalarında döllülük oranı ve çıkış gücü diğer çalışma kaynaklarına göre düşük saptanmıştır. Türkiye'de yetiştirilen Beç tavuklarının yumurtalarında verimli bir kuluçka işlemi için yetiştirme tekniklerinin doğru uygulanması ve bunun kuluçka için öneminin ortaya çıkarmak adına yumurta sayısı yüksek çalışmaların yapılması gerektiği göz ardı edilmemelidir.

Kaynaklar

Ahaotu, E., Nwafor, C., Onyebuchukwu, P., Okpara, O. (2019). Carcass, organ weights and egg quality characteristics of guinea fowl layers fed varying levels of butterfly pea leaf (Centrosema Pubescens) meal. *Sustainability*, 7, 37-51.

Alkan, S., Karslı, T., Durmuş, İ., Karabağ, K. (2016). Beç tavuklarında (*Numida meleagris*) yumurta şekil indeksinin yumurta kalitesine etkileri. *Türk Tarım–Gıda Bilim ve Teknoloji Dergisi*, 4(9), 758-762.

Ancel, A., Armand, J., Girard, H. (1994). Optimum incubation conditions of the domestic guinea fowl egg. *British Poultry Science*, 35(2), 227-240.

Alaşahan, S., Dağoğlu Hark, B., Eltas, Ö. (2019). Prediction of the length and width of quail eggs using linear regression analysis. *Eurasian J Vet Sci*, 35(3), 152-157.

Aysondu, M. H. & Özyürek, S. (2021). Determination of egg internal and external quality characteristics with mathematical formulas in quinea hens. *Erzincan Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, 14(3), 1006-1014.

Ayorinde, K. (1990). Problems and prospects of guinea fowl production in the rural areas of Nigeria. Proceedings of an International Workshop on Rural Poultry Development in Africa; 1990; Ithaca: African Network on Rural Poultry Development, p.106-15.

Bernacki, Z., Kokoszynski, D. & Bawej, M. (2013). Laying performance, egg quality and hatching results in two guinea fowl genotypes. *Arch.Geflügelk.*, 77(2), 109-115.

Gwaza, D., Elkanah, H. (2017). Assessment of external egg characteristics and production indices of the dual purpose French guinea fowl under semiarid conditions in Nigeria. *Research and Reports on Genetics*, 1(1), 13-17.

Islam, M., Nishibori, M. (2009). Indigenous naked neck chicken: a valuable genetic resource for Bangladesh. *World's Poultry Science Journal,* 65, 125- 138.

Khairunnesa, M., Das, S. C. , Khatun, A. (2016). Hatching and growth performances of guinea fowl under intensive management system. *Progressive Agriculture,* 27, 70-77.

Konlan, S. P., Avornyo, F. K., Karbo, N. & Sulleyman, A.(2011). Increasing quinea fowl eggs availability and hatchability in the dry season. *J. World's Poult. Res.* 1(1),1-3.

Rahn, H., Paganelli, C. V. (1989). Shell mass, thickness and density of avian eggs derived from the tables of Schönwetter. *Journal fur Ornithologie*, 130, 59-68.

Rayan, G. N., Mansour, A., Fathi, M. M. (2022). Comparative study of egg and meat quality of quinea fowl under different tropical regions: A Review. *Brazilian Journal of Poultry Science,* 24(4), 001-010.

PROSTAGLANDİN E1 ANALOĞU; MİSOPROSTOL

Arş. Gör. Fatma AKIN (ORCID: 0009-0002-8875-7894)
Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, University of Siirt, Siirt, 56100, Turkiye.
Email: akinfatma5610@gmail.com

Dr. Öğr. Üyesi Devran COŞKUN* (ORCID: 0000-0003-1151-1861)
Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, University of Siirt, Siirt, 56100, Turkiye.
Email: devrancoskun@gmail.com

Doç. Dr. Orhan ÇORUM (ORCID: 0000-0003-3168-2510)
Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, University of Hatay Mustafa Kemal, Hatay, 31060, Turkiye.
Email: orhancorum46@hotmail.com

Prof. Dr. Kamil ÜNEY (ORCID: 0000-0002-8674-4873)
Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, University of Selcuk, Konya, 42031, Turkiye
Email: kuney@selcuk.edu.tr

ÖZET
Misoprostol beşerî ve veteriner hekimliğinde uzun yıllardır mide ülserlerinin tedavisinde kullanılır. Ayrıca beşerî hekimlikte gebeliğin sonlandırılması, doğumun indüksiyonu ve doğum sonrası kanamaların kontrol altına alınması için kullanılır. Bu derleme kapsamında misoprostolün etki mekanizması, farmakokinetiği, uygulama yolları ve dozları, kullanım alanları, klinik çalışmalar ve yan etkileri hakkında bilgi verilmeye çalışılmıştır.
Anahtar Kelimeler: Misoprostol, Peptik Ülser, Gebelik.

PROSTAGLANDIN E1 ANALOGUE; MISOPROSTOL

ABSTRACT
Misoprostol has been used in human and veterinary medicine for many years for the treatment of stomach ulcers. It is also used in human medicine for termination of pregnancy, induction of labour and control of postpartum haemorrhage. Within the scope of this review, information about the mechanism of action, pharmacokinetics, routes of administration and doses, areas of use, clinical studies and side effects of misoprostol has been tried to be given.
Keywords: Misoprostol, Peptic Ulcer, Pregnancy.

1.Giriş

Misoprostol (15-deoksi-16-hidroksi-16-metil prostaglandin E1), sentetik bir prostaglandin E1 analoğudur (Davies ve ark., 2001). Gastrik asit sekresyonunun inhibisyonu ve mukoza koruyucu etkilerinden dolayı peptik ülser tedavisinde kullanılır (Watkinson ve ark., 1998). Misoprostol, prostaglandin reseptörlerine bağlanıp histamin tarafından uyarılan cAMP oluşumunu engeller, böylece doğrudan hidroklorik asidin paryetal hücrelerden salınımını inhibe eder. Ayrıca pepsin içeriğini azaltır, gastrik mukozaya kan akışını dolayısıyla oksijen ve besin maddelerinin gelişini artırarak sitoprotektif etki gösterir (Robert, 1975). Buna ek olarak misoprostol antioksidan, anti-apoptotik ve inflamasyonu baskılayıcı etkilerinden dolayı paklitaksel gibi ilaçların kalp dokusu üzerine oluşturduğu hiper-eozinofili ile karakterize ödem, konjesyon, hemoraji, apoptoz ve dejenerasyondan koruyabileceği ifade edilmiştir (Aktaş ve ark., 2024). Misoprostol, diğer prostaglandin analoglarına kıyasla ucuz olması, kolay bulunabilmesi, oda sıcaklığında stabil kalabilmesi ve yan etkilerinin az olması gibi avantajlarından dolayı veteriner ve beşerî hekimliğinde birçok endikasyon için yaygın olarak kullanılır. Başlıca kullanım alanı mide ülserlerinin tedavisidir. Ayrıca uterotonik ve servikal etkisinden kaynaklı abort, servikal hazırlanma, doğumun indüksiyonu ve doğum sonu kanamanın tedavisi amacıyla oral, intravaginal, dil altı, intrabukkal veya rektal yolla kullanılır (Tang ve ark., 2007). Oral uygulama ile karşılaştırıldığında, intravaginal uygulama sonrası daha yüksek biyoyararlanıma sahip olduğu ve uterus üzerine etkilerinin daha iyi görüldüğü ifade edilmiştir (Allen & O'Brien, 2009).

Misoprostolün insanlarda 0.2 mg/insan dozunda günde 4 defa ya da 0.6-0.8 mg/insan dozunda günde bir defa ve köpeklerde oral yolla 2-5 mg/kg dozda 2 veya 3 defa kullanılması önerilir. Misoprostol farmakokinetik özellikleri köpek ve insanlarda benzerlik gösterir (Maddison ve ark 2008). Köpeklere oral uygulama sonrası misoprostolün tamamına yakını emilirken büyük bir kısmı ilk geçiş etkisine uğrar. Plazma proteinlerine yüksek oranda bağlanan misoprostol, vücutta inaktif metabolitlerine metabolize olur ve özellikle idrar ile atılır. Misoprostolün yarılanma ömrü insanlarda yaklaşık 30 dakika ve farmakolojik etkisinin süresi 3-6 saattir. Misoprostol özellikle antiasit ilaçlar ile etkileşime girer ve bu grup ilaçlar ile kullanıldığında biyoyararlanımının azaldığı ancak klinik cevabının etkilenmediği ifade edilmiştir

(Maddison ve ark., 2008). Ayrıca mide de besinlerin bulunması emilimini azaltır (Feen & Robinson, 1991).

Misoprostol genel olarak iyi tolere edilmesine karşın yaygın görülen bazı yan etkilere sahiptir. En yaygın görülen yan etkileri bulantı, kusma, ishal ve tremorlardır. Bazı hastalarda gastrointestinal kanama, miyokard enfarktüsü ve histeroreksi gibi ciddi yan etkiler bildirilmiştir (Liu, 2023; Rostom ve ark., 2009). Misoprostolün bir diğer yan etkisi; uterusun tonusunu artırarak servikste gevşemeye bağlı yavru atma görülmesidir. Bu etkisinden kaynaklı doğumun başlatılması ve istenmeyen gebeliklerin sonlandırılması için kullanılır (Tang ve ark., 2007). Düşük dozlarda kardiyovasküler sistem üzerine etkilerinin net olmadığı, ancak yüksek dozlarda ciddi kardiyovasküler yan etkiler görülebileceği bildirilmiştir (Lee ve ark., 2021).

2. Kullanım Alanları

2.1 Peptik Ülser Tedavisi

Peptik ülser mide, ince bağırsak veya yemek borusunun iç yüzeyinin mide asidi tarafından tahrip edilmesi sonucu meydana gelen açık yaralardır. Ülserlerin en yaygın nedeni midede *Helicobacter pylori* (*H. pylori*) tarafından meydana gelen enfeksiyonlardır. Misoprostol, peptik ülser hastalığının tedavisi için kullanılan ilk sentetik prostaglandin E analoğudur (Monk ve Crissold, 1987). 1982 yılında misoprostolün beşerî hekimlikte mide asit salgısının önlenmesi ve mukozanın korunması için kullanımı onaylanmıştır (WHO, 2009). O zamandan bu yana peptik ülserin tedavisinde ve önlenmesinde kullanılır (Hunt ve ark.,1983). Misoprostol, yalnızca mide asidi salgısını engellemekle kalmaz, aynı zamanda mide ve duodenal mukozanın bütünlüğünün korunmasını, mide ve duodenal mukoza tarafından mukus ve bikarbonat salgısının uyarılması ve mide kan akışında artışa neden olur (Watkinson & Akbar, 1987; Wilson, 1987).

Misoprostol gastrik sekresyonu güçlü bir şekilde inhibe ettiği için alkol, aspirin, naproksen ve tolmetin gibi maddelerin gastrointestinal mukoza üzerindeki yan etkilerini engelleyebilir (Watkinson ve ark., 1998). Bu etkisinden dolayı romatizmal artrit ve benzeri hastalıklar sırasında uzun süreli NSAID kullanımı sonucu oluşabilecek yan etkilerin azaltılması için kullanılır (Dajani ve ark., 1978; Hunt ve ark., 1983, Watkinson & Akbar, 1987). Misoprostol köpeklerde ve insanlarda mide asidi salgısının güçlü bir şekilde inhibe eder (Dajani ve ark., 1976; Akdamar ve ark., 1982). Köpeklere yüksek

dozda aspirin uygulaması sonrasında gelişen gastrointestinal sistem hasarının misoprostol tarafından azaltılabileceği rapor edilmiştir (Marks ve ark., 2018).

2.2. Gebeliğin Sonlandırılması

Misoprostol uterus tonusunu arttırdığı ve serviksi gevşettiği için yavru atmaya neden olur. Bu etkisi özellikle ikinci ve üçüncü trimesterde gebeliğin sonlandırılması amacıyla kullanılır (Gülmezoğlu ve ark., 2005; Tang ve ark., 2007). Amerika Birleşik Devletleri Gıda ve İlaç Dairesi (FDA), misoprostolün gebelerde non-steroid antiinflamatuar ilaçların kullanımına bağlı olarak ortaya çıkan mide ülseri tedavisinde kullanımı onaylarken (FDA, 2002), Dünya Sağlık Örgütü (WHO) bazı gebeliklerde gebeliğin sonlandırılması için kullanımını önermiştir (WHO, 2003). Kürtaja bağlı gebelerde mortalite oranı gün geçtikçe artmaktadır ve bunun en önemli nedenlerinden birisi rahim ağzının yeterince açık olmamasıdır. Misoprostol kürtaj öncesi servikal dilatasyonu sağlamak amacıyla da kullanılır (Bugalho ve ark., 1994; Henry ve Haukkamaa, 1990). Kürtaj operasyonu öncesi misoprostol uygulanması komplikasyonları dokuz kat azaltmıştır (Bugalho ve ark.,1994; Carbonell ve ark., 1997).

2.3. Doğumun İndüksiyonu

Doğumun fizyolojik olarak başlayamadığı ya da fetüsün risk altında olduğu durumlarda, doğumun suni olarak başlatılması gereklidir (Alfirevic ve Weeks, 2007). Doğum indüksiyonu, hamileliğin tıbbi veya obstetrik komplikasyonları nedeniyle endike olabilir. Ayrıca tıbbi olmayan veya sosyal nedenlerden dolayı talep edilebilir veya seçilebilir (Mozurkewich ve ark.,2011). Serviks açıklığı doğum için uygun olmayan gebelerde doğumun indüksiyonu için oksitosin ve prostaglandin kullanılmaktadır (Leszczynska-Gorzelak ve ark., 1999). Prostaglandinler uterusta doğal olarak bulunan hormonlardır ve doğum sırasında serviksin açılması ve uterusun kontraksiyonunda önemli rollere sahiptir (Alfirevic & Weeks, 2007). Misoprostol uterus düz kas hücrelerine bağlanır böylelikle uterusun kasılma gücünü ve sıklığını arttırmaktadır (Chatsis & Frey, 2018). İlk defa 1987 yılında misoprostolün doğumu tetiklediği ortaya koyulmuştur (Neto ve ark., 1987) ve bu amaç için uzun zamandır etiket dışı olarak kullanılır (Stephenson & Wing, 2015). WHO tarafından doğumun indüksiyonu için misoprostolün oral yolla 2 saatte bir 25 mg dozda ve intravaginal olarak 6 saatte bir 25 mg dozunda kullanımını önerilir (WHO, 2011). Diğer bir prostaglandin analoğu olan dinoprostonla etkinlikleri

karşılaştırıldığında, misoprostolün doğumu daha erken başlattığı ve etkinliğinin daha iyi olduğu bildirilmiştir (Neiger & Greaves, 2001, Harms ve ark., 2001).

2.4. Doğum Sonrası Kanamanın Kontrolü

Doğum sonrası kanama, dünya çapında annelerin doğum sırasında ölmelerinin en yaygın nedenleri arasındadır (Say ve ark., 2014). Doğum sırasında kadınların çoğunda orta derecede kanama görülmesine karşın bazılarında aşırı kanamalar görülebilir ve bu durum annenin yaşamı için ciddi bir risk oluşturur (Gallos ve ark., 2018). Doğum sonrası kanamalar, anne ölümlerinin gelişmiş ülkelerde %8'inden, gelişmekte olan ülkelerde ise %20'sinden sorumludur (Bienstock ve ark., 2021).

Doğumda aşırı kanamayı azaltmak için, uterotonik ilaçlar rutin olarak uygulanır (Hofmeyr ve ark., 2013). Misoprostol, doğum sonrası kanamanın önlenmesi ve tedavisinde kullanılan uterotonik ilaçlardan birisidir (Norman ve ark., 1991). WHO tarafından doğum sonrası kanamanın kontrolü amacıyla misoprostol ve oksitosinin kullanılması önerilir (WHO, 2007). Yapılan çalışmalarda misoprostolün doğum sonrası oluşan kanamaların tedavisinde etkili olduğu ortaya koyulmuştur (Jouppila, 1995; Jackson & Paterson-Brown, 1999). Misoprostolün doğum sonu kanamaları önemli ölçüde azalttığı (Hoj ve ark., 2005) ve bu etkisinin ergotamine benzer olduğu belirtilmiştir (Walraven ve ark., 2005). Ancak etkinliği oksitosin ile karşılaştırıldığında bazı çalışmalar misoprostolü bazı çalışmalar ise oksitosini daha etkili bulunmuştur (Derman ve ark., 2006; Alfi ve ark., 2007).

3. Sonuç ve Öneriler

Misoprostol mide ülserlerinin tedavisi için FDA tarafından ruhsatlanmış olmasına rağmen, insanlarda doğum ile ilgili operasyonlarda (gebeliğin sonlandırılması, doğumun indüksiyonu ve doğum sonrası kanamanın tedavisi) etiket dışı olarak kullanılmaktadır. Diğer prostaglandin analoglarına kıyasla ucuz olması, kolay bulunabilmesi, oda sıcaklığında stabil kalabilmesi ve yan etkilerinin az olması gibi avantajlarından dolayı yaygın bir şekilde kullanılmaktadır.

Beşerî hekimlikte misoprostolün kullanımı ile ilgili birçok araştırma yapılmış olmasına rağmen, veteriner hekimliğinde peptik ülser tedavisi dışındaki diğer kullanım alanları ile ilgili araştırmalar oldukça sınırlıdır. Ancak doğumun başlatılması veya sonlandırılması ile ilgili hormonal mekanizmalar insan ve hayvan türleri arasında benzerlik gösterdiği düşünüldüğünde hayvanlarda peptik ülser tedavisine ek olarak

doğum ile ilgili olaylarda kullanılabileceği düşünülebilir. Ancak hayvanlarda belirtilen bu endikasyonlarda kullanılmadan önce klinik etkilerinin ve olası yan etkilerinin ortaya konulmasına ihtiyaç vardır.

KAYNAKLAR

Akdamar, K., Agrawal, N., & Ertan, A. (1982). Inhibition of nocturnal gastric secretion in normal human volunteers by misoprostol: a synthetic prostaglandin E1 methyl ester analog. *Am J Gastroenterol*, 77(12):902-4. PMID: 6816064.

Aktaş, İ., Gur, F. M., & Bilgiç, S. (2024). Protective effect of misoprostol against paclitaxel-induced cardiac damage in rats. *Prostaglandins & Other Lipid Mediators*, 106813. DOİ: https://doi.org/10.1016/j.prostaglandins.2024.106813

Alfi revic, A., Blum, J., Walraven, G., Weeks, A., & Winikoff, B. (2007). Prevention of postpartum hemorrhage with misoprostol. *Int J Gynaecol Obstet*, 99 (suppl 2): 198–201. DOİ: https://doi.org/10.1016/j.ijgo.2007.09.012

Alfirevic, Z., & Weeks, A. (2007). Oral misoprostol for induction of labour (review). Cohrane review. PMID: 16625542.

Allen, R., & O'Brien, B. M. Uses of misoprostol in obstetrics and gynecology. *Rev Obstet Gynecol*. 2009 Summer;2(3):159-68. PMID: 19826573; PMCID: PMC2760893.

Bienstock, J. L., Eke, A. C., & Hueppchen, N. A. (2021). Postpartum hemorrhage. *New England Journal of Medicine*, *384*(17), 1635-1645. DOİ: https://doi.org/10.1056/nejmra1513247

Bugalho, A., Bique, C., Almeida, L., Bergström, S. (1994). Application of vaginal misoprostol before cervical dilatation to facilitate first-trimester pregnancy interruption. *Obstet Gynecol*, 83(5 Pt 1):729-31. PMID: 8164932.

Carbonell, J. L. L., Varela, L., Velazco, A., & Fernandez, C. (1997). The use of misoprostol for termination of early pregnancy. *Contraception*, *55*(3), 165-168. DOİ: https://doi.org/10.1016/s0010-7824(97)00020-6

Chatsis, V., & Frey, N. (2018). CADTH rapid response reports. Misoprostol for cervical ripening and induction of labour: a review of clinical effectiveness, cost-effectiveness and guidelines. *Ottawa (ON): Canadian Agency for Drugs and Technologies in Health*, http://www.ncbi.nlm.nih.gov/books/nbk538944/

Dajani, E. Z., Callison, D. A., & Bertermann, R. E. (1978). Effects of E prostaglandins on canine gastric potential difference. *The American Journal of Digestive Diseases*, 23, 436-442. DOİ: https://doi.org/10.1007/bf01072927

Dajani, E. Z., Driskill, D. R., Bianchi, R. G., Collins, P. W., & Pappo, R. (1976). SC-29333: A potent inhibitor of canine gastric secretion. *The American Journal of Digestive Diseases*, 21, 1049-1057. DOİ: https://doi.org/10.1007/bf01071862

Davies, N. M., Longstreth, J., & Jamali, F. (2001). Misoprostol therapeutics revisited. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy*, *21*(1), 60-73. DOİ: https://doi.org/10.1592/phco.21.1.60.34442

Derman, R. J., Kodkany, B. S., Goudar, S. S., Geller, S. E., Naik, V. A., Bellad, M. B., ... & Moss, N. (2006). Oral misoprostol in preventing postpartum haemorrhage in resource-poor communities: a randomised controlled trial. *The Lancet*, 368(9543), 1248-1253. DOİ: https://doi.org/10.1016/s0140-6736(06)69522-6

Fenn, G. C., & Robinson, G. C. (1991). Misoprostol—a logical therapeutic approach to gastroduodenal mucosal injury induced by non-steroidal anti-inflammatory drugs?. *Journal of Clinical Pharmacy and Therapeutics*, 16(6), 385-409. DOİ: https://doi.org/10.1111/j.1365-2710.1991.tb00330.x

Gallos, I. D., Papadopoulou, A., Man, R., Athanasopoulos, N., Tobias, A., Price, M. J., ... & Coomarasamy, A. (2018). Uterotonic agents for preventing postpartum haemorrhage: a network meta-analysis. *Cochrane Database of Systematic Reviews*, (12). DOİ: https://doi.org/10.1002/14651858.cd011689.pub3

Gülmezoglu, A. M., Forna, F., Villar, J., & Hofmeyr, G. J. (2007). Prostaglandins for preventing postpartum haemorrhage. *Cochrane Database of Systematic Reviews*, (3).DOİ:https://doi.org/10.1002/14651858.CD000494.pub3

Harms, K., Nguyen, C., Toy, E. C., & Baker III, B. (2001). Intravaginal misoprostol versus cervidil for cervical ripening in term pregnancies. *Obstetrics & Gynecology*, 97(4), S36. DOİ: https://doi.org/10.1016/S0029-7844(01)01225-X

Henry, A. M., & Haukkamaa, M. (1999). Comparison of vaginal misoprostol and gemeprost as pretreatment in first trimester pregnancy interruption. *BJOG: An International Journal of Obstetrics & Gynaecology*, 106(6), 540-543. DOİ: https://doi.org/10.1111/j.1471-0528.1999.tb08321.x

Hofmeyr, G. J., Gülmezoglu, A. M., Novikova, N., & Lawrie, T. A. (2013). Postpartum misoprostol for preventing maternal mortality and morbidity. *Cochrane Database of Systematic Reviews*, (7). DOİ: https://doi.org/10.1002/14651858.cd008982.pub2

Cardoso, P., Nielsen, B. B., Hvidman, L., Nielsen, J., & Aaby, P. (2005). Effect of sublingual misoprostol on severe postpartum haemorrhage in a primary health centre in Guinea-Bissau: randomised double blind clinical trial. *Bmj*, 331(7519), 723. DOİ: https://doi.org/10.1136/bmj.331.7519.723

Hunt, J. N., Smith, J. L., Jiang, C. L., & Kessler, L. (1983). Effect of synthetic prostaglandin E 1 analog on aspirin-induced gastric bleeding and secretion. *Digestive diseases and sciences*, 28, 897-902. DOİ: https://doi.org/10.1007/bf01317040

Jackson, N., & Paterson-Brown, S. (1999). Postpartum haemorrhage. *Hospital Medicine*, 60(12), 868-872. DOİ: https://doi.org/10.12968/hosp.1999.60.12.1253

Jouppila, P. (1995). Postpartum haemorrhage. *Current opinion in Obstetrics and Gynecology*, 7(6), 446-450. DOİ: https://doi.org/10.1097/00001703-199512000-00008

Lee, S., Cauldwell, M., & Wendler, R. (2021). Cardiac effects of drugs used for induction of labour and prevention and treatment of postpartum haemorrhage. International Journal of Cardiology Congenital Heart Disease, 5, 100208. DOİ: https://doi.org/10.1016/j.ijcchd.2021.100208

Leszczyńska-Gorzelak, B., Laskowska, M., & Oleszczuk, J. (1999). Using of misoprostol for preinduction and induction of labor in term pregnancy. *Ginekologia Polska*, *70*(12), 881-889. PMID: 10715910.

Leszczyńska-Gorzelak, B., Laskowska, M., Oleszczuk, J. (1999). Zastosowanie misoprostolu w preindukcji i indukcji porodu w terminie [Using of Misoprostol for preinduction and induction of labor in term pregnancy]. Ginekol Pol. 1999 Dec;70(12):881-9. Polish. PMID: 10715910.

Liu, M. (2023). Side effects of agents that influence corticotrophins, corticosteroids, and prostaglandins. DOİ: https://doi.org/10.1016/bs.seda.2023.08.008

Maddison, J. E., Page, S. W., & Church, D. B. (Eds.). (2008). Small animal clinical pharmacology (Vol. 5). *Elsevier Health Sciences*. DOİ: 10.1016/B978-0-7020-2858-8.X5001-5

Marks, S. L., Kook, P. H., Papich, M. G., Tolbert, M. K., & Willard, M. D. (2018). ACVIM consensus statement: support for rational administration of gastrointestinal

protectants to dogs and cats. Journal of veterinary internal medicine, 32(6), 1823-1840. DOİ: https://doi.org/10.1111/jvim.15337

Monk, J. P., & Clissold, S. P. (1987). Misoprostol: a preliminary review of its pharmacodynamic and pharmacokinetic properties, and therapeutic efficacy in the treatment of peptic ulcer disease. *Drugs*, *33*, 1-30. DOİ: https://doi.org/10.2165/00003495-198733010-00001

Mozurkewich, E. L., Chilimigras, J. L., Berman, D. R., Perni, U. C., Romero, V. C., King, V. J., & Keeton, K. L. (2011). Methods of induction of labour: a systematic review. *BMC pregnancy and childbirth*, *11*, 1-19. DOİ: https://doi.org/10.1186/1471-2393-11-84

Neiger, R., & Greaves, P. C. (2001). Comparison between vaginal misoprostol and cervical dinoprostone for cervical ripening and labor induction. Tennessee Medicine: Journal of the Tennessee Medical Association, 94(1), 25-27. PMID: 11194687

Neiger, R., Greaves, P. C. (2001) Comparison between vaginal misoprostol and cervical dinoprostone for cervical ripening and labor induction. *Tenn Med*, 94(1):25-7. PMID: 11194687.

Neto, C. M., Leano, E. J., Barreto, E. M., Keng, G., & De Aquino, M. M. (1987). Use of misoprostol for labour induction in stillbirth. *Rev Paul Med*, 105:325-328. PMID: 3144030.

Mariani Neto, C., Leão, E. J., Barreto, E. M., Kenj, G., De Aquino, M. M., & Tuffi, V. H. (1987) Uso do misoprostol para indução do parto com feto morto [Use of misoprostol for labor induction in stillbirth]. *Rev Paul Med*. 1987 Nov-Dec;105(6):325-8. Portuguese. PMID: 3144030.

New US food and drug administration labeling on Cytotec (misoprostol) use and pregnancy. ACOG Committee Opinion 283. Washington, DC: American College of Obstetricians and Gynecologists; 2003. ACOG Committee Opinion. American College of Obstetrician and Gynecologist. ACOG Committee Opinion. Number 283, May 2003.

New U.S. Food and Drug Administration labeling on Cytotec (misoprostol) use and pregnancy. Obstet Gynecol. 2003 May;101(5 Pt 1):1049-50. doi: 10.1016/s0029-7844(03)00396-x. PMID: 12738178.

Norman, J. E., Thong, K. J., & Baird, D. T. (1991). Uterine contractility and induction of abortion in early pregnancy by misoprostol and mifepristone. *Lancet*, 338:1233-6. DOİ: https://doi.org/10.1016/0140-6736(91)92102-8

Robert, A. (1975). An intestinal disease produced experimentally by a prostaglandin deficiency. *Gastroenterology*, 69(4), 1045-1047. DOİ: https://doi.org/10.1016/S0016-5085(19)32433-3

Rostom, A., Muir, K., Dube, C., Lanas, A., Jolicoeur, E., & Tugwell, P. (2009). Prevention of NSAID-related upper gastrointestinal toxicity: a meta-analysis of traditional NSAIDs with gastroprotection and COX-2 inhibitors. *Drug, Healthcare and Patient Safety*, 47-71. DOİ: https://doi.org/10.2147/dhps.s4334

Say, L., Chou, D., Gemmill, A., Tunçalp, Ö., Moller, A. B., Daniels, J., ... & Alkema, L. (2014). Global causes of maternal death: a WHO systematic analysis. The Lancet global health, 2(6), e323-e333. DOİ: https://doi.org/10.1016/s2214-109x(14)70227-x

Stephenson, M. L., & Wing, D. A. (2015). Misoprostol for induction of labor. In *Seminars in perinatology* (Vol. 39, No. 6, pp. 459-462). WB Saunders; Philadelphia, ABD.DOİ: 10.1053/j.semperi.2015.07.008

Tang, O. S., Gemzell-Danielsson, K., & Ho, P. C. (2007). Misoprostol: pharmacokinetic profiles, effects on the uterus and side-effects. *International Journal of Gynecology & Obstetrics*, 99, S160-S167. DOİ: https://doi.org/10.1016/j.ijgo.2007.09.004

Walraven, G., Blum, J., Dampha, Y., Sowe, M., Morison, L., Winikoff, B., & Sloan, N. (2005). Misoprostol in the management of the third stage of labour in the home delivery setting in rural Gambia: a randomised controlled trial. *BJOG: An International Journal of Obstetrics & Gynaecology*, 112(9), 1277-1283. DOİ: https://doi.org/10.1111/j.1471-0528.2005.00711.x

Watkinson, G., Hopkins, A., & Akbar, F. A. (1988). The therapeutic efficacy of misoprostol in peptic ulcer disease. *Postgraduate Medical Journal*, 64, 60-77. PMID: 3138682

Watkinson, G., Hopkins, A., Akbar, F. A. (1988). The therapeutic efficacy of misoprostol in peptic ulcer disease. *Postgrad Med J*, 64 Suppl 1:60-77. PMID: 3138682.

Watkinson, G., & Akbar, F. A. (1987). Misoprostol in peptic ulcer disease. Prostaglandins, 33, 78-92. DOİ: https://doi.org/10.1016/0090-6980(87)90051-7

Safe Abortion: Technical and Policy Guidance for Health Systems. 2nd ed. Geneva: World Health Organization; 2012. PMID: 23700650. http://www.ncbi.nlm.nih.gov/books/nbk138196/

WHO. WHO model list of essential medicine. 16th ed. Geneva: WHO; 2009

Wilson, D. E. (1987). Antisecretory and mucosal protective actions of misoprostol: potential role in the treatment of peptic ulcer disease. *The American Journal of Medicine*, *83*(1), 2-8. DOİ: https://doi.org/10.1016/0002-9343(87)90571-7

World Health Organization. WHO recommendations for induction of labour. 2011. p. 1e36. erişim adresleri http://www.ncbi.nlm.nih.gov/books/nbk131963/

ÜLKEMİZDE *ENTAMOEBA HISTOLYTICA* ENFEKSİYONLARININ BÖLGELERE GÖRE PREVALANSI VE ÖNEMİ

Leyla GÜNDÜZ (ORCID:0000-0002-5916-5737)
Van yüzüncü yıl üniversitesi, Sağlık bilimleri enstitüsü, Tıp parazitolojisi, Van
Email: lylgndz_55@hotmail.com

ÖZET

Entamoeba histoltica, *Entamoeba* cinsinden bir tür olup, anaerobik bir parazittir. Hayat döngüsünde kist-metakist – metakistik trofozoit – trofozoit-prekist - dönemleri görülmektedir.Bu parazit *hastalık* yapmadan da bağırsakta yaşamını sürdürebilir. Genelde kalın bağırsağa yerleşip orada yayılır, nadiren de olsa dokuları geçebilmektedir. Kalın bağırsağa yayıldığında, akut dizanteri, bağırsak iltihabı veya ishale neden olabilmekte, bazen de kana geçebilmektedir. Bununla beraber kanla akciğer, karaciğer, gibi organlara ulaşırlar. Sıcak ve ılıman bölgelerde daha çok görülmektedir. Bu parazitin hızlı bir şekilde yayılmasına neden olan etmenler arasında; insan dışkılarının tarla gibi yerlere gübre olarak verilmesi, insektler, bu enfeksiyondan bulaşı olan insanların gıda sanayilerinde çalışıyor olması ve hijyen konusunda dikkat edilmemesi gibi nedenler yer almaktadır. Asıl bulaş oral yoldur. Belirtilerinde; mide krampları, yumuşak dışkılama gibi semptomlar görülebilmektedir. Bu bağlamda hastalığın daha etkili ve şiddetli izlediği amipli dizanteride; karın ağrısı, ateş, dışkılamada kanın izlenmesi, kusma ve iştahsızlık gibi durumların görülmesi olasıdır. Amip beyin ve karaciğer abselerine de neden olabilmektedi. Tanısında, mikroskobik olarak incelenmek üzere dışkı numuneleri ile yapılan çalışmalara bakıldığında %34 oranında hassasiyet tespit edilmektedir. Mikroskobik yönteme ek olarak amibe ait antijenlerin ve karşı antikorların tespit edilmesi ile tanının hassasiyeti artmaktadır. Diğer organlarda görünenlerde, karaciğer absesi gibi durumlarda, ultrasan ve tomografi görüntüleme yöntemleri hastalığın tespitinde yardımcı olmaktadır. Bu bağlamda parazitin olgun kistlerinin su, gıda ve cinsel yol ile bulaşmasıyla trofozoitlerinin kolona invazyonu ile oluşmakta ve asemptomatik taşıyıcılıktan, amibik kolite kadar çok farklı klinik tablolar ile karşımıza çıkabilmektedir. Sonuç olarak bu durum dünyada ve ülkemizde bölgelere göre değişik tablolarla karşımıza çıkmaktadır. Amöbiyaz, bildirimi zorunlu hastalıklar arasında yer almaktadır.Bu bağlamda hastalığı taşıyan kişilerin tedavisi mutlak bir şekilde yapılmalı, kişisel temziliğe dikkat edilmeli, günlük kullanılan suların, kanalizasyon sularıyla karışması önlenmeli ve vektörlerle mücadele gibi başlıca önlemler alınmalıdır. Amöbiyazın tedavi seyrinde kist veya trofozoit formlarında etkili olan antibiyotikler ve antiprotozoner ilaçlar kullanılmalıdır.
Anahtar Kelimeler: *Entamoebahistolytica*, amiplidizanteri, Türkiye

PREVALANCE AND IMPORTANCE OF ENTAMOEBA HISTOLYTICA INFECTIONS BY REGION IN OUR COUNTRY

ABSTRACT

Entamoeba histoltica is a species of the Entamoeba genus and is an anaerobik parasite. Cyst-metachyst - metacystic trophozoite - trophozoite-precyst - periods are observed in its life cycle. The disease settles in the large intestine and can be found there, and in rare cases, it can pass through the tissues. When it spreads to the right side of the large intestine, it can cause acute dysentery, exit symptoms or diarrhea, and sometimes it can pass into the blood. In addition, it can reach organs such as the lungs, heart, etc. with the blood. Warm and moderate systems are more common. Among those that cause rapid treatment of this parasite; There are reasons such as people's policies on using healthy fertilizer in the field, insects, people infected with this economy working in food industries and not paying attention to hygiene. The main transmission is oral. in their averages; Stomach cramps and soft lid swelling may occur. More effective and severe monitoring of the society in this context is amoebic dysentery; It is possible to experience conditions such as abdominal pain, fever, blood in the stool, vomiting and loss of appetite. Amoeba can also cause brain and neurological abscesses. Analyzes made with samples for microscopic examination are found to be 34% accurate in diagnosis. In addition to the microscopic method, the accuracy of the diagnosis increases with the detection of amoeba antigens and antibodies. In cases that appear in other organs, such as liver abscess, ultrasound and tomography imaging methods help detect the disease. In this context, it is formed by the invasion of trophozoites into the colon by the transmission of mature cysts of the parasite through water, food and sexual contact, and can present with very different clinical pictures, from asymptomatic carriage to amoebic colitis. As a result, this situation appears with different patterns depending on the region in the world and in our country. Amoebiasis is among the notifiable diseases. In this context, people with the disease must be treated absolutely, personal hygiene must be taken into consideration, daily water must be prevented from mixing with sewage water, and major measures such as combating vectors must be taken. Antibiotics and antiprotozoan drugs that are effective in cyst or trophozoite forms should be used during the treatment of amoebiasis.

Keywords: Entamoeba histolytica, amoebic dysentery, Türkiye

Genel bilgiler

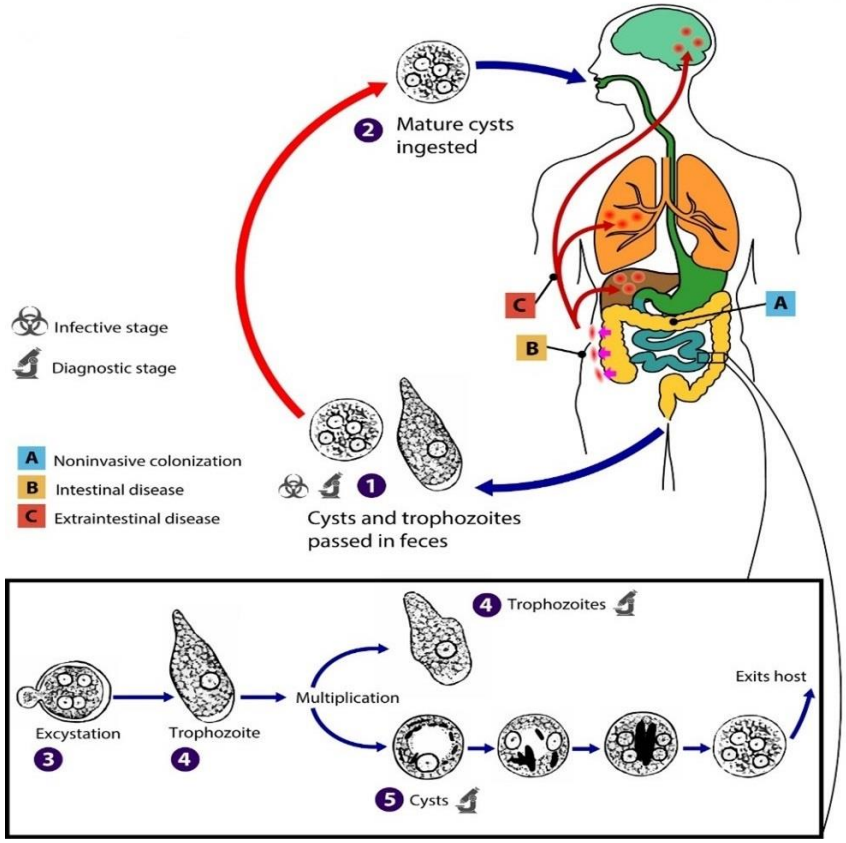
1903'de Schaudinn, *Entamoebahistolytica*ismini, parazitin insan dokusunu tahrip etmesindenkaynaklı olarak ilk defa kullanmaya başlamıştır. Dobell tarafından yazılan,1919 yılında ''insanda yaşayan amip'' başlıklı yazısında amibin hayatdöngüsü tanımlanmıştır (Demirçeken ,2002).Bu döngüde parazitin beş farklı formu bulunmaktadır bunlar; trofozoit, prekist, kist, metakist ve metakistiktrofozoit olmak üzere farklı morfolojik yapısı tanımlanmıştır (Unat ve ark., 1995; Markell ve ark., 1992).

*Trofozoit formu:*12-20 µm çapında olan trofozoitler bağırsak boşluğunda bulunur. Dokudakiler ise 20-40 µm, bazen 50-60 µm çapında olabilmektedir. Bu parazitin dokuda kist şekli bulunmamaktadır. Bu form aktif, hareket eden, büyüyen ve çoğalan şeklidir. Belirgin sabit bir şekli bulunmaz, yalancı ayakları bulunur ve bu sayede sürekli şekil değiştirebilmektedir. Bu ayakların çıkış bölgelerinde ektoplazma ve endoplazma kolay ayırt edilebilir durumdadır. Boyanmış olantrofozoitin çekirdek kısmı tipik bir görünüme sahip olup, çekirdek zarının iç yüzünde tümü aynı büyüklükte olan kromatin tanecikleri bulunur ve karyozom tam merkezdedir (Çetin ve ark. 1995; Markell ve ark. 1992; Unat ve ark., 1995; Saygı, 2009).

Prekistformu: İlk form olantrofozoit formundan kist formuna geçişin ilk basamağıdır. Parazitin trofozoit formda yaşamını devam ettirebilmeşartları zorlaştığında ve hastalık belirtileri azaldığında meydana gelmektedir. Bu form şekil bakımından yuvarlaklaşmış; beslenmesi ve hareket hali durmuştur. Ektoplazma ve endoplazma ayırtedilemez durumdadır. Çekirdek, trofozoit formunanazaran daha da küçük hale gelmiştir. Endoplazmaya bakıldığında uç kısımlar küt çomakçıklarhalinde kromatoid cisimcikler görülebilmektedir (Unat ve ark., 1995; Mandell ve ark., 1995).

Kist formu: Genellikle 15 µm'den küçüktür ve çapı 11-12 µm'dir. Genelde yuvarlak bir şekilde olup prekist formdan meydana gelmektedir. Bazenhafif şekildesimetrisizya da dasöbemsi şekilde olabilir. Glikojen ve çekirdekvakuolüboyanmamış preparatlarda fark edilmeyebilirfakat; kromatoid cisimcikleri görmek mümkündür. Preparatların boyanmış olan halleriyle incelendiğinde, çekirdek yapısının, trofozoitlerin çekirdek yapısından farksız olduğu görülmektedir. Hastalığın bulaşmasında en önemliform, dört çekirdekten oluşanolgunlaşmış kistlerdir (Mandell ve ark., 1995; Markell ve ark., 1992; Unat ve ark., 1995).

Metakist ve metakistiktrofozoit formu: Ağızdan alınmış olan kistin duvarı, ince bağırsağın son bölümüne gelince burada kaybolmaya başlar ve sonrasında dört çekirdekli bir trofozoitortaya çıkar, buna metakistadı verilir. Metakist formun sitoplazmasında, çekirdek sayısı kadar bölünme meydana gelir ve devamında bir kistten dört trofozoitmeydana gelir; bunlara ise metakistiktrofozoitadı verilir (Unat ve ark., 1995).



Şekil 1. *E. histolytica'*nın yaşam döngüsü (Anonim 1, 2024)

E.histolytica*da klinik belirtiler:*Sahip olduğu en yaygın özelliği bağırsak duvarına yerleşebilmesidir. Bağırsak duvarına yapışan amipler bu bölgede salgılamış oldukları hücreyi eritici etkiye sahip enzimlerin etkisiyle dokuya hasar verir ve eritir, devamında derinlere yol alır veburdansubmukozaya geçer (Unat ve ark., 1995 ;Mandell ve ark., 1995).Parazitin hastalık oluşturmasında, trofozoitlerden salınmış olan enzimlerin, enterotoksinveya dasitotoksinlerin ve amibin dokuya teması sonucu gerçekleşen hücre erimesinin büyük bir etkisi vardır (Mandell ve ark., 1995; Markell ve ark., 1992; Unat ve ark., 1995; Özcel ve ark., 2007'a). Hastalık yapıcıforma geçiş yapan*E. histolytica*trofozoitleri dokularda nekroza, ödeme ve erimeye sebep olmaktadır. Bağırsak duvarına etken bir halde yapışan amipler, burada salgıladıkları kollagenaz ve

majornötralproteinaza benzer şekilde birden fazlaproteolitik enzimler sayesinde dokuları eritir ve kandaki eritrositleri fagosite ederek beslenmeyi sağlamış olur. Sonrasında submukozaya geçerek, yanlara yayılır ve ağzı dar bir şişe tarzında amip ülserleri meydana getirirler. Amipler, bağırsak çeperinde meydana gelen ülserlerin çoğu zaman kenarlarında ve dibinde bulunmakla beraber, erimiş olanepitel hücreleri ve eritrositlerle beslenir. Ülserler durumunadaha çok; çekum, rektum ve sigmoid kolonda,daha ağır vaka durumlarında ise; kalınbağırsağın hemen hemen her yerinde ve ayrıca ince bağırsak ve appendikste de rastlanabilmektedir(Özcel ve ark., 2007'a).

Tanı yöntemleri

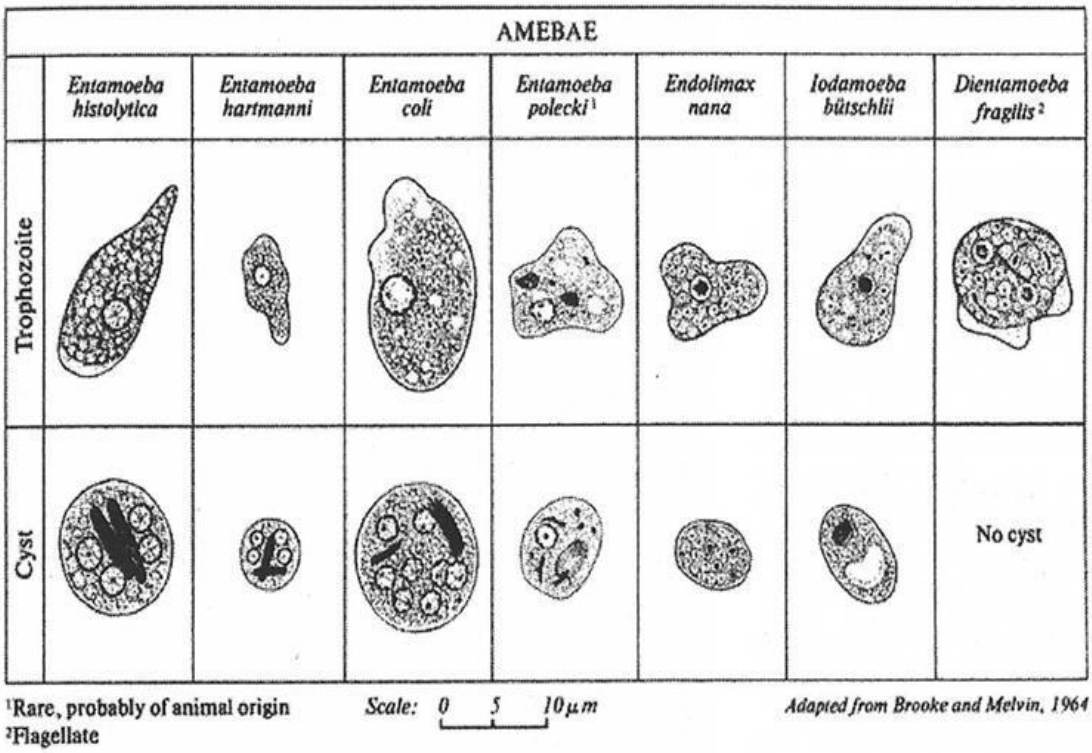
İntestinal parazitlerin tanısında, dışkınumuneleri ile yapılan çalışmalarda mikroskobik yöntemin kullanımı yaygındır. Fakat bu yöntemlerin her birtanesinde ayrı sorunlarve sakıncalarla karşılaşılabilmektedir. Bu nedenle, daha farklıyöntemlerleçalışmakdoğrusonuçlaraulaşmakta fayda sağlamaktadır. Parazit sayısındaki yetersizlikdurumu, var olan formları dışındaki formlarının olması, incelenmiş olan örneklerde birden fazla parazit çeşidi bulunması tanıyı güç duruma düşüren etmenler arasındadır (Aydın ark, 2012., S.Tamer ark., 2008).

Günümüzde tanıda mikroskobi, izoenzim analizleri, antijenbulma yöntemleri, kültür yöntemleri ve PCR benzeri moleküler farklı yöntemler kullanılmaktadır (Özcel ve ark., 2007'a). Serolojik yöntemler daha çok bağırsak dışı amibiyazın tanısında önem taşımaktadır. Bu nedenle IHA, komplement birleşmesi, IFA ve ELISA gibi yöntemler kullanılmaktadır (Unat ve ark., 1995; Özcel ve ark., 2007'a; Markell ve ark., 1992;).

İntestinal sistemamibiyazı, çoğunlukla *Balantidiumcoli*'ye bağlı dizanteri, ülserli kolit, schistosomiasis, kalın bağırsak kanseri gibitüm kalın bağırsak hastalıklarını taklit edebilmektedir. Bundan dolayı kesin tanı, dışkı ya da kalın bağırsaktan sigmoidoskop ve rektoskop yöntemleri sonucunda elde edilmiş olan kazıntıda *E. Histolytica*parzitinin ortaya konulması ile yapılmaktadır. Ayrıca tomografi, radyoloji, ultrasonografi ve radyoizotoplarla yapılan incelemeler tanıyı koymadadestekolmaktadır. Radyolojik yöntemler doğrultusunda yapılan bu incelemeler sayesinde darlıklar ve amebomalar belirlenebilmektedir. Karaciğerin amipli apsesi durumunda diyafram hareketi gittikçe azalmaya başlar, plevrada sıvı birikir ve akciğer bölgesindekollaps ve akciğer apsesi saptanır. Bağırsak yıkamaları, kullanılanantibiyotikler ve antiasitler, radyolojik inceleme

amacı ile kullanılan maddeler trofozoitlerin bulunmasında oldukça güç hale gelir (Özcel ve ark., 2007'a; Saygı, 1998).

Özellikle sulu dışkılarda trofozoidlere, şekilli dışkılarda ise daha çok kistlere rastlanmaktadır. Dışkı incelenmesinde, dışkının bazı alanlarında çok miktarda parazite ratlanılırken, bu durum bazı alanlarda hiç bulunmayadabilir. Sert yapıda olan gaitaların kanlı-mukuslu olan kısımlarından preparasyon işlemi yapılır. Dışkısında fazla miktarda kan olması ve tedavi alan şahıslara ait örneklerde trofozoitlere rastlamak oldukça güç olabilmektedir. Sigmoidoskopi işlemiyle sigmoiddeki, rektoskopi işlemi ile de rektumdaki ülserli yapıyı görerek ve bu kısımlardan kazıntı alınarak amipler aranabilir. Trofozoitlere canlı bir şekilde rastlamak için dışkı soğumadan incelenmelidir (Saygı, 1998; Özcel ve ark., 2007'a).



Şekil 2. Amebaetürlerinindışkıdaki kist yapıları (Anonim 2,2024).

SağlıkAçısındanÖnemi

Bütün yaş gruplarında görülebilen amipli dizanteri, takibinde kanlı ishal ile devam eden rektokolitolayıdır. Tüm dünyada etkili olan, hijyenin, yiyeceklerin ve içeceklerin iyi olmadığı yerlerde çok sık bir şekildegörülebilmektedir (Yıldızhan,2008). Dışkıyla beraber kist, yumurta gibi değişik formlardan geçenparazitoz ortama dağılmaya başlar.

Bazı durumlarda herhangi bir konak (hayvanlar) aracılığı ile detaşınmakta ya da etken direkt olarak yada toprakta belirli bir gelişimi tamamladıktan sonra taşınır (Kapdağlı,2003).Bağırsak parazitlerinin meydanaçıktığıdönemlerebaktığımızda, sonbahar ve yaz mevsimlerinde dahasık oluşu dikkat çekmektedir.Ayrıca yapılan araştırmaların çoğundaintestinalparazitlerçocuklarda daha çok oranda rastlandığı bilinmektedir (Yazar,2005).Bunun nedeni, temizlik alışkanlığınınçoğunluklaçocuklukdönemindegelişmiş olmaması ile açıklanabilmektedir. Hastalığın etkeni olan parazitlerin, kist veya trofozoit formları ya dakurtçukşeklindeki formlarını, insanlar dışkılarıyla,başta parklar olmak üzere etrafa yaydıkları bilinmektedir. Bubağlamda,daha çok sokak, park ve mesire alanları gibi ortamlarda, zaman geçirençocukların risk altında olduğubildirilmiştir.Ülkemizde yapılan araştırmalardaköpeklerin % 86'sında protozoonlarıntespit edildiği bildirilmiştir(Şengür,2005).

Türkiye'de yapılan çalışmalar

Ülkemizde, yöreleri temsilen intestinal parazitlerden biri olan *Entamoebahistoltica* enfeksiyonunun prevalınsı, genellikle hastanelere başvuran hastalara ait verilerin değerlendirildiği retrospektif çalışmalarla ortaya konulmuştur. Ülkemizdeki bölgesel dağılıma baktığımızda yapılan çalışmalarda; Marmara bölgesinde %13-42, Akdeniz'de %55-80, Doğu Anadolu da %59-96, Karadeniz de %55-96, İç Anadolu %74-78, oranında olduğu bildirilmiştir. (Değirmenci ve ark.,2007).

Dokuz EylülÜniv. Tıp fakültesine başvuran 14.246 hasta arasından 1.320'sinde parazitozlarsaptanmıştır. Bu parazitler arasında*E. histolytica*oranı 34(%0.24) olarak hesaplanmıştır (Usluca ve ark., 2010).

Uludağ üniversitesi Tıp fakültesinde incelenen 116 dışkıörneğinden. *E. histolytica*ELISA ile 34/119(%29,3)müspetlikile sonuçlanmıştır. (Alver ve ark., 2015).

Gaziantep ilinde yapılan bir çalışmada, hastaneye ishal şikâyeti ile başvuran 0-12 yasları arasındaki 215 hastaya ait dışkı numuneleri incelenmiş olup,Natif inceleme ile örneklerin 97'sinde(%45.1) amip saptanırken,118 örnekte rastlanılmamıştır. (Zer ve ark.,2009).

Ordu da 7194 kişi ile yapılan bir çalışmada dışkıörnekleriincelenmiş olup, 1181 dışkı numunesinde *E.histolytica*parazititespit edilmiştir (Karaman ve ark.,1014).

Yapılan bir çalışmada ilköğretim dönemindeki çocukların, parazitten kaynaklanan hastalıkların prevelansı tespiti içinyaşları 8-12 olan toplam 310 çocuğundışkıörnekleri incelenmiş olup, *E.histolytica* sıklığı %17.7 oranında tespit edilmiştir (Altındiş ve ark.,2000).

Yapılan bir başka çalışmada, Kayseri ilinde Karpuzseki havzası çevresinde 240 kişidenalınan dışkıörnekleri ile yapılan bir çalışmada. *E.histolytica* 4/240 (%1.66) oranında tespit edilmiştir (Şahin ve ark.,2006).

Karadeniz bölgesinde; Rize'ninçay mahallemevkisinde ilkokul dönemindeki 192 öğrencidenalınan dışkınumuneleri çalışılmış, %2 oranında pozitif olarak bulunmuştur. (Delialioğlu ve ark.,2004).

Isparta ilinde ,2008- 2010 tarihleri arasında Tıp fakültesi hastanesinde yapılan çalışmada 6.565 hastadan alınmış olandışkınumuneleriincelenmiş, olup, örneklerin 338'inde parazit pozitifliğitespit edilmiştir. Bu parazit oranı%0.17-0.19 olarak bildirilmiştir (Kaya ve ark.,2014).

Eskişehir ilinde, Tıp fakültesi hastanesine başvuran hastalardan alınan, 34.733 dışkıörneğinden 1252 dışkıörneğinin parazit taşıdığı tespit edilmiştir. Bunlar arasında *E. Histolytica*%31 (397/1252) olarak izlenmiştir. (Doğan ve ark.,2008).

Kaynaklar

A. Değirmenci, N. Sevil, K. Güneş, A. Yolasığmaz, N. Turgay, "Ege Üniversitesi Tıp Fakültesi Hastanesi Parazitoloji Laboratuvarında 2005 Yılı Boyunca Saptanan Bağırsak Parazitlerinin Dağılımı", *Türkiye Parazitoloji Dergisi*, c.31(2), ss. 133-135, 2007.

A. Kapdağlı, H. Ertabaklar, S. Yaman, S. Ertuğ, "Adnan Menderes Üniversitesi Tıp Fakültesi Parazitoloji Laboratuvarına 2002 Yılında Başvuran Olgulardaki Bağırsak Parazitlerinin Değerlendirilmesi", *Türkiye Parazitoloji Dergisi*, c.4, s.27, ss. 31-34, 2003.

Anonim 1Erişim:https://www.ncbi.nlm.nih.gov/books/NBK7742/Erişim tarihi [27 Ocak 2024]

Anonim 2 2021.Erişim adresi: https://www.cdc.gov/dpdx/amebiasis/index.html[Erişim Tarihi 27 Haziran 2021].

Çetin ET, Anğ Ö, Töreci K. Tıbbi parazitoloji. İstanbul: İ.Ü. Basımevi ve Film Merkezi; 1995.

F. G. Demirçeken, A. Özden, "Amebiyazis ve İnflamatuar Barsak Hastalıkları Birlikteliği: Tanısal Bir İkilem", *Güncel Gastroenteroloji*, c.6, s.3, ss.159, 2002.

G. Sönmez Tamer, Ş. Çalışkan, A. Wıllke, "Kocaeli Üniversitesi Tıp Fakültesi Hastanesi Parazitoloji Laboratuvarına Başvuran Hastalarda Bağırsak Parazitlerinin Dağılımı", *Türkiye Parazitoloji Dergisi*, c.32(2), ss.126-129, 2008.

G. Şengür, Y. A. Öner, "Köpeklerde Barsak Florasının, Barsak Parazitlerinin Araştırılması ve Çocuk Parklarındaki Kumların Dışkı ile Kontaminasyonundaki Rollerinin incelenmesi", *Türk Mikrobiyoloji Cemiyeti Dergisi*, 3557-66, 2005.

İ. Şahin, S. Yazar, O. Yaman, N. Gözkenç, "Kayseri-Karpuzsekisi Havzasında YaşayanlardaBağırsak Parazitlerinin Araştırılması", Türkiye Parazitoloji Dergisi, c.30(3), ss. 178-180, 2006.

M. Altındiş, "Afyon SultandağıİlçesiÇocuklarında Hepatit A ve Hepatit E Enfeksiyon Prevalansı", *Türk Hijyen ve Deneysel Biyoloji Dergisi*, c.57(3),ss. 153–156, 2000.

M. Altındiş, O. C. Aktepe, Z. Çetinkaya, İ. H. Çiftçi, N. Kıyıldı, E. Akbıyık, "Afyon Kocatepe Üniversitesi Tıp Fakültesi Hastanesinde Parazit Saptanma Oranları", *Kocatepe Tıp Dergisi*, c.5, ss. 29- 32, 2004.

M. Aydın, G. Adıyaman, T. Kaya, S. Kuştimur, F.Doğruman Al, "DışkıdaProtozoonlarınAraştırılmasında Konvansiyonel ve Ticari Trikrom Boyama YöntemlerininKarşılaştırılması", *Kafkas Üniversitesi Veterinerlik Fakültesi Dergisi*, c.18 (Suppl-A) ss.A155-A159, 2012.

M. Özkan Arslan, B. Sarı, B. Kulu, N. Mor, "Kars Doğum ve Çocuk Bakımevi Hastanesine Gastrointestinal Yakınmalarla BaşvuranÇocuklardaBağırsak Parazitlerinin Yaygınlığı", *Türkiye Parazitoloji Dergisi*, c32(3), ss.253-256, 2008.

Mandell GL, Bennett JE, Dolin R. Mandell, Douglas andBennett'sprinciplesandpractice of infectiousdiseases. 5th Edt. Volume 2, USA: Churchill Livingstone; 2000.

Markell EK, Voge M, John DT. Medicalparasitology. 7th Edition. Philadelphia: WB Saunders Company;1992.

N. Delialioğlu, G. Aslan, C. Öztürk, M. Bayer, G. Emekdaş, "Mersin İlindeİlkokulÇocuklarında*Entamoebahistolytica*Antikorlarının Araştırılması", Türkiye Parazitoloji Dergisi c.28(4), ss.185-188, 2004.

N. Doğan, C. Demirüstü, "Eskişehir Osmangazi ÜniversitesininBeş Yıllık Bağırsak Paraziti PrevalansınınTürlere ve Cinsiyetlere GöreDağılımı", *Türkiye Parazitoloji Dergisi*, c.32, s.2, ss.120- 125, 2008.

O. Alver, T. Topaç, O. Töre, "*Entamoebahistolytica*Tanısında İki Metodun (EnzymeLinkedImmunosorbentAssay (ELISA) ve Nativ-Lugol) Değerlendirilmesi", *Türkiye Parazitoloji Dergisi*, 39 185-9, 2015.

O. Yaman, S. Yazar, H. Özcan, Ü. Çetinkaya, N. Gözkenç, S. Ateş, İ.Şahin, "2005-2008 Yılları Arasında Erciyes Üniversitesi Tıp Fakültesi Parazitoloji Laboratuarı'naBaşvuran Hastalarda Bağırsak Parazitlerinin Dağılımı", *Türkiye Parazitoloji Dergisi*, c.32(3), ss. 266 – 270, 2008.

Özcel MA, Özbel Y, Ak M. Özcel'in tıbbi parazit hastalıkları. İzmir: Meta Basım; 2007a.

R. Yıldızhan, A. Deveci, A. Kolusarı, M. Kurdoğlu, E. Adalı, "Amipli Dizanteri ve FetalÖlüm: Bir Olgu Sunumu",Van Tıp Dergisi, c.15, s.4, ss. 112-113, 2008.

S. Kaya, A. Ergün, A. Aynalı, T. Öztürk, A. Özseven, E. Sesli Çetin, B. C. Arıdoğan, "Süleyman Demirel Üniversitesi Tıp Fakültesi Hastanesi Parazitoloji Labortuvarınabaşvuran hastalarda bağırsak parazitlerinin dağılımı", Süleyman Demirel Üniversitesi Tıp Fakültesi Dergisi, c.21(1), ss.16-19, 2014.

S. Usluca, T. İnceboz, L. Över, S. Tuncay, G. Yalçın, S. Şahin Arcak, S. Özkoç, Ü. Aksoy, Ç.Akısü, "Dokuz EylülÜniversitesi Tıp FakültesiAraştırma ve Uygulama Hastanesi'nde 2005-2008 Yılları Arasında Saptanan Bağırsak Parazitlerinin Dağılımı", *Türkiye Parazitoloji Dergisi*, c.34(1), ss. 27-31, 2010.

S. Yazar, O. Yaman, N. Gözkenç, İ. Şahin, "Erciyes Üniversitesi Tıp Fakültesi Parazitoloji Anabilim Dalı'na Başvuran Hastalarda Bağırsak Parazitlerinin Dağılımı", *Türkiye Parazitoloji Dergisi*, c.29(4) ss.261-263, 2005.

S. Yazar, O. Yaman, N. Gözkenç, İ. Şahin, "Erciyes Üniversitesi Tıp Fakültesi Parazitoloji Anabilim Dalı'na Başvuran Hastalarda Bağırsak Parazitlerinin Dağılımı", *Türkiye Parazitoloji Dergisi*, c.29(4) ss.261-263, 2005.

Saygı G. Temel tıbbi parazitoloji. Birinci Baskı, Sivas: Esnaf Ofset Matbaacılık; 1998.

Saygı G. Temel tıbbi parazitoloji. İzmir: Dizgi Baskı Es-Form Ltd.; 2009.

Unat EK, Yücel A, Altaş K, Samastı M. Unat'ın tıp parazitolojisi. İnsanın ökaryonlu parazitleri ve bunlarla oluşan hastalıkları. 5. Baskı. İstanbul: İstanbul Üniv. Cerrahpaşa Tıp Fakültesi Yayınları; 1995.

Ü. Karaman, Ö. Enginyurt, Y. Dündar, M. K. Baykal, S.Gür, "Ordu ilinde bağırsak parazitleri sıklığı", *Dicle Tıp Dergisi*, c.41(2), s. 368, 2014.

Y. Zer, İ. H. Kılıç, D. IşıkKaragöz, M. Özaslan, İ. Karaoğlan, İ. Balcı, "Amoebiasis Tanısında DışkıÖrneklerininNatif ve Trikrom Boyama Yöntemleri ile İncelenmesininKarşılaştırılması", *İnfeksiyon Dergisi*, c.23(4), ss. 179-183, 2009.

GIDALARIMIZIN YAĞ KALİTE İNDEKSİ AÇISINDAN DEĞERLENDİRİLMESİ

Doç. Dr. Aydın Şükrü BENGÜ (ORCID: 0000-0002-7635-4855)
Bingol University, Vocational School of Health Services, Department of Medical Services and Techniques, Bingol, Türkiye
Email: abengu@bingol.edu.tr

ÖZET
Diyetle alınan gıdalarda çeşitli özelliklerde ve miktarda yağ asidi bulunmaktadır. Doymuş, doymamış, tekli doymuş, çoklu doymuş yağ asidi gibi. Bu miktar ve oranların insan sağılığına direk etkisi vardır. Ayrıca doymamış yağ asitleri son çift bağın konumuna göre de omega-3 ve omega-6 diye sınıflandırılmaktadır. Bu bilgileri kullanılarak son yıllarda yağ kalite indeksleri olarak adlandırılan Aterojenik indeks (AI), Trombojenik indeks (TI), Hipokolesterolemik/hiperkolesterolemik oran (H/H) ve Sağlığı geliştiren indeks (HPI) hesaplandığı gözlenmiştir. Bu derlemede çeşitli mantarların, hayvansal gıdaların ve baharatların yağ kalite indeksleri hesaplanmıştır. Baharatlarda kimyon ve hardalın AI indeksinin en düşük olduğu, yiyecek sınıfında da mantarların et ürünlerine kıyasla daha düşük AI indeksine sahip olduğu gözlenmiştir. Özellikle kardiyovasküler hastalıklar açısından AI ve TI değerinin düşük, H/H ve HPI değerinin yüksek olması tercih edilmektedir.
Anahtar Kelimeler: yağ, yağ asidi, yağ kalite indeksleri

EVALUATION OF OUR FOODS IN TERMS OF FAT QUALITY INDEX

ABSTRACT
Dietary foods contain fatty acids of various properties and amounts. Such as saturated, unsaturated, monosaturated, polysaturated fatty acids. These amounts and rates have a direct impact on human health. In addition, unsaturated fatty acids are classified as omega-3 and omega-6 according to the position of the last double bond. It has been observed that using this information, the Atherogenic index (AI), Thrombogenic index (TI), Hypocholesterolemic/hypercholesterolemic ratio (H/H) and Health-promoting index (HPI), which are called lipid quality indexes, have been calculated in recent years. In this review, lipid quality indexes of various mushrooms, animal foods and spices were calculated. It was observed that cumin and mustard had the lowest AI index among spices, and mushrooms had a lower AI index compared to meat products in the food class. Especially in terms of cardiovascular diseases, it is preferred that AI and TI values are low and H/H and HPI values are high.
Keywords: lipid, fatty acid, lipid quality indexes

GİRİŞ

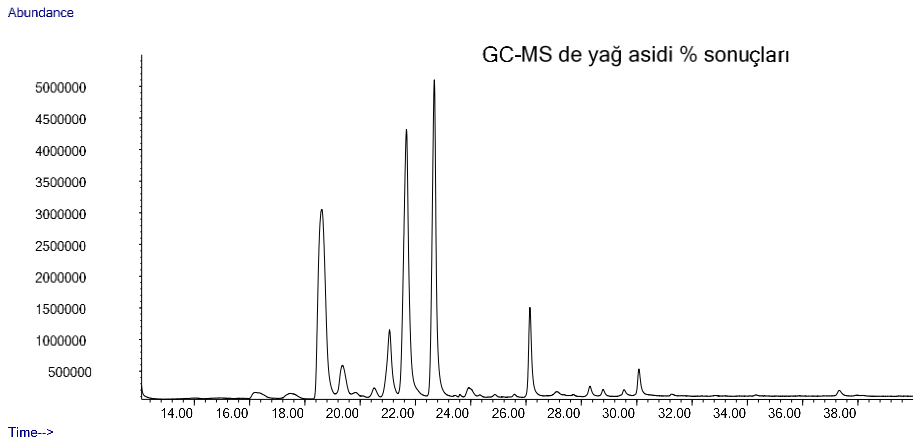
Yağlar, biyokimya'nın inceleme alanına giren vücutta önemli fizyolojik görevler üstlenen kompleks yapıtaşlarından biridir. Yağlar suda çözünmeyen hidrofobik ve apolar bileşiklerdir. Yağ asidleri, yağların yapıtaşlarından olup yapısı uzun karbon zincirlerinin karboksil (-COOH) grubu ile sonlanması ile oluşurlar. Tabiatta en çok çift sayıda karbon içeren (C16, C18, C20 gibi) yağ asidleri bulunursa da tek sayıda karbonlu (C15, C17 gibi) yağ asidleri mevcuttur. İnsan vücudu tarafından sentezlenemeyip dışarıdan alınması zorunlu olan yağ asidlerine esansiyel yağ asidleri denir. İnsan için bunlar linoleik asid, linolenik asid ve araşidonik asidir (Keha ve Küfrevioğlu, 2004).

Karbon zincirinde çift bağ içermeyen yağ asidleri doymuş yağ asidi (SFA) olarak tanımlanır ve şöyle gösterilir. Örneğin C14:0 miristik asid, C16:0 palmitik asid, C18:0 stearik asid, C20: araşidik asid gibi. Karbon zincirinde çift bağ içeren yağ asidlerine de doymamış yağ asdileri (UFA) denir. Çift bağ bir tane ise tekli doymamış yağ asidi (MUFA), birden fazla ise çoklu doymamış yağ asidi (PUFA) olarak adlandırılır. Tekli doymamış yağ asidlerine örnek olarak C16:1 palmitoleik asid ve C18:1 linoleik asid verilebilir. Çoklu doymamış yağ asidlerine örnek olarak C18:2 linoleik asid, C18:3 linolenik asid, C20:4 araşidonik asid verilebilir.

Yağ asidi kaç karbonlu olursa olsun karboksil atomuna en uzak karbon (CH_3, metil grubu) omega karbonu olarak adlandırılır. Çoklu doymamış yağ asidlerinin de son çift bağının konumu omega karbonuna olan uzaklığına göre omega-3 (n-3), omega-6 (n-6) şeklinde daha pratik olarak isimlendirilmektedir. Omega-3 yağ asidlerinin en yaygınları C18:3 linolenik aisd ve C22:6 dokoheksaenoik asidir. Omega-6 yağ asidlerinin en bol bulunanları ise C18:2 linoleik asid, C20:4 araşidonik asid ve C22:4 dokosatetraenoik asidir.

Yağ asidi analizleri laboratuvar ortamında gaz kromatoğrafi kütle spektrometresi (GC-MS) cihazları ile hassas bir şekilde yapılmaktadır. Analiz öncesi örneğin yağı elde edildikten sonra yağ asidlerinin uçucu hale getirilebilmesi için metilasyon (en çok tercih edilen türevlendirme yöntemi) işlemine tabi tutulur. Yaklaşık bir saatlik GC-MS analizi sonrasında elde edilen kromatogramda alıkonma zamanları farklı olan her pik bir yağ asidine aittir (Şekil 1). Cihazın kütüphanesi ile yapılan eşleştirmeler sonucu örnekte bulunan yağ asidleri yüzde olarak elde edilmiş olur. Araştırma makalelerinde bu sonuçlar sıklıkla % doymuş yağ asidi (SFA), % doymamış yağ asidi (UFA), % çoklu doymamış

yağ asidi (PUFA), % omega-3, % omega-6, PUFA/SFA, Omega-3/omega-6 şeklinde raporlanmaktadır (Bengü ve ark. 2019, Bengü, 2020).



Şekil 1. GC-MS analizi sonucu yağ asidlerinin pikler halinde gözlenmesi

Verilerin birbirlerine oranlanması ile elde edilen yeni sonuçların değerlendirilmesi fen ve sağlık bilimlerinde yaygın bir uygulamadır. Özellikle sağlık bilimlerinde aynı kategorideki verilerin oranlanmasına sıkça rastlarız; LDL/HDL, total kolesterol/HDL, trigliserid/HDL, nötrofil/lenfosit, VKİ=kg/m^2 vb. örnekler çoğaltılabilir.

İşte yağ asidlerinden elde edilen sonuçların da kendi içerisinde belli formüllere uygulanması ve oranlanması ile yağ kalite indeksleri denilen Atorejenik indeks (AI), Trombojenik indeks (TI), Hipokolesterolemik/hiperkolesterolemik oran (H/H), Sağlığı geliştirici indeks (HPI) kulanılmaya başlanmıştır.

Sözü geçen yağ kalite indeksleri ve formülleri şu şekildedir;

1. Atorejenik indeks $AI = \frac{C12{:}0+(4xC14{:}0)+C16{:}0}{n-3\ PUFA+n-6PUFA+MUFA}$ (Ulbricht 1991, Bengü 2023)
2. Trombojenik indeks $TI = \frac{C14{:}0+C16{:}0+C18{:}0}{0.5x\ MUFA+0.5x\ n-6PUFA+3x\ n-3PUFA+\frac{n-3PUFA}{n-6PUFA}}$ (Ulbricht 1991, Bengü 2023)
3. Hipokolesterolemik/hiperkolesterolemik oran $H/H = \frac{cis\ C18{:}1+PUFA}{C12{:}0+C14{:}0+C16{:}0}$ (Ulbricht 1991, Bengü 2023)
4. Sağlığı geliştirici indeks $HPI = \frac{1}{AI}$ (Ulbricht 1991, Bengü 2023)

Özellikle kardiyovasküler hastalıklar açısından yiyeceklerde AI ve TI değerlerinin düşük, H/H ve HPI değerlerinin yüksek olması tercih sebebi olarak görülmektedir (Saini ve ark. 2021, Bengü 2024).

Sonuç

Akademik literatürdeki yiyeceklerin yağ asidi ile ilgili makalelerin (Al-Jasass 2012, Bengü 2023, Bengü 2024, Brugiapaglia ve ark. 2014, Fernández ve Juan 2020, Gibbs ve ark. 2013, Saini ve ark. 2021) bulguları yukarıda verilen indekslere uygulanıp gerekli hesaplamalar yapıldığında çizelge 1'deki sonuçlar elde edilmiştir.

Çizelge 1. Çeşitli gıdalarda yağ kalite indekslerinin sonuçları

Ürün adı	**AI**	**TI**	**H/H**	**HPI**
Mantarlar				
Imleria badia	0,21	0,45	4,97	4,90
Boletus edulis	0,12	0,28	8,42	8,70
Cantharellus cibarius	0,16	0,39	4,76	6,21
Pleurotus eryngii	0,25	0,53	3,93	4,00
Hayvansal ürünler				
Biftek	0,59	1,17	1,94	1,70
Gökkuşağı alabalığı	0,39	0,33	2,50	2,58
Hamburger	0,68	1,41	1,74	1,47
Balık burger	0,37	0,8	2,94	2,70
Tavuk burger	0,33	0,68	3,21	3,03
Baharatlar				
Kimyon	0,06	0,14	17,0	16,66
Hardal	0,07	0,08	11,3	14,29
Rezene	0,09	11,5	0,19	11,11
Kişniş	0,10	0,19	12,1	10,00
kereviz	0,15	0,29	7,45	6,67
Dere otu	0,15	0,24	8,2	6,67
Zerdeçal	0,18	0,26	5,96	5,56
Pembe biber	0,20	0,44	5,41	5,00
Maydanoz	0,24	0,11	4,61	4,17
Kırmızı biber	0,29	0,49	3,92	3,45
Anason	0,31	0,63	3,35	3,23
Turşuluk biber	0,31	0,51	3,72	3,23
Mercan köşk	0,43	0,36	2,72	2,33
Beyaz biber	0,48	1,02	2,32	2,08
Acı biber	0,52	0,81	2,57	1,92
Ardıç	0,57	1,11	1,92	1,75
Kakule	0,58	0,92	1,80	1,72
Hindistan cevizi kabuğu	0,58	1,04	1,94	1,72
Kimyon tohumu	0,60	0,46	4,94	1,67
Kekik	0,71	0,42	1,65	1,40
Tarhun	0,75	0,28	1,68	1,33
Tarçın	0,76	1,16	1,52	1,32
Kekik yaprağı	0,78	0,32	1,57	1,28
Siyah biber	0,81	0,85	1,45	1,23
Zencefil	0,83	0,81	1,38	1,20
Galgal kökü	0,95	1,82	1,13	1,05
Karanfil	1,27	1,27	1,00	0,79
Adaçayı	1,29	1,06	0,86	0,78
Reyhan	1,52	0,60	0,74	0,66
Defne yaprağı	2,07	1,38	0,73	0,48
Biberiye	2,08	2,20	0,56	0,48
Limon otu	2,66	2,24	0,43	0,38
Hindistan cevizi	9,62	4,68	0,36	0,10

Çizelge incelendiğinde mantarların AI ve TI değerlerinin kırmızı et, beyaz et, tavuk ve balıktan daha düşük olduğu yani daha tercih edilebilir formda görülebiliyor. Tablodaki 34 adet baharat zaten AI değeri en düşükten en büyüğe şeklinde sıralanmıştır. Dolayısı ile baharatlar grubunun üst sıralarındaki kimyon, hardal, rezene, kişniş ve kereviz en sağlıklı ilk beş baharat olarak dikkat çekmektedir.

Ülkemizde ve dünyada yağ asidi analizleri bir çok tez ve araştırma makalesine konu olmaktadır. Elde edilen bulguların yağ kalite indeksleri açısından da hesaplanması ve bu şekilde yayınlanması, sonuçların yorumlanması açısından faydalı olacaktır.

Kaynaklar

Al-Jasass, F. M., & Al-Jasser, M. S. (2012). Chemical composition and fatty acid content of some spices and herbs under Saudi Arabia conditions. *The scientific world journal, 2012*.

Bengü, A. Ş., Yılmaz, H. Ç., Türkekul, İ., & Hakan, Işık. (2019). Doğadan toplanan ve kültürü yapılan Pleurotus ostreatus ve Agaricus bisporus mantarlarının toplam protein, vitamin ve yağ asidi içeriklerinin belirlenmesi. Türk Tarım ve Doğa Bilimleri Dergisi, 6(2), 222-229.

Bengu, A. S. (2020). The fatty acid composition in some economic and wild edible mushrooms in Turkey. *Progress in Nutrition*, *22*(11), 185-192.

Bengü A, Ş. (2023). Bingöl'den Temin Edilen Pleurotus Eryngii Mantarında Protein ve Yağ Asidi Kalite İndekslerinin Değerlendirilmesi, 6. International Cukurova Agriculture And Veterinary Congress, December 22-24, 2023 / Adana, Türkiye, 994-1001.

Bengü, A, Ş. (2024). Keban Baraj Gölünden yakalanan Gökkuşağı Alabalığı (*Oncorhynchus mykiss)* nın Bazı Besin İçeriğinin Değerlendirilmesi, Türk Tarım ve Doğa Bilimleri Dergisi, (kabul edildi)

Brugiapaglia, A., Lussiana, C., & Destefanis, G. (2014). Fatty acid profile and cholesterol content of beef at retail of Piemontese, Limousin and Friesian breeds. *Meat Science*, *96*(1), 568-573.

Fernández, P. M., & Juan, S. (2000). Fatty acid composition of commercial Spanish fast food and snack food. *Journal of Food Composition and Analysis*, *13*(3), 275-281.

Gibbs, R. A., Rymer, C., & Givens, D. I. (2013). Fatty acid composition of cooked chicken meat and chicken meat products as influenced by price range at retail. *Food chemistry*, *138*(2-3), 1749-1756.

Keha, E. E., & Küfrevioğlu, Ö. İ. (2004). *Biyokimya*. Aktif Yayın Dağıtım.

Ulbricht, T. L. V., & Southgate, D. A. T. (1991). Coronary heart disease: seven dietary factors. *The lancet*, *338*(8773), 985-992.

Saini, R. K., Assefa, A. D., & Keum, Y. S. (2021). Spices in the Apiaceae family represent the healthiest fatty acid profile: a systematic comparison of 34 widely used spices and herbs. *Foods*, *10*(4), 854.

POSSIBILITY OF LONG-TERM STORAGE OF *Petunia hibrida* L.

Stanislava STATEVA (ORCID: 0000-0002-6016-2904)
Institute of Plant Genetic Resources, „ Konstantin Malkov" Sadovo, Plovdiv, Bulgaria
Email: stanislava.stateva@gmail.com

ABSTRACT
In a global aspect, clonal micropropagation is widely used, provoked by the main advantages compared to conventional methods for the production of planting material - virus-free plants, accelerated propagation of newly selected, promising or marketed material and vegetative offspring of the species Several factors determine the success of microvegetative propagation - the genotype and condition of the starting plant, the type of starting explant, the method of introducing the explants into culture, the cultivation conditions. Most often, microvegetative propagation uses an agar medium. The requirements for a certain physical state of the nutrient environment, in addition to the plant species, also depends on the stage in which the culture is located. During the proliferation phase, solid culture medium was almost always applied. The high concentration of cytokinins in the species Petunia hibrida L. has an inhibitory effect, while the lower concentration stimulates proliferation.
Keywords: in vitro, micropropagation, auxins, cytokinins, *Petunia hibrida* L.

Introduction:

The Institute of Plant Genetic Resources "K. Malkov" was established in 1902 as an Agricultural Experimental Station, which in 1977 grew into the Institute of Plant Genetic Resources. IPGR-Sadovo is the National Coordinator of the Program on Plant Genetic Resources, which is part of the European Program on Plant Genetic Resources (ECPGR). The National Seed Gene Bank is located on the territory of the Institute, which stores 57,684 seed samples out of the total of 62,131 registered as a gene pool in the country (Krasteva, 2008). The Plant Biotechnology Laboratory at IRGR "K. Malkov" in Sadovo was established in 1977 by assoc. dr. Chavdar Chavdarov. The scientific activity is aimed at collecting, evaluating, storing and using original samples originating from the country and abroad. Priority thematic directions in the activity of the plant genetic resources program are the permanent enrichment of the collections with germplasm of different origins and diverse types of material; expanding knowledge on the biological features, interactions and reactions of ecotypes and the environment. The available gene pool is annually enriched, its preservation is controlled and provided to our and international scientific centers (Stoyanova, 2002, Dimitrova et al. 2011; Koeva R., 2002; Krasteva, 2008). The upgrading of the collections is achieved through expeditions to individual regions in accordance with the tasks of the implemented projects and through international exchange.

The species Petunia hibrida is L. an annual plant, sunny and prefers moist soils. as the seeds are sown in March, they are evenly covered with soil, sown and sprinkled. Germination is difficult for one month. Because of their small seeds and low germination, Petunia species are challenging to propagate. In vitro micropropagation of Petunia hibrida L. provides a solution to overcome these challenges. The advantages of the in vitro method are conservation of the species for a longer period of time, pathogen-free explants and the possibility of extremely rapid reproduction if necessary (Fay, 1996; Shibli, 2008). The advantages of obtaining plant material in a biotechnological way instead of conventional ways are enormous. In the modern world, this area of human development is increasingly important and significant. Plant biotechnology is the product of the combined use of a certain set of techniques of conventional botany, molecular genetics, microbiology, physiology, biochemistry and molecular biology. The main factors that influence this process of microplant development in controlled conditions are the type of

nutrient medium, the type and concentration of exogenously applied phytohormones, the type of organic supplements, photoperiod, temperature, intensity and spectrum of light, humidity, etc.

Skirvin (1981) pointed out that one of their most important characteristics in in vitro plant cultivation is the total concentration of salts, according to which mineral solutions are divided into three types - high (MS), medium (NN), and low (Wh) salt concentration. In order to induce the formation processes in tissue cultures, it is necessary to include biological regulators of growth and development - phytohormones. Auxins, cytokinins and gibberellins are included in the main nutrient media. BAP (6-benzylaminopurine) is a synthetic cytokinin. The purine compound that stimulates cell division and is (often) included in the composition of nutrient media for in vitro cultivation in order to slow down aging processes. At a higher concentration (above 3–4 mg/l) it can stimulate the formation of adventitious shoots and suppress root formation (Skoog, 1957; Holub et al., 1998).

Auxins, cytokinins and auxin-cytokinin interactions have the main regulatory role for the growth and development of plant tissues and organ cultures (Vasil et al., 1994;Yancheva, 2003).

The aim of the present study is the application of biotechnological approaches to the evaluation, characterization and storage of Petunia hibrida L.

Material and methods:

The research was carried out in the Tissue Culture Laboratory at the Institute of Plant and Genetic Resources "Konstantin Malkov" - city of Sadovo. Seeds of Petunia hibrida L., originating near a deposit in the "Beglika" reserve, Western Rhodopes, were used as starting material for introduction into in vitro culture.

Sterilization is the initial stage of microplant development, obtaining pure plant material growing on artificial nutrient media. Decontamination of the starting plant material was carried out with 50% C_2H_5OH for 3 min followed by 20% bleach (containing 5% active chlorine) for 15 min and washing three times with sterile distilled water.

Plant propagation is mainly used in the propagation of plants that are difficult to propagate conventionally. In the experimental work, a basic nutrient medium was applied - Murashige & Skoog (1962), which was also used as a control variant.

The influence of BAP in concentrations of 0.5 mg/l, 0.7 mg/l and 1.0 mg/l was studied. Added in nutrient medium Murashige & Skoog (1962)

The sterilization of the nutrient medium was carried out by autoclaving for 20 minutes at a temperature of 120 ºC and 1 atmosphere of pressure.

The plant material was placed in individual test tubes with a capacity of 20 ml per Murashige and Skoog (1962) medium. Explants were transferred 30 days after the first culture to new, fresh culture medium containing Murashige & Skoog (1962).

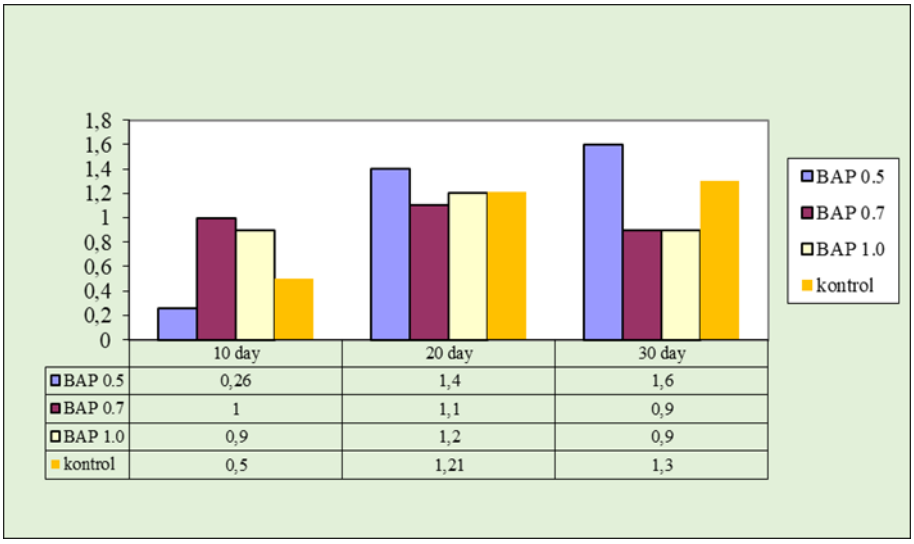
The cultivation of the starting plant material was continued in a phytostatic room at a temperature of 20 º-22 º C, a photoperiod of 16 hours day and 8 hours night and illumination 2000-3000 lx, provided by fluorescent lamps, with white light. The original plants were periodically transferred to fresh nutrient medium at 30-day intervals.

Results and discussion:

After sterilization and introduction of the starting explants into in-vitro culture, the plants can be maintained and multiplied by in vitro methods of vegetative propagation. When the explants were cultivated in vitro, no bacterial contamination was observed, which was due to the successful sterilization. After this stage, the in vitro adaptation ends, the explants resume their growth and development, which proceed normally, without signs of unwanted deviations.

The main place in the synthesis of cytokinin is the apical meristem of the roots, and then it is transported acropetally along the xylem to the aerial organs. They stimulate cell division, induce organogenesis and axillary proliferation.

From the comparative analysis of BAP of Petunia hibrida L. in a concentration of 0.5 mg/l, it is reported that the "height" indicator on the 10th day increases from $\bar{X}$ = 0.26 cm, and on the 30th day it reaches $\bar{X}$ = 1.6 cm (Fig. 1). The proliferation ratio for this variant is 1:2.



	10 day	20 day	30 day
BAP 0.5	0,26	1,4	1,6
BAP 0.7	1	1,1	0,9
BAP 1.0	0,9	1,2	0,9
kontrol	0,5	1,21	1,3

Fig.1 Effect of cytokinin BAP in concentrations of 0.5, 0.7 and 1.0 mg/l with hormone-free medium on the height of explants in Petunia hibrida L.

Comparing the three types of modified nutrient medium against the control on the 10th day of the development of the explants, it was found that the indicator "height" had the highest value in 0.7 mg/l BAP with $\bar{X}$ = 1.0 cm, and for the control $\bar{X}$ = 0.5 cm. The stimulating effect of BAP is expressed in the formation of new sprouts. On the 20th day, a variant with the participation of 0.7 mg/l BAP stood out with a very good realization of the potential of the species. The multiplication factor for 0.7 mg/l BAP was 1:3 and for the control variant it was 1:2.

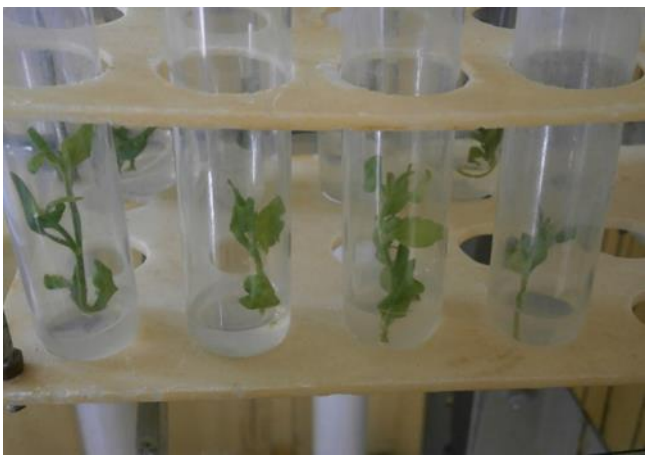


Photo 1. Twenty day-old plants of Petunia hibrida L. in a modified nutrient medium with the participation of 0.7 mg/l BAP

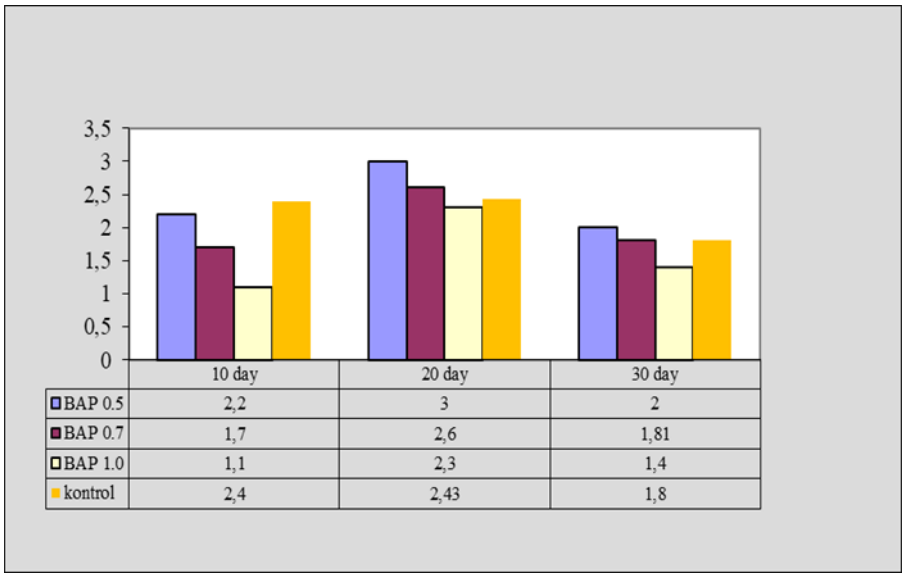
At a concentration of BAP of 1.0 mg/l, the formation of adventitious shoots was suppressed compared to the previous modified nutrient media.

The following dependence is observed for the species - as the period of measurement of the explants increases, the height of the microplants decreases.

When measuring the indicator "number of leaves" for Petunia hibrida L. in the variant with the participation of BAP in a concentration of 0.5 mg/l, maximum values are recorded on the 20th day of the development of the explants. The application of 0.5 mg/l BAP compared to the control variant is characterized by values approximately the same as the control variant.

In a modified nutrient medium with the participation of 0.7 mg/l BAP on the 20th day of the experiment, the microplant foliage had the highest value of $\bar{X}$ =2.6 pieces, a value exceeding the control variant.

When increasing the concentration of 1 mg/l BAP in the nutrient medium, Murashige & Skoog (1962) observed lower values of the "number of leaves" indicator. Figure 2 shows the differences in the cytokinin variants versus the control variant.



	10 day	20 day	30 day
BAP 0.5	2,2	3	2
BAP 0.7	1,7	2,6	1,81
BAP 1.0	1,1	2,3	1,4
kontrol	2,4	2,43	1,8

Fig. 2 Influence of the cytokinin BAP in concentrations of 0.5, 0.7 and 1.0 mg/l with hormone-free medium on the number of leaves of the explants of Petunia hibrida L.

Conclusions:

Based on the observation on nutrient medium Murashige & Skoog (1962), it was established that the performance indicators of the species Petunia hibrida L. are optimal at the concentration of 0.5 mg/l BAP.

Literature:

Dimitrova, V., V. Roychev, R. Ruseva., 2011, Morphological and biological assessment of vines obtained by the in vitro method. Viticulture and winemaking, No. 2, 31-35.

Fay, F.,1996, Micropropagation as a tool in plant conservation. Plant Talk 4:22-23.

Holub J., J. Hanus, D.E. Hanke, M. Strnad (1998), Biological activity of cytokinins derived from ortho- and meta-hydroxybenzyladenine. Plant Growth Regul 26: 109–115

Koeva R., 2002, Plant genetic resources: heritage from the past and the modern projection for sustainable development of science and agriculture, Collection of reports "Anniversary scientific session", volume 1, pp. 5-12, Sadovo

Krasteva L., Tsv. Stoilova, St. Neikov, K. Varbanova, 2008, Collection of local plant genetic resources, Jubilee scientific session "50 years Union of scientists in Bulgaria-Plovdiv"

Shibli. R., M. Shat Nowi, W. Subaih, M.Ajlouni. 2006, In vitro conservation and cryopreservation of plant genetic resources: Review. World journal Agricultural science, 2/4/ 372-382.

Skoog, F. and Miller, C.O. ,1957, Chemical Regulation of Growth and Organ Formation in Plant Tissue Cultured in Vitro. Symposia of the Society for Experimental Biology, 11, 118-131.

Skirvin R. M., 1981, Fruits crops. Cougar B. V. (Ed.) Cloning Agriculture Plant via in vitro techniques. 51:139**.**

Stoyanova S., 2002, The National Genbank in Bulgaria tasks, guarantees and priorities., Collection of reports "Jubilee scientific session", volume I, pp. 19-28, Sadovo

Vasil I. K., T. A. Thorpe, ed. ,1994, Plant cell and tissue culture. Dordrecht: Kluwer Academic Publishers.

Yancheva S. D., S. Golubowicz, E. Fisher, S. Lev-Yadun, M.A. Flaishman, 2003, Auxin type and timing of application determine the activation of the developmental pogram during *in vitro* organogenesis in apple, Plant Sci.165. 299-309.

TÜRKİYE VE DÜNYA ANTEPFISTIĞI ÜRETİMİNİN DEĞERLENDİRİLMESİ

Emine KÜÇÜKER (ORCID: 0000-0002-4198-6262)
Agriculture Faculty Department of Horticulture, Siirt University, Siirt 56100, Turkey
Email: emine.kucuker@siirt.edu.tr

Erdal AĞLAR (ORCID: 0000-0002-41995716**)**
Agriculture Faculty Department of Horticulture, Van Yüzüncü Yıl University, Van 65000, Turkey
Email: erdalaglar@gmail.com

ÖZET
Ilıman iklim meyvesi olan antepfıstığı, dünya genelinde kuzey ve güney yarı kürelerin 30-45° paralelleri arasında yetiştirilebilmektedir. Meyvesinin çerez ve gıda sanayindeki geniş kullanım alanı ve yüksek ekonomik değeri nedeniyle dünya ve Türkiye üretim alanlarında hızlı artış devam etmektedir. Bu artışın en yoğun olduğu ülkeler ABD, Türkiye ve İspanya'dır. Antepfıstığının genetik özelliği olan periyodisite ile birlikte bazı iklim faktörleri ülkelerin üretimlerini yıldan yıla önemli ölçüde değiştirmektedir. Güneydoğu Anadolu Bölgesi Türkiye antepfıstığı rekoltesinin %95,6'sını karşılamaktadır. Gaziantep, Şanlıurfa, Adıyaman, Siirt, Mardin, Kilis, Kahramanmaraş, Batman, Diyarbakır illerinin antepfıstığı üretimi Türkiye üretiminin %86,2'si kadardır. Bu çalışmanın amacı, FAO'nun 2013-2023 yıllarına ait Antepfıstığı üretim ve alan istatistiklerinin antepfıstığı üretimi bakımından değerlendirilmesidir. Böylece dünyada ilk üç sırada yer alan İran, ABD ve Türkiye üretimindeki öne çıkan sorunlar belirlenerek bunlara yönelik stratejiler geliştirilebilecektir.
Anahtar Kelimeler: antepfıstığı, *Pistacia vera* L., verim, kalite

EVALUATION OF TURKEY AND WORLD PISTACHIO PRODUCTION

ABSTRACT
Pistachio, which is a temperate climate fruit, can be grown between 30-45° parallels of the northern and southern hemispheres worldwide. Due to the wide using area of the fruit in the food industry and its high economic value, the production areas of in the world and Türkiye increases by day by. The countries where this increase is the most intense are the USA, Turkey and Spain. Periodicity, which is the genetic characteristic of pistachio, and some climatic factors significantly change the production of countries year by year. The Southeastern Anatolia region accounts for 95.6% of Turkey's pistachio yield. Pistachio production of Gaziantep, Şanlıurfa, Adıyaman, Siirt, Mardin, Mardin, Kilis, Kahramanmaraş, Batman, Diyarbakır provinces is 86.2% of Turkey's production. The aim of this study is to evaluate FAO's pistachio production and area statistics for the years 2013-2023 in terms of pistachio production. Thus, the prominent problems in the production of Iran, USA and Turkey, which are the top three in the world, will be identified and strategies will be developed to address them.
Keywords: pistacia, *Pistacia vera* L., yield, quality

1. GİRİŞ

1.1.Dünya Antepfıstığı Üretimi

Çalışmada antepfıstığı üretimi bazı yetiştiricilik yönleriyle değerlendirilmiştir. Bu bakımdan üretimde lider olan ABD ve İran'da antepfıstığı yetiştirme teknikleri ele alınmış ve Türkiye'de uygulanan yetiştirme teknikleri ile kıyaslanarak bunlarla ilgili yeni stratejiler belirlenmeye çalışılmıştır. Yine Türkiye'de önemli yetiştiricilik sorunları içerisinde bulunan verim, periyodisite ve anaç/çeşit sorunları ele alınarak üretim ve verim etkinliği değerlendirilmiştir. Antepfıstığının Orta Asya ve Yakın Doğu olmak üzere kapsayan iki ayrı gen merkezi içerisinde Türkiye, yakın doğu gen merkezi içerisinde yer almaktadır. Antepfıstığının yabanileri doğal olarak Türkiye'den başlamakta ve Filistin ve Suriye'ye kadar devam etmekte ve buradan Orta Asya'nın (Türkmenistan, Özbekistan, Afganistan, Tacikistan ve Kırgızistan) doğusuna kadar yayılmaktadır (Demircan, 2010). Antepfıstığı bir ılıman iklim meyvesi olup kuzey ve güney yarı kürede 30-45° enlemlerinde yetiştirilmektedir. Anavatan bölgesi olan orta asya ve yakın doğudan başlayan yetiştiricilik zamanla dünya genelinde yayılış göstermiştir (Gözal, 2006). Meyvesinin çerez, gıda sanayi gibi farklı alanlarda kullanılabilmesi meyveye olan ilgiyi artırmakta ve ekonomik değerini her geçen gün yükseltmektedir. Dünya antepfıstığı üretiminde ABD, Türkiye ve İran dünya liderliğini koruyan ilk üç ülkedir. Dünya sıralamasında Çin 4. sırada yer almasına rağmen en büyük ithal eden ülkedir.

Tablo 1: 2013-2020 Yılları Arası Antepfıstığı Üreticisi Ülkelerin Üretim Miktarları (ton) (FAO, 2020).

Ülkeler	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
ABD	213.188	233.146	122.470	406.646	272.290	447.700	336.112	474.004
Türkiye	88.600	80.000	144.000	170.000	78.000	240.000	85.000	296.376
İran	225.001	440.814	430.000	574.987	648.934	143.695	337.815	190.000
Çin	74.000	78.232	83.533	78.588	80.118	80.747	79.819	80.227
Suriye	54.516	28.786	52.499	49.735	51.048	61.631	31.813	69.403

Tablo 2: 2013-2020 Yılları Arası Antepfıstığı Üreticisi Ülkelerin Alan Miktarları (ha) (FAO, 2020).

Ülkeler	2013	2014	2015	2016	2017	2018	2019	2020
Türkiye	544.510	561.860	579.960	608.140	682.370	3.545.000	3.662.100	3.818.470
İran	3.040.540	3.346.250	3.340.000	5.528.700	4.295.350	1.378.360	4.114.320	1.629.600
ABD	821.510	894.360	942.920	967.200	1.011.700	1.068.400	1.375.930	1.505.430
Suriye	599.030	598.930	598.640	598.760	599.660	599.650	599.890	603.630
Tunus	270.600	267.000	266.600	265.800	308.020	289.190	278.570	276.180
Çin	250.000	268.070	280.640	266.240	271.650	272.840	270.240	271.580

1.2.TÜRKİYE ANTEPFISTIĞI ÜRETİMİ

Antepfıstığı yetiştiriciliği Türkiye'de 56 ile kadar yayılış göstermiştir. Ancak toplam rekoltenin yaklaşık %95,6'sı Güneydoğu Anadolu bölgesinden karşılanmaktadır. Bölgedeki en önemli yetiştiricilik yapılan iller Gaziantep, Siirt, Şanlıurfa, Adıyaman, Kahramanmaraş, Kilis, Batman, Mardin, Diyarbakır'dır. Antepfıstığının ekonomik değeri Güneydoğu Anadolu bölgesinin yanısıra Ege, Akdeniz, Marmara ve İç Anadolu bölgelerinin uygun ekolojik alanlarında da yetiştiriciliğe olan ilgiyi artırmaktadır (Yavuz ve ark., 2016).

Şekil 1. Antepfıstığı Ağacının Görünümü

1.3. **ANTEPFISTIĞININ TÜRKİYE VE DÜNYA TiCARETi**

Antepfıstığı ticaretinde üç milyar dolarlık bir hacim göz önüne alındığında, A.B.D., İran, Çin ve Almanya dünya genelinde ilk dört sırayı kapmaktadır. Türkiye, üretim açısından ikinci sırada olmasına rağmen ihracatta beşinci sıraya yerleşmesinin temel nedeni, üretilen antepfıstığının çoğunlukla iç piyasada tüketilmesi ve üretim portföyümüzdeki çeşitlerin uluslararası alanda daha çok çerezlik türler olmasıdır (Ak ve ark., 2012).

Antepfıstığı üretiminin büyük bir kısmını oluşturan Kırmızı ve Uzun çeşitler, uluslararası standartlara uygun meyve büyüklüğü açısından bazı sınırlamalar taşımaktadır. Şekil olarak yeterince çekici olmayabilirler. Ancak, bu çeşitlerin aroma kalitesi diğerlerine göre üstündür. Şekil çeşitliliği ve zengin aroma profili, uluslararası alanda "Türk Fıstığı" olarak bilinip kabul görmelerini sağlamaktadır. Dünya genelinde antepfıstığı üretiminde lider konumda olan İran'da Ohadi, Kallagouchi, Ahmad Aghaii, Akbari, Badami, Zarand, Momtaz ve Safidi gibi çeşitler yetiştirilmektedir. Ticari bahçelerde ise genellikle Fandoghi, Kalleh-Ghouchi, Akbari ve Ahmad-Aghaei gibi çeşitler tercih edilmektedir. ABD ise ikinci sırada yer almakta olup, Kerman, Lost Hills, Golden Hills gibi çeşitler öne çıkmaktadır; en önde gelen çeşit ise Kerman'dır. Ülkemiz dünya üretiminde üçüncü sıradadır ve Siirt, Kırmızı, Uzun, Halebi, Tekin, Barak Yıldızı, Sultani, Keten Köyneği, Beyaz Ben gibi çeşitlerle dikkat çekmektedir (Ertürk ve ark., 2015). Ülkemizdeki bahçe tesislerinde kullanılan kültür çeşitlerinin periyodisite göstermesi, yıllar arasında verimde önemli dalgalanmalara neden olmaktadır; bu dalgalanmalar, %12.5 ile %66.6 arasında değişen bir ortalamaya işaret etmektedir. Periyodisite gösteren yıllarda ise verimde yaklaşık %36'lık bir düşüş yaşandığı gözlenmektedir. Bu oran ABD'de %28 iken, İran'da 10 yıllık bir süreçte sadece 2004 yılı için %39 olarak kaydedilmiştir (Çeçan, 2022). Antepfıstığı Araştırma Enstitüsü tarafından yürütülen AR-GE faaliyetleri neticesinde, seleksiyon ıslahı yöntemiyle yüksek verim ve meyve kalitesine sahip Siirt ve Tekin çeşitleri tescil edilmiştir. Bu çeşitler, yuvarlak ve uzun grup çeşitleri arasında yer almaktadır ve verim açısından oldukça yüksek bir potansiyele sahiptirler. Ayrıca, periyodisite şiddeti düşük olan bu çeşitler, uluslararası çerezlik pazarında rekabet edebilecek özelliklere sahiptirler (Eldoğan ve Şahin, 2015. Gelecek dönemlerde, dünya antepfıstığı ihracatındaki payımızın artırılması hedeflenmektedir ve bu hedefe ulaşmak için Siirt ve Tekin çeşitlerine daha fazla önem verilmesi planlanmaktadır. Bu çeşitlerin,

uluslararası alanda tanınması ve tercih edilmesi, Türkiye'nin antepfıstığı sektöründeki rekabet gücünü artıracaktır.

Tablo 1: 2014-2022 Yılları Arası Antepfıstığı Üreticisi Ülkelerin Üretim Miktarları (ton) (FAO, 2020).

Ülkeler	2013	2014	2015	2016	2017	2018	2019	2020
ABD	213.188	233.146	122.470	406.646	272.290	447.700	336.112	474.004
Türkiye	88.600	80.000	144.000	170.000	78.000	240.000	85.000	296.376
İran	225.001	440.814	430.000	574.987	648.934	143.695	337.815	190.000
Çin	74.000	78.232	83.533	78.588	80.118	80.747	79.819	80.227
Suriye	54.516	28.786	52.499	49.735	51.048	61.631	31.813	69.403

Tablo 2: 2013-2022 Yılları Arası Antepfıstığı Üreticisi Ülkelerin Alan Miktarları (ha) (FAO 2020).

Ülkeler	2013	2014	2015	2016	2017	2018	2019	2020
Türkiye	544.510	561.860	579.960	608.140	682.370	3.545.000	3.662.100	3.818.470
İran	3.040.540	3.346.250	3.340.000	5.528.700	4.295.350	1.378.360	4.114.320	1.629.600
ABD	821.510	894.360	942.920	967.200	1.011.700	1.068.400	1.375.930	1.505.430
Suriye	599.030	598.930	598.640	598.760	599.660	599.650	599.890	603.630
Tunus	270.600	267.000	266.600	265.800	308.020	289.190	278.570	276.180
Çin	250.000	268.070	280.640	266.240	271.650	272.840	270.240	271.580

2. ARAŞTIRMA VE BULGULAR

2.1. **Antepfıstığında Anacın Önemi**

Aşılamada kullanılan ve bitkinin kök sistemini oluşturan bitkiye anaç denir. Başka bir deyişle, meyve türü veya çeşidinden alınan göz veya kalem üzerine aşılandığı önceden toprağa dikilen bitki türü ve çeşidine anaç adı verilir.

Meyvecilikte, doğru anacın seçilmesi, verim ve kalite üzerinde doğrudan etkiye sahip temel faktörlerden biridir. Bu nedenle, dünya genelinde ve ülkemizde, en uygun anacın geliştirilmesi ve kullanılması için yapılan araştırmalar büyük önem taşımaktadır. Antepfıstığı dahil olmak üzere birçok meyve türünde, özellikle sıra arası dikim mesafesinin azaltılması ve toprak koşullarına uygun anacın geliştirilmesine yönelik

çalışmalar sürdürülmektedir. Ülkemizde birim alandan elde edilen verimin düşük olması, ürünün kilogram başına üretim maliyetini artırmakta ve bu da uluslararası pazarlarda İran ve ABD gibi büyük üretici ülkelerle rekabet şansını azaltmaktadır. Bu nedenle, antepfıstığı yetiştiriciliğinin sulu koşullarda gerçekleştirilmesi önem arz etmektedir.

2.2.Anaç Kullanımının Üstünlükleri

- Yetiştiricilik için uygun olmayan iklim ve toprak koşullarında üretim yapılması gerektiğinde,
- Bitki büyümesinin kontrol altına alınması istendiğinde,
- Gençlik döneminin kısaltılması gerektiğinde,
- Meyve kalitesi ve verimin artırılması hedeflendiğinde,
- Hastalıklara ve zararlılara karşı dayanıklılığın sağlanması için,
- Farklı toprak koşullarına uyum sağlama gibi birçok amaç için meyve yetiştiriciliğinde anacın kullanılması yaygındır (Hepaksoy, 2019).

2.3.Ülkemizde Antepfıstığı Bahçelerinde Kullanılan Anaçlar

Antepfıstığı yetiştiriciliğinde sıklıkla tercih edilen anaçlar arasında Pistacia terebinthius (melengiç), P. vera (antepfıstığı), P. khinjuk (buttum) ve P. atlantica (Atlantik sakızı) yer almaktadır. Bu anaçlar ülkemizin çeşitli bölgelerinde doğal olarak yetişmektedir. GAP bölgesinde sulama imkanlarına kavuşan antepfıstığı bahçelerinde sulama uygulamaları başlamış olmasına rağmen, özellikle kontrolsüz sulama yapan üreticilerimiz, anaçlarla ilgili sorunlarla karşılaşmaktadır.

2.4.Siirt çeşidi çöğürleri anaç olarak kullanılmasının Avantaj ve Dezavantajları

- Kolay çimlenme,
- Hızlı büyüme,
- Düzgün gövde oluşturma,
- Kolay aşılanma ve iyi aşı tutma gibi anaçlarda aranan birçok olumlu özelliğe sahiptir.

Güneydoğu Anadolu Bölgesi'nde, antepfıstığı bahçelerinin sulanmaya başlaması ve ayrıca yoğun yağışların etkisiyle, antepfıstığı çöğürlerinin anaçlarında su birikimi

nedeniyle önemli kurumalar meydana gelmiştir. Özellikle Siirt çöğürüyle kurulan bahçelerde, 2017, 2018 ve 2019 yıllarında bitkilerin aşılamadan 2 ay sonra kurumaya başladığı belirlenmiştir. Çöğürler, aşılamadan sonra süren aşı sürgünüyle toprak seviyesine kadar kuruyup, daha sonra tekrar dip sürgünleri oluşturmaktadır. Bu kurumaların, son 3 yılda yaşanan yüksek yaz sıcaklıklarından kaynaklandığı ifade edilmektedir. Güneydoğu Anadolu Bölgesi'nde antepfıstığı çöğürleri aşılanırken, aşıdan hemen sonra anaçlarda şiddetli budama yapılmaktadır. Bu durumda, yoğun şekilde budanan Siirt çöğür anaçlarının yüksek sıcaklıklara dayanamadıkları ve dolayısıyla kurudukları düşünülmektedir. Ancak, şiddetli bir şekilde budanmamış olan çöğürlerde kurumaların daha az görüldüğü belirtilmektedir (Açar, 2020).

Siirt çöğürlerinin hem sulu koşullara dayanıklı olmaması hem de aşılamadan sonra geriye doğru kuruması, bu çöğürlerin antepfıstığı bahçelerinde artık anaç olarak kullanılmaması gerektiğini açıkça göstermektedir. Antepfıstığı bahçeleri için sulamaya ve toprak kökenli hastalıklara hassas olmayan anaçların tercih edilmesi gerekmektedir. Bu bağlamda, daha dayanıklı ve uygun anaçların seçilmesi ve kullanılması, antepfıstığı üretiminde verimlilik ve kalitenin sağlanmasına yardımcı olacaktır (Açar, 2020).

3. SONUÇ VE ÖNERİLER

Güneydoğu Anadolu Projesi (GAP), antepfıstığı yetiştiriciliğinde devrim niteliğinde bir adım atmıştır. Bu proje, sulu tarımı teşvik ederek bölgede önemli bir değişim sağlamıştır. Bundan böyle, GAP bölgesinde kurulacak yeni antepfıstığı bahçelerinde, antepfıstığı çöğürlerinin yerine bölgeye uygun buttum çöğürlerinin kullanılması büyük önem taşımaktadır.

Gaziantep ve Şanlıurfa illerindeki antepfıstığı bahçelerinde, ortalamada 800-1000 kg/ha arası verim elde edilmektedir. Ancak sulu koşullarda yetiştirilen bahçelerde bu verimler 1.600-2.000 kg/ha'a kadar yükselmektedir.

KAYNAKLAR

Anonymous, 2021, The Food and Agriculture Organization (FAO), 2020. Erişim Tarihi 21.10.2021. https://www.fao.org/faostat/data/QCI.

Demircan, M. (2010). Gaziantep'te Antepfıstığı Üretimi (Master's thesis, Sosyal Bilimler Enstitüsü).

Gözel, H. (2006). Kilis Yağlık ve Nizip Yağlık Zeytin Çeşitlerinde Tohumların Çimlenme ve Çeliklerin Köklenme Durumlarının Belirlenmesi Üzerinde Bir Araştırma (Master's thesis, Fen Bilimleri Enstitüsü).

Yavuz, M.A., Yıldırım, H., Onay, Ahmet. (2016). Dünya Antepfıstığı Üretiminde Son On Yılın Değerlendirilmesi. Batman Üniversitesi Yaşam Bilimleri Dergisi, 6(2/2), 22-31.

Ak, B.E., Sakar, E., Yeşiloğlu, H.M., Öztürk, F.F. (2012). Antepfıstığı Yetiştiriciliği. TC Tarım ve Köyişleri Bakanlığı, Çiftçi Eğitim Seti yayın, (2012/31).

Ertürk, Y.E., Geçer, M.K., Gülsoy, E., Yalçın, S. (2015). Antepfıstığı Üretimi ve Pazarlaması. Journal of the Institute of Science & Technology/Fen Bilimleri Estitüsü Dergisi, 5(2).

Çeçan, Ö. (2022). Şanlıurfa İlinde Antep Fıstığının Önemi ve Periyodisitenin Etkileri (Doctoral dissertation).

Eldoğan, Ü., Şahin, A. (2015). Gaziantep İlinde Antepfıstığı Üretim Ekonomisi Araştırması. KSÜ Doğa Bilimleri Dergisi, 18(3), 29-36.

Hepaksoy, S. (2019). Meyvecilikte anaç kullanımı: Armut anaçları. Türk Bilimsel Derlemeler Dergisi, 12(2), 69-74.

Açar, İ. 2020. Antepfıstığı Bahçelerinde Anaç Olarak Kullanılan Siirt Çöğürlerinde Görülen Kurumalar. Antepfıstığı Araştırma Enstitüsü Yayınları, Sayı 8, Gaziantep

ANTEPFISTIĞI YETİŞTİRİCİLİĞİNDE SULU VE KURU TARIM DEĞERLENDİRMESİ

Emine KÜÇÜKER (ORCID: 0000-0002-4198-6262)
Agriculture Faculty Department of Horticulture, Siirt University, Siirt 56100, Turkey
Email: emine.kucuker@siirt.edu.tr

Erdal AĞLAR (ORCID: 0000-0002-41995716**)**
Agriculture Faculty Department of Horticulture, Van Yüzüncü Yıl University, Van 65000, Turkey
Email: erdalaglar@gmail.com

ÖZET
Güneydoğu Anadolu Bölgesi Antepfıstığının (*Pistacia vera* L.) önemli bir gen merkezidir. Bölgede önemli yetiştiricilik alanlarına sahip Gaziantep, Siirt ve Şanlıurfa gibi illerden geçmişten günümüze süregelen susuz koşullarda yetiştiricilik hakimiyetini devam ettirmektedir. Amerika ve İran gibi dünya lideri ülkelerde taban arazide ve sulu koşullarda yetiştiricilik benimsenmiştir. Lider ülkelerin yetiştiricilik sistemleri incelendiğinde antepfıstığı yetiştiriciliğinde sulu tarıma geçilmesi ile verim ve kalitenin artırılması mümkündür. Dünyada sayılı sulama projelerinden bir tanesi olan GAP projesi Türkiye için büyük fırsatlar sunmaktadır. Böylelikle antepfıstığı yetiştiriciliğinde önemli bir problem olan periyodisitenin sulama uygulamaları ile kısmen de olsa ortadan kaldırılarak verim ve kalitenin sürekliliği sağlanabilecektir. Bu çalışmada sulu ve kuru koşullarda antepfıstığı yetiştiriciliği değerlendirilerek Türkiye'nin lider ülkelerle rekabet edebilme yolunda sulamanın etkinliği değerlendirilecektir.
Anahtar Kelimeler: antepfıstığı, anaç, buttum, verim, sulu tarım

EVALUATION OF IRRIGATED AND DRY PRODUCTION İN PISTACHIO CULTIVATION

ABSTRACT
Southeastern Anatolia Region is an important homeland of pistachio (Pistacia vera L.). Gaziantep, Siirt and Şanlıurfa, which have important cultivation areas in the region, continue to dominate the cultivation under irrigated conditions from the past to the present. In world-leading countries such as the USA and Iran, cultivation on bottom land and under irrigated conditions has been adopted. When the cultivation systems of leading countries are examined, it is possible to increase yield and quality by switching to irrigated agriculture in pistachio cultivation. The GAP project, one of the few irrigation projects in the world offers great opportunities for Turkey. Thus, periodicity, which is an important problem in pistachio cultivation, can be partially eliminated with irrigation practices and the continuity of yield and quality can be ensured. In this study, pistachio cultivation under irrigated and dry conditions will be evaluated and the effectiveness of irrigation will be assessed in order for Turkey to compete with leading countries.
Keywords: pistacia, rootstock, khunjuk, yield, irrigated production

1. GİRİŞ

Antepfıstığının sulanması konusunda Türkiye ve dünyada son duruma bakıldığında, ülkemiz antepfıstığı üretim alanlarında genellikle sulama yapılmamaktadır (%3-5). Dünyada ise önemli antepfıstığı üreticisi olan İran ve ABD'de antepfıstığı üretimi tamamen sulu koşullarda yapılmaktadır. Yapılan anketler sonucunda çiftçilerin büyük bir kısmı sulama yapmak istediklerini bildirmişlerdir. Ülkemizde küresel ısınma ve dünya ile rekabet edebilmek için tüm meyve türlerinde olduğu gibi Antepfıstığında da sulama bir tercih değil zorunluluktur (Arpacı ve ark., 1995). Antepfıstığı üretimde lider ülkeler olan ABD ve İran'da sulanan bahçelerde yetiştirilirken Türkiye'de yalnız %8'i sulanan bahçelerde yetiştiricilik yapılmaktadır. İranda sulu koşullarda yetiştiricilikte sık dikim bahçeler kurulur. Bu amaçla 6-8 m aralıklarla kanallar açılmakta ve açılan kanallar içerisine 40-50 cm aralılarla tohum ekimi yapılmaktadır. İranda antepfıstığı yetiştiriciliğinde aşılama arazide yapılmaktadır. Sık dikim sisteminde kök rekabeti sağlanarak bitkilerin bodur kalması sağlanmaktadır (Aydın ve Saltuk, 2018). Güneydoğu Anadolu bölgesi minimum yağış alan bir bölgedir. Ortalama yağış 350-500 mm arasında değişmektedir. ABD ve İran sulu koşullarda ve 1. sınıf tarım arazilerinde Türkiye ve Suriye neredeyse tamamen kuru koşullarda ve çoğunlukla kıraç arazilerde yetiştiricilik yapmaktadır. İran ve ABD de iri meyveli, çıtlama oranı yüksek yuvarlak taneli ürünler yetişirken Türkiyede uzun çeşitler, (periyodisite eğilimi yüksek) yetiştirilmektedir. Yapılan araştırmalar sulama ile normal verim yılında % 30-50 daha yüksek periyodisite yılında ise tam periyodisite yerine kısmi periyodisite alınmıştır (Polatbilek, 2014). Antepfıstığında sulu koşullarda yetiştiricilikte yüksek verim, yüksek çıtlama oranı, kaliteli ve iri meyveler elde edilmektedir. Bunun yanısıra sürgün büyümesi ve kök oluşumuna önemli etkileri bulunmaktadır.

2. ARAŞTIRMA VE BULGULAR

2.1.Yüzey Sulama Yöntemleri

- Yağmurlama Sulama
- Damla Sulama
- Yüzey Damla Sulama
- Mikro yağmurlayıcılar
- Karık sulama

- Tava Sulama
- Dairesel çanak sulama

2.2.Yüzeyaltı Damla Sulama Sistemlerinin Avantajları:

- Buharlaşma kayıpları hiç yoktur.
- Ağaçkakan vb. kuş zararı sıfırdır.
- Laterallerin serilmesi ve toplanması gibi işçilik gideri yoktur.
- Yabancı ot düzeyi çok düşüktür.
- Su tasarrufu çok yüksektir.
- Dış etmenlerin etkisi ile sulama borularının yıpranması söz konusu değildir.

Şekil 1. Yüzeyaltı Damla Sulama Sistemleri

2.3.Antepfıstığında Sulama Zamanı ve Miktarı

Antepfıstığında sulama zamanının belirlenmesinde; tansiyometre yada toprak kuruluğunun el ile kontrol edilmesi ile belirlenir. Toprakta 0-90 ile 0-180 cm derinlikteki yararlı suyun % 50' si bitki tarafından kullanıldığında (15 Mayıs-1 Haziran) sulama yapılmasına karar verilir.

Peki ne kadar sulama (mm) yapılmalı diye düşündüğümüzde yüzey sulama' da Haziran-Eylül ayları arasında 20 günde bir 120 mm' lik su uygulaması, damla sulama'da ise 7 veya 15 gün aralıkla sulama yapılabilir. Yedi gün aralıkla 15-20 mm' lik su uygulaması (her sulamada ağaç başına yaklaşık 150-300 litre), sulamada ıslatılması gereken derinlik

ise 100-120 cm dir. Antepfıstığının yıllık su tüketimi yüzey sulamada yağış ile birlikte 754-803 mm'dir. Net, 560 mm'dir. Damla sulamada ise net 415 mm'dir (Demir ve Atılgan, 2016).

Şekil 2. Antepfıstığında Karık Sulama

2.4.Fizyolojik Olarak Sulamanın Faydası

- Periyodisitenin engellenmesi (sulamanın eksikliği, kültürel tedbirlerin yetersizliği, bitki dokularında yeterli N bulunmaması).
- Verimli, çıtlama oranı yüksek, kaliteli ve dolgun meyve elde etmek.
- Sulanan ve sulanmayan arasında fotosentez hızı bakımından % 32 lik fark vardır. Yani sulanan ağaç daha fazla karbonhidrat biriktirerek karagöz oluşumunu engeller.

2.5.Antepfıstığında Sulamanın Etkileri

Antepfıstıklarında görülen periyodisite, önemli bir yetiştiricilik problemidir. Genetik yapının etkisi ile birlikte kültürel uygulamaların yetersizliği periyodisite oranını artırmaktadır. Sulanan antepfıstığı ağacı ile sulanmayan ağaç arasında fotosentez hızı bakımından % 32 oranında bir fark var olduğu tespit edilmiştir. Yine düzenli sulama yapılan ağaçlarda karbonhidrat birikimi yeterli düzeyde olmakta ve karagöz dökümünü azaltmaktadır (Yükçeken, 1998).

Antepfıstığı sulanması hakkında yapılan bazı bilimsel araştırma sonuçları antepfistiği neden sulanmalidir sorusunun cevabı sulu koşularda; Uzun 179 kg/da, Siirt → 262 kg/da verim elde edilirken kuru koşullarda; Uzun 59 kg/da, Siirt 103 kg/da verim elde edilir.

Sulama ile ilgili yapılan çalışmalar bakıldığında sulu yetiştiriciliğe uygun dikim yapılarak sulanan bahçelerde; suluda Siirt 262 kg/da (7x1 17-20 yaş), kuruda ise Siirt 56 kg/da (8x8m 17-20 yaş) verim elde edildiği tespit edilmiştir (Tekin ve ark., 2001).

Harran ovasında sulamaya haziranda başlayıp, 30 gün aralıklarla eylül başında son verildiğinde (Bu dönemdeki su ihtiyacı yaklaşık 500 mm) verim %50 artmış, Periyodisite azalmış, irilik ve çıtlaklık artmıştır. Sulu koşullarda uygun anaç ve dikim sıklığı ile 320.5 kg/da verim elde edilirken, sulu koşullarda Uzun çeşidinde 104 kg/da, Tekin 232 kg/da (12-16 yaşlarında) verim elde edildiği tespit edilmiştir (Kendirli, 2001).

2.6.Dikim Şekilleri

Sulu koşullarda; sıra arası 6-7 m, sıra üzeri 3 veya 3,5 m mesafede dikim yapılmaktadır. 25-30 yılda sıra üzeri kapandığından, bitkilerin bir kısmı seyreltilebilmektedir. Kuru koşullara göre yoğun bir emek gerekmekte, fazla ürün alınabilmektedir. Dikim mesafeleri sulanan koşullarda; sıra üzeri 4-7 m sıra arası 6-8 m iken sulanmayan koşullarda dikim aralıkları kullanılan anaca göre 6-10 m arasında değişmektedir. Genellikle 8x8 m'dir.

Şekil 3. Antepfıstığı Kapama Bahçelerinden Görünüm

Kuru koşullarda; dikim su ve besinin yeterli olabilmesi için dikim aralıkları geniş tutulmalıdır. Arazi verimli, derin ise 6x6 m iken; kıraç toprak kalınlığı az ise 7x7 m dikim aralığı düşünülmelidir (Demircan, 2010).

3. SONUÇ VE ÖNERİLER

Türkiye'de antepfıstığının en önemli gen merkezi Güneydoğu Anadolu Bölgesidir. Üretimde lider ülkeler olan İran ve ABD'de sulu koşullarda yetiştiriclik yapılmakta ancak; ülkemizde tamamen kuru koşullarda yetiştiricilik hakimdir. Kültürel işlemler arasında sulama uygulamaları antepfıstığında periyodisiteyi azaltan ve verimi artıran uygulamalar arasında önemli yer tutmaktadır.

Dünyanın en büyük sulama projelerinden birisi olan GAP, Amerika ve İran'da olduğu gibi sulanabilir alanda antepfıstığı yetiştiriciliği için büyük fırsatlar sunmaktadır. Yöre çiftçisinde var olan "Antepfıstığı sulanmaz" ön yargısını kırmak ve bu sayede periyodisitenin tamamen olmasa da kısmen ortadan kaldırılması yoluyla sürdürülebilir verim ve çiftçi için gelirin sürekli kılınması sağlanabilecektir. Ülkemiz açısından büyük önemi haiz olan Antepfıstığı çeşit ve anaç ıslahı çalışmalarına ciddi bir ivme kazandırılmalı ve bir an evvel geliştirilecek kombinasyonlardaki fidanlarla bahçeler tesis edilmelidir.

4. KAYNAKLAR

Arpacı, S., F. Akkök, H. Tekin., 1995. Sulu ve Kuru Koşullarda Antepfıstıklarında Verim ve Ürün Kalitesindeki Değişimlerin Karşılaştırılması. Türkiye II. Ulusal Bahçe Bitkileri Kongresi. Adana. Cilt I. S. 429-433

Aydın, Y., Saltuk, B., 2018. Siirt Yöresi Fıstık Üreticilerinin Sulama Eğilimlerinin Belirlenmesi. Isparta Uygulamalı Bilimler Üniversitesi Ziraat Fakültesi Dergisi, 1. Uluslararası Tarımsal Yapılar ve Sulama Kongresi Özel Sayısı: 119-127.

Polatbilek, H. 2014. Güneydoğu Anadolu Bölgesinde yetiştiriciliği yapılan antepfıstığında (*Pistacia vera* L.) alternaria yanıklık hastalığının karakterizasyonu (Master's thesis, Fen Bilimleri Enstitüsü).

Demir, C., Atılgan, A., 2016. Genç Antepfıstığı ağaçlarında farklı sulama yöntemlerinin gelişim parametrelerine etkisi. *Harran Tarım ve Gıda Bilimleri Dergisi*, *20*(4), 313-321.

Yükçeken, Y., 1998. Antepfısığı çöğürlerinde farklı sulama programlarının gövde gelişmesi ve su tüketimine etkilerinin irdelenmesi. MS thesis. Fen Bilimleri Enstitüsü.

Tekin, H., Arpacı, S., Atlı, H. S., Açar, İ., Karadağ, S., Yükçeken, Y., Yaman, A., 2001. Antepfıstığı yetiştiriciliği. *Antepfıstığı Araştırma Enstitüsü Müdürlüğü, Yayın*, (13), 132.

Kendirli, B., 2001. Harran ovası sulama birliklerinde antepfıstığının sulama planlaması. *Journal of Agricultural Sciences*, *7*(04), 114-120.

Demircan, M., 2010. Gaziantep'te antepfıstığı üretimi (Master's thesis, Sosyal Bilimler Enstitüsü).

THE PHARMACIST'S ROLE IN MEDICATION THERAPY COUNSELING

G. AKASHKUMAR
Can Tho University

ABSTRACT
The current article is aimed at identifying the best practice for counseling around depression in community and outpatient pharmacies, resulting in a draft guideline, proposing key steps and an algorithm for integration of community pharmacists into care for patients with depression. A literature review was performed followed by a detailed analysis, for the purpose of creation a short draft document used as a basis for creation of a guideline for pharmaceutical care for patients with depression. The technological scheme PRISMA flow diagram was applied. The paper is based on current knowledge, taking into consideration already published articles, guidelines, and recommendations about pharmaceutical care for patients with depression, giving a basis for further studies. This paper includes two main sections: 1) depression – a short description of the main symptoms, risk factors and pharmacotherapy guidelines available in Bulgaria important for the purposes of ensuring qualitative community-based pharmaceutical care; and 2) the pharmacists' role in providing high-quality care – the main aspects of pharmaceutical care for patients with depression with specific examples. The involvement of pharmacists in supporting depressive patients is crucial taking into account the specific characteristics of the pharmacological treatment: delayed onset of clinical results, risks in case of sudden pharmacotherapy abruption without physician consultation, multiple adverse drug reactions and drug–drug, drug–food and drug–alcohol interactions, etc. The current article could also be used as an initial document for creating a methodological guideline for providing pharmaceutical care services for patients with depression.
Keywords: depression, drug-related problems, pharmaceutical care, pharmacists, guideline

Introduction :

The role of pharmacists in healthcare is integral and multifaceted, encompassing a wide range of responsibilities that contribute significantly to patient care. One of the essential aspects of a pharmacist's role is medication therapy counseling. Medication therapy counseling involves the provision of information and guidance to patients regarding their prescribed medications, over-the-counter (OTC) products, and various aspects of their medication regimen. This vital function not only ensures the safe and effective use of medications but also plays a crucial role in improving patient outcomes and promoting overall well-being.

In this discussion, we will explore the significance of medication therapy counseling, the responsibilities of pharmacists in this domain, and the various ways in which pharmacists contribute to optimizing medication use for patients. Through their expertise, accessibility, and patient-centered approach, pharmacists serve as a valuable resource in the healthcare system, bridging the gap between healthcare providers and patients to promote medication adherence, minimize potential drug-related problems, and enhance patient understanding of their medications.

Medication therapy counseling goes beyond simply dispensing medications; it involves active engagement with patients to educate them about their medications, address their concerns, and empower them to take an active role in their healthcare. Pharmacists are uniquely positioned to provide this level of personalized care and support, making them an essential part of the healthcare team. This discussion will delve into the various aspects of a pharmacist's role in medication therapy counseling, including medication education, adherence support, side effect management, and collaborative care coordination with other healthcare providers.

As the field of pharmacy continues to evolve, so does the pharmacist's role in patient care. In this context, this exploration of the pharmacist's role in medication therapy counseling serves to underscore the critical importance of this function and the positive impact it has on patients' lives. Through effective counseling and patient engagement, pharmacists play

a vital role in ensuring that medications are not only prescribed but also understood, used correctly, and ultimately contribute to improved health outcomes.

Background :

Pharmaceutical care is a responsible provision of drug therapy for the purposes of achieving definite outcomes and improvement of patient's quality-of-life. The main responsibilities of the pharmacists are defined as a result of long-term studies: 1) to ensure that all medications are appropriate, effective, and safe for a particular patient, and 2) to identify, solve, and prevent various drug-related problems (DRPs).In 2013 a working group formed by investigator members of the Pharmaceutical Care Network Europe (PCNE) preformulated the definition so as to respond to the current expectations and views: "Pharmaceutical Care is the pharmacist's contribution to the care of individuals in order to optimize medicines use and improve health outcomes".

Depression is a common psychiatric illness, which is associated with several specific symptoms such as depressed mood, markedly diminished interest or pleasure in activities, psychomotor retardation, weight loss or weight gain, fatigue or loss of energy, feelings of worthlessness or guilt, recurrent thoughts of death, or recurrent suicidal ideation, etc. Being chronic in nature and affecting people of working age, depression leads to great economic and financial burden, which is also evaluated in a number of studies.Moreover, the World Health Organization (WHO) reports that depression will be the second leading cause of disability in the world by 2020.Non-adherence to antidepressants, which is defined as being over 75% after 6 months, could lead to a lack of effect, to higher costs and significant burden for the patient, family, and society.

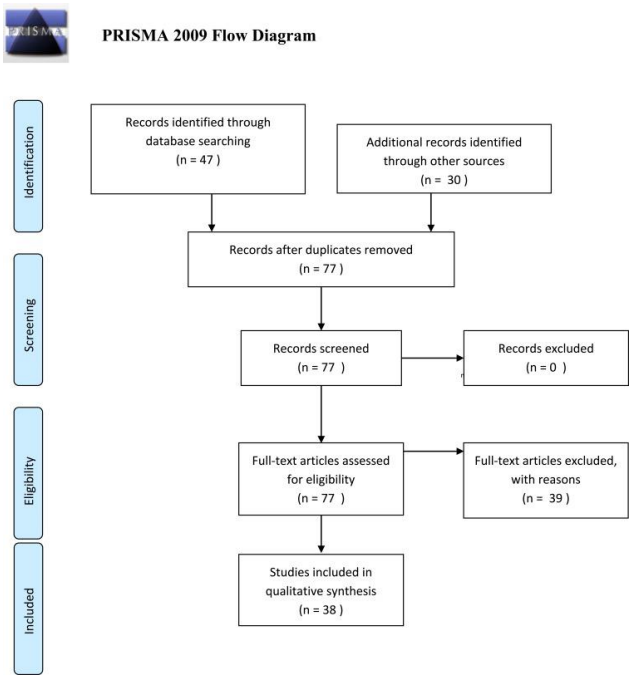
Methods :

A literature review of the published literature regarding pharmaceutical care, depression treatment, and role of the pharmacist in the care for patients with depressive disorder was performed. A detailed analysis for the purpose of creating a short guideline for pharmaceutical care for patients with depression was made. The discussion about the guideline's structure and further validation of the drafted guideline are planned to be the next steps. The paper is based on the current knowledge taking into consideration already

published articles, guidelines, and recommendations about pharmaceutical care for patients with depression.

Results and Discussion :

íThere were 77 papers relevant to our research question: 47 in PubMed and 30 from other sources (books, paper-based reports, guidelines, and articles). The study selection process is presented in Figure 1. No potentially relevant studies after duplicates were removed. After reviewing the titles, abstracts, and the full publications, 39 of the articles meeting exclusion criteria were excluded and only 38 were summarized.

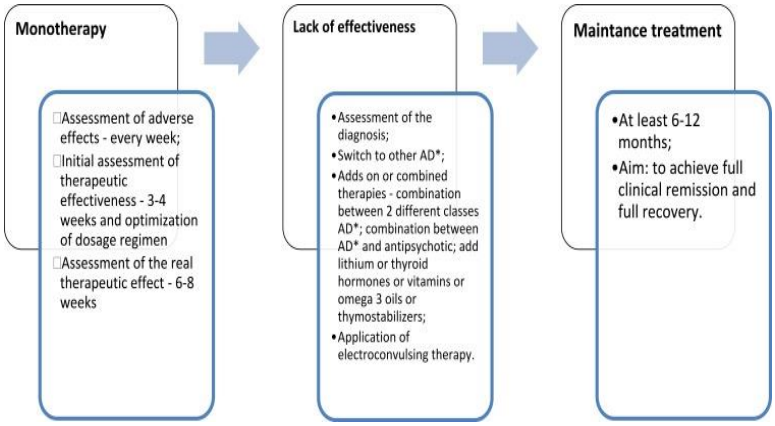


The characteristics of the included studies are initially analyzed, summarized, and combined for the purposes of presenting initial ideas for creating a guideline. They are presented in the current part of the article as we are planning to present a discussed and validated version of the guideline in a further more detailed paper.

Depression – Symptoms, Epidemiology, and Treatment:

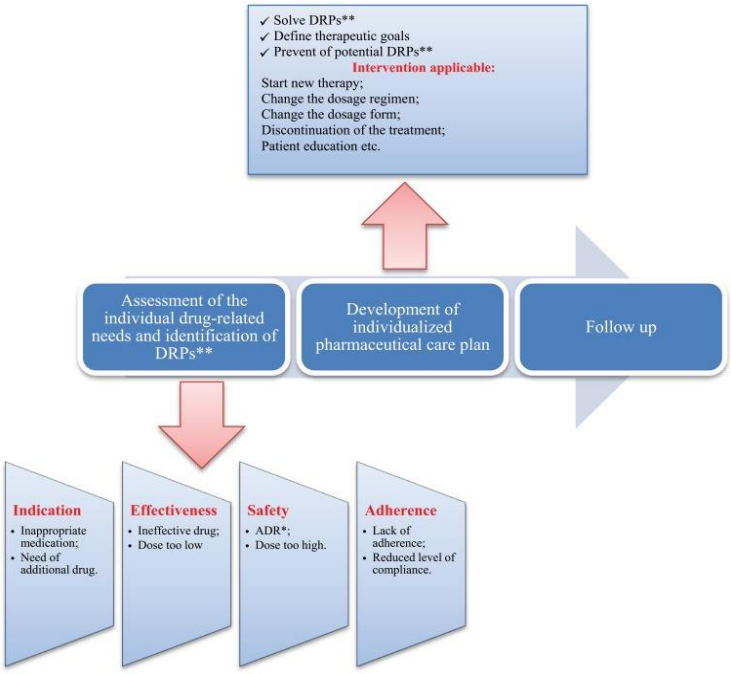
Depression is a common psychiatric disorder affecting more than 300 million people worldwide. It causes significant distress, limitations in personal and social functioning, and worsens the quality-of-life of those affected.The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) outlines specific criteria for the diagnosis of depression. Some of the most specific symptoms are depressed mood, loss of interest or

pleasure, significant weight loss or weight gain, a slowing down of thought and a reduction of physical movement, fatigue or loss of energy, feelings of worthlessness or excessive or inappropriate guilt, diminished ability to think or concentrate, recurrent thoughts of death or suicidal thoughts. Among all mental disorders, depression is related to the highest risk of suicide, followed by schizophrenia and alcohol abuse. The main causes for depression are genetic factors, personal predisposition, concomitant diseases, family history, huge life changes (negative or positive events), or social determinants (stress, isolation, loneliness, unemployment). Depression might be in mild, moderate, or severe form, which is defined after complex clinical evaluation based on the number, type, and severity of the symptoms.



Pharmaceutical Care Aspects for Patients with Depression:

The pharmacist's obligations in the process of providing pharmaceutical care are: (1) collection of specific information for the patient's demographic data, history of disease, medication therapy (current therapy, dose, therapeutic regimen, allergies, immunizations, previous drug therapy), current complaints; (2) analyzing the collected information so as to identify drug-related problems, to assess whether all medications are effective and safe for the patient as well as patient's adherence and compliance. Follow-up was aimed at defining the therapy effectiveness and long-term safety, assessing clinical results, defining the level of achieving the goals, level of adherence, and reassessing of new potential or actual DRPs



Communication with the Patients and Their Family Members/Caregivers:

Establishment of contact with the patient with depression, asking appropriate questions Communication with patients with mental problems presents a challenge for every pharmacist. Despite the various communication difficulties, the pharmacist should apply innovative strategies for overcoming them.37 The pharmacist should play the dominant role during the conversation, applying appropriate voice tone, using simple and short sentences and body language without discussing several issues simultaneously – a focus should be made on a specific problem through a variety of technical and non-technical skills.38 The consulting pharmacist should pay attention to and adapt the discussion towards patient's difficulties related to verbal speech and memorization.

The pharmacist as a health professional is able to recognize the initial symptoms, to identify the risky groups, and to target vulnerable people to join supporting groups, initiate nonpharmacological treatment, or make an appointment with a psychiatrist for prescribing eventually of the most appropriate pharmacotherapy.

Creation of Individualized Therapeutic Plan and Defining of Specific Goals:

The main therapeutic goal in patients with depression is overcoming the symptoms with reducing as much as possible the adverse drug reactions, prevention of suicidal thoughts, and improving the remission rates. The pharmacist may be actively involved in achieving

the goals through realization of various educational programs for clarifying how important the therapy is. Development of an individualized therapeutic plan in collaboration with the psychiatrist and the affected patient and his family members/caregivers, taking into consideration the individual needs and preferences could significantly optimize the therapy and improve the level of adherence.

Conclusion :

Application of pharmaceutical care services for patients with depression is effective and leads to condition improvement, reduction of the side-effects, timely identification of and the overcoming of potential or actual DRPs, and improvement of patients' quality-of-life. Collaboration between psychiatrists, pharmacists, and the active inclusion of the affected and their relatives in the therapy could optimize and improve the complex care for patients with depression and achieving the targeted therapeutic outcomes.

The current article could be used as an initial proposal for creating a methodological guideline for providing pharmaceutical care services for patients with depression. A number of follow-up studies are needed to assess the feasibility of implementing community-based pharmaceutical care for patients with depression, the level of knowledge of pharmacists on depression, the effect of pharmaceutical care on this patient group, and the economic benefits from the point of view of society.

References

Hepler CD, Strand LM. Opportunities and responsibilities in pharmaceutical care. Am J Hosp Pharm. 1990;47(3):533–543. [PubMed] [Google Scholar]

Cipolle R, Strand L, Morley P. Chapter Three: Toward a Philosophy of Pharmaceutical Care Practice. Pharmaceutical Care Practice. The Patient Centered Approach to Medication Management. 3rd ed. McGrawHill Medical; 2012:73–100. [Google Scholar]

Position Paper on the definition of Pharmaceutical Care 2013. PCNE. Available from: https://www.pcne.org//upload/files/3_PCNE_Definition_Position_Paper_final.pdf . Accessed January, 2019.

Diagnostic and Statistical Manual of Mental Disorders (DSM–5). Available from: https://www.psychiatry.org/psychiatrists/practice/dsm. Accessed February5, 2020.

Kessler RC. The costs of depression. Psychiatr Clin North Am. 2011;35(1):1–14. doi: 10.1016/j.psc.2011.11.005 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

Trautmann S, Rehm J, Wittchen HU. The economic costs of mental disorders: do our societies react appropriately to the burden of mental disorders? EMBO Rep. 2016;17(9):1245–1249. doi: 10.15252/embr.201642951 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

Greenberg PE, Birnbaum HG. The economic burden of depression in the US: societal and patient perspectives. Expert Opin Pharmacother. 2005;6(3):369–376. doi: 10.1517/14656566.6.3.369 [PubMed] [CrossRef] [Google Scholar]

Reddy MS. Depression: the disorder and the burden. Indian J Psychol Med. 2010;32(1):1–2. doi: 10.4103/0253-7176.70510 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

Rubio-Valera M, Bosmans J, Fernández A, et al. Cost-effectiveness of a community pharmacist intervention in patients with depression: a Randomized Controlled Trial (PRODEFAR study). PLOS. 2013. doi: 10.1371/journal.pone.0070588 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH

Selvakumar V.
Medicinal plants of Adhatoda

Saravanan R.
Medicinal plants of Adhatoda

Srinivasan R.
Medicinal plants of Adhatoda

ABSTRACT
Adusa is a well-known herbal remedy used in Unani system of medicine for its beneficial effects, especially in bronchitis. The herb containing fresh, dried, ripe leaves of Adhatoda vasica Nees, Family Acanthaceae, is a sub-herbaceous bush which grows and found throughout the year in plains and subHimalayan tracts in India, ascending up to 1200 m., flowering occurs during February-March and also at the end of rainy season. Adusa leaves, bark, root bark, fruit and flowers help to remove intestinal parasites. Adusa herb is used in the treatment of cold, cough, bronchitis and asthma. In acute bronchitis especially when the sputum is thick and sticky, it gives unfailing relief. Its action on liquefying the sputum makes it easier for body to expel sputum. It's dried leaves may be smoked to get relief from asthma. Local application of poultice of adusa leaves is also used with beneficial results over rheumatic joints, inflammatory swellings and fresh wounds. Scabies and other skin diseases may also be treated with a warm decoction of its leaves. In this paper general medicinal uses and pharmacological activities of various parts of this plant have been discussed and reviewed.
Keywords: Adusa, Adhatoda vasica, Unani medicine, traditional uses, health benefits

Introduction

Adhatoda vasica Nees (family Acanthaceae), commonly known as adusa or vasaka, also called malabar nut tree. It is a popular herb of Unani system of medicine due to its beneficial effects, especially in respiratory disorders. It is an evergreen shrub found in many regions of India and around the world. Adusa leaves have a stimulating effect on the respiratory system. Adusa possesses antispasmodic and expectorant properties, and has been used with great success in treating asthma, chronic bronchitis, and other respiratory conditions for centuries. It's boiled leaves may be helpful in treating rheumatic pain, and to relieve the pain of urinary tract infections. Its abortifacient properties have also been established. In some parts of India, it is also used to stimulate uterine contractions, thereby speeding up delivery .

Plant description

Family of Adhatoda vasica Nees is Acanthaceae. It occurs throughout the year and known as timeless shrub measuring 1-3 feet in height with many long opposite branches. The leaves are large and lance-shaped. Stem is herbaceous above and woody below.Leaves are opposite and estipulate. Flowers have spikes or panicles and are small irregular zygomorphic, bisexual and hypogynous . It has capsular four seeded fruits. Color of the flower is either white or purple. Inflorescences in auxiliary spicate cymes, densely flowered; peduncles short; bracts broadly ovate, fallacious. Leaves, flowers, fruits and roots of the plants are extensively used for treating chronic bronchitis, cold & cough, whooping cough, asthma and also used as sedative, antispasmodic and expectorant . Temperament

Mizaj: Hot2 Dry2.

Parts Used: Leaf and flower .

Chemical constituents

The incredible health benefits and treasure trove pharmacological uses of adusa are because of its rich concentration of alkaloids. The main alkaloid found in adusa leaves is a quinazoline alkaloid known as vasicine .Additionally to vasicine, alkaloids like l-vasicinone, deoxyvasicine, maiontone, vasicinolone and vasicinolare also present in the leaves and roots of adusa. Research suggests that these chemicals are responsible for bronchodilatory effect of adusa [9, 10]. There has also been a report of thrombopoietic (platelet increasing) activity with vasicine . The leaves of adusa are rich in vitamin C and

carotene. Identity, purity and strength.Foreign matter: Not more than 2 percentTotal ash: Not more than 21 percentAcid-insoluble ash: Not more than 1 percentAlcohol-soluble extractive: Not less than 3 percentWater-soluble extractive: Not less than 22 percent TLC T.L.C of the pet. using pet. ether: ethyl acetate (24:1) extract on silica gel 'G' plate shows five major spots on spraying with 5% methanolic-sulphuric acid reagent and heating plate for about ten minutes at 110 °C at Rf. 0.94, 0.42, 0.32, 0.24 and 0.13.

Therapeutic uses and health benefits

Anti-asthmatic and bronchodilator activity: In Unani system of medicine adusa has been used mainly to treat respiratory disorders. Vasicine and vasicinone are well established as therapeutical respiratory agents; both of them are the primary alkaloid constituents of adusa . Extracts of adusa's leaves and roots are used in the treatment of bronchitis, and other lung and bronchiole disorders, as well as common cough & cold. It's leaves decoction gives soothing effect on irritation in throat, and also act as an expectorant by liquefying phlegm in the respiratory passages. In order to explore the antitussive properties, experimental studies were conducted on anesthetized guinea pigs and rabbits using extract of adusa which showed thatplant possesses good antitussive activity.

Both in vitroand in vivo bronchodilatory activity using vasicine have been established in recent investigations .Wound healing activity: For the purpose of the study, wounds were created along the vertebral column of buffalo calves, then alcoholic and chloroform extracts of adusa in a powdered form were applied. In comparison to control group, the calves treated with adusa showed significant improvement in healing. Role of adusa in wound repair tissue was studied; showed improved breaking strength, tensile strength, absorption and extensibility. In addition to this, animals treated with adusa showed increased levels of elastin, collagen, hydroxyproline, hexosamine and zinc.

Anti-ulcer activity

Adhatoda vasica has also been studied for its anti-ulcerogenic activity against ulcers induced by ethanol, pylorus, and aspirin. In a controlled study; powder of dried leaves of adusa showed substantial anti-ulcer activity in experimental rats. The highest degree of activity was observed in the ethanol-induced ulceration model.These results suggest that Adhatoda vasica has immense potential as an anti-ulcer agent in addition to its traditionally established pharmacological activities. Further research showed that syrup of adusa improved symptoms of dyspepsia.

Cholagogue activity:

In laboratory experiments when animals were given an intravenous dose of 5 mg/kg, Adhatoda vasica was found to increase bile activity. Study on dogs showed that the amount of bile excretion was increased by 40-100%. The animals also showed an increase in bilirubin excretion.

Anti-allergy activity

An extract composed of vascinol and 20% vasicine inhibited ovalbumin-induced allergic reactions by about 37% at a concentration of 5 mg . Potent antiallergic effects of vasicinone have been established in experiments conducted on mice, rats and guinea pigs.

Anti-tubercular activity

Adhatoda alkaloid vasicine, produces chemical constituents bromhexine and ambroxol, two widely used mucolytics. Growth inhibitory effects on Mycobacterium tuberculosis of these chemicals have been established. Adusa also has indirect effects on tuberculosis by increasing lysozyme and rifampicin levels in bronchialecretions, lung tissue and sputum; which indicates that it may be used as adjuvant in the treatment of tuberculosis.

Abortifacient and uterotonic activity

Adhatoda vasica has been used for inducing abortion and for stimulating uterine contractions in order to speed childbirth because of its abortifacient and uterotonic properties respectively.Significant uterotonic activity of the alkaloid vasicine has been demonstrated through studies on human subjects. This pharmacological action appears to be induced by the presence or absence of certain estrogens. In a research, human myometrial strips taken from the uterus of both pregnant and non-pregnant women were treated with Adhatoda to study activity of vasicine in stimulating uterine contractions. The herb was found to induce uterine contractions, with effectiveness similar to the drug oxytocin. Anti-reproductive properties of Adhatoda vasica were also anecdotally confirmed by local women during the research period. Abortifacient properties of Adhatoda were also demonstrated through animal studies. In a study, aqueous or 90% ethanol plant extract was orally given to rats and guinea pigs for 10 days after insemination. It was found that extract of leaf of Adhatoda vasica at doses equivalent to 175 mg/kg was 100% abortive.Abortifacient effect of Adhatoda vasica was also shown in guinea pigs, with varied effectiveness according to the stage of pregnancy. More pronounced results were found when estrogens were used as a priming influence; this

indicates that the action of vasicine was probably mediated via release of prostaglandins.Insecticidal activity: Use of adusa as an insecticide has been prevalent for centuries in India. Its leaves have been shown to control insect pests both in laboratory and warehouse conditions. Many research have showed antifertility activity against several insect species, may due to its action on blocking the oviduct. Research has also proven Adhatoda's effectiveness as an insect repellent..Anti-bacterial activity: A leaf extract was investigated for antibacterial activity using the paper disc and dilution methods. In vitro studies on Adhatoda's alkaloids showed a strong activity against the bacteria Pseudomonas aeruginosa. was also noted that it possesses significant antibacterial activity against the gram-positive bacteria strains likeStreptococcus faecalis, Staphylococcus aureus, Staphylococcus Epidermidis and against the gram-negative bacteria like Escherichia coli.

Conclusion

Athatoda vasica has many biological activities that have been proved by many experimental studies. It represents a class of herbal medicine that has very strong conceptual or traditional base and a strong experimental base for its use. Main alkaloid present in the leaves of the plant is vasicine, which causes small but persistent bronchodilatation. It alsocontains an essential oil which is mainly responsible for the expectorant action of the plant. Other alkaloids like vasicinone, vasicinolone and vasicol are also present in the leaves and roots; they contribute to the bronchodilatory effect of the plant through anticholinergic action on the vagal innervation of the bronchi. The plant has great potential in treating various disorders but there is still scope and need to further conduct clinical trials to prove its clinical efficacy.

References

1. Anonymous. The Unani Pharmacopeia of India. VolVI, Part-1, New Delhi: CCRUM, Ministry Health and Family Welfare. Govt. of India, 2009.

2. Shinwari ZK, Shah M. The Ethnobotany of Khaghan district, Balochistan, Pakistan. Proc Sym Med Pl 1996.

3. Pandita K, Bhatia MS, Thappa RK, Agarwal SG, Dhar KL, Atal CK et al. Seasonal variation of alkaloids of Adhatoda vasica and detection of glycosides and Noxides of vasicine and vasicinone. Planta Med 1983.

4. Kabir H. Introduction to Ilmul-Advia. 1st ed. Aligarh: Shamsher Publisher and Distributors, 2002.

5. Shrivastava N, Shrivastava A, Banerjee A, Nivsakar M. Anti-ulcer activity of Adhatoda vasica Nees. J Herb

6. Maikhuri RK, Gangwar AK. Ethnobiological notes on the Khasi and Garo tribes of Meghalaya, Northeast India.

7. Dhar KL, Jain MP, Koul SK, Atal CK. Vasicol, a new alkaloid from Adhatoda vasica. Phytochem 1981.

8. Jain MP, Sharma VK. Phytochemical investigation of roots of Adhatoda vasica. Planta Med 1982.

9. Bhalla HL, Nimbkar AY. Preformulation studies III. Vasicinone, a bronchodilatory alkaloid from Adhatoda vasica Nees (absorption, potency and toxicity studies).

INFECTIOUS AND *CONTAGIOUS* DISEASES *IN* ANIMALS: A STUDY OF POLICY FRAMEWORK IN INDIA

Arwa RAFIE
Jamia Milia Islamia University, Delhi, India,

Assist. Prof. Dr. Bhumika SHARMA (ORCID: 0000-0002-3963-6036)
Sharda School of Law, Sharda University, Greater Noida, India
Email: bhumika.sharma1@sharda.ac.in

Arrat BANDAY
Sharda School of Law, Sharda University, Greater Noida, India
Email: 2020588011.arrat@ug.sharda.ac.in

Assist. Prof. Dr. Ritika SHUKLA
Sharda School of *Humanities* & *Social Sciences*, Sharda University, Greater Noida, India, ritika.shukla@sharda.ac.in

ABSTRACT
India, characterized by its rich biodiversity, extensive livestock numbers, and dense human population, faces increased vulnerabilities for the cross-species spread of diseases. The COVID-19 pandemic, recent occurrences of Lumpy Skin Disease in cattle, and the ongoing threat of Avian Influenza underscore the necessity of not only addressing diseases from a human health perspective (zoonosis) but also focusing on the interconnected aspects of livestock and wildlife. This situation presents opportunities to harness the synergies and strengths inherent in each sector, leading to the development of integrated, resilient, and adaptable response systems. The Constitution also lays down certain principles known as Directive Principles of State Policy (DPSPs) that are considered fundamental in the governance of the country and the Governments are required to respect these principles. One Health can be linked to some of these DPSPs, such as Article 47, wherein States shall work towards the improvement of public health as among its primary duties; Article 48, wherein States shall endeavour to organize agriculture and animal husbandry on modern and scientific lines; and Article 48A that is in respect to protecting and improving the environment and to safeguarding the forests and wildlife of the country. India acknowledged the importance of One Health back in 2008, with the establishment of the 'Roadmap to Combat Zoonoses in India' initiative by the Union Ministry of Health and Family Welfare, the Union Ministry of Agriculture, and the Ministry of Wildlife. Prevention and Control of Infectious and Contagious Diseases in Animals Act, 2009 is the primary legal framework in India. One Health essentially encompasses three elements – human, animal and environmental health that ought to be considered as integrated with each other and must be prioritized on an equal basis. India provides an excellent case to examine the dynamics of One Health operationalization.
Keywords: India, animals, Covid-19, Constitution, disease, One-Health.

1. Introduction

Etymologically, the term “animal” is derived from Latin terms - “animal” - living being that can move , “animalis” - animate, and “anima” meaning soul, breath. Biologically, animal would include all living organisms which cannot be described as plants. The meaning of term ‘Animal’ may differ from discipline to discipline and even country to country and statute to statute. Under Indian legislations, the definition is contained under Section 2(1) of Wildlife Protection Act,1972 ; Section 2(a) of Prevention of Cruelty to Animals Act, 1960; Section 47 of Indian Penal Code, 1860 ; and Rule 2 (a) of Prevention of Cruelty to Animals (Transport of Animals on Foot) Rules, 2001. Animals have a significant role in maintaining ecological balance. They are also important for scientific purposes, companionship and various other spheres of human lives. The human-animal bond is a mutually beneficial and dynamic relationship between people and animals. This bond extends to emotional, psychological, and physical interactions of people, animals, and the environment.

Animals have been worshipped as Gods, reviled as evil spirits, endowed with souls or regarded as mindless machines. They have been killed for food with careful respect but also slaughtered for sport. Whilst some species have been object of terror or loathing, others have been taken by humans to their homes and treated as if humans themselves. Animals became especially important as the object of leisure in the first half of the twentieth century. Still, they are consumed for human pleasure in a relatively anthropocentric manner. Almost universally, animals have been considered property under the law, simple things to own. The laws’ relegation of animals to the status of property is key to their continued abuse and exploitation. Animals have always formed and will always form a central feature of the human world.

The Report of the Technical Committee to Enquire into the Welfare of Animals (kept under Intensive Livestock Husbandry Systems), commonly known as the Brambell Report of December 1965 (England) was seminal work on recognizing freedoms for animals. These freedoms define ideal states, forming a comprehensive framework for welfare of animals. There are now the five freedoms (Brambell’s five freedoms) as a compact of rights for animals, viz. Freedom from hunger or thirst; freedom from discomfort; freedom from pain, injury or disease; freedom to express most normal behaviour; and lastly freedom from fear and distress. These freedoms thus grant animals

with rights such as ready access to fresh water and a diet to for proper health; shelter and a comfortable resting area; prevention or rapid diagnosis and treatment and company of the animal's own kind etc.

The animals have been categorized into Companion Animals (dogs, cats, horses, birds, rabbits, goats, gerbils, snakes, rats, mice, fish etc.); farm animals (horse, sheep, buffalo etc); marine life; and wildlife (golden cat, wild pig, snakes, lions, tigers etc). Depending upon the category, different freedoms and rights are granted to the animals. But the basic rights are common to all of them. Similarly, the rights of animals when used in experimentation have been time and again emphasized. Russell and Burch's 3R's i.e. replacement of animals in research with alternatives; reduction in the number of animals used in experiments; and refinement of the care and treatment of the animals who continue to be used in research, testing and education are the three principles of treating animals in experimentation.

Unfortunately, responsiveness for non- human animals is still to gain acceptance in the world where even humans are not treated humanely. India has achieved a substantive accomplishment for the animal rights movement with protective constitutional inclusion for their rights. A number of protective legislations are in existence in India. These statutory provisions mandate to treat animals, birds and other non-human beings humanely.

At international and national levels, number of celebrations takes place to mark the duties to protect the non-human beings. World Day for Laboratory Animals is celebrated on 24 April; World Wildlife Day on 3 March; World Whale Day on 14 Feb 2015 and **World Migratory Bird Day (WMBD)** on second weekend of May every year. The largest movement in the direction of animal protections is marked by World Animal Day, celebrated on 4 October **raising the status of animals in order to improve welfare standards.** It started in 1931 at a convention of ecologists in Florence to highlight the plight of endangered species.

2. Legal Framework for Rights of Animals in India

It is true that Animals feel the same way humans do; the only difference is that humans have the ability to express their thoughts and sentiments through words, but animals cannot and suffer unimaginable cruelty. Humans are the primary consumers of the food

chain, but animals are as important, and we must protect and give them a voice; this is where the concept of animal rights comes into play.

2.1 Constitutional Framework:

The Indian Constitution is the supreme law of India, outlining the fundamental political code, citizens' rights and duties, guiding principles of state policy, procedures, structures, and powers of governmental organisations. It is commonly regarded as a "living document"--dynamic and always evolving in response to changing times. The document provides constitutional supremacy, which means that the Indian Parliament cannot override the Constitution's essential structure. There are various articles in Indian constitution which does not only talk about human rights but also takes into account the right of animals.

Human beings have the right to exist in dignity under Article 21 of our constitution, but do animals have the same right, and if so, are their rights protected and treated as legal entities? Article 21 of the constitution of India provides that:

“No person shall be deprived of his life or personal liberty except according to procedure established by law”. The Supreme Court of India has undertaken an expansive reading of the right to life, including under it the right to food and shelter, right to education, etc.

It was held in the case of the Animal Welfare Board of India vs. Nagaraja and ors. that animals have honor and dignity that they cannot be arbitrarily deprived of, and their rights and privacy must be respected and protected from unlawful attacks. In this case, the purview of the right to dignity was expanded and was no longer confined to human beings. In relation to Article 21, the Supreme Court specifically stated:

Every species has a right to life and security, according to the law of the nation, which includes depriving it of its existence for human convenience. While protecting human rights, Article 21 of the Constitution also protects life. The term "life" has been expanded, and any disturbance from the basic environment, which includes all forms of life, including animal life, that are necessary for human life, falls within the meaning of Article 21 of the Constitution. In the case of animals, "life" denotes something more than mere survival or existence or utilitarian utility for humans, but to live a life. Also, Article 48A establishes the directive principle for environmental conservation and enhancement, as well as the preservation of forests and wildlife. It states that the state would work to maintain and improve the environment, as well as to protect the country's forests and

wildlife. This Article, adopted by the 42nd Amendment in 1976, requires the state to conserve the environment and wildlife. While not judicially enforceable, Article 48A may become enforceable under the scope of Article 21's right to life. The Supreme Court heard a public interest litigation about air pollution in Delhi in M.C. Mehta v. Union of India (2002). In relation to Article 48A and public health, the Court made the following observations: Articles 39, 47, and 48A, individually and combined, impose an obligation on the State to safeguard people's health, improve public health, and protect and develop the environment. The Supreme Court held in another case Sachidanand Pandey & Ors. v. The State of West Bengal & Ors. (1987) that if a question concerning the conservation of the ecosystem is brought before the Court, Article 48A must be considered.

Article 51A (Part IV-A) of the Indian Constitution enshrines the citizens' Fundamental Duties. The article was included as part of the 42nd Amendment to the Indian Constitution in 1976 to align it with Article 29(1) of the Universal Declaration of Human Rights. While Fundamental Duties are not enforceable in courts, they are frequently used in constitutional and other interpretations. The relevant clauses of Article 51A in the context of animal rights are as follows: Every Indian citizen must do the following:

(g) to safeguard and improve the natural environment, including forests, lakes, rivers, and wildlife, as well as to have compassion for all living things;

(h) to foster a scientific temperament, humanism, and a spirit of inquiry and reform

Article 51A (g) imposes an obligation on Indian citizens to maintain and improve the natural environment, as well as to have compassion for all living species. Compassion for all living animals, as defined in Animal Welfare Board of India v. A. Nagaraja & Ors. (2014), comprises care for their pain and well-being. The Supreme Court recognized 51A (g), combined with the duty to nurture scientific temperament under 51A (h), as the magna carta of Indian animal rights jurisprudence.

2.2 Relevant Legislations

Various socio-cultural, religious, and legal issues have influenced animal rights laws in India. Initially, India's legislative foundation for animal rights was weak, with little emphasis on animal care. However, there has been a purposeful shift towards recognizing and safeguarding animal rights over time.

The Prevention of Cruelty to Animals Act (PCA) of 1960: The Prevention of Cruelty to Animals Act (PCA) of 1960 is the primary piece of legislation addressing animal rights

in India. This Act banned cruelty to animals and sought to prevent unnecessary pain or suffering. Various Rules have been enacted under Section 38 such as - Performing Animals Rules, 1973 & Performing Animals Registration Rules, 2001; Breeding of ; Prevention of Cruelty to Animals (Slaughter House) Rules, 2001 ; Prevention of Cruelty (Capture of Animals) Rules,1979 ; Prevention of Cruelty to Animals (Establishment and Regulation of Societies for Prevention of Cruelty to Animals) Rules, 2001 etc.

Wildlife Protection Act of 1972: Another important piece of legislation that has had a significant impact on wildlife protection and welfare in India is the Wildlife Protection Act of 1972. The purpose of this Act was to safeguard endangered animals and their habitats from poaching, hunting, and illegal trading. It establishes protected areas and national parks across the country and offers legislative protections for wildlife conservation.

Biological Diversity Act,2002: The Biological Diversity Act is a path-breaking and progressive legislation which has the potential to positively impact biodiversity conservation in the country. It provides for conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources and knowledge.

Indian Penal Code,1860: Section 289 -Whoever knowingly or negligently omits to take such order with any animal in his possession as is sufficient to guard against any probable danger to human life, or any probable danger of grievous hurt from such animal, shall be punished with imprisonment of either description for a term which may extend to six months, or with fine which may extend to one thousand rupees, or with both.

Section 428- Whoever commits mischief by killing, poisoning, maiming or rendering useless any animal or animals of the value of ten rupees or upwards, shall be punished with imprisonment of either description for a term which may extend to two years, or with fine, or with both. Section 428- Whoever commits mischief by killing, poisoning, maiming or rendering useless, any elephant, camel, horse, mule, buffalo, bull, cow or ox, whatever may be the value thereof, or any other animal of the value of fifty rupees or upwards, shall be punished with imprisonment of either description for a term which may extend to five years, or with fine, or with both.

Section 377 - Whoever voluntarily has carnal intercourse against the order of nature with any man, woman or animal, shall be punished with imprisonment for life, or with impris-

onment of either description for a term which may extend to ten years, and shall also be liable to fine.

Table I – Major Legislations in India for Protecting the Rights of Animals

S.No.	Statute	Objective
1.	Elephants Preservation Act, 1879	To regulate the killing and capture of wildanimals by issue of license
2.	Indian Fisheries Act,1897	To make provisions to prohibit destructionof fish
3.	Indian Forest Act,1927	To consolidate the law relating to forests, the transit of forest produce and the duty leviable on timber and other forest-produce
4.	Prevention of Cruelty to Animals Act,1960 and Allied Rules	To prevent the infliction of unnecessary pain or suffering on animals and for that purpose to amend the law relating to the prevention of cruelty to animals
5.	Wildlife Protection Act,1972 and Allied Rules	To provide for the protection of Wild animals, birds and plants and for matters connected therewith or ancillary or incidental thereto.
6.	Forest (Conservation) Act, 1980 and Allied Rules	To provide for the conservation of forests and for matters connected therewith or ancillary or incidental thereto
7.	Indian Veterinary Council Act, 1984and Allied Rules& Regulations	To regulate veterinary practice in Indiaby establishment of Veterinary Council of India , State Veterinary Councils and Joint State Veterinary Councils
8.	Biological Diversity Act, 2002and Biological Diversity Rules, 2004	To provide for conservation of biological diversity, sustainable use of its componentsand fair and equitable sharing of thebenefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidental thereto.
9.	Prevention and Control ofInfectious and Contagious Diseases in Animals Act, 2009	To prevent, control and eradicate infectiousand contagious diseases affecting animals, prevention of outbreaks or the spreading ofsuch diseases from one state to the other; and to meet international obligations forfacilitating the import and export of animalsand animal products

3. *Infectious and Contagious Diseases in* Animals

Animals can be afflicted with a broad variety of disorders that fall under the category of infectious and contagious diseases. These illnesses are frequently transmitted from one animal to another by direct or indirect contact and can be brought on by bacteria, viruses, fungi, parasites, or other pathogens. Among the most well-known infectious illnesses affecting animals are -

(i) Rabies: A virus that attacks the central nervous system and is usually spread by the bite of an infected animal, most frequently a fox, bat, raccoon, or skunk.

(ii) Foot-and-mouth disease (FMD): A highly contagious virus that affects animals with cloven hooves, including sheep, goats, pigs, and cattle, causes the disease. The symptoms of FMD include fever and blisters on the lips, mouth, and feet.

(iii) Avian Influenza: A virus that predominantly affects birds but can also infect people and other animals is known as avian influenza, or bird flu. Contact with sick birds or their droppings is how it spreads.

(iv) Canine distemper: A viral illness known as canine distemper affects dogs, ferrets, and other animals. It can cause fever, respiratory problems, neurological indications, gastrointestinal disorders, and other symptoms. It spreads by respiratory secretions.

(v) Equine influenza: Horse influenza is a highly contagious respiratory illness brought on by influenza viruses. In tight quarters with horses, whether in racetrack stables or equestrian events, it spreads quickly.

(vi) Canine parvovirus: Dogs, especially puppies, are susceptible to the extremely contagious canine parvovirus. It can cause severe gastrointestinal symptoms and, in extreme circumstances, death. It spreads by contact with contaminated faeces.

4. Essential Elements of The Policy Framework

To combat these infectious and dangerous diseases in animals, India has put in place a number of frameworks and policies. Several essential elements of the policy framework consists of:

(i) Animal Disease Surveillance and Monitoring: To identify and manage animal disease outbreaks, the government, via organisations such as the Department of Animal Husbandry and Dairying (DAHD), carries out surveillance and monitoring programmes.

(ii) Programmes for Vaccination: Vaccination is essential for managing and stopping the spread of infectious illnesses in animals. To protect livestock populations, the government runs immunisation campaigns against diseases like avian influenza, FMD, CSF, and rabies.

(iii) Movement limits and Quarantine: In order to prevent the spread of contagious diseases across national borders, both movement limits and quarantine measures are put into place. These steps aid in halting the entry and spread of illnesses such as avian influenza and FMD.

(iv) Education and Public Awareness: To educate farmers and livestock owners about the value of disease prevention, biosecurity precautions, and appropriate animal health

management techniques, educational campaigns and programmatic initiatives are carried out.

(v) Education and Public Awareness: Programmatic efforts and educational campaigns are conducted to inform farmers and livestock owners about the importance of disease prevention, biosecurity measures, and suitable animal health management approaches.

In order to regulate and stop the spread of infectious and contagious diseases in animals, the Indian government has put in place a number of frameworks and rules. The Department of Animal Husbandry and Dairying, which is part of the Ministry of Fisheries, Animal Husbandry, and Dairying, is the main regulatory authority in India in charge of maintaining animal health and controlling disease.

A foundation for public health and animal welfare is also provided by the Indian Constitution. As per the 2009 Prevention and Control of Infectious and Contagious Diseases in Animals Act, the government is authorised to implement appropriate measures for the avoidance, management, and complete elimination of infectious and contagious diseases in animals. In addition, many state governments pass laws and regulations of their own to deal with certain disease outbreaks and protect the wellbeing of animals. In addition, the Indian government works with foreign agencies like the World Organisation for Animal Health (OIE) and the Food and Agriculture Organisation (FAO) to establish surveillance systems, capacity-building projects, and disease control programmes that help manage infectious and contagious diseases in animals.

5. **India as an Agriculture and Meat Based Economy**

India is one of the major players in the agriculture sector worldwide and it is the primary source of livelihood for ~55% of India's population. India has the world's largest cattle herd (buffaloes), the largest area planted for wheat, rice, and cotton, and is the largest producer of milk, pulses, and spices in the world. It is the second-largest producer of fruit, vegetables, tea, farmed fish, cotton, sugarcane, wheat, rice, cotton, and sugar. The agriculture sector in India holds the record for second-largest agricultural land in the world generating employment for about half of the country's population. Thus, farmers become an integral part of the sector to provide us with a means of sustenance. Department of Animal Husbandry & Dairying, Ministry of Fisheries, Animal Husbandry and Dairying has conducted the latest i.e., 20th Livestock Census in 2019 in participation with all States and Union Territories. It covers all domesticated animals and its

headcounts for total 16 species of animals like Cattle, Buffalo, Mithun, Yak, Sheep, Goat, Pig, Horse, Pony, Mule, Donkey Camel, Dog, Rabbit and Elephant and poultry birds (Fowl, Duck, Turkeys and other poultry birds) possessed by the households, household enterprises/non- household enterprises and institutions at their site. Moreover, the 20th livestock census is indeed a unique attempt as for the first-time data collected in using tablets computers to digitize household level data through online transmission from the field. The total Livestock population is 536.76 million in the country showing an increase of 4.8% over Livestock Census-2012. The total Livestock population in rural and urban area is 514.11 million and 22.65 million respectively with percentage share of 95.78% for rural and 4.22% for urban area. Total Bovine population (Cattle, Buffalo, Mithun and Yak) is 303.76 million in 2019 which shows an increase of 1.3% over the previous census. Considering the number and past trends over last two decades, there is no livestock species which are on the verge of extinction. However, only Camel and Donkey population is showing declining trends over last four Livestock Censuses i.e., 17th (2003), 18th (2007), 19th (2012) and 20th (2019) Livestock Census.

Simultaneously, the meat industry in India is governed by laws that take the environment, culture, and religion into account. States have different laws governing the production and consumption of meat; for example, some prohibit the killing and selling of specific animals because of religious beliefs. Through programmes like the National Meat and Poultry Processing Board and projects to modernise slaughterhouses and meat processing facilities, the government encourages the modernization and sanitary processing of meat. Additionally, initiatives are being made to support meat processing facilities focused on exports, guarantee adherence to international standards, and strengthen India's position in the world meat market.

In India, constitutional organisations tend to concentrate on matters of general governance as opposed to industry-specific matters like meat production. However, areas of agriculture, food processing, and livestock management are overseen by organisations such as the Ministry of Agriculture and Farmers' Welfare, the Ministry of Food Processing Industries, and the Ministry of Animal Husbandry, Dairying, and Fisheries. These organisations have an indirect impact on the production and consumption of meat. The Ministry of Agriculture and Farmers' Welfare, the Ministry of Food Processing Industries, and the Ministry of Animal Husbandry, Dairying, and Fisheries are just a few

of the organisations that the Indian government uses to gather data on the production and consumption of meat. The National Statistics Office (NSO) and the National Sample Survey Office (NSSO) both gather information on food consumption patterns, including the intake of meat, through surveys and data collection. However, because of many factors like the large informal sector, regional variations in dietary preferences, and inadequate infrastructure for data collecting, it can be difficult to gather accurate and current statistical data on meat production and consumption in India.

India's meat industry is divided into several sectors, such as seafood, beef, mutton, and poultry. Other meat-producing industries, such as cattle and mutton, have difficulties because of cultural, religious, and legal considerations, while the poultry industry is better organised and makes a substantial contribution to meat production.

All things considered, even if the country's economy is still diverse and meat production and consumption are only one facet of the larger agricultural and food processing industry, meat consumption is rising in India.

6. **Control and Prevention of Diseases in Animals**

Department of Animal Husbandry & Dairying, Govt. of India has launched National Animal Diseases Control programme for FMD and Brucellosis to control and eradicate these diseases in next 5 years and approved a budget of Rs.13,400 crores for the programme which will have far reaching implications in terms of boosting productivity and profitability from livestock rearing as well as opening up global markets for livestock products. The programme will give fillip to meat exports from India as we would be in a position to get access in markets like USA and EU which are big markets for bovine meat. Identification and traceability are also important from the view point of quality and sanitary reasons. The Department of Animal Husbandry & Dairying has taken up this issue at a massive scale through various schemes. Under NLDCP, all vaccinated animals will be ear tagged and record maintained for identifications and traceability of animals.

India is free of major trade related diseases like Rinderpest, Contagious Bovine Pleuro pneumonia (CBPP), Rift valley fever, etc. OIE has listed India in the countries where there is negligible risk of Bovine Spongiform Encephalopathy (BSE). India is successfully implementing Foot & Mouth Disease (FMD) Control Programme which has been recognized by OIE in its General Session in May, 2015. The major activities supported are vaccination against foot and mouth disease (FMD), brucellosis, peste des

petits ruminants (PPR) and classical swine fever (CSF); establishment and strengthening of veterinary hospitals and dispensaries - mobile veterinary units (ESVHD-MVU); and assistance to States for control of animal disease (ASCAD) for control of state prioritized exotic, emergent and zoonotic animal diseases including LSD. Additionally, there are National Action Plans on diseases like avian influenza, African swine fever (ASF) and Glanders along with guidelines for control and containment of diseases within a definite time frame. While animal husbandry is a state subject, the Department of Animal Husbandry & Dairying, Government of India implements the Livestock Health and Disease Control Programme (LHDCP) in all states with the aim of reducing risk to animal health by prophylactic vaccination against diseases of animals.

7. Sum-Up

India is rich in its livestock wealth, which plays an important role in the socio-economic aspects of India. Exports of animal products contribute significantly in the overall agri products exports. Export of Animal Products include Buffalo meat, Sheep/ Goat meat, Poultry products, Animal Casings, Milk and Milk products, Honey, etc. Livestock is essential to India's agricultural and rural economy since it helps with food production, job creation, reducing poverty, and ensuring a healthy diet. In addition to addressing environmental and animal welfare issues, government policies and actions are designed to support sustainable livestock development, increase production, and improve the well-being of livestock farmers. Animal law in India presents some unique legal challenges involving multiple, and sometimes conflicting, statutory schemes. The animal welfare law in India is not comprehensive enough. The present times call for emphasizing the rights of all including human beings and animals-birds. Prevention and management of diseases in animals-birds is crucial not only to sustain agriculture, meat economy and health of humans. One Health Approach is the suggested principle. To progress towards readying the system to handle any potential pandemic, it is essential to coordinate several actions. These include enhancing disease surveillance, developing disease forecasting models, bolstering research and development capabilities, improving diagnostic capacities, refining regulatory processes, enhancing on-ground responses, and mobilizing resources effectively.

References

1. Richard Ryder, "All Beings Fthat Feel Pain Deserve Human Rights", *The Guardian*, August 6, 2005, available at https://www.theguardian.com/uk/2005/aug/06/animalwelfare.
2. Paul G. Irwin, "A Strategic Review of International Animal", available at http://www.humanesociety.org/assets/pdfs/hsp/soa_ii_chap01.pdf.
3. **World Heritage Convention,1972;** Article 4.
4. World Charter for Nature, 1982; Principle I (4).
5. Rajeev Dhavan, "Do animals have rights?", *The Hindu* , July 14,2000
6. The Constitution of India, 1950.
7. Indian Forest Act , 1927 (No. 16 of 1927).
8. Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (No. 2 of 2007).
9. Drugs and Cosmetics Rules,1945.
10. *Drugs and Cosmetics Act*, 1940 (No. 23 of 1940).
11. Elephants Preservation Act,1879 (No. 6 of 1879).
12. Indian Fisheries Act,1897 (No. 4 of 1897).
13. Prevention of Cruelty to Animals Act,1960 (No.59 of 1960) and Allied Rules.
14. Wildlife Protection Act,1972 (No. 53 of 1972) and Allied Rules.
15. Forest (Conservation) Act,1980 (No. 69 of 1980).
16. Indian VeterinaryCouncil Act, 1984 (No. *52 of 1984).*
17. Biological Diversity Act, 2002 (No. 18 of 2003).
18. Biological Diversity Rules, 2004.
19. Prevention and Control of Infectious and Contagious Diseases in Animals Act, 2009 (No. 27 of 2009).
20. Live-stock Importation Act, 1898 (No. 9 of 1898).
21. Livestock Health & Disease Control scheme, https://dahd.nic.in/schemes-programmes/lh-dc.
22. National Animal Disease Control Programme .
23. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1909227, 21 Mar., 2023.
24. https://projects.worldbank.org/en/projects-operations/project-detail/P177671.

25. Shagun, Snigdha Das, "Climate change is making livestock susceptible to diseases; here is how", 13 Nov. 2022, https://www.downtoearth.org.in/news/climate-change/climate-change-is-making-livestock-susceptible-to-diseases-here-is-how-85882.

MORPHOLOGICAL STATE OF SOILS IN THE DRY SUBTROPICAL ZONE OF AZERBAIJAN

Firoza RAMAZANOVA (ORCID: 0000-0003-0556-4799)
Ministry of Science and Education Republic of Azerbaijan Institute of Soil Science and Agrochemistry, laboratory of soil genesis, geography and mapping; Baku, Azerbaijan
Email: firoza.ramazanova@rambler.ru

Aytan MAMMADOVA (ORCID: 0000-0002-6838-6822)
Ministry of Science and Education Republic of Azerbaijan Institute of Soil Science and Agrochemistry, laboratory of soil GIS; Baku, Azerbaijan
Email: aytan.amea@gmail.com

ABSTRACT
In the given article the research results on change of the morphological – genetic structure of the profile on virgin and irrigated gray-brown (Gypsisols and Irragri Gypsisols, in WRB 2012, Absheron) and meadow-serozem (Gleyic Calcisols and Irragri Gleyic Calcisols, in WRB 2012, Kura-Araksin lowland) soils according to the scheme: virgin land; Secále cereále → Zéa máys; Medicágo; Zéa máys; Secále cereále + Vicia sativa + Brássica nápus → Zéa máys + Glycine max + Sorghum + Amaránthus → Hórdeum + Vicia sativa. The laying of soil sections, their description, the selection of soil samples and the establishment of the preliminary classification name of the soil in the field were carried out according to the Guidelines for Soil Description (FAO) and according to the methods. In soil samples, the following were determined: granulometric composition humus, mobile compounds of phosphorus and potassium, pH, carbonates. Based on morphological and physicochemical properties, the name of gray-brown and meadow-serozem soils was given according to the International Soil Classification based on the Abstract Base. It has been established that significant morphological changes are common to the thickness of the humus horizon, the depth of carbonates and agrochemical parameters of the studied soils. Their maximum values in the arable layer are established in Irrigated Gypsisols and Gleyic Calsisols soils under the collection of 3 green mass crops per year from 1 ha: the thickness of the humus horizon increased to 0.25 and 0.27 cm, respectively, humus - up to 2.73 and 3.00%, the amount of absorbed bases - up to 25.71 and 30,80 mg-eq/100 g of soil, mobile phosphorus - up to 30.9 and 34,00 and exchange potassium - up to 317.3 and 423,1 mg / 100 g of soil. In accordance with the WRB system 2014, Irrigated Gypsisols can be classified - Irragric Cambisols (Protocalcic, Clayic), and Gleyic Calsisols - Irragric Gleyic Calcisols (Calcic, Loamic).
Keywords: soil, horizon thickness, humus, absorbed bases, agrochemical properties

Introduction

Some researchers believe that a natural zonal soil formation process occurs in arable soils, which does not differ from the process under natural vegetation, while others point at profound fundamental changes in the natural soil formation process (Makarov, 1995; Ganieva at al. 2019; Pavlyuk, 2011). The transformation of natural biocenoses into agrocenoses is always accompanied by a change in morphological and physical parameters, as well as the qualitative and quantitative composition of organic residues. A quantitative account of such changes makes it possible to determine the speed and direction of soil formation processes (Field guide to soils of Russia, 2008). Accounting for the content and reserves of nutrients, their distribution in the soil profile makes it possible to establish the amount of available nutrients for crops (Babaev at al. 2020), their biogenic accumulation the direction of migration and participation in the biological circulation of elements (Jenkins at al. 2009), which is very important for increasing agricultural production in the dry subtropical zone of Azerbaijan (Ramazanova, 2023). The aim of the study is to assess changes in the morphological and agrochemical parameters of soils in the dry subtropical zone of Azerbaijan under the influence of their long-term agricultural use.

Materials and Methods

The studies were carried out in 1998-2022. on virgin and irrigated gray-brown (Gypsisols, in and Irragri Gypsisols, in WRB 2012, Absheron) and virgin and irrigated meadow-serozem (Gleyic Calcisols and Irragri Gleyic Calcisols, in WRB 2012, Kura-Araksin lowland) soils according to the scheme:

Original soil; 1.virgin land (Carex pachystylis, Poa bulbosa, Caragana frutex, Alhagi, Artemísia, Sálsola); 2. Secále cereále→Zéa máys; 3.Medicágo; 4.Zéa máys (spring sowing); 5.Secále cereále+Vicia sativa+Brássica nápus→Zéa máys+Glycine max+Sorghum+ Amaránthus→Hórdeum+Vicia sativa; 6.Hórdeum (for grain, farm sowing). Cultivation agrotechnics - zonal with some changes for each option. Repetition - 4-fold, plots area -72 m^2.

The climate is subtropical with dry hot summers, the amount of active t^0 is 4500 - 4848^{0}C, the arrival of FAR is 120-133 kkal/cm^2, the amount of precipitation is 180 - 330 mm per year; days with air t^0>-10^0-285-330 and soil>5^0-315-360. The laying of soil sections, their description, the selection of soil samples and the establishment of the

preliminary classification name of the soil in the field were carried out according to the Guidelines for Soil Description (FAO, 2012) and according to the methods (Soil description manual &FAO, 2012; WRB, 2014; Agrochemical methods of soil research,1975). In soil samples, the following were determined: humus, mobile compounds of phosphorus and potassium, pH, carbonates (Ulanov, 2017). Based on morphological and physicochemical properties, the name of gray-brown and meadow-serozem soils was given according to the International Soil Classification based on the Abstract Base (WRB, 2014). Virgin and irrigated gray-brown soils (Gypsisols and Irragri Gypsisols, in WRB 2012) are located at an altitude of 50-165m above sea level, geographic coordinates - 40°28'871" N and 49°39'969" E and meadow-sierozem soils (Gleyic Calcisols and Irragri Gleyic Calcisols, in WRB 2012) - located at an altitude of 48.80 m above sea level, geographical coordinates - 40° 29′37.689" N and 47 ° 43′34.456" E.

Findings and Discussion

The morphological features of the soil profile are a stable external characteristic of soils, and even a short-term anthropogenic influence on the soil leads to changes in morphological features (Babaev et al, 2020). That is, a plow horizon is formed, with characteristic features that differ from the original genetic horizons of natural soils and is a cultivated horizon with the preservation of the zonal appearance (Classification and diagnostics of soils in the USSR, 1977; Munsell Soil Color Charts, 2009) it affects the direction and intensity of soil formation.

Gypsisols and Irragri Gypsisols. Studies have established that significant changes in the morphological profile of the soil are manifested mainly in the form of an increase in the humus horizon, the depth, as well as the thickness of the carbonate layer. These changes increase on the sowing of row crops, permanent cultivation of barley and on virgin soil, where the depth of occurrence of carbonates is higher, which is associated with higher evaporation from the surface associated with the thinning of the vegetation cover. Permanent sowing of Hórdeum (variant 6) reduces the thickness of the humus horizon of the soil due to the low input of fresh organic matter into the soil. In all studied variants of the experiment in accordance with the "Classification and diagnostics of soils of the USSR" and FAO 2014 - Gypsisols and Irragri Gypsisols - thin, low-humus, which shows the homogeneity of the soil cover of the experimental area. For the sample, we

present a morphological description of the soil profile of section No. A-13 (according to WRB-2014), laid down in the 5th option. The territory is located in the Experimental Economy Research Institute of Fodder, Meadows and Pastures of the Ministry of Agriculture of Azerbaijan, 500m from the Baku - Shemakha highway, at an altitude of 87 m above sea level, geographical coordinates -40^{0}28'26.37"N, 49^{0}39'38,81" E, SU, 27°C; WC - 2, LP -<100. Soil - Irragri Gypsisols. The parent rocks are highly gypsum-bearing clayey deposits of deluvial origin and weathering products of tertiary clays. AA4M, IB, IF, vegetation: Secále cereále+Vicia sativa +Brássica nápus→Zéa máys+Glycine max+Sorghum+Amaránthus→Hórdeum+Vicia sativa, ST, Hp - 0-25 cm.

A1 0-25 25cm 10YR4/2, N, CL, GR, PD3, M (2-5mm) and C (>5mm), (M -< 2mm-200,>2mm->20), F-0.5-2 mm, E,M, M-15-40%, ca, *pF-3, SC, MO 2-10% and N, ST, SC;

A2 25-53 28cm 10 YR5/2, CL , PD3, SB, FRF, AS, E, M -15-40%, C, F, MO 2-10% and N, PM, ca,P, I;

B 53-77 24 cm 10 YR 4/6, CL, FM, FRF, M –2-5 mm, VF- < 0.5C, F-0.5-2 mm and F-< 2mm -20-50% and > 2mm -2-5%, ST 10-25, ca, PM, HA, *pF 3-2, D;

B/C 89-117 28 cm 10YR5/4, CL, PD3, CR, F-0.5-2 mm, VF -< 0.5mm, F-0.5-2mm, C, ST 10-25%, PM, SL 0-5%,C;

C 117-129 12cm 7.5YR 4/6, CL 25-40% silt, PD4, F-0.5-2mm, MO 2-10%, VF, SC, SL, ST, N, S, pF*-3,V-< 2%, C;

C 129-152 23 cm 2.5 YR 8/3, CL, LU, PD4, SC , MO 2-10% and N, CS, F.

The results of the morphological description of section №A-12 show that the thickness of the arable horizon (0-25 cm) is 25 cm. The profile of this section up to the Cca horizon (117-129 cm) is described by the main tone 10YR, and in the Cca horizon (117-129 cm) - in a tone of 7.5 YR, deeper - in a tone of 2.5YR (Babaev, 2019). In the morphological description of the soil profiles of other variants of the experiment, the following horizons were established: A$'$ from 22 to 24 cm thick; A$''$- from 35-49 to 51 cm; B - from 57-65 to 75 cm; B/C - from 100 cm to 113 cm and C - from 121-129 to 148 cm, which corresponded to the statistical parameters of the morphological properties of the gray-brown soils of the Absheron Peninsula (Table 1). The middle of the soil profile consisted of transitional horizons (from humus to parent rock-B, B/C and C. Their total thickness in virgin soil was 64 cm, Secále cereále→ Zéa mays-49 cm, Hórdeum (farm sowing) - 64 cm. The Significant level of the occurrence of carbonates is noted under Hórdeum (65-119 cm), slightly under the Zéa máys of spring sowing (110-120 cm) and is lowered to a

depth of 129-152 cm in variant 5. In variants 3 and 5, the root system of Medicágo and grass mixtures (variant 5) intensively used moisture from the layer of 0-51-53 cm and thereby slowed down the rising migration of carbonates. For 20 years, the capacity of A' under Hórdeum (farm sowing) was 22 cm, under Medicágo - 24 cm, and the highest - under variant 5 (25 cm). This is completely logical - the different depth soil cultivation, depending on the type of intermediate mixed sowing of crops, in order to obtain 3 harvests of green mass per hectare per year, different depths of penetration by the root system of crops and the year-round supply of fresh organic matter of grass mixtures contributed to the approach of soil formation processes to virgin analogues. It has been established that the reaction of the medium in all variants of the upper horizons is weakly alkaline (pH_{water}-8.0-8.1), and in the lower ones-upon transition to the carbonate horizons-alkaline (pH_{water}-9.0-9.1), which corresponds to irrigated gray-brown soils of Azerbaijan (Babaev, 2019). Over a twenty-year period of permanent cultivation of Hórdeum, the humus content in the A' layer was –1.60%, in the A"–1.19%, which is due to an increase in the mineralization of organic matter and a lack of plant material.

In the variant of obtaining 3 harvests of green mass per year per hectare, the humus content in A' is higher than –2.73%, which is associated with the year-round intake of fresh plant residues of grass mixtures into the soil. The largest amount of absorbed bases with a predominance of calcium cation, mobile phosphorus and exchangeable potassium was noted in the soil also under variant 5. It was noted that the amount of absorbed bases increased with an increase in humus in the soil, which indicates the important role of humus in the formation of an absorption complex in the upper soil horizons. Based on the data obtained according to the international classification of soils of the world (WRB 2014), irrigated gray-brown soils can be classified as İrragric Hypergypsic Calicisols (Humic, Arenic).

Table 1: Agrochemical indicators for the genetic horizons of the morphological profile of Gypsisols and Irragri Gypsisols

Variant	Horizon, см	Power, cm	pH of water	Hhumus, %	mg-eq/ 100 g of soil		mg / kg soil	
					Ca	Mg	P_2O_5	K_2O
Notes: Original soil, № A-13	A1	0-22	7,9	2,19	14,34	9,50	20.0	242.8
	A2	22-50	8,9	1,28	10,78	9,36	16.0	203.0
	B	50-75	9,2	0,98	8,40	10,22	14.0	157.3
	B/C	75-100	8,0	0,50	6,95	7,90	5.3	110.5
	C	100-122	8,8	0,10	6,85	3,95	-	37,9
1.Virgin, № R-1	A1	0-13	8,1	1,96	15,0	7,36	11.7	226.6
	A2	13-35	8,6	1,34	12,75	11,40	7.00	211.0
	A/B	35-57	8,8	0,67	11,25	5,86	5.7	161.3
	B	57-100	8,4	0,38	6,88	8,11	2.00	152.3
	C	100-121	7,8	-	7,81	4,34	0,42	22,6
2.Secále cereále → Zéa mays, № A-1	A1	0-23	8,2	2, 13	16,24	7,55	18.0	227.0
	A2	23-50	8,6	1,27	12,39	6,45	14.0	195.7
	B	50-75	8,9	0,61	9,44	5,28	11.7	144.3
	B/C	75-100	9,1	0,27	7,96	3,67	5.3	100.7
	C	100- 124	9,1	0,05	7,61	6,70	2,8	46,1
3.Medicágo, № A-10;	A1	0-24	8,0	2,51	20,60	10,99	27.8	269.5
	A2	24-51	8,6	1,60	19,76	10,55	20.0	231.2
	B	51-75	8,9	1,20	16,15	8,45	18.7	182.3
	B/C	75-113	8,5	0,52	11,61	4,67	10.6	131.5
	C	113-148	8,0	0,17	9,37	7,42	6,9	76,9
4.Zéa mays, № A-8;	A1	0-22	8,3	1,88	14,97	5,01	15,6	215.4
	A2	22-49	8,8	1,10	11,75	4,66	12.9	178.5
	B	49-73	9,2	0,55	12,40	6,12	10.2	130.3
	B/C	73-110	9,0	0,15	11,36	4,51	3.7	74.6
	C	100-120	8,3	-	9,17	7,26	1,9	38,7
5.Secále cereále + Vicia sativa + Brássica nápus → Zéa máys + Glycine max+ Sorghum + Amaránthus→Hórde-	A1	0-25	8,4	2,73	21,25	4,95	30.9	317.3
	A2	25-53	8,8	1,72	20,40	4,45	25.7	241.0
	B	53-77	8,9	1,32	16,80	6,00	22,3	192,3
	B/C	77-117	9,0	0,71	13,80	11,0	17.0	140,0
	C	117 -129	8,0	0,17	10,87	6,08	10,4	92,1
6. Hórdeum, № A-6	A1	0-22	8,1	1,60	13,87	4,64	13.1	158.7
	A2	22-43	8,6	1,19	12,31	4,12	10.4	121.6
	B	43-65	8,8	0,60	11,75	4,66	5.0	77.9
	B/C	65-100	9,0	0,09	9,89	4,59	2.7	50.1
	C	100-119	8,2	0,01	5,26	4,36	1,0	33,1
	C	119-129	7,6	0,01	3,11	4,09	traces	11,7

Gleyic Calcisols and Irragri Gleyic Calcisols (in WRB 2012). Studies have shown that permanent sowing of Hórdeum (variant 6) reduces the thickness of the humus horizon of the soil. In all studied variants of the experiment in accordance with the "Classification and diagnostics of soils of the USSR" and FAO,2014 - Gleyic Calcisols and Irragri Gleyic Calcisols - thin, low-humus, which shows the homogeneity of the soil cover of the experimental area. For the sample, we present a morphological description of the soil profile of section № K-3 (according to WRB 2014) under variant 5. The territory is located in the Experimental Economy of the Institute of Soil Science and

Agrochemistry in Ujar (Kura-Araksin lowland), 600 m from the Baku-Kazakh highway, at an altitude of 16 m above sea level, geographical coordinates - $40^0$30'20.13"N , $47^0$40'26.14"E. SU-29° C, WC 2, LP -<10^0.

Soil - Irragri Gleyic Calcisols. The parent rocks are deluvial-alluvial loams. AA4M, IB, IF, vegetation: Secále cereále + Vicia sativa + Brássica nápus → Zéa máys + Glycine max + Sorghum + Amaránthus → Hórdeum + Vicia sativa, ST, Hp - 0-27 cm.

A1 0-27 27 cm 7,5YR 5/6, CL, SB + GR, FR, M (2-5mm) and C (>5mm), F–0.5-2mm, E, M, M - 15-40%, *pF 3-2, SC, MO 2-10% and N;

A2 27-56 29 cm 7,5YR 5/6**,** CL, SB +CR,F, FR, M (2-5mm) and C (>5 мм), F–0.5-2mm, E, M, M – 15-40%, *pF -2, PM, MO 2-10% and N, C;

A2/B 56-77 21cm 7.5 YR 5/3, CL, SB, PD4 , F, M - 15-40%, M (2- 5 mm) and C (>5mm), F –0.5-2mm, *pF -2, SC, ST 10- 25%,N, C, W;

B/C 77-122 45 cm 2,5 YR 8/7, PD4 , CL, F, CR +SB, F, M (2-5 mm), F-0.5-2mm,*pF -2, SC, MO 2-10% and N, G, İ;

C 122-155 33 cm 10 YR 6/3, C, PD4, F -2-5%, LU, FM -2-6mm, MO 2- 10%, SC, *pF 3-2 .

The morphological description of section № K-3 shows that the thickness of the arable (0-27 cm) horizon is 27 cm. The profile of this section up to the B/C horizon (77-122 cm) is described by the main tone 7.5YR, and in the B/C horizon (77-122 cm) - in 2.5 YR tone, then - in 10YR tone. In the morphological description of the soil profiles of other variants of the experiment, the following horizons were established: A' (arable horizon) with a thickness of 22 to 26 cm; A" (subsoil) - from 44 to 54 cm; B - from 63-75 to 76 cm; B/C - from 103 cm to 119 cm and C-from 129-137 to 152 cm, which corresponded to the statistical parameters of the morphological properties of irrigated meadow-serozem soils of the Kura-Araks lowland. On virgin soil, these parameters along the soil profile corresponded to 14, 37, 61, 102, 131 cm (Table 2). The middle of the soil profile for all variants consisted of transitional horizons (from humus to parent rock - B, B C, and C. A significant level of occurrence of carbonates was noted under Hórdeum (63 - 103 cm), somewhat lower under Zéa máys of spring sowing (74-109 cm) and lowered to a depth of 122-155 cm in variant 5. The root system of Medicágo and grass mixtures intensively used moisture from the layer of 0-54-56 cm and thus slowed down the rising migration of carbonates. For 20 years, the thickness of the arable horizon (A1) under Hórdeum (farm sowing) was 22 cm, under Medicágo-26 cm, and the largest - under var.5 (27cm).This is due to the different depth soil cultivation, depending on the type of intermediate mixed

sowing of crops in order to obtain 3 crops per hectare per year, the depth of penetration of the root system of crops and the year-round supply of fresh organic matter.

The reaction of the medium in all variants of the upper horizons is slightly alkaline (pH_{water} - 7.82-8.0), and in the lower horizons - during the transition to carbonate horizons - alkaline (pH_{water} - 8.66-9.0), which corresponds to irrigated meadow-serozemic the soils of the Kura-Araks lowland (Ramazanova, 2023). During the period of permanent cultivation of Hórdeum, the humus content in the A' layer of the soil was –1.96%, in A"–1.44%.

Table 2: Agrochemical indicators for the genetic horizons of the morphological profile of meadow-serozem soil.

Variant	Horizon,	Power, cm	pH of	Humus, %	mg-eq/ 100 g of soil		mg / kg soil	
					Ca	Mg	P_2O_5	K_2O
Original soil, № K-1	A1	0-23	7,95	2,39	17,73	6,17	16,0	257.1
	A2	23-51	8,79	1,90	12,37	6,08	15.0	140.1
	B	51-75	8,59	1,05	7,59	5,86	11.4	99.1
	B/C	75-109	8,72	0,26	5,27	6,21	5.3	64.7
	C	109-139	7,99	trace	6,02	6,00	1,7	35,9
1.Virgin, № M -24	A1	0-14	7,88	2.40	18,83	5,05	27,3	290,2
	A2	14-37	7,91	1,85	14,05	6,37	12.8	230,4
	A/B	37-61	7,87	1,15	11,30	6,87	9.2	181,5
	B	61-102	7,86	0,42	7,06	8,20	2.0	119,0
	C	102-131	7,69	0,10	4,67	3,69	trace	44,1
2. Secále cereále → Zéa mays, № K-4	A1	0-25	7,82	2.25	19,47	3,34	19,3	291,2
	A2	25-49	8,01	1,83	11,20	4,40	17,6	163,6
	B	49-75	8,10	0,89	7,56	5,80	11,3	109,8
	B/C	75-110	8,91	0,37	5,23	8,05	4,5	52,7
	C	110-141	8,66	0,07	5,00	6,05	2,3	54,7
3. Medicágo, № K-6	A1	0-26	7,88	2.82	20,32	8,50	29,5	397,5
	A2	26-54	8,22	2,07	17,17	6,00	24.3	200,4
	B	54-76	8,13	1,45	15,72	7,00	17,5	137,3
	B/C	76-119	8,79	0,70	10,00	9,20	7,4	90,5
	C	119-152	8,77	0,23	8,11	4,25	6,2	77,9
4. Zéa mays, № K-8	A1	0-23	8,11	2.13	18,37	2,94	17,3	238.0
	A2	23-45	8,48	1,33	11,04	5,29	16,1	134.0
	B	45-74	8,92	0,80	9,85	4,19	5,2	83,4
	B/C	74-109	7,89	0,23	9,32	5,71	3.0	30.8
	C	109-137	8,69	trace	4,76	7,11	1,7	23,1
5. Secále cereále + Vicia sativa + Brássica nápus → Zéa máys + Glycine max+ Sorghum + Amaránthus→Hórde-um+Vicia sativa, № K-3	A1	0-27	7,69	3,00	21,30	9,50	34,00	423,1
	A2	27-56	8,11	2,38	19,21	8,22	24,60	280,1
	B	56-77	8,45	1,54	18,23	7,77	18,3	169,2
	B/C	77-122	8,68	0,74	15,55	9,21	7,8	100,2
	C	122-155	8,73	0,31	9,33	5,87	3,21	47,8
6. Hórdeum, № K-11	A1	0-22	8,00	1.96	17,71	3,36	15,4	209,7
	A2	22-44	8,86	1,44	11,00	5,58	13,1	111,2
	B	44-63	7,91	0,75	8,42	5,62	4,0	76,4
	B/C	63-103	8,26	0,13	7,82	5,75	1.0	24,7
	C	103-129	8,00	0,02	4,87	6,09	trace	14,7
	C	129→	9,00	-	2,01	5,11	-	0,79

In the variant Secále cereále+Vicia sativa+Brássica nápus→Zéa máys+Glycine max+Sorghum+Amaránthus→ Hórdeum+Vicia sativa, the humus content in A' is higher-3.0%, in A" (subsoil)-2.38%, which is due to with a year-round supply of fresh root and stubble residues of grass mixtures to the soil. The largest amount of absorbed bases with a predominance of calcium cation was also noted under variant 5 (in A' it was 30.8 mg-eq/100 g of soil), gradually decreasing along the profile to 15.2 mg-eq/100 g (in the C horizon of the soil). In all variants of the soil profile, the supply of mobile phosphorus and potassium decreased from high in A' to low in the B/C and C horizons. Between the agrochemical indicators of the experimental variants: the humus content, the amount of absorbed bases, the amount of mobile phosphorus and exchangeable potassium, there are close reliable (tf > tst) correlations (0.79±0.16...0.98± 0.06). Based on the data obtained according to the international classification of soils of the world (WRB 2014), irrigated meadow-sierozem soils can be classified as Irragric Gleyic Calcisols (Calcic, Loamic).

Conclusion and Recommendations

A Munsell color book was used to describe the color of the soil samples. The color of the profiles of the irrigated gray-brown soil is described by the tones of the Munsell scales - 10YR - 7.5 YR and 2.5 YR. And the color of the profiles of the irrigated meadow-serozem soil is in tones 7.5YR -2.5 YR and 10 YR.

It has been established that significant morphological changes are common to the thickness of the humus horizon, the depth of carbonates and agrochemical parameters of the studied soils. Their maximum values in the arable layer are established in Irrigated Gypsisols and Gleyic Calsisols soils under the collection of 3 green mass crops per year from 1 ha: the thickness of the humus horizon increased to 0.25 and 0.27 cm, respectively, humus - up to 2.73 and 3.00%, the amount of absorbed bases - up to 25.71 and 30,80 mg-eq/100 g of soil, mobile phosphorus - up to 30.9 and 34,00 and exchange potassium - up to 317.3 and 423,1 mg/100 g of soil. It was revealed that under the influence of long-term various agricultural use, the following genetic horizons are formed in the profile of irrigated gray-brown and meadow-gray soils: A1, A2, B, B/C, C. Considering these changes, in accordance with the WRB 2014 system, irrigated gray- brown soils can be classified as İrragric Hypergypsic Calicisols (Humic, Arenic) and meadow-serozemic soils - Irragrıc Gleyıc Calcısols (Calcıc, Loamıc).

References

Makarov, I.P. (1995). Soil fertility and agriculture sustainability. Moscow, Kolos. 288 p.

Ganieva, S., Dyunyamalieva N., Ramazanova F. (2019). Grazing Effect on Soil Properties in Dry Subtropic Steppesof Azerbaijan. *Journal "Arid Ecosystems"*. Vol. 9 No. 3. p. 174-178. https://doi.org/ 10.1134/S2079096119030028.

Pavlyuk, N.M. (2011). Gaskevich Gray forest soils Opillia (Lviv: LNU named after Ivana Frank, 322 p.

Field guide to soils of Russia. (2008). Moscow, Publisher: *Dokuchaev Soil Institute*, 82 p.

Babaev, M.P., Ramazanova, F.M., Gurbanov, E.A. (2020). The Influence of the Intermediate Sowings of Fodder Crops on Granulometric and Microagagregate Composition Genetically Different Soils in the Arid Subtropical Zone of Azerbaijan. *Journal Agrochemistry*, 3, pp. 19–31. https://doi.org/10.31857/S0002188120030035.

Jenkins, C. N. & Joppa, L. (2009). Expansion of the global terrestrial protected area system. *Biological Conservation*, 142: p. 2166–2174. https://doi.org/10.1016/j.biocon.2009.04.016.

Ramazanova, F.M. (2023). Diagnostics of irrigated soils of the dry subtropical zone of Azerbaijan. *International Conference "Scientific research of the SCO countries: synergy and integration*" Part 3, 2023 年 10 月 14 日。中国北京 . October 14, 2023. *Beijing, PRC. Beijing, China: ©Scientific publishing house Infinity*, 2023. p.161-165. https://doi.org 10.34660/INF.2023.61.52.488 ©Group of authors

Soil description manual. (2012). *Rome, FAO*, 100 p.

Guidelines for soil description. (2012, 2014). *4th edition, Rome, FAO*, 186 p.

World reference base for soil resources 2014 (2015). *International soil classification system for naming soils and creating legends for soil maps Update, FAO*, 192 p.

Agrochemical methods of soil research (1975). *Moscow: Nauka Publishing House*, 656p.

Ulanov, A.K. (2017). The influence of different uses of arable land on the morphological and agrochemical properties of the chestnut soil of Transbaikalia. *Conference: Soils of Russia yesterday, today, tomorrow.* Publishing house: Vyatka State University, pp. 100-107.

Classification and diagnostics of soils in the USSR (1977). *Moscow, Kolos*, 225 p.

Munsell Soil Color Charts (2009). *Michigan, Grand Rapids*.

Babaev M.P., Ramazanova F.M., Nadzhafova S.I., Gurbanov E.A. (2019). Soils of the Republic of Azerbaijan (Irrigated soils of the Kura-Araks lowland and their productive capacity), *Moscow: LAMBERT Academic Publishing*, 287 p.

MOMORDICA CHARANTIA L.'NİN BİYOAKTİF BİLEŞİKLERİ VE SAĞLIĞA FAYDALARI

Zeynep Nur KARAKUŞ (ORCID: 0000-0002-0319-6454)
Uşak University, Eşme Vocational School, Department of Food Processing, Food Technology Program,
Email: zeynep.karakus@usak.edu.tr

Assoc. Prof. Dr. Gülşah ÇALIŞKAN KOÇ (ORCID: 0000-0002-6542-3093)
Uşak University, Eşme Vocational School, Department of Food Processing, Food Technology Program,
Email: gulsah.koc@usak.edu.tr

Assist. Prof. Dr. Yasemin ÇELEBİ (ORCID: 0000-0002-4495-0206)
Uşak University, Eşme Vocational School, Department of Food Processing, Food Technology Program,
Email: yasemin.sezer@usak.edu.tr

ÖZET
Yaygın olarak acı kavun olarak bilinen *Momordica charantia* L., Cucurbitaceae familyasının bir üyesidir. Bu bitki İngilizce'de balsam armudu, acı kabak, Afrika salatalığı, yabani salatalık, acı salatalık, acı kavun, acı elma, karilla meyvesi gibi çeşitli isimlerle bilinmektedir. Antikanser, antiviral, anti-inflamatuar, analjezik, hipolipidemik ve hipokolesterolemik etkiler de dahil olmak üzere çok çeşitli sağlık yararları ile ilişkilidir. Acı kavun, başta gallik asit olmak üzere fenolik bileşikler bakımından zengindir ve ayrıca sağlık yararlarına katkıda bulunan saponinler, peptitler ve alkaloidler gibi çeşitli diğer biyoaktif bileşikleri içermektedir. Acı kavun bitkisinin kökleri, asmaları, sapları, yaprakları, tohumları, olgunlaşmamış ve olgunlaşmış eti dahil olmak üzere her parçasının, özellikle diyabette tıbbi değeri olduğuna inanılmaktadır. Acı kavun, farklı kısımlarında ve olgunluk aşamalarında antioksidan aktivite göstermektedir. Geleneksel Hint ve Batı bitkisel tedavisinde kan glikoz seviyelerini ve lipid metabolizmasını düzenlemek için yaygın olarak kullanılmaktadır. Bununla birlikte, acı kavun preparatları hiperlipidemi ve hiperkolesterolemi için reçete edilmiştir ve antikanser, antiviral ve anti-inflamatuar özelliklere sahip olduğuna inanılmaktadır. Acı kavunun ve biyoaktif bileşenlerinin terapötik etkilerini tam olarak anlamak için daha fazla araştırmaya ihtiyaç duyulmasına rağmen, bitkisel tıpta iyi bilinen bir terapötik ajan olmaya devam etmektedir. Bu araştırmanın temel amacı, acı kavunun biyoaktif bileşiklerinin ve sağlık üzerindeki etkilerinin kapsamlı bir şekilde araştırılmasıdır.
Anahtar Kelimeler: acı kavun, Cucurbitaceae, antioksidan aktivite, diyabet, *Momordica charantia*

BIOACTIVE COMPOUNDS AND HEALTH BENEFITS OF *MOMORDICA CHARANTIA* L.

ABSTRACT

Momordica charantia L., commonly known as bitter melon, is a member of the Cucurbitaceae family. This plant is known by various names in English, such as balsam pear, bitter gourd, African cucumber, wild cucumber, bitter cucumber, bitter melon, bitter apple, carilla fruit, etc. It is associated with a wide range of health benefits, including anticancer, antiviral, anti-inflammatory, analgesic, hypolipidemic, and hypocholesterolemic effects. Bitter melon is rich in phenolic compounds, particularly gallic acid, and also contains various other bioactive compounds like saponins, peptides, and alkaloids, which contribute to its health benefits. Every part of the bitter melon plant, including the roots, vines, stems, leaves, seeds, unripe, and ripe flesh, is believed to have medicinal value, especially in the management of diabetes. Bitter melon exhibits antioxidant activity across its different parts and maturity stages. While it is widely used in traditional Indian and Western herbal therapy for regulating blood glucose levels and lipid metabolism. Nonetheless, bitter melon preparations have been prescribed for hyperlipidemia and hypercholesterolemia, and it is believed to have anticancer, antiviral, and anti-inflammatory properties. Although more research is needed to fully understand the therapeutic effects of bitter melon and its bioactive constituents, it remains a well-known therapeutic agent in herbal medicine, particularly for its potential in managing diabetes and other health conditions.

Keywords: bitter melon, Cucurbitaceae, antioxidant activity, diabetes, *Momordica charantia*

GİRİŞ

Bitkisel ürünler temel besin öğelerini sağlanmalarının yanı sıra çeşitli hastalıkların önlenmesi açısından da büyük öneme sahiptir (Namsa ve ark., 2011). Bitki bazlı ilaçlar eski zamanlardan beri kullanılmaktadır. Meyve ve sebzeler, fitokimyasallar olarak kategorize edilen ve özellikle hastalıkların önlenmesinde etkileri olan birçok bileşik içermektedir. Koroner kalp hastalıkları, diyabet, kanser ve dejeneratif bozukluklar gibi çeşitli hastalıklar genellikle yaşam tarzı değişikliklerine bağlanmaktadır. Bitkiler ve metabolitleri, antikanserojenik, hipokolesterolimik, hipoglisemik ve diğer faydalı özelliklere sahiptirler ve diyete dahil edildikleri takdirde çeşitli hastalıklara karşı koruma sağlamaktadırlar. Aynı zamanda bitkiler antioksidan içerikleri sayesinde vücuttaki oksidatif stresi azaltmaktadır (Martinez-Gonzalez ve Martin-Calvo, 2016). *Momordica charantia*, içeriğindeki biyoaktif bileşikler sayesinde sağlık üzerinde birçok olumlu etkisi bulunan meyvelerden biridir (Aljohi, ve ark., 2016). *Momordica charantia* L. Cucurbitaceae familyasının bir üyesidir (Habicht ve ark., 2011). *M. charantia'* nın en yaygın iki ismi, bitkinin her kısmı acı olduğu için acı kavun ve acı kabaktır (Aminah ve Anna, 2011). Ayrıca dünya çapında balsam armudu (İngilizce), Karella (Hintçe veya Urduca), Nigauri veya Goya (Japonca), Ku gua (Mandarin), Ko guai (Tayvanlı), Kho qua (Vietnamlı), Ampalaya (Filipinli) ve Assorossie (Fransız), Kudret narı (Türkiye) gibi farklı isimlerle de anılmaktadır (Aljohi, ve ark., 2016). Kudret narı, başta Asya ve Afrika olmak üzere gelişmekte olan birçok ülkede popüler şifalı gıdalardandır. Çin, Tayvan, Malezya, Tayland, Vietnam, Endonezya, Hindistan ve Afrika gibi tropikal veya subtropikal iklime sahip çoğu ülkede yetişmektedir (Basch ve ark., 2003). Kudret narının sağlık ve farmakolojik özellikleri son on yılda yaygın olarak araştırılmıştır (Grover ve Yadav, 2004). Literatürde kudret narının sağlık üzerinde antikanser, antiviral, anti-inflamatuar, analjezik, hipolipidemik ve hipokolesterolemik gibi faydalı etkilerle ilişkilendirildiğini ortaya koyan 100'den fazla çalışma bulunmaktadır (Nerurkar ve ark., 2010). Ayrıca, diyabetik hayvanlarda ve tip 2 diyabetik insan deneklerde taze, suyu sıkılmış veya kurutulmuş kudret narının etkinliği üzerine çok sayıda çalışma yapılmıştır (Sathishsekar ve Subramanian, 2005).

Kudret narı insan sağlığı için umut verici bir bitkidir. Bu nedenle, kudret narının tıbbi özellikleriyle ilişkili biyoaktif bileşimi ve etki mekanizmalarının anlaşılması önemlidir.

Bu derleme, kudret narının farmakolojik etkileriyle ilişkili biyoaktif bileşenlerini ve kudret narının sağlık üzerindeki etkisini vurgulamayı amaçlamaktadır.

Kudret Narının Kimyasal Bileşimi

Kudret narı ağırlıkça %91,8 nem, %0,20 yağ, %4,2 karbonhidrat ve %1,4 lif içermektedir. Kudret narı tohumlarında bulunan proteinler, okul öncesi çocuklar için FAO/WHO/UNU tarafından belirlenen amino asit gereksinimlerini karşılamaktadır. Kudret narında bulunan proteinler, sırasıyla %49.3 albümin, %29.3 globulin ve %3.1 glutelin içermektedir. Bu proteinlerin moleküler ağırlığı genellikle 45 ila 55 kDa arasında değişmektedir (Horax ve ark., 2010).

Kudret narı tohumları yaklaşık %35 ila %40 oranında yağ içermektedir. Yağ asidi profili tohumların %3.33 ve %36.71 oranında MUFA (tekli doymamış yağ asidi) ve SFA (doymuş yağ asitleri) içerdiğini göstermektedir. Kudret narında yüksek miktarda (%59.96) çoklu doymamış yağ asitleri (PUFA'lar) bulunmaktadır. PUFA arasında α-eleostearik asit (%54,26) konjuge linolenik asittir ve büyük önem taşımaktadır (Liu ve ark., 2010). Kudret narı tohumları, yüksek miktarda meyve ve yaprakları; potasyum, magnezyum, kalsiyum, sodyum ve fosfor içermektedir. Kudret narı tohumunun krom ve çinko içeriğinin sırasıyla 5,65 ve 45,45 mg/100 g olduğu rapor edilmiştir (Liu ve ark., 2010).

Kudret Narında Bulunan Biyoaktif Bileşikler

Kudret narı başta gallik asit olmak üzere iyi bir fenolik bileşik kaynağıdır (Grover ve Yadav, 2004). Ayrıca başta saponinler, peptitler ve alkaloidler olmak üzere çeşitli diğer biyoaktif bileşikler de içermektedir (Krawinkel ve Keding, 2006). Bu biyoaktif bileşikler potansiyel olarak çeşitli sağlık yararları sağlamaktadır. Kökler, asmalar, saplar, yapraklar, tohumlar, olgunlaşmamış ve olgunlaşmış et dahil olmak üzere kudret narının her parçasının, özellikle antidiyabetik ürünler olarak potansiyel tıbbi değere sahip olduğu iddia edilmektedir. Tablo 1'de kudret narının toplam fenolik, flavonoid ve saponin içeriği verilmiştir.

Tablo 1. Kudret Narı Meyvesinin Toplam Fenolik, Flavonoid ve Saponin İçerikleri

Bileşik	**Ekstrasyon Yöntemi**	**Aralık**	**Referans**
Toplam Fenolik İçeriği	Su	5.1–10.6 mg gallik asit eşdeğerleri (GAE)/ g kurutulmuş kudret narı	Tan ve ark., 2014.
Toplam Flavanoid İçeriği	Su	18.2 mg rutin eşdeğeri (RE)/g kurutulmuş kudret narı	Wu ve ark., 2008
Toplam Saponin İçeriği	Su	46.8–93.2 mg aescin eşdeğeri (AE)/g kurutulmuş kudret narı	Tan ve ark., 2014

Folin-Ciocalteu reaktifi kullanılarak yapılan bir analizde, kudret narında bulunan tüm fenolik bileşiklerin toplam miktarının 42.36 mg GAE/g olduğunu saptanmıştır. Kudret narı ekstraktında epikateşin, klorojenik asit, kateşin, gentisik asit ve gallik asit gibi birçok fenolik bileşenin bulunduğu tespit edilmiştir (Ibrahim, ve ark., 2010; Yadav ve ark., 2010). Kudret narı ekstraktının, 2,2-DPPH (difenil-1-pikrilhidrazil) kullanılarak yapılan serbest radikal temizleme deneyi ile yüksek oranda serbest radikal süpürücü özelliklere sahip olduğu gösterilmiştir (Horax ve ark., 2010).

Kudret narı tohumlarından elde edilen yağın %90,9'unu oluşturan yaklaşık 25 bileşen tespit edilmiştir. Ana bileşenler arasında germacrene, trans-nerolidol, apiole ve cis dihydrocarveol bulunmaktadır (Ahmad ve ark., 2012). Ayrıca yağda bol miktarda bulunan α-eleostearik asit, kan yağını düşürme, tümör hücresi çoğalmasını engelleme, kardiyovasküler hastalıkları engelleme, antikanser ve anti-inflamatuar gibi güçlü özelliklere sahiptir (Liu ve ark., 2010). Kudret narının meyve, tohum ve yaprakları sağlığı geliştiren çeşitli fitokimyasallar içermektedir. Bunlar arasında reçineler, vitaminler, mineraller, alkaloidler, steroidal saponinler, polipeptitler ve aromatik uçucu yağlar bulunmaktadır (Tan ve ark., 2014). Kudret narının tipik bileşenleri, doğada steroidal saponin, alkaloid ve polipeptitler olan charantin, momordicine ve p-insulin'dir. Kudret narının meyve posası, serbest pektik asit içermese de çözünebilir pektine sahiptir. Kudret narı posasından galakturonik asit elde edilmiştir (Güdr, 2016).

Kudret Narının Sağlığa Faydaları

Son yirmi yıl içinde, kudret narı özünün hücre kültürü, hayvan modelleri ve insan çalışmalarında kapsamlı bir şekilde araştırıldığı görülmektedir. Mevcut bilimsel veriler,

kanıta dayalı Batı tıbbında tip 2 diyabet tedavisinde kudret narının kullanımını tam olarak desteklemek için henüz yeterli olmasa da, geleneksel Hint ve Batı bitkisel tedavisinde kan şekerini düşürmeye yönelik bir tedavi olarak yaygın şekilde kullanılmaktadır (Paul ve Raychaudhuri, 2010).

Kudret narının içerdiği biyoaktif bileşenleri ve bunların sağlığa faydaları Tablo 2'de gösterilmektedir.

Tablo 2. *M. charantia'* nın başlıca biyoaktif bileşenleri ve ilgili işlevleri

Başlıca Biyoaktif Bileşenler	**Fonksiyonlar**	**Doku**	**Referans**
Polisakkaridler	Antioksidan, antidiyabetik, bağışıklık güçlendirme, nöroprotektif, antitümör	Bitkinin çeşitli kısımları	Duan ve ark., 2015
Peptidler ve proteinler	Fosfolipaz, süperoksit dismutaz, anti-tümör, bağışıklık baskılama, antimikrobiyal	Tohum	Jabeen ve Khanum, 2017
Lipidler	Antitümör, antioksidan	Tohum, et	Dhar ve ark., 2007
Terpenoidler	Antikanser, antioksidan, antidiyabetik, hipoglisemik, kanser kemoprevensiyonu	Gövde, yaprak, meyve	Akihisa ve ark., 2007
Sapoininler	Antihiperglisemik, hipolipidmik, antiviral	Meyve, kök, tohum	Zhang ve ark., 2011
Fenolikler	Antioksidan, antiinflamasyon, bağışıklık güçlendirici	Meyve, perikarp, tohum	Qader ve ark., 2011
Steroller	Antimikrobiyal	Perikarp, meyve	Panda ve ark., 2015

Antidiyabetik Etki

Kudret narının pankreas beta hücrelerini koruduğu düşünülmektedir. Bir araştırmada, diyabetik sıçanların kudret narı ile tedavi edilip edilmedikleriyle ilgili olarak pankreaslarındaki beta hücrelerinin sayısı incelenmiş ve kudret narı ile tedavi edilen diyabetik sıçanlarda, tedavi edilmeyenlerle karşılaştırıldığında beta hücrelerinin sayısının önemli ölçüde arttığı sonucuna varılmıştır (Ahmed ve ark., 1998). kudret narının hedef dokuların insülin duyarlılığını artırabileceği ve kandan glikoz alımını glikoz taşıyıcıları yoluyla artırabileceği öne sürülmektedir. Meyvenin etanol özütünün karaciğer tarafından glikoz alımını artırdığı ve insülin salgısını teşvik etmek yerine glikojen olarak depolanmasını artırdığı belirtilmektedir (Sarkar ve ark., 1996). Başka bir çalışma, kudret

narının su özütünün hipoglisemik etkilerinin, tip 2 diyabetik farelerin kaslarının plazma zarındaki kolaylaştırıcı glikoz taşıyıcı izoform 4'ün (GLUT4) aktivitesinde artış ile sağladığını bildirmiştir (Miura ve ark., 2001). Benzer şekilde, kudret narının protein özütünün stz diyabetik sıçanlarda kas ve yağ dokularındaki glikoz alımını uyararak kan glikoz seviyelerini önemli ölçüde düşürdüğütespit edilmiştir. Sonuçlar ayrıca ekstraktın hem stz-diyabetik hem de normal sıçanlarda insülin salgısını artırdığını ortaya koymuştur (Yibchok-Anun ve ark., 2006). Yapılan çalışmalar kudret narı ekstraktın, sıçanların beta hücrelerinden insülin salgılanmasını arttırdığını, bu da sülfonilüreye (sentetik bir ilaç) benzer özelliklere sahip olduğunu göstermektedir (Sarkar ve ark., 1996).

Hipolipidemik ve Hipokolesterolemik Etki

Kudret narı hipoglisemik aktivitelerinin yanı sıra, diğer yararlı sağlık etkileriyle de ilişkilendirilmiştir. Sıçanlarda yapılan bir çalışmada, karaciğer ve serum toplam kolesterol ile trigliserit düzeylerinin önemli ölçüde azaldığı ve HDL kolesterol konsantrasyonunun dondurularak kurutulmuş kudret narı preparatı ile arttığı gözlenmiştir (Jayasooriya ve ark., 2000). Çok düşük yoğunluklu lipoprotein (VLDL) üretiminin artması ve karaciğerden apolipoprotein (apo) B-100 salgılanmasının artması, düşük insülin duyarlılığı ve kan glukoz seviyelerinin yükselmesiyle ilişkilendirilmiştir (Avramoglu ve ark., 2006). İnsan hepatoma (HepG2) hücrelerinde yapılan bir in vivo çalışmada, apo B-100 ve yeni sentezlenen trigliseridlerin kudret narı suyu ile önemli ölçüde azaldığını gözlenmiştir (Nerurkar ve ark., 2005). Benzer şekilde, yüksek yağlı bir diyete maruz kalan farelerde kudret narı suyunun apo B-100 ve apo B-48 (bağırsaklardan salgılanan) seviyelerini kontrol seviyelerine normalleştirdiği gözlenmiştir (Nerurkar ve ark., 2008).

Yara İyileştirici, Antimikrobiyal ve İmmünomodülatör Etki

Yapılan çalışmalar kudret narının yara iyileştirici özelliklere sahip olduğunu öne sürmektedir. Kudret narı merheminin sıçanlarda bir yara modelinde eksizyon, insizyon ve ölü alan üzerinde faydalı etkileri olduğu belirtilmektedir (Prasad ve ark., 2006).

İn vitro bir araştırma, kudret narı çekirdeği ekstraktının antimikrobiyal özelliklere sahip olduğunu öne sürmüştür. Bu çalışmada, *Staphylococcus aureus, Bacillus subtilis, Psuedomonas aeruginosa* ve *Escherichia coli* üzerinde dört farklı kudret narı ekstraktının antimikrobiyal etkileri test edimiş ve hazırlanan ekstraktlar arasında, sulu ekstraktın diğerlerine göre özellikle sedef hastalığını şiddetlendiren *Staphylococcus aureus* gibi

mikroorganizmalara karşı daha etkili olduğu sonucuna varılmıştır (Braca ve ark., 2008). Benzer şekilde başka bir çalışma, kudret narı tohumlarının esansiyel yağlarının mikroorganizmaların büyümesini etkili bir şekilde inhibe ettiğini göstermektedir (Braca ve ark., 2008). Başka bir in vitro çalışma ise metanol ve etanol kudret narı ekstrelerinin antimikrobiyal özelliklere sahip olduğunu ve antioksidan aktivitelerinin askorbik asitten daha yüksek olduğunu göstermektedir (Abalaka ve ark., 2011).

Antikanser Etki

Kudret narının kanser üzerindeki potansiyel etkileri de araştırılmıştır.mYasui ve arkadaşları (2005), kudret narı tohumlarından saflaştırılan serbest yağ asitleri olan 9c,11t,13t-konjuge linolenik asitlerin (CLN) kolon kanseri Caco-2 hücreleri üzerindeki antineoplastik etkilerini araştırmışlardır. Sonuçlar, Caco-2 hücrelerinin büyümesinin, programlanmış hücre ölümünün (apoptoz) indüklenmesi yoluyla 9c,11t,13t-CLN tarafından önemli ölçüde inhibe edildiğini göstermiştir (Kobori ve ark., 2008). Wistar fareleri üzerinde yapılan bir başka çalışma, kudret narı ekstraktının sadece kansere karşı koruyucu aktivitelere sahip olmakla kalmayıp aynı zamanda antioksidan özelliklere de sahip olduğunu göstermektedir (Semiz ve Sen, 2007).

SONUÇ

Kudret narının biyoaktif bileşik içeriği ve antioksidan kapasitesi, çeşitli sağlık yararlarıyla ilişkilendirilmiştir, özellikle diyabet tedavisi gibi. Ancak, insanlarda tam etki mekanizmasını anlamak için gelecekteki çalışmaların ve daha fazla insan randomize kontrol çalışmasının yapılması gerekmektedir. Bu çalışmaların, kudret narının terapötik etkilerinden sorumlu olan bileşikler üzerine odaklanması önemlidir. Ayrıca, kudret narı çeşitlerinin biyoaktif bileşiklerinin daha fazla araştırılması ve bu meyvenin gıdalarda veya tedavi edici bir madde olarak kullanılması da önemlidir. Bu, kudret narının sağlık yararlarını daha da artırabilir ve toplumun genel sağlığını olumlu yönde etkileyebilir. Bu nedenle, kudret narının potansiyelini tam olarak anlamak ve kullanmak için daha fazla araştırmaya ve bilimsel çalışmalara ihtiyaç vardır.

KAYNAKÇA

Abalaka, M. E., Inabo, H. I., Onaolapo, J. A., & Olonitola, O. S. (2011). Antioxidant capabilities of extracts and antimicrobial activities of chromatographic fractions of Momordica charantia L. (Cucurbitaceae). Ferm. Tech. Bioeng, 1, 1-6.

Ahmad, Z., Zamhuri, K. F., Yaacob, A., Siong, C. H., Selvarajah, M., Ismail, A., & Hakim, M. N. (2012). In vitro anti-diabetic activities and chemical analysis of polypeptide-k and oil isolated from seeds of Momordica charantia (bitter gourd). *Molecules*, *17*(8), 9631-9640.

Ahmed, I., Adeghate, E., Sharma, A. K., Pallot, D. J., & Singh, J. (1998). Effects of Momordica charantia fruit juice on islet morphology in the pancreas of the streptozotocin-diabetic rat. *Diabetes research and clinical practice*, *40*(3), 145-151.

Akihisa, T., Higo, N., Tokuda, H., Ukiya, M., Akazawa, H., Tochigi, Y., ... & Nishino, H. (2007). Cucurbitane-type triterpenoids from the fruits of Momordica charantia and their cancer chemopreventive effects. *Journal of natural products*, *70*(8), 1233-1239.

Aljohi, A., Matou-Nasri, S., & Ahmed, N. (2016). Antiglycation and antioxidant properties of Momordica charantia. *PloS one*, *11*(8), e0159985.

Aminah, A., & Anna, P. K. (2011). Influence of ripening stages on physicochemical characteristics and antioxidant properties of bitter gourd (Momordica charantia). *International Food Research Journal*, *18*(3).

Avramoglu, R. K., Basciano, H., & Adeli, K. (2006). Lipid and lipoprotein dysregulation in insulin resistant states. Clinica chimica acta, 368(1-2), 1-19.

Basch, E., Gabardi, S., & Ulbricht, C. (2003). Bitter melon (Momordica charantia): a review of efficacy and safety. American Journal of Health-System Pharmacy, 60(4), 356-359.

Braca, A., Siciliano, T., D'Arrigo, M., & Germanò, M. P. (2008). Chemical composition and antimicrobial activity of Momordica charantia seed essential oil. Fitoterapia, 79(2), 123-125.

Dhar, P., Chattopadhyay, K., Bhattacharyya, D., Roychoudhury, A., Biswas, A., & Ghosh, S. (2007). Antioxidative effect of conjugated linolenic acid in diabetic and non-diabetic blood: an in vitro study. *Journal of Oleo Science*, *56*(1), 19-24.

Duan, Z. Z., Zhou, X. L., Li, Y. H., Zhang, F., Li, F. Y., & Su-Hua, Q. (2015). Protection of Momordica charantia polysaccharide against intracerebral hemorrhage-induced brain injury through JNK3 signaling pathway. *Journal of Receptors and Signal Transduction*, *35*(6), 523-529.

Grover, J. K., & Yadav, S. P. (2004). Pharmacological actions and potential uses of Momordica charantia: a review. *Journal of ethnopharmacology*, *93*(1), 123-132.

Güdr, A. (2016). Influence of total anthocyanins from bitter melon (Momordica charantia Linn.) as antidiabetic and radical scavenging agents. Iranian journal of pharmaceutical research: IJPR, 15(1), 301.

Habicht, S. D., Kind, V., Rudloff, S., Borsch, C., Mueller, A. S., Pallauf, J., ... & Krawinkel, M. B. (2011). Quantification of antidiabetic extracts and compounds in bitter gourd varieties. *Food chemistry*, *126*(1), 172-176.

Horax, R., Hettiarachchy, N., Over, K., Chen, P., & Gbur, E. (2010). Extraction, fractionation and characterization of bitter melon seed proteins. *Journal of agricultural and food chemistry*, *58*(3), 1892-1897.

Ibrahim, T. A., El-Hefnawy, H. M., & El-Hela, A. A. (2010). Antioxidant potential and phenolic acid content of certain cucurbitaceous plants cultivated in Egypt. *Natural Product Research*, *24*(16), 1537-1545.

Jabeen, U., & Khanum, A. (2017). Isolation and characterization of potential food preservative peptide from Momordica charantia L. *Arabian Journal of Chemistry*, *10*, S3982-S3989.

Jayasooriya, A. P., Sakono, M., Yukizaki, C., Kawano, M., Yamamoto, K., & Fukuda, N. (2000). Effects of Momordica charantia powder on serum glucose levels and various lipid parameters in rats fed with cholesterol-free and cholesterol-enriched diets. Journal of Ethnopharmacology, 72(1-2), 331-336.

Kobori, M., Ohnishi-Kameyama, M., Akimoto, Y., Yukizaki, C., & Yoshida, M. (2008). α-Eleostearic acid and its dihydroxy derivative are major apoptosis-inducing components of bitter gourd. Journal of Agricultural and food chemistry, 56(22), 10515-10520.

Krawinkel, M. B., & Keding, G. B. (2006). Bitter gourd (Momordica charantia): a dietary approach to hyperglycemia. *Nutrition reviews*, *64*(7), 331-337.

Liu, X. R., Deng, Z. Y., Fan, Y. W., Li, J., & Liu, Z. H. (2010). Mineral elements analysis of Momordica charantiap seeds by ICP-AES and fatty acid profile identification of seed oil by GC-MS. *Spectroscopy*.

Martinez-Gonzalez, M. A., & Martin-Calvo, N. (2016). Mediterranean diet and life expectancy; beyond olive oil, fruits, and vegetables. *Current Opinion in Clinical Nutrition & Metabolic Care*, *19*(6), 401-407.

Miura, T., Itoh, C., Iwamoto, N., Kato, M., Kawai, M., Park, S. R., & Suzuki, I. (2001). Hypoglycemic activity of the fruit of the Momordica charantia in type 2 diabetic mice. Journal of nutritional science and vitaminology, 47(5), 340-344.

Namsa, N. D., Mandal, M., Tangjang, S., & Mandal, S. C. (2011). Ethnobotany of the Monpa ethnic group at Arunachal Pradesh, India. *Journal of Ethnobiology and Ethnomedicine*, *7*, 1-15.

Nerurkar, P. V., Lee, Y. K., & Nerurkar, V. R. (2010). Momordica charantia (bitter melon) inhibits primary human adipocyte differentiation by modulating adipogenic genes. *BMC complementary and alternative medicine*, *10*, 1-10.

Nerurkar, P. V., Lee, Y. K., Motosue, M., Adeli, K., & Nerurkar, V. R. (2008). Momordica charantia (bitter melon) reduces plasma apolipoprotein B-100 and increases hepatic insulin receptor substrate and phosphoinositide-3 kinase interactions. *British journal of nutrition*, *100*(4), 751-759.

Nerurkar, P. V., Pearson, L., Efird, J. T., Adeli, K., Theriault, A. G., & Nerurkar, V. R. (2005). Microsomal triglyceride transfer protein gene expression and ApoB secretion are inhibited by bitter melon in HepG2 cells. The Journal of nutrition, 135(4), 702-706.

Panda, B. C., Mondal, S., Devi, K. S. P., Maiti, T. K., Khatua, S., Acharya, K., & Islam, S. S. (2015). Pectic polysaccharide from the green fruits of Momordica charantia (Karela): structural characterization and study of immunoenhancing and antioxidant properties. *Carbohydrate research*, *401*, 24-31.

Paul, A.; Raychaudhuri, S.S. Medicinal uses and molecular identification of twoMomordicacharantiavarieties—A review. Electronic J. Biol.2010,6,43–51.

Qader, S. W., Abdulla, M. A., Chua, L. S., Najim, N., Zain, M. M., & Hamdan, S. (2011). Antioxidant, total phenolic content and cytotoxicity evaluation of selected Malaysian plants. *Molecules*, *16*(4), 3433-3443.

Sarkar, S., Pranava, M., & MARITA, A. R. (1996). Demonstration of the hypoglycemic action of Momordica charantia in a validated animal model of diabetes. Pharmacological Research, 33(1), 1-4.

Sathishsekar, D., & Subramanian, S. (2005). Beneficial effects of Momordica charantia seeds in the treatment of STZ-induced diabetes in experimental rats. *Biological and Pharmaceutical Bulletin*, *28*(6), 978-983.

Semiz, A.; Sen, A. Antioxidant and chemoprotective properties of Momordica charantiaL.(bitter melon) fruit extract. Afr. J. Biotechnol.2007,6, 273–277.

Tan, S. P., Parks, S. E., Stathopoulos, C. E., & Roach, P. D. (2014). Extraction of flavonoids from bitter melon. Food and Nutrition Sciences, 2014.

Tan, S. P., Stathopoulos, C., Parks, S., & Roach, P. (2014). An optimised aqueous extract of phenolic compounds from bitter melon with high antioxidant capacity. *Antioxidants*, *3*(4), 814-829.

Wu, S. J., & Ng, L. T. (2008). Antioxidant and free radical scavenging activities of wild bitter melon (Momordica charantia Linn. var. abbreviata Ser.) in Taiwan. LWT-Food Science and Technology, 41(2), 323-330.

Yadav, M., Lavania, A., Tomar, R., Prasad, G. B. K. S., Jain, S., & Yadav, H. (2010). Complementary and comparative study on hypoglycemic and antihyperglycemic activity of various extracts of Eugenia jambolana seed, Momordica charantia fruits, Gymnema sylvestre, and Trigonella foenum graecum seeds in rats. *Applied biochemistry and biotechnology*, *160*, 2388-2400.

Yasui, Y., Hosokawa, M., Sahara, T., Suzuki, R., Ohgiya, S., Kohno, H., ... & Miyashita, K. (2005). Bitter gourd seed fatty acid rich in 9c, 11t, 13t-conjugated linolenic acid induces apoptosis and up-regulates the GADD45, p53 and PPARγ in human colon cancer Caco-2 cells. *Prostaglandins, Leukotrienes and Essential Fatty Acids*, *73*(2), 113-119.

Yibchok-Anun, S., Adisakwattana, S., Yao, C. Y., Sangvanich, P., Roengsumran, S., & Hsu, W. H. (2006). Slow acting protein extract from fruit pulp of Momordica charantia with insulin secretagogue and insulinomimetic activities. *Biological and Pharmaceutical Bulletin*, *29*(6), 1126-1131.

Zhang, L. Y., Wang, Y. T., & Geng, L. J. (2011). Bacteriostatic Activity of Total Saponins fromBalsam Pear (Momordica charantia) against Staphylococcus aureus. *J. Microbiol*, *1*, 012.

KUMKUAT *(Fortunella SPPP.)* MEYVE VE YAPRAKLARININ BİYOAKTİF BİLEŞİKLERİ VE SAĞLIĞA FAYDALARI

Zeynep Nur KARAKUŞ (ORCID: 0000-0002-0319-6454)
Uşak University, Eşme Vocational School, Department of Food Processing, Food Technology Program,
Email: zeynep.karakus@usak.edu.tr

Assist. Prof. Dr. Yasemin ÇELEBİ (ORCID: 0000-0002-4495-0206)
Uşak University, Eşme Vocational School, Department of Food Processing, Food Technology Program,
Email: yasemin.sezer@usak.edu.tr

Assoc. Prof. Dr. Gülşah ÇALIŞKAN KOÇ (ORCID: 0000-0002-6542-3093)
Uşak University, Eşme Vocational School, Department of Food Processing, Food Technology Program,
Email: gulsah.koc@usak.edu.tr

ÖZET
Kumkuat, turuncugiller (Rutaceae) ailesine ait olan *Fortunella* cinsindeki bir turunçgil türüdür ve doğal olarak Çin'de ortaya çıkmıştır. Bu meyvenin özgün özellikleri arasında yuvarlak-oval bir şekil ve turuncu ile sarı arasında değişen bir renk tonu bulunmaktadır. Ayrıca, Kumkuat'ın Çince'deki anlamı olan "altın portakal," bu meyvenin kültürel önemini vurgulamaktadır. Yenilebilir ham kumkut içeriği 100 gram başına şu şekildedir: su 80.85 g, karbonhidrat 15.90 g, toplam şeker 9.36 g, toplam diyet lifi 6.5 g, protein 1.88 g, toplam lipit 0.86 g, kül 0.52 g. Ayrıca, kumkut, 186 mg potasyum (K), 62 mg kalsiyum (Ca), 20 mg magnezyum (Mg), 19 mg fosfor (P), 10 mg sodyum (Na), 0.86 mg demir (Fe), 0.17 mg çinko (Zn), 0.135 mg manganez (Mn), ve 0.095 mg bakır (Cu) içerir. Enerji değeri ise 71 kcal (296 kJ) olarak belirlenmiştir. Ayrıca kumkuat meyvesi askorbik asit, flavonoidler, karotenoidler, uçucu yağ gibi sağlık açısından yararlı fitokimyasalları da içermektedir. Kumkuatın antioksidan etkileri, serbest radikallerle mücadele ederek hücresel hasarı azaltabilir ve çeşitli hastalıkların riskini düşürebilir. C vitamini, flavonoidler ve polifenollerin bu konudaki rolü, genel bağışıklık sisteminin güçlenmesine de katkı sağlar, bu da vücudun hastalıklara karşı daha etkili bir direnç geliştirmesine imkân tanır. Antiinflamatuar özellikleriyle de dikkat çeken kumkuat, iltihaplanma ile ilişkilendirilen durumların hafifletilmesine yardımcı olabilir. Ayrıca, kumkuattaki karotenoidlerin ve diğer biyoaktif bileşenlerin kardiyovasküler sağlık üzerindeki olumlu etkileri, kan basıncını düzenleme ve kolesterol seviyelerini dengeleme potansiyeli taşır. Ancak, bu potansiyel sağlık faydalarının daha kesin bir şekilde anlaşılabilmesi için daha fazla araştırma ve klinik çalışmaların yapılması gerekmektedir.
Anahtar Kelimeler: kumkuat, antioksidan aktivite, *Fortunella*, C vitamin

BIOACTIVE COMPONENTS AND HEALTH BENEFITS OF KUMQUAT (*Fortunella* SPPP.) FRUITS AND LEAVES

ABSTRACT

Kumquat is a citrus fruit belonging to the Rutaceae family and the *Fortunella* genus, naturally originating in China. The distinctive features of this fruit include a round-oval shape and a color spectrum ranging from orange to yellow. Furthermore, the Chinese meaning of Kumquat, which translates to "golden orange," underscores the cultural significance of this fruit. The edible raw kumquat content per 100 grams is as follows: water 80.85 g, carbohydrates 15.90 g, total sugar 9.36 g, total dietary fiber 6.5 g, protein 1.88 g, total lipid 0.86 g, ash 0.52 g. Additionally, kumquat contains 186 mg of potassium (K), 62 mg of calcium (Ca), 20 mg of magnesium (Mg), 19 mg of phosphorus (P), 10 mg of sodium (Na), 0.86 mg of iron (Fe), 0.17 mg of zinc (Zn), 0.135 mg of manganese (Mn), and 0.095 mg of copper (Cu). Its energy value is determined to be 71 kcal (296 kJ). Furthermore, the kumquat fruit encompasses phytochemicals beneficial to health, such as ascorbic acid, flavonoids, carotenoids, and volatile oils. Kumquat's antioxidant effects are noteworthy as it combats cellular damage by neutralizing free radicals, potentially reducing the risk of various diseases. The roles of vitamin C, flavonoids, and polyphenols contribute to the reinforcement of the overall immune system, enhancing the body's resistance to illnesses. With its anti-inflammatory properties, kumquat may assist in alleviating conditions associated with inflammation. Moreover, the positive impact of kumquat's carotenoids and other bioactive components on cardiovascular health suggests potential benefits in regulating blood pressure and balancing cholesterol levels. Nevertheless, further research and clinical studies are necessary for a more precise understanding of these potential health advantages.

Keywords: Kumquat, antioxidant activity, *Fortunella*, C vitamin

GİRİŞ

Turunçgiller dünyada en çok üretilen ve ticareti yapılan gıda kaynakları arasında yer almaktadır (USDA, 2017). Kumkuat meyvesi (*Fortunella spp*.), Rutaceae familyasının *Citrus* ve *Poncirus* meyvelerine benzer turuncu renk sergileyen bir meyve türüdür. Taze kumkuat meyvesi, posa, yenilebilir ekzokarp ve mezokarp bölümleri ile bütün şekildedir. Tüketildiğinde ilk başta güçlü ve tatlı bir tat ile birlikte sonrasında hafif bir acılık hissedilmektedir (Barreca ve ark., 2011). Kumkuat botanik olarak *Protocitrus* ve *Eufortunella* olmak üzere iki türe ayrılmaktadır. *Protocitrus* türü, ilkel Hong Kong kumkuatından (*Fortunella hindsii Swingle*) oluşurken, Eufortunella ise yuvarlak kumkuat (*F. japonica Swingle*), oval kumkuat (*F. margarita Swingle*), Meiwa kumkuatları (*F. crassifolia Swingle*), Malaya kumkuatları (F. polyandra Swingle) ve Jiangsu kumkuatını (*F. obovata Swingle*) içermektedir (Palma ve D'Aquino, 2018). Kumkuatın anavatanı Çin ve Tayvan olmakla birlikte Japonya, Hindistan, Filipinler ve Güneydoğu Asya'da da yetiştirilmektedir (Morton ve Dowling, 1987). Kaynar suya kumkuat meyvesi eklenerek hazırlanan çayı da yaygın olarak kullanılmaktadır (Peng ve ark., 2013). Kumkuat meyvesi çayı, solunum yolu iltihabı, soğuk algınlığı ve öksürük tedavisinde, kan damarı yırtılmasının önlenmesinde ve damar geçirgenliğinin iyileştirilmesinde geleneksel bir Çin halk ilacı olarak da kullanılmaktadır (Tan ve ark., 2016). Aynı zamanda kumkuat şekerlemeler, reçeller, şuruplar, alkollü içkilerde meyve ve likör süslemeleri gibi çeşitli ürünlerde kullanılmaktadır (Palma ve D'Aquino, 2018).

Kumkuat, antioksidan, antimikrobiyal ve antikanser aktivite gibi terapötik özellikler gösteren çeşitli bileşenleri ve fitokimyasalları içermektedir. Bu besin maddeleri ve fitokimyasallar arasında vitaminler ve polifenoller (flavonoidler dahil) de bulunmaktadır (Lou ve Ho, 2017).

Kumkuat Meyvesinin Besin Değerleri

Portakal ile karşılaştırıldığında, kumkuat meyvesi su ve fosfor hariç diğer biyokimyasalları daha fazla içermektedir (Meenu ve ark., 2021; Yu ve ark., 2021). Brezilya'da toplanan kumkuat meyvesinin (*F. margarita*) kabuk ve posasının kimyasal bileşimi incelenen çalışmada kumkuatın karbonhidrat ve protein içerikleri sırasıyla 5.23 ± 0.30 g/100 g ve 7.38 ± 0.39 g/100 g şeklinde tespit edilmiştir' (Tablo 1) (Souza ve ark., 2020). Kimyasal bileşimlerdeki bu farklılık, yetiştirme yeri, alt türler, olgunlaşma aşaması ve analiz öncesi depolama süresindeki farklılıklardan kaynaklanmaktadır.

Tablo 1. Brezilya'da Toplanan Kumkuatın (F. margarita) (kabuk ve posa) Yüzde Bileşimi (Souza ve ark., 2020).

Kimyasal Kompozisyon				
Nem[1] ($g \cdot 100\ g^{-1}$)	**Yağ[1]** ($g \cdot 100\ g^{-1}$)	**Total Kül[1]** ($g \cdot 100\ g^{-1}$)	**Protein[1]** ($g \cdot 100\ g^{-1}$)	**Karbonhidrat[1]** ($g \cdot 100\ g^{-1}$)
76.79 ± 0.98	1.18 ± 0.06	3.66 ± 0.18	7.38 ± 0.39	5.23 ± 0.30
Total Lif[2] ($g \cdot 100\ g^{-1}$)	**Çözünmez Lif[2]** ($g \cdot 100\ g^{-1}$)	**Çözünür Lif[2]** ($g \cdot 100\ g^{-1}$)	**Enerji Değeri** ($kcal \cdot 100\ g^{-1}$)	
5.31 ± 0.06	3.28 ± 0.15	2.03 ± 0.09	61.06	

[1] Veriler taze kumkuat meyvesinden, ortalama ± standart sapma olarak ifade edilmiştir, [2] veriler taze kumkuat meyvesinden, ortalama ± standart sapma olarak ifade edilmiştir.

Kumkuat Tablo 2'de gösterilen kalsiyum, demir, potasyum, çinko, tiamin ve niasin gibi çeşitli elementleri içermektedir. Ayrıca güçlü bir doğal antioksidan olan ve bağışıklık sisteminde önemli bir rol oynayan C vitamini (2.32 - 44.24 mg/100 g) bakımından da oldukça zengindir (Tablo 3) (Carr ve Maggini, 2017). (Souza ve ark., 2020).

Tablo 2. Brezilya'da Toplanan Kumkuatta (*F. Margarita*) (Kabuk ve Posa) Bulunan Kimyasal Elementlerin Bileşimi (Souza ve ark., 2020).

Kimyasal Elementler	**Konsantrasyon ($mg \cdot 100\ g^{-1}$)**
Fosfor	16.94 ± 0.23
Potasyum	163.16 ± 3.29
Kalsiyum	64.99 ± 1.41
Magnezyum	16.71 ± 0.40
Sülfür	13.92 ± 0.23
Bakır	0.07 ± 0.01
Demir	0.30 ± 0.06
Çinko	0.09 ± 0.00
Manganez	0.10 ± 0.00
Sodyum	2.63 ± 0.00

Kumkuat Meyvesinde Bulunan Biyoaktif Bileşikler

Genel olarak, turunçgillerde normal C vitamini aralığı 50 ila 100 mg/100 mL'dir. Bundan dolayı, kumkuat meyvesi önemli bir C vitamini kaynağı olarak kabul edilmektedir

(Andrade ve ark., 2002). Ayrıca kumkuat meyvesinin C vitamini içeriği tavsiye edilen günlük miktarın (RDA) %70'ini oluşturmaktadır (Hosseini ve ark., 2019). Diniz ve ark., (2015) yaptıkları çalışmada 100 mL kumkuat suyunda 86.45 ± 6.65 mg askorbik asit bulunduğu bildirmişlerdir (Diniz ve de Oliveira, 2015).

Kumkuatta bulunan toplam E vitamini konsantrasyonu portakalda (*C. sinensis*) bulunandan yaklaşık üç kat daha yüksektir. Kumkuat meyvesi iyi bir antioksidan kapasiteye sahiptir. (%62) (Tablo 3). Kumkuatta bulunan başlıca E vitamini bileşeni ise α-tokoferoldür (Tablo 3). Kumkuat meyvesinde flavonoidler arasında apigenin (38.157.30 µg-100 g^{-1}) bulunmaktadır (Tablo 3). Brezilya'da yetişen kumkuattaki (8.55 ± 1.93 mg GAE-100 g-1) toplam fenolik bileşik konsantrasyonu Tayvan, Çin'de yetişen *F. crassifolia'*dan (229 mg GAE-100 g^{-1}) çok daha düşüktür (Chen ve ark., 2017).

Tablo 3. Brezilya'da Toplanan Kumkuat (*F. margarita*) (kabuk ve posa) Vitaminlerin, Karotenoidlerin ve Biyoaktif Bileşikleri Konsantrasyonu (Souza ve ark., 2020)

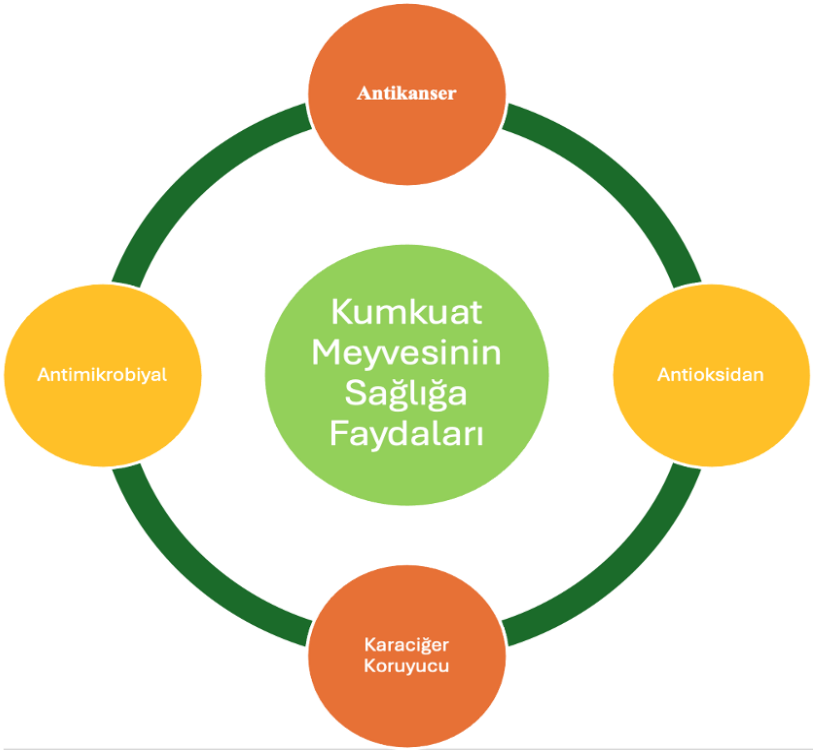
Bileşik	**Konsantrasyon**
C Vitamini (mg·100 g^{-1})	2.32- 44.24
Askorbik Asit	
E Vitamini (µg·100 g^{-1})	
α-tokoferol	569.00 ± 10.20
α-tokotrienol	35.76 ± 4.03
γ-tokoferol	4.22 ± 0.13
Total E vitamini	675.87 ± 54.29
Karotenoidler (µg·100 g^{-1})	
α-karoten	661.81 ± 22.76
β-c-karoten	447.74 ± 19.90
Lutein	173.60 ± 33.61
Total karotenoid	1283.15
Vitamin A değeri (RAE 100 g^{-1}) [1]	129.77
Flavonlar (µg·100 g^{-1})	
Apigenin	38.157.30 ± 531.00
Total Flavonlar	38.157.30 ± 531.00
Flavanonlar (µg·100 g^{-1})	
Eriodictiol	36.880.95 ±384.02
Total Flavanonlar	36.880.95 ± 384.02
Total Fenolikler (mg GAE·100 g^{-1})	98.55 ±1.93
Antioksidan Kapasitesi (%)	62.01 ± 3.41

Kumkuat Meyvesinde Bulunan Esansiyel Yağlar

Kumkuat meyvesinden elde edilen esansiyel yağların sağlığa faydalı özellikler ve farmakolojik aktiviteler sergilediği rapor edilmiştir (Wang ve ark., 2012). Kumkuat meyvesinde bulunan esansiyel yağlar, genellikle kabuk kısmında yoğunlaşmıştır. Esansiyel yağların bileşimi, Kumkuat meyvelerinin alt türlerine, kısımlarına ve ekstraksiyon yöntemine bağlı olarak önemli ölçüde değişmektedir. Ancak farklı alt türlere ait olsa bile limonenin, kumkuatta bulıunan esansiyel yağların ana bileşenidir. Ayrıca limonen, karakteristik aroma ve narenciye kabuğu kokusundan başlıca sorumlu olan ana bileşendir (Chen ve ark., 2017). Kumkuatın taze kabuğundan uçucu yağları çıkarmak ve analiz etmek için hidrodistilasyon ve gaz kromatografisi-kütle spektroskopisi (GC-MS) yöntemi kullanılan çalışmada (Wang ve ark., 2012). yağın %92.36'sını oluşturan 25 bileşen tespit edilmiştir. En önemli bileşikler limonen (%74.79) olup, bunu mirsen (%7.11), kamfen (%1.43) ve α-selinen (%0.7) şeklinde sıralanmaktadır. Başka bir çalışmada, buhar distilasyonu ile homojenize edilmiş taze kumkuattan elde edilen uçucu yağlarda 44 uçucu bileşik rapor edilmiştir, bu bileşikler içinde limonen (%89.60) ana bileşen olup, bunu β-mirsen (%4.42), α-pinen (%1.28), germacrene-D (%1.16), α-terpineol (%0.55) ve geranil asetat (%0.36) izlemiştir (Chen ve ark., 2017).

Kumkuat Meyvesinin Sağlığa Faydaları

Kumkuat meyvesi askorbik asit, flavonoidler, karotenoidler, uçucu yağ gibi sağlık açısından yararlı fitokimyasalları da içermektedir (Wang ve ark., 2012). Kumkuat antioksidan özelliği sayesinde serbest radikallerle mücadele ederek hücresel hasarı azaltır bu sayede kronik hastalıkların oluşmasını önlemektedir. Kumkuat meyvesinden ekstrakte edilen esansiyel yağlar, çeşitli mikroorganizmalara karşı güçlü antimikrobiyal aktivite göstermektedir (Peng ve ark., 2013). Kumkuat meyvesinin sağlık üzerindeki etkileri Şekil 1'de gösterilmektedir.



Şekil 1. Kumkuat Meyvesinin Sağlığa Faydaları

Antioksidan Etki

Bitkilerde bulunan fenolik bileşikler ve flavonoidler, güçlü antioksidanlar olarak bilinir ve kumkuat meyvesinin antioksidan aktivitesinden bu bileşikler sorumludur. Bu antioksidan bileşikler, insan vücudunda üretilen serbest radikalleri temizleyerek kanser, diyabet, siroz, kardiyovasküler hastalıklar ve yaşlanmayla ilgili diğer hastalıklar gibi yaşamı tehdit eden çeşitli hastalıkları önlemektedir (Wu ve ark.,2021). Kumkuat meyvesinin sıcak su ekstresi, meyvelerin etanolik ve metanolik ekstrelerine kıyasla DPPH (1,1-Difenil-2-pikrilhidrazil radikali; $C_{18}H_{12}N_5O_6$, antioksidan analizi) için daha yüksek değerler gözlenmiştir. Meyve kabuğunda meyve özüne kıyasla daha yüksek DPPH değeri göstermiştir. Özellikle, en yüksek DPPH değeri (%46.5 ± 5.3/mg/mL) 90°C'de sıcak su ile ekstrakte edilen olgunlaşmamış kumkuat kabuğunda gözlenmiştir. Bununla birlikte, kaynar su ile ekstrakte edilen kumkuat meyvesinin DPPH değerleri, 80°C ve 90°C'de sıcak su ile ekstrakte edilenlere kıyasla düşük saptanmıştır (Lou ve ark., 2016). Ayrıca, kurutma prosedürünün kumkuatın antioksidan aktivitesi üzerinde önemli bir etkisi olduğutespit edilmiştir. Kumkuatın 150°C'de kurutulmasının, 100°C'de kurutulan kumkuat meyvesine kıyasla çok daha yüksek serbest radikal temizleme

kabiliyeti ile sonuçlandığı belirtilmektedir (Choi, ve ark., 2011). Başka bir çalışmada, olgunlaşmamış meyvenin sıcak su ekstraktının 1.5 saat boyunca <130°C sıcaklıkta kurutulmasının DPPH testi için daha yüksek değerler sergilediği bildirilmektedir. Antioksidan aktivitedeki bu artış, artan fenolik bileşik sayısına bağlanmıştır. Bununla birlikte, kumkuat meyvesi 1.5 saat boyunca 130°C'den daha yüksek bir sıcaklıkta kurutulduğunda da antioksidan aktivitesinde ani bir artış gözlenmiştir. DPPH değerindeki bu artış, kahverengileşme reaksiyon ürünlerinin oluşumuna bağlanmıştır (Lou ve ark., 2015). Kumkuat ekstresinin sıçanların gama ışınına maruz kalmış karaciğer dokularında malondialdehit (MDA), süperoksidaz dismutaz (SOD) ve glutatyon (GSH) seviyelerine karşı etkisi rapor edilmiştir. Kumkuat meyvesi özütünün uygulanmasıyla, MDA içeriği önemli ölçüde azalmış ve SOD ve GSH seviyelerinde de zamana bağlı bir artış gözlenmiştir. Dolayısıyla, bu çalışma Kumkuat meyvesinin bir sistemin antioksidan yeteneğini artırma ve oksidatif stresi yönetme konusundaki güçlü yeteneğini ortaya koymaktadır (Krishna ve Kumar, 2005).

Antimikrobiyal Etki

Kumkuat meyvesinden ekstrakte edilen esansiyel yağın çeşitli mikroorganizmalara karşı güçlü antimikrobiyal aktivitesi olduğu saptanmıştır (Krishna ve Kumar, 2005). Kumkuat kabuğundan elde edilen esansiyel yağının %1.8'ini oluşturan bir keton olan karvonun güçlü antimikrobiyal aktivite sergilediği bildirilmiştir (Oke ve ark., 2009). Kumkuat kabuğundan elde edilen esansiyel bir yağ olan linalolün de *Campylobacter jejuni, Escherichia coli O157, Listeria monocytogenes, Bacillus cereus* ve *Staphylococcus aureus*'a karşı önemli antimikrobiyal aktivite gösterdiği bildirilmiştir (Fisher ve Phillips, 2008). Ayrıca, kumkuat kabuğundan elde edilen esansiyel yağların Gram-negatif mikroorganizmalara (*E. coli, Salmonella typhimurium*) ve Gram-pozitif mikroorganizmalara (*S. aureus, B. subtilis, B. cereus, Lactobacillus bulgaricus, Brevibacillus laterosporus*) ve *Candida albicans*'a karşı güçlü antifungal aktivite sergilediği rapor edilmiştir. Genel olarak, kumkuat meyvesinden elde edilen esansiyel yağlar, ilaç ve gıda endüstrisinde çevre dostu bir antimikrobiyal ajan olarak kullanılmaktadır (Lou ve ark., 2015).

Karaciğer Koruyucu Etki

Karaciğer, vücudun detoksifikasyonu ile ilişkili hayati bir metabolik organdır. Bununla birlikte, çeşitli çevresel faktörlerden kolayca etkilenmektedir (Nakajima ve ark., 2018).

Kumkuat meyvesinin radyasyonun neden olduğu karaciğer hasarı üzerindeki etkisini araştıran bir hayvan çalışması yapılmıştır. Işınlanan grupta, toplam kolesterol, düşük yoğunluklu lipoprotein kolesterol, çok düşük yoğunluklu lipoprotein kolesterol ve trigliseritlerde artış ve yüksek yoğunluklu lipoprotein kolesterol (HDL-C) değerlerinde düşüş gözlenmiştir. Bununla birlikte, kumkuat ekstresi takviyesi, HDL-C'de belirgin bir artışa neden olurken, lipid profiliyle ilgili diğer parametrelerde önemli bir düşüş göstermiştir (HDL-C'nin 29.53 ± 5.61 mg/mL'den 38.5 ve 39.1 mg/mL'ye yükseldiği belirtilmektedir). Ayrıca, alanin aminotransferaz, aspartat aminotransferaz ve gama-glutamil transferaz gibi lipid enzimleri, ışınlamayı takiben bir artış gösterirken, Kumkuat ekstresi uygulamasından sonra kontrol grubuna kıyasla belirgin bir düşüş yaşamıştır. Bu bulgular, kumkuatın γ-ışınlamasına bağlı karaciğer hasarını kontrol etme ve önlemede önemli bir rol oynadığını göstermektedir (Abdallah ve ark., 2019).

Antikanser Etki

Kanser tedavileri genellikle iki ana prensibe dayanır; biri inaktive olmuş apoptoz mekanizmasının aktivasyonu, diğeri ise kusurlu apoptoz mekanizmasının düzeltilmesidir. Jayaprakasha ve ark., 2012'de yaptıkları çalışmada apoptoz mekanizmasını aktive etme prensibine dayanarak kumkuatın insan androjen bağımlı prostat kanseri (LNCaP) hücrelerine karşı antikanser potansiyelini araştırmıştır. Kumkuat ekstresi, dimetil sülfoksit (DMSO) tedavisine kıyasla prostat kanseri (LNCaP) hücrelerinin hücre proliferasyonunu inhibe ettiği bildirilen beş farklı çözücü kullanılarak elde edilmiştir. Genel olarak, en yüksek antikanser aktivitesi 100 µg/mL'de 96 saat sonra n-hekzan ekstresi (%86.4) durumunda gözlenmiş, bunu susuz etil asetat (EtOAc) (%82.8), metanol (MeOH) (%76.7) ve MeOH-su (4:1, v/v) (%68.2) izlemiştir (Jayaprakasha ve ark., 2012). Çeşitli narenciye bitkilerinden elde edilen esansiyel yağların, monoterpenlerin varlığına bağlı olarak farklı kanser hücrelerine karşı antikanserojenik aktivite gösterdiği bildirilmiştir. Kumkuattan hidrodistilasyon yoluyla elde edilen uçucu yağın antikanser aktivitesi araştırılmışlardır. 200 ppm konsantrasyonda kumkuattan elde edilen uçucu yağ, 24., 48. ve 72. saatlerde LNCaP hücre proliferasyonunun sırasıyla %55, %61 ve %63.4 oranlarında inhibisyonunu göstermiştir (Jayaprakasha, Murthy ve Demarais, 2012).

SONUÇ

Sonuç olarak, kumkuat meyvesi, antioksidan, antimikrobiyal, karaciğer koruyucu ve antikanser gibi çeşitli sağlık yararlarına sahip bir turunçgiller türüdür. İçeriğinde bulunan

C, E vitaminlerinin yanısıra özellikle, flavonoidler, karotenoidler gibi fitokimyasallar ve esansiyel yağlar sağladığı pekçok sağlıkfaydalarının ana bileşenlerindendir . Kumkuat meyvesi, antioksidan aktivitesi sayesinde serbest radikallerle mücadele ederek hücresel hasarı azaltmaktadır. Aynı zamanda güçlü antimikrobiyal özellikleri ile çeşitli mikroorganizmalara karşı etkili bir savunma sağlamaktadır. Bu nedenlerle, sağlıklı bir yaşam tarzının bir parçası olarak önerilebilen kumkuat aynı zamanda ilaç ve gıda endüstrilerinde çeşitli uygulamalara yönelik güçlü bir potansiyel sunmaktadır.Bununla birlikte kumkuat meyvesinin içeriğinin ve potansiyel sağlık faydalarını anlamak için , daha fazla araştırma ve klinik çalışma yapılması gerekmektedir,

KAYNAKÇA

Andrade, R. S. G. D., Diniz, M. C. T., Neves, E. A., & Nóbrega, J. A. (2002). Determinação e distribuição de ácido ascórbico em três frutos tropicais. *Eclética Química*, *27*, 393-401.

Barreca, D., Bellocco, E., Caristi, C., Leuzzi, U., & Gattuso, G. (2011). Kumquat (Fortunella japonica Swingle) juice: Flavonoid distribution and antioxidant properties. *Food Research International*, *44*(7), 2190-2197.

Carr, A. C., & Maggini, S. (2017). Vitamin C and immune function. *Nutrients*, *9*(11), 1211.

Chen, M. H., Yang, K. M., Huang, T. C., & Wu, M. L. (2017). Traditional small-size citrus from Taiwan: Essential oils, bioactive compounds and antioxidant capacity. *Medicines*, *4*(2), 28.

Choi, M. Y., Chai, C., Park, J. H., Lim, J., Lee, J., & Kwon, S. W. (2011). Effects of storage period and heat treatment on phenolic compound composition in dried Citrus peels (Chenpi) and discrimination of Chenpi with different storage periods through targeted metabolomic study using HPLC-DAD analysis. *Journal of Pharmaceutical and Biomedical Analysis*, *54*(4), 638-645.

Diniz, A. B., & de Oliveira, D. R. (2015). Chemical composition of kinkan orange and citrus fruits. *Demetra: Food, Nutrition & Health*, *10*(4), 835-845.

Fisher, K., & Phillips, C. (2008). Potential antimicrobial uses of essential oils in food: is citrus the answer?. *Trends in food science & technology*, *19*(3), 156-164.

Hosseini, S. F., Amraie, M., Salehi, M., Mohseni, M., & Aloui, H. (2019). Effect of chitosan-based coatings enriched with savory and/or tarragon essential oils on postharvest maintenance of kumquat (Fortunella sp.) fruit. *Food Science & Nutrition*, *7*(1), 155-162.

Jayaprakasha, G. K., Murthy, K. C., Etlinger, M., Mantur, S. M., & Patil, B. S. (2012). Radical scavenging capacities and inhibition of human prostate (LNCaP) cell proliferation by Fortunella margarita. *Food chemistry*, *131*(1), 184-191.

Jayaprakasha, G. K., Murthy, K. N. C., Demarais, R., & Patil, B. S. (2012). Inhibition of prostate cancer (LNCaP) cell proliferation by volatile components from Nagami kumquats. *Planta medica*, *78*(10), 974-980.

Krishna, A., & Kumar, A. (2005). Evaluation of radioprotective effects of Rajgira (Amaranthus paniculatus) extract in Swiss albino mice. Journal of radiation research, 46(2), 233-239.

Lou, S. N., & Ho, C. T. (2017). Phenolic compounds and biological activities of small-size citrus: Kumquat and calamondin. *Journal of Food and Drug Analysis*, *25*(1), 162-175.

Lou, S. N., Lai, Y. C., Hsu, Y. S., & Ho, C. T. (2016). Phenolic content, antioxidant activity and effective compounds of kumquat extracted by different solvents. *Food chemistry*, *197*, 1-6.

Lou, S. N., Lai, Y. C., Huang, J. D., Ho, C. T., Ferng, L. H. A., & Chang, Y. C. (2015). Drying effect on flavonoid composition and antioxidant activity of immature kumquat. *Food chemistry*, *171*, 356-363.

Meenu, M., Kurade, C., Neelapu, B. C., Kalra, S., Ramaswamy, H. S., & Yu, Y. (2021). A concise review on food quality assessment using digital image processing. *Trends in Food Science & Technology*, *118*, 106-124.

Morton, J. F. (1987). *Fruits of warm climates*. JF Morton.

Oke, F., Aslim, B., Ozturk, S., & Altundag, S. (2009). Essential oil composition, antimicrobial and antioxidant activities of Satureja cuneifolia Ten. Food Chemistry, 112(4), 874-879.

Palma, A., & D'Aquino, S. (2018). Kumquat—Fortunella japonica. In *Exotic Fruits* (pp. 271-278). Academic Press.

Peng, L. W., Sheu, M. J., Lin, L. Y., Wu, C. T., Chiang, H. M., Lin, W. H., ... & Chen, H. C. (2013). Effect of heat treatments on the essential oils of kumquat (Fortunella margarita Swingle). *Food Chemistry*, *136*(2), 532-537.

Souza, C. S. E., Anunciação, P. C., Lucia, C. M. D., Dôres, R. G. R. D., Milagres, R. C. R. D. M., & Sant'Ana, H. M. P. (2020, November). Kumquat (Fortunella margarita): a good alternative for the ingestion of nutrients and bioactive compounds. In *Proceedings* (Vol. 70, No. 1, p. 105). MDPI.

Tan, S., Zhao, X., Yang, Y., Ke, Z., & Zhou, Z. (2016). Chemical Profiling Using Uplc Q-Tof/Ms and Antioxidant Activities of Fortunella Fruits. *Journal of food science*, *81*(7), C1646-C1653.

USDA. Food Composition Databases. National Nutrient Database for Standard. 2017. Available online: https://ndb.nal.usda.gov/ndb/search (accessed on 07 March 2024).

Wang, Y. W., Zeng, W. C., Xu, P. Y., Lan, Y. J., Zhu, R. X., Zhong, K., ... & Gao, H. (2012). Chemical composition and antimicrobial activity of the essential oil of kumquat (Fortunella crassifolia Swingle) peel. *International journal of molecular sciences*, *13*(3), 3382-3393.

Yu, X., Meenu, M., Xu, B., & Yu, H. (2021). Impact of processing technologies on isoflavones, phenolic acids, and antioxidant capacities of soymilk prepared from 15 soybean varieties. *Food Chemistry*, *345*, 128612.

GIDA ENDÜSTRİSİNDE MİKOTOKSİNLER VE AZALTMA YÖNTEMLERİ

Doç. Dr. Yeliz TEKGÜL BARUT
Aydın Adnan Menderes University, Köşk Vocational School, Department of Food Processing Aydın-Turkey
Email: yeliz.tekgul@adu.edu.tr

ÖZET
Gıdalarda küf mantarları tarafından üretilen ikincil metabolitler olan mikotoksinler, gıdaları kullanılamaz hale getirerek ekonomik kayıplara neden olmaktadır. Teratojenik, kanserojenik ve mutajenik etkilere sahip olan mikotoksinler insan sağlığını olumsuz etkilemektedir. Bağışıklık sisteminin bozulması sonucu hastalıklara yatkınlığa neden olmaktadır. Üreme organları, karaciğer ve böbrekler üzerinde olumsuz etkileri vardır. İnsan sağlığı üzerinde olumsuz etkileri olan mikotoksinlerin oluşumunu engellemek için pek çok araştırma yapılmakta olup mikotoksinlerin zararlı etkilerini azaltmak ve ortadan kaldırmak için kullanılabilecek yöntemler bulunmaktadır. Bu çalışmada mikotoksinlerin ortadan kaldırılmasında kullanılan yöntemler ve etkileri derlenmiştir.
Anahtar Kelimeler: mikotoksin, gıda, önleme yöntemleri

MYCOTOXINS AND REDUCTION METHODS IN THE FOOD INDUSTRY

ABSTRACT
Mycotoxins, which are secondary metabolites produced by mold fungi in foods, cause economic losses by making foods unusable. Mycotoxins, which have teratogenic, carcinogenic and mutagenic effects, negatively affect human health. They cause susceptibility to diseases as a result of the impairment of the immune system. It has negative effects on reproductive organs, liver and kidneys. A lot of research is being done to prevent the formation of mycotoxins, which have negative effects on human health, and there are methods that can be used to reduce and eliminate the harmful effects of mycotoxins. In this study, the methods used in the degradation of mycotoxins and their effects are compiled.
Keywords: mycotoxin, food, prevention methods

1. Giriş

Mikotoksinler mantar türleri tarafından üretilen ikincil metabolitlerdir ve karsinojenik, genotoksik, teratojenik, nefro ve hepatotoksik oldukları bildirilmiştir. Mikotoksinlerden kaynaklanan ekonomik kayıplar ve sağlık endişeleri, gıda ve yem üretiminin her seviyesinde ortaya çıkmaktadır ve bu durum, mikotoksinle kirlenmiş gıda ve yemlerin dekontamine edilmesi ve/veya detoksifiye edilmesi için yeni yaklaşımların araştırılmasına yönelik ilgiyi artırmıştır. Bu nedenle, hasat öncesi önleme stratejileri ve hasat sonrası detoksifikasyon prosedürleri de dahil olmak üzere mikotoksinlerin detoksifikasyonu için çeşitli stratejiler yer almaktadır. Hasat öncesi önleme stratejileri uygun çevresel faktörleri, iyi tarım ve üretim uygulamalarını ve uygun depolama uygulamalarını içerir. Hasat sonrası detoksifikasyon stratejileri için fiziksel, kimyasal, biyolojik ve diğer gelişen yenilikçi stratejiler tartışılmaktadır.

Mikotoksinler, çoğunlukla *Fusarium, Aspergillus* ve *Penicillium* cinslerine ait filamentli mantarlar tarafından üretilen oldukça toksik ikincil metabolitlerdir. (Jarda, Liboz, Mathieua, Guyonvarc'h ve Lebrihi, 2011). 100'den fazla mantar tarafından üretilen toksijenik potansiyele sahip yaklaşık 300 mantar metaboliti rapor edilmiştir (Paterson & Lima, 2010). Birçok toksijenik metabolit tanımlanmıştır ve bunlardan bazıları oldukça toksik veya kanserojendir ve hem insanlarda hem de hayvanlarda akut veya kronik etkiler yaratabilirler. Aflatoksinler, okratoksinler, patulin, fumonisinler, trikotesenler ve zearalenon dahil olmak üzere tarım ve gıda sistemlerinde sıklıkla karşılaşılan altı mikotoksin vardır ve bunların her biri birkaç farklı mantar türü tarafından üretilebilir.

Gıda ve yem ürünlerinin mikotoksinler tarafından kontaminasyonu dünya çapında tekrar eden ciddi bir sorundur. Gıda ve Tarım Örgütü'nün tahminlerine göre, dünya genelindeki ürünlerin yaklaşık %25'i mantarlar tarafından üretilen mikotoksinler tarafından kontamine edilebilmekte ve milyarlarca dolara varan önemli ekonomik kayıplara yol açmaktadır (FAO, 2002). Mikotoksin kontaminasyonu nedeniyle Temmuz 2013'te pirinç fiyatları 400 ila 650 dolar arasında ciddi bir artış göstermiştir (FAO, 2013). ABD'de mikotoksinler nedeniyle hayvan yemi ve çiftlik hayvanlarındaki kayıp yıllık yaklaşık 243 milyon dolardır (CAST, 2003). Buna ek olarak, hasat edilen meyve ve sebzelerin %25'i mikotoksin kontaminasyonu nedeniyle atılmaktadır.

Mikotoksinlerin toksisitesi kalıcı olma eğilimindedir ve gıda ve yem zincirine girdikten sonra çıkarılmaları son derece zordur. Hayvan yemlerinde oluşan mikotoksinler yemlerin besin değerlerini azaltabilir. Kirlenmiş yem maddeleri çiftlik hayvanları tarafından yutulduğunda, hayvan sağlığına zarar verir, kronik hastalıklara neden olur ve hatta ölümle sonuçlanır (Laan, Bull, Pirie, & Fink-Gremmels, 2006). İnsan sağlığı riskleri genellikle mikotoksinlerle kontamine olmuş gıda ürünlerinin (meyve, mısır, tahıl vb.) doğrudan alımı veya kontamine yemlerle beslenen hayvanlardan elde edilen hayvansal kaynaklı ürünlerin dolaylı tüketimi ile ilişkilendirilmektedir (Capriotti ve ark., 2012). Gelişmekte olan ülkelerde 4,5 milyar insan kronik olarak yüksek dozda mikotoksinlere maruz kalmaktadır (Williams ve ark., 2004). Genel olarak, mikotoksinlerin hücre çoğalmasını ve protein sentezini engelleyerek bağışıklık sistemine zarar verdiği bilinmektedir. Ayrıca, diğer birçok hastalık mikotoksin alımıyla ilişkilidir. Akut aşırı doz alımında, ana toksik etkiler hepatotoksisite, nefrotoksisite ve hatta bazı durumlarda ölümdür. Kronik tüketimde ise toksik etkiler genotoksisite, karsinojenite ve üreme bozuklukları şeklinde ortaya çıkmaktadır (Anfossi, Baggiani, Giovannoli, & Giraudi, 2010).

Mikotoksinlerin toksik etkileri nedeniyle, mikotoksin bulaşmış gıda ve yemlerin dekontaminasyonu ve detoksifikasyonu için çok sayıda strateji geliştirilmiştir. Bunlar hasat öncesi tedbirler ve mikotoksinle kirlenmiş ürünlerin hasat sonrası detoksifikasyonu olarak sınıflandırılabilir.

2. Mikotoksinler

2.1. Aflatoksinler

Aflatoksinler, *Aspergillus flavus, Aspergillus para- siticus* ve *Aspergillus nomius* mantarları tarafından üretilen en baskın ve oldukça toksik mikotoksinlerdir (Bhat, Rai ve Karim, 2010; O'Riordan ve Wilkinson, 2008). Aflatoksinlerin yaklaşık 18 farklı formu vardır ve bunlardan aflatoksin B_1, B_2 , G_1 , G_2 , M_1 ve M_2 en önemlileridir. AFM_1 ve AFM_2 sırasıyla AFB_1 ve AFB_2 'den üretilen hidrodoksillenmiş metabolitlerdir. Kanserojen, mutajenik ve teratojenik olduğu düşünülen aflatoksinlerin akut veya kronik karaciğer hastalıklarına yol açtığı bilinmektedir. Aflatoksinler arasında AFB1 doğadaki en baskın ve güçlü kanserojen olarak kabul edilmektedir (Murphy, Hendrich, Landgren, & Bryant, 2006; Iamanakaa, de Menezes, Vicentea, Leitea, & Taniwaki, 2007).

2.2. Okratoksinler

Doğal olarak oluşan okratoksin A, B ve C, Aspergillus ve Penicillium tarafından üretilmektedir. Hem sıcak hem de soğuk iklimlerde izole edilen okratoksinler, dünya genelinde mısır, tahıl, kahve, şarap ve domuz ürünleri gibi çeşitli gıdalarda bulunmaktadır (Bayman & Baker, 2006). Bunlar arasında okratoksin A (OTA) en toksik okratoksindir ve toksijenik mantarlar tarafından üretilebilir, genotoksik, hepatotoksik, immünotoksik ve hayvanlar ve insanlar için kanserojeniktir.

2.3. Patulin

Patulin, *Penicillium* ve *Asper- gillus'un* çeşitli türleri tarafından üretilmektedir. Bu mikotoksin sıklıkla meyvelerde (elma, armut, maydanoz, kiraz, kivi vb.), meyve ürünlerinde ve sebzelerde kontaminant olarak bulunur (Demirci, Arici ve Gumus, 2003). Hasat sonrası meyveler için ciddi bir tehlike olan patulin, ilk olarak yaralı meyvelerin yüzeyine temas eder, daha sonra tüm meyveyi kontamine eder ve birlikte depolanan meyvelere yayılabilir. Patulin üretiminin sıcaklık, pH ve su içeriği gibi faktörlerle ilişkili olduğu bulunmuştur.

2.4 Fumonisinler

Fumonisinler, uygun yüksek sıcaklık ve nemli iklimlerde *Fusarium verticillioides ve Fusarium proliferatum* mantarları tarafından sentezlenir ve mısır ve diğer tahıl tanelerinde sıklıkla bulunurlar (Marin, Magan, Ramos ve Sanchis, 2004). İnsanlarda fumonisinler nöral tüp defektlerinin yanı sıra karaciğer ve özofagus kanseri ile ilişkilendirilmektedir (Marasas vd., 2004; Alizadeh vd., 2012). Çeşitli türleri arasında, fumonisin B_1 (FB_1) insanlar için en yaygın olarak bulunan ve baskın kanser teşvik edicidir.

2.5 Zearalenon

ZEN, esas olarak birkaç Fusarium türü tarafından üretilen östrojenik bir mikotoksindir. ZEN üreten mantarlar çoğunlukla yağışlı, ılıman havalarda ve yüksek nemli depolama ortamlarında ortaya çıkar. ZEN'e maruz kalma, özellikle kızlarda erken ergenliğe yansıyan östrojenik etkilerle ilişkilendirilmiştir (Massart, Meucci, Saggese ve Soldani, 2008).

3. Mikotoksin oluşumunun önlenmesi

Küfler bitkilerde ve bitkisel ürünlerde hem yetiştirme hem de depolama aşamalarında ortaya çıkabilir (Gnonlonfin ve ark., 2013). Küf gelişimi ve mikotoksin

oluşumu temel olarak çevresel faktörlere, tarımsal uygulamalara ve depolama koşullarına bağlıdır (Stoev, 2013). Mikotoksin üretim koşulları çeşitli faktörlerden etkilenir: sıcaklık, nem içeriği, mevcut besin, çevrenin insan yoğunluğu ve diğer ilişkili faktörler (Bhat ve ark., 2010). Uygun sıcaklık ve nem, mikotoksijenik mantarların mikotoksin üretmesi için baskın çevresel faktörlerdir. Genel olarak, ılıman ve subtropikal iklimlerdeki ülkelerdeki ürünler mikotoksinlere daha kolay maruz kalabilirken, tropikal ülkelerdeki koşullar mantar büyümesi ve mikotoksin üretimi için uygun değildir (FAO, 2000).

İyi tarım ve üretim uygulamaları, mikotoksijenik mantar gelişimini ve mikotoksin üretimini önlemek için en etkili seçeneklerdir. Modern tarım ve üretim teknolojilerinin yanı sıra daha iyi hükümet düzenlemelerinin uygulanması nedeniyle, gelişmiş ülkelerdeki insanlar gelişmekte olan ülkelerdekilere kıyasla mikotoksinlere daha az maruz kalmaktadır (Bhat ve ark., 2010). Tehlike Analizi ve Kritik Kontrol Noktası (HACCP) sistemleri de mikotoksin önleme ve yönetiminde önemli bir rol oynamaktadır; bu sistemler artık tarla yönetimi, depolama izleme, otomatik ayıklama, ayrıştırma ve temizleme prosedürlerinin tüm aşamalarında mikotoksin önleme, kontrol ve iyi üretim uygulamalarına yönelik stratejileri içermektedir (FAO, 2002; Stove, 2013).

Uygun depolama uygulamaları küf gelişimini önleyebilir ve depoların optimum sıcaklık, nem seviyesi ve nem oranı da küf gelişimini azaltabilir ve mikotoksin üretimini önleyebilir (Peraica, Domijan, Jurjevic ve Cvjetkovic, 2002). Depolama sırasında tarımsal ürünlerin nem seviyesinin düşürülmesi mantar büyümesi ve metabolizması için uygun olmayan koşullar yaratabilir (Lanyasunya, Wamae, Musa, Olowofeso ve Lokwaleput, 2005).

4. Mikotoksin Detoksifikasyonu

Fiziksel yöntemlerle mikotoksin dekontaminasyonu ayıklama ve ayırma, daldırma ve yıkama, ışınlama, filtreleme ve adsorpsiyon gibi çeşitli prosedürleri içerir. Kirlenmiş tahılların yoğunluk özellikleri nedeniyle, tahılların suya daldırılması ve yüzen fraksiyonların atılması genellikle bir miktar aflatoksini ortadan kaldırabilir ve bu yüzdürme tekniği ilgili bir aparatla birlikte aflatoksinlerin %80'ine kadarını ortadan kaldırabilir (Fandohanet al., 2005; Bethkeet al., 2014). Radyasyon, mantar gelişiminin engellenmesi ve ince bir tahıl tabakasına uygulandığında aflatoksinlerin, T-2 toksininin veya deoksinivalenolün dekontaminasyonu için etkilidir (Peraica ve ark., 2002). Son yıllarda mikotoksinleri adsorbe etme kabiliyetlerini tespit etmek için çeşitli adsorbanlar

araştırılmıştır. Genel bir adsorban olarak aktif kömür, geniş bir yüzey alanına ve sulu ortamlarda mükemmel adsorpsiyon kabiliyetine sahiptir. Birçok çalışmada mikotoksinlerin aktif kömür ile adsorpsiyonu rapor edilmiş ve gözenekli yapısı nedeniyle aflatoksin kalıntılarını, patulin, ZEA, DON ve nivalenolü azalttığı gösterilmiştir (Avantaggiato, Havenaar ve Visconti, 2003, 2004; Liu vd., 2011). Kimyasal işlemlerin mikotoksin dekontaminasyonundaki etkinliği araştırılmıştır. Bazlar, oksitleyici maddeler, organik asitler ve diğer maddeleri içeren çok sayıda kimyasal madde mikotoksin kontrolü için uygundur. Son zamanlarda, gliserol ve kalsiyum hidroksit karışımının mikotoksinler için güçlü bir detoksifikasyon etkisine sahip olduğu gösterilmiştir (Venter, 2014). Ozon, etkili bir detoksifikasyon yöntemi olarak gıda işlemede kullanım için onaylanmıştır. Patulin, aflatoksinler ve zearalenonun ozon tarafından etkili bir şekilde parçalandığı gösterilmiştir. AFB_1, AFB_2, AFG_1 ve AFG_2 aflatoksinlerinin ozon ile parçalanması çalışılmış, ozonun aflatoksinleri parçalama kabiliyeti kanıtlanmıştır (Agriopoulou, Koliadima, Karaiskakis, & Kapolos, 2016). Mikotoksijenik fungal büyümeyi önlemek ve mikotoksin kontaminasyonunu ortadan kaldırmak için çok sayıda fiziksel ve kimyasal detoksifikasyon stratejisi geliştirilmiş olsa da, yüksek maliyetleri, biyogüvenlik riski veya sınırlı bağlama kapasiteleri nedeniyle çok az strateji gereksinimleri karşılamaktadır. İnsan tüketimine yönelik gıda güvenliğini sağlamak için uygun biyolojik detoksifikasyon yöntemlerinin geliştirilmesi gerekmektedir (San'Ana, Rosenthal ve De Massaguer, 2008; Walter, Tunde ve Istvan, 2015). Çok çeşitli bakteriler, küfler ve mayalar mikotoksinleri biyolojik olarak parçalama yeteneğini göstermiştir. Bazı uçucu biyoaktif bileşiklerin küf gelişimini engellemede ve mikotoksin birikimini azaltmada etkili olduğu kanıtlanmıştır.

5. Sonuç

Gıda zincirinde mikotoksinlerin ortaya çıkması büyük bir endişe kaynağıdır ve dünya çapında gıda endüstrisinde kaçınılmaz bir sorundur. Hasat öncesi stratejiler için, uygun çevresel koşullar, iyi tarım ve üretim uygulamaları ve uygun depolama uygulamaları, toksijenik mantarların tarlada gelişmesini önlemek için iyi yollardır. Detoksifikasyon prosedürleri için fiziksel işlemler (ayırma, yıkama, ışınlama ve filtreleme dahil), kimyasal işlemler (bazlar, oksitleyici maddeler, organik asitler ve diğerlerini içeren), biyolojik detoksifikasyon yöntemleri (bakteriler, mayalar ve bazı küfler) ve diğer yenilikçi yaklaşımlar önerilmiştir. Bu yaklaşımların her biri pratik ve etkili olabilir. Ancak, bu tür teknikler ne kadar etkili olursa olsun, daha fazla yeşil yenilikçi teknolojinin artan kabulü,

çevre koruma ve gıda güvenliği konusundaki artan farkındalıktan kaynaklanmaktadır. Bu eğilim göz önünde bulundurulduğunda, gelecekteki mikotoksin kontrolleri büyük olasılıkla tek bir işlemden değil, iyi üretim uygulamaları, uygun kalite güvence programları ve üretim süreci boyunca çevre dostu ve biyogüvenli hasat sonrası detoksifikasyon prosedürlerinin bir kombinasyonundan kaynaklanacaktır.

Kaynaklar

Agriopoulou, S., Koliadima, A., Karaiskakis, G., & Kapolos, J. (2016). Kinetic study of aflatoxins' degradation in the presence of ozone. Food Control, 61, 221-226.

Anfossi, L., Baggiani, C., Giovannoli, C., & Giraudi, G. (2010). Mycotoxins in food and feed: Extraction, analysis and emerging technologies for rapid and on-field detection. Recent Patents on Food, Nutrition & Agriculture, 2(2), 140-153.

Avantaggiato, G., Havenaar, R., & Visconti, A. (2003). Assessing the zearalenonebinding activity of adsorbent materials during passage through a dynamic in vitro gastrointestinal model. Food and Chemical Toxicology, 41(10),1283-1290.

Bayman, P., & Baker, J. L. (2006). Ochratoxin: A global perspective. Mycopathologia, 162, 215-223.

Bhat, R., Rai, R. V., & Karim, A. A. (2010). Mycotoxins in food and feed: Present status and future concerns. Comprehensive Reviews in Food Science and Food Safety, 9, 57-81.

Capriotti, A. L., Caruso, G., Cavaliere, C., Foglia, P., Samperi, R., & Lagana, A. (2012). Multiclass mycotoxin analysis in food, environmental and biological matrices with chromatography/mass spectrometry. Mass Spectrometry Reviews, 31(4), 466-503.

CAST. (2003). Mycotoxins: Risks in plant, animal, and human system. In J. L. Richard,& G. A. Payne (Eds.), Council for agricultural science and technology task force report, No. 139. Iowa, USA: Ames..

Demirci, M., Arici, M., & Gumus, T. (2003). Presence of patulin in fruit and fruit juices produced in Turkey. Ernahrungs- umschau, 50(7), 262-263.

Fandohan, P., Zoumenou, D., Hounhouigan, D. J., Marasas, W. F., Wingfield, M. J., & Hell, K. (2005). Fate of aflatoxins and fumonisin during the processing of maize into food products in Benin. International Journal of Food Microbiology, 98, 249-259.

FAO. (2002). Manual on the application of the HACCP system in mycotoxin prevention and control. Rome, Italy: Joint FAO/WHO Food Standards Programme FAO.

food. Food Research International, 42(7), 1902-1914.

Gnonlonfin, G. J. B., Hell, K., Adjovi, Y., Fandohan, P., Koudande, D. O., Mensah, G. A., et al. (2013). A review on aflatoxin contamination and its implications in the

developing world: A Sub-Saharan African perspective. Critical Reviews in Food Science and Nutrition, 53, 349-365.

Iamanakaa, B. T., de Menezes, H. C., Vicentea, E., Leitea, R. S., & Taniwaki, M. H. (2007). Aflatoxigenic fungi and aflatoxins occurrence in sultanas and dried figs commercialized in Brazil. Food Control, 18, 454-457.

Jarda, G., Liboz, T., Mathieua, F., Guyonvarc'h, A., & Lebrihi, A. (2011). Review of mycotoxin reduction in food and feed: From prevention in the field to detoxification by adsorption or transformation. Food Additives & Contaminants, 28(11),1590-1609.

Laan, T., Bull, S., Pirie, R., & Fink-Gremmels, J. (2006). The role of alveolar macrophages in the pathogenesis of recurrent airway obstruction in horses. Journal of Veterinary Internal Medicine, 20, 167-174.

Lanyasunya, T. P., Wamae, L. W., Musa, H. H., Olowofeso, O., & Lokwaleput, I. K.(2005). The risk of mycotoxins contamination of dairy feed and milk on small holder dairy farms in Kenya. Pakistan Journal of Nutrition, 4, 162-169.

Liu, Y. L., Meng, G. Q., Wang, H. R., Zhu, H. L., Hou, Y. Q., Wang, W. J., et al. (2011). Effect of three mycotoxin adsorbents on growth performance: Nutrient retention and meat quality in broilers fed on mould-contaminated feed. British Poultry Science, 52, 255-263.

Marasas, W. F. O., Riley, R. T., Hendricks, K. A., Stevens, V. L., Sadler, T. W., Gelineauvan

Marin, S., Magan, N., Ramos, A. J., & Sanchis, V. (2004). Fumonisin-producing strains of fusarium: A review of their ecophysiology. Journal of Food Protection, 67(8), 1792-1805.

Massart, F., Meucci, V., Saggese, G., & Soldani, G. (2008). High growth rate of girls with precocious puberty exposed to estrogenic mycotoxins. Journal of Pediatric,152, 690-695.

Murphy, P. A., Hendrich, S., Landgren, C., & Bryant, C. M. (2006). Food mycotoxins:An update. Journal of Food Science, 71(5), 51-65.

O'Riordan, M. J., & Wilkinson, M. G. (2008). A survey of the incidence and level of aflatoxin contamination in a range of imported spice preparations on the Irish retail market. Food Chemistry, 107, 1429-1435.

Paterson, R. R. M., & Lima, N. (2010). How will climate change affect mycotoxins in

Peraica, M., Domijan, A. M., Jurjevic, Z., & Cvjetkovic, B. (2002). Prevention of exposure to mycotoxins from food and feed. Archives of Industrial Hygiene and Toxicology, 53, 229-237.

San'Ana, A. S., Rosenthal, A., & De Massaguer, P. R. (2008). The fate of patulin in apple juice processing: A review. Food Research International, 41, 441-453.

Stove, S. D. (2013). Food safety and increasing hazard of mycotoxin occurrence in foods and feeds. Critical Reviews in Food Science and Nutrition, 53, 887-901.

Venter, A. C. (2014). Glycerol compositions and solutions. US Patent Application Publication. No. 20140106008, A1.

Waes, J., et al. (2004). Fumonisins disrupt sphingolipid metabolism, folate transport, and neural tube development in embryo culture and in vivo: A potential risk factor for human neural tube defects among populations consuming fumonisin-contaminated maize. Journal of Nutrition, 134, 711-716.

Walter, P. P., Tunde, P., & Istvan, P. (2015). Mycotoxins-prevention and decontamination by yeast. Journal of Basic Microbiology, 55, 805-818.

Williams, J. H., Phillips, T. D., Jolly, P. E., Stiles, J. K., Jolly, C. M., & Aggarwal, D. (2004).Human aflatoxicosis in developing countries: A review of toxicology, exposure, potential health consequences, and interventions. American Journal of Clinical Nutrition, 80, 1106-1122.

APPROACHES TO PREVENT FOOD WASTE AND UTILIZATION OF WASTE INTO AGRICULTURAL PRODUCTION

Arş. Gör. Dr. M. Safa HACIKAMİLOĞLU (ORCID: 0000-0002-2188-2765)
Ondokuz Mayıs University, Faculty of Agriculture, Field Crops Department, Samsun/Türkiye
Email: safa.hacikamiloglu@omu.edu.tr

Dr. Öğr. Üyesi Mehmet Selim ŞILBIR* (ORCID: 0000-0003-4203-6880)
Iğdır University, Iğdır Vocational School Of Higher Education, Department of Hotel, Restaurant and Catering Services, Iğdır/Türkiye
Email: mselim.silbir@igdir.edu.tr

Dr. Elnaz LATIFIAN (ORCID: 0000-0002-0937-6931)
Ondokuz Mayıs University, Faculty of Agriculture, Field Crops Department, Samsun/Türkiye
Email: eli.latifian@gmail.com

Prof. Dr. Orhan KURT (ORCID: 0000-0002-5662-9372)
Ondokuz Mayıs University, Faculty of Agriculture, Field Crops Department, Samsun/Türkiye
Email: orhank@omu.edu.tr

ABSTRACT
The increasing problem of food waste, which is a growing concern worldwide, arises at various stages including harvesting, transportation, processing, packaging, distribution, and consumption. According to FAO research, the quantities of waste generated at each stage from production to consumption vary in different regions. Globally, approximately 56% of the estimated 931 million tons of food waste is believed to occur (predicted value) in developed countries, while the remaining 44% is in developing countries. Researchers and non-governmental organizations have developed various projects aimed at preventing food waste. In recent years, projects have also been developed in our country to address food waste, with a focus primarily on raising consumer awareness. Approaches to preventing food waste in agricultural production involve the conversion of components arising after harvest, during processing, and post-consumption into organic matter. With the help of the new technology, biophortification, bioenergy, organic farming, and recycling techniques enable the integration of food and product waste to transform into agricultural input. In this review, approaches to the transformation of food waste into agricultural products and various by-products (such as bioethanol, natural color pigments, etc...) will be assessed, and their potentials for our country and the world will be discussed.
Keywords: bioenergy environment, food waste, recycle

Introduction

More than 7 billion people live in the world, and this number is increasing by the minute. In order to meet the food needs of this population, conventional agriculture is carried out in large areas and the world's water-soil reserves are used intensively. In addition to the areas allocated for production, the settlement areas of people are also expanding every year, and in some regions, forests and even wetlands are added to the settlements. Despite the expansion of settlements, there is no potential for expansion of agricultural areas. Moreover, fertilizers and chemicals used in conventional agriculture activities pollute both the ecosystem and residential areas and cause global warming.

Food processing systems harm the environment by becoming waste during processing and consumption, as well as harming nature during the agricultural production phase. The researchers emphasize that more than half of solid waste is consist of food. The amount of waste produced by humans has reached the point of disrupting the environmental balance. The decay and putrefaction activity caused by foodborne garbage in the environment is the main source of important pollution and epidemics today.

At this point, recycling wastes and reusing them in agricultural production aims to protect the environment with a circular approach and reduce agricultural inputs instead of one-way increasing consumption. New technologies need to be developed in order to fully realize recycling, which we are familiar with today. Recent techniques that have been developed with the help of science are compost, anaerobic digestion, vermicompost, fermentation and algae production. Some of these technologies aim to increase yield in agricultural production, some aim to increase quality, some aim to reduce the damage of diseases, and some aim to reduce the price of agricultural inputs. With the help of these technologies, it is aimed to prevent food waste damage and to ensure the continuity of agricultural production.

Material and Methods

The material of this article; it constitutes international statistical data. It also creates application-oriented data obtained from studies conducted in this field.

Hunger is an increasing problem across the world. According to FAO research, more than 840 million people are suffering from hunger, while 3.1 billion people have poor nutritional conditions (FAO,2024). On the other hand, an average person waste 65

kg of food every year. Most of the food waste consist of grain crops, roots, sugar crops. cereals, meat and sugar waste can cause global impact as waste (Chen et al., 2020).

Food waste amounts changes according to country. While developed countries produce less waste, developing countries waste more food. Food waste amounts chancing according to human population, lifestyle, eating habits, industry, agriculture trends. Also, countries with low amounts may change their waste production trends due to lifestyle and culture changes. Food waste amounts of some developed and developing countries listed on Table 1.

COUNTRY	FOOD WASTE (Million Ton)
United Kingdom (Jeswani et al., 2021)	13.1
USA (Thi et al., 2015)	60.9
Australia (Thi et al., 2015)	2.2
Türkiye (Çakar et al., 2020)	16.0
Mexico (Thi et al., 2015)	19.9
China (Thi et al., 2015)	195.0

Food waste created in several steps, which is agricultural production, post harvest, processing and consumption, mentioned by several researchers (Awasthi et al., 2020; Tekiner et al., 2021). Plant diseases and pests can cause big impact on the production and cause big waste. In this phase, insects, birds, fungi, viruses and mold may cause drastical yield loss. On the other hand, high and low temperature, soil salinity and flood can cause the same impact. Wasted products and plant parts creates nearby landfill. Since farmers in developing countries prefer to burn these production residues, extra environmental damage can occur in addition to food residues. Post harvest food waste may occur due to old technology farming equipments and transport failures. Companies would dump the waste in unused areas. Procccessing phase food waste mostly consist of waste water, while the rest is starch, sugar and some other nutrition elements. Consumption phase mostly consist of restaurant and fast food residues. Water, nitrogen, phosporus, heavy metals and some other elements may found at homemade food waste. Water content makes it difficult to recycle. In the short term, food waste may associated with environment pollution, epidemics, odor and greenhouse gas emissions. Bacteria, fungi, viruses may increase in landfill and turn into epidemics with human and animal contact, also they can reach groundwater with the help of rain. In the long periods, greenhouse gas

emissions may effect the global warming, which has catastrophic harm to the world. Many projects have been carried out to reduce food waste in the world. The idea of recycling food scraps is one of them. Trending food recycle methods are compost, biochar and bio-energy applications. This study aims to review this methods.

Findings and Discussion

Waste Recycling Technologies

Compost

Composting is the conversion of waste into useful Products with the help of microorganisms in aerobic conditions. Composting can reduce food waste in production and post production phases. Both plant and animal waste can be used. Aerobic composting (traditional) and worm assisted (vermicompost) composting are most used types (Figure 1) .

Traditional compost

Vermicompost

Figure 1. Compost types

Compost has several advantages for farmers; advert pyhsical properties of soil, increase soil-water capasity, regulation of soil acidity (pH), decrease chemical fertiliser use(Sülük et al., 2023).

Biochar

Biochar production is pyrolysis of biomass at 450-550 °C, without oxygene. Biomass converts into biogas and biochar. Biochar has several benefits like heavy metal absorbtion, soil water capacity regulation, soil microbial structure regulation, air cleaning, biogas production, alternative fuel (Danesh et al., 2023).

Bio-Energy

Food waste is accepted as a good source of bioenergy with rich source of water, proteins enzymes oils lignans colorants etc. Different bioenergy applications are shown in Table 1 (Mohanty et al 2022).

Table 1. Bioenergy applications

Bioelectricity	**Biofuels**	**Bioreactors**
Microbial Fuel Cells	Biobutane	Membrane Reactor
Electrogen Bacteria	Biomethane	
	Biodiesel	

Bioelectricity: While electrogen bacteria decomposing organic material they produce electrons. Electrons move to anaerobic anode and produce electricity (Obileke et al 2021). So many different types of MFC's produced for bioelectiricity.

Biogas: Biogas production is old and viable technology on commercial scale. Mesophylic and hermophylic bacteria can operate the system. All organic waste can be used in biogas production. Several advantages mentioned for biogas production, all type of organic matter can be used, electric can be produced from biogasses, heat production option, cooling, product can be used as vehicle fuel.

Bioreactor: Bioreactor is a term, which consists of microorganisms, processing substrate and producing the desired product under certain conditions batch, semi batch or continuously.

Table 2. Types of bioreactors

Photobioreactor	Airlift bioreactor	Rotary Drum bioreactor
Cell bioreactor	Stirred tank	Membrane fermentor
Fluidized bed reactor	Buble Column reactor	Packed Bed reactor

Bioreactors can produce dangerous chemicals (like painting chemicals) in safe conditions, from cheaper operation cost and work continuously. On the other hand, creating a bioreactor is very complex and first maintenance can be very expensive.

Conclusion and Recommendations

Compost and landfill are the most used methods for food waste, while landfill is harmful fort he environment. Bioenergy applications are new compared to composting techniques. Bioenergy applications are more environment friendly than composting, because of the low emission of greenhouse gases such as methane.

Production of color chemicals is very dangerous process and waste products are polluting water sources. The synthetic pigment industry is creating tonnes of harmful chemicals for the environment and human health. Colour pigment production in bioreactors is a new and promising technology. Bioreactors can operate at a very low cost

and can work continuously. Membrane reactors can produce natural pigments without harmful chemicals without using any dangerous chemicals.

References

Awasthi, S.K., Sarsaiya, S., Awasthi, M.K., Liu, T., Zhao, J., Kumar, S., Zhang, Z., (2020). Changes in global trends in food waste composting: research challenges and opportunities. *Biosource Technology*. 299. https://doi.org/10.1016/j.biortech.2019.122555.

Chen, C., Chaudhary, A., Mathys, A., (2020). Nutritional and environmental losses embedded in global food waste. *Resources, Conservation & Recycling*. 160. https://doi.org/10.1016/j.resconrec.2020.104912.

Çakar, B., Aydın, S., Varank, G., Ozcan, H.K., (2020). Assessment of environmental impact of FOOD waste in Turkey. *Journal of Cleaner Production*. 244. https://doi.org/10.1016/j.jclepro.2019.118846.

Danesh, P., Niaparast, P., Ghorbannezhad, P., Ali, I., (2023). Biochar production: recent developments, applications, and challenges. *Fuel*. 337. https://doi.org/10.1016/j.fuel.2022.126889.

Food and Agriculture Organisation (FAO). https://www.fao.org/newsroom/detail/FAO-UNEP-agriculture-environment-food-loss-waste-day-2022/en. Access Adress (01.03. 2024).

He, Z., Wagner, N., Minteer, S.D., Angenent, L.T., (2006). An upflow microbial fuel cell with an interior cathode: assessment of the internal resistance by impedance spectroscopy. *Environment Science and Technology*. 40(17): 5212–5217. https://doi.org/10.1021/es060394f.

Jeswani, H.K., Figueroa-Torres, G., Azapagic, A., (2021). The extent of food waste generation in the UK and its environmental impacts. *Sustainable Production and Consumption*. 26: 532-547. https://doi.org/10.1016/j.spc.2020.12.021

Mohanty, A., Mankoti, M., Rout, P.R., Meena, S.S., Dewan, S., Kalia, B., Varjani, S., Wong, J.W.C., Banu, J.R., (2022). Sustainable utilization of food waste for bioenergy production: A step towards circular bioeconomy. *International Journal of Food Microbiology*. 365. https://doi.org/10.1016/j.ijfoodmicro.2022.109538.

Obileke, K., Onyeaka, H., Meyer, E.L., Nwokolo, N., (2021). Microbial fuel cells, a renewable energy technology for bio-electricity generation: a mini-review.

Electrochemistry Communications. 125. https://doi.org/10.1016/j.elecom.2021.107003.

Sülük, K., Tosun, İ., Ekinci, K., (2023). Elma işleme atıkları kompostundan solucan kompostu üretimi. *Mühendislik Bilimleri ve Tasarım Dergisi*. 11(2), 844 – 856. DOI: 10.21923/jesd.1214009.

Tekiner, İ.H., Mercan, N.N., Kahraman, A., Özel, M., (2021). Dünya ve Türkiye'de gıda israfı ve kaybına genel bir bakış. *İstanbul Sabahattin Zaim Üniversitesi Fen Bilimleri Enstitüsü Dergisi*. 3(2): 123-128.

Thi, N.B.D., Kumar, G., Lin, C.Y., (2015). An overview of food waste management in developing countries: current status and future perspective. *Journal of Environmental Management*, 157: 2020-229.

Westerholm, M., Liu, T., Schnürer, A., (2020). Comparative study of industrial-scale high-solid biogas production from food waste: Process operation and microbiology. *Bioresource Technology*. 304. https://doi.org/10.1016/j.biortech.2020.122981.

AVAILABILITY OF OLIVE LEAF EXTRACT IN FOOD PRODUCTS AS AN ANTIMICROBIAL PRESERVATIVE

Dr. Ayla MUMCU (ORCID: 0000-0002-8501-9004)
Zeytincilik Araştırma Enstitüsü Müdürlüğü-İzmir
Email: ayla.mumcu@tarimorman.gov.tr (Responsible Author)

Dr. Ferişte ÖZTÜRK GÜNGÖR (ORCID: 0000-0002-0678-7305)
Zeytincilik Araştırma Enstitüsü Müdürlüğü-İzmir
Email: feriste.ozturkgungor@tarimorman.gov.tr

Zeynep Şeyda ERDEMİR TIRAŞ (ORCID: 0000-0002-2138-0298)
Zeytincilik Araştırma Enstitüsü Müdürlüğü-İzmir
Email: zeynep.erdemirtiras@tarimorman.gov.tr

Dr. Erkan SUSAMCI (ORCID: 0000-0003-1956-4634)
Zeytincilik Araştırma Enstitüsü Müdürlüğü-İzmir
Email: erkan.susamci@tarimorman.gov.tr

Doç. Dr. Seda ERSUS (ORCID:0000-0003-0475-4099)
Ege Üniversitesi, Gıda Mühendisliği Bölümü
Email: seda.ersus@ege.edu.tr

ABSTRACT

Olive fruit (*Olea europaea* L.), which is a symbol of Mediterranean civilization, is rich in bioactive substances and has an important place in human nutrition. The olive leaf is also rich in bioactive substances and has been used in many areas for centuries, and is produced in high amounts during harvesting, pruning, and production of olive oil and table olives. Phenolic compounds are the leading bioactive components found in olive leaves. It has been proven by scientific studies that these compounds have many pharmacological properties such as antioxidant, antifungal, antibacterial, antiviral, anti-inflammatory, antiterogenic and anti-cancer. The amount of phenolic compounds, their composition and therefore antimicrobial and antioxidant activities vary depending on variety of olive, season, harvesting time, and also extraction method used. Although the most commonly used extraction method is solvent extraction, new methods are also being studied to increase the extraction efficiency. Since olive leaf extract (OLE) has an antimicrobial effect against many microorganisms, it has the potential to be used in many areas, especially in pharmacology and food. The use of plant extracts alone as antimicrobials in food preservation may require their application in high concentrations and may negatively affect sensory properties due to their strong taste. OLE's dark brown color and bitter taste limit its use in foods. In addition, because of strain, level and growth of microorganisms vary depending on the composition of the food, the expected antimicrobial effect of OLE varies in food applications. Therefore, if OLE is applied to a food as an natural preservative, undesirable microorganism(s) and antimicrobial activity of OLE against this target microorganisms should be determined. Application concentrations of OLE should be selected according to the antimicrobial effect level and physical, chemical, sensory and microbiological quality criteria expected in the food during its shelf life.

Keywords: Olive leaf, olive leaf extract, phenolic compounds, antimicrobial activity

Introduction

The olive tree (*Olea europaea* L.), a member of Oleaceae family and symbol of Mediterranean civilization, peace, and abundance, is widely spread plant in the world. Nearly 98% of the world's olive harvest comes from the 8 million hectares of trees that are found in the Mediterranean region countries (Ahmad-Qasem et al., 2014). The olive fruits are used in the production of olive and olive oil, and the leftover pieces and residues developed as a result of the processing of the olive and pruning are regarded as by-products of olive (Souilem et al., 2017; Talhaoui et al., 2015). Olive leaf (OL), one of these products, contains high amount of polyphenolic compounds and other beneficial phytochemicals, such as flavonoids, triterpenes, and chalcones, which have positive effects on health and has been used in traditional medicine for a long time for its health advantages (Borjan et al., 2020; Hashmi et al., 2015; Benavente-Garcia et al., 2000).

OLs are discarded in large amounts as a residue during pruning, harvesting and production of olive-related products. The amount of OLs released by pruning varies between 12 to 30 kg/tree, depending on the pruning type and age of the tree. They represent 10% of the overall weight of harvested olives (Khemakhem et al., 2017; Talhaoui et al., 2015). The beneficial bioactive properties and potential health benefits of OLs like antioxidant, hypoglycemic, antimicrobial, antihypertensive, anti-inflammatory, anticarcinogenic, and antiatherosclerotic have been reported by many studies on humans and animals, and are attributed to their phenolic compound content (Qabaha et al., 2018; Difonzo et al., 2017; Liu et al., 2017; Boss et al., 2016; Wainstein et al., 2012; Lee and Lee, 2010; Sanchez et al., 2007). The major phenolic substances found in OLs are secoiridoids (oleuropein, dimethyloleuropein, verbascoside, ligtroside, and oleuroside), phenolic acid and its derivatives (vanilic acid, caffeic acid, vanillin), phenolic alcohols (tyrosol, hydroxytyrosol), flavonols (quercetin, isoramnetin, rutin), flavones (luteolin-7-glucoside, apigenin7-glucoside, luteolin, diosmetin, and diosmetin-7-glucoside), and flavon-3-ols (catechin, gallocatechin) (Jung, 2019; Vizza, 2019; Giacometti, 2018; Lockyer, 2016; Talhaoui et al., 2015).

The amount of phenolic substances and their composition in OLs are variable depending on the age of the tree, origin, proportion of branches, harvest time, climate, moisture, storage conditions, etc. (Di Meo et al., 2022; Abaza et al., 2017; Blasi et al., 2016; Çetinkaya and Kulak, 2016). In addition, the quantity and composition of olive leaf

extracts (OLE's) phenolic substances depend on the drying method, such as drying in the sun or shade or in the oven, and the extraction methods. The extraction method type, temperature, pH, solvent type, and extraction time are fundamental factors affecting the quality and quantity of polyphenolic compounds recovered from olive leaves (Giacometti et al., 2021; Alcántara et al., 2020; Ghomari et al., 2019; Rahmanian et al., 2015; Ahmad-Qasem et al., 2014).

OLs' antibacterial properties have long been utilized to treat various illnesses and fevers. Studies showed that OLE has antimicrobial activities against a wide range of bacteria, yeasts, molds, viruses, and other parasites including *Listeria monocytogenes*, E*scherichia coli*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Yersinia enterocolitica*, *Salmonella typhi*, *Bacillus cereus*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Helicobacter pylori*, *Vibrio parahaemolyticus*, *Campylobacter jejuni,* and *Candida albicans* (El-Sohaimy et al., 2021; Sánchez-Gutiérrez et al., 2021; Liu et al., 2017; Gökmen et al., 2016; Techathuvanan et al., 2014; Aliabadi et al., 2012; Keskin et al., 2012; Lee and Lee, 2010; Sudjana et al., 2009; Pereira et al., 2007; Markin et al., 2003). Although the mechanism of antimicrobial action has not yet been fully elucidated, it is reported that phenolic compounds have the ability to denature proteins, damage cell membranes, break down cell peptidoglycans, adversely affect cell membrane permeability, and thus create leakage of cytoplasmic elements such as potassium, glutamate or inorganic phosphate, which delays and inhibits the growth rate of microorganisms (Lee and Lee, 2010; Sanchez et al., 2007). The potential of hydroxyl groups in phenolic substances to attach to important enzymes' active sites and change microbial metabolism is another factor contributing to their antimicrobial effects (Gyawali and Ibrahim, 2014). The length of the saturated side-chain and position of the hydroxyl group in aromatic ring both affect the antimicrobial activity (Cueva et al., 2010). Caffeic acid, for instance, has been shown to have greater antibacterial activity than p-coumaric acid because it contains more hydroxyl groups replaced in the phenolic ring (Stojković et al., 2013).

The level of antimicrobial effect and the sensitivity of microorganisms vary according to the type of microorganism. Pereira et al. (2007) indicated that *B.cereus* was the most susceptible microorganism among the strains tested, while *B.subtilis* was found to be the most resistant. In the same study, *E.coli* (Gram-negative bacteria) was found to be more sensitive compared to *S.aureus* (Gram-positive bacteria). Contrary to this study, Sanchez

et al. (2007) determined that the oleuropein showed greater antimicrobial activity against *St.aureus* than its effect on *E.coli* and this was due to variations in cell structures. Markin et al. (2003) reported that OLE killed *E.coli*, *St.aureus*, *K.pneumonia*, and *P.aeruginosa* in 3 hours of exposure at 0.6% (w/v) concentration. However, due to *B.subtilis*'s ability to form spores, it was possible to inhibit when OLE was used up to 20% (w/v) concentration. Keskin et al. (2012) also demonstrated that OLE significantly decreased the growth of all studied Gram-positive and Gram-negative bacteria, with the exception of *B.cereus* CCM 99, *Enterobacter aerogenes* ATCC 13048, and *Enterobacter cloacae* ATCC 13047. In the study by Sudjana et al. (2009), *C.jejuni*, *Helicobacter pylori*, and *S.aureus* were the most susceptible bacteria to OLE, whereas *E. coli*, *P.aeruginosa*, *B.subtilis*, *K.pneumoniae*, and S*erratia marcescens* were the least susceptible. OLE exhibited antifungal effects with a MIC of 24 mg/ml, minimal fungicidal concentration of 48 mg/ml, and 21 mm inhibitory zone diameter against *C.albicans* PTCC-5027 in the study of Nasrollahi and Abolhasannezhad (2015) and stated that it can be beneficial for treatment and prevention of infections like oral thrush caused by *Candida* spp. Zoric et al. (2016) determined the antifungal effects of OLE against *C.dubliniensis* CBS 7987 and *C.albicans* ATCC 10231 strains and found the MIC value for *C.albicans* to be 46,875 mg/mL and for *C. dubliniensis* to be 62.5 mg/mL. By Markin et al. (2003), the antifungal activity of OLE was demonstrated against *C.albicans* as well as against three dermatophytes, *Microsporum canis*, *Trichophyton mentagrophytes* and *T.rubrum*. It was suggested that it can be used in cases of fungal opportunistic infections. Unlike these studies, Shialy et al. (2015) determined that OLE did not show antifungal activity on *C.tropicalis, C.albicans*, *C.krusei,* and *C.glabrata*.

Awareness of the importance of diet in health has been raised among consumers, and it has shown that foods should be considered for their active positive impacts on health as well as the quality and amount of nutrients they contain. To promote the health benefits of natural resources, research is being done on the creation and marketing of functional foods, dietary supplements, and nutraceuticals made from natural sources. In this respect, OLs products, abundant sources of phenolic compounds, have potential to be used as natural food additives and supplements in foods. Generally, several OL preparations can be found at the markets in the form of dried whole leaf as herbal tea, powders made from dried plant material, liquid extracts, tablets, and food supplements (Arslan et al., 2021;

Romani et al., 2019; Özcan and Matthäus, 2017). Especially use of dried whole OLs to be consumed as tea attracts attention by consumers.

The aim of this study is to evaluate using of OLE in turnip juice as a natural antimicrobial preservative. Turnip juice is a traditional fermented drink that is widely consumed in Türkiye. Although the development of undesirable bacteria is significantly prevented by the lactic acid formed during fermentation, yeast and mold growth is possible, and deteriorations in the form of "membrane formation", especially caused by the *C. inconspicua* yeast species, occur. *C. inconspicua* can be found in foods obtained by lactic acid fermentation, alcoholic and non-alcoholic beverages such as wort, wine and beer, and is among the yeasts that cause spoilage, especially in beer and wine (Deak and Beuchat, 1996; Hutzler et al., 2012; Mixão, 2019). It is stated that *C. inconspicua* yeast does not have fermentation ability, and yeast growth increases at low pH levels due to the production of organic acids by lactic acid bacteria (Biberoğlu, 2012). In the literature, no studies were found regarding the antimicrobial activity of OLE against *C. inconspicua* and use of OLE in turnip juice for food preservation or the use of any plant extracts as a natural preservative instead of pasteurization or sodium benzoate.

The use of plant extracts alone as antimicrobials for food preservation may require their application in high concentrations, and in this case, the sensory properties of the food may be negatively affected due to their strong-hard taste, resulting in a product that is not preferred by consumers. The fact that OLE has a dark brown colour and bitter taste limits its use in foods. When considering its use in a food to benefit from its bioactive properties such as antimicrobial and antioxidant, application concentration and appropriate food selection are among the important points to be considered.

Materials and Methods

OLs were obtained from the gardens within the Olive Research Institute. The microorganisms used (*C. inconspicua* ATCC 16783, *C. krusei* derived from ATCC 14243, *Lb. plantarum* subsp. *plantarum* derived from ATCC 14917 and *Lb. paracasei* derived from ATCC 334) were obtained in lyophilized form.

OL extraction: OLs were washed, dried in an oven at 40 °C for 48 hours and ground by a simple coffee grinder (Alirezalu et al., 2016). Water and ethanol:water mixtures (20:80 and 50:50) were used as solvents in the extraction of the leaves. Extraction processes were basically carried out as follows; In case water, 10 g of powdered OLs were weighed into

a 250 ml volumetric flask and 100 ml of distilled water was added and mixed. Then, extraction was carried out in the soxhlet device chamber at 50 °C for 5 hours. After filtration, the solvent was removed by rotary evaporator, and the obtained extracts were stored at -20 °C (Ersus Bilek, 2010). In case ethanol:water solvents; 10 g of powdered OLs were weighed into a 250 ml volumetric flask and 100 ml of ethanol:water in different ratios was added and extraction was carried out in a magnetic stirrer at 50 °C for 5 hours. After filtration, the ethanol was removed by rotary evaporator and obtained extracts were stored at -20 °C (Ersus Bilek, 2010).

Determination of total phenolic substance content: The Folin-Ciocalteu method was used to determine the total phenol content of OLE (Gutfinger, 1981; Sevim and Tuncay, 2012). For this purpose, 0.1 ml of OLE was taken into a 50 ml volumetric flask and 5 ml of pure water and 0.5 ml of Folin-Ciocalteu solution were added and shaken. After waiting for 3 minutes, 1 ml of 35% Na_2CO_3 solution was added and the volume was made up to 50 ml. After keeping in dark for 2 hours, absorbance was measured at 725 nm. The total phenol content of the sample was determined as mg CAE/100 g powder leaf in terms of caffeic acid.

Determination of antimicrobial activity of OLE: The inhibitory effect of OLE on microorganism growth and its effectiveness levels were determined by the disc diffusion method. For this purpose, the test microorganisms were grown on appropriate solid media (MRS agar was used for lactic acid bacteria, and Sabouraud Dextrose agar was used for yeast species). Culture suspensions equivalent to the 0.5 McFarland standard were prepared from these developing colonies using sterile water and 0.1 ml of these suspansions spread on the surface of solid medium in Petri dishes. Sterile antimicrobial susceptibility blank test discs were impregnated with 0.75 µl of OLE and placed on the agar surface inoculated with the microorganism using a sterile forceps. For comparison purposes, disks with sodium benzoate and potassium sorbate added at a concentration of 0.2 mg/mL were placed on the inoculated agar surface. The inoculated Petri dishes were incubated in a flat position at 30 °C for 72 hours in a microaerophilic environment for bacterial cultures, and for 72 hours at 25 °C for yeast cultures. After incubation, the inhibition zones formed around the discs, if any, were measured in mm with a digital caliper (Bauer et al., 1966; Temiz, 2016).

Results and Discussion

In Table 1, the average values of total phenol amounts of OLEs obtained using different solvents are given. OLEs were obtained using olive leaves obtained from the gardens within the Izmir Olive Research Institute. Extraction procedures were carried out 3 times. In determining the total phenol content, the calibration chart of the caffeic acid solution prepared previously at different concentrations, and the values were calculated as mg CAE/100 g dry leaves in terms of caffeic acid. The highest phenol content was obtained when 50:50 ethanol:water was used as the solvent. For this reason, it was considered to use this solvent type in obtaining extract in the next stages of the study.

Table 1. The average values of total phenolic compound

Total phenolic compound (mg CAE/100 g dry leaves)	Solvent type		
	Distilled water	20:80 ethanol-water	50:50 ethanol-water
	2602±64	2849±42	3574±177

The basic principle of the disc diffusion method is that the antimicrobial active substance inhibits the development of the test microorganism inoculated into the Petri dish and, depending on the level of effect, the formation of an inhibition zone around the disc is determined. The more effective the substance, the greater the size of the inhibition zone formed. The antimicrobial effect varies depending on the concentration of the substance used and the type of microorganism. Therefore, the size of the inhibition zone that will be formed will vary depending on the concentration and type of microorganism. A large inhibition zone means that the antimicrobial effect is high. Within the scope of the study, in disk diffusion test applications, the formation of inhibition zones around the disks to which OLE was added after incubation was not observed, therefore the antimicrobial effect of OLE on the tested yeast species could not be determined.

Table 2. Inhibition zones (mm) according to disk diffusion method results

Substance	*C. inconspicua*	*C. krusei*	*Lb. plantarum*	*Lb. paracasei*
OLE	-	-	-	-
Commercial OLE	-	-	-	-
Sodium benzoate (0.2 mg/ml)	12.27±0.32	10.75±0.19	-	-
Potasium sorbate (0.2 mg/ml)	16.14±1.13	15.23±0.82	-	-

As mentioned before, there are many scientific studies showing that OLE has an antimicrobial effect on many microorganisms, but the level of effect varies depending on

the type of microorganism. There are no studies in the literature demonstrating the antimicrobial activity of OLE on *C.inconspicua*, which is pointed out as a spoilage agent in turnip juice. Although the antimicrobial activity of OLE on this yeast species was not detected in this study, this result contributes to the literature in this sense. On the other hand, although the main goal of the study is to investigate the usability of OLE in turnip juice as a natural antimicrobial, acceptable results were obtained in the sensory evaluations made by adding OLE to turnip juice. Therefore, the results show that since OLE contains high amounts of phenolic compounds, it can be used for enrichment and increasing the functional properties of the product. Sensory evaluations were made to evaluate the effect of OLE and ethanol that may remain in the extract on the sensory quality of turnip juice. It was performed by a panel consist of 10 persons. OLE-added up to 5% (v/v) turnip juice samples were presented to the panel members. According to the evaluation card results, more than 70% of the panelists did not detect alcohol odor or taste in the turnip juice samples with OLE added. No sensory adverse effects were detected in the products up to 5% OLE addition. On the other hand, it was determined that when high amounts of OLE were added, an undesirable taste began to be felt in the product.

Conclusion

Olive leaves are valuable by-product of the olive tree and produced in very high quantities during the pruning of the olive tree, collection and processing of olives, and there is no production or purchasing cost. Because they have valuable compounds, OL has many positive effects on both human health and food quality. For this reason, instead of being thrown away as waste, it can be used for foods to improve food storage life and to develop functional foods, as well as in the fields of medicines, cosmetics and pharmaceuticals. However, OLE concentration is an important factor and should be considered before application because of its pro-oxidant activity and bitter taste. Furthermore, OLE's stability in food products is important for achieving its intended use. On the other hand, in using OLE to produce functional foods, more *in vivo* studies should be conducted to better understand functional effects of the OLE on human health.

Thanks and Information Note

This study was carried out and supported by TAGEM with the project code TAGEM/HSGYAD/Ü/21/A3/P1/2501.

References

Abaza L., Taamalli A., Arráez-Román D., Segura-Carretero A., Fernández-Gutierrérez A., Zarrouk M. & Youssef N.B. 2017. Changes in phenolic composition in olive tree parts according to development stage, *Food Research International*, 100, 454-461.

Ahmad-Qasem M.H., Cánovas J., Barrajón-Catalán E., Carreres J.E., Micol V. & García-Pérez J.V. 2014. Influence of olive leaf processing on the bioaccessibility of bioactive polyphenols, *Journal of Agricultural and Food Chemistry*, *62*, 6190-6198.

Alcántara C., Žugčić T., Abdelkebir R., García-Pérez J.V., Jambrak A.R., Lorenzo J.M., Collado M.C., Granato D. & Barba F.J. 2020. Effects of ultrasound-assisted extraction and solvent on the phenolic profile, bacterial growth, and anti-inflammatory/antioxidant activities of mediterranean olive and fig leaves extracts, *Molecules, 25*, 1718.

Aliabadi M.A., Darsanaki R.K., Rokhi M.L., Nourbakhsh M. & Raeisi G. 2012. Antimicrobial activity of olive leaf aqueous extract, *Annals of Biological Research*, 3, 4189-4191.

Arslan E.E., Karademir G., Berktaş S. & Çam M. 2021. Zeytin yaprağı ekstraktı içeren soğuk çay üretimi, *Mühendislik Bilimleri ve Tasarım Dergisi*, 9, 843-849.

Bauer, A.W., Kirby, W.M.M., Sherris, J.C., Truck, M. 1966. "Antibiotic susceptibility testing by a standardized single disk method", American Journal of Clinical Pathology, 45(4), 493-49.

Benavente-Garcia O., Castillo J., Lorente J., Ortuno A. & Del Rio J.A. 2000. Antioxidant activity of phenolics extracted from Olea europaea L. leaves, *Food Chemistry*, 68, 457–462.

Biberoğlu, Ö. 2012. "Geleneksel Olarak Üretilen Yoğurtlardan Mayaların İzolasyonu ve İdentifikasyonu", Doktora tezi, Atatürk Üniversitesi, Sağlık Bilimleri Enstitüsü, Gıda Hijyeni ve Teknolojisi Anabilim Dalı, Erzurum, 93 s.

Blasi F., Urbani E., Simonetti M.S., Chiesi C. & Cossignani L. 2016. Seasonal variations in antioxidant compounds of Olea europaea leaves collected from different Italian cultivars, *Journal of Applied Botany and Food Quality*, 89, 202-207.

Borjan D., Leitgeb M., Knez Ž. & Hrnčič M.K. 2020. Microbiological and Antioxidant Activity of Phenolic Compounds in Olive Leaf Extract. *Molecules*, 25(24),5946. https://doi.org/10.3390/molecules25245946

Boss A., Bishop K.S., Marlow G., Barnett M.P. & Ferguson L.R. 2016. Evidence to support the anti-cancer effect of olive leaf extract and future directions, *Nutrients*, 8, 513.

Cetinkaya H., Koc M. & Kulak, M. 2016. Monitoring of mineral and polyphenol content in olive leaves under drought conditions: Application chemometric techniques, *Industrial Crops and Products*, 88, 78-84.

Cueva C., Moreno-Arribas M.V., Martín-Álvarez P.J., Bills G., Vicente M.F., Basilio A., Rivas C.L., Requena T., Rodríguez J.M. & Bartolomé B. 2010. Antimicrobial activity of phenolic acids against commensal, probiotic and pathogenic bacteria, *Research in Microbiology*, 161, 372–382.

Deak, T., Beuchat, L.R. 1996. Handbook of Food Spoilage Yeasts, CRC Press, New York, 1996.

Di Meo M.C., Izzo F., Rocco M., Zarrelli A., Mercurio M. & Varricchio E. 2022. Mid-Infrared spectroscopic characterization: New insights on bioactive molecules of Olea europaea L. leaves from selected Italian cultivars, *Infrared Physics & Technology*, 127, 104439.

Difonzo G., Pasqualone A., Silletti R., Cosmai L., Summo C., Paradiso V.M. & Caponio F. 2018. Use of olive leaf extract to reduce lipid oxidation of baked snacks, *Food Research International*, 108, 48-56.

El-Sohaimy S.A., Mansour H.M., Zeitoun A.A. & Zeitoun M.A.A. 2021. Antioxidant, antimicrobial and anti-inflammatory potential of olive leaves, *Zagazig Journal of Agricultural Research*, 48, 161-172.

Ersus Bilek, S. 2010. "The effects of time, temperature, solvent: solid ratio and solvent composition on extraction of total phenolic compound from dried olive (Olea europaea L.) leaves", Gıda, 35(6), 411-416.

Ghomari O., Sounni F., Massaoudi Y., Ghanam J., Kaitouni L.B.D., Merzouki M. & Benlemlih M. 2019. Phenolic profile (HPLC-UV) of olive leaves according to extraction procedure and assessment of antibacterial activity, *Biotechnology Reports*, 23, e00347.

Giacometti J., Žauhar G. & Žuvić M. 2018. Optimization of ultrasonic-assisted extraction of major phenolic compounds from olive leaves (Olea europaea L.) using response surface methodology, *Foods*, 7, 149.

Gökmen M., Akkaya L., Kara R., Gök V., Önen A. & Ektik N. 2016. Zeytin yaprağı ekstraktı ilavesinin köftelerde *S. typhimurium, E. coli* O157 ve *S. aureus* gelişimi üzerine etkisi, *Akademik Gıda*, 14, 28-32.

Gutfinger, T. 1981. "Polyphenols in Olive Oils", Journal of the American Oil Chemists Society, 58, 966-968.

Gyawali R. & Ibrahim S.A. 2014. Natural products as antimicrobial agents, *Food Control*, 46, 412-429.

Hashmi M.A., Khan A., Hanif M., Farooq U. & Perveen S. 2015. Traditional Uses, Phytochemistry, and Pharmacology of Olea europaea (Olive), *Evidence-Based Complementary and Alternative Medicine*, Article ID 541591, http://dx.doi.org/10.1155/2015/541591.

Hutzler, M., Riedl, R., Koob, J., Jacob, F. 2012. "Fermentation and Spoilage Yeasts and their Relevance for the Beverage Industry - A Review", Brewing Science, 65, 33-52

Jung Y.C., Kim H.W., Min B.K., Cho J.Y., Son H. J, Lee J.A.Y., Kim J., Kwon S., Li Q. & Lee H.W. 2019. Inhibitory effect of olive leaf extract on obesity in high-fat diet-induced mice, *In Vivo*, 33, 707-715.

Keskin D., Ceyhan N., Uğur A. & Dbeys A.D. 2012. Antimicrobial activity and chemical constitutions of West Anatolian olive (Olea europaea L.) leaves, *Journal of Food, Agriculture & Environment*, 10, 99-102.

Khemakhem I., Ahmad-Qasem M.H., Catalán E.B., Micol V., García-Pérez J.V. & Ayadi M.A. 2017. Kinetic improvement of olive leaves' bioactive compounds extraction by using power ultrasound in a wide temperature range, *Ultrason Sonochem*., 34, 466–73.

Lee O. & Lee B. 2010. Antioxidant and antimicrobial activities of individual and combined phenolics in Olea europea leaf extract, *Bioresource Technology*, 101, 3751-3754.

Liu Y., McKeever L.C. & Malik N.S.A. 2017. Assessment of the antimicrobial activity of olive leaf extract against foodborne bacterial pathogens, *Frontiers in Microbiology*, 8.

Lockyer S., Rowland I., Spencer J.P.E., Yaqoob P. & Stonehouse W. 2017. Impact of phenolic-rich olive leaf extract on blood pressure, plasma lipids and inflammatory markers: A randomised controlled trial, *European Journal of Nutrition*, 56, 1421-1432.

Markin D., Duek L. & Berdicevsky I. 2003. In vitro antimicrobial activity of olive leaves, *Mycoses*, 46, 132–136.

Mixão, V., Hansen, A.P., Saus, E., Boekhout, T., Lass-Florl , C., Gabaldón, T. 2019. "Whole-Genome Sequencing of the Opportunistic Yeast Pathogen *Candida inconspicua* Uncovers Its Hybrid Origin", Frontiers in Genetics, 10, doi: 10.3389/fgene.2019.00383

Nasrollahi Z. & Abolhasannezhad M. 2015. Evaluation of the antifungal activity of olive leaf aqueous extracts against *Candida albicans* PTCC-5027, *Current Medical Mycology*, 1, 37-39.

Özcan M.M. & Matthäus B. 2017. A review: benefit and bioactive properties of olive (Olea europaea L.) leaves, *European Food Research and Technology*, 243, 89-99.

Pereira A.P., Ferreira I.C., Marcelino F., Valentão P., Andrade P.B., Seabra R., Estevinho L., Bento A. & Pereira J.A. 2007. A Phenolic compounds and antimicrobial activity of olive (Olea europaea L. cv. Cobrançosa) leaves, *Molecules*, 12, 1153-1162.

Qabaha K., Al-Rimawi F., Qasem A. & Naser S.A. 2018. Oleuropein is responsible for the major anti-inflammatory effects of olive leaf extract, *Journal of Medicinal Food*, 21, 302-305.

Rahmanian N., Jafari S.M. & Wani T.A. 2015. Bioactive profile, dehydration, extraction and application of the bioactive components of olive leaves, *Trends in Food Science & Technology*, 42, 150–172.

Romani A., Ieri F., Urciuoli S., Noce A., Marrone G., Nediani C. & Bernini R. 2019. Health effects of phenolic compounds found in extra-virgin olive oil, by-products, and leaf of Olea europaea L, *Nutrients*, 11, 1776.

Sanchez J.C., Alsina M.A., Herrlein M.K. & Mestres C. 2007. Interaction between the antibacterial compound, oleuropein, and model membranes, *Colloid and Polymer Science*, 285, 1351–1360.

Sánchez-Gutiérrez M., Bascón-Villegas I., Rodríguez A., Pérez-Rodríguez F., Fernández-Prior Á., Rosal A. & Carrasco E. 2021. Valorisation of Olea europaea L. olive leaves through the evaluation of their extracts: Antioxidant and antimicrobial activity, *Foods*, 10, 966.

Sevim D., Tuncay O. & Koseoglu O. 2013. The effect of olive leaf addition on antioxidant content and antioxidant activity of "Memecik" olive oils at two maturity stages, *Journal of American Oil Chemists' Society*, 90, 1359–1369.

Shialy Z., Zarrin M., Nejad B.S. & Naanaie S.Y. 2015. In vitro antifungal properties of Pistacia atlantica and olive extracts on different fungal species, *Current Medical Mycology*, 1, 40-45.

Souilem S., Fki I., Kobayashi I., Khalid N., Neves M.A., Isoda H., Sayadi S. & Nakajima M. 2017. Emerging technologies for recovery of value-added components from olive leaves and their applications in food/feed industries, *Food and Bioprocess Technology*, 10, 229-248.

Stojković D., Petrović J., Soković M., Glamočlija J., Kukić-Marković J. & Petrović S. 2013 In situ antioxidant and antimicrobial activities of naturally occurring caffeic acid, p-coumaric acid and rutin, using food systemS, *Journal of the Science of Food and Agriculture*, 93, 3205–3208.

Sudjana A.N., D'Orazio C., Ryan V., Rasool N., Ng J., Islam N., Riley T.V. & Hammer K.A. 2009. Antimicrobial activity of commercial Olea europaea (olive) leaf extract, *International Journal of Antimicrobial Agents*, 33, 461-463.

Talhaoui N., Taamalli A., Gómez-Caravaca A.M., Fernández-Gutiérrez A. & Segura-Carretero A. 2015. Phenolic compounds in olive leaves: Analytical determination, biotic and abiotic influence, and health benefits, *Food Research International*, 77, 92-108.

Techathuvanan C., Reyes F., David J.R. & Davidson P.M. 2014. Efficacy of commercial natural antimicrobials alone and in combinations against pathogenic and spoilage microorganisms, *Journal of Food Protection*, 77, 269–275.

Temiz, A. 2016. Genel Mikrobiyoloji Uygulama Teknikleri, Yenilenmiş 7. Baskı, Hatipoğlu Yayınevi, Ankara, s. 222-234.

Vizza D., Lupinacci S., Toteda G., Puoci F., Ortensia P., De Bartolo A., Lofaro D., Scrivano L., Bonofiglio R., La Russa A., Bonofiglio M. & Perri A. 2019. An olive leaf extract rich in polyphenols promotes apoptosis in cervical cancer cells by upregulating p21cip/waf1 gene expression, *Nutrition and Cancer*, 71, 320-333.

Wainstein J., Ganz T., Boaz M., Dayan Y.B., Dolev E., Kerem Z. & Madar Z. 2012. Olive leaf extract as a hypoglycemic agent in both human diabetic subjects and in rats, *Journal of Medicinal Food*, 15, 605-610.

Zorić N., Kopjar N., Kraljić K., Orśolić N., Tomić S. & Kosalec I. 2016b. Olive leaf extract activity against Candida albicans and C. dubliniensis - the in vitro viability study, *Acta Pharmaceutica*, 66, 411 - 421.

MERSİN İLİNDE YEM BİTKİLERİ YETİŞTİRİCİLİĞİNİN MEVCUT DURUMU

Dr. Öğretim Üyesi Aybüke KAYA (ORCID: 0000-0002-6866-1951)
Hatay Mustafa Kemal Üniversitesi, Ziraat Fakültesi, Tarım Ekonomisi Bölümü
Email: aybukekaya@mku.edu.tr

Dr. Öğretim Üyesi Veysi ACIBUCA (ORCID: 0000-0002-8478-7300)
Mardin Artuklu Üniversitesi, Kızıltepe Meslek Yüksekokulu, Organik Tarım Pr.
Email: veysiacibuca@artuklu.edu.tr

ÖZET
Tarım sektörünün kilit unsurlarından biri olan yem bitkileri yetiştiriciliği, modern dünyada giderek artan nüfus ve beslenme ihtiyaçlarına yönelik çözümleri barındırmaktadır. Yem bitkileri, hayvanlar için gerekli olan protein, enerji, vitamin ve mineral gibi besin öğelerini sağlamak açısından kritik bir rol oynar. Bunun yanı sıra, çeşitli iklim ve toprak koşullarında yetişebilme özellikleri, yem bitkilerini tarımın farklı coğrafyalarda yaygın bir şekilde uygulanabilir kılarken, bu çeşitlilik aynı zamanda biyoçeşitliliğin korunmasına da katkı sağlar. Bu çalışmada, Mersin ilinde yetiştiriciliği yapılan yem bitkilerinin önemi, avantajları ve gelecekteki potansiyeli üzerinde durulacaktır. Mersin ili toplam 1.8 milyon başlık hayvan varlığı ile özellikle küçükbaş hayvancılık açısından Türkiye'nin önemli illerinden bir tanesidir. Çalışmanın ana materyalini Mersin ili Tarım ve Orman İl Müdürlüğü ve Türkiye İstatistik Kurumu (TÜİK) veri tabanlarından alınan ikincil veriler oluşturmaktadır. Ayrıca yem bitkilerinin tohum fiyatlarına ilişkin bilgiler ticari tohumların piyasa fiyatlarına ilişkin değerlerden oluşmaktadır. Mersin ili kaba yem fiyatları ise; Mersin ili, Tarım ve Orman İlçe Müdürlüğü tarafından aylık olarak çiftçiden alınan ve bakanlığa bildirilen fiyatlardan oluşmaktadır. Çalışmadan elde edilen sonuçlar Mersin ilinde kaliteli kaba yem üretiminin önemli bir kaynağı olan yem bitkileri üretiminin diğer tarla bitkilerine göre çok düşük olduğu belirlenmiş olup üretim potansiyelinin artırılmasına yönelik politikaların uygulanması önerilmiştir.
Anahtar Kelimeler: Yem bitkileri, üretim potansiyeli, destekleme politikaları, Mersin.

THE CURRENT SITUATION OF FORAGE CROPS IN MERSIN PROVINCE

ABSTRACT
Forage crops are one of the key elements of the agricultural sector. They provide solutions to the growing population and nutritional needs of the modern world. Forage crops have a vital role to play in the provision of nutrients such as protein, energy, vitamins and minerals for animals. In addition, their ability to grow in different climatic and soil conditions means that forage crops are widely used in different geographical areas of agriculture, while this diversity also contributes to the conservation of biodiversity. This study highlights the importance, benefits and future potential of fodder crops grown in Mersin province. With a total of 1.8 million animals, Mersin province is one of the most important provinces in Turkey in terms of small ruminant livestock. The main material of the study consists of secondary data obtained from the databases of the Directorate of Agriculture and Forestry of the Province of Mersin and of the Turkish Statistical Institute (TURKSTAT). In addition, the information on the prices of the seeds of the fodder crops consists of values related to the market prices of the commercial seeds. The prices of forage crops in Mersin Province consist of the prices received monthly from farmers and reported to the Ministry by the Mersin Province Agriculture and Forestry Directorate. The results of the study show that the production of fodder crops, which is an important source of quality fodder production in Mersin province, is very low in comparison with other field crops and it is recommended that policies be implemented to increase the production potential.
Keywords: Forage crops, production potential, support policies, Mersin.

1. GİRİŞ

Dünya üzerindeki muazzam çeşitliliği ve zenginliğiyle, bitkiler sadece doğanın birer parçası değil, aynı zamanda yaşamın temel taşlarıdır. Yem bitkileri yetiştiriciliği, bu eşsiz zenginliği insanlık için teminat altına alma ve tarımın sürdürülebilirliğini sağlama amacını taşır. Yem bitkileri, hayvanlar için besin kaynağı olmanın yanı sıra, toprak kalitesini artırarak ekosistem dengelemesine de katkıda bulunur. Yem bitkileri, hayvanlar için gerekli olan protein, enerji, vitamin ve mineral gibi besin öğelerini sağlamak açısından kritik bir rol oynar. Bunun yanı sıra, çeşitli iklim ve toprak koşullarında yetişebilme özellikleri, yem bitkilerini tarımın farklı coğrafyalarda yaygın bir şekilde uygulanabilir kılarken, bu çeşitlilik aynı zamanda biyoçeşitliliğin korunmasına da katkı sağlar. Yem bitkileri yetiştiriciliği sadece tarımın ekonomik yönünü güçlendirmekle kalmaz, aynı zamanda çevresel sürdürülebilirliği destekler. Toprağı erozyona karşı koruyarak, su kaynaklarını etkin bir şekilde kullanarak ve karbon döngüsüne olumlu etkilerde bulunarak ekosistemlerin dengesini sağlamada önemli bir rol oynar. Ayrıca yem bitkileri çayır meraların aşırı kullanımının önlenmesine yardımcı olmakla birlikte, su kaynaklarının korunmasına da ciddi ölçüde katkı sağlamaktadır (Gündüz, 2010). Yem bitkileri tarımının yaygınlaştırılmasıyla, tarımsal ürünlere ait üretim ve kaliteyi negatif etkileyen birçok faktörü ortadan kaldırmaktadır. Özellikle toprak verimliliği, toprak organik maddesinin artırmakta, aynı zamanda kimyevi gübre ve ilaç kullanımında önemli oranda tasarruf sağlamaktadır (Cesur, 2010).

Verimli ve sürdürülebilir bir hayvancılık için kaliteli kaba yeme ulaşabilmek temel bir zorunluluktur. Bunu sağlamak için birinci öncelik olan çayır ve meralar dışında ülkelerin yem bitkileri üretimini artırıcı ve destekleyici faaliyetlerde bulunması gerekir (Özkan, 2020). Tarım sektörü içerisinde değerlendirilen hayvancılık faaliyetlerine ilişkin girdilerin büyük bir kısmı yem giderlerine ait olup bu oran yaklaşık %70 olarak bilinmektedir. Yem giderlerinin %78'i kaba yem, %22'lik kısmı ise karma yemlerden karşılanmaktadır (Harmanşah, 2018). Hayvancılık faaliyetleri gelişmiş olan ülkelerde yem bitkilerinin ekiliş oranı toplam tarla arazisinin, Almanya'da %36'sında, Hollanda'da %31'inde, İtalya'da %30'unda, Fransa ve İngiltere'de %25'ini kaplamaktadır (Açıkgöz ve ark., 2005). Son yıllarda bitki yetiştiricileri, biyotik ve abiyotik streslere toleranslı, yüksek verimli yem çeşitleri geliştirerek hayvancılık verimliliğine önemli katkılarda bulunmuşlardır (Aguirre et al., 2013; Hernandez et al., 2017). Özellikle gelişmiş ülkeler

yem bitkileri tarımına gereken önemi vererek tarım ve sanayi alanında birçok sorunun oluşmasını engellemektedir. Gerek hayvan besleme bakımından gerekse de bitkisel üretime destek olarak tarım topraklarının muhafazası ve verimliliğini sürdürmek için yem bitkileri tarımı önemlidir. Yem bitkilerinin tarımsal faaliyet içerisinde istenilen oranlarda kullanılması gıda üretimi, temiz ve yaşanabilir bir çevre açısından çok büyük önem arz etmektedir (Cesur, 2010). Çevre sorunları, gelişmiş ve gelişmekte olan ülkelerde toplum gündeminde önemli ve öncelikli konular arasındadır (Karaer ve Gürlük, 2003).

Tarım sektörünün kilit unsurlarından biri olan yem bitkileri yetiştiriciliği, modern dünyada giderek artan nüfus ve beslenme ihtiyaçlarına yönelik çözümleri barındırmaktadır. Bu çalışmada, Mersin ilinde yem bitkileri yetiştiriciliğinin önemi, avantajları ve gelecekteki potansiyeli üzerinde durulacaktır.

2. MATERYAL ve YÖNTEM

Mersin ili, Türkiye'nin Akdeniz Bölgesi'nde yer alan bir liman şehridir. Bu şehir dünyada, 36-37° kuzey paralelleri ile 33-35° doğu meridyenleri arasındadır. Mersin, kara sınırı 608 km, deniz sınırı 321 km, yüzölçümü 15.853 km^2 olan bir ildir. İlin kuzey kesimi Batı ve Orta Toroslar' dan oluşan dağlık bir yapıya sahip olmakla birlikte sahil şeridinde düz araziler bulunmaktadır. Güneyinde Akdeniz, doğusunda Adana, batısında Antalya, kuzeyinde ise Niğde, Karaman ve Konya illeri yer almaktadır (Anonim, 2023). Hayvancılıkta da önemli bir il olan Mersin, 1.321.761 küçükbaş hayvan ile Türkiye'de 5. sırada yer alırken, 18.764.056 kanatlı hayvanla Türkiye genelinde ilk sırada yer almaktadır. Ayrıca, hayvansal ürün üretiminden 418 milyon TL katkı sağlanmaktadır (MTSO, 2019).

Çalışmanın ana materyalini Mersin ili Tarım ve Orman İl Müdürlüğü ve Türkiye İstatistik Kurumu (TÜİK) veri tabanlarından alınan veriler oluşturmaktadır. Ayrıca yem bitkilerinin tohum fiyatlarına ilişkin bilgiler ticari tohumların piyasa fiyatlarına ilişkin değerlerden oluşmaktadır. Mersin ili kaba yem fiyatları ise; Mersin ili, Tarım ve Orman İlçe Müdürlüğü tarafından aylık olarak çiftçiden alınan ve bakanlığa bildirilen fiyatlardan oluşmaktadır.

3. BULGULAR

Türkiye'de üretilen kaba yem ile hayvanların yaşama payı ihtiyacının sadece yarısına yakını karşılanabilmektedir (TOB, 2019). Yonca yem bitkileri içerisindeki en önemli ürünlerden biridir. Ayrıca yüksek besin kalitesi, yüksek verim ve yüksek adaptasyon

özelliği nedeniyle 35 milyon hektarı aşan bir alanda her kıtada 80'den fazla ülkede yetiştiriciliği yapılan küresel anlamda en önemli baklagil yem bitkisidir (Radovic et al., 2009). Mersin ilinde 2022 yılında 1000 da'lık alanda yonca üretimi yapılmış olup bu rakam ülkemizin toplam üretiminin % 0.15'ine denk gelmekte olup oldukça düşük olduğu görülmektedir. Son 5 yıllık süreçte Mersin ilinde yonca ekim alanında %85 oranında artış olduğu görülmekte olup üretici sayısında ise kayda değer artış olmadığı görülmektedir (Tablo 1).

Tablo 1. 2018-2022 yılları arasında Mersin ili ve Türkiye genelindeki Yonca ekim alanı ve üretimi

Üretim Yılı	Mersin*				Türkiye**				
	Çiftci Sayısı	İndeks (2018=100)	Ekim Alanı (da)	İndeks (2018=100)	Ekim alanı (da)	İndeks (2018=100)	Üretim (ton)		
							Yeşil ot	İndeks (2018=100)	Kuru ot
2018	25	100	543.23	100	6.351.052	100	17 544 946	100	-
2019	28	112	710.20	131	6.412.128	101	17 949 264	102	-
2020	33	132	864.64	159	6.628.887	104	19 290 519	110	-
2021	33	132	767.06	141	6.730.474	106	19 310 959	110	-
2022	27	108	1004.17	185	6.435.927	101	19 064 213	109	-

Kaynak:*TOB, 2023; **TÜİK, 2023

Korunga yoncaya göre soğuğa daha dayanıklı, kıraç alanlarda yetiştirilmesi bakımından daha başarılı, kaba yem olarak yüksek oranda protein ile besin değerleri açısından da yoncaya neredeyse eş değer bir yapıya sahiptir (Azuhnwi et al., 2011; Temel ve Özalp, 2016). Mersin ilinde 2022 yılında 10600 da'lık alanda 8075 ton korunga (yeşil ot) üretimi yapılmış olup aynı dönemde Türkiye genelinde ise 1.6 milyon da alanda yaklaşık 1.8 milyon ton üretim elde edilmiştir (Tablo 2).

Tablo 2. 2018-2022 yılları arasında Mersin ili ve Türkiye genelindeki Korunga ekim alanı ve üretimi

Üretim Yılı	Mersin				Türkiye				
	Çiftçi Sayısı	İndeks (2018=100)	Ekim Alanı (da)	İndeks (2018=100)	Ekim Alanı (da)	İndeks (2018=100)	Üretim (ton)		
							Yeşil ot	İndeks (2018=100)	Kuru ot
2018	116	100	5.297,01	100	1.817.338	100	1 934 847	100	-
2019	105	91	4.426,12	84	1.752.763	96	1 781 789	92	-
2020	145	125	6.397,96	121	1.744.949	96	1 934 697	100	-
2021	112	97	5.827,87	110	1.814.737	100	1 546 641	80	-
2022	90	78	10.600,00	186	1.618.249	89	1 786 207	92	-

Kaynak: *TOB, 2023; **TÜİK, 2023

Yem bitkileri içerisinde fiğ; yeşil ot, kuru ot, silaj ve dane olarak değerlendirilebilen iyi ve önemli bir bitkidir. Fiğ, organik madde miktarı düşük toprakların iyileştirilmesinde yeşil gübre olarak da kullanılmaktadır. Ayrıca toprakta azot miktarını artırdığından, kendisinden sonra ekilen ürünün verimini de arttırmaktadır. Mersin ilinde 2022 yılında 9768 da'lık alanda 7525 ton fiğ(yeşil ot) üretimi yapılmış olup aynı dönemde Türkiye genelinde ise 3.4 milyon da alanda (adi fiğ ve Macar fiği toplamı) yaklaşık 4 milyon ton üretim elde edilmiştir (Tablo 3). Mersin ilinde incelenen dönemde Macar fiğ üretimi yapılmamıştır.

Tablo 3. 2018-2022 yılları arasında Mersin ili ve Türkiye genelindeki fiğ ekim alanı ve üretimi

Üretim Yılı	Mersin				Türkiye				
	Çiftçi Sayısı	İndeks (2018=100)	Ekim Alanı (da)	İndeks (2018=100)	Ekim Alanı (da)	İndeks (2018=100)	Üretim (ton)		
							Yeşil ot	İndeks (2018=100)	Kuru ot
2018	526	100	26.184,95	100	3.869.465	100	4 273 945	100	-
2019	301	57	13.946,84	53	3.914.980	101	4 303 868	101	-
2020	73	14	3.666,05	14	3.759.436	97	4 542 965	106	-
2021	83	16	3.200,23	12	3.652.849	94	3 989 934	93	-
2022	35	7	9.768,00	37	3.421.760	88	4 020 433	94	-

Kaynak: *TOB, 2023; **TÜİK, 2023

Mısır bitkisi farklı amaçlarla kullanılmakta olup özellikle hayvan beslenmesinde kullanılan bir üründür. Bu amaçla kullanımının oranı dünya genelinde üretimde %73, gelişmiş ülkelerde ise %90'dır. Türkiye'de ise bu oran %70'tir (Öz ve ark., 2017; Karaer ve ark., 2021). Mersin ilinde 2022 yılında 16739 da'lık alanda 75000 ton silajlık mısır üretimi yapılmış olup aynı dönemde Türkiye genelinde ise 5.2 milyon da alanda (adi fiğ ve Macar fiği toplamı) 28.5 milyon ton üretim elde edilmiştir (Tablo 4).

Tablo 4. 2018-2022 yılları arasında Mersin ili ve Türkiye genelindeki silajlık mısır ekim alanı ve üretimi

Üretim Yılı	Mersin				Türkiye					
	Çiftçi Sayısı	İndeks (2018=100)	Ekim Alanı (da)	İndeks (2018=100)	Ekim Alanı (da)	İndeks (2018=100)	Üretim (ton)			
							Hasıl	İndeks (2018=100)	Silajlık	İndeks (2018=100)
2018	239	100	7423.52	100	4.726.428	100	215 443	100	23 197 536	100
2019	115	48	4585.41	62	5.074.127	107	152 417	71	25 499 870	110
2020	114	48	3720.49	50	5.262.613	111	126 142	59	27 186 949	117
2021	62	26	2231.88	30	5.306.706	112	128 704	60	27 309 962	118
2022	59	25	16.739,00	225	5.298.522	112	114 672	53	28 558 983	123

Kaynak: *TOB, 2023; **TÜİK, 2023

Mersin ilinde diğer tek yıllık yem bitkilerinin (burçak, yem baklası, yem bezelyesi.. vs) üretim ise oldukça düşük olup 2022 yılındaki toplam ekim alanları 460 da olduğu belirlenmiştir(Tablo 5).

Tablo 5. 2018-2022 yılları arasında Mersin ili ve Türkiye genelindeki diğer tek yıllık yem bitkileri ekim alanı ve üretimi

Üretim Yılı	Mersin				Türkiye				
	Çiftçi Sayısı	İndeks (2018=100)	Ekim Alanı (da)	İndeks (2021=100)	Ekim Alanı (da)	İndeks (2018=100)	Üretim (ton)		
							Yeşil ot	İndeks (2021=100)	Kuru ot
2018	22	100	633	100	-	-	-	-	-
2019	16	73	561	89	-	-	-	-	-
2020	20	91	650	103	-	-	-	-	-
2021	15	68	471	75	15.226	100	19 591	100	-
2022	18	82	460	73	16.932	111	28 424	145	-

Kaynak: *TOB, 2023; **TÜİK, 2023

Tablo 6'da ise 2023 yılında Mersin ilinde kaba yem ve tohum fiyatlarına ilişkin veriler bulunmakta olup söz konusu rakamlar ortalama fiyatları yansıtmaktadır.

Tablo 6. Mersin ilinde 2023 yılı için bazı yem bitkilerine ait tohum ve kaba yem fiyatları

Tohum*	Fiyat (₺)		Kaba yem**	Fiyat (₺/kg)
	Minimum	Maksimum		
Yonca (sertifikalı-kaplamasız) kg	65	245	Yonca	6.25
Korunga (sertifikalı) kg	50	75	Korunga	4.75
Adi fiğ (yerli) kg	30	55	Fiğ	0
Macar fiğ (sertifikalı) kg	30	55	Saman	2.30
Silajlık mısır (50.000 adet)	1650	2050	Mısır silajı	2.60

Kaynak:* Anonim, 2023; **TOB, 2023 (Mersin İli çiftçilerinden aylık alınarak Bakanlığa bildirilen fiyatlardır).

4. SONUÇLAR

Çayır ve mera alanları ve yem bitkileri tarımı kaliteli bir kaba yem kaynağıdır. Ancak bu kaynaklardan doğal çayır ve meralar, uzun yılardır devam eden erken ve aşırı otlatmalar nedeni ile verim güçlerini önemli ölçüde kaybetmiştir. Kaliteli kaba yemin üretiminin diğer kaynağı olan yem bitkilerinin ise üretimi diğer tarla bitkileri ürünlerine göre çok düşük ve yetersizdir kalmıştır. Yem bitkileri üretimindeki artış kaba yem açığının kapatılmasına önemli katkılar sağlamakla beraber halen ihtiyaç durumu üretimden fazladır. Kaba yem açığını doğuran en önemli unsurlar ise yağış yetersizliği, otlatmanın

fazla olması, çayır mera yönetim ve planlamalarına ilişkin uygulama kaynaklı sorunlar, sürü yönetimi kaynaklı sorunlar, kentleşme ve tarım arazilerinin amaç dışı kullanımı gibi konulardır. Bu kapsamda hayvansal üretim faaliyetlerinde yanlış hayvan besleme ve alışkanlıklar diğer önemli nedenler arasındadır. Bu çalışmada özellikle keçi yetiştiriciliği açısından önemli illerimizden birisi olan Mersin'in yem bitkileri üretimi araştırılmıştır. Çalışmadan elde edilen sonuçlar Mersin ilinde kaliteli kaba yem üretiminin önemli bir kaynağı olan yem bitkileri üretiminin diğer tarla bitkilerine göre oldukça düşük olduğu belirlenmiş olup hayvancılık faaliyetleri ile ilgili yapılacak tarımsal yayım çalışmaları ile ilin yetiştirici birliklerinin yapacağı projelerde yem bitkilerinin hayvan besleme ve verimlilik açısından önemi göz ününe alınarak üretimlerinin arttırılmasına yönelik eğitimlerin yapılması önem arz etmektedir.

KAYNAKÇA

Açıkgöz E., Hatipoğlu, R., Altınok, S., Sancak, C., Tan, A., Uraz, D. 2005.Yem Bitkileri Üretimi ve Sorunları. Türkiye Ziraat Mühendisliği VI. Teknik Tarım Kongresi, 3-7 Ocak 2005. 503-518, Ankara.

Aguirre, L.M., Cardona, C., Miles, J. W., Sotelo, G. 2013. Characterization of Resistance to Adult Spittlebugs (Hemiptera: Cercopidae) in Brachiaria Spp. Journal of economic entomology, 106(4), 1871-1877.

Anonim, 2023. www.mersinkulturturizm.gov.tr Erişim tarihi: 28.10.2023

Azuhnwi, B.N., Boller, B., Martens, M., Dohme-Meier, F., Ampuero, S., Günter, S., Kreuzer, M., Hess, H.D. 2011. Morphology, Tannin Concentration and Forage Value of 15 Swiss Accessions of Sainfoin (*Onobrychis Viciifolia Scop.)* As İnfluenced By Harvest Time and Cultivation Site. Grass and Forage Science, 66(4): 474-487.

Cesur, C. 2010. Sürdürülebilir Tarımda Yem Bitkilerinin Rolü ve Önemi. Bitkisel Araştırma Dergisi (2010) 2: 31-34.

Gündüz, T.E. 2010. Diyarbakır Koşullarında Karışım Oranının Macar Fiği (*Vicia pannonica Crantz*) + Buğday (*Triticum aestivum var. aestivum L.)* Karışımında Ot Verimi ve Kalitesine Etkisi. Yüksek Lisans Tezi, Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, Adana

Harmanşah, F. 2018. Türkiye'de Kaliteli Kaba Yem Üretimi, Sorunlar ve Öneriler, TÜRKTOB Dergisi, 25: 9-13.

Hernandez, L.M., Sotelo, G., Bonilla, X., Alvarez, E., Miles, J. W., Worthington, M. 2017. Phenotyping Brachiaria Genotypes to Assess Rhizoctonia Resistance By Comparing Three İnoculum Types. Plant Disease, 101(6), 916-923.

Karaer, F., Gürlük, S. 2003. Gelişmekte Olan Ülkelerde Tarım-Çevre-Ekonomi Etkileşimi. Doğuş Üniversitesi Dergisi, 4(2): 197-206.

Karaer, M., Gülümser, E., Hanife, M.U.T., Gültaş, H.T. 2021. Ana Ürün Silajlık Mısır Yetiştiriciliğinde Sulama Suyu Kullanım Etkinliği ve Ekonomik Analizi. ISPEC Journal of Agricultural Sciences, 5(3), 652-658.

MTSO, 2019. Mersin Ekonomi Raporu. http://www.mtso.org.tr/tr/a/2017-mersin-ekonomik-raporu Erişim Tarihi: 23.10.2023

Öz, A., Kapar, H., Dok, M. 2017. Karadeniz Tarımsal Araştırma Enstitüsü Yayınları. http://arastirma.tarim.gov.tr/ktae/Belgeler/brosurler/Mısır%20Tarımı.pdf Erişim tarihi: 28.10.2023

Özkan, U. 2020. Türkiye Yem Bitkileri Tarımına Karşılaştırmalı Genel Bakış ve Değerlendirme. Turkish Journal of Agricultural Engineering Research, 1(1), 29-43.

Radovic, J., Sokolovic, D., Markovic, J., 2009. Alfalfa-Most İmportant Perennial Forage Legume in Animal Husbandry. Biotechnology in Animal Husbandry, 25, 465-475.

Temel, O., Özalp, M. 2016. Artvin'in Şavşat İlçesinde Yetiştirilen Korunga (*Onobrychis sativa Scop.)* Yem Bitkisinin Verimi ve Kalitesi Üzerine Yükseltinin ve Bazı Toprak Özelliklerinin Etkisi. Anadolu Tarım Bilimleri Dergisi, 31(1), 106-116.

TOB, 2019. 3. Tarım Orman Şurası Raporları (Basılmamış).

TOB, 2023. Mersin Tarım ve Orman İl Müdürlüğü Raporları.

TÜİK, 2023. Türkiye İstatistik Kurumu. https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr Erişim Tarihi: 23.10.2023.

DİSKRİMİNANT ANALİZİ VE VETERİNERLİK ALANINDA KULLANILMASI

Dr. Öğr. Üyesi Ömer ELTAS (ORCID: 0000-0002-7415-3371)
Atatürk Üniversitesi Veteriner Fakültesi Biyometri Ana Bilim Dalı Erzurum-Türkiye
Email: omer.eltas@atauni.edu.tr

ÖZET
Diskriminant analizi (DA), bir sınıflandırma yöntemidir ve veri setindeki örnekleri farklı sınıflara ayırmak için kullanılır. Temel olarak, diskriminant analizi, veri setindeki değişkenlerin sınıflara olan etkisini ölçer ve sınıflandırma için en iyi değişkenleri bulmaya çalışır. Diskriminant analizi, özellikle istatistiksel bir örneklem üzerinde çalışırken farklı sınıfların belirlenmesi veya yeni örneklerin sınıflandırılması gerektiğinde kullanılır. Ayrıca boyut azaltma yöntemlerinden biri olarak da kullanılabilir. Diskriminant analizi, veri setinin sınıf bilgisine dayanan iki ana bileşen olan açıklanabilirlik ve ayırt edicilik arasındaki dengeyi sağlamaya çalışır. Açıklanabilirlik, veri setindeki toplam değişkenliğin sınıf ortalamaları ve değişkenlikleri arasındaki ilişkilerle açıklanmasını ifade ederken, ayırt edicilik, sınıflar arasındaki farklılıkları ifade eder. Diskriminant analizi, iki temel yaklaşıma sahiptir: lineer diskriminant analizi (LDA) ve doğrusal olmayan diskriminant analizi (non-linear discriminant analysis). LDA, veri setindeki sınıfları birbirinden ayıran en iyi lineer kombinasyonu bulmaya çalışırken, doğrusal olmayan diskriminant analizi, veri setindeki sınıfları ayıran en iyi doğrusal olmayan kombinasyonu bulmaya çalışır. İki gruplu ve ikiden çok gruplu olarak uygulanabilen diskriminant analizi, sınıflandırma problemlerinde yaygın olarak kullanılan bir yöntemdir. Özellikle istatistiksel verilerle çalışırken, veri setindeki değişkenlerin sınıflara olan etkisini anlamak ve sınıflandırma yapmak için güçlü bir araçtır. Diskriminant analizi veteriner hekimlikte hastalıkların teşhisi, ilaç etkinliği ve toksisite değerlendirmesi, hayvan popülasyonları arasındaki farkların incelenmesi, zoonoz hastalıkların izlenmesi, hastalık risk faktörlerinin belirlenmesi ve hayvan türlerinin tanımlanmasında kullanılabilir.
Anahtar Kelimeler: Diskriminant Analizi, Sınıflandırma, Veteriner Hekimlik

DISCRIMINANT ANALYSIS AND ITS USE IN THE VETERINARY FIELD

ABSTRACT
Discriminant analysis (DA) is a classification method and is used to separate the samples in the data set into different classes. Basically, discriminant analysis measures the effect of variables in the data set on classes and tries to find the best variables for classification. Discriminant analysis is used when different classes need to be identified or new samples need to be classified, especially when working on a statistical sample. It can also be used as one of the size reduction methods. Discriminant analysis tries to achieve the balance between explainability and distinctiveness, two main components based on the class information of the data set. Explainability refers to the explanation of the total variability in the data set by the relationships between class means and variabilities, while distinctiveness refers to the differences between classes. Discriminant analysis has two basic approaches: linear discriminant analysis (LDA) and non-linear discriminant analysis. While LDA tries to find the best linear combination that separates the classes in the data set, non-linear discriminant analysis tries to find the best non-linear combination that separates the classes in the data set. Discriminant analysis, which can be applied with two groups and more than two groups, is a widely used method in classification problems. It is a powerful tool for classifying and understanding the impact of variables in the data set on classes, especially when working with statistical data. Discriminant analysis can be used in veterinary medicine to diagnose diseases, evaluate drug effectiveness and toxicity, examine differences between animal populations, monitor zoonotic diseases, identify disease risk factors and identify animal species.
Keywords: Discriminant Analysis, Classification, Veterinary Medicine.

GİRİŞ

Son yıllarda yapılan bilimsel araştırmalarda incelenen olayların analizinde, kısıtlayıcı varsayımlar altında geçerli olan tek değişkenli analizlerin yeterli olmadığı görülmektedir. Tek değişkenli analizlerle ilgili en önemli kısıt, olaydaki birçok faktörün deneysel olarak kontrol altında tutulması ve her defasında tek bir faktörün etkisinin incelenmesidir. Tek değişkenli istatistiklerin kısıtlılığı nedeniyle çok değişkenli istatistiksel analizler, araştırmacılar tarafından tercih edilmeye başlanmıştır.

Bu çalışmada, çok değişkenli analiz yöntemlerinden biri olan ve gözlemleri en az hata ile ait oldukları gruplara ayırmak için yapılan işlemlerin tümü olarak tanımlanan diskriminant analizinin teorik altyapısı sunulmuştur.

Diskriminant Analizinin kullanımı, varsayımları, matematiksel işlemlerle teorik yapısı, fonksiyonunun elde edilişi ve anlamı, son olarak teknikleri ve veterinerlik alanında kullanılabilirliği gösterilmiştir.

Diskriminant Analizinin Kullanımı ve Varsayımları

Diskriminant Analizi, farklılığın en fazla hangi değişkenlerde yoğunlaştığının belirlenmesi ve böylece grupların farklılaşmasına sebep olan faktörlerin saptanmasını da sağlar. Analiz sonucunda yapılan sınıflama ile orjinal grup üyeliklerinin karşılaştırılması bilinen fonksiyonun yeterli olup olmadığını test etmeye olanak sağlar (Erçetin, 1993).

Diskriminant Analizi, hatalı sınıflandırma olasılığını en aza indirgeyerek birimleri ait oldukları gruplara ayırmak amacına yönelik olan, istatistiksel bir karar verme yöntemidir (Tatlıdil, 1996).

Diskriminant Analizi, X veri setindeki değişkenlerin iki veya daha fazla gerçek gruplara ayrılmasını belirlemek amacıyla yararlanılan bir yöntemdir (Özdamar, 1999). Diskriminant Analizi, genel anlamda ayırma olup, bireylere ait p tane özellikten yararlanarak ait oldukları grupları belirlemede veya mevcut grupları birbirinden ayıracak en iyi fonksiyonu bulmada kullanılan çok değişkenli istatistik tekniklerinden biridir. Bazı yazarlar Diskriminant Analizinde ayırma fonksiyonu katsayılarının hesaplanmasında başvurulan yöntemlere göre Diskriminant Analizini, kanonik Diskriminant Analizi, en çok olabilirlik Diskriminant Analizi ve Bayes Diskriminant Analizi şeklinde adlandırırlar (Çamdeviren, 2000).

Diskriminant Analizi, gruplar arasında çeşitli değişkenlere bağlı olarak farklılıklarını ortaya koymasına olanak sağlamaktadır. Birimler en az hata ile ait oldukları birimlere

ayrılmaktadır. Ayrıca iki veya daha fazla gruptaki birimlerin etkileşim seviyelerinin hangi düzeyde olduğu, diğer değişkenler arasında ne gibi farklılıklar olduğunu ortaya koymaktır (Tümer, 2001).

Diskriminant Analizi, bir araştırmacının aynı anda çeşitli değişkenlere göre iki ya da daha fazla örnek grubu arasındaki farklılıkları çalışmasına olanak sağlayan bir istatistiksel tekniktir. Genel olarak birimlerin gruplanmasında bazı matematiksel eşitliklerden faydalanılır. Diskriminant fonksiyonu olarak adlandırılan bu eşitlikler birbirine en çok benzeyen grupları belirlemeye olanak sağlayacak şekilde grupların ortak özelliklerini belirlemek amacıyla kullanılmaktadır. Grupları ayırmak amacıyla kullanılan karakteristikler ise diskriminant değişkenleri olarak adlandırılmaktadır.

Kısaca, Diskriminant Analizi, iki veya daha fazla sayıdaki grubun farklılıklarının diskriminant değişkenleri vasıtasıyla ortaya konması işlemidir. Birbiriyle yakından ilişkili birkaç istatistiksel yaklaşımı kapsayan geniş bir kavramdır (Klecka, 1980). Bu yaklaşımlar iki ana kategoride ele alınabilir. Birinci kategoriyi oluşturan yaklaşımlardan gruplar arası farklılıkları yorumlamada faydalanılırken, ikinci kategorideki yaklaşımlar birimleri gruplara ayırmak amacıyla kullanılmaktadır. Diskriminant Analizi eğer bir ayırma fonksiyonu belirlemeye yönelik olarak uygulanmış ise tanımlayıcı diskriminant analizi, eğer sınıflama amacıyla uygulanmış ise tahmin edici diskriminant analizi olarak adlandırılır. Tahmin edici Diskriminant analizi, davranış değerleri içinde bulunan temel bilgilerin gruplar için verilerin nasıl belirleneceği sorusuna işaret eder. Bir girdi, eğer tahmin grubunun üyesi değilse yanlış sınıflandırılmış olarak nitelendirilir. Genellikle yanlış sınıflandırma olasılığını ve bedelini düşürmek de oldukça önemlidir (Demirhan, 1997).

Araştırıcının, p tane özelliği bilinen gözlemleri belli özelliklerine göre bazı gruplara ayırmak istemesi, elde edilecek somut ve özetleyici bilgiler açısından istatistiksel değerlendirmede önemli bir konudur. Araştırıcı, hatalı sınıflandırma olasılığını en aza indirgeyerek gözlemleri ait oldukları gruplara ayırmak veya bu gözlemlerin çekilmiş oldukları grupları belirlemek isteyecektir (Johnson-Wichern 2002).

Diskriminant Analizi X veri setindeki değişkenlerin iki veya daha fazla gerçek gruba ayrılmasını sağlayabilmek amacıyla yararlanılan bir yöntemdir. Araştırmacının p tane özelliği bilinen birimleri doğal ortamdaki gerçek guruplarına, sınıflarına optimal düzeyde atamasını sağlayacak fonksiyonlar bulmasına yarayan bir yöntemdir. Elde edilebilecek

somut özetleyici bilgiler açısından istatistiksel değerlendirme de önemli bir konudur. Çünkü hatalı sınıflandırma olasılığını en aza indirgeyerek birimleri ait oldukları guruplara ayırır, ait oldukları ana kütleleri belirler.

Diskriminant Analizi ve Çoklu Diskriminant Analizi'nin çeşitli amaçları:

-Örnek durumları bir diskriminant tahmin denklemi yardımıyla gruplara ayırmak.

-Örnek durumların tahmin edildiği gibi sınıflandırılıp sınıflandırılmadığına bakarak teoriyi test etmek.

-Gruplar arasındaki ve gruplar içindeki farkları incelemek.

-Gruplar arasında ayrım yapabilmek için en kolay yolu belirlemek.

-Bağımlı değişkendeki değişimin yüzdesini bağımsız değişkenler yardımıyla belirlemek. Diskriminant Analizi bağımlı dağişkenin iki ihtimalli bir değişken olduğunu varsayar.

-Dizisel Diskriminant Analizini kullanarak kontrol değişkenleri tarafından hesaplanan bağımsız değişkenler yardımıyla bağımlı değişkendeki varyansın yüzdesini belirlemek.

-Bağımlı değişkeni sınıflandırmada bağımsız değişkenlerin birbirine göre önemini değerlendirmek.

-Grupları ayırt etmede fazla işe yaramayan değişkenleri elemek.

Bir araştırmada belli bir özellik kümesine bakarak gruplar arasında ayrım yapılırken, analizin ne kadar iyi ayrım yapabildiğini, hangi özelliklerin en kuvvetli ayırt ediciler olduklarını belirlemek önemlidir. Diğer uygulama ise sınıflandırma amacı ile bir veya daha fazla matematiksel denklem üretmektir. Bu denklemler diskriminant fonksiyonları adını alırlar ve bunlar bir durumun en uygun şekilde yerleştirileceği grubu belirlemeye yararlar. Diskriminant Analizinin temeli, incelenen bireyin ana kütlesinin belirlenmesini sağlayacak bir fonksiyonun bulunmasıdır. Bu fonksiyonun bulunmasında, belirlenecek grupların ortalamaları arasındaki farklılığın maksimum olması amaçlanmaktadır.

Gruplar arasındaki ayrımı gerçekleştirmede kullanılan özellikler ayırt edici değişkenler (tahmin ediciler) adını alan bağımsız değişkenlerdir. Bu değişkenler ölçümün belli bir aralığında veya oranı seviyesinde ölçülmelidir. Bu da ortalama ve varyansların hesaplanabileceği ve matematiksel denklemlerde kullanılabilecekleri anlamına gelir. Gruplara ayrılacak durum sayısı ile değişken sayısı arasındaki fark ikiden çok olmadıkça, ayırt edici değişkenlerin sayısı ile ilgili bir kısıt yoktur.

Ayırt edici değişkenlerin sahip olabilecekleri istatistiksel özelliklerle ilgili bazı kısıtlamalar vardır. Hiçbir değişken diğer ayırt edici değişkenlerin bir lineer bileşimi olmamalıdır. Bir lineer bileşim sabit katsayılar ile çarpılan bir ya da daha çok değişkenin ağırlıklı toplamıdır. Bu yüzden bir araştırmacı bu değişkenlerin yanında bunların toplamını ya da ortalamasını kullanma şansına sahip olmaz. Birbiri ile oldukça uyumlu iki değişkeni de aynı anda kullanamayız. Lineer bileşimlere karşı olan bu kısıtlama sezgisel olarak anlamlı olsa da matematiksel olarak gereklidir. Lineer bileşim olarak elde edilecek bir değişken, bileşenlerin sahip olduğu bilgilerin ötesinde yeni bir bilgi içermediğinden kullanımı gereksizdir.

Birçok uygulamada gerekli olan bir başka varsayım her bir grup için kovaryans matrislerinin eşit olmasıdır. En kolay ve sıkça kullanılan diskriminant analizi türü ayırt edici değişkenlerin basit bir lineer bileşimi şeklinde olan bir doğrusal diskriminant fonksiyonu kullanılandır. Bu yöntem en kolay olandır. Çünkü eşit grup kovaryans matrisleri varsayımı diskriminant fonksiyonu ve belli başlı önem testlerini hesaplamada kullanılan formüllerin basitleştirilmesini sağlar. Diskriminant analizi, grupların kovaryans matrislerinin eşit olup olmamasına göre farklı biçimlerde uygulanabilmektedir. Her ne kadar diskriminant analizinin temel varsayımlarından birisi grupların kovaryans matrislerinin birbirine eşit olduğu biçiminde ise de bu varsayım geçerli olmaması durumlarında da diskriminant analizi yapılabilmektedir.

Başka bir varsayım her bir grubun çok değişkenli normal dağılıma sahip olan bir kütleden alınmasıdır. Böyle bir dağılım her bir değişkenin tüm diğerlerinin sabit değerleri etrafında normal bir dağılıma sahip olmaları durumunda ortaya çıkar. Bu önem testlerinin ve grup üyeliklerinin olasılıklarının kesin hesaplanmasına müsaade eder. Bu varsayım kaldırıldığında hesaplanan olasılıklar doğru değildir. Ama bunlar dikkatli yorumlanırsa yine oldukça faydalı olabilirler.

Diskriminant Analizi aynı zamanda birbirine girmiş ortak özelliklere sahip grupları birbirinden ayırmak için grup ortalama vektörlerini birbirinden ayıracak fonksiyonlar geliştiren bir yöntemdir.

Diskriminant Analizi; ANOVA (tek değişkenli varyans analizi) ve MANOVA (çok değişkenli varyans analizi) yöntemleri gibi grupları ortalamalarına (ortalama vektörlerine) göre ortak ortalamadan (ortalama vektöründen) farklı olmalarını sağlayacak bir ayırma kriteri geliştirmeyi amaçlayan bir yöntemdir. Bu nedenle veri setlerine

Diskriminant Analizi uygulanabilmesi için veri setlerinin ANOVA ve MANOVA için gerekli olan aşağıdaki varsayımları taşıması gerekir.

-Veriler çok değişkenli normal dağılım göstermelidir.

-Değişkenlerin varyans ve kovaryansları homojen olmalıdır. Analizde yer alan değişkenler ortak kovaryans matrisine sahip çok değişkenli ana kütleden çekilmiş örnekler olmalıdır.

-Değişkenlerin ortalamaları ve varyansları arasında bir korelasyon bulunmamalıdır.

-Değişkenler arasında çoklu bağlantı bulunmamalıdır.

-Veri seti grupların birbirinden ayrılmasında rol oynamayacak gereksiz değişken içermemeli, grupların birbirinden ayrılmasını sağlayacak kadar doğru ve gerekli değişkenleri içermelidir. Bu varsayımlar diskriminant analizine genelde yapılan yaklaşımlara dayalı bir matematiksel model ortaya koyar. Eğer belli bir problemin verileri varsayımları sağlamazsa istatistiksel sonuçlar tam olarak gerçeği yansıtmayacaktır.

Tüm istatistiksel ve matematiksel modellerde olduğu gibi, diskriminant analizi de bazı varsayımlara dayanmaktadır. Analizin ayırım gücü dayandığı varsayımların sağlanmasına ya da bu varsayımlar karşısında sağlam olmasına bağlıdır. Özellikle modelin başarısının, beklenenden düşük çıktığı durumlarda, doğru yorumda bulunabilmek için bu varsayımların test edilmesi gerekmektedir.

Bu varsayımlardan bir ya da daha fazlasının sağlanmadığı durumda, diskriminant analizi optimum bir sınıflandırma ortaya koyamayacaktır. Varsayımlarda bağımsız değişkenlerin normal dağılıma sahip olduğu belirtilmiştir. Ancak yapılan araştırmalar mali oranlar kullanılarak yapılan çalışmalarda mali oranların normal dağılıma uygunluk göstermemesi sebebiyle dağılımların normalden ziyade sağa çarpık olduğunu göstermektedir. Bu durumda mali oranlar kullanılarak yapılan çalışmalar değişkenlerin dağılımını normal dağılıma yaklaştırmayı hedeflemektedir (İç ve Yurdakul, 2000)

İki Gruplu ve İkiden Çok Gruplu Doğrusal Diskriminant Analizi

Doğrusal diskriminant fonksiyonları ile ilgili çalışmalar, 1936 yılında Fisher'in klasik makalesi yayınlandığında başlamıştır. Bununla birlikte Hodges'in de belirttiği gibi Pearson'un ırk benzerliği katsayısı, Mahalanobis'in D2'si, Hotelling'in T2 istatistiği ile ilgili başlangıçtaki çalışmalar arasında yakın bir ilişki vardı. Doğrusal diskriminant analizindeki temel problem p tane değişkenin hangi lineer bileşiminin örnekleri en iyi şekilde ayırt edeceğidir. Sonuçlar genellikle grup içi oranları, gruplar arası oranları ve de

toplam varyansı da içeren bir kurala göre hesaplanmaktadır. Fisher sadece bir tek lineer diskriminant fonksiyonu kullanmıştır. Birden fazla lineer fonksiyon olması durumunda çözüm matris cebirleri teorisinde kolayca elde edilebilir ve bir determinant denkleminin köklerinin bulunması esasına dayanır. Sosyal bilimler literatüründeki diskriminant analizi uygulamaları bu türdedir.

Fisher, lineer diskriminant fonksiyonuyla ilgili çalışmasında örneklerin gruplara yanlış atanması problemini ele almıştır. 1939 yılında Welch tarafından yayınlanan bir makalede bu problemin, hipotez testi ve Neyman ve Pearson'un verdiği hata tipleri üzerine kurulu yeni bir formülasyonu önerilmiştir. Welch probleme örnek uzayı iki bölgeye bölerek ve sonra da bu iki bölgeden birisine yanlış sınıflandırma yapma olasılığını en aza indirecek şekilde bir örnek gözlem atamıştır. Sınıflandırma ve atama kuralları için uygun bir kararın seçimi ilk olarak gözlemin iki örnek grubundan birisine ait olduğu bir öncelik mevcut olduğunda; ikinci olaraksa bu tür bir öncelik mevcut olmadığında yapılmalıdır. Welch tarafından ayırt etme probleminin olasılık açıdan yorumu ve özellikle de atama problemleri hakkındaki fikirleri, içinde istatistiksel karar fonksiyonlarının da yer aldığı birçok yayının yapılmasına sebep olmuştur. Kabul edilebilir süreçler hakkındaki tartışmalar, minimax metodu, Bayes teoremi ve benzerleri, bu alanda çalışan uzmanların temel çalışma konuları haline gelmiştir.

Bir diskriminant fonksiyonu bulunurken, gruplar arası varyansın grup içi varyansa göre en büyüklenmesi gerekir. Yani, gruplar arası varyans / grup içi varyans oranının en büyük olması istenir (Cangül, 2006).

Doğrusal diskriminant fonksiyonunun kullanılabilmesi için ana kütlelerin normal dağılımlı ve ortak varyans-kovaryans matrisine sahip olmaları gerekir. Bu varsayımların bozulduğu durumlar için de bazı çalışmalar yapılmıştır.

İki gruplu doğrusal DA, çoklu değişkenleri tek bir doğrusal bileşene dönüştürerek veri setinin boyutunu azaltır. Bu bileşen, farklı gruplar arasındaki değişkenlikleri maksimize etmek ve aynı gruptaki değişkenlikleri minimize etmek için seçilir. Bu sayede, veri setindeki grupların ayrımını en iyi şekilde yapabilen bir doğrusal ayrışım elde edilir.

İki gruplu doğrusal DA 'nın çalışma prensibi şu adımlardan oluşur:

1-Veri setindeki her bir örnek için, girdi özelliklerine dayalı bir vektör oluşturulur.

2-Her bir örnek vektörü, sınıf bilgisiyle birlikte iki gruplu doğrusal DA modeline verilir.

3-İki gruplu doğrusal DA modeli, veri setindeki gruplar arasındaki farklılıkları maksimize etmek için uygun bir doğrusal ayrışım bileşeni bulur.

4-Elde edilen doğrusal bileşen kullanılarak, veri seti boyutu azaltılır ve yeni bir alt uzay oluşturulur.

5-Yeni alt uzayda, veri noktaları daha iyi sınıflandırılabilir hale gelir.

İki gruplu doğrusal diskriminant analizinin avantajları şunlardır:

-Boyut azaltma: İkili gruplu doğrusal DA, yüksek boyutlu veri setlerinde boyut azaltma yaparak veri setinin karmaşıklığını azaltır.

-Sınıflandırma performansı: İki gruplu doğrusal DA, veri setindeki gruplar arasındaki farkı en iyi şekilde yakalamaya çalışır ve bu nedenle sınıflandırma performansı genellikle yüksektir.

-İyi tanımlanmış model: İki gruplu doğrusal DA, belirli bir matematiksel temele dayanan ve iyi tanımlanmış bir modeldir.

İkiden çok gruplu diskriminant analizi, özellikle denetimli öğrenme problemlerinde ve çok sınıflı sınıflandırma problemlerinde yaygın olarak kullanılan bir yöntemdir.

İki gruplu diskriminant analizinden farklı olarak, ikiden çok gruplu diskriminant analizi birden çok sınıfı ayrıştırmak için, birden fazla doğrusal bileşen oluşturur.

İkiden çok grup olması durumunda kullanılan diskriminant analizi teknikleri, iki grup için geliştirilenlerin genel bir halidir. Burada p değişkenli, ikiden çok sonlu sayıda grup bulunmaktadır. Bireyler gruplar arasında ayırma gücü en büyük olacak şekilde belli sayıda doğrusal bağıntılar yardımıyla sınıflandırılmaktadır. Genel olarak, ikiden fazla grup olması durumunda bulunacak diskriminant fonksiyonu sayısı; r = min (k - 1, p) = min(q , p) tanedir. Burada k grup sayısını, p değişken sayısını göstermektedir.

Sonuç olarak, ikiden çok gruplu diskriminant analizi, veri setindeki birden çok sınıfı ayrıştırmak için kullanılan bir sınıflandırma yöntemidir. Bu yöntem, boyut azaltma ve sınıflandırma performansı açısından avantajlar sunar.

Özel Durumlarda Kullanılan Diskriminant Analizi Teknikleri

Fisher yöntemi ve genelleştirilmiş hali olan Anderson yöntemi kullanılarak doğrusal diskriminant fonksiyonu bulunduğunda tanımlanan bu fonksiyondaki veriler normal dağılımlı ve ana kütleler ortak varyans-kovaryans matrisine sahiptir.

Doğrusal diskriminant fonksiyonunun normallikten uzaklaşmayı engellemede kuvvetli, fakat eğik dağılımlarda kullanılamayabilir olduğu gösterilmiştir.

Bu varsayımların bozulduğu durumlarda alternatif fonksiyonlar kullanılır. Karesel Diskriminant Fonksiyonu; verilerin normal dağıldığı ancak, grupların varyans-kovaryans matrislerinin farklı olmaları durumunda kullanılan fonksiyondur.

Verilerin karışık olması durumunda yani bazılarının sürekli ve normal dağılımlı, bazılarının ise kesikli olması durumunda doğrusal diskriminant fonksiyonuna bazı karesel terimler eklenerek yeni bir fonksiyon oluşturulur. Buna Yüksek Derece Terimli Doğrusal Diskriminant Fonksiyonu (doğrusal diskriminant fonksiyonu + karesel terimler) adı verilir.

Doğrusal diskriminant fonksiyonunda olduğu tahmin edilen katsayılar, doğrusal diskriminant fonksiyonunun sonuçlarına çok yakın değerler alırlar (Tatlıdil, 1996-Aldrich & Nelson, 1986-Anderson, 1982).

Yüksek dereceli fonksiyonda olduğu gibi değişkenlerden bazılarının sürekli, bazılarının kesikli olduğu durumlarda diskriminant analizine alternatif olarak lojistik regresyon analizi önerilmektedir.

Diskriminant analizi, çekildiği ana kütlesi bilinmeyen herhangi bir gözlemin uygun ana kütleye atanmasıdır. Verilerden grup ya da grupların konum ve yayılma parametrelerinin bilinmesi durumunda yeni çekilen herhangi bir gözlemin bu gruplara atanıp atanmayacağına karar verme konusu diskriminant fonksiyonları yardımıyla yapılmakta ve bu işlemlere tanımlama analizi adı verilmektedir. Aynı biçimde tek bir örneklemin ortalamasının bilinen tüm diğer grupların ortalaması ile karşılaştırılması da yine bu fonksiyonlardan yararlanarak yapılmakta ve böyle analizlere de belirleme analizi adı verilmektedir (Flury, 1988).

Diskriminant analizi gelecekte kullanılabilir fonksiyonlar ortaya koyar. Bu nedenle kümeleme analizinden farklılaşmakta ve temel bileşenler analizi, korelasyon analizi, çok değişkenli regresyon analizine yaklaşmaktadır.

Çok Değişkenli İstatistiksel Analizlerle Diskriminant Analizinin Karşılaştırılması

Gözlemlerin, gruplara ayrılmasında kullanılan yöntemlerden üç tanesi; Kümeleme, Diskriminant ve Lojistik Regresyon Analizleridir.

Diskriminant Analizi, tek faktör çok değişkenli varyans analizi MANOVA'nın uzantısı olan çok değişkenli analiz türüdür. Diskriminant analizinin amacı bireyleri bilinen belli özelliklerinden faydalanarak kendi arasında ortak özelliklere sahip gruplara ayırmaktır. Gruplar arası ayırımda ayırıcı değişkenler belirlenir. Bir birimin hangi gruba dahil

edileceğini belirlemede kullanılır. Bir çok yönden MANOVA ile Diskriminant Analizi birbirinin aynısıdır. MANOVA'daki bağımlı değişkenler (ölçülebilir değişkenlerin belli bir kümesi), diskriminant analizindeki bağımsız değişkenlerdir. Benzer şekilde diskriminant analizindeki ölçülemeyen tek bağımlı değişken de MANOVA'daki bağımsız değişken halini almaktadır. Ayrıca, ikisi de gruplar arasındaki istatistiksel farklılıkları değerlendirirken aynı metodları kullanır. Ancak farklılıklar, analizlerin hedefleri etrafında ve ölçülemeyen değişkenlerin görevleri üzerine odaklanır. Diskriminant analizi, bağımlı değişken olarak bir tek ölçülemeyen değişken kullanılır. Bağımlı değişkenin kategorize edildiği varsayılır. Bağımsız değişkenler genelde bağımlı değişken kategorileri yardımıyla oluşturulan gruplar arasında en yüksek farka sahip olanı oluşturmada kullanılır. MANOVA' da ölçülebilir değişkenlerin kümesi bağımlı değişkenler olarak görev görür ve böylece amaç, bağımlı değişkenlere göre farklılıklar sergileyen örnek grupları bulmak haline dönüşür. Bu gruplar önceden belirlenmemiştir. Bunun yerine araştırmacı grupları oluştururken bir ya da daha fazla (ölçülemeyen) bağımlı değişken kullanır. MANOVA, bu grupları oluştururken bile her bir ölçülemeyen değişkenin etkisini değerlendirme etkisini değerlendirme özelliğini korumaktadır (Hair et al., 1998).

Çok değişkenli istatistiksel analizlerden biri olan Kümeleme Analizinin amacı, gruplanmamış verileri benzerliklerine göre sınıflandırmak, gruplarda toplamak ve araştırmacıya işe yarar özetleyici bilgiler elde etmede yardımcı olmaktır. Diskriminant analizi, kümeleme analizi ile aynı değildir. Diskriminant analizinde gruplar önceden belirlenir ve amaç bağımsız değişkenlerin gruplar arasında en uygun ayırımı yapabilecek olan lineer bileşimini belirlemektir. Kümeleme analizinde ise gruplar önceden belirlenmemiştir ve amaç örnek durumların gruplara yığılmasını en iyi şekilde sağlayan yöntemi bulmaktır. Kümeleme analizinde de diskriminant analizinde olduğu gibi verilerin normal dağılımlı olması gerektiği varsayımı olmakla birlikte bu varsayım prensipte kalmaktadır ve kümeleme analizinde kovaryans matrisine ilişkin bir varsayım da bulunmamaktadır. Kümeleme analizinin sosyal bilimlerde, tıpta, ziraat ve mühendislik alanlarında kullanımı yaygın olarak görülmektedir.

Lojistik regresyon analizinin temel amacı, diğerlerinde olduğu gibi bir veya birden fazla bağımsız değişken arasındaki ilişkiyi modellemektir. Diğer regresyon analizlerinde bağımlı değişken sürekli iken, lojistik regresyon analizinde bağımlı değişken kategoriktir.

Bağımsız değişkenlerin tümü kategorik değişken, sürekli değişken veya kategorik ve sürekli değişkenlerin bir karması olabilir. Lojistik regresyon analizi çeşitli varsayım (normallik, ortak kovaryansa sahip olma gibi) ihlalleri durumunda diğer analizlere alternatif oluşturmaktadır (Bayram, 2002). Diskriminant analizi, günümüzde diskriminant analizinin yerine sıkça kullanılan lojistik regresyonun olmadığı önceki zamanlarda bir alternatif metod olarak kullanılmaktaydı. Diskriminant analizinin iki temel varsayımı olan; verilerin çok değişkenli normal dağılması ve grupların ortak varyans-kovaryans matrisli olmaları, pratikte genellikle sağlanamadığı için bu yöntemin kullanımı kısıtlı olmaktadır. Varyasımların bozulumu durumunda kullanılan bazı özel diskriminant fonksiyonları olmakla birlikte yorum kolaylılığı ve kestirim güçlülüğü nedeniyle lojistik regresyon analizi son yıllarda daha çok kullanılmaya başlanmıştır. Çünkü lojistik regresyon, genelde varsayımlarla daha az çelişen (bağımsız değişkenler normal olarak dağılmayabilirler, lineer olarak bağımlıdır, ya da eşit grup içi varyansa sahiptirler), kategorik ve aynı zamanda sürekli değişkenlerle ilgilenir ve ayrıca birçok kişi için daha kolay yorumlanabilen katsayılara sahiptir. Lojistik regresyon, verilerin dağılımı normal olmadığında ya da grup büyüklükleri farklı olduğunda tercih edilebilmektedir. Küçük hacimli örneklemler olması durumunda ve sınıflama amacına yönelik çalışmalarda diskriminant analizinin, sonsal olasılıkların kestirimine yönelik çalışmalarda ise lojistik regresyon analizinin tercih edilebilir olması söylenebilir.

Kümeleme analizinde gözlemlerin atanacağı küme sayısı bilinmezken, diskriminant ve lojistik regresyon analizinde grup (küme) sayısı bilinmekte, mevcut veriler kullanılarak bir ayrımsama modeli elde edilmekte ve kurulan bu model yardımı ile veri kümesine eklenen yeni gözlemlerin gruplara atanması mümkün olabilmektedir (Tatlıdil, 1996).

Diskriminant Analizinin Veterinerlik Alanında Kullanılabileceği Bazı Durumlar

1. Hastalık Teşhisi ve Sınıflandırma: Veteriner hekimler, hayvanlarda çeşitli hastalıkları teşhis etmek ve sınıflandırmak için diskriminant analizi kullanabilirler. Örneğin, bir grup belirli semptomları olan hayvanları, farklı hastalık gruplarına ayrılmış bir diskriminant analiz ile değerlendirebilirler.
2. Tür Tanımlama: Veteriner hekimler, belirli bir tür veya ırkın hayvanlarını ayırt etmek amacıyla diskriminant analizi kullanabilirler. Bu, genetik özellikleri, morfolojik özellikleri veya başka özellikleri baz alarak yapılabilir.
3. İlaç Etkinliği ve Toksisite Değerlendirmesi: Diskriminant analizi, belirli bir tedavi

protokolünün hayvanlarda etkinliğini veya bir ilacın olası toksisitesini değerlendirmek için kullanılabilir.

4. Hayvan Popülasyonları Arasındaki Farkların İncelenmesi: Veteriner hekimler, belirli bir coğrafi bölgedeki hayvan popülasyonları arasındaki genetik veya morfolojik farklılıkları anlamak için diskriminant analizi kullanabilirler. Bu tür analizler, koruma stratejileri veya genetik çeşitliliği değerlendirmek için kullanılabilir.

5. Zoonoz Hastalıkların İzlenmesi: Hayvanlarda ortaya çıkan zoonoz hastalıkları izlemek ve insan sağlığını korumak için diskriminant analizi kullanılabilir. Bu, hastalık yayılımını kontrol altına almak ve etkili önlemler almak açısından önemlidir.

KAYNAKLAR

Bayram, Nuran. (2002). Diskriminant Analizi: Akademisyenler Üzerine Bir Uygulama. *Marmara Üniversitesi Sosyal Bilimler Enstitüsü Dergisi: Öneri*, 5(17), p.219-229. https://doi.org/10.14783/maruoneri.683495

Çamdeviren, H. (2000). Lojistik Regresyon ve Diskriminant Analizi. Doktora Tezi, Ankara Üniversitesi, Ankara, Türkiye.

Demirhan, N. (1997). Kümeleme Analizi ile Konfeksiyon Üretiminde Beden-Drop Ölçülerinin Belirlenmesi ve bir Uygulama. Yüksek Lisans Tezi, Marmara Üniversitesi, İstanbul, Türkiye.

Erçetin, Y. (1993). Diskriminant Analizi ve Bankalar Üzerine Bir Uygulama, *Türkiye Kalkınma Bankası A. Ş., APM/28 (KİG-26)*, 1-2.

Hair, J. F., Anderson, R. E., Tatham, R. L. & Black, W. C. (1998). Multivariate Data Analysis, *Prentice Hall International*.

İç, Y. T. & Yurdakul, M. (2000). Analitik Hiyerarşi Süreci (AHS) Yöntemini Kullanan Bir Kredi Değerlendirme Sistemi. *Gazi Üniversitesi Müh. ve Mim. Fakültesi Dergisi*, 15(1), p. 1-14.

Johnson, R. A. & Wichern, D. W. (1998). Applied Multivariate Statistical Analysis, *Prentice Hall*, USA.

Karels, V. G. & Prakash, J. A. (1987). Multivariate Normality and Forecasting of Business Bankruptcy. *J. of Business Finance & Accounting*, 14(4), p. 573-593. https://doi.org/10.1111/j.1468-5957.1987.tb00113.x

Klecka, W. R. (1980). Discriminant Analysis, Sage Pub., Beverly Hills,. Leeuwen. H, P. (1985). The Prediction of Business Failure at Robobank. *J. of Bank Research*, p. 91-98.

Cangül, Oya. (2006). Diskriminant Analizi Ve Bir Uygulama Denemesi. Yüksek Lisans Tezi, Bursa, Türkiye.

Özdamar, Kâzım. (1999). Paket Programlar ile İstatistiksel Veri Analizi. Kaan Kitabevi, Eskişehir, Türkiye.

Polat, E. (1995). Türk Bankacılık Sisteminde Problemli Kredileri Önceden Belirleyecek Model Geliştirilmesi İçin Bir Uygulama. Pamukbank T. A. Ş. Eğitim Yayınları, İstanbul.

Tatlıdil, Hüseyin. (1996). Uygulamalı Çok Değişkenli İstatistiksel Analiz. Cem Web Ofset Ltd. Şti., Ankara,Türkiye.

Tatsuoka, M. M. (1976). Discriminant Analysis. *Data Analysis Strategies and Designs for Substance Abuse Research,* p. 201-220.

Tümer, M. (2001). Kuzey Kıbrıs Türk Cumhuriyeti İmalat Sanayinde Faaliyet Gösteren Kobileri Ayrıştıran Faktörlerin Tespiti. Doğu Akdeniz Üniversitesi, p. 296-303.

THE EFFECT OF PLANTING DISTANCES ON GROWTH CHARACTERISTICS AND YIELD OF YELLOW MAIZE

Ali Ihsan AZEEZ
College of Energy and Environmental Sciences – Al-Karkh University of Science – Republic of Iraq
Email: Zzed1666@gmail.com

Imad Khalaf AZEEZ
Department of Field Crops Sciences – College of Agriculture – University of Diyala – Republic of Iraq
Planting spacing effect on growth and yield characters in Maize
Email: Dremad1956@yahoo.com

ABSTACT
This experiment was conducted in Muqdadia 50 Km north of Baquba to study effect of planting Maize by squares method, using the standard plant spacing (75×20) as a control treatment and (35×35), (40×40) cm between rows and plants. These treatment putted in the randomized completce design with three replications. All the soil and field practices done accordding to the recommendation of ministry of Agriculture in Iraq .Characters studied were : plant height, internode number, leaf area , days from planting to 50% flowering, florescence (flowering), ears number , columns number, grain number in column results showed :- plant specing affectlad stem diametr and grain number in ear and plant weight, (35×35) (75×20)cm significantly effect .planting by sqaures affected plant height , ears number per plant, plants weight and grain number (40×40) (75×20) cm in column.
Keywords: yellow maize, leaf, soil

The introduction

Yellow corn (Zea mays L.) is one of the important strategic crops in the world, and America and Central America are the original and secondary homeland of the yellow corn plant (Nimer and Al-Hosary 2015). Its cultivation has also been known in Mexico for thousands of years, and this crop has received wide attention because of its high capacity. On production compared to other crops, it is the first ever in producing grain yield per unit area (Al-Sahuki 1990). The yellow corn plant is considered a C4 plant, as these plants are distinguished by having a biochemical and anatomical mechanism to raise the internal CO2 concentration in its fixation sites, and this decreases and sometimes eliminates the loss. Carbon by photorespiration, as C4 plants that live in hot and dry areas have a high efficiency in using water in those environments. Therefore, they can increase the rate of photosynthesis two or more times per 1 gram of water compared to C3 plants (Al-Mubarak 2018). They are also a source of food for humans and animals (Al-Awadi (2004) Grain crops and their industrial products are considered important food sources for global food, in addition to their importance for fodder and their many industrial uses. More than 60% of the world's food is concentrated in the three main crops, which are wheat, rice, and yellow corn (Rhodes 2006), and the yellow corn crop is suffering from a decline. In production rate. This decline requires conducting scientific and applied studies and increasing yields. Increasing the productivity of any crop depends mainly on many factors, most notably agricultural operations, such as the method of distributing plants in the field, which is one of the important applications for exploiting various environmental factors (light, water, soil, etc.). Among these factors, to increase the quantity and type of economic yield per unit area, is the variation in the planting distance. Between plants, it leads to a different plant density, as plant density is one of the most important factors in controlling the percentage and efficiency of interception of effective solar radiation through the process of photosynthesis, which in turn affects the process of growth and production of the crop (Jadoua Khudair and Rafiq 2010).

The issue of establishing the ideal number of plants per unit area is also one of the important and necessary matters to obtain the highest limit of production, as under conditions of sufficient moisture and soil fertile with nutrients, high density is necessary in order to benefit from other growth factors with high efficiency. Studies have also proven that square planting is more efficient in taking advantage of the light, water, and

nutrients ready for individual plants than rectangular planting. (Al-Muaini and Al-Obaidi 2018). Also, reducing the distance between plants increases the concentration of auxin in the plant due to shading, which increases the height of the plant. On the contrary, increasing the distance between plants allows the penetration of a greater amount of Ba by light, so the auxin is photo-oxidized, and the elongation of the internodes decreases, and the height of the plant decreases as a result. The shorter distance also allows for less competition for water, carbon dioxide, and nutrients, which reflects positively in increasing the efficiency of photosynthesis (Abdullah et al. 2010).

Materials and working methods

A field experiment was carried out in the Muqdadiya district, 50 km north of Baqubah, in the fall season of 2018, to study the effect of yellow corn using the square method, where the distances between the lines and plants were (75 x 20), (40 x 40), and (35 x 35) cm, respectively. It included three Plant densities are (66666, 62500, 81632) plants/ha. Randomized complete block design (RBCD) was used for the above three treatments using the yellow corn variety Ibaa 5018 with three replicates. The area of one experimental unit was (6) m2, and the following characteristics were studied.

1- Date of male flowering (day): According to the number of days from planting until the appearance of the male inflorescence, 50% of the plants

2- Female flowering time (day): According to the number of days from planting until the appearance of the female inflorescence (silver) 50%

3- Plant height (cm): The height was measured from the soil to the end of the male inflorescence

Leaf area (2 cm) and its index: The square of the leaf length that lies under the first petiole was measured and multiplied by a constant (0.65) for a plant that has 13 leaves or less. The leaf area index was calculated by dividing the leaf area of a single plant by the area it occupies for each treatment separately (Al-Sahoki and Jiyad 2013) and the equation was based on Al-Sahoki 1995

$$\text{Plant leaf area guide} = \frac{\text{left area(m2)}}{\text{(m2)land of plants occupied by the area}}$$

5 -Stem diameter

6-teblets weighing 300 grams

7-The average number of rows in the coop

8-Average number of nests

9-Grain yield

10-Average number of grains per row

11-Number of papers

12-Oil percentage

13The percentage of protein in the grain

14- Chlorophyll percentage

15-Plant weight.

The results were statistically analyzed manually and using a statistical calculator. The least significant difference was calculated and the results were compared based on it.

A table showing the average temperatures from planting to harvest

Fourth month	the third mounth	second month	first mon
Minor-major	Minor-major	Minor-major	Minor-major
Average for the first 10 days 42-26	Average for the first 10 days 41-24	Average for the first 10 days 43-25	Average for the first 10 days 42-28
Average of 10 days per second 16-29	Average of 10 days per second 40-22	Average of 10 days per second 44-27	Average of 10 days per second 43-26
Average of 10 days three13-24	Average of 10 days three 39-29	Average of 10 days three 43-25	Average of 10 days three 43-27

Results and discussion

1-Number of days from planting until (50% male flowering)

The study showed that there are no significant differences in the number of days from planting until (50%) male flowering, and this agrees with Al-Dawoudi et al. (2015), where the results showed that the number of days for the traditional treatment (20 x 75) is 61, and for the treatment (35 x 35) it is 63 days, and for the treatment (40 x 40) it is 65 days, and the treatment (20 x 75) cm is the least number of days than the rest of the transactions, but there are no significant differences between the transactions

2-Number of days from planting until (50% female flowering)

The study showed that there were no significant differences between plant densities for female flowering, and this is consistent with (Rahim, Al-Akidi, et al. 2015), where the (20 x 75) treatment reached 50% female flowering within 66 days, the (35 x 35) treatment within 70 days, and the (40 x 40) within 72 days, and the treatment (20 x 75) cm was the smallest number of days compared to the rest of the treatments, but there are no significant differences between the treatments

3-plant height

This trait has an important correlation with many traits, as there was a highly significant increase in the average plant height depending on the change in plant density. Highly significant statistical differences appeared, as the (75 x 20) cm treatment outperformed each of the last two treatments for this trait, and the height rate was ((293) cm. The treatment (40 x 40) cm also outperformed the treatment (35 x 35) cm with a rate of (214.13), which gave the least significant difference with a rate of (211) cm, and the rate was (8.25) LSD. This result is consistent with what was indicated by (Al-Ani 1983). (Al-Harbawi, 1991) also obtained an increase in the average height of the plant that was planted at a distance of (50 x 50) compared to (75 x 25) cm. This also agrees with (Dawood, 2009). The height of the plant in high density is due to the increase in the intensity of competition between plants, and this He agrees with Ali (2003) and also agrees with (Al-Rifai and Al-Nimr 2017). He also does not agree with (Cooperlo 2004), who obtained a height at a distance of 1.5 feet compared to 0.5 feet between one line to another, and he does not agree with HUSSEN 200

4-paper space

There were no statistically significant differences between plants in leaf area as a result of changing plant densities.

5-paper space guide

The leaf area of a plant constitutes the area of land it occupies has a significant impact on the total grain yield per unit area, as it increases with the increase in leaf area, but this is to a certain extent and then decreases (DUNCON 1975). However, the leaf area index follows a path similar to that of leaf area, and no significant differences appear.

6-leg diameter

It is noted from the results of the study that there are no statistically significant differences for plant densities in the average stem diameter for the three different

densities, as the diameter was calculated after taking the stem circumference with a measuring tape and extracting the average diameter by using the law of the circumference of a circle.

7-Average weight of 300 tablets

There were no statistically significant differences in the weight of 300, and this is due to the absence of significant differences in paper area and its index. This result is not consistent with Karlen 1997.

8-Average number of rows in the cob

No significant differences appeared in the average number of rows in stalks as a result of changing plant densities, and some consider that the average number of rows in stalks is one of the components of the yield.

9-Average number of grains per row

Significant differences appeared in the number of grains in the row as a result of changing plant densities, which indicates the accumulation of sufficient dry materials to make food. The treatment (20 × 40 cm, with an average of (17.42) grains per row compared to the last treatment (35 × 35 cm), which gave the least significant difference (16.90), and the LSD was (3.41).

10-Average number of nests

There were no statistically significant differences in the number of shoots as a result of changing plant densities

- 11-Grain yield

The study showed that the treatment (40 x 40) cm had the highest rate (120.33) grams, while the treatment (35 x 35) cm had the lowest rate (116.8) with no significant differences between the treatments.

12-Number of papers

The study showed that there were no significant differences in the number of leaves as a result of changing plant densities. The number of leaves is very important in crop production for the purpose of intercepting the maximum possible solar rays, as well as the number of yellow leaves. It is believed that the appearance of dry leaves is the transfer of matter and the distribution of mineral and organic elements to the more competitive outfalls such as new leaves, grains and roots (Cardiner et al. 1990). This agrees with

Youssef 2009. Younis 2009, who stated that there were no significant differences between the varieties in this trait.

13-Oil percentag

No significant statistical differences appeared between the arithmetic means of the coefficients in this trait, which were calculated using the Kjeldahl method. This is due to several reasons, including the type of variety and its genetic characteristics. Studies have shown that the percentage of oil is affected by the variety of the crop, its genetic characteristics, and the amount of fertilizer.

14-Protein percentage

No statistically significant differences appeared between the arithmetic averages of the parameters in this trait, which were calculated using the Kjeldahl method. This is due to several reasons, including that this percentage is affected by nitrogen fertilizer. Studies have shown that the percentage of protein is affected by the variety of the crop, its genetic characteristics, and the amount of fertilizer.

15-Chlorophyll percentage

No statistically significant differences appeared between the arithmetic means of the parameters in this trait, as the chlorophyll rate was measured using a SPED device that measures the chlorophyll percentage in the leaf. This is due to several reasons, including that this percentage is affected by nitrogen fertilizer. Studies have shown that the percentage of chlorophyll is affected by its genetic characteristics and the amount of fertilizer.

16-Weight of the whole plant. Significant statistical differences appeared in the weight of the whole plant, as it was superior

17-The treatment (35 x 35) cm had a rate of (1.35) grams as the highest significant difference over the treatment (40 x 40) cm as the least significant difference at a rate of (1.15) grams, and the rate of LSD was (0.3039) grams.

18-Average maximum temperature: It is the maximum temperature that the plant can tolerate and in which the plant can live. If it exceeds it, the plant is exposed to damage. The maximum degree of tolerance for the yellow corn crop in Iraq is (40-44) degrees Celsius, and 49 degrees is considered fatal to most yellow corn cells.

19-Minimum temperature average: A drop in crop temperatures below the minimum kills the growing shoots and freezes the water in the cytoplasm. The minimum limits for yellow corn yields are (8-10) at germination, while the seedlings die at (-3) degrees Celsius

A table showing the effect of planting distances on growth characteristics and yield of yellow maize

Paper space guide	Paper space	Qatar the leg	number Papers	Height	Adjectives / adjectives
2.50	3751.03	2.562	13	239	75×20
2.93	3590.18	2.461	13.6	214.13	35×35
2.33	3739.93	2.442	13.75	211.81	40×40
N.S.	N.S.	N.S.	N.S.	8.25	LSD

Supplement the table for the studied characteristics

He got it Cereals	Weight 300 grain	Number of goats	Number of days from planting until 50% flowering	Number of days from planting until 50% male flowering	adjectives / Transactions
117.1	115	1,46	66	61	75×20
116.8	116.8	1.26	70	63	35×35
120.33	112.16	1.56	72	65	40×40
N.S.	N.S.	N.S.	N.S.	N.S.	LSD

Supplement the table for the studied characteristics

Chlorophyll percentage	Oil ratio	Protein percentage	Whole plant weight	Number of rows	Number of row beans	Adjectives / Transactions
20.48	4.87	14.55	1.24	8.1	19.02	75×20
19.67	4.48	14.07	1.35	8.3	16.90	35×35
20.3	5.2	12.65	1.153	7.98	17.42	40×40
N.S.	N.S.	N.S.	0.3039	N.S.	3.41	LSD

Conclusions

It was shown through this study that planting using the square method gives better field characteristics and yields than the traditional treatment, especially when the plant density of the square method is higher than the traditional spacing.

Recommendations

We recommend using the square method because it gave good characteristics and helped reduce jungle competition for the crop in addition to increasing production per unit area resulting from collecting agricultural crops.

The reviewer

1. -Al-Sahuki, Medhat Majeed. 1990. Yellow corn production and improvement. Ministry of Education and Scientific Research. Baghdad University.
2. -Al-Ani, Hakim Saleh Mahdi. 1993. Response of yellow corn (Zea mays L.) to nitrogen fertilization and planting distances. Master Thesis . College of Agriculture - University of Baghdad
3. Al-Younis, Abdel Hamid Ahmed, Mahfouz Abdel Qader, and Zaki Abdel Elias. 1987. Grain Crops - Ministry of Higher Education and Scientific Research - Mosul University Press.
4. Al-Younis, Abdel Hamid Ahmed. 1993. Production and improvement of field crops - University of Baghdad - College of Agriculture.
5. Abdullah, Ayman Sobhi 2001. The effect of planting date and plant density on the characteristics and yield of green fodder for yellow corn. Master's thesis, College of Agriculture - Tikrit University.
6. Dawoud, Wissam Malek, Souad Khairy, Najm Abdullah Juma 2009. The effect of the direction of lines and the distribution of plants on light interception, growth characteristics, and yield of yellow corn, Zea mays L.. Diyala Journal of Agricultural Sciences 1 (1): 162-171.
7. Al-Issa, Talib Ahmed Issa. 1994 Ministry of Education and Scientific Research - University of Baghdad. Translator.
8. The Blessed. Nader Falih Ali. 2018. Jungle Life. Ministry of Education and Scientific Research - College of Agriculture - University of Diyala.
9. Al-Badiri. Wafa Mohan Ajeel. 2018. Climatic requirements for growing yellow corn in Al-Qadisiyah Governorate. University of Maysan - College of Education, Department of Geography.
10. Al-Tamimi. Wafa Muhammad Lafta 2015. The effect of nitrogen fertilization and irrigation methods on the qualitative characteristics of yellow maize plants, Zea mays L. Al-Furat Journal of Agricultural Sciences -7 (3) 179-18611 - Abdel Ziad Ismail and Medhat Majeed Al-Sahuki. 2008. Chlorophyll content in hybrids and strains of yellow corn as a result of two levels of plant density and nitrogen. Iraqi Agricultural Sciences Journal - 39 (5): 1-12.

11. Al-Rifai. Dedication, Youssef Nimr. 2017 The effect of plant density on the productivity of some genotypes of local yellow corn (Zea mays L.) Al-Baath University Journal - Volume 39 - Issue 8.
12. Firman. Tahseen Ali Abdul Hussein, Iyad Hussein Ali Al-Muaini. 2016. Response of yellow maize (Furat) hybrids to plant densities and cultivation methods and their impact on yield characteristics and growth. Al-Furat Journal of Agricultural Sciences 8 (1): 74-85.
13. . Youssef, Yamama Al-Husri. 2015 The effect of plant density on some production and quality traits of the yellow maize variety, Ghouta 1. Damascus Journal of Agricultural Sciences. Volume (31). Issue 2. Pages 83-92Z
14. Makkiya Kazem. 2001. Growth response and yield of two genotypes of yellow maize.(Zea mays L) for different agricultural distances. Master's thesis. College of Agriculture - University of Baghdad.
15. Captain, Muwafaq Abdel Razzaq, Hadi Muhammad Karim Al-Aboudi, Intisar Hadi Hamidi Al-Halafi. 2010. The effect of the herbicide atrazine and primacram and planting distances on the growth and yield of yellow maize and associated bushes. Karbala University Scientific Journal. Volume Eight. Issue Three. Scientific.
16. Al-Kanani. Ahmed Abdel Hussein Jaber, Rashid Khudair Abis Al-Jubouri. 2013. The effect of nitrogen fertilizer, spraying with potassium, and application times on the growth and yield of yellow corn (Zea mays L.), research class 106. Al-Furat Journal of Agricultural Sciences.5(3).- 77 91
17. Al-Daoudi. Ali Hussein Rahim, Khaled Khalil Ahmed Al-Jubouri, Muhammad Ibrahim Muhammad Al-Akidi 2015. Performance of three hybrids of yellow corn (Zea mays L.) for plant density and nitrogen fertilizer. Diyala Journal of Agricultural Sciences, 7(1): 133-147.
18. Salama. Mahmoud Abbas Abd, Hassan Bardan Aswad, Hakim Saleh Mahdi. 2007. The effect of distance between plants and nitrogen fertilization on the growth and yield of yellow corn (Zea mays L.), Research Class 106. Al-Anbar Journal of Agricultural Sciences. Volume. 5. Issue (1).

19. Abd. Ziad Ismail, Radhi Dhiyab Abd Al-Asafi. 2006. Improving the chlorophyll content in two synthetic varieties of yellow corn using the beehive selection method. Master's thesis. College of Agriculture - University of Baghdad.
20. Shati. Raysan Karim, Makiya Kazem Alalak. 2008. Growth response of different genotypes of yellow maize (Zea mays L.) to different planting distances. Al-Anbar Journal of Agricultural Sciences. Volume 6..Issue (2) 22 - License,SA.2008.Maize from New world Eneyclopedia Http://www.New. World enclopedia .org /entryl Maize .
21. - Acciares.H.A and Zuluaga.M.S.2006.Effect of plant row spacing and herbicide use on weed above ground biomass and corn grain yield . Planta Daninha Vol .24 (2) 287-293.
22. Wanger.K.2006-Aglopulat from for a grobion diversity resnerch ,Genflow . Apubication A Publication about Agricultural Bidiversity Biodiversity lnterntional . Rome . ltaly . p:13.

TIBBİ VE AROMATİK BİTKİLERİN TIBBİ AMAÇLI OLARAK KULLANIMLARI VE BU KONUDA YAPILAN ÇALIŞMALAR

Doğan ARSLAN* (ORCID: 0000-0001-7156-5269)
Siirt Üniversitesi, Ziraat Fakültesi, Tarla Bitkileri Bölümü, Kezer Kampüsü, Siirt
Email: doganarslan@siirt.edu.tr

Aynur BİLMEZ ÖZÇINAR (ORCID: 0000-0002-3173-6147)
Siirt Üniversitesi, Ziraat Fakültesi, Tarla Bitkileri Bölümü, Kezer Kampüsü, Siirt

ÖZET
Hastalıkların tedavisinde tıbbi bitkilerin kullanımı, insanoğlunun kadim bir gelenek olup, günümüzde de birçok hastalığa karşı kullanılabilen bileşimlerin doğal kaynağıdır. Birçok bitki, insanlar üzerinde önemli biyolojik etkisi olan geniş çeşitliliğe sahip kimyasal madde içermektedir. Bitkisel ilaçlar, gelişmekte olan ülkelerde kırsal toplulukların kültür ve geleneklerinin önemli bir parçasını oluşturmaktadır. Gelişmekte olan ülkelerde yaşayan nüfusun %80'i temel sağlık ihtiyaçları için genelde bitkisel kökenli geleneksel ilaçlara güvenirler. Modern anlamda farmakolojik olarak üretilen ilaçların etken maddelerinin en az %25'i bitkilerden elde edilmektedir. İlaç elde edilen bitkilere olan talep; düşük maliyetli olması, yan etkilerinin olmaması, toksik etkilerin azlığı ve doğal olarak üretilmiş olmasından dolayı hem gelişmiş hem de gelişmekte olan ülkelerde artış göstermektedir.
Anahtar Kelimeler: Tıbbi ve aromatik bitkiler, kullanımı, tedavi

USE OF MEDICINAL AND AROMATIC PLANTS FOR MEDICAL PURPOSES AND STUDIES CONDUCTED ON THIS TOPIC

ABSTRACT
The use of medicinal plants in the treatment of diseases is an ancient tradition of humankind and is the natural source of compounds that can still be used against many diseases today. Many plants contain a wide variety of chemicals that have significant biological effects on humans. Herbal medicines form an important part of the culture and traditions of rural communities in developing countries. 80% of the population living in developing countries rely on traditional herbal medicines for their basic health needs. At least 25% of the active ingredients of modern pharmacologically produced drugs are obtained from plants. Demand for plants from which medicines are obtained; It is increasing in both developed and developing countries due to its low cost, lack of side effects, low toxic effects and being produced naturally.
Keywords: Medicinal and aromatic plants, use, treatment

GİRİŞ

Asırlardır tedavi amacıyla dünyada ve Anadolu'da geleneksel olarak tıbbi bitkilerden hazırlanan droglar kullanılmakta ve birçok hastalığın tedavisinde yer almaktadır. Günümüzde gelişen kimya bilimi ve teknolojisi sayesinde, bitkilerde insan sağlığına faydalı birçok fitokimyasal~~lar~~ tespit edilmiş ve ilaç haline getirilerek bilimsel açıdan insanların hizmetine sunulmuş ve sunulmaya da devam etmektedir. (Akçiçek, 2010).

İnsanlığın tedavide tıbbi bitkilerin kullanımı kadim bir gelenek olup, bitkisel ilaçlar, gelişmekte olan ülkelerde kırsal toplulukların kültür ve geleneklerinin önemli bir unsurunu oluşturmuştur (Njume ve ark., 2009). Bitkilerin iyileştirici etkisinin olduğu inancının çok eskilere dayandığı bilinmektedir. Tıbbi ve aromatik bitkiler hakkında en eski kitabın Çin hükümdarı Shin–Nong tarafından M.Ö. 3700 yıllarında yazıldığı ifade edilmektedir. Hükümdarın yazmış olduğu kitapta 200'den fazla bitkinin bahsi geçmektedir (Ceylan, 1995). Eski devirlere ait mezarlarda bulunan bazı yazı, şekiller Mısırlılar ve Çinliler aynı zaman diliminde bitkisel droglardan faydalandıkları ve bunların ticaretini yaptıkları görülmektedir (Ceylan, 1995). Tıbbi ve aromatik bitkiler, çok eski zamanlardan bugüne kadar günlük hayatımızın ve kültürümüzün vazgeçilmez bir unsuru haline gelmiştir. Yapılan araştırmalarla Dünyada yenilebilir tıbbi aromatik bitkilerin 10.000'den fazla olduğu tespit edilmiştir. Bu bitkilerin sağlık sektörü, kozmetik, gıda ve son zamanlarda gıda teknolojisi alanında antioksidan olarak kullanılmıştır. Tarih boyunca da tıbbi aromatik bitkilerin ekim ve toplama işlemi devam etmiştir (Nohutçu ve ark. 2019).

Ülkemizin sahip olduğu zengin bitki çeşitliliğine; üç fitocoğrafik (Avrupa-Sibirya, İran- Turan ve Akdeniz) bölgenin kesiştiği bölgede bulunmasına, sahip olduğu jeomorfolojik çeşitliliğe, farklı iklim yapısı ve bölgeler arasındaki yükselti farklılığına borçlu olmaktadır (Özhatay ve ark., 2009).

Tıbbi ve aromatik bitkilere, yurt içinde ve yurtdışında ihtiyaç duyulan talebin karşılanması neticesinde türler yok olma tehdidi altına girmiş ve kültüre alınmaları zorunlu hale gelmiştir. Bu nedenle ülkemizde doğal olarak yayılış gösteren tıbbi ve aromatik bitkilerin, bilinçli bir şekilde toplanması, nesli tükenmekte olan türlerin korunması, ekonomik olarak önemli olanların kültüre alınması gibi önlemlerin alınması gerekmektedir (Kızıl ve Ertekin, 2003).

Dünya sağlık örgütünün (WHO) yayınlamış olduğu rapora göre, gelişmekte olan ülkelerde yaşayan nüfusun % 80'i temel sağlık ihtiyaçları için genelde bitkisel kökenli geleneksel ilaçlara güvenmektedirler. Modern anlamda farmakolojik olarak üretimi yapılan ilaçların etken maddelerinin en az %25'i bitkilerden elde edilmektedir (Sekar ve Kandavel, 2010). Dünyada bitkisel droglar için başlıca ticaret merkezleri Çin, Almanya, ABD, Fransa, İtalya, Japonya, İspanya, İngiltere ve Hong Kong gelmektedir (Faydaoğlu ve Sucuoğlu, 2011).

Sentetik olarak üretimi yapılan birçok ilacın etken maddeleri de ilk defa bitkilerden izole edilen kimyasalların yapı benzerlerinden olmaktadır (Sekar ve Kandavel, 2010). İlaç elde edilen bitkilere olan talep; düşük maliyetli olması, yan etkilerinin olmaması, toksik etkilerin az olması ve doğal olarak üretilmiş olmasından kaynaklı olarak hem gelişmiş hem de gelişmekte olan ülkelerde artış göstermektedir (Sekar ve Kandavel, 2010).

İlaç endüstrisinde sentetik ilaçlar önemli paya sahip olmasına rağmen, günümüzde kullanılan ilaçların yaklaşık %50'sini doğal ilaç etken maddeleri ve bileşiklerinden üretilen ilaçlar oluşturmaktadır. Ayrıca, yeni ilaçların ortalama yarısının doğal kaynakları esas alması ilaç geliştirme çalışmalarının hızla doğaya yöneldiğini gözler önüne sermektedir. Doğal kaynaklardan elde edilen ilaç hammaddeleri ve ilgili bileşikler arasında antibakteriyel, antikanser, antikoagülan, antiparazitik ve immunosupresan ajanlar tedavide kullanım olarak ilk sırada bulunmaktadırlar (Harput, 2010).

Tıbbi bitkiler günümüzde birçok hastalığa karşı kullanılabilen bileşimlerin doğal kaynağı (Vital ve ark., 2010) olup, bu bitkilerin birçoğu içeriğinde insanlar üzerinde önemli biyolojik etkisi olan geniş çeşitliliğe sahip kimyasal maddeler ihtiva etmektedir (Njume ve ark., 2009). Bitkilerin sentezlemiş olduğu flavonoid, alkaloid, terpenoid, tanin, berberin, kinin ve emetinler türevi metabolitler enfeksiyon hastalıklarının tedavisinde yaygın bir kullanıma sahiptir (Hussain, 2011).

Günümüzde çoklu antibiyotik direncine sahip mikroorganizmaların artmasıyla birlikte bu mikropların neden olduğu enfeksiyonların tedavisi giderek zorlaşmaktadır. Bilinen tüm antibiyotiklere direnç geliştiren bakterilerde, ilaca olan direnç artmakta ve bu yüzden hızlı yayılma seyretmektedir. Bundan dolayı, sentetik modern ilaçlara alternatif seçenek olarak tıbbi bitkilerin kullanılması önerilmekte ve bazı geleneksel bitkilerin antimikrobiyal olarak tüketimi yapılmaktadır (Yarnell ve Abascal, 2004). Yapılan

çalışmalarda, bitkilerin tedavi edici etkilerinin tek bir etken maddenin yanı sıra çok sayıda bileşimin sinerjik etkisinden kaynaklandığı ve bu nedenle de tek bir antibiyotikle öldürülmesi zor mikroorganizmaların bitkisel bileşimlerin dirençliliğine karşı koyamayarak daha etkin bir tedavi sağlandığı rapor edilmektedir (Shanthi-Sree ve ark., 2010, Mohd Nazri ve ark., 2011). Bu durum, araştırmacıları bitki özütlerinden elde edilen doğal antimikrobiyal ajanların inhibitör etkiye sahip bileşimlerini incelemeye teşvik etmiştir (Dash ve ark., 2011).

Halk hekimliğinde, bitkiler ve bu bitkilerin meyve, kök, kabuk, tohum gibi bölümlerinden çıkarılan ekstraktlar bu gibi hastalıkların tedavisinde yaygın olarak kullanılmaktadır. Bilhassa en çok kullanılan tıbbi bileşiklerin dörtte biri bitki bazlı bileşenler içermektedir (Khan ve ark. 2021).

Dünyada 2019 yılı sonu itibariyle yayılmaya başlayan COVID-19 virüsü ile birlikte şifalı bitkilere ve geleneksel tedavilere olan ilgi bir hayli artmıştır. Bu dönemde yapılan aşıların ve mevcut ilaçların virüsü tamamen yok etmediği bilindiği için hastalığa karşı direnç sağlamak veya hastalıktan korunmak için başka önlemler alınmaya ihtiyaç duyulmuştur. Astım, balgam, bronşit, soğuk algınlığı ve grip, öksürük, solunum yolu enfeksiyonları gibi hastalıkların semptomlarını tedavi etmek veya hafifletmek için yüzlerce bitki kullanılmaktadır. En çok kullanılan bitkiler arasında *Sambucus nigra* (Porter ve Bode 2017), *Origanum vulgare* L. (Gilling ve ark. 2014), *Salvia officinalis* L. (Geuenich ve ark. 2008), *Mentha x piperita* L. (Li ve ark. 2017), *Glycyrrhiza glabra* L. (Kılıç 2019), *Zingiber officinale Roscoe* (Saleem et al. 2020), *Allium sativum* L. (Ekşi ve ark. 2020), *Achillea millefolium* L. (Akan ve Bakır, 2015), *Rosmarinus officinalis* L (Akbulut ve ark. 2019), *Thymbra spicata* L. (Sargın 2015) gelmektedir. Solunum yolu hastalıkların tedavisinde sıklıkla kullanılan bu bitkiler infüzyon, dekoksiyon, tıbbi yağ ve toz olarak hazırlanmaktadır (Çakılcıoğlu ve ark. 2011, Pilau ve ark. 2011, Alamgeer ve ark. 2018, Hussein ve Dhabe 2018, Erşen Bak ve Çifci 2020).

Li ve Hu (2008), yürütmüş olduğu çalışmada, *Achyranthes bidentata* Blume bitkisinin kurutulmuş köklerinde saponin gibi çeşitli sekonder metabolitleri, ecdysterone, polisakkarit ve betaini ihtiva ettiğini, özellikle Güney Asya ve Hindistan'da uzun yıllardır geleneksel kullanımının mevcut olduğunu ve bu bitkinin antiromatizmal, sindirime yardımcı, idrar söktürücü olarak özellik gösterdiğini ve son yıllarda osteoporoz ile ilgili

çalışmalar sürdürülen bitkiden pek çok yeni bileşik izole edilmeye başlandığını ifade etmiştir.

Yapılan araştırmada, COVID-19 döneminde en çok talep edilen 24 bitki taksonu tespit edilmiştir. Bu bitkiler genellikle bitkisel satış listelerinin başında yer alan türlerdir. Ancak pandemi sürecinde *Sambucus nigra, Aloysia citriodora, Echinacea angustifolia, Thymus* spp., *Sideritis* spp. gibi türlerin satışlarında önemli bir artış olduğurapor edilmiştir. Bu durum, halk arasında bu bitkilerin COVID-19 semptomlarına karşı etkili olduğu konusunda bir fikir birliği olduğu kanısına varılmıştır (Akbulut ve Özkan 2023).

Özellikle influenza virüslerine karşı antiviral etkileri olduğu anlaşılan *Sambucus nigra* L. (Ataee ve ark. 2016), *Galanthus elwesii* Hook.f. (Hudson ve ark. 2000), *Salvia* L. türleri (Özçelik ve ark. 2011), *Dianthus superbus* L. (Nile ve ark. 2020), *Anacardium occidentale* L. (De Freitas ve ark. 2020) ve daha birçok bitki üzerinde deneysel çalışmalar bulunmaktadır.

SONUÇ

Modern tıpta geliştirilmiş olan sentetik ilaçlar ve bunlarla tedavi yöntemlerine karşın tıbbi bitkilerle yapılan tedaviler önemini arttırarak korumaya devam etmektedir. Özellikle sonbahar ve kış aylarında sık görülen grip, soğuk algınlığı ve virüslerin neden olduğu solunum yolu hastalıklarının tedavisinde ilaç tedavi öncesinde geleneksel tedavi yöntemleri daha çok tercih edilmektedir.

Tarımı yapılan tıbbi ve aromatik bitkilerin birçok alan~~lar~~da (ilaç, gıda, kozmetik, sanayi vb.) kullanımı arttırılmalıdır. Özellikle sağlık sektöründe, ilaç üretiminde tıbbi ve aromatik bitkilerin kullanım oranlarının arttırılması elzemdir. Böylelikle daha fazla ekonomik kazanç sağlanabilecek, insanların sağlıklarını korumaları ve hastalıktan kısa sürede ve doğal yöntemlerle iyileşebilmeleri açısından ilerlemeler kaydedilebilecektir.

KAYNAKLAR

Akan, H., Bakır, Y. (2015). Kâhta (Adıyaman) Merkezi ve Narince Köyü'nün etnobotanik açıdan araştırılması. BEÜ Fen Bilimleri Dergisi, 4(2), 219-248.

Akbulut S, Karaköse M, Özkan ZC (2019) Traditional uses of some wild plants in Kale and Acıpayam Provinces in Denizli. Kastamonu University Journal of Forestry Faculty, 19 (1): 72-81. https://doi.org/ 10.17475/kastorman.543529.

Akbulut S., Özkan Z.C. 2023. Kuzey Anadolu'da Covid-19 semptomlarına karşı kullanılan tıbbi ve aromatik bitkiler. AÇÜ Orman Fak Dergisi. 24(1):87-95.

Akçiçek E. 2010. Bitkilerle Tedavide Güncel Arastırmalar (Eski İlaçlar, Yeni Uygulama Alanları). Bitkilerle Tedavi Sempozyumu, Merkezefendi Geleneksel Tıp Dernegi, İstanbul, 50-51.

Alamgeer Younis W, Asif H, Sharif A, Riaz H, Bukhari IA, Assiri AM (2018) Traditional medicinal plants used for respiratory disorders in Pakistan: a review of the ethno-medicinal and pharmacological evidence. Chinese Medicine, 13(48): 1-29.

Ataee R, Falahati A, Ebrahimzadeh MA, Shokrzadeh M (2016) Anticonvulsant activities of Sambucus nigra. European Review for Medical and Pharmacological Sciences, 20(14): 3123-3126.

Ceylan A 1995. Tıbbi Bitkiler I. Ege Üniversitesi Ziraat Fakültesi Yayınları No:312, III. Baskı, İzmir.

Çakilcioglu U, Khatun S, Turkoglu I, Hayta S (2011) Ethnopharmacological survey of medicinal plants in Maden (Elazig-Turkey). Journal of Ethnopharmacology, 137: 469-486.

Dash, BK., Sultana, S., Sultana, N. 2011. Antibacterial Activities of Methanol and Acetone Extracts of Fenugreek (Trigonella foenum) and Coriander (Coriandrum sativum). Life Sci and Med. Res., 27:1-8.

De Freitas CS, Rocha ME, Sacramento CQ, Marttorelli A, Ferreira AC, Rocha N, de Oliveira AC, de Oliveira Gomes AM, Dos Santos PS, Oliveira da Silva E, da Costa JP, de Lima Moreira D, Bozza PT, Silva JL, Barroso SPC, Souza TML (2020) Agathisflavone, a Biflavonoid from Anacardium occidentale L.inhibits influenza virus neuraminidase. Current Topics in Medicinal Chemistry, 20(2): 111-120.

Ekşi G, Özkan AMG, Koyuncu M (2020) Garlic and onions: an eastern tale. Journal of Ethnopharmacology, 253: 112675.

Erşen Bak F, Çifci K (2020) Traditional uses of some medicinal plants in the central villages of Artvin. Artvin Coruh University Journal of Forestry Faculty, 21(2): 318-329.

Faydaoğlu, E., Sürücüoğlu, M.S. 2011. Geçmişten günümüze tıbbi ve aromatik bitkilerin kullanılması ve ekonomik önemi. Kastamonu University Journal of Forestry Faculty, 11(1): 52-67.

Geuenich S, Goffinet C, Venzke S, Nolkemper S, Baumann I, Plinkert P, Reichling J, Keppler OT (2008) Aqueous extracts from peppermint, sage and lemon balm leaves display potent anti-HIV-1 activity by increasing the virion density. Retrovirology, 5(27): 1-16

Gilling DH, Kitajima M, Torrey J, Bright KR (2014) Antiviral efficacy and mechanisms of action of oregano Tıbbi yağ and its primary component carvacrol against murine norovirus. Journal of Applied Microbiology, 116(5): 1149-1163.

Harput Ü.Ş. 2010. Bitkilerle Tedavide Güncel Araştırmalar (Yeni İlaç Geliştirme Çalışmalarında Tıbbi Bitkiler). Bitkilerle Tedavi Sempozyumu, Merkezefendi Geleneksel Tıp Derneği, İstanbul, 45-46.Hudson ve ark. 2000

Hussain, T., Arshad, M., Khan, S., Satar, H., Qureshi, MS. 2011. In Vitro Screening of Methanol Plant Extracts for Their Antibacterial Activity. Pak. J. Bot., 43:531-538.

Hussein S, Dhabe A (2018) Ethnobotanical study of folk medicinal plants used by villagers in Hajjah district-Republic of Yemen. Journal of Medicinal Plants Studies 6(5): 24-30.

Khan T, Khan MA, Mashwani ZR, Ullah N, Nadhman A (2021) Therapeutic potential of medicinal plants against COVID-19: The role of antiviral medicinal metabolites. Biocatal. Journal of Agricultural Biotechnology, 31: 101890.

Kılıç M. (2019). Artuklu (Mardin) Yöresinde Yetişen Bitkiler Üzerine Etnobotanik Bir Araştırma (Doktora Tezi) Manisa Celal Bayar Üniversitesi Fen Bilimleri Enstitüsü, Manisa.

Kızıl, S., Ertekin, A.S. (2003). Diyarbakır ve Çevresinde Yayılış Gösteren Bazı Tıbbi Bitkiler. Türkiye 5.Tarla Bitkileri Kongresi, Ekim, Diyarbakır.

Li Y, Liu Y, Ma A, Bao Y, Wang M, Sun Z (2017) In vitro antiviral, anti-inflammatory, and antioxidant activities of the ethanol extract of Mentha piperita L.. Food Science and Biotechnology, 26(6): 1675-1683

Li J, Hu Z (2008). Accumulation and dynamic trends of triterpenoid saponin in vegetative organs of Achyranthus bidentata. Journal of Integrative Plant Biology, doi: 10.1111/j.1744-7909.2008.00764.x: 1-8.

Mohd Nazri, NAA., Ahmat, N., Adnan, A., Syed Mohamad SA., Syaripah Ruzaina SA. 2011. In vitro Antibacterial and Radical Scavenging Activities of Malaysian Table Salad. Afr. J. Biotech., 10:5728-5735.

Nile SH, Kim DH, Nile A, Park GS, Gansukh E, Kai G (2020) Probing the effect of quercetin 3-glucoside from Dianthus superbus L. against influenza virus infection-in vitro and in silico biochemical and toxicological screening. Food and Chemical Toxicology, 135: 110985 https://doi.org/10.1016/j.fct.2019.110985

Njume, C., Afolayan, AJ., Ndip, RN. 2009. An Overview of Antimicrobial Resistance and The Future of Medicinal Plants in The Treatment of Helicobacter pylori Infections. Afr. J. Pharm. Pharmacol., 3:685-699.

Nohutçu, L., Tunçtürk, M., Tunçtürk, R. (2019). Yabani bitkilerin korunması ve sürdürülebilirlik. Yüzüncü Yıl Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 24(2), 142-151.

Ozçelik B, Orhan İE, Kan Y (2011) Determination of antiviral activity and cytotoxicity of selected sage (*Salvia* L.) species. Journal of Pharmacological Sciences, 36: 155-160.

Özhatay, N., İlçim, A., Ok, T. (2009). Ahırdağı Sessiz Güzelleri 200 Yabani Bitki. İstanbul.

Pilau MR, Alves SH, Weiblen R, Arenhart S, Cueto AP, Lovato LT (2011) Antiviral activity of the Lippia graveolens (Mexican oregano) Tıbbi yağ and its main compound carvacrol against human and animal viruses. Brazilian Journal of Microbiology, 42(4): 1616-1624.

Porter RS, Bode RF (2017) A review of the antiviral properties of black elder (Sambucus nigra L.) products. Phytotherapy Research, 31(4): 533-554.

Sargin SA (2015) Ethnobotanical survey of medicinal plants in Bozyazı district of Mersin, Turkey. Journal of Ethnopharmacology, 173: 105-126 https://doi.org/10.1016/j. jep.2015.07.009

Sekar, S., Kandavel, D. 2010. Interaction of Plant Growth Promoting Rhizobacteria (PGPR) and Endophytes with Medicinal Plants - New Avenues for Phytochemicals. J. Phytology, 2:91-100.

Shanthi Sree, KS., Yasodamma, N., Paramageetham, CH. 2010. Phytochemical Screening and In Vitro Antibacterial Activity of The Methanolic Leaf Extract: Sebastiania chamaelea Müell. Arg. The Bioscan, 5:173-175.

Vital PG., Velasco JRN., Demigillo JM., Rivera WL. 2010. Antimicrobial Activity, Cytotoxicity and Phytochemical Screening of Ficus septica Burm and Sterculia foetida L. leaf extracts. J. Med. Plants Res., 4:058-063.

Yarnel, E., Abascal, K. 2004. The Leading Publisher in Biotechnology. Alternative and Complementary Therapies Part 2: Vol. 10, No.5: 277-284.

SÜRDÜRÜLEBİLİR ARICILIKTA DİJİTAL ÇÖZÜMLER: BLOKZİNCİR TEKNOLOJİSİNİN KULLANIM OLANAKLARI

Zekiye ŞENGÜL (ORCID: 0000-0002-2496-2867)
Siirt Üniversitesi, Ziraat Fakültesi, Tarım Ekonomisi Bölümü
Email: zekiye.sengul@siirt.edu.tr

ÖZET
Son yıllarda sürdürülebilir arıcılık, biyoçeşitlilik kaybı, çevresel bozulma ve gıda güvenliği gibi sorunları ele alarak tarımsal sürdürülebilirliğin kritik bir bileşeni olarak öne çıkmaktadır. Ancak, arıcılık sektörü açısından bakıldığında, koloni kayıpları, hastalık ve zararlı salgınları ve tedarik zinciri boyunca izlenebilirlik eksikliği gibi önemli zorluklarla karşılaşıldığı görülmektedir. Bu durum, sürdürülebilir arıcılığın potansiyelini tam olarak gerçekleştirebilmek için karşılaşılan zorlukların üstesinden gelinmesinin gerekliliğini vurgulamaktadır. Eş zamanlı olarak, blokzincir teknolojisi, şeffaflığı, izlenebilirliği ve verimliliği artırarak çeşitli sektörlerde dönüşüm potansiyeli göstermiştir. Bu çalışma kapsamlı bir literatür taraması ve vaka çalışmalarının analizi aracılığıyla, arıcılık sektörünün karşı karşıya olduğu temel sorunları ele alıp, ardından, blokzincir teknolojisinin arıcılık uygulamalarını nasıl dönüştürebileceğini araştırmakta olup, bu teknolojinin sürdürülebilir arıcılık için dijital bir çözüm olarak potansiyelini incelemektedir. Çalışma ayrıca, arıcılıkta blokzincir çözümlerinin uygulanabilirliğini, teknolojik altyapı, maliyet ve arıcıların yeni teknolojileri benimseme konusundaki hazırlığı gibi faktörleri dikkate alarak değerlendirmektedir. Bulgular, blokzincir teknolojisinin güvenli ve şeffaf kayıt tutma yeteneği ile arıcılık uygulamalarının sürdürülebilirliğini artırabileceğini, kovandan sofraya ürün izlenebilirliğini kolaylaştırarak bal ve diğer yüksek katma değerli arı ürünlerinin üretiminde şeffaflığı teşvik edebileceğini, ürünlerin saflığını garanti altına alabileceğini, arı popülasyonlarının korunmasına katkı sağlayabileceğini, arıcıların geçim kaynaklarını destekleyebileceğini ve etkin pazar işlemlerini kolaylaştırabileceğini göstermektedir. Ancak, başarılı bir uygulama için teknik, ekonomik ve sosyal engellerin üstesinden gelinmesi gerekmektedir. Çalışma, blokzincir teknolojisinin sürdürülebilir arıcılık uygulamalarına entegrasyonunu destekleyen ekosistemi geliştirmek için politika yapıcılar, teknoloji geliştiriciler ve arıcılar dahil olmak üzere paydaşlara temel bir çerçeve oluşturmaktadır.
Anahtar Kelimeler: Sürdürülebilir arıcılık, dijital dönüşüm, blokzincir

DIGITAL SOLUTIONS FOR SUSTAINABLE BEEKEEPING: THE POTENTIAL OF BLOCKCHAIN TECHNOLOGY

ABSTRACT

In recent years, sustainable beekeeping has emerged as a critical component of agricultural sustainability, addressing issues such as biodiversity loss, environmental degradation and food security. However, the beekeeping sector faces significant challenges such as colony losses, disease and pest outbreaks, and lack of traceability along the supply chain. This highlights the need to overcome these challenges in order to realize the full potential of sustainable beekeeping. Concurrently, blockchain technology has shown the potential to transform various sectors by increasing transparency, traceability and efficiency. Through a comprehensive literature review and analysis of case studies, this study addresses the key issues facing the beekeeping sector, then explores how blockchain technology can transform beekeeping practices and examines its potential as a digital solution for sustainable beekeeping. The study also assesses the viability of blockchain solutions in beekeeping, taking into account factors such as technological infrastructure, cost and beekeepers' readiness to adopt new technologies. The findings show that blockchain technology can enhance the sustainability of beekeeping practices through its ability to provide secure and transparent record keeping, promote transparency in the production of honey and other high value-added bee products by facilitating hive-to-table product traceability, guarantee the purity of products, contribute to the conservation of bee populations, support beekeepers' livelihoods and facilitate efficient market transactions. However, technical, economic and social barriers need to be overcome for successful implementation. The study provides a basic framework for stakeholders including policy makers, technology developers and beekeepers to develop the ecosystem that supports the integration of blockchain technology into sustainable beekeeping practices.

Keywords: Sustainable beekeeping, digital transformation, blockchain

1. GİRİŞ

Arıcılık, ekonomik zorluklarla karşı karşıya olan kırsal bölgelerde yaşayan nüfus için ideal, erişilebilir ve güçlendirici bir iş fırsatı olarak ön plana çıkmaktadır (FAO, 2021). Arıcılık, başlangıç maliyetlerinin ve işgücü ihtiyacının nispeten düşük olması, az arazi kullanımı gerektirmesi gibi rekabetçi avantajlar sayesinde çiftlik sistemlerine kolaylıkla entegre edilebilmektedir (Merdan, 2020). Ek olarak, arıların gerçekleştirdiği tozlaşma işlemi, sadece arıcılara ekonomik kazanç sağlamakla kalmayıp, çiftçilere de verim artışı yoluyla dolaylı faydalar sağlamaktadır. Polinatörlerin tozlaşma sürecindeki kritik rolü, dünya çapında önem taşıyan tarımsal ürün türlerinin yaklaşık %75'i üzerinde doğrudan bir etkiye sahiptir. Bu süreçte özellikle arılar, çeşitli meyve, tohum ve kuruyemişlerin yanı sıra kahve, kakao ve kanola gibi yüksek ekonomik değere sahip tarım ürünlerinin verimliliği ve kalitesi üzerinde önemli bir faktör olarak öne çıkmaktadır (Potts et al., 2016). Bu, kırsal bölgelerde gıda arzının artmasına ve dolayısıyla açlığın azalmasına önemli bir katkı sağlamaktadır. Arıcılık faaliyetlerinin genişletilmesi, kırsal alanlarda gıda maliyetlerinin düşürülmesine yardımcı olarak yoksulluğun azaltılmasında da etkili bir rol oynamaktadır.

Ancak, arıcılığın sürdürülebilirliği, iklim değişikliği, habitat yıkımı, zararlılar, hastalıklar ve pestisit kullanımı gibi birçok faktörden kaynaklanan tehditler altındadır (Kösoğlu vd., 2021). Bu tehditler, ekolojik dengeyi tehlikeye atmanın yanı sıra tarım ve ilgili endüstrilerde ciddi ekonomik riskler de oluşturmaktadır. Arıcılık sektörünün uzun vadeli sürdürülebilirliğini ve dayanıklılığını güvence altına alma amacıyla bu zorluklara karşı yenilikçi çözümlerin geliştirilmesine olan ihtiyaç, küresel toplum tarafından her zamankinden daha fazla bir aciliyetle hissedilmektedir.

Bu zorluklara karşılık olarak, tarımın dijital dönüşümü, umut verici bir çözüm olarak öne çıkmaktadır. Hassas tarım, Nesnelerin İnterneti (IoT) ve Yapay Zeka (AI) gibi dijital çözümler, tarım sektöründe devrimsel değişiklikler yaratmaktadır (Ercan vd., 2019). Bu teknolojiler, tarımsal alanların daha etkin izlenmesi ve yönetilmesine, kaynak kullanımının optimizasyonuna ve çevresel etkilerin azaltılmasına olanak tanımaktadır. Özellikle, hassas tarımın alt dallarından biri olan hassas arıcılık, kaynak tüketimini en aza indirmek ve arıların üretkenliğini en üst düzeye çıkarmak için bireysel arı kolonilerinin izlenmesine dayanan bir arı kovanı yönetimi stratejisi olarak tanımlanmaktadır (Şengül ve Yücel, 2022). Aynı zamanda, IoT cihazları aracılığıyla arı sağlığı ve kovan

koşullarının izlenmesi, arıcıların yönetim uygulamalarına gerçek zamanlı veriler sunmaktadır. Bu bağlamda yapılan araştırmalar, IoT teknolojileri ve makine öğrenimi yaklaşımlarının entegrasyonunun arıcılık uygulamalarını geliştirebileceğini desteklemektedir (Zgank, 2019).

Dijital inovasyonların öncüsü olarak, blokzincir teknolojisi, başlangıçta dijital para birimlerinin temeli olarak tasarlanmış olup, toplumun ve ekonominin birçok alanında dönüşüm yaratma potansiyeline sahip temel bir teknoloji olarak kendini göstermiştir (Tüfekçi ve Karahan, 2019). Bu teknolojinin merkeziyetsizlik, şeffaflık ve güvenlik gibi temel özellikleri, tarım başta olmak üzere, birçok sektördeki acil sorunların çözümü için benzersiz avantajlar sunmaktadır (Parlar, 2022). Özellikle tedarik zinciri yönetiminde, blokzincir teknolojisi ürün hareketlerinin ve işlemlerin kaynağından tüketiciye kadar değiştirilemez bir kaydını sunarak, bu düzeydeki şeffaflık ve izlenebilirlik sayesinde sahteciliği önleyebilmekte ve gıda ürünlerinin, özellikle bal ve diğer arı ürünlerinin bütünlüğünü güvence altına almaktadır (Koç, 2020). Ayrıca, akıllı sözleşmelerin kullanımı ile, sözleşme koşullarının kod satırlarına doğrudan yazılması sayesinde, işlemlerin otomatikleştirilmesi ve operasyonların daha akıcı hale getirilmesi mümkündür; bu da tarımsal tedarik zincirinde maliyetleri düşürme ve verimliliği artırma fırsatları sunmaktadır (FAO, 2021).

Blokzincir günümüzde finans, sağlık hizmetleri, enerji, turizm ve kamu uygulamalar gibi farklı sektörlerde uygulama alanı bulmuştur (Koç, 2020). Bu teknolojinin çeşitli alanlarda uygulanma potansiyeline rağmen, arıcılık alanında bu yenilikçi teknolojinin adaptasyonu ve potansiyel faydaları kapsamlı bir şekilde araştırılmamıştır. Bu araştırma, arıcılık sektöründe blokzincir teknolojisinin entegrasyonunu ve bu entegrasyonun sürdürülebilir arıcılığa potansiyel katkılarını derinlemesine incelemeyi amaçlamaktadır. Çalışma, blokzincir teknolojisinin arıcılık uygulamalarındaki sürdürülebilirlik ve verimlilik üzerine olası etkilerini, potansiyel avantajları, karşılaşılabilecek zorlukları ve uygulanabilir stratejileri ayrıntılı bir şekilde değerlendirerek, bu alandaki temel bilgiyi geliştirmeyi hedeflemektedir.

2. ARICILIK SEKTÖRÜNÜN SÜRDÜRÜLEBİLİRLİĞİNİ ETKİLEYEN FAKTÖRLER

Arıcılık sektöründeki sürdürülebilirlik, ekolojik, ekonomik ve sosyal boyutları kapsayan çeşitli faktörler tarafından etkilenmektedir (Şengül and Saner, 2023). Geleneksel olarak,

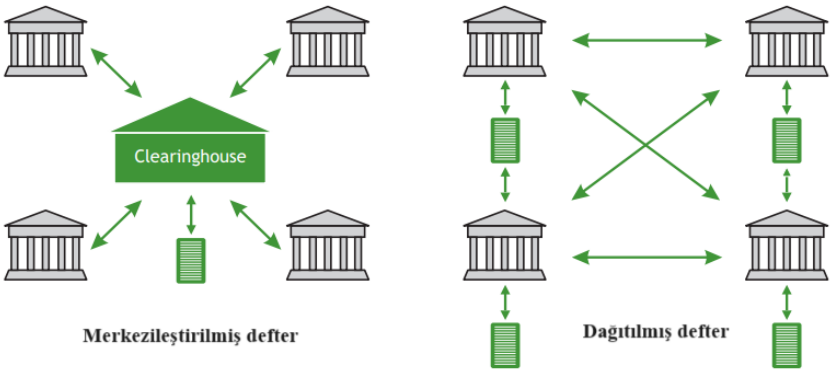
bal arılarının çiçekleri ve tarım ürünlerini tozlaştırmadaki hayati rolleri dolayısıyla arıcılık faaliyeti, sürdürülebilir olarak kabul edilmiştir (Torné-Noguera et al., 2016). Ancak çevresel tehditler, ekonomik zorluklar ve yönetilen bal arısı popülasyonlarının yaban arı popülasyonları üzerine etkileri gibi çeşitli zorluklar arıcılığın sürdürülebilirliğini olumsuz yönde etkileyebilmektedir (Henry and Rodet, 2018). Son on yıl içerisinde Koloni Çöküş Sendromu (CCD), dünya çapında kolonilerde beklenmedik ve hızlı bir şekilde kayba neden olarak, özellikle arıcılar ve ekolojik sistemler için önemli sorunlar oluşturmuştur (Kösoğlu vd., 2021). CCD'nin kesin bir nedeni tanımlanamamış olup, mevcut araştırmalar, çeşitli stres faktörlerinin bir araya gelmesini, bu fenomenin birincil nedeni olarak kabul etmektedir. Pestisitler, özellikle de neonikotinoidler, arıların yön bulmasında, bağışıklık tepkisinde ve hatta üreme başarısında bozulmalara yol açmaktadır (Blacquière et al., 2012; Henry et al., 2012; Sandrock et al., 2014). Varroa destructor akarı gibi parazitler ve Nosema ceranae gibi patojenler koloni düşüşlerine önemli ölçüde katkıda bulunmaktadır (Cox-Foster et al., 2007; Genersch, 2010). Arı kolonilerindeki parazit yükleri, arıcılık yönetim uygulamaları, besin kaynakları ve iklim koşulları gibi faktörlerden etkilenmektedir (Guichard et al., 2020). Kentleşme ve yoğun tarım uygulamaları, arıların beslenmesi için çeşitlilik sunan doğal manzaraları monokültür tarım alanlarına dönüştürerek habitat yıkımını derinleştirmektedir. İklim değişikliği ise, çiçeklenme zamanları ve bitkisel dağılımlarda değişiklikler yaratarak, çiçeklerin polen ve nektar üretim zamanı ile arıların beslenmeye en uygun olduğu dönemler arasında senkronizasyon sorunlarına neden olmaktadır. Bu durum, arılar için ek stres faktörleri oluşturarak, onların beslenme kaynaklarına erişimini daha da zorlaştırmaktadır (Potts et al., 2010).

Arıcılığın sürdürülebilir gelişiminde, ekonomik faktörler üretim verimliliği, ürün kalitesi ve sektörel sürdürülebilirliği artırma açısından önemli bir role sahiptir (Vysochanska, 2023). Bu çerçevede, arıcıların karşılaştıkları en büyük sorunlardan biri pazarlama ile ilgili olup, piyasa koşullarında ürünlerinin hak ettiği değeri bulamaması, dış kaynaklı ürünlerin kontrolsüz girişi, ürün doğallığına dair tereddütler, kooperatiflerin pazar payını düşürmesi ve fiyat belirsizliği gibi sorunlar, arıcıların karşılaştığı temel problemler arasında yer almaktadır (Akın ve Yılancı, 2021). Ek olarak ürünlerin pazarlara erişimini sağlamak ve ekonomik değerlerini artırmak amacıyla farklılaştırılması gerekmektedir. Ancak özellikle kaynak kısıtlılığına sahip küçük ölçekli üreticiler ve kırsal alanlarda ürün

farklılaştırma sürecinin yüksek maliyetleri pazara girişi engelleyen bir faktör olarak ortaya çıkmaktadır. Diğer taraftan, tüketicilere pazarda belirli, güvenli, besleyici veya sürdürülebilir alternatifler sunabilmek için ürünlerin farklılaşma özelliklerinin standartlaştırılmış ve doğrulanabilir bir biçimde ifade edilmesi gerekmektedir. Bu süreci maliyet etkin bir şekilde gerçekleştirmek, küçük ölçekli üreticilerin ve kırsal alanların gelişim potansiyelini maksimize edebilmektedir (FAO, 2021).

3. BLOKZİNCİR TEKNOLOJİSİ

Bitcoin gibi kripto paraların temeli olan blokzincir teknolojisi, Dağıtılmış Defter Teknolojisi'nin (DLT) en yaygın olarak tanınan örneklerinden biridir (Nakamoto, 2008). Şekil 1'de görüldüğü gibi dağıtılmış defterler, bir ağdaki bilgisayarlar veya düğümler arasında paylaşılan, merkeziyetsiz bir veritabanı olarak tanımlanmaktadır (Crosby et al., 2016). Merkezi yönetimli geleneksel veritabanı sistemlerinin aksine, DLT, işlemlerin doğrulanması ve veri bütünlüğünün korunması için herhangi bir merkezi otoriteye ihtiyaç duymaksızın mutabakat mekanizmalarını temel almaktadır (Wattenhofer, 2017). Bu merkeziyetsiz yapı, artırılmış güvenlik, şeffaflık ve sistemsel arızalara karşı üstün direnç gibi kritik avantajlar sunmaktadır (Zheng et al., 2017).



Şekil 1. Geleneksel merkezileştirilmiş defter ile dağıtılmış defter (Kaynak: Tripoli and Schmidhuber, 2018)

3.1. Blokzincir Evrimine Genel Bakış

Blokzincir teknolojisinin kökenleri 1970'li yılların sonlarına kadar uzanmaktadır. Bilgisayar bilimci Ralph Merkle, Merkle ağaçları olarak bilinen bir veri saklama yapısını patentlemiştir. Bu yapılar, şifreleme kullanarak blokları birbirine bağlama özelliğine sahiptir (Öztürk ve Berber, 2024). Blokzincir teknolojisinin gelişim evreleri aşağıda verilmiştir:

Blokzincir Öncesi Dönem: Blokzincir teknolojisinin ortaya çıkışından önce, kayıt tutma işlemleri için merkezi olmayan ve manipülasyona karşı dayanıklılık sağlayacak sistemlerin geliştirilmesine yönelik önemli bir ilgi mevcuttu. Haber ve Stornetta (1991) tarafından önerilen, merkezi bir otoriteye gerek kalmaksızın dijital belgelerin bütünlüğünü doğrulama ve koruma amacına yönelik zaman damgalama kavramı, bu alandaki ilk çalışmalardan biri olarak kabul edilmektedir. Szabo'nun (1998) geliştirdiği 'bit altın' fikri ise, kripto para birimlerinin temel prensiplerini içeren ve merkeziyetsiz bir dijital para birimi konseptini öngören, fakat uygulamaya konulamayan bir vizyonu temsil etmektedir.

Blokzincir1.0: Kripto Para Birimleri Dönemi: Nakamoto (2008) tarafından Bitcoin'in tanıtılması, dijital para birimleri ve blokzincir teknolojisi alanında dönüşüm sağlayan bir çağın başlangıcı olmuştur. Bitcoin, merkezi olmayan bir defter sistemini kullanarak dijital para birimlerinin çift harcama problemine güvenilir bir üçüncü tarafa gerek duymaksızın çözüm getiren temel blokzincir teknolojisine dayanmaktadır. Bu dönem, kripto para birimlerinin güvenli, eşler arası işlemleri sağlama noktasında yoğunlaşmış, ancak temel olarak finansal uygulamalarla sınırlı kalmıştır.

Blokzincir 2.0: Akıllı Sözleşmelerin Ortaya Çıkışı: Ethereum'un 2015 yılında piyasaya sürülmesiyle birlikte, belirli koşullar altında otomatik olarak yürütülen programlar olan akıllı sözleşmelerin dönemi başlamıştır (Buterin, 2014). Ethereum, merkeziyetsiz finans (DeFi), oyunlar ve non-fungible token'ler (NFT'ler) gibi çeşitli alanlarda merkeziyetsiz uygulamaların (DApps) geliştirilmesine olanak sağlayarak blokzincir uygulamalarının yelpazesini genişletmiştir. Bununla birlikte, bu nesil, ölçeklenebilirlik ve güvenlik konularında önemli zorluklarla karşı karşıya kalmıştır.

Blokzincir 3.0: Ölçeklenebilirlik ve Güvenlik Sorunlarının Aşılması: Üçüncü nesil blokzincir teknolojisi, önceki nesillerin karşılaştığı ölçeklenebilirlik ve güvenlik sorunlarına çözüm bulmayı hedeflemektedir. İşlem hacmini ve verimliliği artırmayı amaçlayan Katman 2 çözümleri ve Proof-of-Stake gibi mutabakat mekanizmalarına geçiş gibi yenilikler bu doğrultuda geliştirilmiştir (Dinçel, 2020). Ayrıca, farklı blokzincir platformları arasındaki iletişimi ve varlık transferini kolaylaştırmayı amaçlayan entegrasyon protokolleri geliştirilmektedir. Bu yenilikler, teknolojinin tedarik zinciri yönetimi, oylama sistemleri ve kimlik doğrulama gibi alanlarda uygulanabilirliğini artırmaktadır.

Blokzincir 4.0 ve Web3 (Gelecek perspektifi): Yapay Zeka (AI) ve Nesnelerin İnterneti (IoT) gibi ileri teknolojilerin blokzincir ile entegrasyonu, bağlantılı ve zeki sistemlerin yeni bir çağını işaret etmektedir (Tapscott and Tapscott, 2016). Web3, kullanıcıların kendi verileri üzerinde daha fazla kontrol sağlayabileceği, blokzincir destekli merkeziyetsiz bir internet vizyonunu tanımlamaktadır. Bu gelişme, dijital ortamın daha demokratikleşmesini, artan şeffaflığı, güvenliği ve kullanıcı yetkilendirmesini teşvik eden bir evrimi vaat etmektedir.

3.2. Blokzincir İşleyişi ve Sürdürülebilir Arıcılıkta Uygulanabilirliği

Blokzincir teknolojisi, modern veri yönetimine özgün bir yaklaşım sunarak, güvenlik, şeffaflık ve değiştirilemezlik ilkeleri üzerine inşa edilmiş bir sistemdir (Tanrıverdi vd., 2019). Verilerin manipülasyona karşı korunmasını sağlamak ve işlemlerin doğruluğunu tesis etmek amacıyla kullanılan blokzincir, kriptografik hash fonksiyonları ve karmaşık konsensus algoritmaları yardımıyla tüm düğümlerin (nodes) sürekli bir uyum ve doğrulama içerisinde olmasını sağlamaktadır (Aslan ve Kasapbaşı, 2022). Bu işleyiş süreci, her adımda, işlemlerin kaydedilmesinden onay aşamasına, blokların bağlantı kurulmasından veri bütünlüğünün korunmasına kadar, zincirin her halkasının sağlamlığını ve güvenilirliğini garanti etmektedir. Aşağıda, blokzincir teknolojisinin temel adımlarını tanımlayan bir çizelge yer almaktadır (Çizelge 1). Bu çizelge, blokzincirin nasıl işlediğine dair bir çerçeve sunarak, teknolojinin veri bütünlüğünü nasıl sağladığını ve güvenliği nasıl artırdığını açıklamaktadır.

Çizelge 1. Blokzincir teknolojisinin temel adımları

Adım	Açıklama
1. İşlem Kaydı	Bir işlem blokzincir ağına girildiğinde, işleme dair tüm detaylar kaydedilir. Bu detaylar, işlemin katılımcıları, zamanı, yeri ve nedeni ile işlem miktarı ve koşulları gibi bilgileri içerir.
2. İşlem Onayı	Ağdaki düğümler (nodes) tarafından işlem onaylandıktan sonra, işlemler bloklara dahil edilir ve blokzincir defterine eklenir. Her bir işlemle birlikte, işlemin tamamlandığını ve değiştirilemeyeceğini garanti altına alan bir kriptografik hash fonksiyonu kullanılarak bir hash üretilir.
3. Blok Bağlantısı	Her yeni blok, kendisinden önceki blokun hash değeri ile bağlantılıdır, bu şekilde bir zincir oluşturulur. Bu yöntemle, blokların sırası ve bütünlüğü korunur, herhangi bir bloktaki değişiklik tüm zincirin geçersiz kılınmasına yol açar.
4. Konsensus Mekanizması	İşlemler ve bloklar ağ tarafından kabul edilmeden önce, düğümler arası bir konsensus mekanizması çalıştırılır (örneğin Proof of Work ya da Proof of Stake). Bu mekanizma, işlemlerin ve blokların ağa eklenmesi için gereken onay sürecini düzenler ve ağ güvenliğini pekiştirir.
5. Veri Bütünlüğü ve Güvenliği	Blokzincirin sağladığı veri bütünlüğü ve güvenliği, bir bloğun içeriği değiştirilirse, tüm zincirin etkileneceği ve bu değişikliğin kolaylıkla tespit edileceği şekilde tasarlanmıştır. Böylece, blokzincirde kaydedilen bilgilerin değiştirilemez ve güvenilir olduğu garantilenir.

Kaynak: IBM, 2024; AWS, 2024; Oracle, 2024; Investopedia, 2024 kaynaklarından yararlanılarak hazırlanmıştır.

Blokzincir teknoloji içerisinde, hashler kritik bir işlev görmektedir. Hash kodları veya hash fonksiyonları, herhangi bir veri kümesi için eşsiz, sabit uzunluktaki dijital imzalar oluşturma mekanizması sağlamaktadır (Rivest, 1992). Bu imza, orijinal veri kaynağını doğrulama ve tanımlama işlemlerini kolaylaştırmaktadır. Bir girdiye belirli bir hash algoritması uygulanması sonucunda, orijinal verilerin kısa bir temsilcisi olan bir hash değeri elde edilmektedir. Kaynak veride yapılan küçük bir değişiklik, örneğin tek bir karakterin değiştirilmesi bile, hash çıktısında önemli farklılıklar yaratmaktadır. Bu durum, hash'lerin değişikliklere karşı olan duyarlılığını vurgulamaktadır (Knuth, 1998). Bu özellikler sayesinde, hash fonksiyonları veri bütünlüğü ve blok zincir güvenliğinin temel taşları arasında yer almaktadır.

Blokzincir teknolojisi, her biri özgü özelliklere ve belirli kullanım alanlarına sahip çeşitli hash algoritmalarından faydalanmaktadır.

SHA-256: Blokzincirler içinde geniş çapta kullanılan bu algoritma, veri bütünlüğünü doğrulama ve kriptografik anahtar üretimi gibi işlemlerde kritik güvenlik özellikleri sağlamaktadır (Dang, 2015).

MD5: Hash çakışmaları nedeniyle güvenlik açıklarına rağmen, 128-bitlik parmak izi üretimi sayesinde hızlı ve temel veri bütünlüğü kontrolleri için yaygın olarak kullanılmaya devam etmektedir (Stevens, 2009).

RIPEMD-160: 160-bit hash değeri ile veri bütünlüğü temini ve kriptografik anahtar oluşturma işlemlerinde kullanılmaktadır (Dobbertin et al., 1996).

CRC32: Öncelikle hata tespiti amacıyla geliştirilmiş olup, dosya bütünlüğü denetimlerinde tutarlı hash çıktıları sağladığı için blokzincir uygulamalarında yer bulmaktadır.

Tiger Algoritması: 192 bitlik mekanizması sayesinde daha hızlı ve verimli bir hash fonksiyonu sunmaktadır, gelişmiş işleme yetenekleri ile modern sistemler için avantajlar sağlamaktadır (Anderson and Biham, 1996).

Blokzincir sistemleri, güvenlik ve verimlilik maksimize edilirken olası zayıflıkların azaltılması amacıyla, tek bir hash fonksiyonuna bağımlı kalmayıp çeşitli fonksiyonların bir arada kullanılması stratejisini benimsemektedir. Bu çok yönlü yaklaşım, ağ üzerindeki verilere yapılabilecek manipülasyonları önemli ölçüde güçleştirmekte ve böylece sistemin genel güvenliğini artırmaktadır (Narayanan et al., 2016).

SHA-256 Hash fonksiyonunun hassasiyeti: Bir örnek incelenmesi: Bu örnek incelemesi, SHA-256 kriptografik hash fonksiyonunun hassasiyetini ve kriptografi alanındaki önemini göstermek amacıyla yazar tarafından hazırlanmıştır. Pervari Balı'nın farklı yazılış biçimlerine uygulanan SHA-256 algoritması ile elde edilen hash değerlerinin analizi üzerinden, hash fonksiyonlarının temel özellikleri anlatılmaktadır (Şekil 2). SHA-256, herhangi bir boyuttaki girdi verisinden sabit büyüklükte, 256-bit (32 bayt) hash değeri elde etmek amacıyla geliştirilmiş bir kriptografik hash fonksiyonudur. SHA-256'nın ürettiği hash değerlerinin benzersizliği, girdi verisinde meydana gelebilecek en küçük değişikliklerin bile tamamen farklı bir hash değeri üretilmesine yol açması sayesinde, veri bütünlüğünün doğrulanmasında son derece etkilidir. Pervari Balı, Siirt'in Pervari ilçesine özgü bir bal olup, coğrafi işaretle tescillenmiştir. Bu örnek uygulamada, "Pervari Bal" ifadesinin farklı yazılış biçimleri üzerinden SHA-256 hash değerleri üretilmiş ve karşılaştırılmıştır.

"Pervari Bal" (büyük 'P' ve büyük 'B' ile):

- SHA-256 Hash: e84af46e18ea2718457b07249a30127ddf6ecb17007711096b3d37a04bf1d1a3

"Pervari bal" (büyük 'P' ve küçük 'b' ile):

- SHA-256 Hash: 56dc81b57962e08c26b4df931b7959d5b068d976ddf281c4a5d235560dac5650

"pervari bal" (küçük 'p' ve küçük'b' ile):

- SHA-256 Hash: bd915e66ea03bfd0977b15a74244927bd62fae90603e13afab4e14d54a9c4b1f

Gözlemlenen üç farklı durumda da, "Pervari Bal" ifadesinin yazımındaki küçük farklılıklar (büyük-küçük harf kullanımı) SHA-256 hash değerlerinde büyük ve tamamen farklı sonuçlar üretmiştir. Bu, SHA-256 algoritmasının ve genel olarak hash fonksiyonlarının son derece hassas olduğunu ve veri bütünlüğü kontrolünde nasıl etkili kullanılabileceğini göstermektedir. Bu özellik, dijital güvenlik, veri doğrulama ve kriptografik imzalarda hash fonksiyonlarının kritik önemini vurgulamaktadır.

SHA-256, tek yönlü bir fonksiyon olup; yani, veriler bir kere hash formuna dönüştürüldüğünde, bu işlem geri alınmamaktadır ve verilerin orijinal formuna dönüştürülmesi mümkün olmamaktadır. Bu özellik, parolalar gibi hassas bilgilerin saklanmasında SHA-256'ı güvenli bir seçenek haline getirmektedir çünkü, saklama işlemi sırasında yalnızca hash değeri saklanmakta ve kullanıcı doğrulaması, girdi verisinin yeniden hesaplanan hash'i ile saklanan hash değeri karşılaştırılarak gerçekleştirilmektedir.

Blokzincir teknolojisi, izinsiz ortak ağlardan, tek bir kuruluşun kontrolündeki özel ağlara ve bunların birleşimi olan hibrit ile birden çok kuruluşun yönetimindeki konsorsiyum ağlarına kadar çeşitli yapılandırmalar altında uygulanabilmektedir (Çizelge 2). Ortak blokzincir ağları, herkese açık olup, tüm katılımcıların eşit haklara sahip olduğu, Bitcoin ve Ethereum gibi kripto para birimlerinin temelini oluşturmaktadır. Öte yandan, özel blok zincirleri, belirli erişim kısıtlamaları ile daha kontrollü bir yapı sunmakta ve Ripple gibi işletmelere özel uygulamalar için kullanılmaktadır (Tanrıverdi vd., 2019; Vurdu, 2021). Hibrit blok zincirleri, belirli verilere özel erişim ile genel veri paylaşımını dengelerken, konsorsiyum blok zincirleri, ortak hedefleri olan kuruluşlar tarafından yönetilen ve işbirliği odaklı projelerde tercih edilen bir yapı sunmaktadır (AWS, 2024).

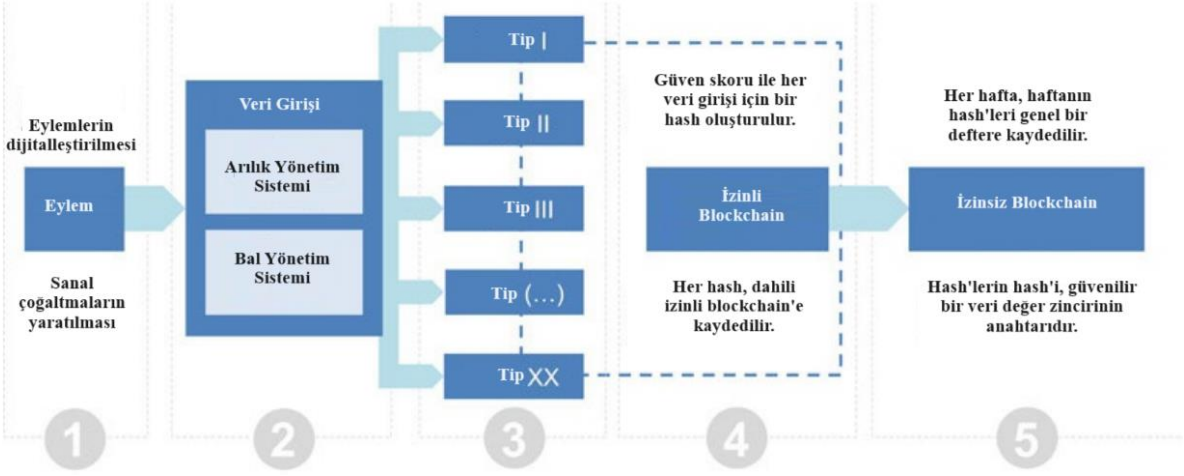
Çizelge 2. Blokzincir yapılar türleri

Tür	Özellikler
Ortak Blokzincir	- İzinsiz ve herkese açık ağdır. - Tüm katılımcılar ağı okuma, yazma ve doğrulama yetkisine sahiptir. - Kripto para birimlerinin ticaretinde ve madenciliğinde yaygın olarak kullanılır. - Dağıtık konsensüs mekanizmalarına dayanır ve merkezi otorite gerektirmez.
Özel Blokzincir	- Yönetilen blokzincir olarak da bilinir. - Ağa katılım ve izinler belirli kurallar çerçevesinde sınırlıdır. - İş dünyası ve kurumsal kullanımlar için idealdir, çünkü erişim kontrolü ve gizlilik ön plandadır. - Kısıtlı erişim ve yüksek performans gerektiren uygulamalar için uygundur.
Hibrit Blokzincir	- Hem ortak hem de özel blokzincir özelliklerini birleştirir. - Belirli verilerin gizliliğini korurken, diğer verileri kamuya açık tutar. - Akıllı sözleşmeler ve karmaşık erişim kontrolleri kullanarak gizlilik ve şeffaflık arasında denge kurar. - Çeşitli uygulama senaryolarına esneklik sağlar.
Konsorsiyum Blokzinciri	- Belirli bir grup tarafından yönetilir ve izin gerektirir. - Katılımcı kuruluşlar arasında yönetim ve sorumluluk paylaşılır. - Ağ, belirli bir sektöre veya ortak hedefe yönelik çoklu kuruluşlar tarafından kullanılır. - İşbirliğine dayalı projelerde tercih edilen bir yapıdır.

Kaynak: IBM, 2024; AWS, 2024; Oracle, 2024; Investopedia, 2024 kaynaklarından yararlanılarak hazırlanmıştır.

Blokzincir yapı türlerinin arıcılık sektörüne entegrasyonu: Arıcılık sektöründe, taklit ve tağşiş, ürün kalitesinin düşmesi ve pazarlamada karşılaşılan zorluklar gibi mevcut

problemlere müdahale etmek amacıyla, çok katmanlı blokzincir teknolojisinin entegrasyonu önerilmektedir (FAO, 2021). Bu entegrasyon, sektörün dinamik gereksinimlerine uygun olarak, her aşamada özel işlevler sergileyen bir yapıya dayanmaktadır. İlk evrede, izinli blokzincir kullanımı, arıcıların ve diğer ilgili tedarik zinciri katılımcılarının belirlenmiş veri setlerine erişimini güven altına alırken, hassas bilgilerin korunmasına olanak tanımaktadır. İkinci olarak, izinsiz blokzincir teknolojisi aracılığıyla, bal üretiminin her bir noktası geniş bir veri paylaşım ağı içerisinde doğrulanabilmekte ve bu sayede ürünün provenansının şeffaf bir kaydı sürdürülebilmektedir. Üçüncü safha, otomatik veri toplama ve üçüncü taraf doğrulama gibi ileri teknolojik süreçlerin entegrasyonu ile, balın kalite ve köken bilgilerinin güvenilirliğini pekiştirmektedir. Bu kapsamlı yaklaşım, arıcılık ürünlerinin tedarik zincirindeki sahteciliğe karşı direncini artırmakta, tüketicilerin güvenini kazanmakta ve üreticilere uluslararası pazarlara erişimde yeni fırsatlar sunmaktadır (Şekil 3).



Şekil 3. Verilerinin arıcılık blok zincirine yazılması süreci (Kaynak FAO, 2021)

Dünya genelinde bokzincir teknolojisinin potansiyelini değerlendirmek ve çeşitli uygulamalar geliştirmek isteyen girişimciler ve kurumlar için bir dizi blokzincir platformu bulunmaktadır (Aslan ve Kasapbaşı, 2022). Bu platformlar, kullanıcıların ihtiyaç duyduğu güvenlik, esneklik ve ölçeklenebilirlik gibi kritik özellikleri sunarak, geniş bir kullanım alanı yelpazesinde yenilikler yapılmasını sağlamaktadır. Çizelge 3'te, Hyperledger Fabric, Ethereum, Corda ve Quorum gibi lider blokzincir platformları

detaylı bir şekilde incelenerek, her birinin nasıl farklı gereksinimlere yanıt verdiği ve teknolojik çözümlerde nasıl bir rol oynadığı açıklanmaktadır.

Çizelge 3. Blokzincir uygulama geliştirme platformları

Platform	Açıklama	Kullanım Alanları
Hyperledger Fabric	Modüler ve genel amaçlı bir çerçevedir. Benzersiz kimlik yönetimi ve erişim denetimi özellikleri sunmaktadır.	Tedarik zinciri takibi ve izlenmesi, ticaret finansmanı, sadakat ve ödül programları, finansal varlıkların mutabakatı
Ethereum	Merkezi olmayan, açık kaynak bir blokzincir platformudur. Ethereum Enterprise, iş kullanım örnekleri için tasarlanmıştır.	Akıllı sözleşmeler, merkezi olmayan finans (DeFi), dApp'ler
Corda	İş için tasarlanmış, açık kaynak kodlu bir blokzincir projesidir. Katı bir gizlilik içinde işlem gerçekleştiren, birlikte çalışabilir blokzincir ağları oluşturmak için kullanılmaktadır.	Finansal işlemler, ticaret finansmanı, tedarik zinciri yönetimi
Quorum	Ethereum'dan türetilmiş, açık kaynak kodlu bir blokzincir protokolüdür. Özel ve konsorsiyum blokzincir ağları için tasarlanmıştır.	Yüksek hacimli ticari işlemler, izinli ağlar, gizlilik odaklı uygulamalar

Kaynak: IBM, 2024; AWS, 2024; Oracle, 2024; Investopedia, 2024 kaynaklarından yararlanılarak hazırlanmıştır.

Blokzincir teknolojisinin sürdürülebilir arıcılıkta uygulanabilirliği, çeşitli platformların özellikleri ve sağladıkları avantajlar bağlamında değerlendirilmesi: Sürdürülebilir arıcılık bağlamında bu teknolojilerin kullanım olanaklarını değerlendirirken, her birinin bu alana özgü katkıları ve potansiyel zorlukları bulunmaktadır.

Hyperledger Fabric, modüler yapısı ve özellikle güçlü kimlik yönetimi ve erişim denetimi özellikleriyle, arı ürünlerinin tedarik zincirini takip etme ve izleme konusunda önemli avantajlar sunmaktadır. Bu platform, arıcılık ürünlerinin kaynağının ve sürdürülebilirlik standartlarına uygunluğunun doğrulanmasında kritik bir rol oynayabilmektedir. Özellikle, arı ürünlerinin etiketlenmesi süreçlerinde güvenlik ve şeffaflık sağlayarak, tüketicilere ve işletmelere ürünlerin gerçek kökeni hakkında güven vermektedir. Ancak, Hyperledger Fabric'in kurulumu ve yönetimi, diğer bazı blokzincir platformlarına göre daha teknik bilgi ve kaynak gerektirebilmektedir.

Ethereum, akıllı sözleşmeler ve merkezi olmayan uygulamalar (dApps) oluşturma yeteneği sayesinde, sürdürülebilir arıcılık projeleri için daha dinamik bir çerçeve sunmaktadır. Özellikle, fon toplama, ödeme ve ödüllendirme mekanizmalarının otomatikleştirilmesi konusunda büyük fırsatlar sağlamaktadır. Bu, arıcılık toplulukları için daha adil ve şeffaf bir ekonomik modelin temelini atabilir. Ancak, Ethereum'un ağ

ölçeklenebilirliği konusundaki zorluklar, küçük ölçekli arıcılar için belirli uygulamaların uygulanmasını zorlaştırabilmektedir.

Corda, özellikle finansal işlemler ve ticaret finansmanı gibi alanlarda güçlü gizlilik protokolleri ile öne çıkmaktadır. Bu, arı ürünlerinin ticaretini ve finansmanını kolaylaştırırken, katılımcıların mahremiyetini koruyabilmektedir. Corda'nın tedarik zinciri yönetimine uygulanabilirliği, özellikle arı ürünlerinin sürdürülebilir kaynaklardan temin edildiğinin doğrulanması açısından değerli olabilir. Ancak, Corda'nın diğer platformlara göre daha dar bir kullanım alanı odaklı olması, genel uygulanabilirliğini sınırlayabilmektedir.

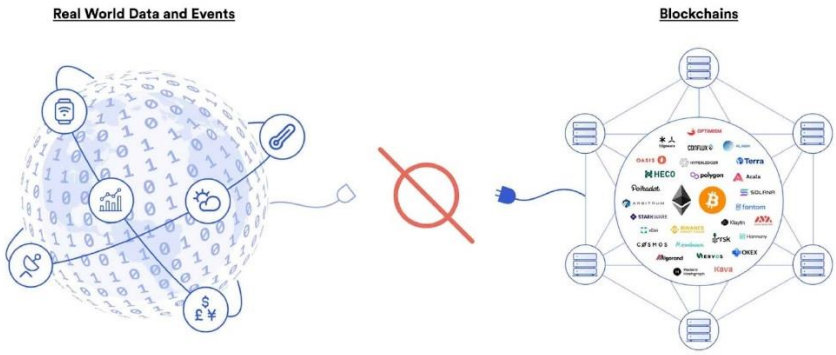
Quorum, Ethereum temelli olması nedeniyle benzer avantajlar sunarken, özellikle gizlilik ve ölçeklenebilirlik konusunda ek iyileştirmeler getirmektedir. Quorum, özel ve konsorsiyum blokzinciri ağları için tasarlandığından, arıcılık sektöründe gizlilik gerektiren işlemler ve yüksek hacimli ticari işlemler için uygundur. Bu, özellikle büyük arıcılık işletmeleri ve kooperatifler tarafından değerlendirilebilmektedir.

Sonuç olarak, sürdürülebilir arıcılıkta blokzincir teknolojisinin uygulanabilirliği, seçilen platformun özelliklerine, projenin özgün ihtiyaçlarına ve kullanıcıların teknik yeteneklerine bağlıdır. Hyperledger Fabric ve Quorum, özellikle tedarik zinciri yönetimi ve ticari işlemler için güvenlik ve gizlilik sağlarken, Ethereum ve Corda, akıllı sözleşmeler ve dApp'ler aracılığıyla daha geniş bir etkileşim ve işlem otomasyonu imkanı sunmaktadır. Bu nedenle, sürdürülebilir arıcılık hedeflerine en uygun platformun seçimi, spesifik kullanım durumları ve arıcılık topluluğunun gereksinimleri doğrultusunda yapılmalıdır.

Blokzincir teknolojisiyle ilgili önemli bir husus, blokzincir ekosistemlerinin doğası gereği içe kapalı oluşu ve dış dünya ile etkileşime geçebilmek için blokzincir oracle'larının kullanılmasının zorunlu hale gelmesidir (Şekil 4). Blokzincir oracle'ları kendiliğinden yürütülen akıllı sözleşmelerin, gerçek dünya olayları, finansal piyasalardan fiyat akışları, geleneksel web API'ları ve diğer blokzincirlerden gelen bilgilere erişimini sağlayarak, daha karmaşık ve işlevsel merkezi olmayan uygulamaların (dApps) geliştirilmesine olanak tanımaktadır. Bu oracle'lar, sadece veri sağlamakla kalmaz, aynı zamanda verinin doğruluğunu doğrulama, blokzincir ile uyumlu hale getirme ve akıllı sözleşmeye güvenli bir şekilde aktarılmasını sağlama gibi önemli işlevler üstlenirler. Chainlink, Band Protocol, Tellor ve API3 gibi projeler, blokzincirler ve gerçek dünya

arasındaki bu kritik köprüyü kurarak, DeFi'den tedarik zinciri yönetimine, tahmin piyasalarından sigortacılığa kadar bir dizi alanda yenilikçi çözümler sunmaktalar (Chainlink, 2024).

Son yıllarda DLT'lere özellikle blokzincir teknolojisine olan ilgi artmış ve dünyanın çeşitli bölgelerinde, tarımsal süreçlerin iyileştirilmesi amacıyla blokzincir teknolojisi temelli uygulama ve platformlar yükseliş göstermektedir. Bu alan, Skuchain, Provenance, AgriDigital gibi yenilikçi girişimlerin yanı sıra Cargill Risk Management gibi köklü şirketlerin geliştirdiği çözümleri kapsamaktadır (Leduc et al., 2021). Arıcılık bağlamında, Yeni Zelanda'da, Manuka balının izlenebilirliğini artırmak amacıyla blokzincir tabanlı bir pilot proje uygulanmış ve bu, arıcılık yönetimi çözümlerinin geliştirilmesine olanak sağlayan MyApiary gibi platformların ortaya çıkmasına yol açmıştır (FAO, 2021).



Şekil 4. Blok zincirleri ile gerçek dünya iletişimi (Kaynak: Chainlink, 2024)

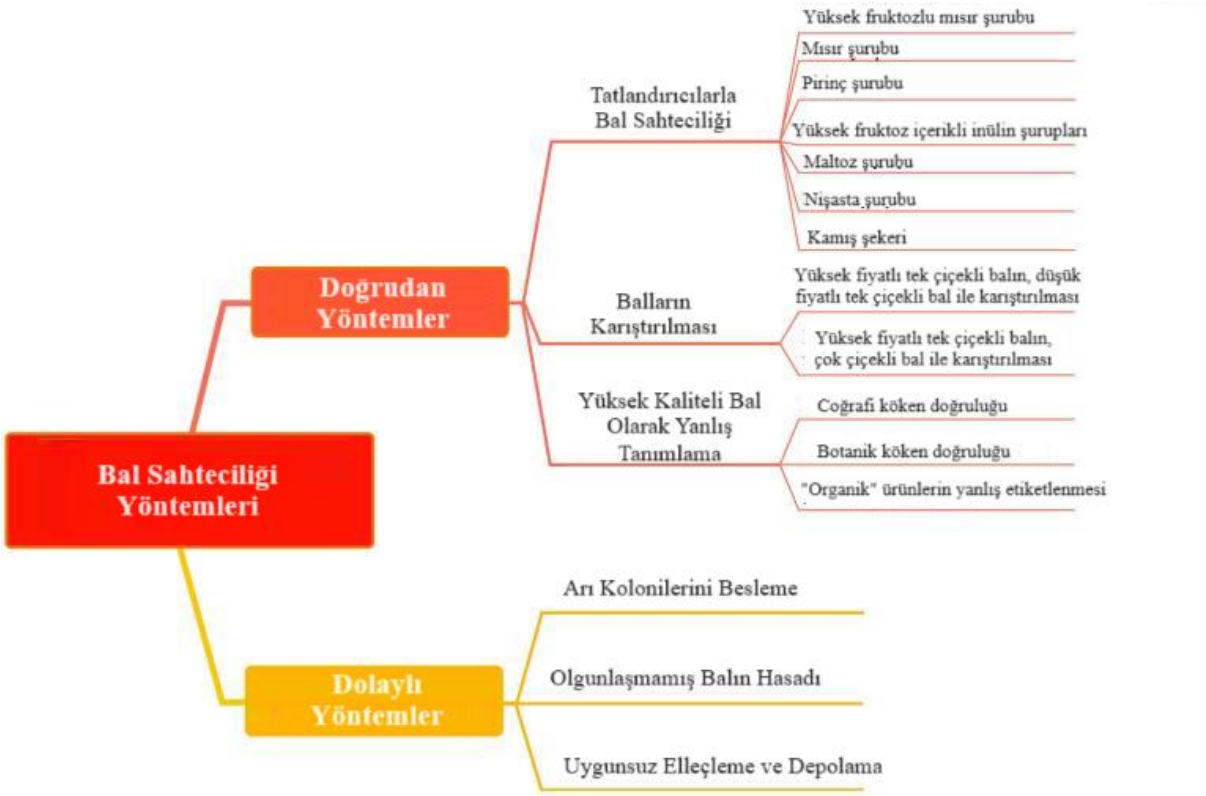
4. ARICILIK SEKTÖRÜNDE BLOKZİNCİR KULLANIM ALANLARI

Sürdürülebilir arıcılıkta blokzincir teknolojisinin kullanımı, şeffaflık, veri güvenliği ve işlemlerin doğrulanabilirliği gibi önemli avantajlar sunmaktadır. Bu teknolojiler, arıcılık ürünlerinin kaynağını doğrulamak, sahteciliği önlemek ve sürdürülebilirlik standartlarına uyumu teşvik etmek için kullanılabilmektedir.

4.1. Balda Tağşiş Sorunu ve Blokzincir ile İzlenebilirlik Sistemi

Bal tağşişi, küresel gıda güvenliği ve halk sağlığı alanlarında artan bir endişe olarak ortaya çıkmakta, tüketici güvenini zedelemekte ve arıcıların ekonomik refahını olumsuz yönde etkilemektedir. Bu durum, araştırmacıları ve politika yapıcıları, gıda sahteciliğinin önüne geçilmesine yönelik daha etkili stratejiler geliştirmeye zorlamaktadır.

Balın artan talebi ve ticari değeri, balda taklit ve tağşişi motive etmektedir. Geçmişte meydana gelen taklit ve tağşiş vakaları incelendiğinde, tağşiş uygulamalarının çoğunlukla şeker şuruplarıyla yapılan hileli eklentileri ve çiçek veya coğrafi kökenle ilgili yanlış etiketleme veya yanlış beyanı içerdiği görülmektedir. Ucuz şeker şurubunun bulunmasından bu yana, üreticiler mali karlarını arttırmak için balı genellikle daha ucuz diğer tatlandırıcılarla seyreltmektedir (Şekil 5). Şeker ilavesi sağlık açısından önemli bir tehdit oluşturmasa da, balı besinsel faydaları için, özellikle de şeker yerine kullanan tüketiciler bilgilendirilmedikleri için sağlıklarını tehlikeye atabilmekteler. Yapılan bir araştırmaya göre yetkililer tarafından yapılan rastgele örneklemelerde genellikle tağşiş edilmiş balda şeker kamışı, mısır şurubu, pirinç şurubu ve pancar şekeri şurubu izlerine rastlanmaktadır (Ahmad and Khairatun, 2021). Türkiye'de taklit ve tağşiş yapılan ya da kişilerin hayatını ve sağlığını tehlikeye düşürecek şekilde bozulmuş, değiştirilmiş ürün gruplarına ve tespit edilen uygunsuzluklara bakıldığında ise bala glikoz ve fruktoz şurubu ile invertaz enzimi ve polen katılması sıkça rastlanılan tağşişlerdendir (Türkmen ve Ataseven, 2020). Bazen saf bal gibi görünmesi için bal kokusu ve balmumu parçaları da eklenmektedir. Balda bir diğer yaygın hileli uygulama da menşe ülkesinin veya botanik kaynağının yanlış beyan edilmesidir. Bal, çiçek kaynağına göre monofloral (veya unifloral) veya multifloral (veya polifloral) olarak sınıflandırılabilir (Özkök ve Bayram, 2021). Monofloral bal, multifloral baldan daha kaliteli olarak algılanır, dolayısıyla tağşişe karşı daha hassastır. Bal ayrıca coğrafi kökenine göre de sınıflandırılmaktadır. Coğrafi işaretler, menşe adı ya da mahreç işareti olarak tescil edilmektedir (TÜRKPATENT, 2024). Bu ballar genellikle özel, lezzet ve tat sunmakta ve yüksek kaliteli ürünler olarak algılanmaktadır. Sonuç olarak, tağşişe karşı oldukça hassastırlar. Genel olarak, belirli bir bölgenin spesiyalitesi olan ballar, yanlış etiketlemeye veya daha düşük maliyetli ve düşük kaliteli ballarla hileli bir şekilde karıştırılmaya daha yatkındır. Chowdhury et al. (2021), tarafından yapılan çalışmada birçok ülkede balın düşük maliyetli şekerlerle, örneğin yüksek fruktozlu mısır şurubu ile sahteciliğinin yaygın bir uygulama olduğunu belirtmektedir. 2016 yılında Avrupa Komisyonu'na bağlı Ortak Araştırma Merkezi (JRC), bal pazarlamasındaki sahtecilik uygulamalarının ne derecede yaygın olduğunu belirlemek üzere bir araştırma gerçekleştirmiştir. Bu çalışma kapsamında yapılan analizler sonucunda, incelenen 893 bal kavanozunun %14.2'sinin, şeker katkısı ile tağşiş yapılarak Avrupa Birliği standartlarına uygun olmadığı bildirilmiştir (Aries et al., 2016).



Şekil 5. Bal ile ilgili ana sahtecilik yöntemlerinin şematik gösterimi (Kaynak: Zhang et al., 2023)

Bal sahteciliğinin tespiti için çeşitli metodolojilerin geliştirildiği görülmektedir. Örneğin, yakın kızılötesi spektroskopisi (Zhou et al., 2023), fizikokimyasal ve reolojik parametreler (Mohamat et al., 2023) ile makine öğrenimi ile entegre edilmiş hiperspektral görüntüleme teknikleri (Phillips and Abdulla, 2022) bal sahteciliğinin saptanmasında önemli yöntemler arasında yer almaktadır. Elektronik dil ve FTIR spektroskopisi kullanarak balda şeker şurubu katkısının belirlenmesi üzerine çalışmalar (Sobrino-Gregorio et al., 2018; Irudayaraj et al., 2003) da dikkate değerdir. Balda C4 ve C3 şekerlerinin varlığı ile sahteciliğin izotop oranı kütle spektrometrisi ile belirlenebileceği bir metodoloji (Elflein and Raezke, 2008) ve reolojik parametrelerin bal sahteciliğini işaret edebileceğine dair bulgular (Kamboj and Mishra, 2015) literatürde yer almaktadır. Çeşitli araçlar ve yöntemler balın saflığını ve doğruluğunu saptama konusunda önemli ilerlemeler sağlamış olsa da, blokzincir teknolojisi, bu çabaları bir adım ileri taşıyarak, bal ürünlerinin izlenebilirliğini ve şeffaflığını artırma potansiyeline sahiptir. Yapılan çalışmalar, blokzincir'in uçtan uca izlenebilirliği sağlama potansiyeline sahip olduğunu,

AgriBlockIoT gibi geliştirilen çeşitli blokzincir tabanlı çözümlerin, IoT cihazlarını entegre ederek tedarik zincirinde kesintisiz veri akışı sağladığını ortaya koymaktadır (Verny and Guan, 2023; Pincheira et al., 2018). Arıcılık bağlamında blokzincir, her bir bal kavanozunun kökenine dair değiştirilemez kayıtlar oluşturarak, tüketicilere ürünlerin gerçekliğini doğrulama imkanı sunmaktadır. Bu çerçevede, Blokzincir Destekli Bal İzlenebilirlik Sistemi (Blockchain-Enabled Honey Traceability System) gibi girişimler, kovanlardan tüketicilere kadar balın izlenmesini sağlayacak blokzincir temelli sistemler geliştirerek, bal değer zincirindeki güven sorunlarını gidermeyi, arıcılar için sürdürülebilir gelişimi teşvik etmeyi ve tüketicilere güvenilir ürünler sunmayı amaçlamaktadır (Appalachian State University, 2024). BumbleChain gibi projeler ise, blokzincir ve RFID teknolojilerini birleştirerek bal sektöründe şeffaflık ve izlenebilirlik sağlamayı, arı popülasyonlarını korumayı, bal sahteciliği ile mücadele etmeyi ve arıcılara global bir platform sunmayı hedeflemektedir. Bu yaklaşımlar, bal tedarik zinciri boyunca tüm süreçlerin açık ve doğrulanabilir bir kaydını sunarak tüketicilere değer katmakta ve sektördeki güveni artırmaktadır (BumbleChain, 2024).

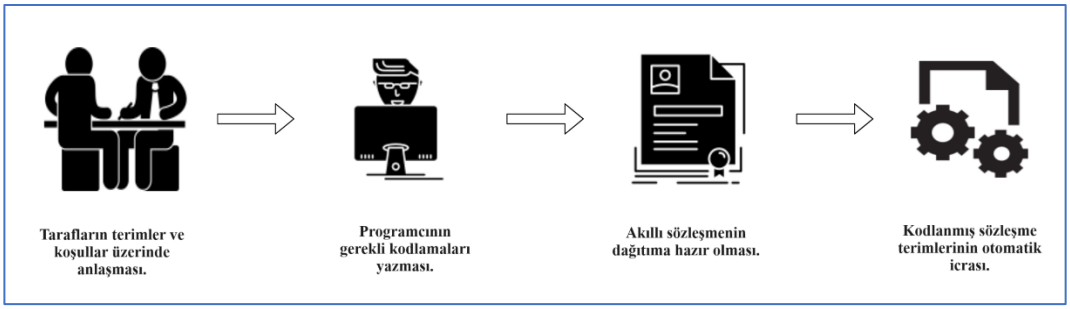
4.2. Arıcılıkta Blokzincir-IoT Entegrasyonu

Bal arısı kolonilerinin sağlığı, tozlaştırıcı olarak oynadıkları rol nedeniyle tarım ve çevre için kritik öneme sahiptir. Nesnelerin İnterneti (IoT), arı kovanlarının sıcaklık, nem, zararlı varlığı ve arı hareketliliği gibi temel parametrelerin izlenmesi amacıyla sensörlerle donatılmasını kapsamaktadır. Geleneksel olarak, IoT sistemleri, tüm verileri bir bulut sunucusuna göndermektedir. Bu, tüm paydaşlar için bilgilere kolay bir şekilde erişim sağlamanın ve basit bir web uygulaması kurmanın bir yolunu sunmaktadır. Ancak, bu yaklaşımın sorunlarından biri, tüm verilerin üçüncü bir tarafça yönetilen merkezi bir sunucuda saklanmasıdır. Bu sorunun çözümü, blokzincir ağı kullanımında bulunabilmektedir. Blokzincir ağının merkeziyetsiz karakteri ve veri değişmezliği gibi temel özellikleri, bulut veritabanının kısa vadeli sorunlarını çözmede avantaj olarak kullanılabilmektedir. IoT kullanılarak toplanan kritik veriler, verilerin herhangi bir anda manipüle edilmediğinin kanıtlanması amacıyla blokzincir ağında saklanabilmektedir (Lukovac et al., 2023). Blokzincir üzerinde saklanan bu verilerin analizi, kovan sağlığını olumsuz etkileyen faktörlerin belirlenmesine imkan tanımakta, böylece arıcıların kovan koşullarını proaktif bir şekilde iyileştirmeleri mümkün hale gelmektedir. Bu iyileştirme süreci, zararlı varlık baskınlarının önlenmesinden, nem ve sıcaklık düzeylerinin ideal

değerlerde tutulmasına kadar geniş bir yelpazede önlemleri içermektedir. Ayrıca, elde edilen veri setlerindeki örüntülerin analiz edilmesi, erken hastalık tespit sistemlerinden optimal kovan yerleşim stratejilerine varıncaya kadar farklı öngörücü modellerin geliştirilmesine zemin hazırlamaktadır. Bu öngörücü modeller, arı kolonilerinin sağlık ve verimliliğinin artırılmasına yönelik stratejik kararların alınmasında arıcılara rehberlik etmektedir.

4.3. Arıcılıkta Blokzincir Tabanlı Akıllı Sözleşmeler

Akıllı sözleşmeler, belirlenen şartların gerçekleşmesiyle otomatik olarak icra edilen, yasal müdahalelere, gecikmelere veya ödeme belirsizliklerine ihtiyaç duymadan, dijital para biriminin alıcıya transferi gibi işlemleri önceden tanımlanmış kurallar çerçevesinde gerçekleştiren kendi kendine yürütülen programlanmış protokollerdir. Bu sözleşmeler, blok zincir teknolojisiyle oluşturulan ve aracı kurumlara ihtiyaç duymadan kendini yürütebilen, gelecek için büyük potansiyele sahip uygulamalardır (Bölükbaşı, 2023). Bir akıllı sözleşmenin oluşturulması ve uygulama adımları Şekil 6'da verilmiştir.



Şekil 6. Akıllı sözleşme oluşturma adımları (Kaynak: Pranto et al., 2021)

Bu sözleşmeler, sektörel düzeyde, akıllı bal ticareti ve polinasyon hizmetleri gibi yenilikçi iş modelleri geliştirmek için kullanılabilmektedir. Bu bağlamda, Dijital Türk Lirası gibi ülkelerin resmi dijital para birimlerinin entegrasyonu, ödeme süreçlerini daha da hızlandırarak ve güvenliği artırarak, bu sistemlerin işlevselliğini ve kapsamını genişletme potansiyeline sahiptir (TCMB, 2023). Akıllı sözleşmelerin etkin uygulanabilmesi için blokzincir teknolojisinde olduğu gibi değiştirilemez veri kaynaklarına dayanması gerekmekte, böylece ilgili tüm taraflar sözleşmenin şeffaf ve doğru olarak uygulandığından emin olabilmektedirler.

Akıllı bal ticareti sözleşmeleri: Detaylı ve özgün veri setlerine dayalı, güvenilir izlenebilirlik sistemleri, işletmeler arasında bal ticaretini otomatize etme, riskleri azaltma ve piyasa verimliliğini artırma bakımından hayati öneme sahiptir. Bal türlerine yönelik standartlaştırılmış tanımların oluşturulması, akıllı sözleşmelerin geliştirilmesi için bir başlangıç noktası teşkil etmektedir. Kabuklu kırmızı mercimek gibi net tanımlamalara ve belirgin özelliklere sahip emtiaların kullanılması örnek alınarak, bal kalitesine yönelik standartlar belirlenebilir ve bal ticareti, bu standartlar çerçevesinde akıllı sözleşmeler yardımıyla otomatize edilebilir. Bu tür bir düzenleme, şeffaf ve yasal olarak doğrulanabilir standartlar kullanılarak, ürün ihtisas borsası benzeri bir yapı oluşturabilir (Göksu, 2022).

Diğer taraftan blokzincir teknolojisinin – IoT teknolojileri ile entegrasyonu sayesinde üretim süreci boyunca, arı kolonisi kayıtlarından ve kovanlarda yer alan IoT sensörlerden toplanan veriler, arıların beslenme desenleri, kovan aktivite seviyeleri ve sürü oluşum eğilimleri gibi arı davranışları hakkında değerli bilgiler sağlamaktadır (Guruprasad and Leiding, 2024). Bu veriler, önceden belirlenmiş protokoller kullanılarak otomatik analizlere tabi tutulabilir ve bu analiz sonucunda balın doğru kategoriye sınıflandırılması ve daha sonrasında gerçekliğinin doğrulanması sağlanabilir. Doğrulanmış veriler, hem açık hem de kapalı blokzincir sistemlerinde akıllı sözleşmelerin yürütülmesi için kullanılabilir, böylece bal ticareti daha şeffaf, güvenilir ve verimli bir şekilde gerçekleşebilir. Kapalı akıllı sözleşmeler, özelleştirilmiş şartlar altında ve spesifik bal türlerinin, gelecekteki bir tarihte önceden belirlenmiş fiyatlara satın alınmasını düzenleyen, taraflar arası karşılıklı anlaşmalardır. Açık akıllı sözleşmelerin bağlamında ise, bal paketleyicileri, market zincirleri veya kooperatifler gibi alıcılar tarafından, belirlenen kalite seviyelerine ve sabit fiyatlara göre önceden belirlenmiş miktarda bal satın alma niyetini ifade eden bir teklif niteliğindedir (FAO, 2021).

Akıllı polinasyon hizmetleri sözleşmeleri: Dünya üzerindeki gıda ürünlerinin üçte biri, böcekler tarafından sağlanan tozlaşma işlemine bağımlıdır; bu böcekler arasında bal arıları (Apis mellifera) ve 20.000'den fazla yerli arı türü bulunmaktadır (Berenbaum, 2007; Droege and Packer, 2015). Böcekler aracılığıyla gerçekleşen tozlaşmaya dayanan ürünleri yetiştiren çiftçiler, ya yerli tozlaştırıcı böceklerden yararlanarak, kendi arılarını temin etmekte veya arıcılara tozlaşma hizmetleri için ödeme yapmaktadır. Şengül (2020),

tarafından Ege bölgesinde yapılan çalışmada görüşülen üreticilerin %6.71'isin sözleşmeli ayçiçek ve kanola polinasyonuna gittikleri belirtilmiştir.

Geleneksel sözleşmelere göre, akıllı sözleşmeler, çiftçiler ve arıcılar arasındaki tozlaşma hizmetleri için yapılan sözleşmelerin işlem süreçlerini dönüştürme potansiyeline sahiptir. Bu blokzincir tabanlı programlar, anlaşmanın kritik yönlerini otomatize edebilmektedir. Örneğin, akıllı sözleşmeler, IoT sensörleri tarafından sağlanan kovan sağlığı verilerini (arı popülasyonunu, sıcaklığı vb. izleyen) yetiştiricinin ödemesiyle bağlantılandırabilir. Bu, arıcıların sundukları tozlaşma hizmetinin kalitesine dayalı olarak tazminat almalarını sağlayacaktır (FAO, 2021). Ayrıca, akıllı sözleşmeler, kovanların teslim alınması ve geri dönüşünü GPS verileri ile izleyebilir, doğrulanmış konumda ödemeleri otomatikleştirebilir ve sürdürülebilir arıcılık uygulamalarını sözleşme şartları olarak dahil ederek bu uygulamaları teşvik edebilir. Bu teknoloji, gıda üretiminin kritik bir unsuru olan tozlaşma hizmetlerine şeffaflık, güven ve verimlilik getirebilmektedir.

Son olarak merkezi olmayan blokzincir ağları, çeşitli paydaşların (arıcılar, çevreciler, politikacılar ve tüketiciler) arı popülasyonunun sağlığını destekleyici bilgilere şeffaf erişimini sağlayarak işbirliğini kolaylaştırmaktadır. Bu ortak platform, sürdürülebilir arıcılık uygulamalarına yönelik ortak sorumluluğu teşvik etmektedir.

4.4. Blokzincir Teknolojisinin Benimsenmesinin Önündeki Bazı Temel Engeller

Blokzincir teknolojisinin çiftçiler tarafından benimsenmesi önünde birçok temel engel bulunmaktadır (Cuellar and Johnson, 2022). Bu engellerin başında teknik okuryazarlık ve beceri eksiklikleri, yetersiz altyapı, finansal kısıtlar, hükümet desteğinin yetersizliği, veri gizliliği ve güvenlik endişeleri, karmaşık uygulama zorlukları ve değişime direnç gelmektedir. Çalışanların çoğu, blokzincir ve IoT gibi teknolojileri anlama ve kullanma becerisinden yoksundur, bu durum teknolojinin benimsenmesini zorlaştırmaktadır. Eğitim ve fiziksel altyapı dağınıklığı, benimsenme sürecini daha da karmaşık hale getirmektedir. Blokzincir teknolojisi ve IoT cihazlarının tarım sektöründe kullanılmasına ilişkin maliyetler, özellikle gelişmekte olan ülkelerdeki çiftçiler ve işletmeler için hem başlangıçtaki yatırım hem de devam eden bakım ve güncellemeler açısından yüksek olabilmekte ve bu durum benimsenme sürecini engellemektedir. Araştırmalar, gelişmekte olan ülkelerde yeni teknolojilerin benimsenmesini teşvik etmek için sübvansiyonlar, teşvikler ve bu teknolojileri erişilebilir ve uygun fiyatlı hale getirmek için Ar-Ge yatırımları için yeterli hükümet desteği olmadığını öne sürmektedir. Blokzincir doğası

gereği gelişmiş güvenlik ve veri bütünlüğü sunsa da, saldırılara karşı savunmasızlığı ve gizlilik ihlalleri potansiyeli ile ilgili endişeler devam etmektedir. Son olarak tarımsal tedarik zinciri, farklı bölgeler ve ülkelerdeki çok sayıda paydaşı içeren oldukça karmaşık bir yapıya sahiptir. Böylesine çeşitli ve parçalı bir sistemde blokzincir teknolojisini uygulamak lojistik ve düzenleyici zorlukları ortaya çıkarmaktadır. Tarımsal tedarik zincirindeki paydaşlar arasında, özellikle de geleneksel çalışma yöntemlerine alışkın olan ve blokzincir teknolojisinin getirebileceği faydalara şüpheyle yaklaşanlar arasında yeni teknolojilerin benimsenmesine karşı da direnç oluşabilmektedir.

5. Sonuç ve Öneriler

Bu çalışmada sürdürülebilir arıcılık uygulamalarının desteklenmesi amacıyla, blokzincir teknolojisinin uygulanabilirliği ve bu süreçte ortaya çıkan engeller detaylı bir şekilde ele alınmıştır. Blokzincir'in izlenebilirlik, veri güvenliği ve merkezi olmayan yapısı gibi özellikleri, şeffaflığı artırma, bal tedarik zincirlerini düzene sokma, kovan yönetimini optimize etme ve çevreye duyarlı uygulamaları benimseyen arıcıları ödüllendirme konusunda gerekli araçları sunmaktadır. Çalışma sonuçları balda tağşişin önlenmesi ve arıcılık sektöründe adil rekabetin sağlanması açısından, blokzincir teknolojisinin önemini vurgulamıştır. Tağşiş, arıcılar arasındaki adil rekabeti baltalayarak ve pazar bütünlüğünü bozarak ciddi sorunlara yol açmaktadır. Uzun vadede, arıcılık faaliyetlerinin azalmasıyla birlikte arılar tarafından sağlanan tozlaşma gibi ekolojik hizmetlerin kaybı, çevre ve tarımsal sürdürülebilirliği olumsuz yönde etkileyecektir. Bu bağlamda, blokzincir teknolojisi, balın izlenebilirliğini artırarak ve tedarik zincirindeki her bir adımı kayıt altına alarak tağşişle mücadelede kritik bir rol oynayabilmektedir. Bu teknolojinin sağladığı şeffaflık, tüketicilere aldıkları ürünlerin kaynağını ve kalitesini doğrulama olanağı tanırken, aynı zamanda ürünün doğallığı ile ilgili yapılan manipülasyonlarına karşı bir savunma hattı oluşturmaktadır. Bu şekilde, blokzincir, pazar bütünlüğünü koruyarak ve adil rekabeti teşvik ederek arıcılık sektörünün sürdürülebilirliğine katkıda bulunmaktadır.

Arıcılıkta blokzincir teknolojisinin potansiyelinin tam anlamıyla kullanılabilmesi için şu adımların atılması kritik önem taşımaktadır: Öncelikle, tedarik zincirinin çeşitli aşamalarında blokzincir'in gerçek dünya uygulamalarını gösteren hedefe yönelik pilot projelerin hayata geçirilmesi gerekmektedir. Eğitim ve kapasite inşası çabaları, blokzincir konseptlerini ve avantajlarını tüm deneyim seviyelerinden arıcılara erişilebilir kılmak

üzere yoğunlaşmalıdır. Sektör genelinde standartlar oluşturulması, bilgi alışverişinin şeffaf gerçekleşmesini temin edecek ve blokzincir sistemlerinin geniş çapta benimsenmesini sağlayacaktır. Teknik beceri seviyesine bakılmaksızın arıcıları yetkilendirecek kullanıcı dostu blokzincir araçları ve arayüzlerin geliştirilmesi esastır. Nihayetinde, arıcılık, teknoloji, araştırma ve ilgili organizasyonları kapsayan çeşitli sektörler arasında stratejik ortaklıkların kurulması, arıcılık sektörü için yenilikçi ve etkileyici blokzincir çözümlerinin geliştirilmesine olanak tanıyacaktır.

Kaynak

1. Ahmad, N.N. and Khairatun, S.N. (2021). Exploring fraudulent honey cases from readily available food fraud databases, GATR Global J. Bus. Soc. Sci. Review, 9(2), 99 – 113. https://doi.org/10.35609/gjbssr.2021.9.2(1)
2. Akın, M. Ş., ve Yılancı, A. (2021). Kırsal kalkınma için aracılığın önemi: refahiye örneği. Çekmece İZU Sosyal Bilimler Dergisi/Cekmece IZU Journal of Social Sciences.
3. Anderson, R., & Biham, E. (1996). Tiger: A fast new hash function.9p.
4. Appalachian State University. (2024). Building a blockchain-enabled honey traceability yystem, 6p, https://business.appstate.edu/sites/default/files/blockchain-prototype-flash-grant.pdf
5. Aries, E., Burton, J., Carrasco, L., De Rudder, O., & Maquet, A. (2016). Scientific support to the implementation of a coordinated control plan with a view to establishing the prevalence of fraudulent practices in the marketing of honey. European Commission, Belgium, 38.
6. Aslan, M., & Kasapbaşı, M. C. (2022). Blok zinciri platformları, fikir birliği mekanizmaları ve ağın güvenlik analizi. Haliç Üniversitesi Fen Bilimleri Dergisi, 5(1), 43-72.
7. AWS. (2024). Blok zinciri teknolojisi nedir? Amazon Web Services, Inc. From https://aws.amazon.com/tr/what-is/blockchain/?aws-products-all.sort-by=item.additionalFields.productNameLowercase&aws-products-all.sort-order=asc (Erişim tarihi:19 Mart 2024)
8. Berenbaum, M. (editor). (2007). Status of pollinators in North America. Washington, D.C.: The National Academies Press
9. Blacquière, T., Smagghe, G., van Gestel, C. A. M., & Mommaerts, V. (2012). Neonicotinoids in bees: a review on concentrations, side-effects and risk assessment. Ecotoxicology, 21(4), 973–992.
10. Bölükbaşı, Ö. (2023). Akıllı sözleşmelerin genel işlem koşulları bakımından değerlendirilmesi. Sakarya Üniversitesi Hukuk Fakültesi Dergisi, 11(1), 191-218.

11. BumbleChain. (2024). Meet BumbleChain: Uplifting the global honey industry with blockchain, https://thoughtforfood.org/content-hub/meet-bumblechain-uplifting-the-global-honey-industry-with-blockchain/
12. Buterin, V. (2014). Ethereum: A next-generation smart contract and decentralized application platform.
13. Chainlink. (2024). What is an oracle in blockchain? From https://chain.link/education/blockchain-oracles#toc-first (Erişim tarihi: 19 Mart 2024)
14. Chowdhury, S. A., Carter, J. F., Anuj, S. R., Cozzolino, D., Hungerford, N. L., & Fletcher, M. T. (2021). The validity of protein in australian honey as an internal standard for c4 sugar adulteration. Food Analytical Methods, 14(4), 823-833. https://doi.org/10.1007/s12161-020-01938-6
15. Cox-Foster, D. L., Conlan, S., Holmes, E. C., Palacios, G., Evans, J. D., Moran, N. A.,[...] & Lipkin, W. I. (2007). A metagenomic survey of microbes in honey bee colony collapse disorder. Science, 318(5848), 283–287.
16. Crosby, M., Pattanayak, P., Verma, S., & Kalyanaraman, V. (2016). Blockchain technology: Beyond bitcoin. Applied Innovation Review, 2, 6-19.
17. Dang, Q. (2015), Secure hash standard, Federal Inf. Process. Stds. (NIST FIPS), National Institute of Standards and Technology, Gaithersburg, MD, https://doi.org/10.6028/NIST.FIPS.180-4.
18. Dinçel, C. (2020). Blok zinciri teknolojisinin muhasebe ve denetim mesleğine etkisi. İstanbul Üniversitesi, Sosyal Bilimler Enstitüsü, İstanbul, 102-142.
19. Dobbertin, H., Bosselaers, A., & Preneel, B. (1996). RIPEMD-160: A strengthened version of RIPEMD. 13p.
20. Droege, S. and Packer, L. (2015). Bees: An up-close look at pollinators around the world. Voyageur Press, Minneapolis, Minnesota.
21. Elflein, L. and Raezke, K. P. (2008). Improved detection of honey adulteration by measuring differences between13c/12c stable carbon isotope ratios of protein and sugar compounds with a combination of elemental analyzer - isotope ratio mass spectrometry and liquid chromatography - isotope ratio mass spectrometry (δ13c-ea/lc-irms). Apidologie, 39(5), 574-587. https://doi.org/10.1051/apido:2008042

22. Ercan, Ş., Öztep, R., Güler, D., & Saner, G. (2019). Tarım 4.0 ve Türkiye'de uygulanabilirliğinin değerlendirilmesi. Tarım Ekonomisi Dergisi, 25 (2), 259-265.
23. FAO. (2021). IZSLT, Apimondia and CAAS. Good beekeeping practices for sustainable apiculture FAO Animal Production and Health Guidelines No. 25. Rome. https://doi.org/10.4060/cb5353en
24. Genersch, E. (2010). Honey bee pathology: current threats to honey bees and beekeeping. Applied Microbiology and Biotechnology, 87(1), 87–97.
25. Göksu, E. (2022). Ürün ihtisas borsasının odun dışı orman ürünleri uygulanabilirliği üzerine bir araştırma: çam balı örneği. Üniversitesi, Basılmamış Doktora Tezi, Ege Fen Bilimleri Enstitüsü, Tarım Ekonomisi Anabilim Dalı, İzmir, 261s.
26. Guichard, M., Dietemann, V., Neuditschko, M., & Dainat, B. (2020). Advances and perspectives in selecting resistance traits against the parasitic mite varroa destructor in honey bees. Genetics Selection Evolution, 52(1). https://doi.org/10.1186/s12711-020-00591-1
27. Guruprasad, S. M., & Leiding, B. (2024). BeeOpen—an open data sharing ecosystem for apiculture. Agriculture, 14(3), 470.
28. Haber, S., & Stornetta, W.S. (1991). How to time-stamp a digital document. Journal of Cryptology.
29. Henry, M., and Rodet, G. (2018). Controlling the impact of the managed honeybee on wild bees in protected areas. Scientific Reports, 8(1). https://doi.org/10.1038/s41598-018-27591-y
30. Henry, M., Beguin, M., Requier, F., Rollin, O., Odoux, J.-F., Aupinel, P., [...] & Decourtye, A. (2012). A common pesticide decreases foraging success and survival in honey bees. Science, 336(6079), 348–350.
31. IBM. (2024). What is blockchain? From https://www.ibm.com/topics/blockchain (Erişim tarihi:19 Mart 2024)
32. Investopedia. (2024). Blockchain facts: what is it, how it works, and how it can be used. From https://www.investopedia.com/terms/b/blockchain.asp (Erişim tarihi:18 Mart 2024)

33. Irudayaraj, J., Xu, R., & Tewari, J. (2003). Rapid determination of invert cane sugar adulteration in honey using ftir spectroscopy and multivariate analysis. Journal of Food Science, 68(6), 2040-2045. https://doi.org/10.1111/j.1365-2621.2003.tb07015.x
34. Kamboj, U. and Mishra, S. (2015). Prediction of adulteration in honey using rheological parameters. International Journal of Food Properties, 18(9), 2056-2063. https://doi.org/10.1080/10942912.2014.962656
35. Knuth, D. E. (1998). The art of computer programming, Volume 2 (3rd ed.): Seminumerical algorithms. Addison-Wesley.
36. Koç, E. (2020). Tedarik zinciri izlenebilirliği ve sürdürülebilirliğinde yeni paradigma: Blokzincir. Bingöl Üniversitesi Sosyal Bilimler Enstitüsü Dergisi (BUSBED), 10(20), 417-437.
37. Kösoğlu, M., Tunca, R. İ., Yücel, B., Balkanska, R., & Yıldırır, Z. T. (2021). Arıcılıkta sürdürülebilirlik mümkün mü?. MAS Journal of Applied Sciences, 6(3), 610-623.
38. Leduc, G., Kubler, S., & Georges, J. P. (2021). Innovative blockchain-based farming marketplace and smart contract performance evaluation. Journal of Cleaner Production, 306, 127055.
39. Lukovac, P., Simić, M., & Radenković, B. (2023, June). IoT system for smart beekeeping. In E-business technologies conference proceedings (Vol. 3, No. 1, pp. 159-162).
40. Merdan, K. (2020). Arıcılıkta maliyet unsurları. Academic Social Resources Journal, 5(13), 201-207.
41. Mohamat, R. N., Noor, N. R. A. M., Yusof, Y. A., Sabri, S., & Zawawi, N. (2023). Differentiation of high-fructose corn syrup adulterated kelulut honey using physicochemical, rheological, and antibacterial parameters. Foods, 12(8), 1670. https://doi.org/10.3390/foods12081670
42. Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. https://bitcoin.org/bitcoin.pdf
43. Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). Bitcoin and cryptocurrency technologies: A comprehensive introduction. Princeton University Press.

44. Oracle. (2024). Oracle Blockchain. Oracle. From https://www.oracle.com/tr/blockchain/ (Erişim tarihi:18 Mart 2024)
45. Özkök, A., ve Bayram, N. E. (2021). Kestane (castanea sativa) balı örneklerinin botanik orijinlerinin doğrulanması ve toplam polen sayıları. Uludağ Arıcılık Dergisi, *21*(1), 54-65.
46. Öztürk, E., ve Berber, A. (2024). Blokzincir teknolojisi ve akıllı sözleşmeler: temel yapı, özellikler ve veri güvenliği perspektifi. Periodicum Iuris, *2*(1), 33-76.
47. Parlar, T. (2022). Blokzincir teknolojisi ve merkeziyetsiz finans uygulamaları. Journal of Politics Economy and Management, 5(2), 165-174.
48. Phillips, T. and Abdulla, W. H. (2022). A new honey adulteration detection approach using hyperspectral imaging and machine learning. European Food Research and Technology, 249(2), 259-272. https://doi.org/10.1007/s00217-022-04113-9
49. Pincheira, M., Ali, M. S., Vecchio, M., & Giaffreda, R. (2018). Blockchain-based traceability in agri-food supply chain management: a practical implementation. 2018 IoT Vertical and Topical Summit on Agriculture - Tuscany (IOT Tuscany). https://doi.org/10.1109/iot-tuscany.2018.8373021
50. Potts, S. G., Biesmeijer, J. C., Kremen, C., Neumann, P., Schweiger, O., & Kunin, W. E. (2010). Global pollinator declines: Trends, impacts and drivers. Trends in Ecology & Evolution, 25(6), 345-353.
51. Potts, S. G., Imperatriz-Fonseca, V., Ngo, H. T., Aizen, M. A., Biesmeijer, J. C., Breeze, T. D., ... & Vanbergen, A. J. (2016). Safeguarding pollinators and their values to human well-being. Nature, 540(7632), 220-229.
52. Pranto, T. H., Noman, A. A., Mahmud, A., & Haque, A. B. (2021). Blockchain and smart contract for IoT enabled smart agriculture. PeerJ Computer Science, *7*, e407.
53. Rivest, R. (1992). The MD5 message-digest algorithm. MIT Laboratory for Computer Science and RSA Data Security, Inc.
54. Sandrock, C., Tanadini, L. G., Pettis, J. S., Biesmeijer, J. C., Potts, S. G., & Neumann, P. (2014). Sublethal neonicotinoid insecticide exposure reduces reproductive output of bumblebee queens (Bombus terrestris). Proceedings of the Royal Society B: Biological Sciences, 281(1790), 20140854.

55. Sobrino-Gregorio, L., Bataller, R., Soto, J., & Escriche, I. (2018). Monitoring honey adulteration with sugar syrups using an automatic pulse voltammetric electronic tongue. Food Control, 91, 254-260. https://doi.org/10.1016/j.foodcont.2018.04.003
56. Stevens, M. (2009). Attacks on hash functions and applications. 258 p
57. Szabo, N. (1998). "Bit Gold." Nick Szabo's essays on the origins of money.
58. Şengül, Z. (2020). Ege bölgesinde arıcılık yapan işletmelerin sürdürülebilirlik yönünden değerlendirilmesi. Ege Üniversitesi Fen Bilimleri Enstitüsü, Doktora Tezi
59. Şengül, Z., ve Yücel, B. (2022). Biyosistem mühendisliği akademik çalımaları 1. (Editör: Doç.Dr. Mehmet Fırat Baran). Bölüm 7 hassas arıcılık teknolojileri. 135–154.
60. Şengül, Z., and Saner, G. (2023). Assessing the sustainability of beekeeping farms in Turkey: case of the Aegean region. New Medit, 22(3). https://doi.org/10.30682/nm2303e
61. Tanrıverdi, M., Uysal, M., & Üstündağ, M. T. (2019). Blokzinciri teknolojisi nedir? Ne değildir: Alanyazın İncelemesi. Bilişim Teknolojileri Dergisi, 12 (3), 203-217.
62. Tapscott, D., & Tapscott, A. (2016). Blockchain revolution: how the technology behind bitcoin is changing money, Business, and the World.
63. TCMB. (2023). Digital Turkish Lira first phase evaluation report, 63p, https://www.tcmb.gov.tr/wps/wcm/connect/b2527947-27ca-41d1-8a9b-1c9a8c211682/Digital+Turkish+Lira+First+Phase+Evaluation+Report.pdf?MOD=AJPERES
64. Torné-Noguera, A., Rodrigo, A., Osorio, S., & Bosch, J. (2016). Collateral effects of beekeeping: impacts on pollen-nectar resources and wild bee communities. Basic and Applied Ecology, 17(3), 199-209. https://doi.org/10.1016/j.baae.2015.11.004
65. Tripoli, M., & Schmidhuber, J. (2018). Emerging Opportunities for the Application of Blockchain in the Agri-food Industry.40p. http://www.fao.org/3/ca1335en/CA1335EN.pdf (Erişim tarihi: 07 Mart 2024)

66. Tüfekçi, A. ve Karahan, Ç. (2019). Blokzincir teknolojisi ve kamu kurumlarınca verilen hizmetlerde blokzincirin kullanım durumu, Verimlilik Dergisi, Yıl: 2019, Sayı: 4, T. C. Sanayi ve Teknoloji Bakanlığı Yayını, 157-193.
67. Türkmen, S., ve Ataseven, Y. (2020). Türkiye'de taklit ve tağşiş yapılan gıdalara ilişkin yasal düzenlemelerin ve uygulamaların değerlendirilmesi. Tarım Ekonomisi Araştırmaları Dergisi, *6*(1), 65-75.
68. TÜRKPATENT. (2024). Coğrafi işaret nedir? https://ci.turkpatent.gov.tr/sayfa/co%C4%9Frafi-i%C5%9Faret-nedir
69. Verny, J. and Guan, W. (2023). Perspective chapter: blockchain adoption in food supply chain. Blockchain Applications - Transforming Industries, Enhancing Security, and Addressing Ethical Considerations. https://doi.org/10.5772/intechopen.106402
70. Vurdu, S. A. (2021). Dış ticarette blokzincir uygulamaları, Sosyal, Beşeri ve İdari Bilimler Dergisi, 4(9): 924-936.
71. Vysochanska, M. (2023). Economic aspects of the balanced development of the beekeeping industry. Ukrainian Journal of Applied Economics and Technology, 8(2), 387-393. https://doi.org/10.36887/2415-8453-2023-2-56
72. Wattenhofer, R. (2017). The science of the blockchain. Inverted Forest Publishing.
73. Zgank, A. (2019). Bee swarm activity acoustic classification for an iot-based farm service. Sensors, 20(1), 21. https://doi.org/10.3390/s20010021
74. Zhang, X. H., Gu, H. W., Liu, R. J., Qing, X. D., & Nie, J. F. (2023). A comprehensive review of the current trends and recent advancements on the authenticity of honey. Food Chemistry*: X*, 100850.
75. Zheng, Z., Xie, S., Dai, H. N., Chen, X., & Wang, H. (2017). An overview of blockchain technology: Architecture, consensus, and future trends. In IEEE 6th International Congress on Big Data (pp. 557-564). IEEE.
76. Zhou, M., Long, T., Zhao, Z., CHEN, J., WU, Q., & Zou, Z. (2023). Honey quality detection based on near-infrared spectroscopy. Food Science and Technology, 43. https://doi.org/10.1590/fst.98822
77. Cuellar, D., and Johnson, Z. (2022). Barriers to implementation of blockchain technology in agricultural supply chain. arXiv preprint arXiv:2212.03302.

REKOMBİNANT DNA TEKNOLOJİSİ VE BİTKİLERDEKİ UYGULAMALARI

Hale YILDIZ (ORCID: 0009-0007-5454-0466)
Sivas Bilim ve Teknoloji Üniversitesi, Tarım Bilimleri ve Teknoloji Fakültesi, Tarım Bilimleri Anabilim Dalı, Sivas
Email: yildizzhale@gmail.com

Dr. Öğr. Üyesi Yeter ÇİLESİZ (ORCID: 0000-0002-4313-352X)
Sivas Bilim ve Teknoloji Üniversitesi, Tarım Bilimleri ve Teknoloji Fakültesi, Bitkisel Üretim ve Teknolojileri Bölümü
Email: ycilesiz@sivas.edu.tr

Prof. Dr. Tolga KARAKÖY (ORCID: 0000-0002-5428-1907)
Sivas Bilim ve Teknoloji Üniversitesi, Tarım Bilimleri ve Teknoloji Fakültesi, Bitki Koruma Bölümü
Email: tkarakoy@sivas.edu.tr

ÖZET
Kuraklık, sıcaklık veya tuzluluk gibi abiyotik stres koşulları, dünya genelinde tarımsal üretimde büyük kayıplara sebep olmaktadır. Son yıllarda küresel iklim değişikliğine bağlı olarak modern tarım, abiyotik ve biyotik stres koşulları başta olmak üzere birçok zorlukla karşı karşıyadır. Gelişen tarım teknolojileri, abiyotik stres koşulları ile mücadelede önemli bir rol oynamaktadır. Bu mücadelenin en temel noktalarından biri de rekombinant DNA teknolojisiyle, bir organizmanın genetik materyaline istenilen özellikleri kontrol eden genlerin eklenmesi veya var olan genlerin düzenlenmesiyle, bitkilerin belirli özelliklerini iyileştirmeyi ve tarımsal üretimde çeşitli avantajlar sağlamayı amaçlamasıdır. Transgenik bitki üretimi, günümüz tarımına çeşitli avantajlar sunarak tarımsal verimliliği arttırmakta, çevresel ve ekonomik zorluklarla başa çıkmaya yardımcı olabilmektedir. Ayrıca gelecekte, tarımsal sürdürülebilirlik ve verimlilik açısından önemli bir role sahip olacağı düşünülmektedir. Bu çalışmada, rekombinant DNA teknolojisinin bitki ıslahında kullanımı incelenmiş ve bitki gen transformasyonu için günümüzde kullanılmakta olan metotlar derlenmiştir.
Anahtar Kelimeler: Rekombinant DNA, ıslah, transgenik bitki

RECOMBINANT DNA TECHNOLOGY AND ITS APPLICATIONS IN PLANTS

ABSTRACT

Abiotic stress conditions such as drought, heat or salinity cause major losses in agricultural production worldwide. In recent years, due to global climate change, modern agriculture has been facing many challenges, especially abiotic and biotic stress conditions. Developing agricultural technologies play an important role in combating abiotic stress conditions. One of the fundamental points of this struggle is that recombinant DNA technology aims to improve certain characteristics of plants and provide various advantages in agricultural production by adding genes that control desired characteristics to the genetic material of an organism or by regulating existing genes. Transgenic plant production offers various advantages to today's agriculture, increasing agricultural productivity and helping to cope with environmental and economic challenges. It is also thought that it will have an important role in terms of agricultural sustainability and productivity in the future. In this study, the use of recombinant DNA technology in plant breeding was examined and the methods currently used for plant gene transformation were compiled.

Keywords: Recombinant DNA, breeding, transgenic plant

GİRİŞ

Günümüz ve gelecekte öngörülen iklim koşullarında yaşanması muhtemel sıcaklık ve kuraklık dönemleri gibi oluşabilecek iklimsel faktörler, dünya genelinde tarımsal üretimde verim ve kaliteyi etkilemekte, yıldan yıla milyarlarca dolarlık zarara neden olabilecektir. Bir organizmadan diğerine istenilen genin transferi ve ardından yabancı bir genin genomdaki stabil entegrasyonu ve ifadesi, 'Genetik Transformasyon' olarak adlandırılmaktadır. Aktarılan gen 'transgen' ve başarılı bir gen transferi sonrasında geliştirilen organizmalar 'transgenikler' olarak bilinmektedirler. Transgenik bitkiler, verim kayıplarını azaltma, daha fazla miktar ve kalitede ürün elde edebilme gibi nedenlerden dolayı artan dünya nüfusuna güvenli bir gıda kaynağı sağlama konusunda umut vaat eden bir yol sunmaktadır. Bitkilerin abiyotik stres koşullarına tolerans/dayanıklılık sağlayabilmesi için yapılan ıslah çalışmaları yüzlerce geni kapsayan karmaşık bir yapıya sahiptir (Hatipoğlu, 2016; Babaoğlu ve ark., 2000; Gao, 2021).

Bitkisel üretimde daha yüksek verim ve kaliteli ürün elde edebilmek için genetik transformasyon araştırmaları son yıllarda önem kazanmıştır. Genetik bitki transformasyonu için ilk çalışmalar yarım yüzyıl önce başlamış, ancak başarılı sonuçlar elde edilememiştir. Rekombinant DNA moleküllerinin ilk üretimi, restriksiyon enzimlerinin kullanımıyla 1970'lerin başlarında çalışılmış ve ardından 1980'lerde bazı bitki türlerine ait transgenik çeşitler (mısır, tütün, domates, pirinç, kereviz, buğday ve üzüm) elde edilmiştir. Domates, 1994 yılında Amerika Birleşik Devletleri pazarında çiftçilerin üretimine sunulmak üzere Gıda ve İlaç İdaresi (FDA) tarafından gıda tüketimi için onaylanan ilk transgenik tarım ürünü olmuştur. Günümüzde, transgenik tarım ürünleri dünya genelinde tarım arazilerinin %10'unu temsil etmekte ve birçok ülke için ana gelir kaynaklarından birini oluşturmaktadır. Değiştirilmiş özelliklere sahip transgenik bitkiler, standart ıslah yöntemleri ile elde edilen çeşitlerin yarısından fazlasıyla yer değiştirmiştir (Mittler ve Blumwald, 2010; Arvas ve Kaya, 2019).

Genetik mühendisliği şu anda gen transferi için farklı teknolojiler sunmaktadır; ancak düşük gen transfer verimliliği bazı sınırlamaları da beraberinde getirebilmektedir. Transgenik bitkilerin üretimi tarımsal verimliliği artırmayı amaçlamaktadır. Ayrıca hedefleri arasında yüksek kalitede besinsel özellikler sağlamak, herbisitlere, zararlılara, virüslere, antibiyotiklere, kuraklığa, tuzluluğa, hasat kayıplarına, ani sıcaklık

değişimlerine, UV ışığa bağlı zararlar gibi durumlara karşı dayanıklılık/tolerans sağlamaktır. (Ahmad ve ark., 2012; Bozdoğan, 2012)

Gen transferi, tarımsal açıdan önem taşıyan bitkilere, istenilen genlerin aktarılmasını sağlayarak, bitki türlerine ait yeni çeşitlerin geliştirilmesine büyük katkılar sunmaktadır. Biyoteknolojideki ilerlemeler, bitki gen transferi tekniklerindeki gelişim, moleküller genetik tekniklerindeki gelişmeler bitki ıslahına önemli pozitif katkılar sağlamıştır. Rekombinant DNA teknolojisine dayanan genetik transfer tekniklerinin ortaya çıkması, zararlılara karşı direnç sağlayan genlerin ve aynı türe ait olmayan genlerin eklenmesiyle mümkün olmuştur. Tarımsal üretimde verimliliğin sürdürülebilirliğini sağlamak ve oluşan gıda talebinin karşılanabilmesi için elde edilen ürün miktarının arttırılması gerekmektedir. Ancak, birçok bitki türünde var olan genetik potansiyelin bu artış için yeterli olmadığı bilinmektedir (Sharma ve ark., 2005; Davis, 2006). Transgenik bitkiler, gelişmiş ve gelişmekte olan ülkeler için önemli avantajlar sağlama potansiyeline sahiptir.

Bitki Gen Transformasyon Çalışmaları

Gen transformasyonu, genetik mühendisliği teknikleri kullanılarak, organizmanın genomuna istenilen genin eklenmesi, silinmesi veya değiştirilmesini ifade eder. İlk bitki genetik transformasyon çalışmaları, Coe ve Sarkar (1966) tarafından mısırda (*Zea mays*) apikal meristemde doğrudan genomik DNA kullanılarak gerçekleştirildi. *E.coli*'den izole edilen restriksiyon enzimleri ile gerçekleştirilen rekombinant DNA çalışmaları, seçilen DNA parçalarının kesilip birliştirilmesiyle gerçekleştirilmiştir. Bu sayede transgenik bitki türleri ortaya çıkmıştır. Başarılı bir gen transformasyonu için yapılması gereken birkaç önemli adım bulunmaktadır. Bu sürecin en son ancak en önemli kısmı, genotip ve doku kültürü uygulamasının uygunluğuna dayalı olarak uygun bir transformasyon yönteminin belirlenmesidir (Mubeen ve ark., 2016; Kalefetoğlu Macar ve ark., 2017).

Bitki Gen Transformasyonu Yöntemleri

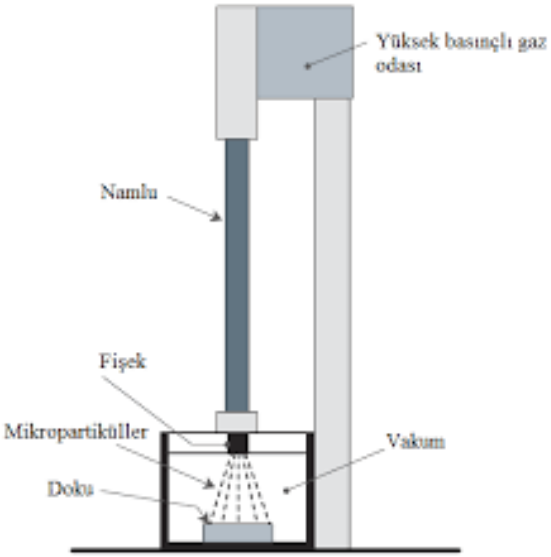
Bitki genetik transformasyon teknikleri, dolaylı ve doğrudan genetik transformasyon olmak üzere iki türe ayrılır. Dolaylı genetik transformasyon, *Agrobacterium* aracılığıyla gen transferini içeren, organizmaları vektör olarak kullanan bir yöntemdir. Diğer yandan, doğrudan genetik transformasyon, hedef genleri bitki hücrelerine iletmek için dış kuvvetlerden yararlanır; bu kuvvetler arasında öne çıkanlar; biyolistik/gen tabancası,

elektroporasyon, ultrasonikasyon ve mikroenjeksiyonla transformasyon yöntemleridir (Kaur ve Devi, 2019; Ramkumar ve ark., 2020).

Doğrudan Gen Transformasyon Yöntemleri

Biyolistik (gen tabancası) Yöntemi

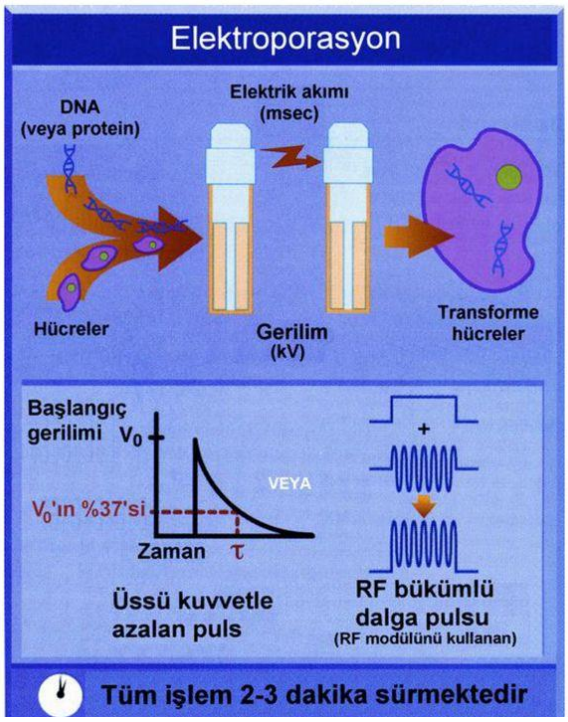
Biyolistik yöntem (aynı zamanda gen tabancası olarak da bilinir), eksojen DNA'nın bitki genomuna doğrudan aktarılmasının fiziksel bir yöntemidir. Biyolistik yöntem aracılığıyla bitki transformasyonu, alıcı materyalin kaynağıyla sınırlı değildir; hücreler, olgunlaşmamış embriyolar ve organlar, hepsi transformasyon hedefleri olarak kullanılabilir. Bu yöntemde hedef gen, altın veya tungsten tozunun yüzeyine kaplanarak bir DNA kaplı mikro taşıyıcı oluşturulur. Yüksek basınçlı helyum darbeleri, elektrik deşarjı veya basınçlı helyum gaz akışı kullanılarak DNA kaplı mikro taşıyıcıyı gaz hızlandırma tüpüne doğru hızlandırır. Bu partiküller, hedef genin dışında kaplanan hücrede kalırken, yeterli hızda alıcı hücreleri delmek için yeterli momentum kazanır ve sonunda bitkinin kromozomuna entegre olur, transgenik bitkiyi üretir. *Agrobacterium* aracılığıyla bitki genetik dönüşümünden sonra, biyolistik/gen tabancası yöntemi giderek en önemli transformasyon yöntemlerinden biri haline gelmiş ve birçok bitki türüne başarıyla uygulanmıştır. Biyolistik yöntem aracılığıyla bitki gen transformasyonu, hedef materyallerin çeşitliliği ve işlem kolaylığı ile ayırt edilir. Ancak, *Agrobacterium* aracılığıyla transformasyonla karşılaştırıldığında, daha düşük bir transfer oranı, daha yüksek maliyetler ve korumasız eksojen DNA gibi bazı dezavantajları vardır. Ayrıca, bu yöntem sadece 10 kb'den küçük DNA fragmentlerini transfer edebilir çünkü daha büyük fragmentler biyolistik yöntem sırasında kolayca kırılabilir veya metal partiküllere zayıf bağlanabilir, bu da istenmeyen DNA entegrasyon olaylarına yol açabilir. Biyolistik/gen tabancası yöntemi, pirinç ve soya fasulyesinde başarıyla gerçekleştirilmiştir (Bhat ve Srinivasan, 2002; Liu ve ark., 2013; Kalefetoğlu Macar ve ark., 2017)



Şekil 1: Biyolistik (gen tabancası) (Kalefetoğlu Macar ve ark., 2017)

Elektroporasyon Yöntemi

Elektroporasyon, gen transferi için sıklıkla kullanılan popüler, basit ve hızlı bir yöntemdir. Özellikle prokaryot ve ökaryot organizmalarda etkili bir şekilde uygulanabilir. Elektroporasyon, hücre zarının geçirgenliğini artırmak için elektrik alanının kullanıldığı bir tekniktir. Bu yöntemde, hedef hücreler, genetik materyali içeren bir çözeltiyle karıştırılır ve ardından bir elektrik alanına maruz bırakılır. Elektrik alanının etkisiyle hücre zarında geçici bir delinme meydana gelir, bu da genetik materyalin hücre içine girmesine izin verir. Elektroporasyon, gen transferi için birçok avantaj sunar. Bu yöntem, diğer gen transfer tekniklerine göre daha yüksek verimlilikle çalışabilir ve birçok farklı hücre türü üzerinde uygulanabilir. Bununla birlikte, elektroporasyonun optimizasyonu, hücre hasarı ve toksisite gibi bazı zorlukları içermektedir, bu da dikkatli bir şekilde kontrol edilmesi gereken parametreleri içerir. Bu yöntem, genetik mühendisliği uygulamalarında gen transferi için etkili bir araç olarak kullanılmaya devam etmektedir (Keshavareddy ve ark., 2018; Ramkumar ve ark., 2020).



Şekil 2: Gen transformasyonunda elektroporasyon yöntemi (Khawar ve Özcan, 2002).

Mikroenjeksiyon Yöntemi

Mikroenjeksiyon yönteminde, genetik materyal içeren bir çözelti ince bir iğne veya pipetle hazırlanır. Bu iğne veya pipet, hedef hücrenin zarına doğrudan nüfuz etmek üzere ayarlanır ve genetik materyal, enjeksiyon yöntemiyle hücre içine bırakılır. Bu işlem gen transferini doğrudan ve hassas bir şekilde gerçekleştirmeyi sağlar. Mikroenjeksiyon, gen transferi için hassas bir yöntem olup, özellikle embriyonik hücrelerin veya hayvan modellerinin genetik modifikasyonunda yaygın olarak kullanılır. Ancak, bu yöntem, mikrocerrahi beceri gerektirir ve genellikle düşük verimliliğe sahiptir, bu nedenle özellikle hücre kültürü çalışmalarında veya küçük organizmalarda kullanılmaktadır.

Vakum İnfiltrasyonu Yöntemi

Vakum infiltrasyonu yöntemi, özellikle bitkilerde genetik mühendislik çalışmalarında kullanılan bir gen transfer teknolojisidir. *Agrobacterium* aracılığıyla bitki gen transformasyonunu kolaylaştırmak için kullanılan yöntemlerden biridir. Bu yöntem, genetik materyalin hedef bitki dokularına etkili bir şekilde taşınmasını sağlayarak genetik modifikasyon amaçlarına hizmet etmektedir. Vakum infiltrasyonu yönteminde, genetik materyal içeren bir çözelti veya süspansiyon, hedef bitki dokularının boşluklarına nüfuz

etmesi için bir vakum altında uygulanır. Bu işlem, genetik materyalin bitki hücrelerine geçişini kolaylaştırır ve genetik modifikasyonun etkili bir şekilde gerçekleşmesini sağlar. Vakum infiltrasyonu yöntemi, bitkilerde gen transferini sağlamak için özellikle kullanışlıdır, çünkü genetik materyalin bitki dokularına daha etkili bir şekilde taşınmasına imkân tanır. Bu yöntem, özellikle tarımsal uygulamalarda bitkilerin özelliklerini geliştirmek amacıyla genetik modifikasyon yapmak isteyen araştırmacılar tarafından tercih edilmektedir. İlk olarak 1993 yılında *Arabidopsis*'in transformasyonu için rapor edilmiştir. O zamandan beri protokollerin oluşturulması ve yenilenmesi için birçok çalışmaya devam edilmektedir.

Ultrasonikasyon Yöntemi

Ultrasonikasyon yöntemi, yine *Agrobacterium* aracılığıyla gen transformasyonunu kolaylaştırmak için geliştirilen bir yöntemdir. Genetik materyalin hedef hücrelere transferini gerçekleştirmek üzere kullanılan bir tekniktir ve genellikle mikroorganizmalar, hücre kültürleri veya doku örnekleri üzerinde uygulanır. Ultrasonikasyon yönteminde, genetik materyali taşıyan bir çözelti veya süspansiyon, ultrasonik dalgalar yardımıyla hedef hücrelere yönlendirilir. Bu dalgalar, genetik materyalin hücre zarından geçişini kolaylaştırarak gen transferini sağlar. Bu yöntem, genetik materyalin hücre içine girmesini kolaylaştıran mekanik stres ve şok dalgalarını kullanır. Ultrasonikasyon yöntemi, gen transferi için non-invaziv bir yaklaşım sağlar ve özellikle mikroorganizmalar veya hücre kültürleri gibi daha küçük ölçekli sistemlerde etkilidir. Ancak, bu yöntemin optimize edilmesi ve genetik materyalin hücre içine geçişi için uygun koşulların belirlenmesi gereklidir. Ultrasonikosyon, gen transferi alanında geniş bir uygulama potansiyeli sunan, güvenli ve etkili bir teknik olarak değerlendirilmektedir.

Lazer Mikroışınlar Yöntemi

Lazer mikroışınlar yönteminde, genetik materyal içeren bir çözelti, odaklanabilir bir lazer ışını ile hedef hücrelerin zarına yönlendirilir. Bu işlem, genetik materyalin hücre zarını geçişini sağlar ve gen transferini gerçekleştirir. Lazer mikroışınlar, gen transferini belirli hücre bölgelerine odaklanarak hassas bir şekilde gerçekleştirmeyi amaçlar. Lazer mikroışınlar yöntemi, gen transferini hassas bir şekilde kontrol etmek ve belirli hücre

bölgelerine odaklanmak isteyen araştırmacılar için kullanışlı bir tekniktir. Bu yöntem, özellikle hücre seviyesinde spesifik genetik modifikasyonlar yapmak isteyen çalışmalarda etkili olabilir.

Silikon Karbid Fiberler Aracılığıyla Transformasyon Yöntemi

Silikon karbid fiberler aracılığıyla transformasyon yönteminde, genetik materyal, genellikle plazmid DNA veya başka bir genetik materyal formu, silikon karbid fiberlerin yüzeyine adsorbe edilir. Ardından, bu genetik materyal içeren fiberler, hedef bitki dokularına uygulanır. Silikon karbid fiberlerin hedef hücre zarına nüfuz etmesiyle birlikte genetik materyal hücre içine taşınır.

Silikon karbid fiberler aracılığıyla transformasyon yöntemi, özellikle bitkilerde genetik mühendislik çalışmalarında tercih edilen bir tekniktir. Bu yöntemin avantajları arasında gen transferinin belirli bitki dokularına odaklanabilmesi, genetik modifikasyonların hedeflenen bölgelerde gerçekleştirilebilmesi ve uygulamanın genellikle düşük maliyetli olması bulunabilir. Ancak, bu yöntemin optimize edilmesi ve gen transferi verimliliğinin artırılması için dikkatlice ayarlanması gerekmektedir.

Cam Boncuklarla Çalkalama Yöntemi

Bu yöntemde genetik materyal içeren bir çözelti, mikroskobik cam boncuklar kullanılarak hedef bakteri hücrelerine uygulanır. Bu cam boncuklar genetik materyali hedef hücrelerin içine alacak şekilde çalkalanır veya karıştırılır. Bu işlem, genetik materyalin bakteri hücre zarını geçmesini ve hücre içine taşınmasını sağlar. Cam boncuklarla çalkalama yöntemi, genetik materyalin bakteri hücrelerine etkili bir şekilde taşınmasını sağlayan bir basit ve ekonomik bir tekniktir.

Elektroforez Yöntemi

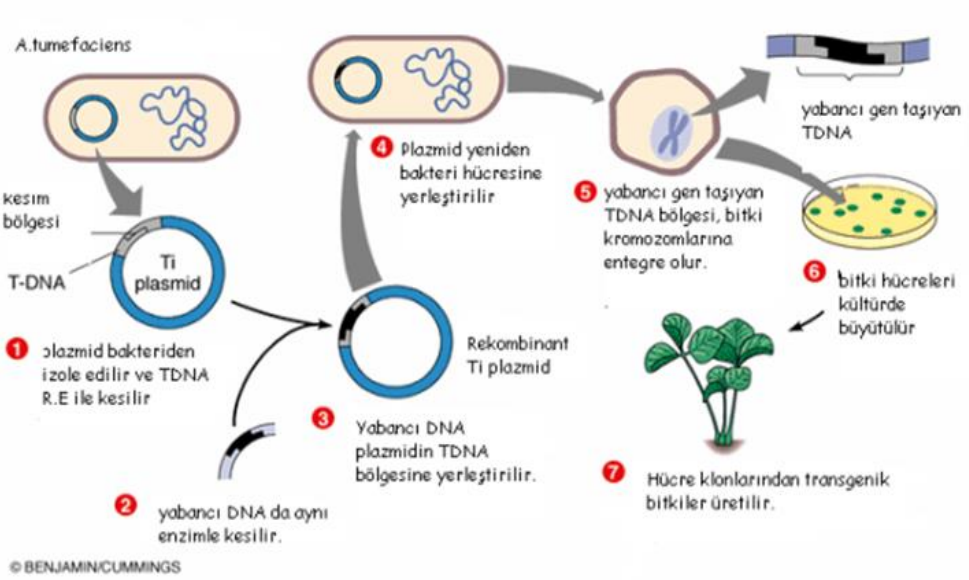
Elektroforez, genetik materyalin ayrılması ve analiz edilmesi amacıyla kullanılan biyokimyasal bir yöntemdir. Bu teknik, DNA, RNA veya proteinler gibi yüklü molekülleri bir elektrik alanında hareket ettirerek onları ayırmak için elektrik yüküne dayanır. Elektroforez yöntemi, genetik materyalin farklı boyutlardaki fragmanlarını ayrıştırmak için bir jel matris kullanır. Bu jel, elektroforez sırasında uygulanan elektrik alanında moleküllerin göç etmesine izin verir. Moleküller, elektrik alanına dik olarak

yerleştirilmiş bir matris içinde hareket ederken, küçük moleküller daha hızlı göçerken büyük moleküller daha yavaş hareket eder. Elektroforez yöntemi genellikle bir agaroz veya poliakrilamid jel içinde gerçekleştirilir. Bu jeller, farklı molekül büyüklüklerine göre seçicilik sağlar. Elektroforez sırasında, genetik materyal bir örneğin uygulandığı kuyucuklardan bir elektrik akımı aracılığıyla jel boyunca hareket eder. Jel içindeki poroz yapısı, moleküllerin boyutlarına göre ayrışmasına izin vermektedir (Paoletti ve Pimentel, 1996; Tzfira ve Citovsky, 2006; Rivera ve ark., 2012; Mubeen ve ark., 2016; Gosal ve Wani, 2018; Su ve ark., 2023;)

Dolaylı Gen Transformasyon Yöntemleri

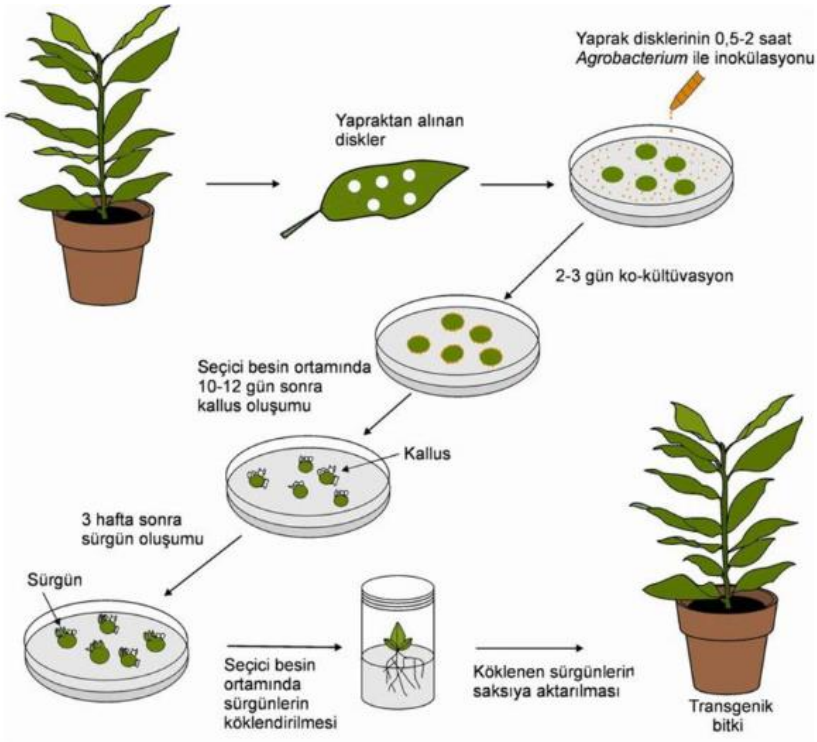
***Agrobacterium* Aracılığıyla Transformasyon**

Agrobacterium tumefaciens, toprakta doğal olarak yaşayan, gram negatif, spor oluşturmayan, hareketli, çubuk şekilli (basil) bir bakteri olup yaralanmış dokulardan organizmaya girerek tümör benzeri dokular oluşturmaktadır. Bu bakteri meyve ağaçları, asma, otsu ve odunsu süs bitkileri ve sebzelerin dahil olduğu bir çok dikotiledon bitkide taç tümörlerine neden olmaktadır. *Agrobacterium tumefaciens*'in taç tümör oluşturmasının nedeni sahip olduğu tümör indüksiyon plazmidinin (Ti plazmidi) T-DNA bölgesini bitki genomuna entegre etmesidir. Ti plazmidi dairesel bir DNA molekülüdür. Ti plazmidi; Vir, Ori, Opin, T-DNA adı verilen farklı bölgelerden meydana gelmektedir. T-DNA aktarımı için gerekli olan bölge Vir bölgesidir. Ori bölgesi, replikasyonun başladığı nokta olarak bilinir. Opin bölgesi ise bakteri tarafından karbon ve azot kaynağı olarak kullanılan opinlerin (octopin ve nopalinin) parçalanmasından sorumlu gen bölgesi olarak tanımlanır. Tümör oluşumu, opin sentezi ve farklılaşmanın engellenmesi olaylarından sorumlu olan 24 bp'lık sağ ve sol sonlanma bölgeleriyle sınırlandırılmış DNA'nın yer aldığı bölge T-DNA bölgesi olarak adlandırılmıştır (Khawar ve Özcan, 2002).



Şekil 3: *Agrobacterium tumefaciens* ile gen transformasyonu

Diğer biyolojik olmayan bitki gen transformasyonu yöntemlerinin geliştirilmesine rağmen, *Agrobacterium* aracılı transformasyon, popülerliğini koruyup, en etkili yöntemlerden biri olmaya devam etmiştir. *Agrobacterium* aracılı gen transferinin monokotiledon bitkilere uygulanamayacağı düşünülüyordu. Ancak, pirinç, muz, mısır, buğday, şeker kamışı gibi bitkiler için tekrarlanabilir ve etkili metodolojiler geliştirilmiştir; aynı zamanda İtalyan çimi (*Lolium multiflorum*) ve uzun saplı çim (*Festuca arundinacea*) gibi yem otu türleri için başarıyla uygulanmıştır. Ticari olarak önemli karaçam türleri arasında, hibrit meşe, embriyonik doku ile *A. tumefaciens*'in birlikte kültüre alınmasıyla kalıcı olarak gen transformasyonuna uğrayan ilk tür olmuştur. Daha sonra, bu yöntem, ladin türlerinin birkaçına başarıyla uygulanmıştır (Khawar ve Özcan, 2002; Gelvin, 2003; Rivera ve ark., 2012; Kaur ve Devi, 2019; Brown ve ark., 2023).



Şekil 4: *Agrobacterium* ile gen aktarımı (Khawar ve Özcan, 2002)

Agrobacterium aracılığıyla yapılan gen transformasyonu, bitki biyoteknolojisi alanında önemli bir araç olup, tarım endüstrisinde bitki yetiştiriciliği ve ürün geliştirme çalışmalarında geniş bir kullanım alanına sahiptir.

SONUÇ

Gen transformasyonu, bitkilerde doğal yollarla gerçekleşmeyen ve geleneksel yöntemlerle elde edilemeyen birçok önemli özelliğin kazanılmasında gen teknolojisinin bugünkü en kritik uygulama alanlarından biridir. Yirmi yıldan fazla bir süredir, farklı hücre tipleri ve bitki türleri için çeşitli transformasyon yöntemleri doğrudan ve dolaylı olarak geliştirilmiştir. Ancak, tüm bu yöntemlerin her bitki için uygun olmaması, hücrelerin canlılığında azalmaya neden olması ve düşük verimlilikle birlikte rejenerasyon zorlukları gibi sorunlar, araştırmacıları sürekli olarak yeni yöntemler aramaya ve optimizasyon çalışmalarına yönlendirmiştir. Rekombinant DNA teknolojisinin ilerlemesiyle, hedeflenen gen bölgelerinin değiştirilerek, bitkisel üretimde ürünlerin verim ve kapasitelerinin artışının sağlanması, yakın gelecekte, dünya gıda ihtiyacının sağlanması için umut vaat eden bir süreci işaret etmektedir.

KAYNAKÇA

Ahmad, P., Ashraf, M., Younis, M., Hu, X., Kumar, A., Akram, N. A., Al-Qurainy, F. (2012). Role of transgenic plants in agriculture and biopharming. *Biotechnology Advances, 30*(3), 524–540.

Arvas, Y. E., Kaya, Y. (2019). Genetiği Değiştirilmiş Bitkilerin Biyolojik Çeşitliliğe Potansiyel Etkileri. Yuzuncu Yıl University Journal of Agricultural Sciences, 29(1), 168-177.

Babaoglu, M., Davey, M. R., Power, J. B. (2000). Genetic engineering of grain legumes: key transformation events. *AgBiotechNet, 2*(ABN 050).

Bhat, S. R., Srinivasan, S. (2002). Molecular and genetic analyses of transgenic plants: *Plant Science*, *163*(4), 673–681.

Bozdoğan, E. (2012). Genetiği Değiştirilmiş Organizmalar ve Olası Riskler. Çukurova Üniversitesi Ziraat Fakültesi Dergisi, 27(1), 13-20.

Brown, P. J., Chang, J. H., Fuqua, C. (2023). Agrobacterium tumefaciens: A transformative agent for fundamental insights into host-microbe interactions, genome biology, chemical signaling, and Cell Biology. *Journal of Bacteriology*, *205*(4).

Davis, L. C. (2006). Genetic engineering, ecosystem change, and agriculture: an update. *Biotechnology and Molecular Biology Review*, *1*(3), 87-102.

Gao, C. (2021). Genome engineering for crop improvement and future agriculture. *Cell*, *184*(6), 1621–1635.

Gelvin, S. B. (2003). *Agrobacterium* -mediated plant transformation: The biology behind the "gene-jockeying" tool. *Microbiology and Molecular Biology Reviews, 67*(1), 16–37.

Gosal, S. S., Wani, S. H. (2018). Plant genetic transformation and transgenic crops: Methods and applications. *Biotechnologies of Crop Improvement, Volume 2*, 1–23.

Hatipoğlu, R. (2016). Transgenik Bitkilerin Dünü, Bugünü ve Geleceği. Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi, 25(Özel Sayı-2), 346-356.

Heyn, R. F., Rörsch, A., Schilperoort, R. A. (1974). Prospects in genetic engineering of plants. *Quarterly Reviews of Biophysics*, *7*(1), 35–73.

Kalefetoğlu Macar, T., Macar, O., Yalçın, E., Çavuşoğlu, K. (2017). Gene technology and plant genetic transformation methods. *Afyon Kocatepe University Journal of Sciences and Engineering*, *17*(2), 377–392.

Kaur, R. P., Devi, S. (2019). In Planta transformation in plants: A Review. *Agricultural Reviews*, *40*(03).

Keshavareddy, G., Kumar, A. R. V., S. Ramu, V. (2018). Methods of plant transformation- A Review. *International Journal of Current Microbiology and Applied Sciences*, *7*(07), 2656–2668.

Khawar, K., Özcan, S. (2002). In vitro induction of crown galls by Agrobacterium tumefaciens super virulent strain A281 (pTiBo 542) in lentil (Lens culinaris Medik.). *Turkish Journal of Botany*, *26*(3), 165-170.

Liu, W., Yuan, J. S., Stewart Jr, C. N. (2013). Advanced Genetic Tools for Plant Biotechnology. *Nature Reviews Genetics*, *14*(11), 781–793.

Mittler, R., Blumwald, E. (2010). Genetic engineering for modern agriculture: Challenges and perspectives. *Annual Review of Plant Biology*, *61*(1), 443–462.

Mubeen, H., Naqvi, R. Z., Masood, A., Shoaib, M. W., Raza, S. (2016). Gene transformation: methods, uses and applications. *Journal of Pharmaceutical and Biological Sciences*, *4*(2), 54.

Paoletti, M. G., Pimentel, D. (1996). Genetic engineering in agriculture and the environment. *BioScience*, *46*(9), 665–673.

Ramkumar, T. R., Lenka, S. K., Arya, S. S., Bansal, K. C. (2020). A short history and perspectives on Plant Genetic Transformation. *Methods in Molecular Biology*, 39–68.

Rivera, A. L., Gómez-Lim, M., Fernández, F., & Loske, A. M. (2012). Physical methods for genetic plant transformation. *Physics of Life Reviews*, *9*(3), 308–345.

Sharma, K. K., Bhatnagar-Mathur, P., Thorpe, T. A. (2005). Genetic Transformation Technology: Status and Problems. *In Vitro Cellular; Developmental Biology - Plant*, *41*(2), 102–112.

Su, W., Xu, M., Radani, Y., Yang, L. (2023). Technological Development and application of plant genetic transformation. *International Journal of Molecular Sciences*, *24*(13), 10646.

Tzfira, T., Citovsky, V. (2006). Agrobacterium-mediated genetic transformation of plants: Biology and biotechnology. *Current Opinion in Biotechnology*, *17*(2), 147–154.

Evrak Tarih ve Sayısı: 08.01.2024-96750

T.C.
SİİRT ÜNİVERSİTESİ
Veteriner Fakültesi Dekanlığı

Sayı : E-44401325-903.07-96750
Konu : Kongre Başkanı Görevlendirmesi (Doç. Dr. H. Turan AKKOYUN)

REKTÖRLÜK MAKAMINA

Üniversitemiz, Ege Üniversitesi ve İktisadi Kalkınma ve Sosyal Araştırmalar Enstitüsü iş birliği ile 9-10 Mart 2024 tarihleri arasında Adana'da düzenlenecek olan 7. Uluslararası Çukurova Tarım ve Veteriner Bilimleri Kongresi'ne Fakültemiz personellerinden Doç. Dr. H.Turan AKKOYUN Kongredeki iş ve işlemleri yürütebilmek amacıyla Kongre Başkanı olarak görevlendirme talebinde bulunmuştur. Bahsi geçen personelimizin kongre başkanlık görevini yürütmesi Dekanlığımız tarafından uygun görülmüş olup; Makamınızca da uygun görülmesi hususunu;

Olurlarınıza arz ederiz.

Prof. Dr. Mürsel KÜÇÜK
Dekan

OLUR
__.__.____
Prof. Dr. Nihat ŞINDAK
Rektör

Ek:Görevlendirme Oluru Talebi

Bu belge, güvenli elektronik imza ile imzalanmıştır.

Belge Doğrulama Kodu :BSPB384BJC Pin Kodu :98252 Belge Takip Adresi : https://turkiye.gov.tr/ebd?eK=5481&eD=BSPB384BJC&eS=96750

Adres:Batman Yolu 10.km Merkez, 56100 Siirt/Türkiye
Telefon:0 484 212 11 11 Faks:0 484 223 19 98
e-Posta:veteriner@siirt.edu.tr Elektronik ağ:siirt.edu.tr/akademik/veteriner
Kep Adresi:siu@hs01.kep.tr

Bilgi için: Cengiz KURTAK
Unvanı: Yazı İşleri Sorumlusu
Tel No: 0484 212 1111-3238

Bu belge, güvenli elektronik imza ile imzalanmıştır

Ege Ünv. Evrak Tarih ve Sayısı: 05.01.2024-1645695

T.C.
EGE ÜNİVERSİTESİ REKTÖRLÜĞÜ
Ziraat Fakültesi Dekanlığı
Basın ve Halkla İlişkiler Birimi

Sayı : E-60373694-051-1645695 05.01.2024
Konu : 7. Uluslararası Çukurova Tarım ve Veteriner Bilimleri Kongresi ve Küresel Uygulamaları Kongresi

İKTİSADİ KALKINMA VE SOSYAL ARAŞTIRMALAR ENSTİTÜSÜ

Siirt Üniversitesi ve İKSAD Enstitüsü işbirliğinde 9-10 Mart Aralık 2023 Adana'da düzenlenecek olan "7. Uluslararası Çukurova Tarım ve Veteriner Bilimleri Kongresi ve Küresel Uygulamaları Kongresi"ne Ege Üniversitesi Ziraat Fakültesi'nin katılımcı kurum olarak bilimsel destek sunmasını istemekteyiz. Kongre düzenleme kurulunda Dekan Yardımcımız Prof. Dr. Özer Hakan BAYRAKTAR ile Kurumsal İletişim ve Uluslararası İlişkiler Koordinatörümüz Doç. Dr. Fulsen ÖZEN görevlendirilmiştir.

Bilgi edinilmesi ve gereği arz/rica olunur.

Prof. Dr. Banu YÜCEL
Rektör Yardımcısı

Bu belge, güvenli elektronik imza ile imzalanmıştır.

Adres:Ege Üniversitesi Ziraat Fakültesi 35100 Bornova/İzmir
Telefon:+90 (232) 311 26 01 Faks:+90 (232) 388 18 64
e-Posta:ziraatdekanlik@mail.ege.edu.tr Web:http://agr.ege.edu.tr/
Kep Adresi:egeuniversitesi@egeuniversitesi.hs03.kep.tr

Bilgi için: Sema SEZER
Unvanı: Şef V.
Tel No: 0232 311 29 51

Bu belge,güvenli elektronik imza ile imzanlamıştır.