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7th SYMPOSIUM ON EUROASIAN BIODIVERSITY

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About the Symposium

The 7th EuroAsian Biodiversity Symposium (SEAB-2024) was successfully held in Erzurum from August 22 to 24, 2024. Scientists from 27 different countries participated, with a total of 116 Oral Presentations and 22 Poster Presentations. The symposium was awarded support under the TÜBİTAK 2223-C Multi-Participant International Event Organization Grant. SEAB 2024, a continuation of previous symposiums held in cities such as Baku, Kyiv, Minsk, and Antalya, brought together researchers from Eurasia and around the world with the aim of finding solutions to global environmental challenges. This scientific platform, which fosters interdisciplinary collaborations, provided an important opportunity for the sharing of the latest scientific developments and the establishment of new research partnerships. Organized by our scientific committee and organizational team to the highest academic standards, we believe that the presented works will make valuable contributions to the scientific literature. Although the official language of the symposium was English, presentations were made in Turkish, Azerbaijani, English, and Russian.

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- Ministry of Science and Education of Azerbaijan, Baku Dendrology Institute, Madrakan, Baku, Azerbaijan
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- Erzurum Technical University, Faculty of Science, Department of Molecular Biology and Genetics, Erzurum, Türkiye
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Symposium Topics

Animal Biodiversity
Integration of Artificial Intelligence and Biodiversity Research
Biochemical Diversity of Life
Biodiversity Conservation Strategies and Practices
Innovative Approaches in Biodiversity Awareness and Education
Biodiversity and Food Diversity
Biogeography and Biodiversity
Biological Invasions and Biodiversity
Bioinformatics
Biotechnology
Bioremediation
Technological Applications of Biodiversity
Eco-Tourism
Environmental Toxicology and Biodiversity
Forest Ecosystem and Biodiversity
Genetically Modified Organisms and Biodiversity
Genetic Resources and Biodiversity

Effects of Global Diseases on Biodiversity
Impacts of Green Energy Technologies on Biodiversity
Effects of Climate Change on Biodiversity
Marine and Freshwater Biodiversity
Microbial Biodiversity
Plant Biodiversity
Post-Genomic Technologies and Biodiversity
Renewable and Sustainable Biodiversity
Soil Biodiversity
Urban Biodiversity
Wildlife Biodiversity
Biodiversity and Public Health
Microbial Biodiversity in Health
Biodiversity and Infectious Diseases
Biodiversity and Pandemic
Biodiversity and Drug Discovery



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A horizontal band of silhouettes in shades of blue and teal. It features various animals including camels, giraffes, and elephants, interspersed with different types of trees. The background behind the silhouettes is a light blue gradient with faint, overlapping lines.

INVITED SPEAKERS' ABSTRACTS OR TEXTS



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Invited Speakers

Prof. Dr. Ökkeş ATICI

Atatürk University

Türkiye

WOS h-index: 19

Title of speech:

“Renewable and Sustainable Biodiversity”

Prof. Dr. Metin TURAN

Yeditepe University

Türkiye

WOS h-index: 38

Title of speech:

“Biodiversity and Traceability in Agricultural Production”

Ass. Prof. Dr. Paulraj Mosae SELVAKUMAR

Asian University for Women

Bangladesh

WOS h-index: 20

Title of speech:

“The Mighty Palmyrah and Green Bangle Bangle Movement: Empowering Women, Preserving Biodiversity in Bangladesh and Asia”

Asst. Prof. Dr. K.J. Senthil KUMAR

National Chung Hsing University

Taiwan

Scopus h-index: 25

Title of speech:

“Essential Oils from Taiwan’s Indigenous Forest Species: Health Benefits, Industrial Applications, and a Sustainable Future”



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Prof. Dr. Ökkeş ATICI
Atatürk University, Türkiye

Renewable and Sustainable Biodiversity

Ökkeş ATICI

Department of Biology, Faculty of Science, Atatürk University, 25240, Erzurum, Türkiye

ABSTRACT

Allelopathy is an ecological phenomenon in which plants influence the growth, survival, and reproduction of surrounding organisms through chemical interactions that can be either beneficial or detrimental. This process plays a critical role in shaping plant interactions and ecosystem dynamics, thereby contributing to the sustainability and regeneration of biodiversity. In this study, we evaluate the complex chemical nature of allelochemicals, their mechanisms of release, and their multiple effects on plant communities and biodiversity. While allelopathic interactions can reduce local species diversity, they can also enhance ecosystem diversity by creating diverse habitats and modulating species competition. This selective process is essential for maintaining ecological balance, facilitating species coexistence, and enhancing ecosystem resilience to environmental stressors. The study highlights the dual role of allelopathy in both suppressing dominant species and promoting the coexistence of diverse species, thereby contributing to ecosystem stability. It also highlights the potential of allelopathy in agricultural and conservation practices. By incorporating allelopathic principles into sustainable agriculture, reliance on synthetic herbicides and pesticides can be reduced, resulting in minimized environmental impact and enhanced biodiversity. Furthermore, the strategic use of allelopathy in ecological restoration is highlighted, suggesting that the selective use of species with strong allelopathic properties can significantly improve the success of ecosystem restoration efforts. The ability of allelopathy to regulate interspecific competition and prevent the dominance of invasive species is crucial for maintaining the stability and diversity of plant communities. This study suggests further research and innovation in understanding the complexity of allelopathic interactions and their potential applications in biodiversity conservation strategies, highlighting the importance of these processes in combating biodiversity loss and supporting ecological balance.

Keywords: Allelopathy, Allelochemical, Biodiversity, Agricultural, Conservation



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Prof. Dr. Metin TURAN
Yeditepe University, Türkiye

Biodiversity And Traceability in Agricultural Production

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ABSTRACT

Biodiversity is the term used to describe the variety of life at all levels, from genes to species and ecosystems. The continued presence of biodiversity is fundamental for ecosystems to be in a position to provide the many services upon which humanity depends. In agricultural areas around the world, 40 hectares of land is degraded every minute. Degraded soils lose their productivity and become areas with low production capacity and high costs. It serves to increase the physical, chemical and biological properties of soils by managing regenerative, agricultural model, organic agriculture, sustainable agriculture, zero ploughing, intercropping system, rotation, cover crop, biological control and biodynamic models together and in combination. Regenerative agriculture is a farming approach that focuses on regenerating the natural resources of the soil, biodiversity, and ecosystem services. It prioritizes soil health, biodiversity, and ecosystem services over crop yields and profitability. Regenerative agriculture aims to: Promote soil health through practices like no-till or reduced-till farming, cover cropping, and incorporating organic amendments. Enhance biodiversity by maintaining diverse crop rotations, planting cover crops, and incorporating beneficial insects. Build resilience in ecosystems by reducing tillage, using cover crops, and incorporating organic matter.

Soil biodiversity is essential for maintaining healthy ecosystems and agricultural productivity. Soil organisms like microorganisms, fungi, and insects play a critical role in decomposing organic matter, fixing nitrogen, and suppressing plant diseases. Soil biodiversity is influenced by factors like: Soil structure and texture, Organic matter content, Water availability, Temperature, Crop rotation and diversity, Traceability in agricultural production refers to the ability to track the origin, movement, and handling of agricultural products throughout the supply chain. This is important for ensuring food safety, authenticity, and sustainability. Traceability can be achieved through: Blockchain technology: a digital ledger that records transactions and movements of products. Supply chain mapping: identifying and documenting the flow of products from farm to table. Certification schemes: third-party certifications that verify compliance with sustainability standards. Electronic data exchange: sharing information electronically between stakeholders in the supply chain.



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Benefits of Regenerative Agriculture, Soil Biodiversity, and Traceability: Improved soil health: Regenerative agriculture practices can increase soil carbon sequestration, reduce erosion, and enhance water holding capacity. Increased biodiversity: By promoting diverse crop rotations and incorporating cover crops, regenerative agriculture can increase biodiversity. Enhanced ecosystem services: Regenerative agriculture can promote ecosystem services like pollination, pest control, and climate regulation. Improved food safety: Traceability ensures that products are safely handled and transported throughout the supply chain. Increased transparency: Traceability provides consumers with information about the origin, quality, and sustainability of their food. Reduced environmental impact: Regenerative agriculture practices can reduce greenhouse gas emissions, conserve water, and promote sustainable land use.

Challenges and Opportunities:

Scaling up regenerative agriculture practices: Large-scale adoption requires policy support, education, and infrastructure development. Integrating traceability systems: Implementing effective traceability systems requires collaboration between stakeholders in the supply chain. Balancing economic and environmental goals: Regenerative agriculture practices may require adjustments to farm management strategies to balance economic and environmental goals. Building consumer trust: Providing transparent information about agricultural practices and products is essential for building consumer trust. In conclusion, regenerative agriculture, soil biodiversity, and traceability are interconnected components of sustainable agricultural production. By promoting these practices, we can ensure food security, improve environmental sustainability, and enhance social responsibility in the agricultural sector.



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Ass. Prof. Dr. Paulraj Mosae SELVAKUMAR
Asian University for Women, Bangladesh

Palmyraculture and Green Bangle Movement: Empowering Women, Preserving Biodiversity in Bangladesh and Asia

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ABSTRACT

The Asian Palmyrah palm (*Borassus flabellifer*), often called the “Tree of Life,” is a keystone species in South Asian ecosystems, playing a vital role in sustaining rural livelihoods. Through Palmyraculture—the cultivation and utilization of the palm—this tree supports millions by providing food, fibers, and eco-friendly handicrafts. Its vast utility, from leaves to roots and fruits to seeds, positions it as a cornerstone of the green economy and environment, transforming waste into wealth and promoting sustainable development. Bangladesh faces significant threats from rising sea levels, deforestation, climate change, and socio-economic pressures. In response to these challenges, the Green Bangle Movement (GBM) has emerged as a transformative grassroots initiative in Bangladesh, rooted in the principles of the Chipko and Green Belt Movements. The GBM empowers women to revitalize mangroves and palm cultivation, focusing on conservation and sustainable utilization to support their livelihoods. The movement has made notable strides in enhancing biodiversity and empowering women. By engaging local women in environmental activities, the GBM provides training in sustainable agriculture, nursery management, plantation practices, and creative craftwork. These efforts align with the United Nations Sustainable Development Goals, fostering economic independence and revitalizing traditional knowledge. In this study, the impact of the Palmyraculture and Green Bangle Movement through the activities and impact assessments, demonstrating its contribution to a more equitable and environmentally resilient future for Bangladesh and the wider Asian region are explored. By integrating modern conservation practices with cultural heritage, the movement showcases the potential of plantation and utilization of palm and mangrove initiatives in driving sustainable development and biodiversity preservation.



Keywords: Asian palm, biodiversity, women's empowerment, Green Bangle Movement, South Asian ecosystems, Palmyraculture

INTRODUCTION

The Asian Palmyra palm (*Borassus flabellifer*), a gigantic fan-shaped tree largely spread in South Asia over Tamilnadu and Kerala of India, Northern Srilanka, Bangladesh, Myanmar, Thailand, Vietnam and Cambodia, is an important species that vastly contributes to biodiversity and ecosystem. From ancient times, it has been widely discussed and praised in Tamil classical Sangam literature and Tala Vilasam recorded 801 uses of Palmyra palm. Much literary evidence reveals that tribal communities in Orissa, Tamilnadu, Chhattisgarh, Maharashtra, Rajasthan, Andhra Pradesh, West Bengal and Kerala used Palmyra as a medicine for various disease ailments such as snake bites, skin infection, Diarrhoea, Syphilis, Jaundice and earache either by itself or in combination with other medicinal plants (Gunaga et al., 2016). It has been traced as a raw material for olden manuscripts, papers and writing materials. Presently, it can be extensively manoeuvred in many forms such as mesocarp pulp, immature endosperm, tuberous seedlings, sap, palm heart, toddy, arrack and fibers (Davis & Johnson, 1987, p. xx). In India, the evidence of the use of *Borassus* sugar by the Greek Emperor Megasthenes in the court of Chandragupta in the 4th Century BC has been recorded in history (Ferguson William, 1888). Considering its many economic benefits, Mahatma Gandhi termed the Palmyra to be the tree of the poor and the remedy against poverty (Rangaswami, 2016).



Figure 1. Female and male Palmyra tree

Palmyraculture and Its Applications

Palmyraculture (in Tamil: Panaiyaanmai) is the cultivation and utilization of the Palmyra for a self-reliant lifestyle. 'Palmyraculture' promotes Sustainable Development through three main pillars: Environment, Economic, and Social. In terms of Environmental Sustainability, Palmyra acts as the main breeding and nesting site for various epiphytes, reptiles, birds and plants, and a natural rainwater harvesting system to store water and turn an arid region into a fertile one (Thevamirtha et al., 2021, p. xx). Recent research on Tamarind, Pineapple, Cashew, Portia and Neem plantations with young Palmyra plants showed that the plants near the Palmyra did not require watering in intervals since it was the major provider of water and nutrients. Similarly, its leaves provided shade for plants around its vicinity. Due to its immense ability to nurture plants and animals, it is often mentioned as a 'keystone species' and the great utility from the wide variety of commercial uses of edible parts such as jaggery, sap, toffee, wine, sugar and non-edible products such as mats, baskets, coir, toys, infrastructures made out of its leaves, trunk, tuber coat makes it a 'multi-purpose tree'. In addition to this,



Palmyra toddy, a nutritious drink, has recently gained special attention due to its ban in Tamil Nadu. Unlike branded alcohol that takes months and years to ferment, toddy needs only a few days to make a healthy drink. With rich nutritional and pharmaceutical values, its parts can be directly consumed or manipulated into other value-added products. Its leaves, roots and sap have high energy content and healing properties (Selvakumar & Thanapaul, 2021).



Figure 2. Palmyrah Sap / Toddy tapping in Tamilnadu, India

Palmyra Palm for Biodiversity

The Palmyra tree can be considered the greatest companion of animals and birds. Almost 15 species of birds depend for nesting and roosting in the shadows of Palmyra which includes Eagles, Bats, Vultures, Parrots, Peacocks, Northern Sparrows and the Baya weaver birds. It provides an ideal resting site for peacocks at night and parrot birds hatch their eggs on the tree. Some nocturnal birds also rest on the tree during their hunting time. When the fruit (nungu) is ripe, a large number of squirrels can be seen climbing on the Palmyra for a tasty treat (Alaguraj, 2017). By April, the Palmyra palm becomes a major nesting spot for Asian Palm Swift or *Cypsiurus balasiensis* (Raju, 2015) and also a resting site for migratory heron species (Krishnan et al., 2017). One of the studies done in the Union territory of Puducherry observed that for the first time in India red-headed Falcon *Falochicquera* was found breeding on the Palmyra palm (Lekshmi & Boobalan, 2018). Research, undertaken to improve the well-being of poor farmers in Cambodia by promoting a feeding system of pigs using the juice of Palmyra Palm which is highly rich in carbohydrates (sugar), showed a drastic increase in the daily livelihood gain of pigs due to the experiment (Borin & Preston, 1995).

Palmyra palm is also a 'hotspot' for various bacteria, yeast and fungi. A study done by (Chewapat et. al, 2021), showed that fibre of Palmyra peel, that are highly effective cellular fixator for carbon dioxide fixation, can be used in microbial cultivation for anoxygenic photosynthetic bacteria. Viable cells of these bacteria can be an excellent nutrient feed for various cattle and animals. Again, (Artnarong et al., 2016) isolated yeast and acetic acid bacteria from Palmyra fruit pulp to make vinegar. Yeast strains like *Candida sanyaensis*, *Candida tropicalis*, *Hanseniaspora guilliermondii* and *Lachancea thermotolerans* have been isolated from the sap of Palmyra (Savitree et al. 2020). In North India, a study detected the tendency of the sand fly vector *Phlebotomus argenteipes*, whose bite leads to the transmission of the parasite Visceral leishmaniasis, to reach vertical heights in Palmyra trees up to 18.4 meters above the ground level. Using the data, sticky CDC traps were placed set in the tree canopy- capturing 3,990 *P. argenteipes* and providing a breakthrough for sand fly control (Poché et al.,



2012).

Palmyra Palm for Sustainable Development

Overall, Palmyra products hugely improve the lives of rural communities and contribute to the GDP of a country- helping attain Economic sustainability. Social Sustainability is a key parameter in SDG that Palmyra provides through nutritious food, shelter and cultural significance. With these parameters, Palmyra palm attains a maximum number of SDGs (Selvakumar et al., 2021), such as Affordable and Clean Energy (SDG-7), Climate Action (SDG-13) and Life on Land (SDG-15), that directly or indirectly warrants an equilibrium between present needs and the demand of future generations. Asian Palmyra palm is the ‘tree of life’ as it provides humankind with all the basic things needed for survival on the earth, including air, water, food, medicine, shelter, clothing, energy, education, innovation, employment, sports and games, aestheticism, biodiversity and ecosystem development, green economy, and spiritual enlightenment. It also acts as the main source of income and food for many people living in rural areas- attaining SDG-1 (No Poverty), SDG-2 (Zero Hunger) and SDG-3 (Good Health and Well-being). By its virtue, people need not have to invest much to ensure a stable income source throughout the year, for example, the Palmyra climbers. The contribution of Palmyra climbers, or Palmyra warriors, towards social sustainability is vital. Climbing the Palmyra tree requires practice, strength, and a good physique. The techniques of climbing and toddy tapping are learned from the ancestors. As a result, the financial condition of low-income families improves- leading to Reduced Inequalities (SDG-10), and Sustainable Cities and Communities (SDG-11).

At present, atmospheric evolution has become a driving force for the extinction of many species on Earth (Hooper et al., 2012). Human interventions have caused the biggest impact on the environment mainly by land-use change, habitat fragmentation, over-poaching, pollution and also due to many invasive species. As a result, 25% of all mammal species and 13% of all bird species are threatened, also 21,000 other species of plants and animals are extinct (Tilman et al., 2017). Even so, despite the vital role of Palmyra in promoting biodiversity and resilient communities alongside combating climate change and disastrous events like sea level rise and water salinity, mass deforestation of the Asian Palm is on the rise- which calls for conservation initiatives to be undertaken.

Green Bangle Movement

The world boasts an average of over 420 trees per person, while Bangladesh struggles with a mere 89 trees per person, highlighting the pressing disparity in global tree distribution. So increasing the number of plants in Bangladesh is the need of the hour. To address the pressing challenge, the Green Bangle project (GBP), a project funded by the Swiss Philanthropy Foundation in Bangladesh, was founded in dedication to tree plantation endeavors to advance economic turn of events, ecological protection and sustainable development. Within 3 years, 30000 palm and mangrove plants will be sowed on the shorelines of the Sitakund and Guliakhali beaches of Bangladesh as a part of this venture. Inspired by the Chipko Movement and the visionary environmentalist Wangari Maathai, founder of the Green Belt Movement, the project is set to flourish as a Bangladesh-Asian initiative- the Green Bangle Movement. Around 100 female students from 19 different countries are currently involved in the project; many of them are committed Country Representatives who work to raise awareness of the project’s activities and turn it into a movement in their home countries through campaigns.

Leveraging meaningful partnerships and community engagement, the project is based on empowering women in nursery work and Palmyra handicrafts through ecopreneurship and ecofeminism. GBP has already established a nursery ‘Shyamol Churi Nursery’ at the main campus of the Asian University for Women (AUW), nurturing thousands of saplings for future plantation efforts. Workshops and training sessions are regularly conducted to educate local communities, particularly coastal women, on environmental protection and Palmyra leaf crafting. The Nursery team comprising more than 20 students and two dedicated Research Assistants



(RA) visit the nursery every week to take care of the saplings and supervise weeding and watering, which extends their knowledge and research prospects in the field. Currently, the nursery contains more than 1000 Palmyra palm and 200 sugar date palm saplings alongside 700 Portia & Palm species.



Figure 3: Palmyrah Palm and Nypa palm plantation at Guliakhali Beach, chittagong, Bangladesh

Six different species of mangroves and palms, namely *Nypa fruticans*, *Heritiera fomes*, *Sonneratia apetala*, *Borrassus flabelifer*, *Phoenix sylvestris*, *Excoecaria agallocha* and *Avicennia officinalis*, are being grown for the coasts because of their effectiveness in penetrating soil and controlling rising sea levels. For this, the coastal women are being trained as the nurturers of these saplings so that they can continue as custodians after the plantation is completed. In the meantime, they are learning to utilize different parts of Palmyra for small and medium enterprises- enabling them to financially support themselves and their families. For instance, AUW students trained rural women on the techniques of crafting with palm leaves using leaf-splitting machines as a part of the skill-share program. They were also provided with nursery kits, and assigned to grow 2500 sugar-date palm saplings which will be bought by GBP for the plantation. They can flexibly implement the skills in related sectors like agriculture and cottage industries, thus, they will have options for vocations even after the project ends.

According to the evaluations of over 9500 mangrove and palm saplings, including about 2000 Palmyra palms, planted along the Guliakhali embankment until now, the ecosystem of the area seems to be reviving through the plantation. Roots have developed due to heavy rain after plantation- preventing cattle from feeding on the young plants. Thus, the plants were not washed away by tides when immersed in seawater and later new leaves were seen to grow out. As long as the plants thrive, the local communities as well as the flora and fauna will keep reaping the benefits of Palmyra. At the same time, death from thunderbolts and other environmental catastrophes will be kept at bay. Therefore, besides the nutritional and pharmacological facilities, the initiative promises long-term ecological benefits and economic opportunities for the region- fostering a healthier environment and stronger community resilience against climate change.

In addition to this, GBP is motivated to spread awareness about the multifarious benefits and uses of Palmyra through their innovative campaigns. In a recent attempt, boiled Palmyra Tube Root and its Bhorta were introduced in the AUW Community, aspiring to introduce the nutritional and medicinal value of such dishes locally with the help of the Movement's project representative. Events like this are designed to propagate the environmental and cultural influence of Palmyra creatively. GBP orchestrated a workshop on combating water contamination to make the young women aware of the causes, effects and control measures of water pollution through practical demonstration. Displaying the handicrafts made of palm tree parts, GBP left an impact in a multi-cultural festival held at Chittagong, Bangladesh. Recognized for its impact, the project won the 1st Runner-Up Prize at the 'Hult Prize at the Asian University for Women' in 2024 for proposing a start-up idea based on palm bags as alternatives to nursery poly bags.



Conclusion

Palmyraculture is a way to achieve self-reliance and sustainable development in southeast Asia, It is repositioned as a cornerstone of the green economy and environmental stewardship, it transforms waste into wealth while fostering sustainable development GBM's multifaceted course of action addresses ecological challenges, and empowers communities, and fosters sustainable livelihoods, representing a significant effort towards environmental conservation and sustainable development in the region. GBM and its plantation activity help to fight against rising sea water levels, reforestation, soil conservation, water cycle regulation, climate change mitigation, community engagement and education, habitat restoration, promote Indigenous species, and support sustainable livelihoods.

Acknowledgment: This work was supported by the Swiss Philanthropy Foundation. Special thanks to the Asian University for Women, All the members of the Green Bangle Movement, Palmyraculture Research group, Palmyrah warriors/Artisans, Dr. Selvam Thorez, Young Power in Social Action (YPSA), Forest Department of govt of Bangladesh, BSRI, BFRI -Bangladesh & PDB, PRI, Sri Lanka.

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SEAB 2024
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Asst. Prof. Dr. K.J. Senthil KUMAR
National Chung Hsing University, Taiwan

Essential Oils from Taiwan's Indigenous Forest Species: Health Benefits, Industrial Applications, and a Sustainable Future

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ABSTRACT

Essential oils, also known as plant volatiles, have garnered attention in cosmetic applications due to their array of beneficial properties, including their aromatic fragrances and potential therapeutic effects on the skin and hair. These oils serve as natural sources of biologically active ingredients, offering a broad spectrum of bioactivities such as antioxidant, anti-inflammatory, dermatoprotection, antiaging, and antimicrobial properties, thus becoming integral components of herbal cosmetic products. Taiwan's rich forest biodiversity hosts over 5000 known native species of flora. Our ongoing research focuses on exploring the skin health benefits of essential oils extracted from indigenous forest species of Taiwan. In our investigations, we initially screened the anti-melanogenic properties of 16 essential oils extracted from native forest species in Taiwan, along with 31 commercial essential oils. Among them, *Alpinia nantoensis* leaf and rhizome (1) *Calocedrus formosana* wood (2), *Pogostemon cablin*, and *Glossogyne tenuifolia*, along with their bioactive compounds, exhibit robust melanin and tyrosinase inhibitory activities in skin melanocytes. Furthermore, our studies have unveiled that these essential oils not only inhibit cellular tyrosinase activity but also modulate melanin biosynthesis pathways. Additionally, we have discovered that *Glossogyne tenuifolia* essential oil and limonene from *Alpinia nantoensis* essential oil protect skin keratinocytes from ultraviolet irradiation-induced photodamage and photoaging (3). Collectively, our findings underscore the potential of essential oils as promising natural sources for the development of skin whitening/lightening and anti-aging agents for cosmetic applications.

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A horizontal band of silhouettes featuring various African animals including camels, giraffes, and elephants, interspersed with palm trees and other foliage. The background behind the silhouettes is a light blue gradient with faint, overlapping lines.

SYMPOSIUM PROGRAM



7th Symposium on EuroAsian Biodiversity (SEAB) – 2024 SYMPOSIUM PROGRAM



22.08.2024

HYBRID SALON (ONLINE) and CONFERENCE SALON

Registration & Opening Ceremony

10:00 Prof. Dr. Ramazan MAMMADOV – Azerbaijan Dendrology Institute – Azerbaijan

10:15 Prof. Dr. Ahmet HACİMÜFTÜOĞLU – Rector of Atatürk University, Türkiye

10:30 Prof. Dr. Bilent ÇAKMAK – Rector of Erzurum Technical University, Türkiye

10:45 Invited Speaker: Prof. Dr. Metin TURAN - Biodiversity and Traceability in Agricultural Production

11:00 Invited Speaker: Assoc. Prof. Dr. Paulraj Mosae SELVAKUMAR - The Mighty Palmyrah and Green Bangle Movement: Empowering Women, Preserving Biodiversity in Bangladesh and Asia

Break (60 minutes)

ONLINE ORAL PRESENTATIONS

ONLINE SALON 1

Chair Prof. Dr. Serkan ÖRTÜCÜ

Javad KARIMI

13:00 Enhancement of Tomato Defense Mechanisms Against Herbiyory Through Priming by Entomopathogenic Fungi

Javad KARIMI

13:15 Potential of Entomopathogenic Fungi as microbial control agents of grapevine cicada, Psalmocharias alhageos (Hemiptera: Cicadidae)

Mubasher Ahmed MALİK

13:30 Effect of TOSVIT® and Azostar on growth and disease severity of G1 Garlic, Allium sativa

Gunay İSMAYILOVA

13:45 Retrotransposon- movements in three wheat genotypes by horizontal gene transfer

Gunay İSMAYILOVA

14:00 Effects of various abiotic stress factors on the activity of retrotransposons

ONLINE SALON 2

Asst. Prof. Dr. Baycan MOR

Sushil GOSWAMI

Protection of Marine Biodiversity: A need for regional cooperative approach

Dilay BALABAN

Utilizing Stable Isotope Analysis in Marine Turtle Conservation

Tuğçe BİNEN

Applications of Mixed Stock Analysis to Sea Turtles

Nihal GÖKÇE

Effects of Climate Change on Biodiversity

Elif Naz GÜRSOY

Chelidonium majus: Could Be an Effective Agent in The Diabetic Wound Healing Process?

ONLINE SALON 3

Assoc. Prof. Dr. Abdülkerim KARABULLUT

Abdullah ADIYAMAN

The Price of the Modern World: Evaluating the Relationship Between Air Pollution and Autism

Tuğba AKKAŞ

Field Deployable and Disposable Multi-Walled Carbon Nanotube-based Screen Printed Electrode Sensors: Application in Bisphenol A Detection in Tap Water

Nebiyi Tuğba GÖKSİN

The Use of Diatom Indices in The Evaluation of Water Quality Of Streams Flowing Into Izmit Bay

Abdül Hakan EREN

Investigating the Roles of miRNAs in Certain Plant Species Under Alkali Conditions

Ergun Firat ÖZLER

Investigation of the Dispersion of Avocado Peel Cellulose in Dental Polymer PMMA and 3D Print Resin

Break (15 minutes)



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Chair	Prof. Dr. Sevgi SEVSAY	Assoc. Prof. Dr. Güler YENİCE	Asst. Prof. Dr. Özlem Özdemir TOZLU
14:30	Dilek OSKAY A New Distribution Area of the Endangered Endemic <i>Linum vuralianum</i> (Linaceae), in Türkiye	Kamala SADİGOVA Propagation By Seed of The Relict Wood Species on The Absheron Peninsula	Mevlîde Nur DİLGEN Anti-Quorum Sensing Activity of Some <i>Salvia</i> Species
14:45	Atila DURMUŞ Effect of Climate Change on Populations of Pathogen-Carrying Birds	Kamala SADİGOVA Extraction And Comparative Study of Essential Oil from Lemon Varieties Grown at Lankaran Regional Scientific Center	Ilyâ KABAK Rare species of the ground-beetles of the genus <i>Carabus</i> Linné, 1758 (Coleoptera, Carabidae) of the Katon-Karagai State National Natural Park, Eastern Kazakhstan
15:00	Sevgi SEVSAY Contributions to the terrestrial Parasitengona fauna (Acari: Trombidioidea) of Bingöl and Hakkari (Türkiye)	Fevzi ÖZGÖKÇE Biodiversity and Ethnobotany	Selma SAOULIA Metal resistance evaluation of two plant growth-promoting bacterial strains (<i>Pantoea</i> sp. et <i>Bacillus</i> sp. D13)
15:15	Yusuf KÜÇÜKBAĞRIACIK Spirulina Extract as a Potential Anticancer Agent in SKBR-3 Breast Cancer Cells	Veyssel BAY Exploring the Microbial Landscape of Gangrenous Mastitis in Sheep Using 16S rRNA Sequencing	Yöunesse EL-OUAZZANI Plant Biodiversity and Public Health: An Ethnobotanical Study of Traditional Phytotherapeutic Practices in Arid and Semi-Arid Areas of Morocco
15:30	Fatma SEÇER ÇELİK Evaluation of the relationship of inflammation pathways with tumor formation and progression	Ummahan ÖZ Identification of Secondary Metabolite Biosynthetic Gene Clusters in <i>Punica granatum</i> L. Using Bioinformatics Analysis	Aimeken NYGYMETOVA Assessing the efficacy of cyanobacterial strains as <i>Oryza sativa</i> growth biostimulants in saline environments
Break (15 minutes)			
Chair	Prof. Dr. Atila DURMUŞ	Asst. Prof. Dr. Ahmet POLAT	Prof. Dr. Mustafa DARILMAZ
16:00	Yasemin AŞ Efficacy of entomopathogenic fungus, <i>Beauveria bassiana</i> for biocontrol of Superworm, <i>Zophobas morio</i> (Fabricius, 1776) (Coleoptera: Tenebrionidae)	Bektaş SÖNMEZ Long-Term Trends in the Incubation Period and Estimated Sex Ratio of the Green Turtle	Various active for the rooting of olive pems Effect of Reagents
16:15	Mehmet KARACA First record of <i>Prozercon semiseparatus</i> from Türkiye (Acari: Mesostigmata: Zerconidae)	Ruhane TOSUNOĞLU Investigation of The Activity of <i>Origanum syriacum</i> Against Candidal Biofilms	Ali SALEHİ Rooting Pattern of <i>Pinus TEADA</i> and <i>Alnus</i> subcordata in Forestation in North of Iran
16:30	Mehmet KARACA Altitude and habitat preferences of zerconid mites (Acari: Zerconidae) in Akdağ National Park, Türkiye	Yaren DOĞRUL Natural and New Generation Hydrogels Enriched with Plant Polysaccharides for Wound Healing	Shebneem ALIYEVA Reproduction of <i>Jacaranda minisifolia</i> D. Don belonging to the family Bignoniaceae Juss., genus <i>Jacaranda</i> L. in conditions of Absheron



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16:45	Shalala Adil GÜLMAMMADOVA Ornamental plants in Sabir Garden on Absberon	Hale TATLI Determining the age parameters of a population of <i>Eumeces schneiderii</i> from Şanlıurfa, Türkiye	Amer MIRZAZADEH Evaluation of plant species diversity and floristic characteristics in plant ecological group in relation to altitudinal gradient, Kourdkey forest, North of Iran.
17:00	Heena GOSWAMI Conservation Forensics: Our Ally in the Fight Against Wildlife		

FACE-TO-FACE ORAL PRESENTATIONS

CONFERENCE SALON

Chair: Assoc. Prof. Dr. Mehmet Enes ARSLAN

13:00	Zeynep SELVİTOPI	The first emergence of entomopathogenic fungal disease in Tawny marbled minor, <i>Oligia latruncula</i> (Lepidoptera: Noctuidae)	
13:15	Nida ŞAHİN	Isolation of New Filamentous Fungi Capable of Degrading Microplastics	
13:30	Büşra YAZIÇILAR	Impacts of ZnO Nanoparticles on Callus Formation of Triticale Under In Vitro Conditions	
13:45	Şükriye KARADAYI	Use of Microbiota in Estimate Time of Death Using Metagenomic Analysis Methods	
14:00	Şükriye KARADAYI	Use of Microbial Diversity in Forensic Identification Case Solutions	
Break (30 minutes)			
Chair: Assoc. Prof. Dr. Sibel TURANLI			
14:45	Ahmet POLAT	A Faunistic Research on The Helophoridae and Hydrphilidae Families of İkiz Lakes (Tekirdağ)	
15:00	Şeyma Nur KESKİN	Time and Dose-Dependent Repellent Effect of <i>Brassica nigra</i> Essential Oil Against <i>Musca domestica</i> L. (Diptera: Muscidae)	
15:15	Secil Nazife PARLAK	Histopathological Features and Experimental Approaches in Gastric Ulcer Research	
15:30	Sinan İŞLER	Salep Tubers Caught in Bio-Smuggling Production Trials in Van Botanical Garden	

****A vehicle will depart from in front of the Symposium building at 16:15 for the trip to Atatürk University's Biodiversity Center.****



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23.08.2024

HYBRID SALON (ONLINE) and CONFERENCE SALON

10:00

Invited Speaker: Prof. Dr. Ökkes ATICI - Renewable and Sustainable Biodiversity

10:30

Invited Speaker: Asst. Prof. Dr. K.J. Senthil KUMAR - Essential Oils from Taiwan's Indigenous Forest Species: Health Benefits, Industrial Applications, and a Sustainable Future

Break (30 minutes)

ONLINE ORAL PRESENTATIONS

ONLINE SALON 1

ONLINE SALON 2

ONLINE SALON 3

Chair

Asst. Dr. Ahmet POLAT

Prof. Dr. Adem KARA

Prof. Dr. Nezzat ESİN

Azada ZAMANOVA

Maria EL OUAZZANI

Münayyar SAFAROVA

The influence of biofertilizer, manufactured by special technology on the growth and development of selected crops

Estimation of the Pollution Degree of urban Wastewater and Olive Mill Wastewater mixture: Biodegradability Index as an Assessment Tool of Treatment Efficiency

Classification, Cultivation, Distribution, Uses and Importance as a Medicinal Plant of Saffron Plant

Aygun SADIGOVA

Arzuğül Tanas YILMAZ

Naila BAYRAMOVA

Determination of DNA polymorphism among cultivated and wild grape genotypes of Azerbaijan with RAPD markers

SALL4 Gene: Its Role in Embryonic Development and Cancer

Changes of some blood parameters in immature rabbits caused by acute hypoxia

Aynur HÜSEYNOVA

Yeşim AKTÜRK DIZMAN

Nurana AGHAYEVA

Leucaena Leucocephala (Lam.) De Wit Restoration of Green Space and Economic Efficiency

Codon Usage Bias Analysis of the DNA Polymerase Gene of *Amsacta moorei* entomopoxvirus and Its Host Adaptability

Anatomical and Morphological Studies on *Helichrysum arenarium* (Asteraceae)

12:15

Factors disrupting the ecological balance of the vegetation of Okchuchay area of Zangilan region

A Review on the Morphological Structure of the Larynx, Trachea and Syrinx in Birds

Algal Flora of Cotton Fields in the Turkestan Region

Break (15 minutes)



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Chair	<u>Prof. Dr. Kenan KARAGÖZ</u>	<u>Prof. Dr. Atilla YILDIZ</u>	<u>Assoc. Prof. Dr. Elvin ALIYEV</u>
12:45	Ekrəm FIRIL Determination of Some Biological Activities of Methanol and Ethanol Extracts of <i>Picnomon acarna</i> (L.) Cass.	Ahmedul KABİR A New Home for Cocoa in Bangladesh	Sanubar ASLANOVA Talış xerophilic forests and dry subtropical steppe zone soils
13:00	Minara HASANOVA Biological Features and Usefulness of The Yiteks <i>Agnus–Cistus</i> L.	Evin ALIYEV Characteristics of soil and climatic conditions of the Lankaran region oncultivation of <i>Diospyros</i> L.	Sanubar ASLANOVA Meadow and meadow-steppe soils of the subalpine zone of Talışh
13:15	Minara HASANOVA About The Impact of Climate Change on the Forests of the Zagalata State Nature Reserve	Elçin ALLAHYAROV Current problems of biodiversity conservation in the Republic of Azerbaijan	Sewinj MAHARRAMOVA Changes in Soil Indicators Along the Highway Due to Anthropogenic Effects
13:30	Nuray ÖZTÜRK Biological Diversity Analysis of Insect Fauna in Forest Nurseries of The Western Black Sea Region of Türkiye	Eda ERKAN The Role of Visual Communication Design in Promoting Europe’s Ecotourism Destinations	Shabnam ALIYEVA Seed Propagation of the <i>Jacaranda Mimisifolia</i> Belonging to the <i>Jacaranda</i> L. Genus of the <i>Bignoniaceae</i> Juss. Family
13:45	Ömer ERTEEN Evaluation of Bee Breeds and Ecotypes in Türkiye in terms of Biodiversity	Sibel KIZILDAĞ Morphological and molecular taxonomy of species of the genus <i>Satyrrium</i> (Scudder, 1876) (Lepidoptera: Lycaenidae) in the Eastern Anatolia Region	Shaika Mohammad CHOWDHURY Green Bangle Project and Movement for Biodiversity, Environmental Conservation, and Sustainable Development
Break (15 minutes)			
Chair	<u>Asst. Prof. Dr. Burak ALAYLIAR</u>	<u>Asst. Prof. Dr. Gözde Büsra EROĞLU</u>	<u>Asst. Prof. Dr. Ayşe Gül KASAPOĞLU</u>
14:15	Şükran DERTLİ The Link between Biotechnology, Biodiversity and Artificial Intelligence: A Bibliometric Study	Konul BAYRAMOVA In The Poultry Farms of The Western Region of Azerbaijan Common Helminths	Fatma Necmiye KACI Therapeutic Effects of Combination Therapy with 3ab and Low Dose Cisplatin on Cervical Cancer Cells
14:30	Şükran DERTLİ Evaluation of Bioinformatics, Energy and Artificial Intelligence Theses in ProQuest Database	Lala ABDULLAYEVA The importance of the effect of some environmental factors of the feeding of the mulberry silkworm	Subahat İSKENDEROV GREEN TECHNOLOGIES OF SOIL AND VEGETATION COVER
14:45	Tamilla KARİMOVA Impact of Modern Climate Changes on Population Health	Mahmoud BAYAT Modeling productivity–diversity relationship using artificial neural networks and parametric models in typical uneven-aged and mixed forests in northern Iran	Showmiya SEGARUBAN Exploration of the role of Palmyrah palm (<i>Borassus Flabellifer</i>) in Biodiversity and Ecosystem development in Batticaloa and Jaffna district, Sri Lanka



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7th Symposium on EuroAsian Biodiversity (SEAB) – 2024 SYMPOSIUM PROGRAM



15:00	Tamraz TAMRAZOV Effect of Biological Diversity in Crop Rotation on Biochemical Indicators and Yield in Green Mass of Corn, Soybean and Winter Forage Pea	Huseynaga ASADOV The influence of biofertilizer, manufactured by special technology on the growth and development of selected crops	Zamina BUNYATZADE Based on milk functional appointed food of their products of technology processing and safety research
15:15	Tubukhanim KASIMZADE New Eco-Geobotanical Assessment Methods of Plant-Soil Cover	Jalal MAMMADOV Development prospects of pistachio (Pistachia L.) in Azerbaijan	Zeynep ÇINAR A Preliminary Study on the Amyolytic Activity of Plectosphaerella cucumerina Isolate OZ-08
Break (15 minutes)			
Chair	Assoc. Prof. Dr. Songül KARAKAYA		
15:45	Zumrud MAMMADOVA Ecological characteristics and essential oil content of rose hips (lat . rosa) growing in the territory of Fuzuli region freed from occupation of Azerbaijan		
16:00	Yusale JAFAROVA Optimization of Sterilization Protocols for Biotechnological Propagation of Corylus avellana		
16:15	Vedat GÜNTAY Evaluation of International Day for Biological Diversity 2024's Social Media Posts In Terms Of Visual Communication Design		
16:30	Farkhad YESKENDIROV Ephedra major and Ephedra equisetina: Comparative Phytochemical Analyses and Their Effects		
16:45	Hassan POURBABAËI Evaluation of plant species diversity and floristic characteristics in plant ecological group in relation to altitudinal gradient, Kourdkey forest, North of Iran		
17:00	Suzan KUNDAKÇI Contributions to Description of Persicaria amphibia (Polygonaceae) in Türkiye		



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7th Symposium on EuroAsian Biodiversity (SEAB) – 2024 SYMPOSIUM PROGRAM



FACE-TO-FACE ORAL PRESENTATIONS	
CONFERENCE SALON	
Chair: Prof. Dr. Ümit İNCEKARA	
11:30	Seher GÜVEN Contribution to Floral Morphology of Asclepiadoideae (Apocynaceae) from Türkiye
11:45	Seher GÜVEN Morphological and Chorological Contributions to the Genus Cionura (Apocynaceae: Asclepiadoideae) from Türkiye
12:00	Hayal AKYILDIRIM BEĞEN Molecular and Morphological Description of Epigaea gaultherioides (Boiss. & Balansa) Takht. from Türkiye
12:15	Hayal AKYILDIRIM BEĞEN Molecular Description of Some Medicinal Lamiaceae species from Artvin, Türkiye
Break (60 minutes)	
Chair: Assoc. Dr. Harun ARSLAN	
13:30	Sibel DOĞAN Some differences in the setal structures of Eustigmaeus anninae (Acariformes: Stigmaeidae) in Türkiye
13:45	SEHER ÖZTÜRK The Antibiofilm Potential of Camellia sinensis Against Pseudomonas aeruginosa (PAO1)
14:00	Zeliha YETİM Female Germline Stem Cells in Different Mammalian Species
14:15	Merve YILDIRIM Antibacterial activity of 2-methoxy phenethylamine-based imine and Beta-lactam derivative in nosocomial infections
14:30	Hilal YANIK Evaluation Of the Tourism Potential of Erzurum Nene Hatun Historical National Park
14:45	Burak ÇİFTÇİ Geological and Natural Formations Ornithofauna of Erzurum (Türkiye)
Break (30 minutes)	
Chair: Prof. Dr. Murat ÜNAL	
15:30	Murat ÜNAL Contributions to Conservation Biology of endemic Ferula huber-morathii (Apiaceae) in Türkiye (Alpaslan Dam II Example)
15:45	Musa TATAROĞLU A New Cynipid Record (Hymenoptera: Cynipidae) from Türkiye
16:00	Narmin KARIMOVA Production and Optimisation of Lipase Enzyme from Anoxybacillus gonensis Using Hazelnut Peels



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7th Symposium on EuroAsian Biodiversity (SEAB) – 2024 SYMPOSIUM PROGRAM



16:15	Amina IBRAHIMOVA	Three phase partitioning for simultaneous purification of soybean (Glycine max L.Merrill) polysaccharide , protein and biomolecules using a single-step extraction
16:30	Afig GAZIYEV	Physiological Processes in Plants Under Various Spectra of Light
16:45	Hassan POURBABAËI	Study on biodiversity of vascular plants in the forest reservoir of Caspian Poplar (Populus caspica Bornm.), Safrabasteh, Astaneh Ashrafce, Guilan, North of Iran
17:00	Naim Filitz KARADAŞ	The Therapeutic Use of Plant Extracts in Fish Diseases

ONLINE POSTER PRESENTATIONS

ONLINE POSTER SALON

11:30	Rashad KHALILOV	AFL And EFL teaching and learning through translanguaging: Global climate change context using IT technology
11:40	Yusala ISMAYILOVA	Impact Of Climate Change And Anthropogenic Factors On The Development Of Harmful Fauna
11:50	Valentina MURSALIYEVA	Establishment of in vitro culture and chemical composition of hexane extract of callus and regenerants of <i>Nedzwedzka semretschenska</i>
12:00	Ayğün SARDAROVA	The Anatomical Characteristics of the Vegetative and Generative Organs of the Medicinal <i>Silybum Marianum</i> L., Spread in the Mountainous Region of the Lesser Caucasus
12:10	Ali KANDEMİR	Investigation of the relationship between the general morphological characters of Turkish <i>Potanilla</i> (Rosaceae) taxa and the phytogeographical region to which they belong
12:20	Damla Ekin ÖZKAYA	Molecular Approach to the Apoptotic Effect of <i>Citrus aurantium</i> L. Flavonoids on Cancer Cells
12:30	M Jefwin PAUL	Insights into the Endosperm Haustorium of Germinated Asian Palm Seeds: A Study on Material Characterization
12:40	Wala Masri	Investigation of the Genome Size Effects of In Vitro and In Vitro Serial Passages of the Local SARS-CoV-2 Isolate
12:50	Beyza ESEN	Pharmacogenetic Applications in Cancer Treatment
13:00	Günay NƏSİBOVA	Bioecological characteristics of <i>Onobrychis</i> Mill. (Fabaceae) species common in Azerbaijan
13:10	Chinnaz NAMAZOVA	Influence of local plant vegetal resources on health



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7th Symposium on EuroAsian Biodiversity (SEAB) – 2024 SYMPOSIUM PROGRAM



13:20	Shamaddin GAHRAMANOV	Innovative Approaches to the Protection of Trees and Shrubs from Harmful Organisms in Absheron Peninsula
13:30	Jamilya GUSSEINOVA	Effects of Herbicide Exposure on the Gills of Common Carp (<i>Cyprinus carpio</i>)
13:40	Seymen CİMBİZ	Transcriptomics of biostimulation of plants under abiotic stress
13:50	Salih MAHARRAMOV	Embryotropic Influence of Caropodium platycarpum and Ajuğa chia Mixture in Rats
14:00	Vusala BADALOVA	Morphological Structure and Germination Capacity Of Pollen Of Some Species Belonging To The Passiflora L. Genus

FACE-TO-FACE POSTER PRESENTATIONS

POSTER SALON

13:30-15:00	Javad TORKAMAN	Carbon Sequestration of Oak seedling (<i>Quercus castaneifolia</i> C.A.Mey)
	Olha PETRYK	A preliminary study on the coating of chitosan to create hydrophobic surfaces
	Rabia SAĞAN	Studies on pollen viability of <i>Tripleurospermum ziganense</i> (Asteraceae) – a critically endangered endemic species from Türkiye
	Rabia SAĞAN	Stigma Receptivity of Endemic <i>Tripleurospermum ziganense</i> (Asteraceae)
13:30-15:00	Salih DOĞAN	Two cases of numerical variations in setae pdx of <i>Neophyllobius yunusi</i> Akyol & Koç (Acariformes: Camerobiidae)
	Hüseyin İNCEER	Floral Ecology of Endemic <i>Tanacetum albipannosum</i> (Asteraceae)

24.08.2024

SOCIAL EVENT DAY

Closing Speech

10:00	
10:30	Social Program: A guided tour will be organized to visit Çifte Minare, Taşhan, Erzurum Castle, Erzurum City Archive, Erzurum Museum (Paid, Optional, Museum Card Accepted), Yakutiye Madrasah (Paid, Optional, Museum Card Accepted). The vehicle will depart from in front of the Symposium building at 10:30.



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ORAL PRESENTATIONS

Enhancement of Tomato Defense Mechanisms Against Herbivory Through Priming by Entomopathogenic Fungi

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Abstract

Plants use various defense mechanisms to protect themselves from biotic and abiotic stressors. Some invaders activate host plant defenses, enhancing host resistance to plant herbivory. This study investigated the impact of two entomopathogenic fungi (EPFs), *Metarhizium anisopliae* strain F01 and *Beauveria bassiana* strain GHA, on activation of defense mechanisms in tomato plants (*Solanum lycopersicum*). We first assessed the systematic growth of these entomopathogenic fungal isolates from leaf tissues to other parts of tomato plants over time. Following inoculation, we observed changes in the growth of both the aerial and underground tissues of the treated tomatoes. Additionally, the total phenolic, flavonoid contents, and DPPH scavenging activity across leaves, stems, and roots changed over time compared to the control tomatoes. Both *B. bassiana* and *M. anisopliae* as endophytes in tomatoes reduced preference of *Tuta absoluta* for the plants in both choice and no-choice tests. Furthermore, the developmental parameters of *T. absoluta* were decreased when they fed on tomatoes colonized by these fungal endophytes. Notably, for the first time, we found that pre-inoculation with *M. anisopliae* or *B. bassiana* significantly activated *PR-10*, *ERF*, and *TGA* gene expression in the phytohormone pathways of tomatoes following *T. absoluta* attack, compared to infested plants grown without the fungi. Additionally, tomatoes colonized by endophytic fungi showed high induction of *P450* in the phenylpropanoid pathway and other defense-related genes (*PRODH*, *nsLTP*, and *WIP*) after *T. absoluta* herbivory, unlike non-colonized tomatoes. These findings suggest that endophytic EPFs can effectively prime plant defense responses, leading to stronger and faster reactions to recurring stress. This study provides valuable insights into the mechanisms through which *B. bassiana* and *M. anisopliae* promote tomato plant growth and enhance their defense against *T. absoluta*, offering the potential for developing EPFs for plant protection applications.

Keywords: Endophyte, insect pathology, microbial control, immune response **Acknowledgement:** This work was supported by The Ferdowsi University of Mashhad (Iran) and Iran National Science Foundation.

Potential of Entomopathogenic Fungi as microbial control agents of grapevine cicada, *Psalmocharias alhageos* (Kolenati) (Hemiptera: Cicadidae)

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Abstract

Regarding the inefficiency of prevalent control methods and their incompatibility with environmental concerns to control the grapevine cicada, *Psalmocharias alhageos* (Kolenati) (Hemiptera: Cicadidae), which has lately become a major pest by invading grape vineyards in Middle Eastern, there is a serious need to find suitable and effective alternative control measures. While the nymphal stage of this species inflicts significant root damage and resides in subterranean habitats, entomopathogenic fungi (EPF) are considered one of the potent groups that can effectively manage this pest as they have shown great potential against an extensive array of soil-dwelling pests. Thus, the current study aimed to assess the efficacy of three EPF species, *Beauveria bassiana*, *Beauveria varroae*, and *Metarhizium anisopliae*, against the nymphal stage of the grapevine cicada. The highest virulence was achieved by *M. anisopliae* with an LC₅₀ value of 1×10^6 conidia/ml, followed by *B. bassiana* with an LC₅₀ of 7.2×10^6 conidia/ml in the laboratory petri dish assay. In the soil column assay, the greatest efficacy against nymphs was recorded for *M. anisopliae* at the highest concentration tested (1×10^8 conidia/ml) causing 75% cumulative mortality. Soil type significantly influenced the activity of *M. anisopliae* against *P. alhageos* in a way that nymphal mortality was higher in clay loam (>80) and loam soil than in sandy loam, respectively. When tested at temperatures of 20, 25, and 30 °C, *M. anisopliae* induced the highest mortality at 20°C (>90%) and the lowest at 30 °C (>35%). When applied to soil pots under semi-field conditions in a vineyard, *M. anisopliae* was recorded as the most virulent species among all EPF tested by producing 65% mortality at the concentration of 1×10^8 conidia/ml. Respecting our assessments of pure cultures of EPF holds promise for the management of *P. alhageos*. Nevertheless, future extensive evaluations of these microbial agents, especially *M. anisopliae*, must comprehensively understand their potential applications in the field and determine their compatibility for integration with other complementary tools.

Keywords: biocontrol, insect pathology, microbial control, vineyard management

Effect of TOSVIT® and Azostar on growth and disease severity of G1 Garlic, *Allium sativa*

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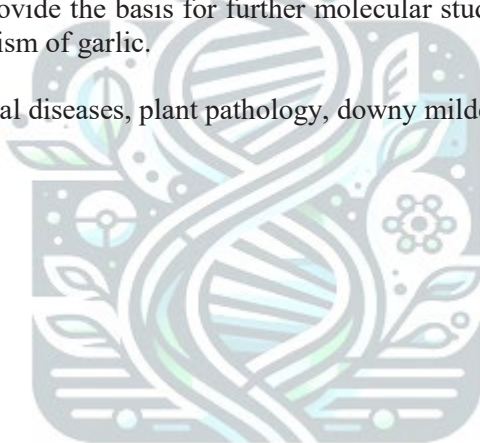
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Abstract

The G1 Garlic, *Allium sativa* introduced by the National Agricultural Research Council (NARC) in 2018, is very important because of its high vitamin content. However, this garlic variety is prone to fungal diseases such as downy mildew and collar rot, causing a yield loss of up to 30%. In this study, we tested the effect of TOSVIT ® (Kimatec Spain) and Azostar® (Azoxystrobin 7%+Propiconazole 11.7%), both alone and in combination, on the growth and disease severity of NARC G1 under greenhouse and field conditions. The highest leaf length width and disease-free, less shiny plant of NARC G1 were observed in the application of TOSVIT ® alone after 7, 14, and 21 days of application. In the combined application of TOSVIT ® and Azostar, changes were noticed in the leaf length, width, and brightness of the NARC G1 leaf. On the other hand, the Azostar application showed a shiny leaf with no change in length and width. Thus, the results obtained from this study provide the basis for further molecular studies to understand the growth and disease control mechanism of garlic.

Keywords: G1 Garlic, fungal diseases, plant pathology, downy mildew, collar rot



Retrotransposon-movements in three wheat genotypes by horizontal gene transfer

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Abstract

Since plants are sedentary organisms, they are constantly exposed to the unpredictable effects of the environment. At this time, depending on the frequency and duration of stress factors, changes in the transcriptional state of genes are temporarily "remembered", then transferred to daughter cells and, in some cases, offspring, which is called transgenerational epigenetic inheritance. These molecular mechanisms, which do not involve changes in the DNA sequence, have an epigenetic basis. Transposon elements (TEs) are mobile genetic elements that make up the majority of animal and plant genomes. These mobile elements can influence genome evolution by altering gene expression. Some types of TEs can insert into a new location in the genome and disrupt or restore the function of neighboring genes. Studying the movement activity of retrotransposons in response to stress factors can help to understand their resistance to changing environmental conditions. The main goal of the research is to determine the movement activity of retrotransposons in wheat genotypes (Republic-100, Red wheat and Nurlu-99) grown under salt stress (150 and 200 mM NaCl), heavy metal (10 and 20 mg/l CdSO₄) and *in vitro* conditions. In this study, barley-specific (SUKKULA), rice-specific (HOUBA) and soybean-specific (SIRE1) retrotransposons were investigated in wheat plant samples by IRAP (Inter-Retrotransposon Amplified Polymorphism) marker method. The samples were studied comparatively *in vivo* and *in vitro* conditions. *In vitro* callus samples were cultured in MS (Murasige and Skoog) medium. The mobility of retrotransposons of other plants, which is not unique to wheat, can be activated or weakened by stress. The discovery of these retrotransposons in the wheat plant gives rise to the term Horizontal Gene Transfer (HGT). Based on gel-electrophoresis results, the Jaccard coefficient was calculated and a phylogenetic tree was constructed. The obtained research results are expected to be useful for the understanding of spontaneous genomic insertions during wheat development and their impact on genetic and epigenetic changes. This study is one of the first studies investigating epigenetic changes in the wheat plant grown in Azerbaijan.

Keywords: Epigenetics, callus culture, wheat, horizontal gene transfer, retrotransposons

Effects of various abiotic stress factors on the activity of retrotransposons

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Abstract

The wheat crop accounts for the majority of all cultivated land and is considered the most important whole grain food for humans worldwide. Biotic and abiotic stress factors affect gene expression in plants. At this time, depending on the frequency and duration of stress factors, changes in the transcriptional state of genes are temporarily "remembered", then transferred to daughter cells and, in some cases, even to offspring, which is called transgenerational epigenetic inheritance. While some of the changes are caused by the abnormal cells that were previously present in the cultured explants, some of them are caused by temporary physiological and developmental difficulties caused by the culture conditions. When studying epigenetic changes, transposon elements should be considered in particular. They can even influence the evolution of the genome by altering gene expression. For this purpose, in this study, the mobility of retrotransposons under the influence of various abiotic stress factors was investigated. In this study conducted for the purpose of studying and analyzing epigenetic changes in plants, the presence of *Sukkula* specific to barley, *Houba* specific to rice and *Sire I* retrotransposons specific to soybean was detected for the first time in different wheat genotypes. A group of samples was taken from 10- and 20-day-old regenerant, *in vitro* callus culture tissue and *in vivo* leaves of wheat plant and studied comparatively. In the other group, 10 and 20 mg/l concentrations of CdSO₄ were applied to 15- and 30-day-old intact plants and *in vitro* callus culture. Retrotransposons were determined by the *IRAP* marker (Inter Retrotransposon Amplified Polymorphism) method. Polymorphism values were calculated by the Jaccard coefficient, and a phylogenetic tree was constructed. Thus, the value of polymorphism in 15-day-old Jumhuriyet-100 callus cells and leaf samples was in the range of 0-50% for *Houba* retrotransposon. Looking at the calculated polymorphism values for *Sukkula* retrotransposon, it was in the range of 0-83% in 15-day-old Jumhuriyet-100 callus and 0-67% in leaf. This study is one of the first studies conducted to study epigenetic changes in local wheat varieties.

Keywords: Epigenetics, retrotransposons, wheat, callus, phylogenetics

Protection of Marine Biodiversity: A need for regional cooperative approach

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Abstract

United Nations Convention on Law of the Sea (UNCLOS herein after) envisage to establish a legal order to facilitate international communication, cooperation, promotion of peaceful uses of the seas and oceans, the equitable and efficient utilization of their resources, the conservation of their living resources and having due regard to the protection and preservation of the marine environment. UNCLOS promotes conservation and sustainable usage of marine living resources including marine mammals and highly migratory species. UNCLOS emphasize on the scientific research and cast an obligation on the coastal State to ensure through proper conservation and management measures that the maintenance of the living resources in the exclusive economic zone is not endangered by over-exploitation along with the duty to cooperate at local, regional and global level.

Further, during United Nations conference on Sustainable Development (Rio+20) states have committed themselves to address the issue of the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction by developing an international instrument under the United Nations Convention on the Law of the Sea which resulted in international instrument on the conservation and sustainable use of marine Biological diversity in areas Beyond National Jurisdiction (BBNJ). The BBNJ agreement, a milestone for global community to prevent biodiversity loss in the high seas was in making for more than a decade leading to the conclusion of international negotiations and its adoption by consensus at the 5th BBNJ Intergovernmental Conference in New York. This paper is an attempt to assess and examine the practical implementation of the treaty through regional and global cooperation in place of individual state centric approach within the overall framework of UNCLOS in order to prevent the loss of biodiversity and marine ecology. As the oceans are not having fixed boundaries, this paper has been developed with supposition of utilitarian perspective of regional cooperative approaches of states in place of individual approach in favor of mankind. The paper has been developed by using primary and secondary sources for the study of actions of the states on subject matter.

Keywords: Marine biodiversity, UNCLOS, regional practices, law of the sea

Effects of Climate Change on Biodiversity

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Abstract

For the past ten millennia, humanity lived with the acceptance that it was a part of nature. However, with the invention of tools, the agricultural revolution, and the development of trade routes, this acceptance was gradually rejected, and humans began striving for dominance over nature. From the 16th century onwards, the organic worldview was replaced by a mechanical mindset, and the industrialization movement that began in the 18th century fundamentally altered humanity's perception of nature. Nature came to be viewed as a mere provider of services for human welfare and happiness. Parallel to these developments, the human population, which was one billion at the beginning of the 1800s, reached eight billion by the 2000s. Activities such as agriculture, livestock farming, industrial production, transportation, and urbanization, which were carried out to meet the needs of the growing human population, have not only led to environmental degradation but have also dramatically increased the amount of greenhouse gas emissions released into the atmosphere. Climate change, whose effects have become more pronounced since the 1970s, is a result of global warming and the disruption of the natural greenhouse effect caused by these emissions. At this point, climate change is driving ecosystems toward collapse, causing the extinction or threatening the survival of species in both aquatic and terrestrial systems. This study first examines the relationship between global greenhouse gas emission volumes, climate change, and biodiversity, presenting statistical data that show for the first time a significant decline in global biodiversity due to anthropogenic effects. The study will then investigate species that are under threat or endangered and will offer public policy recommendations on this issue. The findings demonstrate that a substantial number of plant and animal species are struggling to adapt to climate change, with many already having been erased or on the brink of being erased from existence.

Keywords: Anthropogenic impact, biodiversity, climate change, environment, public policies

Chelidonium majus: Could Be an Effective Agent in The Diabetic Wound Healing Process?

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Abstract

Medicinal plants have been used since ancient times to administer many diseases and disorders in medical care. *Chelidonium majus* (CM) contains a complex mixture of alkaloids, flavonoids, and phenolic acids. It has anti-viral, anti-tumor, anti-microbial, and anti-inflammatory effects and is used folklorically in various countries to relieve or alleviate skin diseases. In this study, 54 female Wistar albino rats with streptozotocin (STZ) induced diabetes, gel control, negative control, positive control, celandine aerial parts (30;60 and 90 mg/kg/day), and celandine root parts (5;10 and 20 mg/kg/day) were divided into nine groups. Gels prepared from different parts and doses were applied topically to the wounds. The animals were sacrificed on the seventh day of wound healing, and wound healing activity was evaluated macroscopically and histopathologically. Wound care rates (WCRs) results indicated that CM-containing gels showed the most efficient doses at 60 mg/kg (aerial parts) and 15 mg/kg (root). The histopathological analysis of wound tissue sections showed that both the negative control and gel control groups were impaired in regenerating an intact epidermal barrier. However, the 90 mg/kg (aerial parts) group showed a reduction in granulation and inflammation, while the 60 mg/kg (aerial parts) group exhibited dense moulding of hair follicles, sebaceous glands and collagen. These different effects can be varied according to the dose and the part of the plant used. The results obtained according to our histopathological findings prove that CM accelerates the healing process in the in vivo diabetic wound healing model. Therefore, our results lead us to consider that CM might be used as a potential agent in diabetic wound healing.

Keywords: *Chelidonium majus*, Diabetic wound healing, histopathology, wound care rate

Acknowledgement: This research was supported by Gazi University Scientific Research Projects (BAP), Ankara, Turkey (Project Number: FGA-2021-7299)

The Use of Diatom Indices in The Evaluation of Water Quality of Streams Flowing into Izmit Bay

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Abstract

In this study, epilithic diatoms of 13 stations in 8 streams flowing into Izmit Bay were investigated to reveal the ecological quality of these lotic systems. Water and epilithic diatom samples were taken from 13 stations located in Ballıkaya (1), Saz (2), Dil (3), Çınarlı (4 and 5), Yırım (6 and 7), Kiraz (8 and 9), Hisar (10 and 11) and Değirmen (12 and 13) streams flowing into Izmit Bay. The physico-chemical and biological parameters were studied by taking water and epilithic diatom samples 4 times throughout the year in fall, winter, spring and summer in 2022-2023. A total of 347 diatom taxa belonging to 32 families were identified from 51 samples. Using 18 different diatom indices, Saz (2), Dil (3), Yırım (7), Kiraz (9) and Hisar (11) stations were indicated as bad quality, while Hisar (10), Değirmen (12) stations were reported as poor quality, and Ballıkaya (1), Çınarlı (4 and 5), Yırım (6) and Kiraz (8) stations were detected as medium quality. According to the Redundancy Analysis (RDA), Saz (2), Dil (3) and Hisar (11) stations are of worse quality than the other stations in terms of physico-chemical parameters and dominant diatom species.

Keywords: Streams, Diatom Indices, Ecological Quality, Izmit Bay



Investigating the Roles of miRNAs in Certain Plant Species Under Alkali Conditions

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Abstract

As the concentration of sodium cations in the soil increases, the soil acquires a highly alkaline reaction characteristic. Alkali salt stress associated with sodium cations is directly related to the presence of NaHCO₃ (sodium bicarbonate) or Na₂CO₃ (sodium carbonate) in the soil. Crops growing in alkaline soils may be subjected to both high pH stress and bicarbonate stress. Understanding the response to saline-alkali stress can be achieved through a comprehensive investigation of the mechanisms of alkali salt tolerance in plants. Alkali tolerance in plants is a complex mechanism that involves various gene expression profiles and interactions of gene products, rather than a single gene expression.

MicroRNAs (miRNAs) play a crucial role in the adaptation of plants to challenging environmental conditions, such as alkali stress. Through their effects on ion homeostasis, antioxidant defense, hormone signaling pathways, and gene expression, plants can minimize the adverse effects of alkali stress. miRNAs, which regulate numerous biological processes involving complex mechanisms, are key to understanding the responses of plants to alkali stress. Specifically, gaining further insight into the number, characteristics, sequences, and potential impacts of miR156, miR171, miR172, miR164, miR393, miR398, miR390, and miR858 will enhance our understanding of plant responses to such stress. Consequently, research in this area lays a significant foundation for plant biotechnology and genetic engineering applications.

Keywords: miRNA, alkaline stress, alkaline-salt stress, plant miRNA

Investigation of the Dispersion of Avocado Peel Cellulose in Dental Polymer PMMA and 3D Print Resin

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Abstract

The world's natural resources are gradually being depleted for various reasons. Although it is not yet considered a major problem today, it will become a serious problem for humanity in the future. Recycling wastes and making them reusable in different sectors can be considered as a solution to this problem. It is known that the recovery of valuable organic compounds contained in vegetable wastes such as fruit peels will make great contributions to both the environment and the national economy. Avocado is a highly nutritious and valuable fruit that is often consumed in daily life. Its homeland is Central Mexico and it is a fruit that grows in tropical and subtropical climates. With the development of greenhouse cultivation, it can be produced in our country as it is all over the world. The peel of the avocado, which makes up 13% by mass, contains high amounts of organic compounds such as cellulose, lignin and hemicellulose that can be recovered. Cellulose is a natural biopolymer found in the cell wall of plants and forms a large part of the cell structure and is one of the most valuable industrial raw materials. Cellulose is widely used in industries such as textiles, plastics, wood and paper products, cosmetics and pharmaceuticals.

Polymethylmethacrylate (PMMA) is a thermoplastic synthetic polymer that is transparent, resistant to atmospheric conditions and has many properties that can be used in different fields from the medical and pharmaceutical industry to the construction industry. In recent years, the blends obtained by mixing PMMA with cellulose have shown a great potential in terms of durability and biodegradability, and in recent years, the inclusion of natural polymers in synthetic polymers to improve their properties and contribute to the environment and national economy has attracted attention as important innovations.

In this study, avocado peels were firstly dried in an oven under suitable conditions. Three different alkaline methods were used to isolate cellulose from the dried peels and cellulose isolation was carried out with the method with the highest yield and the study continued. The cellulose obtained was dried in an oven under appropriate conditions, ground in a mechanical grinder and pulverized. Avocado peel cellulose was mixed with Polymethyl methacrylate (PMMA) under appropriate conditions, poured into the prepared silicone mold and sent for FTIR analysis. Avocado peel cellulose was poured into the silicone mold prepared by mixing with 3D Print resin material under appropriate conditions and sent for FTIR analysis. Both stages were studied in pairs as control and study. In general, FTIR analysis provides information about chemical bonds and possible behavior of structures. With the FTIR analysis, it was understood that cellulose purified from avocado peel can participate in both dental polymers and 3D print resin without the problem of dissolution with dental polymer PMMA and 3D print resin.

Keywords: Avocado, cellulose, polymethylmethacrylate, biomaterial

Acknowledgement: We would like to thank Prof. Dr. Mine Çömlekoğlu, Ege University Faculty of Dentistry, Department of Prosthodontics and Prof. Dr. Burcu Okutucu, Ege University Faculty of Science, Department of Biochemistry for their support in this study.

A New Distribution Area of the Endangered Endemic *Linum vuralianum* (Linaceae), in Türkiye

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Abstract

Linum vuralianum Yılmaz & Kaynak (Linaceae) is an endemic species described in 2008, known from only two localities (Emet-Kütahya and Pelitözü-Bilecik) in Türkiye. According to the distribution area and population data, the threat category of the IUCN has been recommended as “EN” by the authors of the species. It has been determined that the species has a new distribution area in Çamlıca Mountain, Soma-Manisa with this study. It has been determined that *Linum vuralianum* is distributed in open forest places at about 1000 m altitude on the north-western view of Çamlıca Mountain. According to the observations made during the field study, it was concluded that the threat category of the species should be protected in the same way.

Keywords: Distribution, Endemic, *Linum vuralianum*, Manisa, Türkiye.



Contributions to the terrestrial Parasitengona fauna (Acari: Trombidioidea) of Bingöl and Hakkari (Türkiye)

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Abstract

Trombidioid mites, which have a very wide distribution, prefer very different habitats. While some of these mites generally like moist habitats, some of them prefer completely wet habitats. Due to their similar morphology and lifestyle, terrestrial some trombidioid larvae can mistakenly be identified as water mite larvae at first glance. Terrestrial Parasitengona goes through seven life stages: egg, inactive prelarva, active larva, inactive protonymph, active deutonymph, inactive tritonymph and active adult stage. Like in water mites, the life cycle of Trombidia usually includes the typical sequence of immobile, parasitic and predatory instars. The few exceptions from this pattern in Trombidia concern an additional moulting in postlarval instars or a deviation of life styles in particular instars (e.g. reduction of parasitism in the larva). The subject of this study consist of mites obtained from field studies carried out to collect water mites. Water mites were collected from on top and inside of moist-wet moss on stream banks. The collected moss were washed with water using two series of sieves of 2000 micron and 500 micron. The material remaining in the 500 micron sieve was taken into a white cuvette and live mite samples were extracted with the help of a pipette. In this study, Trombidiodea specimens found accidentally in the extracted water mites are given. The specimens in this study obtained from the provinces of Bingöl and Hakkari in 2021-2022. Trombidioid specimens were cleared in lactophenol solution and placed in Hoyer's medium on microscope slides. Photos were taken with the Olympus BX63 DIC microscopes. Totally, 5 species in 4 genera within 3 families were identified; Of these, *Atractothrombium sylvaticum* (C. L. Koch, 1835), *Calyptosoma velutinum* (Müller), *Valgothrombium major* (Halbert) and *Johnstoniana rapax* Wendt and Eggers were given from Bingöl, and *Valgothrombium valgum* (George) were from Hakkari. This study aimed to contribute to the spread of the trombidioid mite fauna existing in Türkiye. Attention has also been drawn to mites that prefer the same environment with water mites and watery moss.

Keywords: Actinotrichida, new record, Southeastern Anatolia, Trombidiformes.

Evaluation of the relationship of inflammation pathways with tumor formation and progression

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Abstract

Many treatment approaches target the direct destruction of tumor cells, with multidrug resistance in cancer cells being a major factor in the ineffectiveness of cancer therapy. Cancer is seen as a cell-intrinsic genetic disease. It has been shown that inflammation is intimately related to the majority of cancer types' malignant progression and all stages of development, as well as to the effectiveness of anti-cancer treatments. Rudolf Virchow first suggested the link between inflammation and cancer in the middle of the 1800s. This was based on his findings that inflammatory cells were frequently found in tumor biopsies and that cancer first appeared in areas of chronic inflammation.

Inflammation associated with cancer is now recognized as a hallmark of the disease, and a direct correlation has been found between chronic inflammation and the growth of tumors. In actuality, an elevated incidence of cancers as well as the malignant evolution of most cancer types have been linked to chronic, dysregulated, persistent, and unresolved inflammation. There are still a number of barriers and difficulties in the clinical field of cancer therapy, despite the significant advancements made in the regulation of inflammation targeting the innate and adaptive immunity. Additionally, during the anti-tumor process, precision medicine—also known as personalized medicine—should consider the various inflammatory responses displayed by cancer patients and apply specialized therapeutic strategies that focus on inflammation.

Inflammation brought on by cancer therapy frequently gives cancer cells that remain resistant to other treatments, accelerating the spread of the disease. Numerous substances, including the intestinal microbiota and its metabolites, are implicated in the regulation of inflammation and cancer. Furthermore, precision therapy must to include anti-tumor medications that target inflammation. It will be a while before these theories are used to develop therapeutic cancer treatments. Furthermore, other research projects would keep improving the field by supporting the theoretical underpinnings of inflammation-targeting cancer treatments. The aim of this study is to evaluate its effect on cancer formation based on pro or anti-inflammatory pathways through in vitro and in vivo studies.

Keywords: Inflammation, cancer, personalized medicine

Efficacy of entomopathogenic fungus, *Beauveria bassiana* for biocontrol of Superworm, *Zophobas morio* (Fabricius, 1776) (Coleoptera: Tenebrionidae)

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Abstract

Zophobas morio (Fabricius, 1776) an insect of the family Tenebrionidae, has larvae that reach a size of 50 to 60 mm and are known to damage products containing resistant amylase, particularly wheat flour. Both the larvae and adults of this species are harmful due to their powerful mandible, which can penetrate packaging products, including those used for pulses, thereby compromising the contents. The species reproduces rapidly, with an extended larval period, making it a persistent pest in stored products found in warehouses and homes. Conversely, *Z. morio* is also used as a food source for some domestic animals, highlighting its dual role as both a beneficial and harmful insect. The study aimed to evaluate the efficacy of entomopathogenic fungi for the biological control of *Z. morio* to prevent economic losses in packaged amylase food products. For this purpose, the virulence of *Beauveria bassiana* Ric1 was evaluated against *Z. morio* larvae. The larvae were exposed to five different conidial concentrations of *B. bassiana* Ric1 to determine its virulence. The experiments were conducted in triplicate with each group consisting of ten healthy 3rd instar *Z. morio* larvae. Conidial suspensions at the two highest concentrations (1×10^8 and 1×10^9) resulted in 100% larval mortality within four days. Additionally, 1×10^7 and 1×10^6 conidia mL⁻¹ concentrations achieved 100% mortality on days six and seven, respectively. The lowest concentration (1×10^5) led to 50% mortality by the end of the bioassay. To confirm that *B. bassiana* Ric1 caused larval death, the cadavers were incubated on moist paper at room temperature for several days. Mycosis rates of 100% were observed at concentrations of 1×10^8 and 1×10^9 , while concentrations of 1×10^7 , 1×10^6 , and 1×10^5 resulted in mycosis rates of 90%, 80%, and 40%, respectively. The LC₅₀ value of *B. bassiana* Ric1 was calculated to be 2.06×10^5 conidia mL⁻¹ for *Z. morio* larvae. These results indicate that *B. bassiana* Ric1 is a promising biocontrol agent against *Z. morio*.

Keywords: *Beauveria bassiana*, *Zophobas morio*, biocontrol, virulence

Biodiversity and Ethnobotany

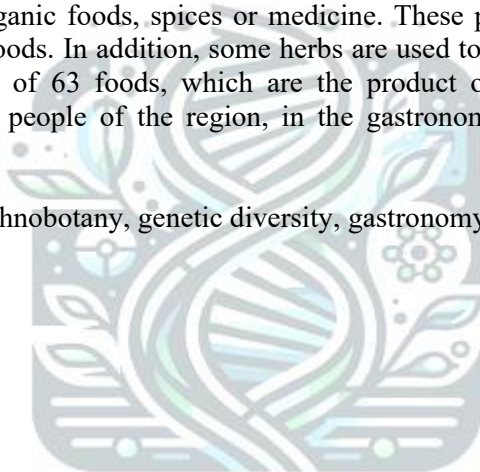
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Abstract

In order to determine the plants used by the local people in Van and its surroundings, field studies were carried out at different times between 2000 and 2022. The information for these plants, such as local names, their usages, used parts, methods of preparation have been recorded. The role of traditional foods in gastronomy tourism is increasing day by day in our country and all over the world. With this study, the plants used by the local people for centuries for food purposes and the experience and knowledge gained in the field of gastronomy were recorded. A total of 250 different wild plant uses were determined in 4000 questionnaires applied face to face to resource persons in the field. Although there are some overlapping uses, 180 plants were determined to be used as food and 70 plants as medicine. Ethnobotanical uses in Van have been brought to a scientific platform with the contribution of other disciplines, especially the place in gastronomic tourism. In rural areas, before the flowering period in spring, many plants are collected and used as raw, brine or dried as organic foods, spices or medicine. These plants are mainly used in the preparation of traditional foods. In addition, some herbs are used to add fragrance and flavour to traditional foods. The role of 63 foods, which are the product of a deep-rooted tradition of ethnobotanical uses of the people of the region, in the gastronomy tourism of Van has been revealed.

Keywords: Biodiversity, ethnobotany, genetic diversity, gastronomy, Türkiye.



Exploring the Microbial Landscape of Gangrenous Mastitis in Sheep Using 16S rRNA Sequencing

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Abstract

Gangrenous mastitis is a severe and life-threatening condition in sheep characterized by the rapid necrosis of mammary tissue. This disease can lead to substantial economic losses in the sheep industry due to decreased milk production, increased veterinary costs, and even the death of affected animals. Gangrenous mastitis is often associated with pathogens such as *Staphylococcus aureus*, *Mannheimia haemolytica*, and other opportunistic bacteria. However, traditional culture-based diagnostic methods may fail to identify the full spectrum of pathogens involved in these infections, particularly in cases of polymicrobial communities. Recent advances in 16S rRNA gene sequencing provide a comprehensive approach to characterizing the microbial communities present in gangrenous mastitis. This molecular technique enables the identification of both culturable and non-culturable bacteria, offering a more complete understanding of the microbiota involved in the disease. In this study, we utilized 16S rRNA sequencing to analyze milk and tissue samples from sheep with clinical signs of gangrenous mastitis. Our findings revealed a complex and diverse microbiome. Notably, bacterial diversity in case samples was lower than in healthy samples, and healthy samples had similar bacterial content, while case samples had diverse bacteria. Main bacteria in case samples were *Staphylococcus* spp. and *Escherichia* spp., while *Prevotella* spp., *Faecalibacterium* spp., and *Bacteroides* spp. dominate healthy samples. These insights into the microbial ecology of gangrenous mastitis could pave the way for novel diagnostic and therapeutic approaches. By understanding the intricate interactions among bacterial populations in the mammary gland, we can develop more effective strategies for the prevention and management of gangrenous mastitis in sheep, ultimately improving animal welfare and productivity.

Keywords: Gangrenous mastitis, sheep, 16S rRNA sequencing

Long-Term Trends in the Incubation Period and Estimated Sex Ratio of the Green Turtle

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Abstract

In many species of reptiles, including sea turtles, hatchling sex depends on incubation temperature. Different groups of reptiles manifest this temperature-dependent sex determination in different ways. Researchers have found that higher temperatures in sea turtle species produce a greater proportion of females, while lower temperatures produce more males. Several methods are used to estimate the sex of hatchlings. Using the incubation period (IP), which is the number of days between the laying of the clutch and the emergence of the first group of hatchlings, is one method to estimate the sex ratio of hatchling sea turtles. Long and short periods represent low and high temperatures, respectively. The aim of this study is to estimate the sex ratio of green turtle hatchlings at the Samandağ beach between 2013 and 2023 by using the IP. In addition, to determine if there is a temporal trend in sex ratios and IP. Monitoring and conservation studies were conducted from June to September during all nesting seasons. All nests were protected in situ, and IP was identified for all of them. For sex ratio, IP was first converted to mean temperature during the middle third of incubation (proposed by Broderick et al., 2000 for Mediterranean green turtle). This temperature value was then used in the sex ratio estimation model proposed by Kaska et al. (1998) to obtain the estimated sex ratio. Tests for trends in IP and sex ratio values across years were performed using the nonparametric Mann-Kendall trend test. A comparison of IP and sex ratio values between years was performed with the Kruskal-Wallis test due to a lack of normality. The IP of a total of 7179 nests was calculated between 2013 and 2023. The average IP was 52.35 days and the sex ratio was 68.59%. The Kruskal-Wallis test showed significant differences between years for both IP and sex ratio. The IP showed a slightly decreasing trend between 2013 and 2023 (Kendall's tau: -0.038, $p < 0.0001$), while the sex ratio also showed a slightly increasing trend (Kendall's tau: 0.039, $p < 0.0001$). The Samandağ green turtle population produced female-biased hatchlings during the 11-year period. However, it can be said that this female-biased hatchling production tends to increase slightly over time. Rising temperatures as a result of global climate change may affect this situation even more in the coming years, leading to a shift towards single sex. In this case, it is essential that new conservation measures are taken and that more detailed research is carried out.

Keywords: Sex ratio, incubation period, green turtle, *Chelonia mydas*, Samandağ

Acknowledgement: I would like to specially thank the Hatay Directorate of Nature Conservation and National Parks of the TC Ministry of Agriculture and Forestry, the Samandağ Environmental Protection and Tourism Association. I would also like to thank the volunteers whose names I cannot mention who voluntarily supported the Samandağ sea turtle protection and monitoring study between 2013-2023.

Investigation of The Activity of *Origanum syriacum* Against Candidal Biofilms

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Abstract

Origanum syriacum is an aromatic and medicinal plant used in traditional treatment approaches. In this study, the in vitro antibiofilm activity of *O. syriacum*, which is collected from Mount Ida, the extract was investigated against *Candida albicans* (ATCC 10231), *C. dubliniensis* (CBS 7987), *C. glabrata* (ATCC 2001), *C. parapsilosis* (ATCC 22019) and *C. tropicalis* (KUEN 1025). Initially, *O. syriacum* samples collected from Mount Ida were extracted using ethanol as a solvent. Then, the anticandidal activity of *O. syriacum* was determined by agar well diffusion and swarming motility. After that, the antibiofilm activity was determined by crystal violet assay and microscopy techniques. According to our results, we obtained zone diameters of 25 and 22 mm for *C. tropicalis* and *C. glabrata*, respectively. However, no effect of the extract on motility was found. While strong antibiofilm activity was observed against *C. albicans*, *C. tropicalis* and *C. parapsilosis*, no antibiofilm activity was found against *C. dubliniensis* and *C. glabrata*. As a result, it was concluded that *O. syriacum* extract has antibiofilm and anticandidal activities depending on the *Candida* species. This research was conducted at Erzurum Technical University under the scope of TÜBİTAK 2209-A.

Keywords: *Origanum syriacum*, Antibiofilm, Candida Species, Anticandidal activity.



Natural and New Generation Hydrogels Enriched With Plant Polysaccharides For Wound Healing

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Abstract

The skin, as the largest and most external organ of our body, can be easily damaged by endogenous physical, chemical and biological factors. Damaged skin tissue is still open to bacterial and fungal infections. Skin wounds are divided into chronic and acute wounds. While acute wounds undergo a smooth wound healing process, chronic wounds result in the healing process remaining in a certain stage. Wound healing is a physiological process that is influenced by a number of factors. The use of appropriate and effective wound care materials can help to accelerate this process. Since traditional wound dressings are not fully effective in the wound healing process, there is a need for the development of new functionalized wound dressing materials. As a modern wound dressing, hydrogels keep the wound environment moist and contribute to wound healing with their high-water retention capacity and adjustable properties (*in situ* formation, sensitivity to stimuli, injectability) compared to other wound dressings (film, foam, hydrocolloid, etc.). Due to their beneficial metabolites and compounds, plants are natural alternatives to chemical compounds that have been used medically for many years in the treatment of many diseases. There are studies showing that plant polysaccharides (starch, cellulose, pectin, etc.) form hydrogel matrices and positively affect the wound healing process. In this review, the potential of using reliable, natural and new wound dressing materials developed by adding plant polysaccharides to hydrogels, which have increased in recent years, as modern dressings has been evaluated.

Keywords: Polysaccharide-based Hydrogel, Wound Healing, Herbal Polysaccharides, Wound Dressing

Anti-Quorum Sensing Activity of Some Salvia Species

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Abstract

The prevalence of bacterial infections is a significant contributor to the morbidity and mortality rates observed across all regions of the globe. The majority of pathogenic bacteria utilise quorum sensing (QS) systems to regulate the expression of virulence factors during the establishment of infection. For this reason, intervention in the QS system is seen as a new approach to control infections caused by bacteria. It is well documented that a significant number of plant species are capable of producing secondary metabolites that are highly effective against infectious bacteria. *Salvia* is one of the most important medicinal and aromatic plants of the Lamiaceae family and many species are native to Mediterranean Europe. Many species belonging to this genus have been proven to have therapeutic potential, but there have not been sufficient studies on anti-QS activity. The aim of this study was to investigate the anti-quorum sensing effect of four different *Salvia* species collected from Turkey. For this purpose, the effect of different extracts of *Salvia huberi* Hedge, *Salvia fruticosa* Miller, *Salvia sclarea* L. and *Salvia aethiopsis* L. species on *Chromobacterium violaceum* ATCC 12472 biomonitor strain was investigated by disc diffusion method. Three different solvents (ethanol, methanol and water) and four different extraction techniques (maceration, soxhlet, microwave and sonication) were used to prepare the extracts. After placing the extract impregnated discs on the surface of the inoculated petri dishes, the petri dishes were incubated for 24 hours. After incubation, the zone diameters formed around the discs were measured and the mean and standard deviation values of the data of the repeated study were determined. Water extracts of *S. huberi*, *S. fruticosa* and *S. sclarea* species obtained by ultrasonic extraction technique were found to have anti-quorum sensing effect (Zone diameters; 10.33 ± 0.58 , 8.33 ± 0.58 , 9.67 ± 0.58 , respectively). This study demonstrated the effect of *Salvia* species as quorum-sensing inhibitors and virulence suppressors and this effect varies according to the plant species, the solvent used and the extraction method.

Keywords: Quorum sensing, *Salvia*, *Chromobacterium violaceum*

Rare species of the ground-beetles of the genus *Carabus* Linné, 1758 (Coleoptera, Carabidae) of the Katon-Karagai State National Natural Park, Eastern Kazakhstan

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Abstract

Among 11 species of the genus *Carabus* Linné, 1758 recorded from the territory of the Katon-Karagai State National Natural Park (KKSNP), 4 are rare: *Carabus (Morphocarabus) spasskianus schestopalovi* Plutenko, 1995 – this poorly known taxon is only known from the mountain ridges to the South of the Bukhtarma River: the eastern portion of the Narymsky Mt. R. and the Sarymsakty Mt. R., namely from the mountains to the South of the Soldatovo Vill. to the left bank and upper course of the Sarymsakty Riv. The species occurs in stony habitats of the upper forest and alpine zones, at elevations of 2100–2360 m. *Carabus (Morphocarabus) michailovi* Kabak, 1992 – this species is endemic for the South Altai mountains within limits of Eastern Kazakhstan: the mountain ranges Narymsky (upper course of the Ozyornaya Riv.), Sarymsakty (upper courses of the Siralka, Shurshutsu, Putotshnaya, Sarymsakty, Tautukol' rivers), Kurchum (upper courses of the Kurchum and Topolyovka rivers), Tarbagatai (environments of the Burkhat Pass and upper course of the Uryl'ka Riv.) and Southern Altai (near the Ugulgun Pass and the Takyr Mt.). The species is listed in the Red Book of the Republic of Kazakhstan. This *Carabus* species is unique in the Southern Altai region living only in the mountain meadows, mainly between 1900 and 2800 m. *Carabus (Megodontus) imperialis* Fischer von Waldheim, 1823 is an endemic of the western part of the Altai mountains within boundaries of Kazakhstan from the vicinities of Oskemen and Ridder cities in the North to the Kalba and Azutau mountain ridges in the South. In KKSNP, *C. imperialis* is known from the southern slopes of the Listvyaga Mt. R. (Salkynshoky Mt. and Seredtshikha Riv.), the Bukhtarma Valley (mouth of the Bobrovka Riv. and Ust'-Sobatshe), the vicinities of the lakes Rakhmanovskiye and from the northern slopes of the Sarymsakty Mt. R. (Izvestkvaya Yama). This species is listed in the Red Book of Kazakhstan. It occurs in a wide belt of altitudes in both the forest and open biotopes at elevations from 350 to 2000 m (570–1800 m in the KKSNP). *Carabus (Megodontus) leachii sarymsaktensis* Obydov, 1999 – this is the southern subspecies of an endemic species for the Altai mountains. Area of this geographic form occupies the mountain ranges to the South of the Bukhtarma River: Sarymsakty, Kurtshumsky, Azutau, Tarbagatai, Southern Altai. In the territory of KKSNP, it is known from the Sarymsakty Mt. R. (the upper courses of the Shurshutsu, Siralka, Putotshnaya and Sarymsakty rivers), from the Tarbagatai Mt. R. and from the southern slopes of the Southern Altai Mt. R. (sources of the Temir-Kaba Riv.). The record from the vicinities of the Rakhmanovskiye Klyuchi Vill. needs to be proved. The species occurs in the forest and alpine zones, at elevations of 1450–2500 m.

Keywords: *Carabus*, distribution, Kazakhstan, Altai

Metal resistance evaluation of two plant growth-promoting bacterial strains (*Pantoea* sp. et *Bacillus* sp. D13)

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Abstract

Heavy metals are the main inorganic contaminants in the environment, including cadmium, chromium, copper, lead, mercury, nickel, zinc, etc... Their presence represents a serious menace to all living organisms. Microbe-related technologies may provide an alternative or addition to conventional metal removal or recovery methods. Numerous studies have reported that Plant-growth-promoting rhizobacteria (PGPR) are potential abiotic stress-tolerant agents including tolerance to heavy metals. In this context, this study aims to evaluate bacterial tolerance to various heavy metals of two plant growth-promoting bacterial strains (*Pantoea* sp et *Bacillus* sp D13). Firstly, the ability of strains to grow in the presence of wastewater collected from the Oued El Malah (irrigation canal), wilaya Sétif / Algeria was evaluated. Counting was carried out on nutrient agar prepared with wastewater at different concentrations (100%, 50%, 20%, 10%, 5%). The results showed significantly different values, unlike *Pantoea*, *Bacillus* growth on nutrient agar (30°C/72h) is proportionally reduced in the presence of raw and diluted wastewater. The number expressed in CFU/ml for *Bacillus* averaged 2.10⁶ CFU/ml for the control without wastewater and wastewater at different concentrations has an inhibitory effect on bacterial growth. In contrast, *Pantoea* sp growth on wastewater-based media was higher, reaching around 2,10⁷ CFU/ml, and are significantly similar at different wastewater concentrations, attesting to the bacterium's tolerance to the inhibitors contained in wastewater. After that, the resistance of these bacteria to various heavy metals (Co, Pb, Hg, and Cd) is tested on LB agar medium containing increasing concentrations of these metals (50, 100, 500, and 1000ppm), and the minimum inhibitory concentration (MIC) was determined by the lowest concentration inhibiting bacterial growth after 4 days. According to the results, *Pantoea* and *Bacillus* strains tolerate a concentration of 1000 ppm of Pb, 100 ppm of Co, and 50 ppm Cd. However, the metal tolerance of *Pantoea* to Cd reaches a maximum level of 100 ppm. As a result, this study, generally it illustrated the role the PGPR as biological stress-tolerant agents, because the tested strains have grown in different concentrations of wastewater. In addition, in particularly it proved their metal-stress resistance in different concentrations of different metals. Thus, it strengthened the approach of Microbe-related technologies to remove environmental contaminants including heavy metals.

Keywords: Heavy metals, Plant-growth-promoting rhizobacteria (PGPR), metal resistance, *Pantoea* sp, *Bacillus* sp D13.

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Plant Biodiversity and Public Health: An Ethnobotanical Study of Traditional Phytotherapeutic Practices in Arid and Semi-Arid Areas of Morocco

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Abstract

Traditional medicine in Morocco is deeply rooted in cultural heritage and relies heavily on the use of medicinal plants. These plants have been employed for centuries to treat a wide range of health disorders, with their efficacy transmitted across generations. However, this valuable knowledge is often undocumented and at risk of being lost. This ethnobotanical study was conducted in the Ouarzazate province, located in the southeast of the Anti-Atlas Mountains, known for its arid and semi-arid climates. The survey aimed to document the use of medicinal plants by the local population, gather comprehensive information on their therapeutic applications in public health and contribute to the preservation of local phytotherapy knowledge. The research team conducted field surveys and interviews with 600 respondents. Data were collected through structured and semi-structured interviews with local informants, including herbalists, traditional healers, and the local population who use medicinal plants for health and well-being. Questionnaires encompassed plant identification, preparation methods, therapeutic applications, administration methods, and cultural significance. Data analysis was conducted using both quantitative and qualitative methods. The findings of this study provide valuable insights into the traditional medicinal plant knowledge of the local population. The identification of 79 endemic botanical species frequently used, highlights the rich biodiversity of the region and the significance of these plants in traditional healthcare practices. This information can be used to support the conservation of medicinal plants, promote sustainable traditional use practices, and develop new phytotherapeutic products.

Keywords: Biodiversity, Public health, Ethnobotany, Medicinal plants, Phytotherapy.

Acknowledgment: This work was supported by the Laboratory of Microbial Biotechnology and Plant Protection, Faculty of Sciences, Ibn Zohr University, Agadir, Morocco.

Assessing the efficacy of cyanobacterial strains as *Oryza sativa* growth biostimulants in saline environments

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Abstract

High soil salinity, as a result of anthropogenic impact, is one of the most common factors of environmental stress, slowing down plant growth and development, and leading to a decrease in yield worldwide. Under conditions of increased soil salinity, plants are exposed to hyperosmotic stress, resulting in reduced CO₂ fixation, production of reactive oxygen species (ROS), and subsequent plant death. In this context, soil microflora represented by phototrophic and heterotrophic microorganisms adapted to high salinity conditions hold great potential for enhancing plant resistance to high salt concentrations in the soil. These microorganisms are not only key nitrogen fixers in agricultural soils but also release substances that promote plant growth, such as hormones, vitamins, and polyphenolic compounds with strong antioxidant activity. Additionally, the growth-promoting effect of phototrophic microorganisms is associated with reducing the content of oxidized substances in the soil, supplying oxygen to the rhizosphere, resistance to salt stress, and phosphate solubilization. The growth-stimulating activity of the cyanobacteria *Nostoc* sp. J-14 and *T. variabilis* K-31 in saline soil on the growth of *Oryza sativa* was studied. For this purpose, 13 seeds of *O. sativa* were sown in plastic pots containing 240 g of artificially saline soil. To test the salt tolerance of cyanobacterial isolates, the pots were divided into different salinity levels (0, 2, 4, 8, and 16 g/L NaCl). Before seed germination, the temperature was maintained at 30°C. On the 5th day of growth, the soil was treated with 30 ml of liquid cyanobacterial inoculant: (1) *T. variabilis* K-31, (2) *Nostoc* sp. J-14, and (3) a control variant, every 48 hours. The pots were placed in a growth chamber with a relative humidity of 75%. Illumination was provided by a fluorescent lamp at 100 μmol (photons) m⁻² s⁻¹ for 16 days at 28°C and 24°C during the day and night, respectively. After 16 days, six replicates of each treatment were selected for further analysis. Individual plant samples from each pot were separated into roots and shoots for further measurement of length and dry weight determination. Based on the results obtained during the experiment, the average size of seedlings was calculated using Microsoft Excel. According to the results, both studied cyanobacterial strains *T. variabilis* K-31 and *Nostoc* sp. J-14 positively influenced plant growth, as evidenced by the emergence of *O. sativa* shoots in the experimental groups. However, as the experiment continued, some divergence in trends was observed. The cyanobacterial strain *Nostoc* sp. J-14 showed the greatest increase in shoot length at a salt concentration of 2 g/L, with an average shoot length of 25.43 ± 0.05 cm. The shoot length of the cyanobacterial strain *T. variabilis* K-31 at a concentration of 16 g/L was 21.97 ± 0.06 cm.

Keywords: Soil salinity, Cyanobacteria, Plant growth promotion, *Oryza sativa*, Salt stress resistance

Rooting Pattern of *Pinus teada* and *Alnus subcordata* in Forestation in North of Iran

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Abstract

Alnus subcordata (alder) as a native tree species and *Pinus taeda* (pine) as a non-native tree species have been planted in many forest areas of northern Iran. These tree species have shown different patterns in terms of quantitative and qualitative growth. The present study was conducted in order to investigate the pattern of micro and macro roots of these species. Random sampling was done with 8 square-shaped samples with dimensions of 15 x 15 meters. In each plot, soil samples with roots were collected from two depths of 0-10 and 10-20 cm. After separating small and large roots in the laboratory, their dry weight was determined using Avon. After evaluating the normality of the data, the independent t-test was used to compare the roots in different masses and depths. The comparison of the average root weight at the depths of 0-10 and 10-20 cm between pine and alder showed that in both depth classes, the microroot weight of the root is significantly higher than that of alder pine. The comparison of the average root value of pine and alder without considering the depth showed that the average root value of alder is significantly higher than that of pine. Also, the comparison of the average value of coarse root in the classification depth of 0-10 and 10-20 cm between pine and alder showed that the coarse root of pine is significantly higher than alder. The comparison of the average of the coarse root regardless of the depth showed that there is no significant difference between these two species, although the pine had a larger root than the alder.

Keywords: Fine Root, Coarse Root, Guilan Province.

Acknowledgement: This work was supported by Department of Forestry of University of Guilan

Conservation Forensics: Our Ally in the Fight Against Wildlife

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Abstract

Preventing wildlife crime helps maintain government revenues and supports economic stability, especially in developing nations. Wildlife crime can impact human health (e.g., zoonotic diseases). Conservation Forensics can be defined as the application of forensic science principles to the protection and preservation of wildlife and ecosystems. It involves the use of advanced technologies and methodologies to analyze evidence related to wildlife crimes such as poaching, illegal trade, habitat destruction, and pollution. Conservation forensics uses rigorous scientific techniques like gene analysis, chemical analysis, geographical analysis, statistics, artificial intelligence, and computational modeling to investigate and analyze evidence.¹ Conservation Forensics plays a vital role in gathering evidence, identifying perpetrators, and ultimately bringing them to justice. The goal is to directly benefit law enforcement personnel and agencies involved in protecting imperiled wildlife. Wildlife crime investigation can rely heavily on conservation forensics to combat illegal activities threatening biodiversity.² This specialized field provides valuable insights into the illegal wildlife trade, enabling law enforcement agencies and conservation organizations to take targeted actions to preserve biodiversity and combat poaching. Conservation forensics is a multidisciplinary field that combines scientific techniques, law enforcement, and genetics to safeguard biodiversity. This article will employ various methodologies to understand the application of conservation forensics that will bridge wildlife crime investigation, forensics, and conservation efforts. In this article, we explore the applications, case studies, collaborations, and future prospects of conservation forensics.

Keywords: Conservation Forensics; Wildlife; Crime; Evidence

Determining the age parameters of a population of *Eumeces schneiderii* from Şanlıurfa, Türkiye

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Abstract

The age, growth, and body size of a species have distinctive effects on its population dynamics and life history. In this regard, studies aimed at determining the age of individuals are of significant importance. In the context of this study, the ages of 18 individuals (comprising seven males, eight females, and three juveniles) of the orange-tailed skink, *Eumeces schneiderii*, which were sampled from Şanlıurfa Province, were determined from histological sections using the skeletochronology method. The age of the females ranged from four to eight years (mean: 6.5), while that of the males ranged from five to nine years (mean: 7.5). Furthermore, the age of all the juvenile individuals in the population was determined to be two years. The mean age of all individuals, irrespective of sex, was determined to be six years. The body sizes of males in the population were found to vary between 85 mm and 140 mm (mean: 116.71 mm), while the body sizes of females ranged between 82 mm and 125 mm (mean: 107.75 mm). A positive correlation was identified between the snout-to-vent length (SVL) and age in all individuals (Pearson's correlation coefficient (r) = 0.797, $p < 0.05$). Upon evaluation of the results, it can be concluded that the average size and age of the male and female individuals in this study were similar.

Keywords: age, body size, skeletochronology, lizard, population

Acknowledgments: A more detailed version of this study has been published in the journal Ecology and Evolution (vol.14, issue 6, e11521, 2024).

The first occurrence of entomopathogenic fungus isolation in Tawny marbled minor, *Oligia latruncula* (Lepidoptera: Noctuidae)

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Abstract

Entomopathogenic fungi are important microbial agents that help keep agricultural and forest pests below the economic damage threshold. In August 2023, spontaneously dead and with sclerotic bodies of *Oligia latruncula* larvae were found in the grass field in Erzurum, Türkiye. Fifteen days after they were grown in PDA medium, green-gray colonies were observed in the fungal Petri dish. They were stained with lactophenol blue and mycelium for microscopic examinations, spore structures were visualized under a light microscope at 400x magnification. Molecular analysis of the fungus isolated from dead larvae shows that it was determined that it was an entomopathogenic fungus of the *Cladosporium* sp. As a result of the phylogenetic tree drawn according to ITS and EF-1 α genes, this fungus isolated from Türkiye was determined to be close to *Cladosporium* sp. isolates from China and Brazil. *Cladosporium* species are widely distributed in terrestrial (animals and plants) and marine substrates due to its high sporulation. While they are so widespread in the atmosphere, their prevalence is only 10.3% in lepidopteran species. Considering that many species in the order Lepidoptera are agricultural or forest pests in the larval stage, it is important to obtain new *Cladosporium* isolates from Lepidoptera and investigate their usability in biological control. In this study, an entomopathogenic fungus was isolated for the first time from the larvae of the grass pest *O. latruncula*. Thus, an important microbial agent that has the potential to be used in the biocontrol of harmful larvae has been identified. This study will shed light on other studies on developing a new mycoinsecticide by mass production of *Cladosporium* sp. against *O. latruncula* larvae.

Keywords: *Cladosporium* sp., *Oligia latruncula*, microbial control, entomopathogenic fungi

Isolation of New Filamentous Fungi Capable of Degrading Microplastics

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Abstract

The increase of daily use of plastics, environmental pollution has increased at the same rate. This situation threatens the lives of living beings and the environment. Although it takes too many years for plastics to break down in nature, this period can be shortened by bacteria and fungi. Although studies on plastic pollution continue, the invisible part is forgotten. Since microplastics are difficult to recycle, fungi and bacteria, which can biotechnologically break down microplastic pieces, can destroy the majority of microplastics by being used in the biodegradation method. Thanks to the excellent appetites of fungi and their adaptations, it is possible to reduce pollution by feeding on the organic substances of microplastics. Within the scope of this study, local fungi were isolated from samples taken from areas with high plastic pollution. This study observed whether these fungi used plastics as nutrients by being inoculated in plastic feedlots. Classical identification was carried out by selecting fungal colonies that degrade the plastics best. Only 4 isolates from these species gave positive results, 3 of them could be classical identified. Among the identified species, *Gliocladium roseum* N26 and *Acremonium sp.* N14 were known to degrade different types of microplastics in the literature. However, there is no record in the literature that *Torula herbarum*, the N23 isolate that causes the highest zone formation, degrades microplastics.

Keywords: Plastic pollution, Biodegradation, Microplastics, Fungi, *Torula herbarum*

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Use of Microbiota in Estimate Time of Death Using Metagenomic Analysis Methods

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Abstract

Determining the time of death is crucial for solving many forensic cases. Since the exact time of death can only be defined for individuals who die under observation, the term "Post-Mortem Interval (PMI)" is used instead of the time of death in the literature. In PMI estimation, biochemical evaluations have traditionally utilized blood, vitreous fluid, synovial fluid, pericardial fluid, urine, and cerebrospinal fluid. Additionally, processes such as algor mortis, rigor mortis, livor mortis stages, changes in body coloration, and post-mortem events like stomach content digestion are commonly employed to estimate PMI. Despite the development of various methods for PMI determination, no single method has been universally accepted as the gold standard due to the physical, chemical, and biological factors that influence this process. In recent years, advancements in DNA sequencing technology have led to the evaluation of metagenomic studies involving changes in microbial communities for PMI determination. These new techniques allow for the identification of microbial diversity at the species level in a sample. Preliminary studies in this regard suggest clues that microbial populations may undergo significant sequential changes after death, which could potentially aid in determining PMI. Recent studies suggest that if the postmortem succession of microbial communities in the decomposition environment of the corpse as PMI markers is reproducible and predictable, these communities can be used as biomarkers. Specifically, the high bacterial diversity and richness found in various habitats such as cecum, and oral regions provide potential applications for more accurate PMI estimation through metagenomic analysis. However, more extensive and comprehensive studies are needed in this area. A significant portion of the studies conducted so far have been on animal cadavers. Limited information is available regarding the relationship and abundance of microbes with human organs post-mortem, based on autopsy materials. Therefore, enhancing the accuracy of PMI estimation in elucidating forensic cases requires reviewing current literature, conducting laboratory studies on new scientific techniques, and exploring methods such as bioinformatics analysis and machine learning. This study aims to evaluate and discuss recent studies focusing on post-mortem microbial diversity changes for PMI estimation. Systematic literature search different electronic databases using PubMed/Google Scholar/ EMBASE/Scopus/ CINAHL/Web of Science/Cochrane library was conducted for PMI estimation. The results show that metagenomic analysis of biomarkers identified from microbiota, processed with bioinformatics techniques and machine learning algorithms can contribute to the accuracy of PMI prediction.

Keywords: Microbial diversity, postmortem Interval, metagenomic analyzes

Use of Microbial Diversity in Forensic Identification Case Solutions

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Abstract

Microorganisms are microscopic organisms such as bacteria, fungi, viruses, algae, and certain small protozoa. Microbiome research is concerned with the composition profile and diversity of microbial flora, as well as the study of interactions between microbes, hosts, and the environment. Recent advancements in Next-Generation Sequencing (NGS) technologies and bioinformatics have significantly broadened the scope of microbiome analysis as a forensic tool. Prior to the emergence of NGS technology, traditional culture methods for studying microorganisms were much more time-consuming and laborious. However, large-scale research programs like the Human Microbiome Project (HMP) have produced substantial amounts of data over the past 15 years, enabling the characterization of microbial diversity worldwide. Thus, current studies on the human microbiome and its environmental impacts have begun to attract the interest of forensic scientists. This interest stems from each individual possessing a unique microbial community that can persist over long periods, differing from those of other individuals. Moreover, it is known that different regions of the body host diverse microbial communities, with oral cavities, skin, and intestines exhibiting greater diversity compared to other body parts. Studies analyzing body surface microbiomes for identification purposes primarily characterize microbiomes through amplification sequencing of the 16S rRNA gene. Using this method, Schmedes et al. demonstrated that the hidSkinPlex panel, consisting of markers from 17 skin body sites, could identify individual hosts with an accuracy ranging from 92% to 100%. Similarly, researchers at Harvard University analyzed the microbiomes of saliva, skin, feces, and other body parts from 242 volunteers participating in the HMP to test the uniqueness and stability of microbiomes in identifying individuals based on microbial features at the strain level. Multiple studies have revealed correlations between microbial compositions on individuals' hands and those on the surfaces of their computers and smartphones. Moreover, it was observed that inanimate objects can harbor these bacteria for longer than two weeks. This study aims to evaluate and discuss the use of microbial diversity in forensic identification cases in accordance with current literature.

Keywords: Microbial diversity, Forensic identification, Metagenomic analyzes

Salep Tubers Caught in Bio- Smuggling Production Trials in Van Botanical Garden

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Abstract

Among the seed plants in the world, Orchidaceae is one of the families that are most dependent on the living environment. 187 species of the family, which is represented by 25000-35000 species in the world, are distributed in our country. These species, especially those that are traded and used, face the threat of extinction in our country. In this study, the subject of our study is the preservation of 2900 salep tubers caught during bio-smuggling activities in the rural area of Van Province in the Van Botanical Garden operating under the Van Yüzüncü Yıl University, Van Flora Application and Research Center Directorate. First of all, the received salep tubers were divided into sizes and evaluated in 6 groups (large size: 4-5.2 x 3-4.5 cm, large size broken: 4.2-5.7 x 3-3.5 cm, medium size: 2.4-4 x 2.2-3.2 cm, medium size broken: 3.2-3.5 x 2.2-2.7 cm, small size: 1.5-3.1 x 1.1-2, 2 cm, small size broken: 2.2-2.7 x 1.7-2 cm). Two different habitats were selected as the application area, and these habitats were prepared in a mechanized manner, and 1000 tubers were applied manually to each area, paying attention to the distances on and between rows for a certain trial. As a result of our study; The numbers of individuals germinating and growing in two different habitats were compared with their growth characteristics and measurements. The differences in the soil properties of the two habitats were associated with growth data and the success of salep production and the ecological conditions affecting this success were emphasized.

Keywords: Salep, cultivation, protection, bio smuggling.

The influence of biofertilizers, manufactured by special technology on the growth and development of selected crops

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Abstract

Field experiments were conducted in farms of the Goranboy district of the Republic of Azerbaijan. For the experiment, vegetable crops such as tomatoes, eggplants, cucumbers and peppers. The introduction of biofertilizer into the experimental field was carried out as follows. Plowing was carried out at a depth of 30cm and after that this area was leveled. After a certain time, plowing was carried out again at a depth of 20-22cm on ha and each m² of area was applied 833 gr of biofertilizer manufactured by special technology. Field experiments for each selected plant were carried out in a plot with dimensions of 3m·3m for optimal and rapid analysis of the obtained data. Field experiments carried out in such small areas pursue the following goals. Firstly, the process of growth and development, as well as the increase in productivity are analyzed more optimally, and secondly, the dynamics of the ecological state of the soil cover, which includes root systems, is traced in a more convenient form. 8 small areas with dimensions of 3 m 3 m were selected to conduct a full set of field experiments. A control option was intended, where biological activation of the soil layer was not carried out for each selected crop. Biofertilizer was used in the following quantities for four experimental areas. Similarly, the amounts of biopreparations "Baktovit" and "Biomax" for spraying plants were calculated. The calculations were carried out as follows: 10 liters of "Baktovit" and 10 liters of "Biomax" are required for each 300 m² of the area. Then 0.033 liters of "Biomax" were needed for 1 m² of area. As noted above, biopreparations were not used for the control option; biofertilizers were made using a special technology. The results of the field experiments were as follows. The green mass of the tomato plant increased by 21.5%, and the yield increased by 32.6% in relation to the control variant. Similar figures for cucumber, eggplant, and pepper were 31.5% and 37.1%; 41.2% and 44.7%; 29.5% and 34.3% accordingly.

Keywords: biofertilizer, bio preparation, crop, tomato, baktovit, biomax

Determination of DNA polymorphism among cultivated and wild grape genotypes of Azerbaijan with RAPD markers

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Abstract

In Azerbaijan, along the banks of the Kura River and in the Karabakh region, both table and technical grape varieties are cultivated, alongside wild grape varieties. Since ancient times, unripe and ripe fruits of wild Caucasian grapes have been used in medicine, agriculture, and the preparation of special sauces. Studying the genetic resources and biodiversity between wild and cultivated grapes (*Vitis spp.*) is crucial for understanding evolutionary processes, developing conservation strategies, and improving breeding programs aimed at grapevine enhancement. This study investigates the genetic diversity and evolutionary relationships between wild grape genotypes (*V. vinifera* subsp. *sylvestris*) and ancient, valuable cultivated grape varieties (*V. vinifera* subsp. *vinifera*) found around the Kura River in Azerbaijan. It was aimed to detect genetic diversity among grape samples of Azerbaijani origin using Random Amplified Polymorphic DNA (RAPD)-based genotyping analysis. A total of 21 genotypes, including six wild and fifteen cultivated genotypes, were evaluated. Percentage genetic similarities, polymorphism information content (PIC), and resolving power (RP) values were calculated. The minimum similarity between Shirvan-Shahi samples and wild grape samples is 50 percent. The highest genetic similarity was observed between VS6 and VVSH varieties with a similarity index of 0.954.

Mean RP and PIC values were as 3.34 and 0.43, respectively. The results revealed that the average genetic similarity among *V. vinifera* samples was higher than the average similarity index among wild genotypes. Additionally, a high genetic proximity index was observed between some cultivated samples and wild varieties. This research reveals significant genetic differentiation and hybridization events, highlighting unique alleles in wild grapevines that contribute to stress resistance and environmental adaptability. It also provides insights into many historical domestication processes, emphasizing the importance of preserving genetic diversity and proposing strategies to enhance grapevine cultivars' resilience against climate change, pests, and diseases. These findings suggest the need for further molecular marker studies to clarify the evolutionary relationships and origins of these wild grapevines.

Keywords: *Vitis vinifera* subsp. *sylvestris*., *Vitis vinifera* subsp. *vinifera*, RAPD, genetic similarity, molecular marker

***Leucaena Leucocephala* (Lam.) De Wit Restoration of Green Space and Economic Efficiency**

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Abstract

When restoring and (or) expanding landscaping, priority should be given to the use of evergreen, long-lived and more suitable for landscaping, fast-growing, useful species and plant species that are well adapted to local conditions. Taking into account the soil and climatic characteristics of the adjacent territories, it is possible to use *Leucaena leucocephala* (Lam.) de Wit (White-headed Mimosa) as planting material for the restoration and protection of green spaces. The use of *Leucaena leucocephala* (Lam.) de Wit (White-headed mimosa), introduced in the conditions of Absheron, in landscaping, in agriculture, when creating soil-protecting covers brings it to the forefront as a promising species. The grown planting material is planned to be used in forest plantations, adjacent cities and towns, along the sides of highways, around rivers and reservoirs. *Leucaena leucocephala* (Lam.) de Wit (White-headed mimosa) Evergreen shrub or tree with gray-brown bark up to 20 m high, belonging to the *Fabaceae* family, the genus *Leucaena* L., including about 50 species of trees and shrubs, distributed from Texas to Peru. Easily propagated by seeds and vegetatively, grows quickly, is not picky about the soil. Quickly adapts to environmental changes and is drought-resistant. The species *Leucaena leucocephala* completes its development cycle in the dry-subtropical climate of Absheron. In the conditions of Absheron, the bioecological characteristics, generative reproduction, phenology, morphology, and prospects of the plant were studied. If the above-ground part of the species *Leucaena leucocephala* is destroyed by frost, a new one is reborn from its root in the second year. Even during forest fires, the plant is not completely destroyed; the surviving roots grow back. After pruning, it recovers very quickly. The ability of this species to self-heal and quickly produce makes it easy to propagate and quickly create greenery. The plant is used mainly in the production of coal and paper, easily processed water-soluble preservatives, porous, non-deformable during drying, lightweight structures and boxes, various types of fences, furniture, creating shade and enriching the soil with nitrogen. The species *Leucaena leucocephala* has a symbiotic relationship with soil bacteria of the genus *Rhizobium*, which live in root nodules and fix atmospheric nitrogen, some of which is used by the plant, and the rest enriches the soil or other plants. The deep root helps break up compacted subsurface layers, thereby improving water infiltration and reducing surface runoff by preventing saline groundwater from escaping to the surface. To thrive it requires a sunny location with chalky sandy soil pH 8 *Leucaena leucocephala* growing in contour strips helps control erosion on steep slopes. It prevents wind damage and its leaves are used as green manure. Abandoned, previously cultivated fields or cleared forest clearings can be quickly greened using this species. The plant produces seeds for up to 20 years. In ideal conditions it blooms all year round, and the fruits ripen 10-15 weeks after flowering; it can bear fruit in the first year after planting. Often flowers, unripe and ripe fruits appear on a tree at the same time. The plant blooms in april-july, fruits ripen in august-october. The importance of the species *Leucaena leucocephala* (Lam.) de Wit in food and agriculture was studied. Young shoots, young leaves and seeds can be used as vegetables in human nutrition. In the Philippine Islands, the young pods are cooked as vegetables and the seeds are used as a coffee substitute. *Leucaena leucocephala* has a high pollinating ability, which allows it to be used in beekeeping. Ripe or unripe, green or dry, it is prized as an excellent source of protein for livestock feed. The nutritional value is equal to or superior to alfalfa. The wood is hard and heavy, suitable for use as fuel or charcoal, for making small furniture and paper pulp. It is used to make various decorations for tourists in Puerto Rico and the Virgin Islands. *Leucaena leucocephala* (Lam.) de Wit is an important species both economically and environmentally in modern times when global problems such as desertification, erosion and forest fires are raging.

Keywords: *Leucaena leucocephala* (Lam.) de Wit, landscaping, economic efficiency

Estimation of the Pollution Degree of urban Wastewater and Olive Mill Wastewater mixture: Biodegradability Index as an Assessment Tool of Treatment Efficiency

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Abstract

The discharge of untreated olive mill wastewater (OMW) during the olive oil harvest season can negatively affect various ecosystems and water resources, especially the Wastewater treatment plant, due to its high organic and mineral content with the complex mixture of phenolic compounds. This environmental concern poses significant challenges in Mediterranean countries, especially Morocco. This study aims to evaluate the pollution degree of a mixture of urban wastewater from a wastewater treatment plant located in the high Atlas Mountains in Morocco, focusing on the biodegradability index as a crucial assessment tool for treatment efficiency. The biodegradability index, calculated as the ratio of biochemical oxygen demand (BOD) to chemical oxygen demand (COD), was measured in both raw (RWW) and treated wastewater (TWW) for one year to quantify the proportion of organic matter amenable to biological treatment processes. Our findings demonstrate that the biodegradability index of the urban wastewater and OMW mixture varies significantly depending on the proportion of each component, with an average value of 0.46 for RWW and 0.42 for TWW which meets the threshold for effluent biodegradability. Overall, this research provides valuable insights into the pollution characteristics and treatment feasibility of urban wastewater and OMW mixtures, underscoring the potential effectiveness of biological processes in wastewater treatment strategies.

Keywords: Olive mill wastewater, Urban Wastewater, OMW mixture, Biodegradability Index.

Codon Usage Bias Analysis of the DNA Polymerase Gene of *Amsacta moorei* entomopoxvirus and Its Host Adaptability

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Abstract

Amsacta moorei entomopoxvirus (AMEV) is a poxvirus exclusively infecting insects and is the most thoroughly investigated member of the genus *Betaentomopoxvirus*. It has been evaluated as a potential vector for gene therapy, a means to express foreign proteins, and as a biological control agent. One of its open reading frames, AMV050 (AMEV DNA pol gene), encodes a putative DNA polymerase responsible for catalyzing the replication of the viral genome in AMEV. The codon usage patterns of viruses mirror their evolutionary history and genetic structure, enabling rapid adaptation to changes in the external environment, particularly within their host species. Although there has been substantial progress in genomic analyses, the codon usage pattern of AMEV is still not well understood. In this study, we obtained DNA pol gene sequences of AMEV and six reference entomopoxviruses from the National Center for Biotechnology Information (NCBI) database and conducted an extensive analysis to investigate the codon usage patterns in these entomopoxviruses. We employed various bioinformatics techniques to assess nucleotide compositions, relative synonymous codon usage (RSCU), the effective number of codons (ENC), the codon adaptation index (CAI), and other related indices. Together with the analysis of base composition and relative synonymous codon usage (RSCU), the findings indicated a preference for codons ending with A and T in the overall codon usage. The effective number of codons (ENC) showed a pronounced level of codon usage bias (CUB) in the AMEV DNA pol gene. Analysis of the ENC-GC3s plot, Parity rule 2 bias, and neutrality plot indicated that natural selection is a key factor in shaping the codon usage pattern of the AMEV DNA polymerase gene, whereas mutation pressure has a relatively minor impact. Furthermore, the analysis of the codon adaptation index highlighted the high adaptability of the AMEV DNA pol gene to its host. Our research enhances understanding of the evolution of AMEV DNA pol genes and its adaptation to host, providing crucial insights for future foundational research on entomopoxviruses.

Keywords: AMV050, DNA polymerase, *Amsacta moorei* entomopoxvirus, codon usage bias

Changes of some blood parameters in immature rabbits caused by acute hypoxia

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Abstract

Changes in the blood homeostasis of an immature organism immediately after acute hypoxia have been little studied, moreover, there are practically no studies that could assess the level of adaptability of the organisms that had a session of oxygen deficiency. The report presents data on changes in the most important constants (pH, glucose, hemoglobin) and oxidative blood parameters in the immature rabbits after acute hypoxia and subsequent physical activity (PA). The experiments were conducted on 3-month-old Chinchilla rabbits, divided into 3 groups of 5 each. 1st group was subjected to acute hypoxia (20-minute breathing with a gas mixture of 5%O₂+95%N₂), 2nd group – to a 10-minute running load, and the 3rd group – to acute hypoxia followed by running load. Blood samples taken from the ear vein were analyzed 1, 3, 6 h after the appropriate procedures. The glucose levels were measured using a glucometer, and the hemoglobin levels – on an automatic hem-analyzer. Lipid peroxidation (LPO) in serum and erythrocytes was assessed by measuring the concentration of malondialdehyde (MDA). The total antioxidant activity (TAA) of the serum was determined by the reaction of inhibition of Tween 80 oxidation. The obtained blood parameters were compared with those of the healthy controls. It has been shown that the blood pH shifts to slightly acidic values 1 h later of hypoxia. PA following hypoxia leads to a shift in pH to an even more acidic values and delays recovery to control in the slightly alkaline zone. Blood glucose level after acute hypoxia shows a hyperglycemic effect. PA following hypoxia actually has no effect on the glucose level dynamics, although intact animals have some hypoglycemic effect after running. Blood hemoglobin undergoes phase changes after acute hypoxia, which manifests itself as a significant initial decrease and over-recovery in the next period. PA following hypoxia did not produce significant changes in the hemoglobin dynamics, despite the fact that intact animals respond to PA with an initial increase in hemoglobin levels. All these reactions at the homeostatic blood level indicate compensatory and adaptive processes occurring in the organism of immature animals in response to hypoxia effect. The study of the effect of acute hypoxic stress has revealed the changes in free radical oxidation in blood. It has been shown that acute hypoxia leads to both intensification of LPO and activation of the antioxidant system in the blood. In the post-hypoxic period (within 6 h later), an increase in MDA content both in serum and red blood cells was observed; in serum, this indicator stabilizes at a level exceeding the control level, while in erythrocytes continued growth is observed. These changes occur with an increase in the superoxide dismutase (SOD) activity in serum and erythrocytes, which are indicative of an urgent adaptive reaction to the oxidative effect of hypoxia. In order to assess the adaptive potential of blood redox-system to the impact of hypoxia, the effect of physical loading (as the factor increasing oxygen consumption) on the antioxidant activity of serum in the animals exposed to acute hypoxia was studied. Data on the changes in SOD activity and TAA indicate that in the timeframe of 3-6 h after the consistent presentation of acute hypoxia and physical exertion, some instability appears in the oxidant-antioxidant system in immature organism. The conclusion is made that although the most important homeostatic parameters of the blood, such as glucose, lactate, hemoglobin, pH, react to the temporary restriction of oxygen supply by the changes within the physiological limits, the instability found in the free radical system introduces probable uncertainty in achieving homeostatic equilibrium in the blood system due to endogenous resources under the impact of adverse factors. Perhaps, after a certain critical time, the application of the exogenous agents such as antioxidants, antihypoxants will be required.

Keywords: Immature organism, hypoxia, physical load, blood, adaptation.

Anatomical and Morphological Studies on *Helichrysum arenarium* (Asteraceae)

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Abstract

The objective of this research is to conduct anatomical and morphological studies on *Helichrysum arenarium* (Asteraceae) to better understand its biological traits and potential medicinal uses. *Helichrysum arenarium* is a perennial herb with significant medical, pharmaceutical, and ecological importance due to its valuable biologically active compounds. This study argues that detailed anatomical and morphological analysis is essential for accurately identifying this species and distinguishing it from similar species in medicinal collections. The research employed microscopic and histological techniques to examine the internal structures of *H. arenarium* at the cellular level. The study included anatomical analysis of the plant's root, stem, leaf, and flower, focusing particularly on the flower powder to identify key diagnostic features. *Helichrysum arenarium* is a 40 cm tall herb with grayish-white, pubescent stems and leaves, bright yellow flowers in terminal panicles, and one-seeded achenes. The root consists of three layers: epidermis, cortex, and central cylinder, which play crucial roles in water and nutrient absorption and distribution. Microscopic analysis of the flower powder revealed diagnostic features such as fringed teeth of the corolla, ovary trichomes, and specific pollen grain structures. Anatomical study of the stem identified the presence of the epidermis, cortex, and phloem, with the cortex serving as protection and water conservation. The leaves were characterized by stomata and a specific mesophyll structure, facilitating environmental adaptation. The anatomical examination of the flower provided insights into the reproductive traits and pollinator interactions by detailing the structure of the petals, stamens, pistil, anther, and embryo. The anatomical and morphological studies on *H. arenarium* deepen our understanding of its biological properties and suggest new possibilities for its use in medicine, pharmaceuticals, and ecology. The research findings contribute to developing improved methods for cultivating, harvesting, and processing the plant, ultimately enhancing the quality and efficacy of derived products.

Keywords: *Helichrysum arenarium*, anatomical study, morphological study, pharmacognosy, Azerbaijan flora

Algal Flora of Cotton Fields in the Turkestan Region

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Abstract

Cotton fields, despite their economic importance and contribution to the textile industry, pose significant environmental challenges. The main problems associated with cotton cultivation include the use of pesticides and chemical fertilizers, water resources, soil salinization, soil erosion, carbon footprint, health impacts on the population, and the destruction of natural habitats. Intensive use of pesticides and chemical fertilizers on cotton fields leads to environmental pollution. These chemicals can infiltrate soil and water resources, adversely affecting biodiversity and ecosystem health. The algal flora of cotton fields represents a complex of algae inhabiting soils and water systems associated with agricultural lands. These algae play a crucial role in the ecosystem of cotton fields, influencing soil formation processes, nutrient cycling, and the maintenance of biological diversity. Microalgae in the soils of cotton fields perform important ecological functions. They participate in photosynthesis, producing oxygen and organic matter, which serves as a food source for other microorganisms and plants. The algal flora contributes to the accumulation of organic carbon in the soil, improving its structure and fertility.

In this context, the aim of our research is to study the species diversity of cyanobacteria and microalgae in the cotton fields of the Turkestan region. A total of 28 algological samples were collected. During the study, field collections and laboratory analyses were conducted using methods commonly accepted in algological practice. The qualitative composition of cyanobacteria was analyzed using the fouling glass method. For this, the soil samples were placed in Petri dishes, soaked with BG11 medium, and cover glasses were placed on the surface so that they were in full contact with the soil. The dishes were incubated in natural light at room temperature. Cyanobacteria and microalgae were studied using Premere and MicrosAustria light microscopes with magnifications ranging from 40 to 100 times. All samples were microscopically observed and identified based on their cellular morphology as described by Gollerbakh (1953), A.M. Muzafarov (1988), and with updates from AlgaeBase, CyanoDB, and relevant modern taxonomic works. As a result of the study, 45 species of microalgae and cyanobacteria were identified from the soil samples. Among them, five species were yellow-green algae, 19 species were cyanobacteria, seven species were diatoms, and 14 species were green algae. The most frequently encountered species included *Phormidium autumnale*, *Nitzschia palea*, *Chlorella vulgaris*, *Nostoc linckia*, and *Anabaena flos-aquae*. These species represent various taxonomic groups and play key roles in soil processes. *Chlorella vulgaris* is an important component in food chains and nutrient cycling. Cyanobacteria proved to be the most diverse group, including 19 species. The family *Nostocaceae*, which includes the genera *Anabaena* and *Nostoc*, showed the greatest species diversity. Heterocystous forms, such as *Anabaena cylindrica* and *Nostoc commune*, constitute the main portion of cyanobacteria. These organisms play a key role in biogeochemical cycles, especially in nitrogen fixation, which is critical for agriculture. The results of the study, based on collected soil samples, revealed a significant diversity of microalgae and cyanobacteria inhabiting this ecosystem. The observed species diversity of microalgae and cyanobacteria highlights their importance for ecosystem processes and soil fertility maintenance.

Keywords: Algal flora, Microalgae, Cyanobacteria

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Biological Features and Usefulness of *Vitex agnus-castus* L. (Verbanaceae)

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Abstract

More than 1,500 species of plants included in the flora of Azerbaijan are medicinally important, and about 800 of them belong to essential oil plants. The fact that essential oil plants have complex biologically active substances has become the focus of researchers' attention and has led to conducting large-scale, multi-faceted research works. One of such promising essential plants is *Vitex agnus-castus* L., which is well cultivated in the climate of Absheron. *Vitex agnus-castus* (womangrass) belongs to the family of - Verbanaceae - the genus *Vitex* L. in its wild state is common in the Mediterranean Basin, North America, North-Eastern Africa in tropical and subtropical zones, Asia Minor, Iran, forests and reserves of Crimea, Krasnodar, and Caucasus. This is a deciduous tree up to 3 m tall with a wide crown. The branches are hairy, gray in color and have a dark smell. The underside of the branches and finger-shaped leaves are covered with white hairs. The leaves are lanceolate or narrowly lanceolate. The leaves are finger-shaped compound leaves consisting of 3-7 leaflets located opposite each other. The fragrant flowers are dense and clustered at the ends of the branches. Fragrant flowers are collected in dense panicles and false spikes. The tubular inflorescence is five-membered. The calyx is tubular and has five teeth. There are four stamens and they come out from the flower crown. The corolla is light blue in color and is located in a dense cluster of flowers. It blooms from June to September, it looks very beautiful when it blooms. Its small, globose, blackish fruits give a peppery taste when crushed. Pollination takes place through insects. The plant has a very strong and pleasant aroma. Fruits ripe from October to November. This research was conducted in 2020-2023 in the "Introduction and acclimatization of trees and shrubs" and "Essential oil plants" laboratory at the Institute of Dendrology. Propagation of common *Vitex* by seeds Q.A. Firsova (1955), morphological characteristics of sprouts I.T. Vasilchenko (1960), annual height growth A.A. Molchanov (1967) methods were studied. During the study, seed samples collected from local conditions were used. The dependence of seed germination on the time of sowing was studied.

The study of essential oil used plant raw materials from the collection area of the Institute. Determination of ethereality in laboratory conditions was carried out by Clevedger's hydro - distillation method. The weight ratio of the main components of the essential oil was determined in the chromatograph by gas chromatography using a capillary column. The normalization method was used to calculate the masses of the components. As a result of the research, it was determined that vegetative propagation of the plant is more promising. The oil obtained from the raw leaves has a greater effect than the essential oil obtained from its seeds, the leaves are rich in substances with high antimicrobial properties. Its seeds are used in almost all women's diseases. It is used in the cuisine of many countries, especially Eastern countries. Leaves and fruits are added to meat dishes, soups, sausages, canned fish, and jams. It is mainly used in cosmetics, medicine, food industry, aromatherapy and phytotherapy.

Keywords: *Vitex agnus-castus*, essential oil, antimicrobial activity, seed germination, microbial activity, seed germination

A New Home for Cocoa in Bangladesh

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Abstract

Cocoa, *Theobroma cacao*, reserves the mystery of chocolate and relevant products known for delicious taste and multiple other benefits. With an origin in Central America, tropical Africa is the leading producer of raw cocoa in addition to Brazil and Indonesia sharing a significant role. The partial shade loving nature made this tree among the best secondary crop supporting biodiversity and environment. Unfortunately, the climate change and socio-economic factors are threatening global cocoa production causing a decline and price hike. Cocoa product related market in Bangladesh is 100% import dependent though a suitable cultivation environment prevails. This study aims at developing cocoa plantation in Bangladesh with a scientific approach to introduce it as a commercial crop. Further, it focused on processing of cocoa beans to demonstrate manufacturing of useful products.

Seeds were collected from three different sources and a nursery technology was developed first to produce primary seedlings. The soil and water, also physico-chemical and environmental parameters were analyzed at regular intervals, which were found to be aligned with the recommended standards. One year old seedlings were transferred to the experimental field and closely monitored with proper maintenance and care. The first set of flowers were apparent on 3 year old plants, shortly fruit development followed. After a year, a standard manual procedure was performed to produce chocolate bar from the beans.

This work successfully completed nursery technology development and cultivation of cocoa in Bangladesh in addition to some product preparation. A structured feasibility study is required to introduce it as a commercially profitable crop.

Keywords: Cocoa, Nursery, New crop.

Characteristics of soil and climatic conditions of the Lankaran region oncultivation of *Diospyros L.*

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Abstract

Lankaran - Astara region is divided into two parts according to the type of relief: the foothills and the coastal. The hydrological conditions of the region are also very suitable for the cultivation of the The Caucasian Persimmon (*DiospyrosL.*) plant. There are more than 20 rivers and small river beds here. They take their start from the mountain and flow down. The water mode varies depending on their sources. The flow of water in the rivers varies unevenly, which depends on the seasons of the year. These natural conditions influence the richness and identity of the region's vegetation. This causes the region's floristic nature, endemic and relict forms in the botanical composition. The vegetation changes depending on relief, vertical zonality. The mountainous 350- 400m above sea level - the lower third period Hirkan forests are distinguished with with a rich composition variety of vegetation cover. We need to take into consideration the ecological and biological requirements of the region for cultivation of the The Caucasian Persimmon (*DiospyrosL*) plant in order to obtain normal products in the region. Dry and hot winds are harmful for the The Caucasian Persimmon (*Diospyros L.*) plant. Strong winds break the herbs. The The Caucasian Persimmon (*Diospyros L.*) plant extracts water and soluble nutrients from soil. The physical and chemical properties of the soil also have a great impact on the productivity of the *DiospyrosL*.plant. The best soil to buy high quality and high yields is Persimmon (*Diospyros L.*) soil. The plant grows well in thick fertile soil where the ground water is in deep layer. In solid, clayey and waterproof soils its roots easily get ill and diminish its resistance to external environments.

In our research, the characteristics of the soil and climate conditions for the cultivation of the Caucasian Persimmon (*Diospiros L.*) in the Lankaran region were investigated. The natural environment of the Lankaran - Astara region correspond to almost all ecological - biological requirements for the disseminations as well as increasing the high productivity of *DiospyrosL*. The relief of the region, the chemical composition of the soil, climatic conditions are very convenient for plants that produce good crops in a number of subtropical conditions.

Keywords: soil and climate, relief, subtropical conditions

The Role of Visual Communication Design in Promoting Europe's Ecotourism Destinations

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Abstract

Ecotourism is a type of tourism that contributes to the protection of natural areas, increases the economic well-being of local people and promotes environmental awareness. Europe has a significant potential for ecotourism with its rich biodiversity and unique natural beauties. In this context, the promotion of Europe's ecotourism destinations is of great importance both nationally and internationally. Visual communication design stands out as an effective tool in the promotion of ecotourism destinations. Visual communication elements used correctly attract the attention of potential tourists and encourage them to participate in ecotourism activities. The strategic use of visual communication design in the promotion of Europe's ecotourism destinations makes significant contributions to the sustainable development of the tourism sector. The analyses in this study emphasize the critical role of visual communication design in the promotion of ecotourism and offer suggestions for future promotion strategies. In this study, the short film "A Sustainable Journey" and promotional materials prepared by Central Europe Eco-Tourism (CEETO) were examined through semiotics. As a result of the study, it is seen that the video touches on the subjects of ecotourism and sustainable hosting by including images of nature and natural structures, and also emphasizes concepts such as sustainable food, local community, local food, local heritage, relationship with nature, etc. It was observed that written information was predominant in infographics and no visuals were used other than icons. It is noteworthy that the use of natural colors such as green, blue, and gray and yellow were preferred in brochures, posters and infographics. The brochure was designed in different languages in order to achieve international expression.

Keywords: Ecotourism, Visual Communication Design, Central Europe Eco-Tourism, CEETO

Morphological and molecular taxonomy of species of the genus *Satyrium* (Scudder, 1876) (Lepidoptera: Lycaenidae) in the Eastern Anatolia Region

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Abstract

The genus *Satyrium* was established by Scudder in 1876, based on the type species *Lycaena fuliginosa* Edwards, 1861. Nowadays *Nordmannia* Tutt, [1907]; *Strymonidia* Tutt, [1908]; *Superflua* Strand, [1910] and *Armenia* Dubalolov and Korshunov, [1984] is represented by subgenera. The taxonomy of this genus has become quite confusing due to variations in inter- and intraspecific morphological characteristics due to geographical diversity. Therefore, there has a need to test species boundaries with molecular analyses. The results obtained may reflect the evolutionary patterns of taxa in terms of morphological adaptation to environmental trends. In the presented study, the external morphology of six *Satyrium* species in the Eastern Anatolia Region were examined. The first barcoding of *Satyrium* members collected from Eastern Anatolia for species delimitation analysis was performed according to the mitochondrial *cytochrome oxidase-I* gene sequence. Genetic distances between *Satyrium* taxa were calculated according to the Kimura 2-parameter. The phylogeny estimation among all species of the genus was calculated by Neighbor joining and structuring the maximum likelihood trees. According to these results, *S. spini*, *S. ilicis*, *S. abdominalis* and *S. ledereri* have determined as strong species, and populations of *S. marcidum* and, *S. armenium* are in the speciation process.

Keywords: DNA barcoding, genetic distance, Lycaenidae, phylogeny estimation.

Acknowledgement: This work was supported by the Research Council of Van Yüzüncü Yıl University (YYUBAP, Project No: FYL-2022-10040), Van, Türkiye.

In the Poultry Farms of The Western Region of Azerbaijan Common Helminths

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Abstract

Poultry, which is considered one of the efficient areas of agriculture, forms the basis of the country's industry. One of the problems that hinders the development of this field is massive parasite infection of birds. Despite important control measures against invasive diseases, many helminths still cause serious damage to poultry farms. A number of research works were conducted to determine the prevalence of helminthosis in poultry - geese, ducks and chickens - kept in both individual and farm farms of the western region of Azerbaijan. Increasing the effectiveness of anti-helminthic measures, developing more progressive methods and tools for eliminating helminthosis of poultry are among the issues of special importance at present. It is intended to study the modern situation of helminthosis in poultry mainly in geese, ducks and chickens in private and farm farms of Dashkasan, Gadabey and Agstafa regions in the Western region of Azerbaijan and to develop more efficient methods against them from an economic point of view, and to apply them in poultry farms. Also, the use of the most modern technologies in farmers and private farms with different conditions of keeping, growing and feeding, brings to the fore the application of more sophisticated, economically efficient methods that can meet modern requirements in the treatment and prevention of diseases that may occur, as well as mass infections.

Examinations were carried out with K. I. Scriabin's helminthological dissection method. Scalp samples collected from birds were subjected to helmintooscopic and helmintolarvoscopic examinations by Fülleborn, Darling and successive washing methods, and the level and extent of helminth infestations in farms were determined. Different types of helminths were collected from geese, ducks, and chickens as a result of slitting examinations, and the species composition of helminths was investigated. Dashkasan, Aghstafa and Gadabey regions from the regions covering the Western region of Azerbaijan have a favorable economic and geographical position. For this reason, in the course of research, continuous scientific-research experiments were conducted in individual and farm farms located in various villages of the mentioned regions. According to the results of helminthological examinations in Dashkasan, Gadabey and Agstafa regions in the western region of Azerbaijan, some types of helminths were found in the intestines of geese that were slaughtered in the autumn-winter season and the IE was 38.5%. When analyzing the species composition of helminths, it was determined that there were more cestodes than *F. fasciolaris*, *D. lanceolata*, trematodes *E. revolutum*, *E. recervatum*, nematodes *A. anseris*, *C. anseris*, *G. Dispar*. Different types of helminths were found in the ducks and chickens where the analogous slit examinations were performed. Paying attention to the species composition of detected helminths, it was determined that cestodes *F. fasciolaris*, *D. lanceolata*, trematodes *E. revolutum*, *E. recervatum*, nematodes *G. Dispar* dominated.

Keywords: helminths, cestodes, goose, duck, slit examination

The importance of the effect of some environmental factors on the feeding of the mulberry silkworm

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Abstract

The purpose of the research is to study the influence of environmental factors – heat and moisture on introduced mulberry silkworm breeds in the conditions of Azerbaijan. In the course of the study, the influence of environmental factors on mulberry silkworm breeds (China-21, Ukraina-1) was studied in 3 seasons. Recent serious environmental changes, environmental factors have a very serious impact on all living things, as well as on metabolic processes in the body of mulberry silkworm. The impact of external environmental changes, environmental factors on living things, and all living things on the environment is a natural process. The mulberry silkworm belongs to the group of poikilotherm creatures and its body temperature is not constant. The experiments were conducted according to the agrozootechnical rules adopted in sericulture in our republic. During the experiment, phenological observations were made, and the researches were started when 3-5 leaves were formed on the mulberry trees. During the study, the influence of environmental factors on worms was monitored in separate feeding years of the Mulberry silkworm, and temperature and humidity were determined with appropriate devices in accordance with standards. Our experiment was carried out in the spring under unfavorable conditions: the feeding of worms started from the 4th day of the first year until the end of feeding, and the temperature in the room was kept at 26-27°C (norm 23-24°C). Relative humidity was lower than 51-56% (norm 70-75%). The temperature in the room was 28.5°C until the end of the 5th year of the worms. Many of the mulberry silkworm breeds with high productivity under optimal environmental conditions sharply reduce their productivity when exposed to unfavorable conditions. And heat and moisture directly play a major role in the development of mulberry silkworm. All living things in nature come into contact with the external environment, and the rapid or slow course of their development largely depends on external environmental factors. Climatic factors, especially solar radiation, light, heat, atmospheric pressure, relative humidity, soil moisture, wind, create conditions for the development of the biocenosis during the development of mulberry silkworm. Temperature, relative humidity, weathering, leaf quality play a major role in the cultivation and yield of mulberry silkworm.

Key words: temperature, humidity, cocoon, mulberry silkworm, , development.

Acknowledgement: Thank you for accepting my article. I thank all the participants of the SEAB 2024 organization and the multilateral international event organization TÜBİTAK 2223-C for supporting the conference.

Modeling productivity–diversity relationship using artificial neural networks and parametric models in typical uneven-aged and mixed forests in northern Iran

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Abstract

The relative importance of different biotic and abiotic variables in determining productivity remains unclear for many forest ecosystems around the world. This article investigates the productivity–diversity relationship in typical uneven-aged and mixed forests in northern Iran. Using a large dataset from 258 forest monitoring permanent sample plots distributed across uneven-aged and mixed forests in northern Iran, we tested the relationship between tree species diversity and forest productivity and examined whether several biotic and abiotic variables (i.e., solar radiation, topographic wetness index, wind velocity, seasonal air temperature, basal area (BA), tree density, basal area in largest trees (BAL)) had an effect on productivity. In our study, productivity was defined as the mean annual increment of the stem volume of a forest stand in m³ha⁻¹yr⁻¹. Plot estimates of tree volume growth are based on averaged plot measurements of volume increment over a 9-year growing period. We investigated relationships between productivity and tree species diversity using a parametric model, i.e., multiple linear regression, and two artificial neural network models, i.e., multilayer perceptron (MLP) and radial basis function (RBF) networks. According to a sensitivity analysis, diversity had significant and positive effects on productivity in species-rich broadleaved forests (approximately 31%), but the effects of biotic and abiotic variables were also important (29% and 40% respectively). The artificial neural network based on the MLP was found to be superior for modeling productivity–diversity relationships.

Keywords: Biotic and abiotic factors; topographic wetness index; tree volume growth

Talish xerophilic forests and dry subtropical steppe zone soils

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Abstract

Vermic cambisols. This type of soil is spread in Zuvand (below the subalpine belt) in the southwestern part of the middle mountain belt of the region. In this regard, the area where they are formed is characterized by unique mountain-xerophytic phytocenoses. Here, mountain-gray brown soils have developed in valley-hill terrain. These lands occupy the foothills under the bushes in the mountainous part of Talish and cover the lower borders of the forest zone. Mountain-brown soils are mainly formed on the weathering products of carbonate, clay-limestone rocks, calcareous sandstones, conglomerates, delluvial and proluvial sediments. The amount of humus in the topsoil is 5.4-6.8%. The amount of total nitrogen is 0.23-0.40%. The absorption capacity of 100 g of soil varies between 31.3-39.7 m/eq. The granulometric composition is heavy granular and light clay, alluvial-powdery, medium clayey and dusty-silty in the lower and middle layers. It should be added that according to ecological-geographic characteristics, mountain-brown soils are divided into three subtypes: washed, typical and carbonated. The formation of mountain-brown soils in complex relief conditions, as well as exposure to a wide erosion process as a result of the combined effect of natural and anthropogenic factors, has been explained in the literature. Therefore, the amount of sodium cation in the sum of absorbed bases is in most cases below 5%. In particular, it is appropriate to implement comprehensive measures against erosion in the degraded pasture areas to increase the productivity of the lands under summer pasture. Eutric ectysols. This type of soils reflects the zonation within the highlands of the studied region. Here, one of the main indicators of marshy-swampy soils, which is characteristic of the type of swampy soil, is the sharp siltation of the profile. Thus, the amount of physical clay (<0.01 mm) in the soil profile varies between 65-82%. The thickness of the upper layer is 40-45 cm, and its amount is 6-10%; the total amount of humus reaches 10-12% in the fertile layer. Total nitrogen is 0.2-0.3 and more. The granulometric composition of meadow-swamp soils is more pronounced in soils with heavy and long periods of excess moisture. Wetland vegetation spreads along the banks of Vilashchay, Lankaranchay and other rivers, which take their source from springs in the mountains (Komürgey, etc.) located in the highlands of the area. The vegetation of the patchy meadow-swamp soils here consists mainly of hydrophytic and mesophytic plants. It should be noted that the flora of swamps in such areas is considered typical for those lands and enriches the palette of living life. Based on the above-mentioned evidence, we conclude that the meadow-swamp lands of the region are formed surrounded by marshy mountain-meadow lands, as well as riverside and springside vegetation is recorded here. The riverside and spring areas of these lands are used as summer pastures, as well as rural meadows. Thus, we come to the conclusion that the physical and geographical conditions of the mountainous part of Talish and the biodiversity of its flora have not been studied from an ecological and phytocenological point of view. Therefore, for the first time, it created a basis for studying the biodiversity of the wild flora of the area.

Keywords: mountain-xerophyte, carbonate, clayey, humus.

Meadow and meadow-steppe soils of the subalpine zone of Talish

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Abstract

District regosols. Soils belonging to this type are formed in the ecosystem of the mountainous part of Talish and cover a wide area. The mountain-meadow lands spread in the region occupy areas at an altitude of 1800 to 2500 m above sea level. The main characteristic of the type is its richness in organic matter, as well as the subalpine vegetation that spreads on the soil, and grasses that form perennial grasses ensure the soil's fertility. In particular, the amount of humus in grassy mountain-meadow soils (in the upper layer) reaches 11.3-14.7%. However, the amount of humus in the mountain-meadow type soils in the high mountainous part of Lerik region varies in the range of 4.90-6.70%. The morphological characteristics of mountain-meadow soils are expressed in accordance with the conditions of tillage. In these soils, strong sandification and washing of the top layer of soil were observed. Those lands are very divided into genetic layers. In the scientific researches of mountain-meadow soils of Azerbaijan, H.A. Aliyev, M.A. Salayev, G.Sh. Mammadov and others, scientists researching mountain-meadow soils (their soil-cultivating properties, morphological and based on their genetic characteristics): they attributed the mountain-meadow type to grassy mountain-meadow and blackish mountain-meadow subtypes. Grassy mountain-meadow lands are formed in fairly smooth parts of the terrain and in a very low geographical position. The granulometric composition is light and medium loamy, and there are gravelly non-carbonate soils, the thickness varies between 50-100 cm. In such soils, strong erosion processes are evident in moderate and severe degree. In this sense, the acceleration of erosion depends on the disturbance of the humus layer of mountain-meadow soils. These lands are mostly used as summer pastures in Yardimli, Lerik and Astara regions. In particular, about 40-45% of the highland area in the summer grazing areas of the region has been stripped of the mountain structures and turned into rocks, spurs and ravines. Mountain-meadow-steppe lands - Haplic phaeozems. This type of soil is widespread in the heights and slopes of the subalpine meadow-steppe zone (Talysh mountain systems) located at an altitude of 2000-2100 m above sea level in the subalpine zone, as well as in the Peshtasar mountains. Depending on the relief, the soils differ in terms of their degree of development, thickness of the profile, skeletal structure and amount of humus. Thus, they vary according to the amount of humus in thick and less skeletal soils; high, skeletal soils formed on steep and low-humidity slopes are low in humus and more prone to erosion. The granulometric composition of mountain-meadow-steppe soils is heavy and medium loamy. In particular, the amount of physical clay fluctuates between 32.3-62.0% and particles between 12.7-15.48%. It is known that the pomegranate particles of the soil were washed away due to the effects of erosion processes and the amount of the previously mentioned indicators decreased significantly. Humus, which is an indicator of the fertility of the corresponding type of soil, was 5.80-1.20% of the profile of non-eroded mountain-meadow-steppe soils, while on the contrary, it was between 2.98-1.0% in eroded soils. In this regard, differences in total nitrogen and total phosphorus content were also determined. In this sense, in the non-eroded type of soils, the total amount of absorbed bases was 45.20-47.85 mg.eq in the upper layers (in 100 g of soil), while in the eroded types, it was 25.20-27.90 mg.eq. contane. The amount of humus in this type of soil varies between 5.2-7.4%. Therefore, the amount of nitrogen fluctuates between 0.26-0.56% and the absorption capacity between 39-65 mg.eq. The amount of humus in this type of soil varies between 5.2-7.4%. Therefore, the amount of nitrogen fluctuates between 0.26-0.56% and the absorption capacity between 39-65 mg.eq.

Keywords: humus, clay, erosion, subalpine, steppe.

Changes In Soil Indicators Along The Highway Due To Anthropogenic Effects

Maharramova Sevinj¹

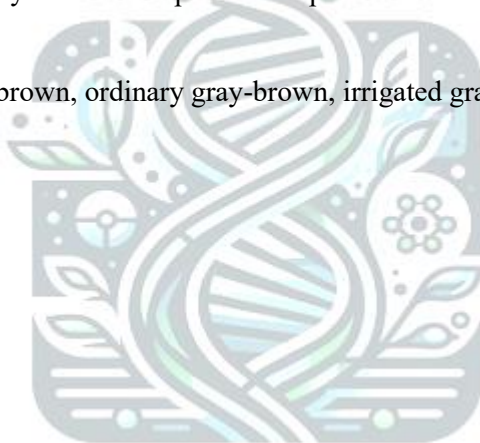
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Abstract

Recent changes in land use practices, sometimes improper, have led to decreased soil fertility indicators and subsequently reduced plant productivity. Research conducted in the Ganja-Gazakh region of Azerbaijan explored various aspects of soil, yielding specific findings. It was determined that dark gray-brown, ordinary gray-brown, and irrigated gray-brown subtypes are prevalent in the region, classified under mountain brown (chestnut) soil type. Consequently, it is crucial to assess soils used for different crops along the Ganja-Gazakh highway, evaluate their current condition, and devise strategies for improvement.

Various plants were cultivated along the Ganja-Gazakh highway in Azerbaijan for research purposes, with experimental plots selected at characteristic sites. The selection of sites for experimental plots was based on visual inspections and existing soil maps. Chemical analysis of soil samples from genetic layers in the experimental plots was conducted using widely accepted methods in the republic.

Keywords: soil, dark gray-brown, ordinary gray-brown, irrigated gray-brown, genetic layers



Therapeutic Effects of Combination Therapy With 3AB and Low Dose Cisplatin on Cervical Cancer Cells

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Abstract

Chemotherapy is one of the primary methods for treating cancer patients. However, due to the side effects and undesirable outcomes caused by many chemotherapeutic drugs, studies have shown that administering existing chemotherapeutic drugs in lower doses and in combination can mitigate these side effects in patients. In this study, we examined the therapeutic effects of combination therapy with 3-aminobenzamide and low-dose cisplatin on cervical cancer cell lines. Within the scope of the study, cisplatin (100-1500 ng/mL), 3-aminobenzamide (1-1000 µg/mL), and their combinations (IC20 cis + IC50 3AB) were administered to the cells in the determined dose ranges. The cytotoxic effect of the compounds on the HeLa cell line was determined by the WST-8 assay. According to the calculations, the IC20 value of cisplatin was found to be 201 ng/mL, and the IC50 value of 3-aminobenzamide was found to be 239.4 µg/mL. After being administered in combination, the survival rate for IC20 cis + IC50 3AB was calculated as 16.7%. The effects of cisplatin and 3-aminobenzamide alone and in combination on OCT-4 gene expression in the HeLa cell line were analyzed by qPCR. According to the results, the treatment effects of IC20 cisplatin, IC50 3AB, and IC20 cis + IC50 3AB on OCT-4 gene expression were found to be 3.3, 0.7, and 5.8-fold downregulation, respectively. In light of these results, it was observed that the applied compounds, especially the combination of low-dose cisplatin with 3-aminobenzamide, caused a significant suppression in OCT-4 gene expression compared to the application of the drug alone. Consequently, it has been added to the literature that a more effective treatment strategy for cervical cancer can be developed by applying low-dose cisplatin in combination with other inhibitors.

Keywords: Chemoresistance, 3-Aminobenzamide, low-dose cisplatin, HeLa

Effect of Biological Diversity in Crop Rotation on Biochemical Indicators and Yield in Green Mass of Corn, Soybean and Winter Forage Pea

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Abstract

Currently, it is known that population growth in the world is many times higher than the growth of protein production. It is a necessary and irreplaceable substance for life. Providing the population with food products, as well as with protein and high-calorie food items, is one of the main problems ahead. Green fodder is the basis of fodder base of our republic. Green fodder differs from other types of fodder due to its high nutritional value. The quality indicators and nutritional value of green fodder differ sharply depending on the soil-climatic conditions, duration of cultivation, and the variety of the plant, and this situation is more noticeable in legumes. Along with the increase in productivity in agriculture, the increase in product quality is also important. Taking into account that the quality indicators of green fodder are high in the phase of bean formation for soybeans and winter fodder peas, and in the phase of milk ripening for corn, samples of plants mentioned in these phases were taken and analyzed in the study. As a result of the inclusion of plants with agrobiological characteristics in the crop rotation, green and above-ground dry biomass and grain yield, as well as quality indicators, increased. Along with the mentioned plants, the dynamics of accumulation of green and dry biomass of corn was studied, and it differed in that the amount of digestible protein in its product in the milk ripening phase (36 and 32 g in 1 kg of dry matter, depending on the planting schemes) was less than that of legumes. Factors that lead to a decrease in green mass yield in continuous crops (decrease in soil fertility, the amount of pests and weeds being more than in rotation cropping, etc.) have also been observed to have an effect on its quality indicators. Based on the results of the research, the green mass yield of 559.4 and 302.0 s per hectare in the phase of formation of beans of autumn fodder pea "Azerbaijan 1508" and soybean variety "Biyson" in rotational cropping, and 537.6 and 249.2 s per hectare in continuous cropping was determined. The amount of protein is 24.5 and 9.2 per hectare for the plants mentioned in the rotation; oil was determined at 5.0 and 3.1 s. From the "Zagatala 420" variety of maize, 581.3 s per hectare was obtained in the milk ripening phase in the rotation cropping, and 517.6 s per hectare in the continuous cropping. The amount of protein in the green mass was 9.0 and 7.9, fat 2.5 and 2.4, and ash 7.0 and 6.2%, respectively. In the course of research, it was found that the green mass yield of winter fodder peas and soybeans in the phase of bean formation is 21.8 and 52.8 s per hectare, respectively, compared to continuous cropping. and corn was 63.7 s higher in the milk ripening phase. Accordingly, the quality indicators of the product differed. The amount of quality indicators (except for cellulose, AEM) in the absolute dry matter of plants mentioned in the alternate cropping option was higher than that of continuous cropping.

Keywords: crop rotation, continuous planting, green mass yield, green fodder, diversity

Acknowledgement: I express my deep gratitude to your Organizing Committee for organizing an important symposium and at the same time publishing the results of our scientific research. Participation is important to us

Physiological Processes in Plants under Various Spectra of Light

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Abstract

For all living beings present in nature, the primary source of energy is solar radiation. Light and illumination are among the main ecological factors in the life of green plants. Overall, 3.5% of light reaches the Earth, and depending on the Earth's movement, light falls on the Earth's surface every 8 minutes. Of the mentioned illumination, 1% is used in the photosynthesis process of green plants, 1% is reflected from the leaf surface to the atmosphere, and 1.5% is the energy of living beings in the seas and oceans. The spectra of light change depending on the rotation speed of the Sun. The angle at which the Sun's rays fall significantly affects the germination of seeds and the formation of roots in plants. If the Sun approaches the zenith during the midday hours, then ultraviolet rays increase, and infrared rays decrease. In such cases, the illumination will consist of violet and yellow rays. When the Sun rises early in the morning, the spectra are mainly infrared and green. For the normal development and adaptation of plants, it is more effective for the illumination spectrum to be collective. In such cases, the height and development of plants are at the same level, and they are in a pollinated state. Sometimes, the thickness and density of the cloud layer can also affect the intensity of the light spectra falling on the Earth's surface. Experimental studies are needed to learn about the variability caused by the effects of mono spectrals on plants. For this purpose, trees and shrubs of the same age have been placed in separate chambers, and they have been placed in chambers with white light and other mono spectrals separately. Before placing the experimental plants in the chamber, the height of the plants' vegetative organs, the number of leaves, and the total amount of chlorophyll in the leaves - determined per 5 mm² area, were determined with a chlorophyllometer, after which the plants were placed in the chamber. After 10, 20, and 30 days of the experiment, bio morphological determinations were made in various organs of the tree and shrub plants. During the experiment, from the beginning to the present, the plants were always illuminated with mono spectrals (for 10 hours), the relative humidity of the chambers was kept stable at 60-65%, the above-ground parts were continuously sprayed with water, and the soil in the pots was watered. During the experimental trials, 4-year-old seedlings were used, they were planted in previously prepared pots with a volume of 1kg, placed in separate monospectral chambers, the duration of illumination was 9 hours, and the temperature, relative humidity, and ventilation were kept at the same level, with white light and seedlings from the collection of the Dendrological park of the same species used as a control variant. The experiments were continued from April to October. Observations in plants were carried out during the spring, summer, and autumn seasons, and it was noted that in the Japanese privet *Liqustrum japonicum* L., European olive *Olea europaea* L., Japanese loquat *Eriobotrya japonica* (Thunb.) Lindl., palm *Chamaerops*, cypress, and juniper - depending on the illumination, no significant variability was determined in the biometric morphological structure, only the formation of leaves in green light. In blue light, the stretching of stem cells and height growth, in red light, the transverse growth of leaves and the predominance of chlorophyll "b" over chlorophyll "a" were confirmed, and the positive effect of red light on the development process was noted. As a result, we can say that light spectra carry a special significance in the life of plants. However, since the effect of individual mono spectrals - green, red, and blue spectra - creates different degrees of energy effect depending on quantum energy, the height and development of plants are not the same, depending on the biological affiliation of the plants.

Keywords: chlorophyll, mono spectrum, growth, development

Change of Characteristics of the Quality Indicators of tea Leaves During the Vegetation Period Depending on Geographical Relief

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Abstract

Tea growing is an economically efficient and highly profitable activity in the field of agricultural production of the Republic of Azerbaijan. For more than 100 years Chinese tea species *Thea sinensis* L. is planted and cultivated in the Lankaran-Astara region, which is a subtropical area of the Republic of Azerbaijan. Since tea growing is a profitable field, it is currently cultivated in large areas of tea fields in the southern region of our Republic - Lankaran, Astara, Lerik, Masalli, as well as Zagatala-Balakén regions in the northern region. The study was conducted in 2022-2024 in the river areas located in Khanbulan village of Lankaran district and Hucu village of Lerik district, which is a subtropical area with high humidity. Soil samples were taken and its water capacity and water holding capacity, mechanical and organic components and some metal ions were determined. The tea plant is very sensitive to environmental factors. It is demanding on soil acidity, relative humidity of atmospheric air, light and heat. Therefore, in our study, in order to ensure the dynamic development of the tea plant, samples of podzol-yellow and podzol-clay-yellow soil were taken. The areas where tea is cultivated are mainly plains or mountain slopes. The soils of these areas belong to podzol-yellow or podzol-clay-yellow type, and metal ions are distributed in different amounts. Thus, since the types of soils common in this region - podzol-clay-yellow and ensure the presence of metal ions in the lump, it affects both the quality of tea leaves and the antioxidant character of the biologically active compounds of the extractive substance (summary), as well as the color shades of tea. It was clear from the researches that depending on the relief of the areas and the vegetation period, the quality of tea leaves varies considerably. It has been proven that when the height of mountain slopes is 600 and 700 m (Hücü village, Lerik), the quality indicators of flashes are much higher and stable. It is known that tea growers collect the initial leaves (2nd and 3rd leaves) of the plants several times during the development period as flash. Flavonoids - tanin, catechin-tanin complex, flavonol, caffeine and extractive substances in the flash are its quality indicators and have antioxidant properties. From the conducted bioecological and biochemical determinations, it became clear that flavonoids, which are the quality indicators of tea leaves (flash), ensure the health of the human body, as ecologically healthy food, they are indispensable antioxidants in the process of metabolism. The quality indicators of the extractive extract obtained from flashes depend on metal ions - green, pink, velvety, black fractions are obtained. Tea is a non-alcohol drink, which is significantly different from other drinks due to its nutritional value, biochemical properties, active effect on people's health and comfort. Tea is the second most popular non-alcoholic drink after water in the world, including in our republic. It has a tonic effect on the human body. Therefore, people use tea as a means of removing fatigue and general weakness from the body. Rich biochemical content of tea confirms its physiological and biochemical value. From this point of view, tea is the real beauty of Azerbaijani people's tables.

Keywords: *Thea sinensis* L., flash, flavonoids, metal ions, antioxidant.

Evaluation of International Day for Biological Diversity 2024's Social Media Posts in Terms of Visual Communication Design

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Abstract

Biodiversity refers to the variety of all life forms, namely plants, animals, microorganisms and their genetic material, within an ecosystem or worldwide. This term encompasses genetic diversity (genetic differences within a species), species diversity (number of different species) and ecosystem diversity (variety of different ecosystems or habitats). International Day for Biological Diversity is a global event celebrated every year on May 22nd and aims to raise awareness about the conservation and sustainable use of biodiversity. In 2024, social media posts made within the scope of this event have great importance in terms of visual communication. Visual content attracts attention more quickly and effectively than written content. Content is usually consumed quickly on social media platforms. Therefore, using visually appealing designs is important to attract the attention of the target audience and increase their engagement. Visual communication design helps to convey messages more effectively by simplifying complex information and making it easier to understand. Infographics, video content and graphical data presentations in particular make information understandable and attractive. This study aims to evaluate social media posts for the International Day for Biodiversity 2024 from a visual communication design perspective. Animated graphic designs were preferred in social media designs for the International Day for Biodiversity. Different language options were created to customize the target audience. In this way, the target audience was encouraged to re-share the message. In the teaser prepared for the International Day for Biodiversity 2024, the target audience is encouraged to participate with the phrase Share information about your event. #PartOfThePlan was preferred as the hashtag in the posts. In this context, a call for cooperation was made to stakeholders.

Keywords: Biological Diversity, Social Media, Visual Communication Design

***Ephedra major* and *Ephedra equisetina*: Comparative Phytochemical Analyses and Their Effects**

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Abstract

Ephedra, one of the oldest medicinal plants used in traditional alternative medicine worldwide, serves as a potent remedy for treating a variety of stimuli such as the common cold, bronchial asthma, cough etc. Our study aimed to identify the phytochemical composition and assess the DNA protective activity of *Ephedra* species, specifically *Ephedra major* and *Ephedra equisetina*. *Ephedra major* is known to contain moderate levels of ephedrine, along with components like flavonoids and tannins, traditionally utilized in the treatment of respiratory tract diseases. *Ephedra equisetina*, on the other hand, contains higher concentrations of ephedrine and other bioactive compounds, widely used in traditional medicine for treating asthma, bronchitis, and allergic reactions. Upon examining the study findings, both plant species exhibited comparable levels of total phenolic and flavonoid compounds in both tests, indicating their content of phenolic and flavonoid substances and their potential for antioxidant activity and DNA protection. Additionally, a significant DNA protective effect was observed at a concentration of 0.5 mg/mL even in the presence of Fenton's reagent. These findings highlight the therapeutic significance of *Ephedra* species in traditional medicine, particularly in managing respiratory ailments, and underscore their potential as sources of natural antioxidants and DNA protective agents

Keywords: *Ephedra major*, *Ephedra equisetina*, DNA protective agents, Phytochemical analyses

Contributions to Description of *Persicaria amphibia* (Polygonaceae) in Türkiye

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Abstract

Persicaria amphibia (L.) Delarb. is the rather few truly amphibious plants with so different terrestrial and aquatic forms that many unexperienced botanist think they are different species. The aim of this study was to update the morphological characteristics of *P. amphibia* considering the populations distributed in aquatic and terrestrial environments. For this purpose, samples collected from their natural habitats and kept in the Herbarium of Recep Tayyip Erdoğan University, Department of Biology, and plants in other national and international herbariums were examined in detail. Morphological characteristics of the collected specimens were examined in detail under stereomicroscope and some of the important traits were photographed for further interpretation. As a result of these examinations, it was determined that in the aquatic forms of *P. amphibia*, ochrea is glabrous, the leaves are oblong, the petiole is 0.4–8 cm and completely glabrous. In contrast, the ochrea is hairy, the leaves are lanceolate, the petiole is 0.2–2.8 cm and distinctly hairy in terrestrial forms. The taxon has been confirmed from 71 localities in Türkiye. In addition, it was determined that the *P. amphibia* is mostly distributed in Iran-Turanian and less widespread in Europe-Siberian and Mediterranean phytogeographic regions in our country. In this study, the all populations of *P. amphibia* distributed in Türkiye were examined morphologically in detail and a new key including both terrestrial and aquatic form of *P. amphibia* were prepared for Turkish Flora. It was also determined that there are some morphological differences in plants distributed in terrestrial and aquatic environments and supplied important contributions to the description of *P. amphibia*.

Keywords: Anatolia, Aquatic form, Morphology, *P. amphibia*, Terrestrial form

Acknowledgements: This study was supported by Scientific and Technological Research Council of Turkey (TUBITAK) under the Grant Number 219Z024. The authors thank to TUBITAK for their supports.

Morphological and Chorological Contributions to the Genus *Cionura* (Apocynaceae: Asclepiadoideae) from Türkiye

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Abstract

Cionura is a monotypic genus represented by *C. erecta* which has a wide range of distribution from southeastern Europe to the Mediterranean regions and Afghanistan. The aim of the present study is to re-evaluate the morphological features and the distribution of *C. erecta* in Türkiye. Morphological examinations were performed on the samples kept in national/international herbaria and the specimens newly collected from natural habitats of the genus. An extended description supported by detailed morphological photographs, and a current distribution map for *C. erecta* in Türkiye were created. *C. erecta* is characterized by shrub or semi-shrub twining stems, simple, opposite, ovate, and basally cordate or subcordate leaves, white or cream-yellow flowers consisting of a typical gynostegial, parted corona, and gynostegium with apically bifid stigma. In this study, *C. erecta* was examined morphologically in detail, and its description was contributed. This research also supplied 147 new locality records for *C. erecta* in addition to its knowledge in the Flora of Türkiye, and the number of known localities from our country for the taxon was revised as 169. It is determined that *C. erecta* has a wide distribution in Türkiye, excluding northeastern Anatolia, in various habitats such as beaches, *Quercus* sp. and *Pinus* sp. forest clearings, maquis shrublands, roadsides, rocky and stony slopes, stream beds, and lakesides from sea level to higher regions up to 2500 m.

Keywords: *Cionura erecta*, chorology, monotypic, morphology.

Molecular and Morphological Description of *Epigaea gaultherioides* from Türkiye

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Abstract

The genus *Epigaea* is represented worldwide by 3 species, and these species exhibit limited distribution. *E. repens* in the eastern part of N. America, *E. asiatica* in Japan, and *E. gaultherioides* in SW Transcaucasia and in Türkiye. The species *E. gaultherioides* is found in the Caucasus region, including Türkiye, at elevations of approximately 900-2300 meters in the border areas of Georgia and Türkiye. Although there are studies on the morphology of this species, there are no studies on its molecular structure and phylogeny. The aim of this study is to reveal the differences of the *E. gaultherioides* species from other species using both morphological and molecular studies. The difference between *E. gaultherioides* and the other two is in the color, shape and size of corolla, inflorescence and structure of leaves. *E. gaultherioides* has a large corolla (4-7 cm) with lobes 0.7-1.1 cm, stamens 10 and thus almost funnellform; the inflorescence consists of 1-2, rarely 3 or 4 widely spaced flowers. In the case of *E. repens* and *E. asiatica* the corolla is much smaller, with a long tube (salverform) and the more numerous closely spaced flowers form a very dense cluster. Chloroplast genome matK gene region sequences of the specimen are determined and compared with similar taxa. Gene sequences were generated molecular studies depend on matK gene region because there aren't use any other gene region for other *Epigaea* species. The MEGA Maximum likelihood and dendrogram analysis show that the total sample divides into three groups corresponding to each species. As with the similarities in their morphological characteristics, phylogenetic analyses have revealed that the species *E. asiatica* and *E. gaultherioides* (68%) are more closely related to each other, whereas the species *E. repens* (99%) forms an almost entirely separate group. It has been determined that the species *E. repens* differs from the other two species both morphologically and molecularly. Diagnostic characters, description, and conservation status of *E. gaultherioides* are provided.

Keywords: Caucasus, *Epigaea*, molecular, morphological, Türkiye.

Molecular Description of Some Medicinal Aromatic Lamiaceae species from Artvin, Türkiye

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Abstract

DNA barcoding serves researchers in various fields such as the classification of living organisms, food safety, and determining the purity of food products. DNA barcoding, one of the modern molecular biology techniques, is successful in species identification and the discovery of unknown species. It also provides precise and accurate results in areas such as determining the authenticity of processed or unprocessed food products that are commercially important and detecting food fraud. In this study, barcode gene sequences of four medicinal and aromatic plants from the genera *Teucrium* and *Origanum* of the Lamiaceae family, which are distributed in the Artvin province, were created: *Teucrium polium*, *T. hircanum*, *Origanum vulgare*, and *O. rotundifolium*. Two different gene regions known as barcode regions (ITS, matK) located in the nuclear and chloroplast DNA of the plants were sequenced. The DNA sequences obtained from these gene regions were uploaded to the reference databases of NCBI (National Center for Biotechnology Information) and BOLD Systems (Barcode of Life Data Systems). Additionally, the establishment of a National DNA Barcoding Database has been initiated, and the DNA barcoding processes for these plant species, which are naturally distributed in Artvin and prioritized for the project, have been completed and registered on behalf of our country. A phylogenetic tree was constructed for these species, and their degrees of relatedness were determined. A haplotype analysis was performed by aligning one sample obtained in this study with 23 sequences of the *matK* gene region for *Origanum vulgare* stored in GenBank using the MAFFT program (669 bp). According to the haplotype analysis results, the sample obtained in this study was identified as a new haplotype. the genetic distance (K2P) between haplotypes ranged from 0.01% to 0.4%. In this study, the ITS region of the *Origanum rotundifolium* species obtained was found to be identical to the GU381463 sequence stored in GenBank. Within the scope of this study, both international databases have been examined and international information flow will be facilitated through the database to be created.

Keywords: DNA barcoding, Lamiaceae, medicinal-aromatic plants, *Origanum*, *Teucrium*.

The Antibiofilm Potential of *Camellia sinensis* Against *Pseudomonas aeruginosa* (PAO1)

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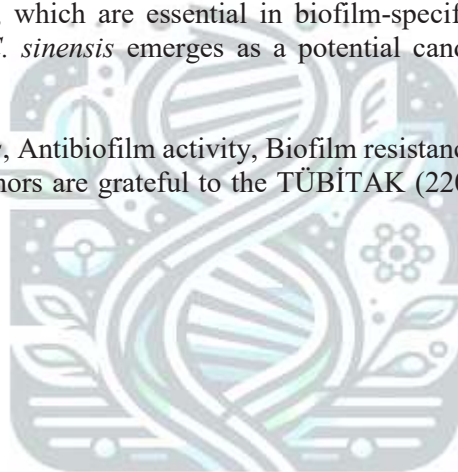
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Abstract

The importance of biofilms in infectious diseases is getting more interesting. Despite this, an antibiotic with antibiofilm properties has not yet entered clinical use. Therefore, in this study, it was aimed to investigate the antibacterial and antibiofilm properties of *Camellia sinensis*. Initially, *C. sinensis* samples collected from the Giresun province were individually extracted using methanol and ethanol. Then, antibacterial properties were examined by microdilution test, and antibiofilm was examined by crystal violet, microscopy, SEM analysis and qRT-PCR method. Our results indicate that the methanolic and ethanolic extracts showed no activity against *Staphylococcus aureus*, but exhibited an MIC value of 128 µg/mL against *Pseudomonas aeruginosa*. Furthermore, it induced morphological changes, reduced adhesion capability, and declined the expression levels of the *ndvB* and *lasB* genes, which are essential in biofilm-specific antibiotic resistance in *P. aeruginosa*. Consequently, *C. sinensis* emerges as a potential candidate for combating biofilm resistance in *P. aeruginosa*.

Keywords: *Camellia sinensis*, Antibiofilm activity, Biofilm resistance, *ndvB*, *lasB*.

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Evaluation Of The Tourism Potential Of Erzurum Nene Hatun Historical National Park

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Abstract

Protection of nature is one of the most important concepts that human beings have to focus on today. Land and sea areas established and governed by law to ensure the continuity and protection of biological diversity and natural and cultural resources are defined as "Protected Areas". Protected areas differ from other areas with their ecological, cultural and socio-economic characteristics as well as their biological diversity. National parks, one of the most important classifications of protected areas, have "natural", "historical" and "both natural and historical" features according to their types. This study was carried out in Erzurum Nene Hatun Historical National Park, which was declared in 2009 with a size of 387 hectares and located within the borders of Yakutiye District of Erzurum Province. In this study, the existing potential of the national park has been classified in terms of values that constitute a source of tourism at regional level. SWOT Analysis technique was used as a method in the research, and the strengths and weaknesses, opportunities and threats of the area in terms of historical resource values were tried to be determined. With the help of SWOT analysis, observations and studies conducted in the region, existing and potential tourism activities were evaluated and classified. Aziziye, Mecidiye bastions, Nene Hatun Mausoleum, trenches, martyrs' cemeteries, material elements and traces used in the war, which constitute the resource values in Erzurum Nene Hatun Historical National Park, were discussed. As a result of the research, the types of tourism that mutually benefit from each other (historical tourism, mountain and nature walks, botanical tourism, etc.) were determined under the headings of use, re-functioning and protection of the national park for tourism purposes, and then the national park was generally introduced. With the studies carried out, the opportunities and problems of the National Park are analyzed and suggestions are made for the solution of the problems.

Keywords: National Park, Erzurum, Tourism Potential, Eco-tourism

Contributions to Conservation Biology of endemic *Ferula huber-morathii* (Apiaceae) in Türkiye (Alpaslan Dam II Example)

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Abstract

As human beings' interest and knowledge towards the environment increases, they feel more responsibility for the sustainability of the environmental order. In recent years, biodiversity, one of the most prominent components of the environment, has started to become the center of attention by taking its share of this responsibility. The current situation has been determined with biodiversity inventory studies on both a global and national scale. In 2019, the biodiversity inventories of all provinces in Turkey were completed and the results were shared on the platform called "Noah's Ark". After the current situation was revealed, it was understood that more effort and time should be given to creatures that are in the threat categories classified by the International Union for the Conservation of Nature (IUCN) and are facing the threat of extinction.

In this study; how *Ferula huber-morathii* (Apiaceae) (Helizan in Turkish name), which is in the EN (Endangered) category and locally endemic and only distributed in Erzurum and Muş provinces in Turkey, was affected by the Alpaslan II Dam built on its distribution area, how this effect was minimized with protection works and what was done to increase its population and the results obtained by focusing on the processes of these works were shared. *In situ* conservation (*in situ*) and *ex situ* conservation (*ex situ*) methods, which are two important strategies in the conservation biology of *F. huber-morathii*, were applied. The translocation of rooted individuals before the dam's water retention time and the cultivation trial with 400 seeds by surrounding a 400 m² area with wire fence within the species' habitat were considered as *in situ* conservation, germination performance studies of the seeds collected from natural populations were carried out in different environmental conditions in the laboratory environment and the compatibility of germinated seeds with soil in cultivation containers was tested, then their compatibility in natural environments was examined. In addition to all these, in order for conservation biology studies to be successful, the local people in the habitat of the species should be informed about this plant and become volunteer protectors in the field in conservation studies. For this purpose, endemic plants training was carried out on 4 groups including primary school, middle school, high school students and adults. The success of the endemic training was measured with pre-test and post-test in the trainings carried out in schools and attitude surveys in the trainings carried out with adults and shared as a result.

Keywords: *Ferula huber-morathii*, conservation, endemic, education

Acknowledgement: This work was supported by ENERGO-PRO. Also thanks to environmental engineer Muhammed Fatih AYDIN from ENERGO-PRO in addition to Prof. Consulting and Entrepreneurship (PDG).

A New Cynipid Record (Hymenoptera: Cynipidae) from Türkiye

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Abstract

Cynipid species belonging to the Cynipidae family (Hymenoptera: Cynipoidea) are known as gall wasps and are found on every continent except Antarctica. Based on recent phylogenetic studies, more than 1500 species in this family are classified into 10 tribes. The number of taxonomic and faunistic studies on gall wasps (Cynipidae and Diplolepididae) has increased in recent years in order to reveal the cynipid diversity of Türkiye. As a result of the studies conducted so far, Türkiye's gall wasp fauna is represented by a total of 174 species, with 167 species belonging to the Cynipidae family and 7 species to the Diplolepididae family (rose gall wasp). To further enrich the gall wasp fauna, a field study was conducted in Burdur province, Türkiye, in May 2024. Gall samples were collected from the buds of young shoots of *Quercus trojana* Webb in the sampling area (Türkiye, Burdur, Yeşilova, Niyazlar, 37°28'N, 29°43'E, 1305 m a.s.l.). These gall samples were photographed and transported in glass jars to the Entomology Research Laboratory (ERL-PAU) for the emergence of adults. The galls were checked weekly, and available literature was used for species identification. As a result of the study, the sexual generation of *Dryocosmus destefanii* Cerasa & Melika, 2018 was determined and it is recorded from Türkiye for the first time. Both asexual and sexual generations of this species were described in Italy, and only its distribution in Italy was known. It is thought that the distribution of this species, which forms galls on oaks belonging to the section Cerris, will be detected in other Mediterranean countries in the future. Furthermore, this study has once again demonstrated that similar taxonomic or faunistic research conducted in Türkiye will contribute to the country's fauna.

Keywords: Gall wasp, *Dryocosmus*, *Quercus trojana*, oak, Burdur.

Production and Optimisation of Lipase Enzyme from *Anoxybacillus gonensis* Using Hazelnut Shells

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Abstract

Lipases are enzymes that play an important role in living organisms. Although lipases are normally known as hydrolases that break down fats and separate fatty acids, they are widely used in bioconversion processes because they can also catalyse esterification and transesterification reactions in the absence of water. They play an important role especially in fat digestion, absorption and metabolism. They are also widely used enzymes in the biotechnological field. In recent years, interest in lipases has increased due to their potential industrial applications. Most of the commercially produced lipases are obtained from animal and microbial sources. It is a simple and reliable method to produce lipases from microorganisms. Examples of these microorganisms are bacteria, fungi and yeasts. Studies have shown an increasing interest in new enzymes (hydrolases, lipases and esterases) isolated from extremophilic bacteria. In this study, 11 thermophilic bacteria were isolated from water samples taken from Pasinler hot spring in Erzurum. Then, D2 isolate, which showed the best lipolytic activity among these strains, was selected and the identification phase was started. As a result of conventional analyses, the test strain was isolated at 2% salt concentration, pH: 7.0 and 55°C, catalase, gram, oxidase positive, motile and rod cell morphology. 16S rRNA sequence analysis showed that the test isolate was 99% similar to *Anoxybacillus gonensis*. Then, the extracellularly synthesised lipase enzyme from strain D2 was purified by three-phase partitioning (TPP) method. In the first step, optimum studies were carried out to realise the production of the enzyme at the highest rate. Enzyme production optimization results were determined as pH 7.0, 72 hours, 4 g of hazelnut shell waste (treated with 2% NaOH) and temperature 55°C respectively. The highest activity value of lipase enzyme using hazelnut shells was determined to be 96.2 U/mL. As a result, in the study, 31.45% efficiency and up to 6.78 times safety were obtained. The aim of this study was to isolate and optimize the bacteria with the best lipase enzyme activity using hazelnut shells instead of standard medium.

Keywords: Hazelnut Shell, Thermophile, *Anoxybacillus gonensis*, Lipase

Three phase partitioning for simultaneous purification of soybean (*Glycine max L.Merrill*) polysaccharide , protein and biomolecules using a single-step extraction

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Abstract

Peroxidases are oxidoreductases that are widely used in clinical, biochemical, industrial and biotechnological fields. Peroxidases in plants play a role in different effects such as defense mechanism, lignification and oxidative reaction. This successful first single-step extraction method is used to simultaneously purify protein, polysaccharide and biomolecules from soybean (*Glycine max L.Merrill*) using a fast, effective and low-cost three-phase partitioning method (TPP) is released. This three-phase method is the addition of ammonium sulfate directly to soybean extract and then storage by adding tert-butanol. As a result, in this study, 85% efficiency and up to 8 times safety were obtained. Time, temperature, pH, plant extract/t-butanol ratio, ammonium sulfate density, properties of the effects on treatment with oxidizing agents. This temperature, pH and bulk density of t-butanol were optimized. The optimized effect was formed at 30 degrees, pH 6 and 50% ammonium sulfate saturated solution with plant extract-t-butanol ratio of 1:2 (v/v) and room temperature for 60 minutes. The carbohydrate ratio in the lower phase changed to 81%. The statistical activity of the upper phase, i.e. t-butanol, was determined as 90%. After the enzyme was partially purified, it was analyzed by using SDS-PAGE analysis. As a result, by using TPP, in single – step the purification of both carbohydrates, proteins and biomolecules from the soybean (*Glycine Max L.Merrill*) plant was carried .

Keywords: Peroxidase, TPP, *Glycine max L.Merrill*, enzyme, carbohydrate

Impact of Modern Climate Changes on Population Health

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Abstract

The article is devoted to research to identify the relationship between climate change and human health. The key provisions and conclusions of the synthesis reports of the Intergovernmental Panel on Climate Change are noted. The direct and indirect effects of climate change on human health are considered. According to studies by the WHO Regional Office for Europe, the main dangerous factors leading to an increase in the burden of diseases in the population associated with climate change are: heat and cold waves, extreme hydrometeorological situations, shortage of drinking water of adequate quality, disruption of infrastructure as a result of the increased frequency of dangerous hydrometeorological phenomena, increased degree of air pollution in large populated areas, degradation of permafrost zones. Initiatives in the field of adaptation to negative climate change carried out in the European region are analyzed. The review was formatted following the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline [13]

Keywords: climate change; human health; World Health Organization; European Union countries; environmental factors.



The Impacts of Climate Change on The Forests Of The Zagatala State Nature Reserve

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Abstract

Zagatala State Nature Reserve is located on the southern slope of the part of the Greater Caucasus physical-geographical region belonging to our country, and at the same time in the northwest of our country. This area is geobotanically located in the territory of Guton-Shahdag and Iberia geobotanical regions. The territory of Guton-Shahdag district is the highest part of the area where we conducted research. Subalpine and alpine meadows, typical for high mountain regions, cover large areas in this region. Broad-leaved forests have formed in the territory of Iberia region. As you go from the bottom to the top in the territory of the reserve, the air temperature naturally decreases and the natural conditions change, accordingly. This type of climate change in mountainous areas ultimately leads to the creation of natural conditions that are not favorable for the existence of forest-forming tree species and to the low growth of trees. Forests formed by short trees, which are common in the upper parts of the forest belt, are not as productive as forests in the middle and low mountain belt. The density of trees present here decreases and dense grass cover develops between such sparse trees. In this strip, grass cover with sparse trees creates special meadow-forest complexes. Experts call such natural complexes "park forests". In this zone, the trunks of tree plants take a bush-like shape or are spread over the surface of the earth. Forests in the territory of the reserve are divided into zones as follows: Forests of the low mountain belt. These forests are spread over typical and washed brown mountain-forest soils in a temperate-warm climate with approximately equal distribution of precipitation throughout the year at altitudes of 1000-1100 meters above sea level. In this belt, oak, beech and walnut trees occupy a dominant position. Single chestnut and linden trees are also found in these forests. Forests of the middle mountain belt. These forests are located at an altitude of 1000-1100 meters above sea level and up to 1800 meters above sea level in a mild-warm climate where annual rainfall is approximately evenly distributed, mainly on brown mountain-forest soils, and in rare cases on brown mountain-forest soils under oak forests. Eastern beech dominates these forests. In this belt, the Iberian oak is the second most widespread. In these forests, beech and oak trees are mixed with walrus. Forests of the high mountain belt. These forests are spread in areas with an altitude of 1800-2200 (sometimes 2300 m) meters above sea level. Eastern beech, eastern oak, Trautfetter birch, and aspen trees dominate in this belt as forest-forming tree species. These forests are mainly formed on brown mountain-forest soils. Caucasian rhododendron is also found at the upper border of this zone. The modern flora of the Zagatala State Nature Reserve has undergone a long historical development from the end of the Cretaceous period of the Mesozoic era to the present. During this period, the flora of the southern slope of the Greater Caucasus physical-geographical region belonging to our country, including the flora of the Zagatala State Nature Reserve, has undergone great changes due to climate changes. Here, the process of forming new plants continues. Ultimately, new plant forms emerge. Endemic trees, shrubs and herbs grow in the territory of the reserve. The forest belt existing in the territory of the reserve is bordered by thickets of Caucasian rhododendron and juniper bushes. It should also be noted that more than 60% of the territory of the Zagatala State Nature Reserve consists of untouched broad-leaved forests. In addition to the height of the area above the world ocean level, the tree species of the area under our study are strongly influenced by the relief conditions, especially the direction of the slopes. In recent years, due to the change in the Earth's climate on a planetary scale, certain changes have been observed in the species composition of the flora existing in the territory of the reserve. Thus, there is an increase in the number of plants in the territory of the reserve, including forest-forming tree species, and tree species that require humidity. In our study area, climate change is causing frequent flooding events in many river basins, which in turn is causing soil erosion and forest degradation.

Keywords: Great Caucasus, physical-geographical, northwest, geobotany, forest, meadows.

Exploration of the role of Palmyrah palm (*Borassus Flabellifer*) in Biodiversity and Ecosystem development in Batticaloa and Jaffna district, Sri Lanka.

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Abstract

Palmyra is a palm, belonging to the family Arecaceae also known as *Borassus Flabellifer* distributed all over Asian countries. The tree can grow up to 25 to 30 meters in height and has a massive black trunk. The life span of Palmyra is more than 100 years. The Palmyra tree is ecologically and economically important, providing benefits to the environment and humans. It supports a diverse range of flora and fauna. The Palmyra tree is a highly adaptable species that can thrive in tropical conditions. Also, Palmyra has various genetic variations itself such as *Borassus flabellifer* (Indian and Malayan spp.), *B. deleg* (Sudan), *B. heiniana* (NewGuinea) etc where the tree shows different types of symbiotic behaviour such as mutualism, commensalism, amensalism, parasitism and predation, with various of species in the environment. This study explores the various kinds of relationships with Palmyra and other species and through its contribution how the biodiversity and ecosystem can be protected from climate change. The first part of the study carried out landscape analysis which was conducted in Batticaloa and Jaffna districts in Sri Lanka. There were 11 types of flora such as Neem (*Azadirachta indica*), Fragrant screw-pine (*Pandanus odorifer*), Banyan tree (*Ficus benghalensis*), (*Asparagus racemosus Willd*), *Spinifex littoreus (Burm.f.) Merr*, Honey Suckle Mistletoe (*Dendrophthoe falcata (L.f.) Ettingsh.*), Erect Prickly Pear (*Opuntia stricta (Haw.) Haw*), Ceylon date palm (*Phoenix pusilla*), Crown Flower (*Calotropis gigantea (L.) Dryand.*), Sponge gourd (*Luffa aegyptiaca*), Bushweed (*Flueggea leucopyrus Willd.*) and 6 types of fauna were observed the Oriental garden lizard (*Calotes versicolor Squamata*), Monkey (*toque macaque*), Red-vented bulbul (*Pycnonotus cafer humayuni*), Ashy Woodswallow (*Artamus fuscus*), Indian Roller (*Coracias benghalensis*), cow and there were weaver birds nest observed in 50 trees and more 40 termiterium observed in various locations. For wet lab analysis, 2 types of experiments were performed. Gram staining, Catalase test, urease test, indole test, citrate test and TSI test were performed to identify the bacteria. *E.coli*, *Salmonella* and *Enterobacter* were given positive to the tests. To identify Soil pH in the soil and leaves sample, the pH was changed from 8 to 6.2-7 throughout 4 weeks. The questionnaire survey was conducted among 60 Palmyra climbers and people who do small business on Palmyra wood, leaves and fruit in the east, North and North-west provinces in Sri Lanka, questioned about their relationship to Palmyra and the species they encountered when working with the Palmyra tree and its products. There were other species mentioned as well, such as mynas, eagles, squirrels, ants, garden lizards, monitor lizards, parrots, frogs, pigeons, bats, sparrows, woodpeckers, cobras, monkeys, goats, rabbits, pigs, rats, and caterpillars. The majority reported encounters with snakes, crows, bees, and wasps, mostly in summer and rainy seasons. Participants have a mutual relationship with the Palmyra tree and experience inter-species antagonism with other species. The study aims to explore the interconnection between Palmyra, biodiversity, and ecosystem. The research conducted a thorough analysis and the results revealed that the area is a thriving habitat for an extensive variety of flora and fauna, consisting of numerous species of plants, animals, birds, and microorganisms.

Keywords: Palmyra tree, symbiosis, biodiversity, ecosystem, landscape analysis.

Acknowledgement: This work was supported by a senior thesis research Grant, Asian University for Women, Bangladesh. SS acknowledges CACM, Batticaloa for the support.

Reproduction of *Jacaranda mimisifolia* D. Don belonging to the family Bignoniaceae Juss., genus *Jacaranda* L. in conditions of Absheron

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Abstract

Most of these plants are imported from foreign countries. These plants, belonging to the family Bignoniaceae Juss., are rare. However, most of the plants in this family are decorative. With this in mind, efforts were made to reproduce in our republic *Jakaranda mimisifolia* D. Don, belonging to the genus *Jakaranda* L. With seed propagation of *Jacaranda mimisifolia* D. Don, which belongs to the genus *Jacaranda* L., the winged seeds were separated from the shell after fruits collected in the current dried. Collected seeds are soaked, kept for a day at room temperature. Seeds are sown to a depth of 1-1.2 cm in soil enriched with a special extract in autumn, in September, and in spring, at the beginning of April. From time to time the field was agrotechnically maintained. Seeds began to germinate at a temperature of 22-24°C. Seed germination in both cases lasted 2-3 weeks. When the seeds germinate, you need to work so that the area is lit. For seeds sown in spring, the percentage of plant germination by the end of the growing season reached 3.2-3.4%. Of the seeds sown in autumn, the first sprouts began to appear in the second decade of October, the germination rate was 4.3%. In the greenhouse conditions, from seeds sown in the second decade of September in autumn, the first sprouts began to appear in the first decade of October, and according to the results of the growing season, 4.6% of seedlings were obtained. From the seeds sown in the first decade of April in spring, seedlings began to appear in the third decade of April, and at the end of the growing season, 5.2% of seedlings were obtained. Plants 20-30 cm high were transplanted into open ground in the second decade of May. At the same time, this plant is also propagated by the driven method. Shoots planted in greenhouse conditions develop better. In August, plants of the first growing season begin to form umbrellas. Maintaining the temperature in the greenhouse at 22-24°C from April to the second decade of October had a positive effect on the productivity of the plant. It is known that in the greenhouse conditions, plants shed their leaves at temperatures below 16°C. In the leaf changing periods of the of *Jacaranda mimisifolia* D. Don in spring (March-April) and autumn (September-October), watering is reduced. It should also be taken into account that the water in the area where *Mimosa Jacaranda* is planted in the conditions in the greenhouse should be soft and left for a day before watering. Since *Jacaranda mimisifolia* D. Don is grown in tropical conditions, the air humidity must be high. When transplanting plants in open conditions, it is desirable to ensure good ventilation of the root system of the plant, and sprinkle the lower part with expanded clay and peat. It is better to plant species 1-2 months before planting in the field in pots with a diameter of 9-11 cm. After the plant has fully recovered in the pot, transfer it to the selected area. Feeding *Jacaranda mimisifolia* D. Don should be carried out periodically, it should be provided with complex mineral fertilizers.

Keywords: *Jacaranda* L., condition, species, develop, plants

Ornithological Importance of Bulanık Lowland (Muş)

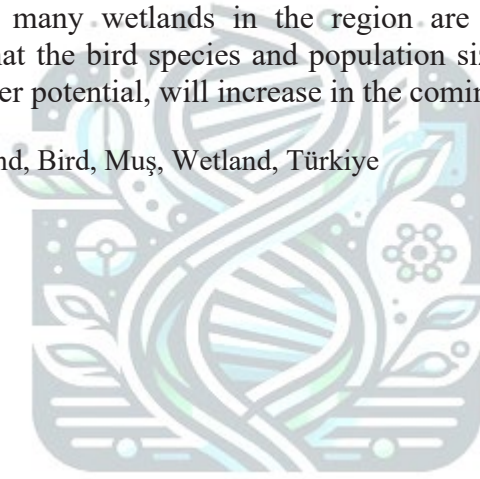
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Abstract

This study was carried out between 2021 and 2023 in the Bulanık lowland located within the borders of Bulanık district of Muş province. The area, located on Turkey's eastern bird migration route, provides a very important ornithological useful with its different habitat structures. 113 bird species were identified during four season observations, taking into account the climatic structure of the area. Among the bird species identified, Egyptian Vulture (*Neophron percnopterus*) is under threat (EN) according to the IUCN category, Northern Lapwing (*Vanellus vanellus*) is under near threat (NT), European Turtle-dove (*Streptopelia turtur*) and Common Pochard (*Aythya ferina*) are vulnerable (VU) category. The remaining 109 species are in the low critically (LC) category. The Crane (*Grus grus*) is the flag species in the region which uses the reeds and meadows in the area for breeding. Due to climate change, many wetlands in the region are in danger of drying out. However, it is thought that the bird species and population size of the Bulanık lowland, which has significant water potential, will increase in the coming years.

Keywords: Bulanık Lowland, Bird, Muş, Wetland, Türkiye



A Faunistic Research on The Helophoridae and Hydrophilidae Families of İkiz Lakes (Tekirdağ)

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Abstract

This study was carried out in two lakes, one small and the other large, called İkiz Lakes, located in Pınarca village of Kapaklı district of Tekirdağ province. They are two different lakes, located approximately 500 meters away from each other, fed by two different branches of the Kurt stream, one of the branches of the Çorlu Stream, which separates from the Ergene River. An average of 6 locations were determined for each lake and sampling was carried out from these locations for 2 years. As a result of the study, 4 species from the Helophoridae family (*Helophorus aquaticus*, *H. griseus*, *H. obscurus*, *H. montenegrinus*) and 13 species from the Hydrophilidae family (*Anacaena limbata*, *Berosus affinis*, *Cymbiodyta marginella*, *Enochrus fuscipennis*, *E. quadripunctatus*, *E. affinis*, *E. nigrinus*, *Helochares lividus*, *Hydrobius fuscipes*, *Limnoxenus niger*, *Hydrochara flavipes*, *Laccobius gracilis*, *Coelostoma orbiculare*) 17 species were identified and the distribution of these species in Turkey and the world are emphasized. All of these species have been determined as new records for Tekirdağ province.

Keywords: Helophoridae, Hydrophilidae, İkiz Lakes, Tekirdağ, Türkiye

Acknowledgement: This work was supported by Atatürk University with the BAP project no. FBA-2022-10950.



Optimization of Sterilization Protocols for Biotechnological Propagation of *Corylus avellana*

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Abstract

Hazelnut (*Corylus avellana*) is one of the main food crops that people have focused on commercial cultivation since ancient times. The composition of the hazelnut is quite rich in important elements, both for its nutritional and pharmaceutical value. After the discovery of the secondary metabolites formed in the hazelnut as a result of its life activity, this plant attracted the attention of scientists in a completely different direction. The compounds formed in its composition are a biological alternative source of expensive anticancer compounds obtained through chemical synthesis. Taxols, the main molecule of paclitaxel drugs successfully used in oncology, are metabolic products of *C. avellana*. Although they are synthesized chemically in large quantities in pharmaceuticals, the isolation of such compounds from natural sources has always been a priority issue of the medical world. With the help of biological technologies, it is possible to obtain such compounds both sterile and without harming the environment. The discovery of important compounds in environmentally accessible materials also contributes to the important problem of our planet, "biodiversity conservation". Secondary metabolites are formed not only in the seeds of hazelnuts, but also in parts that are waste products of the food industry. The aim of this study was to test several variants of the sterilization protocol for obtaining the callus culture of *C. avellana* and to select the most optimal one. *C. avellana in vitro* asepsis is difficult for a number of reasons, such as the effectiveness of the means used for sterilization, high bacterial and fungal contamination, the presence of high amounts of phenolic compounds, and necrosis of the explant after the collection of the latter. In the first test variant, 3 different schemes of a sterilization protocol, differing in the duration of exposure to sterilizing substances (3, 5 and 10 min.), were applied. Additionally, in one variant, an antifungal substance was used in that protocol. In the protocol used in our study, the main sterilizing agents were NaClO (active substance 5%), KMnO₄. These substances and other agents were used in 3 schemes. As a result of the study, it was found that a 5-minute sterilization process according to the scheme and the use of an antifungal agent significantly increase the chance of obtaining sufficiently uninfected material.

Keywords: *Corylus avellana*, sterilization protocol, taxol, sterilizing agents, *in vitro*.

Ecological characteristics and essential oil content of rose hips (lat . rosa) growing in the territory of Fuzuli region freed from occupation of Azerbaijan

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Abstract

Rose hips (lat. Rosa) - rose-like plant genus belonging to the Rosacea family. Out of 300 species of this genus, 42 species are found in Azerbaijan, 36 of which are wild. 2 types are more important for industry. These are brown and wrinkled hips. It grows in forests, thickets and along rivers of northern and temperate climate zones. It is common in the Greater and Lesser Caucasus regions of Azerbaijan, as well as in the mountainous areas of Talysh. All species of rose hips are shrubs of different heights (up to 0.6-2.5 m), with thorns on their trunks and branches. More than 2,000 types of plants can be found in the area with rich vegetation. On the foothills of the mountains, there are stony, sibiya, wormwood-combush steppe and semi-steppe plants, and on the slopes of the mountains, thickets, broad-leaved forests (pistachio, oak, etc.) occupy a large place. According to the climatic conditions, the territory of the district belongs to the hot-dry climate type. The research work started at the beginning of May. The plant is found on the slopes, along the road, along the river banks, along the foothill settlements. It is resistant to shade, diseases and pests. In nature, it reproduces generatively and vegetatively. During the research, it was determined that the height of the hip bush is up to 1.5-2.5. The branches and trunk are covered with strong, hook-like thorns. The leaves are elliptic or inverted egg-shaped and have 3-5 pieces. The edges of the leaves are serrated. The upper and lower parts are covered with weak hairs. Its flowering starts from the beginning of May and lasts until the end of June. Its flowers are fragrant with essential oil according to the literature, it was determined that essential oil is widely used in perfumery and medicine. In addition to the high amount of vitamins C, B1, B2 and K in its composition, the hips containing protein, minerals, potassium, sodium, calcium, magnesium, phosphorus and fruit acids have many health benefits. It blooms once during the growing season. The flower is very fragrant and is white, pink and in some cases light pink in color. its diameter is up to 7-8 cm. It is located singly in the flower cluster. The fruit begins to ripen at the end of September and at the beginning of October. It has a berry-like fruit, red spherical or oblong in shape. The inner surface is densely covered with hairs. Ripe fruits are bright red or orange in color. As the reluts of yhe studt samples of the essential oil medicinal plant rose hip were collected. It was submitted to the laboratory for the purpose of obtaining essential oil from its samples. Essential oil was obtained from the collected samples by steam distillation and its percentage was studied. The amount of essential oil is up to 0.15-0.2%. The chemical composition of essential oil was studied by the gas-liquid chromatography method of the brand "Kiristal" 2000 M. Raw material samples were collected, essential oil was obtained in laboratory conditions, and the % amount was determined. It was determined that 1.04% limonene and 0.38% nononal are predominant in the obtained essential oil.

Keywords: Ecological property, essential oil, chemical composition.

Current problems of biodiversity conservation in the Republic of Azerbaijan

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Abstract

The Republic of Azerbaijan is a country with the richest natural resources in the Caucasus region. Due to its biological diversity, Azerbaijan occupies one of the unique places in the world. Rich species of plants and animals are concentrated here. The fauna of modern Azerbaijan has 18,000 species of animals and includes 97 species of mammals. The biodiversity of the Azerbaijani flora includes medicinal, essential oil, ornamental, fruit and other useful plants. It should be noted with regret that as a result of prolonged thoughtless human economic activity, the biological diversity of the vegetation cover of our republic has been degraded, modified, reduced, and sometimes destroyed. Conservation of biodiversity is an important aspect of the sustainable development of any country. In Azerbaijan, which has unique natural resources, these issues are becoming especially relevant. This article is aimed at analyzing and evaluating the economic aspects of biodiversity in the Republic of Azerbaijan. Azerbaijan is actively working in the field of biodiversity conservation through legislative measures, programs and strategies, paying attention to both national and international aspects of this problem. With its unique natural resources, Azerbaijan is facing various difficulties that threaten its ecosystems and biodiversity. To solve these problems, it is necessary to identify key environmental risk factors that are priorities for the conservation of the country's biodiversity: high concentration of industrial enterprises; development of the oil and gas complex with possible negative consequences of exploration, production and transportation of hydrocarbons; the presence and development of manifestations of dangerous physical and geological processes; availability of facilities – potential sources of man-made emergencies; Unacceptable accumulation of solid household waste in the vicinity of settlements; transformation of natural systems as a result of non-ecological farming, unregulated traffic, fires, unjustified collapse of water bodies and the construction of dams; reduction of biodiversity, first of all, the number and area of distribution of populations of rare plant and animal species as a result of unregulated (over normative and poaching) use of them and increased loads on biological resources; Insufficient incentives for the development of environmental education and upbringing of various segments of the population, as well as the introduction of economic measures to stimulate environmentally oriented consumption. By analyzing these aspects, we can understand what measures and strategies can contribute to the sustainable development of the country, the conservation of nature and its riches, as well as the well-being of the local population. It is only through the joint efforts of the Government, society and scientific communities that it is possible to ensure the sustainable development of natural ecosystems and the preservation of the country's unique natural heritage for future generations

Keywords: biodiversity; environmental risks; Azerbaijan; economic aspects.

Evaluation of plant species diversity and floristic characteristics in plant ecological group in relation to altitudinal gradient, Kourdkoy forest, North of Iran.

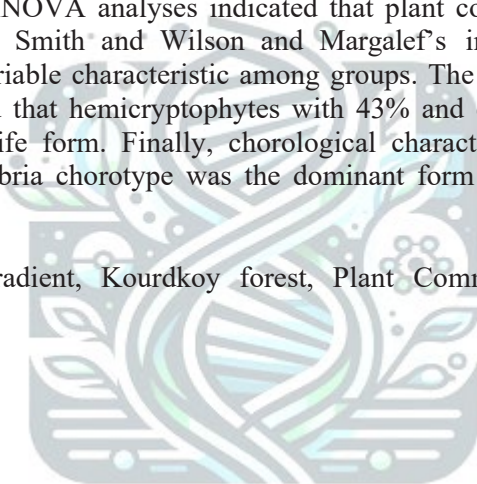
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Abstract

Vegetation cover is the living part of ecosystem which is a consequence of environmental factors that are prevailed in ecosystems. This study was done to investigate the effect of altitudinal gradient on plant species communities in the Kourdkoy forest, Golestan province, 48 circular plots (1000 m²) were established using a random- systematic sampling design method in the six altitudinal classes from 500 to 1700 m a.s.l in 200 m intervals. So, tree and herbaceous species were measured in each 1000 m² plots and 100 m² subplots, respectively. In total, 60 plant species belong to 37 families, 55 genera and 5 plant communities including Cyclameno-Fagetum, Carexeto-Fagetum, Athyriumeto-Fagetum, Athyriumeto-Fagetum and Galiumo-Fagetum were identified. The results of ANOVA analyses indicated that plant communities were different in terms of Shannon-Wiener, Smith and Wilson and Margalef's indices ($P \leq 0.05$). Whereas, altitude factor was only variable characteristic among groups. The life form spectrum based on Raunkiaer method revealed that hemicryptophytes with 43% and cryptophytes with 22% have been the most dominant life form. Finally, chorological characteristics of the plant species indicated that the Euro- Sibia chorotype was the dominant form with the highest number of species.

Keywords: Altitudinal Gradient, Kourdkoy forest, Plant Communities, Species Diversity, TWINSpan.



Green Technologies of Soil and Vegetation Cover

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Abstract

Soil-vegetation technologies are also divided into two parts. Technologies aimed at ensuring the stable presence of soil-vegetation cover in natural flora and the improvement of indicators characterizing that presence. Technologies that ensure the sustainable existence of soil vegetation in agrocenoses and at the same time are aimed at increasing productivity. One of the important advantages of soil-vegetation technologies is that, unlike other technologies such as machine building, device manufacturing, and other technologies, the implementation soil-vegetation technologies is very cheap, and this factor ensures that these technologies are very economically profitable. Another important advantage of soil-vegetation technologies is that the implementation process of these technologies involves a large number of people. The lack of implementation of soil-vegetation technologies is that the net income (profit) obtained at this time is very low compared to other technologies. It is for this reason that famous science centers such as Fraunhofer and Max Planck centers, which deal with the transfer of high science intensive technologies to the market economy, have not looked at such soil-vegetation technologies as a separate research object. As a result of the researches, the following initial systematization of high science-intensive soil vegetation technologies to be applied in the conditions of Azerbaijan was carried out. Systematization aimed at the integration of research results into the educational process, which includes the development of transfer models of soil-vegetation technologies to market needs. The development of technology that improves soil fertility and plant productivity, the formation of a new concept called "ecology of plant productivity" within the framework of science-education integration, and the implementation of preliminary activities for its use within the framework of training and education methodology. Restoration of man-made polluted lands with ecologically clean, inexpensive methods and development of rehabilitation technology. Ensuring the implementation of the assessment of ecological and economic benefits to be obtained within the framework of modern standards. Preparation of materials for a free seminar on the restoration of man-made contaminated land with ecologically clean methods for students majoring in the field of ecology within the framework of the integration of science and education. Implementation of assessment of the ecological condition of summer and winter pastures of Azerbaijan. The restoration of the ecological state, especially the development of technologies aimed at the rehabilitation of the green cover, the determination of the effect of the ecological state of pastures on climate changes, the formation of a new concept called "ecology of climate changes" within the framework of the science-education integration model and implementation of preliminary activities for its use within the framework of training-educational methodology.

Keywords: green technologies, soil, plant cover, ecology.

Development prospects of pistachio (*Pistachia L.*) in Azerbaijan

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Abstract

The pistachio plant (*Pistachia L.*) has been of interest to people since ancient times due to its valuable industrial and medicinal plant, as well as its longevity and ability to grow in difficult conditions. Another and one of the most important superior qualities of pistachios is drought resistance. Currently, in a time when the world's water reserves are running out, it is possible to grow pistachio in areas where the cultivation of other fruit crops is not suitable. All these positive qualities have made pistachio the most attractive plant in the agricultural field. The first places in pistachio production are occupied by Iran, USA and Turkey. In terms of productivity and production, the United States remains the leader in the world market. Of course, the main reason for this is the innovative style of cultivation and the modern scientific and technological approach. Looking at the worldwide pistachio export figures, it becomes clear once again how pistachio is a strategic fruit on a global scale. Pistachio production has been very weak in Azerbaijan for many years. So, different samples were brought and planted many times, but it was not possible to cultivate it widely. In this regard, great efforts are being made to satisfy the population's demand for pistachios. From this point of view, the establishment of pistachio orchards and plantations, extensive cultivation and production of fruits in our country has been set as a goal. For this, first of all, cultivars and varieties resistant to biotic and abiotic factors of the environment, stress factors should be identified and planted, their bioecological characteristics should be studied in detail so that it is possible to predict the optimal conditions for their cultivation and submit them to the state variety test. From this point of view, the topic is very relevant and is of great importance as a priority issue. The soil and climatic conditions of many areas of Azerbaijan are very favorable for growing pistachio. It was also calculated that the funds spent on planting pistachio plants are much lower than the funds spent on planting other fruit crops. From this point of view, it is more appropriate to plant large gardens of this plant in our country, rather than importing pistachio fruits at high prices from abroad. It should be noted that Absheron pistachio varieties grown in Azerbaijan have always been known for their popularity. So, these varieties do not lag behind the varieties produced in the world with their indicators, and even have many advantages. Many of those varieties are cultivated in the collection area of the Absheron Experimental Station. The main goal before us is to plant gardens of these varieties in large areas and promote them in the world market. As a result of the research, it was calculated that if a pistachio garden is planted in a 6x3 scheme on a total of 500 hectares in the country, 264000 trees will be produced. And after 15 years, if each tree yields at least 5 kg (1320000 kg), it makes 1320 tons of pistachios. With this indicator, it is possible to fully cover the country's demand for pistachios from abroad at the expense of domestic production. As we mentioned above, pistachio has a longer life than other fruits. If we take into account that productivity has increased several times in the following years, we can confidently say that we can prevent millions of foreign exchange funds spent on foreign markets by meeting the domestic demand in terms of food security. The pistachio plant can be considered as the most successful and suitable plant in the direction of restoration of areas with global climate change, water problems and desertification. This can be beneficial for our country both economically and ecologically in the future.

Keywords: variety, food, industry, ecological, economic

Biological Diversity Analysis of Insect Fauna in Forest Nurseries of The Western Black Sea Region of Türkiye

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Abstract

In this study, a survey of insect species was carried out in seven forest nurseries of the Western Black Sea Region. The insect samples were collected using sweep nets, light traps, Scandinavian three funnel pheromone traps, visual control method, and pitfall traps between May and September during 2021 and 2022. The insect samples were examined under a stereo microscope and scanning electron microscope, and then identified by using related literature. Some insect specimens were identified by scientists. The alpha and beta diversity analyses have been conducted for the obtained data. SHE analysis was used to examine the relationships among species richness, Shannon information function, and evenness. Also, Hulbert's family of diversity index, Hulbert-Smith-Grassle index of order w , Rényi's generalized entropy, Tsallis generalized entropy, and Hill's diversity number of α profile techniques have been calculated. Finally, principal component analysis was performed to evaluate the effects of all parameters. In total, 4 orders, 16 superfamilies, 26 families, 50 subfamilies, 77 tribes, 92 genera, 105 species, and 710 individuals were collected. The most abundant order was Coleoptera (79.25%-84 species), followed by Hemiptera (11.32%-11 species), Lepidoptera (5.66%-6 species), and Hymenoptera (3.77%-4 species). A total of 438 individuals were captured in pheromone traps, while 189 individuals were collected with visual inspection, 51 individuals with light traps, 29 with sweep nets, and 3 with pitfall traps. In 2021, a total of 288 specimens were collected. The greatest insect abundance was recorded in August (19%, 131 individuals). In 2022, a total of 422 specimens were captured and the greatest quantities were obtained in July (18%, 128 individuals). Shannon-Wiener and Simpson diversity indices showed that the highest species diversity was recorded in Muzaffer Büyükterzi and Çayırköy Nurseries with 3.231 and 0.946, respectively. Margalef's richness index was the highest in Muzaffer Büyükterzi Forest Nursery with 9.360. The highest Simpson's dominance index was recorded in Gököy Forest Nursery with 0.169. The highest Shannon and Simpson evenness was recorded in Çayırköy Forest Nurseries with 0.936 and 0.661 respectively. The highest beta diversity (dissimilarity) was recorded between Muzaffer Büyükterzi Forest Nursery and Pınar Forest Nursery with 0.795. As a result, the highest species diversity was determined in Muzaffer Büyükterzi Forest Nursery in all profile techniques. Finally, SHE analysis showed that Çayırköy Forest Nursery had higher diversity.

Keywords: Biodiversity, Coleoptera, Hemiptera, Hymenoptera, Nursery

Acknowledgement: This work was supported by the Düzce University Research Fund, Project Numbers 2020.02.02.1144 and 2022.02.02.1355. The authors greatly acknowledge the support of the General Directorate of Forestry. The authors also thank to Prof. Dr. Kürşat Özkan for their help during the calculation of diversity profile techniques.

Study on biodiversity of vascular plants in the forest reservoir of Caspian Poplar (*Populus caspica* Bornm.), Safrabasteh, Astanehe Ashrafiee, Guilan, North of Iran

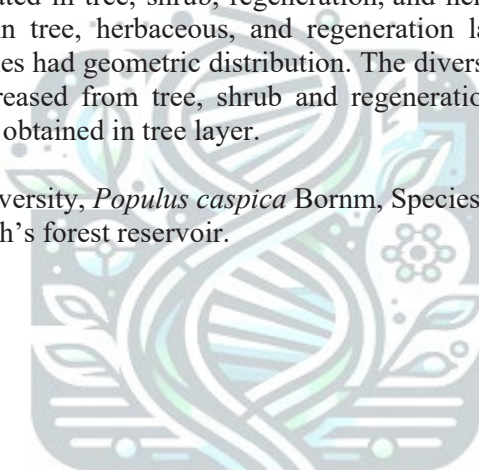
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Abstract

In order to investigate variations in plant diversity in the forest reservoir of Caspian poplar (*Populus caspica* Bornm.), Safrabasteh, Astanehe Ashrafiee city, 40 sampling plots with an area of 0.1 ha were taken by the randomized-systematic method. The diameter at breast height of all tree species ($DBH \geq 7.5$ cm), and height were measured, and also type of species identified in the plots. In addition, shrubs and saplings were counted and the cover of herbaceous species were estimated using the Domin criterion. The Species Important Value (SIV) and the diversity indices, including Shannon-Wiener (H'), Simpson (1-D), McArthur's N_1 and Hill's N_2 , evenness indices consist of Shannon-Wiener, Wilson and Smith (Evar), and Nee (EQ), and also Margalef's richness index were calculated in tree, shrub, regeneration, and herbaceous layers, respectively. The result indicated that in tree, herbaceous, and regeneration layers, SIV had a lognormal distribution, but shrub species had geometric distribution. The diversity values had the highest in herbaceous layer, and decreased from tree, shrub and regeneration species, respectively. The highest evenness value was obtained in tree layer.

Keywords: Plant species diversity, *Populus caspica* Bornm, Species Important Value (SIV), species richness, Safrabasteh's forest reservoir.



Propagation By Seed of the Relict Wood Species on the Absheron Peninsula

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Abstract

Relic tree species occupying a unique special place in the dendroflora of Azerbaijan are considered a living sign of ancient natural history. They have been exposed to climatic changes occurring in nature for hundreds of years, and have left traces of the past centuries on themselves. The distribution area of relict tree species is found both on the slopes of Talysh mountains and in the forests of the southern part of the Greater Caucasus. Currently, based on the research data of the Hirkan National Park in Lankaran, information on the distribution of more than forty relict tree species in our flora has been published. These relict tree species were reflected in the book "Dendoflora of Azerbaijan" published by the Dendology Institute of the Ministry of Science and Education of the Republic of Azerbaijan, and they were included in the "Red Book" (T. S. Mammadov). In the conditions of climate changes that we are witnessing, the ecological factors that occur and exist in nature, like all other living things, have their effect on relict tree species. In such conditions, either the area or the species composition of relict tree species are subject to change. Preservation of rare and long-lived relict tree species and their reproduction should always be in the focus of researchers. The soil of the Absheron Peninsula is subject to this or different salinization, the relative humidity varies according to the seasons, there is a dry subtropical climate with water shortage, high temperature and many windy days. There are no tree species in the natural flora of the peninsula, the range of shrub species is short and small bushes. Acclimatization of the relict tree species of the Azerbaijani flora, resistant to the environmental factors of the Absheron peninsula, resistant to salinization and drought, and the high temperature factor, in Absheron conditions and studying their bioecological properties is one of the priority studies. For this purpose, we consider it appropriate to reproduce the relict species by means of seeds. Lankaran Hirkan National Park employees relict species - *Parrotia persica* C. A. Mey., *Alnus Mill.*, *Populus tremula*, *Fagus L.*, *Tilia L.*, *Carpinus L.*, *Quercus castaneifolia* C. A. Mey., *Ulmus L.*, *Lotus L.*, *Leucaena leucocephala* (Lam.) de Wit. seeds were collected. The seeds were first germinated in laboratory conditions and then transferred to the experimental area of the Institute of Dendrology. The plot of land was prepared in advance, agrotechnical regulations were implemented, irrigation was carried out after planting the seedlings, the experimental area was covered with polyethylene (special type) to ensure the humidity of the soil was 75%, and the relative humidity of the air was 75-80%. The seeds gave 80-90% germination. It was determined that the degree of adaptation of ironwood, alder, birch and white-headed acacia species is more optimal in the subtropical climate of the Absheron Peninsula. The wood of the proposed long-lived tree species has strong wood and abundant leaves, so it allows more oxygen into the air, and also creates a moderate temperature around the canopy. Thus, it is purposeful to use long-lived species when greening on the Absheron Peninsula. We hope that the reproduction of relict species will be continued on the Absheron peninsula and will be used in greening.

Keywords: long-lived trees, distribution area, climate change, adaptation mechanism, greening.

Change of Characteristics of The Quality Indicators of Tea Leaves During The Vegetation Period Depending on Geographical Relief

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Abstract

Tea growing is an economically efficient and highly profitable activity in the field of agricultural production of the Republic of Azerbaijan. For more than 100 years Chinese tea species *Thea sinensis* L. is planted and cultivated in the Lankaran Astara region, which is a subtropical area of the Republic of Azerbaijan. Since tea growing is a profitable field, it is currently cultivated in large areas of tea fields in the southern region of our Republic - Lankaran, Astara, Lerik, Masalli, as well as Zagatala-Balakén regions in the northern region. The study was conducted in 2022-2024 in the river areas located in Khanbulan village of Lankaran district and Hucu village of Lerik district, which is a subtropical area with high humidity. Soil samples were taken and its water capacity and water holding capacity, mechanical and organic components and some metal ions were determined. The tea plant is very sensitive to environmental factors. It is demanding on soil acidity, relative humidity of atmospheric air, light and heat. Therefore, in our study, in order to ensure the dynamic development of the tea plant, samples of podzol-yellow and podzol-clay-yellow soil were taken. The areas where tea is cultivated are mainly plains or mountain slopes. The soils of these areas belong to podzol-yellow or podzol-clay-yellow type, and metal ions are distributed in different amounts. Thus, since the types of soils common in this region - podzol-clay-yellow and ensure the presence of metal ions in the lump, it affects both the quality of tea leaves and the antioxidant character of the biologically active compounds of the extractive substance (summary), as well as the color shades of tea. It was clear from the researches that depending on the relief of the areas and the vegetation period, the quality of tea leaves varies considerably. It has been proven that when the height of mountain slopes is 600 and 700 m (Hücü village, Lerik), the quality indicators of flashes are much higher and stable. It is known that tea growers collect the initial leaves (2nd and 3rd leaves) of the plants several times during the development period as flash. Flavonoids - tanin, catechin-tanin complex, flavonol, caffeine and extractive substances in the flash are its quality indicators and have antioxidant properties. From the conducted bioecological and biochemical determinations, it became clear that flavonoids, which are the quality indicators of tea leaves (flash), ensure the health of the human body, as ecologically healthy food, they are indispensable antioxidants in the process of metabolism. The quality indicators of the extractive extract obtained from flashes depend on metal ions - green, pink, velvety, black fractions are obtained. Tea is a non-alcohol drink, which is significantly different from other drinks due to its nutritional value, biochemical properties, active effect on people's health and comfort. Tea is the second most popular non-alcoholic drink after water in the world, including in our republic. It has a tonic effect on the human body. Therefore, people use tea as a means of removing fatigue and general weakness from the body. Rich biochemical content of tea confirms its physiological and biochemical value. From this point of view, tea is the real beauty of Azerbaijani people's tables.

Keywords: *Thea sinensis* L., flash, flavonoids, metal ions, antioxidant.

Contribution to Floral Morphology of Asclepiadoideae (Apocynaceae) from Türkiye

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Abstract

The subfamily Asclepiadoideae is represented by 16 taxa belonging to 5 genera (*Araujia*, *Cionura*, *Cynanchum*, *Gomphocarpus* and *Vincetoxicum*) in Türkiye. It is known that the floral morphology supplies an important contribution to delimitation of the Apocynaceae taxa. Thus, in this study, the floral characteristics of the Turkish Asclepiadoideae members stored at both Herbarium of Recep Tayyip Erdoğan University, Department of Biology and Herbarium of Istanbul University, Faculty of Pharmacy were examined in detail using a stereomicroscope. Our results showed that all the examined taxa are characterized with the inflorescence including terminal or axillary cymes, rarely solitary flowers, actinomorphic, bisexual, pentamerous flowers with rotate or campanulate corolla, coralline or gynostegial, free or partly fused corona segments, and a typical gynostegium composed of unlobed or bifid stigma. The present research also pointed out that the length of pedicel, sepal, petal and pistil, the pubescence, color and type of the corolla, the origin, type and shape of the corona, and the shape of the stigma are the most important floral traits at the species level within the Turkish Asclepiadoideae.

Key words: Anatolia, Asclepiadoideae, corona, flower morphology.

Acknowledgement: This work was supported by Scientific and Technological Research Council of Turkey (TUBITAK) under the Grant Number 122Z547. The authors thank to TUBITAK for their supports. We would also like to thank the management of The Herbarium of the Faculty of Pharmacy of Istanbul University (ISTE) for contributing to our study by providing plant materials related to *Gomphocarpus fruticosus*.

Seed Propagation of The *Jacaranda mimosifolia* Belonging to The *Jacaranda* L. Genus of The Bignoniaceae Juss. Family

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Abstract

Decorative plants are widely used in the reconstruction and improvement works carried out in our republic in recent years. Most of these plants are imported from foreign countries. Of these plants, Bignoniaceae Juss. plants belonging to the family are rare. However, most of the plants included in the family are plants that have a decorative appearance. Taking this into account, efforts were made to reproduce *Jakaranda mimosifolia* D. Don, which belongs to the genus *Jakaranda* L., in our republic. In the seed propagation of *Jacaranda mimosifolia* D. Don, belonging to the genus *Jacaranda* L., the winged seeds were separated from the shell after drying the fruits collected in the current year. Collected seeds are soaked, kept for a day at room temperature. In greenhouse conditions, the seeds were sown in the soil at a depth of 1-1.2 cm, rich in special extract, in the second decade of September in the fall, and in the third decade of April in the spring. From time to time, the field was agrotechnically maintained. After planting, the seeds are covered with cellophane to retain moisture. The seeds started to germinate when the temperature was 22-24 C⁰. Germination of seeds lasted 2-3 weeks in both cases. When the seeds germinate, it is necessary to work so that the area is bright. From the seeds sown in spring, at the end of the growing season, the germination percentage of the plant reached 3.2-3.4%. From the seeds sown in autumn, the first sprouts started to appear in the second decade of October, the percentage of germination was 4.3%. At the end of the growing season, 4.6% sprouts were obtained from the seeds sown in the second decade of September in the greenhouse conditions. From the seeds sown in the 1st decade of April in spring, sprouts started to appear in the 3rd decade of April, and at the end of the growing season, 5.2% sprouts were obtained. Plants with a height of 20-30 cm were transplanted to open fields in the second decade of May. In the research work, the propagation of *Jakaranda mimosifolia* D. Don species belonging to the genus *Jakaranda* L. by seeds in Absheron conditions, the morphological aspects of the seedlings were studied on scientific grounds. Seed sowing period, soil characteristics, sowing depth, initial germination period, morphological characteristics were analyzed, disease and pest control measures were selected.

Keywords: seed, reproduction, morphological aspect, agrotechnical.

Ornamental plants in Sabir Garden on Absheron

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Abstract

Flowers decorate gardens, parks, public gardens, boulevards, streets, personal plots, and serve for interior decoration. To develop the landscape design of any city or locality, it is necessary to study ornamental plants and design compositions. Composition (from Latin composition - "connection", "connection") refers to the arrangement of various forms in space in combinations that create a harmonious unity. The garden, being an integral composition, in turn consists of secondary compositions, united by a common design and purpose to this end, the laboratory of "Landscape architecture" of the Institute of Dendrology of the Ministry of Science and Education of the Republic of Azerbaijan has been conducting research work in the parks and gardens of Absheron since 2019. In the research work carried out in the second decade of May 2023, a scientific expedition was organized to the territory of the Sabir Garden on Absheron, observations were made, herbariums of ornamental trees, shrubs and herbaceous plants belonging to 32 families, 42 genera, 50 species introduced into the conditions of Absheron from local and foreign flora, their taxonomic composition and origin were determined, the grouping of plants in compositions according to biological and decorative features, the design of compositions in a regular (geometric form) and landscape or landscape style (original form), the rules for the use of small architectural forms around compositions (fountain, lantern, bench) were studied, basket with flowers, figure, etc.). Ornamental plants are the objects of research. When conducting research work, methods of foreign and local scientists were used. The forms of creating compositions, the arrangement of plants in compositions were studied using the methods of Bochkova I.Y., Vasilyeva V.A., Golovnya A.I., Lazarev N.N., Konstantinova E.A., Serikova G.A., the taxonomic composition of ornamental plants was studied using the methods of Kizima G.A., Mammadov T.S. Flower beds bordering lawns help to beautifully arrange the transition of tree and shrub groups to the plane of the lawn or clearing. At the same time, flower beds can include a variety of flowering plants, be monochrome, or generally consist entirely of ornamental foliage plants and small shrubs. With regular planning, straight paths are laid, plantings are made in rows, which, of course, greatly facilitates the care of plants. Trees are placed along the boundaries of the plot, retreating, as expected, from the neighbouring one by three to four meters. Parks and gardens of the city of Baku are the main green areas for mass recreation, walking and entertainment. In the conditions of Absheron, which do not have natural forests, these green areas are the main factors that improve the living conditions of the urban population. Currently, the main task of landscape design is considered to be the creation of beauty and harmony in combination with the usability of building infrastructure, smoothing out the conflict between urbanization forms and nature, which often suffers from them. As a result of the research work, it was revealed that ornamental trees, shrubs and herbaceous plants from 32 families, 42 genera, 50 species studied on the territory of the Sabir Garden adapt well to the soil and climatic conditions of Absheron, are promising, can be widely used in landscaping, in parks and gardens when creating various forms of compositions.

Keywords: ornamental, plant, garden, landscape, composition

Various Active for the Rooting of Olive Penns Effect of Reagents

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Abstract

Meeting the population's demand for nutrients has always been an actual issue. Most of the nutrients are of vegetable origin. Increasing the productivity of these plants is always one of the main tasks ahead. Recently, a series of environmental changes in nature hurt plants. For this reason, many ways of increasing plants are being investigated. The most convenient way of propagating the olive plant is using a pen. At this time, the olive pens retain all the properties of the parent tree, and fruiting occurs in a shorter time. In our study, the effect of biologically active reagents on the reproduction of olive plants through the pen was investigated. The research was conducted in the greenhouse of the Absheron Experimental Station. During the experiment, one-year and two-year seedlings were taken from the studied olive varieties. The seedlings were planted in a rooting medium with a 1:1 ratio of the perlite-peat mixture. The temperature in the greenhouse varies from 18 to 260 C, and the humidity varies from 68 to 87%. Olive varieties grown in Absheron conditions (Azerbaijani olive, Agbaba, Jigrina, and Pikvales) were taken as research material during the experiments. During the studies, different results were obtained with different reagents. Na⁺ salts of indolyl acetic acid and naphthenic acid were used to influence the rapid rooting of pencils. Compared with the control variant, a positive effect of indolyl acetic acid and naphthenic acid on olive pens was observed. Thus, as a result of the effect of biologically active reagents (indolyl acetic acid and Na⁺ salt of naphthenic acid), the rooting of olive pens was accelerated. The number of roots and calluses was higher in biennial cultivars than in one-year cultivars. Rooting was observed in 79 out of 100 one-year pens and 87 out of two-year pens taken under the influence of indolyl acetic acid. As a result of the research, it was found that annual and two-year pens obtained from olive varieties should be kept at the specified time (12 hours) and amount (0.005%) of naphthenic acid Na⁺ salt. When the specified amount is exceeded, the development of the neck and roots of the olive plant is weakened. Different results were obtained for the investigated varieties. Among these varieties, the best result was observed in Agbaba and Azerbaijan olive. So, in these varieties, the number of roots increased, and their development went faster. In other varieties, although the rooting was weak, the further development of the roots was satisfactory.

Keywords: Olea, active reagents, propagation, rooting

SALL4 Gene: its Role in Embryonic Development and Cancer

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Abstract

The SALL4 gene is a member of the Spalt-like transcription factor family and is known to play a critical role in embryonic development and maintenance of stem cell pluripotency. It also plays an important role in organ and tissue formation during early embryonic development. SALL4 helps embryonic stem cells maintain their ability to differentiate into different cell types, making it vital for early developmental stages and regenerative medicine research. Recent studies have shown that SALL4 is overexpressed in cancer cells and is closely related to cancer development, progression, and metastasis. However, the link between resistance genes, which is reported to be the most important reason for limited treatment efficacy in some types of cancer, and the SALL4 gene has not yet been revealed. Therefore, determining the relationships between SALL4 and resistance genes using the qRT-PCR method, revealing its molecular mechanisms through processes such as proliferation, apoptosis, and metastasis, and clarifying changes at the protein level using the western blot method may help develop new therapeutic strategies and improve patient response to treatment. Understanding more about the functioning and regulation of the SALL4 gene could provide important perspectives on developmental biology, stem cell research, and potential therapeutic approaches for diseases associated with this gene. For instance, the ability of SALL4 to maintain stem cell pluripotency is an important factor for the therapeutic use of stem cells. Furthermore, the role of SALL4 in cancer cells holds the potential to develop new targets for cancer therapy. In conclusion, the SALL4 gene is a versatile gene that plays an important role in both normal developmental processes and disease states. A better understanding of this gene could lead to important steps forward in many biological and medical fields.

Keywords: SALL4 gen, Cancer, Embriyonic development, stem cell

New Eco-Geobotanical Assessment Methods of Plant-Soil Cover

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Abstract

Eco-geobotanical assessment of soil-plant cover is one of the least explored areas for managing and optimizing the use of soil and plant resources. This approach requires taking into account a number of properties and composition of both vegetation and soil cover on the territory, climate and agro-climate, relief, environmental (susceptibility to anthropogenic impacts) parameters, etc. In particular, appropriate to study the causes of soil pollution, salinization, and a number of other negative factors is considered. With this in mind, on the territory of 230,000 hectares of the Shirvan of Azerbaijan, comprehensive surveys of vegetation and soil cover were carried out, and on the basis of field and laboratory studies, the indicators necessary for eco-geobotanical assessment were obtained. Eco-geobotanical assessment of soil and vegetation cover is distinguished by their complexity and structure from a methodological point of view. In addition to botanical, biogeocenological, soil and soil-assessment methods, the use of aerospace and photogrammetric, statistical, comparative geographical, and cartographic research methods is required here. The results obtained by applying this assessment made it possible to carry out an eco-geobotanical grouping of the territory of Shirvan and develop a concept for managing soil cover and vegetation (in the broadest sense, landscape complexes). In this connection, drawing up an action plan to restore the soil and vegetation cover, increase the productivity of pastures, and preserve valuable fodder, as well as rare and endangered plant species, has become one of the main goals. Data on a new method of eco-geobotanical assessment of the vegetation and soil cover of Shirvan in Azerbaijan, developed by us for the first time on the basis of data on soil bonitation, their ecological assessment and the state of natural plant communities characteristic of this territory has been shown in the paper. The soil-vegetation cover of Shirvan was grouped according to the ecological-geobotanical assessment indicators and 4 groups were identified based on the data of the eco-geobotanical assessment. Management is carried out in 3 directions: with application in crop production, with application in animal husbandry and improvement, and social policy and agricultural culture. Thus, the method of eco-geobotanical assessment developed for the first time can be applied to territories with similar soil and vegetation cover throughout the Republic.

Keywords: Vegetation, soil cover, eco-geobotanical assessment method, bonitation, Shirvan, Azerbaijan



POSTER PRESENTATIONS

Impact Of Climate Change And Anthropogenic Factors On The Development Of Harmful Fauna

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Abstract

In the last decades, due to the influence of natural and anthropogenic factors such as low and high temperature, drought and high humidity, reduction of food supply, unfavorable environmental factors have caused changes in the populations of many harmful insect species. Thus, the spread and damage level of *Euphyllura olivina* and olive moth (*Prays oleae* Bern), which were not common in previous years, on the olive trees cultivated on the Absheron Peninsula, the American white butterfly (*Hyphantria cunea*) on mulberry trees, in open and covered vegetable fields. tomato moth (*Tuta absoluta*) spread and reduced damage was observed. Polyakov.I.J., Persov M.P., Smirnov V.A., "Forecast for the development of pests and diseases of agricultural crops" "Kolos", 1984,pp: 105 -128, from the literature source, the spread of the main harmful species, the time of the first mass appearance, the determination of the optimal period of harmful activity (Tanski, 1988) was performed according to the methodology. The degree of damage to the leaves and the product was determined according to a 4-point scale (Polyakov, 1975).

The unstable change of environmental and climatic factors, which has been discussed more in the world in recent years, has affected the natural development of many physiological processes in the way of life of living organisms. The mentioned ecological and including anthropogenic effects caused the disruption of the natural order of the existing plant-harmful fauna formed over the centuries. Harmful fauna develops in two directions in existing ecological and environmental conditions. 1. Natural balanced harmful fauna in plant-pest relationship formed over centuries in developing natural ecosystems (forest, meadow, etc.). 2. Harmful fauna formed by the influence of anthropogenic factors in the agrobiocenoses created by introducing new lands into the crop rotation and controlled in one way. As known, the harmful fauna that appeared in newly created agrobiocenoses was formed from the environment of natural biocenoses formed throughout history. This means that in the new agrobiocenoses, new populations of harmful insect species have been created due to the feeding of agricultural plants. As a result of the assimilation (use) of raw land in natural ecosystems, harmful organisms spread on wild cereal plants migrated to cultivated grain fields, and pest insects spread on wild cruciferous plants migrated to vegetable and vegetable plants and became the dominant pests of many agricultural plants.

Cultivated horticulture established in mountain foothills, forest surroundings, and grassland areas were the source of various types of harmful insects that spread and cause damage, harmful fauna organisms that migrated from nearby forests, shrubs, in short, natural ecosystems and moved to cultivated fields. The settlement period can be long-term or short-term, depending on the satisfaction of the nutritional needs of harmful fauna that have migrated from certain areas. As a result of the "action" of anthropogenic factors, the species diversity of harmful insects spread over cultivated plants in newly created agrobiocenoses has increased. Favorable climatic conditions can cause the mass reproduction of harmful fauna in a short period of time. Scientifically based, balanced management of harmful fauna for the purpose of protecting cultivated flora has an important ecological importance.

Keywords: climate change, anthropogenic factor, harmful fauna, development, decline.

The Anatomical Characteristics of the Vegetative and Generative Organs of the Medicinal *Silybum Marianum* L., Spread in the Mountainous Region of the Lesser Caucasus

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Abstract

In this scientific study, the anatomical characteristics of the vegetative and generative organs of the medicinal plant *Silybum Marianum* L. were investigated. During the research, plant samples collected from the mountainous area were processed with the necessary chemical reagents. The sections obtained from different organs were analyzed under a microscope, and the results were categorized. In the microscopic study, objective lenses with higher magnification were used to closely observe and study the individual tissues seen at lower magnifications. When a general overview of the leaf (folium), one of the studied organs of *Silybum Marianum* L., is conducted, the following tissue types are observed. First, the covering of the plant, which takes the form of a single layer of cells called the epidermis, surrounds the leaf externally. Stomata and trichomes observed on the leaf epidermis can also be found on the covering tissue of other aerial organs of the plant. In the aerial organs of the plant, the chlorenchyma tissue cells forming under the covering tissue mainly constitute the mesophyll in the leaf laminae. Analyzing the sepals of the flower, which is the generative organ of the plant, it is observed that they contain filling cells of the main parenchyma and aerenchyma. Additionally, it is seen that another type of parenchyma, the pith parenchyma, forms in the stem (cormos) and flower axis, while the cortex parenchyma forms in the root. The transmission systems connecting all the organs of the plant are formed in the aerial organs as complex fibrous collateral-type transmission bundles. In the roots (radix) of the plant, it is observed that special secretion cavities form along the line encircling the central cylinder of the root. Based on the parenchymal rays in the xylem of the central cylinder of the root, it is understood that it has a diarch structure.

Keywords: epidermis, collateral, main parenchyma, stomata, folium

Pharmacogenetic Applications in Cancer Treatment

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Abstract

Pharmacogenetics is the study of the genetic factors that determine drug responses among individuals. Pharmacogenomics is the study of genetic factors that are important in the development and introduction of new medicines, including medicine, bioinformatics, cell biology, molecular biology, genomics, epidemiology, and pharmacology. Standard medicine doses work well for a large proportion of the population. Weight, age, gender, infections, alcohol, diet, liver, and kidney function may change this. However, some people treated with standard doses metabolize more rapidly, and the doses used classically are ineffective. For effective treatment, it is necessary to increase the dose. If a person has an enzyme that metabolizes the drug, they slowly need lower doses of medication because standard doses cause the drug to cause toxic effects. Drugs are metabolized by different metabolic reactions involving detoxification enzymes. Encoding metabolic enzyme polymorphisms in genes alter enzyme activity and cause the enzyme to work with different activity between individuals. happens. Individuals, therefore, respond differently to standard treatment doses. Polymorphisms in metabolic genes affect a patient's response to cancer treatment, such that the drug may cause toxicity at the dose that would produce a therapeutic effect. There is a very fine line between doses. In most cancer treatments, dose adjustment in patients is based on a trial-and-error approach. Different perspectives on the patients and the genetic elements of the tumor that will determine drug efficacy will help to determine individual dosage differences and reduce side effects.

Keywords: Bioactive compounds, cancer, pharmacogenetics, polymorphisms

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Bioecological characteristics of *Onobrychis* Mill. (Fabaceae) species common in Azerbaijan

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Abstract

The genus *Onobrychis* Mill. belongs to the family Fabaceae. With ca 80 species, mainly distributed in Central and Southern Europe, North Africa and Western Asia. There are 39 species of the genus, which is considered one of the valuable breeds in the Caucasus and Azerbaijan, in the Caucasus and 21 species in Azerbaijan. Generally accepted floristic, systematic, ecological, geographical, geobotanical methods, "Flora Azerbaijan" and other numerous designations, as well as methodical instructions of L.I. Prilipko were used in the work. Recent taxonomic changes have been made according to actual materials and "Конспект флоры Кавказа", International Code of Nomenclature for algae, fungi and plants (Shenzhen Code, 2018). The works of R. D. Yaroshenko, A. R. Shennikov, Y. M. Lavrenko and other researchers were used in the classification of vegetation based on ecological-phytosenological and dominance principles. The genus *Onobrychis* has life forms such as herbs, subshrubs or small shrubs. They are covered with dense gopartican hairs. The leaves are single-lobed subfoliolate, sometimes the main stem becomes copartican. Red-red, pink, whitish or yellowish flowers are collected in axillary clusters or spikes. The calyx with five teeth is bell-shaped, the sail of the 5-membered petals is ovate or lanceolate, almost sessile. The column of the short-legged tooth is straight or curved. Beans are hemispherical or flattened, unopened, 1-2 seeds. Ten species of the genus *Onobrychis* have been identified in the steppe plateau, namely *Onobrychis cyri* Grossh., *O. cornuta* (L.) Desv., *O. vicifolia* Scop., *O. schuschajensis* Agayeva Grossh., *O. transcaucasica* Grossh., *O. caput-galli* (L.) Lam., *O. vaginalis* C.A.Mey., *O. atropatana* Boiss., *O. radiata* (Desf.) Bieb., *O. michauxii* DC. *Onobrychis* species are valuable fodder plants, below is information on the bioecological characteristics of some economically important species of the genus. Thus, as a result of the conducted research, it was found that *O. vicifolia* (= *Onobrychis altissima* Grossh.), *O. transcaucasica* and *O. cyri* cultivation of species purposeful. These species have greater importance due to their usefulness.

Key words: *Onobrychis*, Bozghir plateau, bioecological characteristics

Establishment of *in Vitro* Culture and Chemical Composition of Hexane Extract of Callus and Regenerants of *Niedzwedzkia Semiretschenskia*

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Abstract

A rare endemic species of *Niedzwedzkia semiretschenskia* (*Incarvillea niedzwedzkia*), a narrow local Paleogene relic of the desert flora of Central Asia and Kazakhstan, is represented by limited natural populations that are endangered. *N. semiretschenskia* as relict species listed in the Red Book of Kazakhstan and the Red Book of the International Union for Conservation of Nature and Natural Resources. To solve the problem of species degradation, it is necessary to use alternative knowledge-intensive methods for the effective conservation of valuable species genetic resources with unique scientific and commercial potential as a highly decorative and medicinal culture. The purpose is establishment *in vitro* an aseptic culture from the initial seeds collected in natural population in the south of Kazakhstan and to study the chemical composition of hexane extract of this species cultivated *in vitro*. The influence of plant growth regulators in Murashige and Skoog nutrient medium on seed germination, adventitious shoot formation and rooting *in vitro* was studied. The propagation coefficient for micro-cutting was estimated during four passages. Hexane extract from callus and regenerant plants of *N. semiretschenskia* was obtained at a temperature of 20°C for 4-5 hours. The obtained extracts were analyzed on an Agilent 7890A GC gas chromatograph with an Agilent 5975C inert MSD quadrupole mass spectrometer as a detector. The components of the mixture were separated on a quartz capillary column HP-5MS. The components were identified based on a comparison of the characteristics of the mass spectra with data from the electronic libraries W8N05ST.L and NIST08. It was shown, that *in vitro* germination did not exceed 25% on Knopp medium, and the maximum of germination was during seed planting in the soil substrate. The addition of 6-benzylaminopurine to the nutrient medium induced the callus formation from cotyledon's tissue and adventitious shoots from apical explants of seedlings with native leaves. The optimal for clonal propagation is the MS medium, containing 0.5 mg/l 6-benzylaminopurine; in this case, a maximum propagation coefficient of 7.84 was at the second passage. It was found during conservation at a low positive temperature for 12 months, the tube-culture plants of *Incarvillea* retain their viability and restore their growth when transferred to the stationer conditions of the light room. The obtained *N. semiretschenskia* oils are a pale-yellow mobile liquid with a specific odor (the yield from the callus is 0.82%, from regenerate plants - 0.74%). As a result of the analysis of hexane extract from regenerating plants, 16 compounds were identified, of which the major compounds are higher acyclic hydrocarbons (nonacosan, dodecane, heptacosan, ets), organic acids (palmitic acid, linoleic acid, ethyl 9,12,15-octadecatrienoate), amounting to 92.57%. 18 compounds were identified from callus, such as: 9,12-octadecadienoic acid, clionasterol, hexadecanoic acid, β -sitosterol, 7,10,13-hexadecatriena, 5,12-naphthacenedione, squalene, hexatriacontane, amounting to 91.55%. The results obtained indicate the expediency of conducting further phytochemical studies of extracts from callus biomass in dynamics, and conducting a comparative chemical analysis of test tube regenerants and plants grown in a greenhouse and in natural conditions. The research *in vitro* establishment and micropropagation of endemic species were carried out and deposited *in vitro* collection of *N. semiretschenskia* was created.

Keywords: *Incarvillea niedzwedzkia*, *in vitro* culture, micropropagation, callus tissue

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Molecular Approach to the Apoptotic Effect of *Citrus aurantium* L. Flavonoids on Cancer Cells

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Abstract

Citrus aurantium L. belongs to the Rutaceae family and contains many flavonoids, such as nobiletin, hesperidin, and naringin. These flavonoids have anti-cancer, anti-inflammatory, antiviral, and antioxidant properties and have been used for centuries in the treatment of various diseases. Studies have reported that flavonoids have antiproliferative effects on different cancer types by stopping the cell cycle and promoting apoptotic death. The death of cells and stopping metastasis by apoptosis activation is a mechanism that prevents the progression of the disease. There are two main apoptotic pathways: extrinsic (death receptor pathway) and intrinsic (mitochondrial pathway). Caspases (caspase: cysteine aspartyl protease), which play an important role in these pathways, are cysteine proteases that degrade proteins. TNF- α (tumor necrosis factor alpha) induces apoptosis by activating caspases. Caspase 3, which has a key role in the apoptotic pathway, is activated by TNF- α /TNFR complex induction of caspase 8 and drives the cell to apoptosis (extrinsic pathway). In the other pathway, when the cell receives a death signal, the mitochondrial membrane is altered, and cytochrome c is released into the cytoplasm. Cytochrome c in the cytoplasm binds to Apaf-1 (apoptosome formation) and activates procaspase-9. The activated caspase 9 promotes caspase 3 activation and leads to cell death (intrinsic pathway). In addition to its role in the apoptotic pathway, TNF- α is also known to be a cancer-preventive mediator molecule by suppressing cell proliferation. In this context, the proinflammatory cytokine tumor necrosis factor alpha (TNF- α) has been proposed to be an important molecule in the tumor microenvironment and has been shown to play two different roles in the evolution of the disease, both necrotic and promoting. Investigation of the effects of extracts obtained from different parts of *C. aurantium* fruit on cancer cell lines and elucidation of apoptosis pathways by analyzing the role of TNF- α , caspase 3, caspase 8, and caspase 9 genes in the apoptotic pathway at the molecular level after extract application is of great importance for the development of drugs with minimal side effects and natural ingredients. Analyzing the effects of *C. aurantium* extracts, which are known to have anticancer properties, on the mentioned genes in the future is of great importance in terms of increasing the effectiveness of today's treatment methods.

Keywords: *Citrus aurantium* L., cancer, caspase, TNF- α , apoptosis

Acknowledgement: This work was supported by Muğla Sıtkı Koçman University, Faculty of Science, Plant Biotechnology Laboratory.

Insights into the Endosperm Haustorium of Germinated Asian Palm Seeds: A Study on Material Characterization

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Abstract

The Asian Palmyra palm, an iconic tree in Tamil Nadu, is deeply ingrained in the daily lives of rural communities due to its multifaceted uses, ranging from ecological benefits to economic value. Despite its historical significance, the full potential of the Palmyra palm, especially the endosperm haustorium of its germinated seeds, remains underexplored. This study focuses on the phytochemical and material characterization of the endosperm, particularly the haustorium, which plays a crucial role in nourishing the developing embryo during seed germination. Our research involved the collection and processing of germinated seeds from Tamil Nadu, followed by comprehensive phytochemical analysis to identify the presence of carbohydrates, proteins, amino acids, and reducing sugars. Spectral analysis, including UV-Vis Spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Diffraction (XRD), Dynamic Light Scattering (DLS), and Scanning Electron Microscopy (SEM), provided insights into the molecule and material structure, and chemistry of the endosperm powder. The results revealed that the haustorium powder is rich in essential nutrients and possesses significant antioxidant and anti-inflammatory properties. The study also demonstrated the potential of the haustorium powder as a sustainable food source with a long shelf life, making it suitable for value-added products. The findings highlight the importance of Palmyra palm not only as a traditional resource but also as a subject of modern scientific inquiry with potential applications in nutraceuticals and material science. This research contributes to the broader understanding of the Palmyra palm's role in biodiversity and its importance in sustainable development.

Keywords: Asian Palm; *Borassus flabellifer*; Haustorium

Acknowledgment: We acknowledge All the Palmyrah Warriors(tappers) and artisans for their contribution to palmyraculture for the sustainable development

Investigation of the Genome Size Effects of *In Vivo* and *In Vitro* Serial Passages of the Local SARS-CoV-2 Isolate

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Abstract

The SARS-CoV-2 pandemic has affected many aspects of our lives. The scientific community is in awe of the SARS-CoV-2 virus's ability to evolve through mutations that affect its transmission bottlenecks and ability to evade the host immune system. In this study, we aimed to gain a better understanding of the genomic changes that might occur during serial passaging of the local SARS-CoV-2 Ank1 isolate. The local SARS-CoV-2 isolate was serially passaged ten times *in vitro* and *in vivo* (Vero E6 cells and type 1 interferon knockout transgenic mice (IFNAR^{-/-}), respectively). Whole genome sequencing of the isolates was performed using the Illumina NextSeq 550 next-generation sequencing (NGS) platform and the Paragon CleanPlex® SARS-CoV-2 panel. The raw sequence data were then analyzed Genome Detective platform to investigate the genome size effects in the genetic material of the isolates. According to our results, *in vitro* passaging, at passage number 10, four non-synonymous substitutions and two synonymous substitutions were detected compared to the original isolate. Interestingly, *in vivo* passaging, at passages 9 and 10, two additional non-synonymous substitutions were observed. Our obtained result indicated that the SARS-CoV-2 passaging processes *in vitro* and *in vivo* affect its genome, we speculated that the host environments obtained in the laboratory selectively pressed on the isolate.

Keywords: SARS-CoV-2; COVID-19; Genome; Bioinformatic; Genome Detective; CleanPlex® SARS-CoV-2 panel.



Influence of local plant vegetal resources on health

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Abstract

It is known that the state of the agricultural sector has a significant influence on the development of the country's economy. Agriculture occupies a special place in the economy of any country, especially our country. The development of this sector is to maintain the economic stability of the country and satisfy the influence demand of the population. After the adoption in 2016 by the head of the country of the system "On the production and processing of local agricultural products in the country," positive changes occurred in the current situation in agriculture. Correct realization of agrarian policy leads to providing people with quality local products and improved the quality of life. According to the World Health Organizations foodborne diseases are spreading rapidly in the world. They say that the conservation and proper use of each country's unique local resources is one of the main factors influencing the healthy growth of generations and the dynamics of the physical development of the nation. Although these problems are serious, the production of GMO foods is expanding. Since the republic has enough of its own resources, it is important to completely refuse these products and control the gene pool in order to remain healthy. Taking into account all the civilized forms of the world experience, our republic's favorable geographical position, rich natural resources and great economic potential bring to the fore some relevant requirements for increasing the production of local agricultural plants. First of all, it is required to increase the production of ecologically clean agricultural products and adjust our population according to import demand.

Through domestic production, it is necessary to replenish the country's reserve fund with local varieties and carry out preventive measures. Innovative development of agriculture in economic development brings the country large incomes, but also helps it not to depend on food products from foreign countries. *Citrullus lanátus* are also one of the popular food items. Today this area is not managed by a high-level scientific center that meets modern requirements, but is produced to meet a certain volume of needs of the population. The goal of researchers at the Institute of Genetic Resources is to prevent these processes to a certain extent, discover lost varieties, restore those that are in danger of extinction, study and return them to their ecosystem. The compatibility of each variety with environmental conditions, yield and sugar content should be taken into account. When taking melon plants, a number of physiological processes in the body are normalized, food is easily digested and absorbed by the organism, and has a corresponding therapeutic effect. *Citrullus lanátus* contain natural sugars, mineral salts, vitamins, folic acid (rare in nature, vitamin B9) necessary for the body, and are actively involved in the formation and purification of blood in the organism. They play an irreplaceable role in the biosynthesis of purine and pyrimidine bases and in the changes occurring in the organism of amino acids. Oils obtained from melon seeds are widely used in the treatment of anemia, bronchitis, rheumatism, cardiovascular, liver, kidney and tuberculosis diseases.

Keywords: Natural resources, physiological processes, gene pool, environmental cleanliness.

Innovative Approaches to The Protection of Trees and Shrubs From Harmful Organisms in Absheron Peninsula

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Abstract

The main goal of the research is to protect perennial trees and shrubs introduced in the Absheron Peninsula from harmful organisms by using modern plant protection tools innovatively. From this point of view, ecological safety measures against dangerous harmful organisms of a number of perennial trees and shrubs used in greening in the peninsula have been used. Microbiological preparations bitoxybacillin (BTB) and lepidoside, as well as adhesive paper tapes against the larvae of the pest, were used in order to fight against leaf-eating beetles (*Galerucella luteola* Müll.), a pest of the *Ulmus* L. plant in the area. Distribution area and density of the pest I. Ya. Polyakov et al. (1984) was determined according to the methodology. Bondarenko H. V. (1986) literature source was used to study the efficiency of microbiological preparations and the method of mechanical control against the pest. Also, the natural enemies of harmful insects in the Absheron dendroflora were studied and researches were conducted in the direction of their effective activity. The following entomophages were found in the dendroflora: 7-spotted *Coccinella septempunctata*, *Stethorus punctillum* Weise. (1891), *Chrysopa carnea* Step., *Mantis religiosa*, *Araneae* sp., *Amblyseius fallacis* Garman. (1948), *Aeolothrips fasciatus* Lin. (1758), *Syrphus balteatus* De Geer., etc. Tryaptsin, Shapiro and Shepetilnikov (1965) in the collection and storage of entomophages, and Velikan V. S., Golub V. B. et al. method was used. In determining entomophages, the doctor of biological sciences G. A. Mustafayeva helped. For the first time in the region, the parasitic characteristic of liana plants, including *Hedera helix* L., which are cultivated by being attached to the trunks of perennial trees and shrubs, was discovered, the damage to the plants was determined, and recommendations were made to eliminate the current deficiency. The method of Serebryakov U. Q. (1964) was used in the research work to study the parasitism feature of the plant. *Ailanthus altissima* (Mill.) Swingle that poses a potential threat to perennial trees and shrubs in the peninsula has been identified and its invasive status studied. Vinogradova Yu. K., Mayorov S. P. and others literature sources were used in determining the invasive properties and invasive status of the plant (2011). The main goal of the conducted scientific researches was to protect biodiversity in the Absheron dendroflora by protecting perennial trees and shrubs from the unpleasant negative effects of harmful agents.

Keywords : trees and shrubs, pests, protection, entomophagy, innovative approach.

Effects of Herbicide Exposure on the Gills of Common Carp (*Cyprinus carpio*)

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Abstract

Agriculture is a vital part of Kazakhstan's economy, playing a crucial role in meeting domestic food needs and stimulating export growth. However, the intensive use of modern chemical methods for weed control raises serious concerns about environmental and public health. This issue is especially pressing as Kazakhstan's water resources, which are essential for drinking water, biodiversity, and economic activity, are increasingly threatened by agricultural runoff that pollutes water bodies and adversely affects aquatic flora and fauna. The response of living organisms allows us to assess the anthropogenic impact on the environment in biologically meaningful terms. To assess the impact of herbicides on living organisms, bioindication methods are used, based on the reaction of living organisms (bioindicators), which allows us to assess the anthropogenic impact on the environment in terms of indicators that have biological meaning. At the level of organisms and ecosystems, the impact of stress factors is discernible only through the appearance of external symptoms of damage. Studying aquatic organisms in polluted water areas helps to identify and determine the types of harmful and toxic substances, so that all possible measures can be taken to eliminate their source. This is crucial not only because such pollution significantly deteriorates the flora and fauna of the water body, but also because it has a direct negative impact on the health of the local population. The aim of this study is to assess the impact of herbicides on the health of common carp (*Cyprinus carpio*) using a model experiment that evaluates histopathological changes in the gills. The object of the study was the common carp (*Cyprinus carpio*) one-year-old common carp who were acclimated in the laboratory and then exposed to Roundup solution at concentrations of 100 mg/L and 150 mg/L of glyphosate (with the toxic dose starting at 50 mg/L). The experiment was conducted over 48 hours, in triplicate, with two groups of 5 fish each. A third group, also consisting of 5 fish, served as a control. Histopathological examinations were carried out after the series of experiments. Gill samples were collected, fixed in a 10% formalin solution, and subjected to standard histological processing. The results revealed significant histopathological changes in the gills. In the first group, at a concentration of 100 mg/L of glyphosate, toxic effects resulted in the fusion of gill plates, epithelial hypertrophy, and cartilage edema, along with the adhesion of the respiratory epithelium of the gill lamellae, edema, and the accumulation of inflammatory infiltrates. At a concentration of 150 mg/L of glyphosate, acute exposure caused more severe damage, including epithelial necrosis and the destruction of secondary gill lamellae. These results highlight the potential risks associated with glyphosate-based herbicides, emphasizing the need for stricter regulations, the adoption of safer agricultural practices, and the development of water treatment technologies to protect aquatic ecosystems. The presence of these histopathological changes in the vital organs of fish serves as an early warning sign of ecotoxicological threats, underscoring the importance of continuous monitoring and protection of water resources in Kazakhstan.

Keywords: pollution, herbicide, histology, toxicology, Common Carp (*Cyprinus carpio*)

Transcriptomics of biostimulation of plants under abiotic stress

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Abstract

Natural stressors are rarely effective on their own. Throughout their lifetimes, living things can experience stress from a variety of environmental, climatic, and geographic causes. Abiotic elements in particular, such as light, drought, salt, pollution, and cold, can hinder plant growth, reduce production, or even kill plants. Many defense mechanisms are triggered in plants to help them withstand stressful conditions that arise in their surroundings and complicate their survival. "Stress resistance" or "stress tolerance" refers to the defense mechanism that plants develop in order to live in certain environments. The most prevalent type of free radicals in plants are called reactive oxygen species (ROS), which are produced by enzymes like NADPH oxidase, cell wall peroxidases, and amino oxidases during photosynthetic reactions in chloroplasts, plastids, and peroxisomes as well as in the citric acid cycle in mitochondria. A non-radical atom or molecule can have an electron removed from it or have an electron added to it to form them. Because they are able to donate or remove electrons from other molecules, they function in the body as reductants or oxidizers. They are also produced as part of the plant's regular developing process, but because of the way they interact with the detoxifying system, they don't have any negative effects. Under normal circumstances, the quantities of the main recognized ROS found in cells—singlet oxygen, superoxide anion, hydrogen peroxide, and hydroxyl radical—are constantly balanced. Plants have a variety of antioxidants that regulate and detoxify reactive oxygen species (ROS) in order to survive and adapt to oxidative stress. Two types of antioxidants are distinguished: enzymatic and non-enzymatic antioxidants. Ascorbic acid, carotenoids, glutathione, tocopherols (vitamin E), and phenolic compounds are examples of non-enzymatic antioxidants. Superoxide dismutase, ascorbate peroxidase, glutathione peroxidase, and catalase are examples of enzymatic antioxidants. Transcriptomic research can use techniques like microarray analysis and RNA sequencing technologies to thoroughly assess the levels of gene expression. Comprehensive insights into the regulation of gene expression, gene function, disease causes, and treatment responses are offered by these investigations.

Keywords: Antioxidants, ROS, stress resistance, stress tolerance, transcriptomic

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Embryotropic Influence of *Caropodium platycarpum* and *Ajuga chia* Mixture in Rats

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Abstract

This research studied the embryotropic influence of caropodium (*Grammosciadium platycarpum*)-ajuga (*Ajuga glabra*) mixture having anthelmint affect in pregnant rats. In the implantation, in the bormation of organs and in foetus periods, the rats under experiment were giren three times increased quantity of treatment doze of this mixture (18 kq) in cooked form and the period of pregnancy, the development of embryos were watched and they were compared with the embryos of animals under control. The embryo sizes were not out of norm and abnormal changes in inside orqans were not observed structurally ($p \geq 0,05$). It was established that the implantation, place of reabsorption the amount of alive embryos, the amount of dead embryos, the size and weight of placenta do not differ from the group under control in the experimented animals ($p \geq 0,05$). Skeletal bones were evaluated and compared with the embryos in the control group. The bones of rat embryos, which were given 3 times the treatment dose of the mixture in all three stages of pregnancy, were of normal size and there was no difference compared to the bones of the animals in the control group ($p \geq 0.05$). The length of the shoulder (scapula) bone in the embryos in the experimental groups was 3.74 mm and 3.65 mm, the length of the bazu (brachii) (humerus) was 3.92 and 3.84 mm, the length of the elbow (ulna) (antebrachium) was 4.05 and 3.98 mm, and the shaft in the experimental and control group embryos, respectively. Forearm (radius) was measured as 3.20 and 3.01 mm, femur (femoris) as 2.80 and 2.60 mm, shin (tibia) as 3.22 and 3.15 mm, calf (fibula) (metacarpus/metatarsus) as 2.94 and 2.82 mm. The investigations carried out show that the caropodium- ajuga mixture has no embryotic influence.

Keywords: Embryotrop, implantation, foetus periods, place of reabsorption, Caropodium, Ajuga, Toxicology

Morphological Structure and Germination Capacity of Pollen of Some Species Belonging to The *Passiflora* L. Genus

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Abstract

The study of the viability of pollen in trees, shrubs, liana-type plants under the conditions of introduction combines a lot of information. So, this indicator is one of the determinants of any plant's adaptation to a new environment. That is why determining the viability of pollen is of particular importance in order to obtain a high-quality seed yield in the species introduced in Absheron conditions. Pollen grains of the flowers of *Passiflora* species are flat, spherical in shape, pollinated by themselves and by insects. Pollen viability and germination were studied in *Passiflora incarnata*, *Passiflora edulis*, *Passiflora caerulea*, *Passiflora ligularis* grown in the experimental field of the Dendrology Institute. For this purpose, the first and fully opened flowers were taken from the mother plant in the morning and collected in a paper bag, the area where the species grew and the time of collection were noted and submitted to the laboratory.

The viability of pollen in the studied *passiflora* species was studied by aceto-carmin and iodine staining. For this purpose, live and dry pollens of the flower were visually observed by means of "Nikon eclipse E-100" and "AmScope" microscope (with 10, 25- and 40-times magnification lens). During the observation, it was found that a large amount of pollen was formed in the pollen box of the 4 studied species. In the 2nd stage of the experiment, 1 drop of 5% iodide solution is added to the pollen box placed in the object glass according to the same procedure. The undyed part of the pollen is colorless, and depending on the species, most of it is dark. Unstained pollen is sterile, and dark colored pollen is fertile. Since starch does not accumulate in sterile pollen, they are light in color and do not have fertilizing properties. Fertile pollen was mostly observed in *P. caerulea* L. species, followed by *P. edulis* L. and *P. incarnata* L. species. Since there is a lot of starch in fertile pollens, their fertilization ability is also much higher. That is why the species we studied bloom and bear fruit until the end of autumn. Nutrient medium was prepared using 5-25% sucrose solution to study pollen germination ability. During each of the 2 studies, 1 drop of nutrient medium was placed on a sterile object glass, the studied pollen was placed inside it, mixed lightly with a glass rod, covered with a cover glass and treated with glycerin. Then, the object glass was placed on wet filter paper and placed inside the Petri dish. During our research on pollen germination, it was observed that in *passiflora* species, pollen germinated 40-60 minutes after being sprinkled on nutrient sucrose medium, and the pollen tube appeared within 2-3 hours. During 10-12 hours, the pollen tube slowly elongated and reached its maximum size within 24 hours.

Keywords: pollen, *Passiflora*, fertile, experiment, sterile

Carbon Sequestration of Oak seedling (*Quercus castaneifolia* C.A.Mey)

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Abstract

One of the most important ways to reduce atmospheric carbon is the carbon sequestration by trees. Chestnut-leaved oak (*Quercus castaneifolia* C.A.Mey) is one of the most important native oaks of Iran distributed in the Hyrcanian Forests. The pure and mixed stands of it cover about 6.5% of these forests. In this study, carbon sequestration of Oak (*Quercus castaneifolia*) seedlings was evaluated by using some morphological characteristics of the root and shoot. For this purpose, one hundred seedlings were sampled by method of Systematic-Random from the sowing bed on March 2022 in the Pylambra nursery at Guilan province. Seedlings are divided to three grades small, medium and large according to Root Collar Diameter (RCD). The biomass and carbon sequestration of oak seedling were calculated according to the basic density of its root and shoot. The Pearson's correlation coefficient was used for correlation detection between variables. The one way analysis variance test at the 95% confidence level was used to recognize difference among biomass and carbon sequestration of three group of the Oak seedlings. The results of correlation analysis showed that the root collar diameter (RCD) had the strongest correlation with other morphological characteristics. The amount of the basic density for the root and shoot of the Oak seedling was obtained about 0.57 gr/cm³ which is the same for both of them. The amount of the biomass and carbon sequestration of the root was obtained more than shoot at the small and medium seedlings, whereas in large seedling was the same. In general, by increasing the size of seedling the biomass and carbon sequestration increased.

Keywords: Oak seedling, Biomass, Carbon sequestration, Basic density, Root Collar Diameter

A preliminary study on the coating of chitosan to create hydrophobic surfaces

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Abstract

Chitosan is a naturally hydrophobic polymer due to its hydroxyl (-OH) and amino (-NH₂) groups. In addition, coating chitosan polymer on various surfaces such as automobile paints, plastics, or textiles can also provide hydrophobic properties. This research aimed to obtain a hydrophobic surface by coating chitosan polymer on automobile acrylic paint. For this purpose, the surfaces were cleaned with detergent and warm water, then ultrasonically cleaned with 100% ethanol and rinsed with deionized water. Then, the layers were immersed in 5 M NaOH at 60°C for 1 hour to facilitate the formation of single -OH groups on the surface. At the end of this period, the layers were rinsed ten times with fresh deionized water and kept in fresh deionized water until ready for coating. Then, the chitosan solution prepared in 0.5% (v/v) acetic acid with pure water was heated in a microwave oven for approximately 1 minute until completely dissolved. After the prepared solution was cooled to room temperature, it was centrifuged at 1000 rpm for 30 seconds to remove insoluble particles. The painted surfaces cut into 2x2 cm dimensions were immersed in the coating solution prepared in the previous step for 30 minutes. The chitosan-coated surfaces were then dried at 80°C for 24 hours. After ten microliters of pure water were dropped onto the chitosan-coated surfaces, the drops were photographed under a stereo microscope turned sideways. Then, the contact angles of the water drops were calculated using the ImageJ program from the photos transferred to the computer. As a result, the contact angle of the group without pretreatment (control) was found to be 64.5±1%. Except for the experimental setup number 3, which was pretreated and not washed, all applications caused an increase in the contact angle. Among the applications, the highest contact angle (80.5±1.5%) was obtained from the experimental group no. 1, which was not pretreated and washed. Coating the paint surfaces with a single concentration (0.5%) of chitosan, a contact angle difference of approximately 16 degrees was obtained compared to the control, making the surface more hydrophobic.

Keywords: Chitosan coating, Acrylic surface, Contact angle

Studies on pollen viability of *Tripleurospermum ziganaense* (Asteraceae) – a critically endangered endemic species from Türkiye

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Abstract

Pollen viability is one of the main factors affecting reproductive biology. Viable pollen grains are important for survival of the next plant generation and it play an important role for genetic diversity of the species with reproduction. Therefore, it can be helpful for conservation studies of threatened species. *Tripleurospermum ziganaense* Inceer and Hayırlıoğlu-Ayaz (Asteraceae) is critically endangered (CR) endemic species in Türkiye due to several antropogenic pressures. In this study, we presented the results of pollen viability test of this species for the first time. In order to determine the rate of pollen viability orcein, tetrazolium (TTC) and safranin were used. Plant materials were collected from Gümüşhane province where its natural population is located, during the vegetation period. Pollen grains obtained from disk flowers at anthesis stage were stained with %1 solution of orcein, safranin and tetrazolium for 12 hours. Dark colored pollen grains were considered alive and others were considered non-living. According to the results obtained, the viable pollen rate for *T. ziganaense* is $79\pm 8.1\%$ in safranin and $91\pm 5.51\%$ in TTC. However, it is not possible to distinguish between living and non-living with orcein. In the study, it was determined that the pollen viability rate was over 70% in safranin and tetrazolium and these results indicate that *T. ziganaense* has high pollen viability. The present data obtained from pollen viability test can be used for reproductive biology and conservation activities of the endangered endemic *T. ziganaense* as well as other treated endemic species of *Tripleurospermum*.

Keywords: *Tripleurospermum ziganaense*, pollen viability, reproductive biology, conservation

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Stigma Receptivity of Endemic *Tripleurospermum ziganaense* (Asteraceae)

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Abstract

Stigma receptivity, which involves many biochemical processes such as capturing pollen through adhesion, allowing its hydration, and ultimately forming a pollen tube, is an important stage in the maturation of a flower and hence, it has a critical role in reproductive biology and genetic diversity. Therefore, it is a parameter used for conservation studies of threatened species. *Tripleurospermum ziganaense* known from only one population in Gümüşhane is endemic to Türkiye. It is critically endangered (CR) species due to several antropogenic pressures. In this study, we presented the results of stigma receptivity test of this species for the first time. In order to determine the stigma receptivity hydrogen peroxide (H₂O₂) were used. Plant materials were collected from Gümüşhane province, where its natural population is located, in pre-anthesis and anthesis stages. Stigmas obtained from disk flowers, in pre-anthesis and anthesis stages were stained with solution of H₂O₂ for 2 hours. As a result of the observations, bubbles formed on the stigma were considered ready for receptivity or pollen reception, while the absence of bubbles was considered as the stigma not being suitable for pollination and fertilization yet. According to the results obtained herein, the stigma receptivity score for *T. ziganaense* is 1.66±0.47 with H₂O₂ in anthesis. However, the bubbles on the stigmas are not observed in pre-anthesis stage. This findings indicate that the stigma receptivity is pozitif in anthesis stage, while it is negative in pre-anthesis stage in this species. The present data obtained from stigma viability can be used for reproductive biology and conservation acivities of the endangered endemic *T. ziganaense* as well as other treatedned endemic species of *Tripleurospermum*.

Keywords: *Tripleurospermum ziganaense*, stigma receptivity, hydrogen peroxide, conservation

Acknowledgement: This work was supported by the Scientific and Technological Research Council of Türkiye (TUBITAK, Project No 122Z845) in the frame of 2519-COST CA18201 "An integrated approach to conservation of threatened plants for the 21st Century".

Two cases of numerical variations in setae *pdx* of *Neophyllobius yunusi* Akyol & Koç (Acariformes: Camerobiidae)

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Abstract

Neophyllobius yunusi Akyol and Koç (Camerobiidae) has been known from Afyonkarahisar and Kütahya provinces, Türkiye. It can be recognized by having *pdx* present, dorsal setae with small denticles, tarsus IV with 1 midventral setae, femur I with 4 setae and femur II with 3 setae. The aim of this study is to demonstrate the existence of numerical variations in the seta *pdx* of *N. yunusi*. Altogether 21 females and 1 protonymph specimen of *Neophyllobius yunusi* collected by using Berlese-Tullgren within the scope of an on-going study on mite biodiversity were examined. Specimens were cleared in 60% lactic acid and mounted in Hoyer's medium on microscopic slides. Asymmetrical variations in 2 of the specimens were detected with the aid a Leica DM 4000B phase-contrast microscope. There are typically 1 pair of setae *pdx* on prodorsum of *Neophyllobius yunusi*; however, the *pdx* on the left is a duplex in a female, the left *pdx* is missing and the right *pdx* is a duplex in a protonymph. This is the first report on the numerical variations in *N. yunusi*. These variations disrupting the bilateral symmetry can be expressed as anomaly.

Keywords: Acari, anomaly, asymmetry, dorsal seta, morphology.

Acknowledgement: The mite specimens in this study were collected during a project (№ 121Z986) supported by the Scientific and Technological Research Council of Türkiye (TÜBİTAK). We gratefully appreciate TÜBİTAK's financial assistance.

Investigation of the relationship between the general morphological characters of Turkish *Potantilla* (Rosaceae) taxa and the phytogeographical region to which they belong

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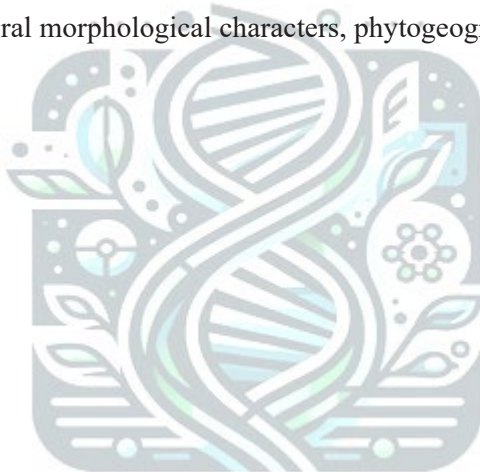
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Abstract

There are 63 taxa belonging to the genus *Potantilla* in Turkey. 12 of these taxa are Irano-Turan element, 11 are Mediterranean element, 20 are European-Siberian element and 19 are unknown. It was examined which general morphological characters of the taxa represent the phytogeographical regions of the taxon. For this purpose, Principal Component Analysis (PCA) and Nonmetric Multidimensional Scaling (NMDS) Analysis were applied. According to the results of both analyses, no significant relationship between their morphological characters and the phytogeographic element to which they belong.

Keywords: Potantilla, general morphological characters, phytogeographical region, Türkiye.



Floral Ecology of Endemic *Tanacetum albipannosum* (Asteraceae)

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Abstract

Many plant species especially endemic species are extinction the results of biotic, habitat, area and climatic factors with antropogenic pressures increasing in every day. Antropogenic pressures and many ecological factors such as climate changes can cause disruption of plant reproductive sytems and thus decreasing of genetic diversity. *Tanacetum albipannosum* (Asteraceae) is endemic to Türkiye and it is distributed in north east Anatolia and east Anatolia. The species is an Irano-Turanian element and grows on rock crevices and rocky slopes. *Tanacetum albipannosum* is classified within LR(cd) (the lower risk, conservation dependent) category of IUCN (The International Union for Conservation of Nature) in Red Data Book of Turkish Plants. Little is known about the floral ecology or the life history of the species that could be used to inform conservation or management decisions. In this study, reproductive phenology (flowering and fruiting) and microclimatic factors (air temperature and relative humidity) in the habitat of the species were presented for the first time in detail. Reproductive season of the species lasted from June to July. The flowering peaked mid-June, while the fruiting peaked early July. In the habitat of the species, the average temperature and relative humidity in the reproductive season were detected as $17.34\pm 6.35^{\circ}\text{C}$ and $67.03\pm 21.34\%$, respectively. On the other hand, significant correlations were found between phenological traits and microclimatic factors.

Keywords: Microclimate, phenology, reproductive biology, *Tanacetum albipannosum*

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FULL TEXT ARTICLES



The Therapeutic Use of Plant Extracts in Fish Diseases

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Abstract

The use of plants for medicinal purposes dates back to the beginning of human history. Medicinal and aromatic plants are used in both traditional and modern medicine for the treatment and prevention of diseases, as well as for maintaining health. According to data published by the World Health Organization (WHO), the use of herbal medicines for therapeutic purposes is 80% in developing countries, while this rate is 40% in developed countries, and it is predicted that these rates will increase worldwide in the future. Aquaculture is rapidly increasing both in our country and around the world. The goal in aquaculture is to bring the species being farmed to market as quickly and cost-effectively as possible. For this purpose, drugs used both for growth and for the treatment of diseases help reduce the effects of toxins, allowing energy and nutrients to be used in the synthesis of animal products. However, when these substances are used frequently, they eventually lead to resistance in fish, leave residues in their meat, and cause adverse effects in humans who consume these products. Due to these reasons, the use of these products has been restricted in our country and many others. Consequently, in recent times, natural plant extracts and essential oils are being used to enhance the growth rates of farmed species and improve product quality.

Keywords: Fish, plant extract, essential oil, disease, medication.

1. INTRODUCTION

Plants have been used for medicinal purposes throughout human history. Generations of experience have helped us determine which plants are effective for treating specific ailments. For example, the use and study of herbal medicines in China and India date back approximately 5,000 years. In ancient Greece, Hippocrates, regarded as the father of modern medicine, used hundreds of plants in his medical practices, many of which are still in use today. In this way, herbal treatments are considered methods whose effectiveness has been proven over time and continue to be adopted and used by different cultures around the world (Yiğitaslan *et al.*, 2011). Approximately 25% of the drugs used in modern medicine today are derived from plant sources. The most well-known among these is aspirin, which is obtained from the bark of the willow tree. Other examples include atropine from *Atropa belladonna*, ephedrine from the *Ma huang* plant, and paclitaxel (Taxol) from the Pacific yew tree. These plant-based products have long been considered more effective than their synthetic alternatives. Advances in chemistry and biochemistry in the 19th and 20th centuries accelerated the pharmaceutical industry, leading to the development of many new drugs in the laboratory that meet medical needs. These drugs were developed following analytical, toxicological, pharmacological, and clinical studies to ensure effectiveness, safety, and quality standards (Karagülle, 2003).

Today, the use of medicinal and aromatic plants is gaining increasing interest. Although these two terms are often mentioned together, each has a different meaning. Medicinal plants are used for treating diseases in humans and animals, while aromatic plants are mainly preferred for their pleasant scents. The use of medicinal plants dates back to 5000 B.C to the Mesopotamian civilization, where over 250 herbal products were known to be used for this purpose. The prevalence of these plants is geographically more common in regions such as Asia, Africa, and the Middle East, and it varies according to the level of development of countries. Nowadays, a significant number of these plants can be cultivated both globally and in Turkey, with agricultural production carried out in addition to wild collection. Turkey serves

as a genetic center for many plant species, hosting 174 different families, 1,251 genera, and over 12,000 species and subspecies (Aktop and Çağatay, 2022).

1.1. Aquaculture and Plant-Based Products

The goal in aquaculture is to bring the cultivated species to market in the shortest time and at the lowest cost. To achieve this, antibiotics used both for disease treatment and growth promotion reduce the effects of toxins, allowing nutrients and energy to be utilized in the synthesis of animal products. However, the frequent use of these substances has led to resistance in fish over time, residue build-up in their flesh, and adverse effects on humans consuming these products. Consequently, many developed countries, including Turkey, have imposed restrictions on the use of these substances. These restrictions have also directly affected countries that sell animal food products to the European Union, which played a significant role in the decision (Parlat *et al.*, 2002).

In recent years, concerns have grown in the farming sector over the use of antibiotics, known as synthetic products, due to the emergence of resistant bacterial strains and the presence of residues in animal products that pose potential risks to human health. This situation has gained even more significance following the European Union's decision in 2002 to prohibit the addition of additives like antibiotics to animal feed starting from 2006. These developments have encouraged scientists to research alternative medicines that can be derived from natural sources (Şergezer *et al.*, 2008).

1.2. Antioxidant Properties of Plant Extracts

Phytochemicals contain antioxidants that are critically important for food substances and the organisms that consume them. Antioxidants protect against oxidative damage caused by free radicals. These free radicals are produced during metabolic processes through electron transfer and aerobic respiration. While an organism's own antioxidant defense systems are generally sufficient, there are instances where exogenous antioxidants are needed. These can be divided into two main groups: enzymatic and non-enzymatic natural antioxidants. The enzymatic group includes enzymes such as superoxide dismutase and catalase, while non-enzymatic antioxidants consist of factors like phenolic compounds, carotenoids, and vitamins. These antioxidants neutralize free radicals, preventing cellular damage and cell injury, reducing the effects of aging and tumor development. The literature indicates that phenolic compounds isolated from plants have high antioxidant capacity and exhibit effectiveness comparable to synthetic antioxidants. These compounds are important factors that support a healthy life (Beer *et al.*, 2017).

1.3. Mechanisms of Action of Medicinal Plants

Approximately 16% of the plants used worldwide have been scientifically tested for their therapeutic value. Many medicinal plants remain undiscovered or untested today, indicating that the full medicinal potential of these plants is not yet fully understood. Among the most widely known phytochemical compounds are phenolic compounds (polyphenols), tannins, saponins, carotenoids, coumarins, tocopherols, terpenes, isothiocyanates, sulfides, sulforaphanes, terpenoids, alkaloids, flavonoids, phytosterols, phytoestrogens, and indoles (Fidan and Dündar, 2007). These compounds are rich in phytochemicals, particularly those with antioxidant activities, and are used to combat many diseases today (Vital *et al.*, 2010). They are secondary metabolites produced by the metabolism of aromatic amino acids in plants. The physicochemical properties of these compounds include the condensation of up to eighty monomers, complex formation with proteins resulting in precipitation, and water solubility

(Saldamlı, 1998). To date, approximately 200,000 phenolic compounds have been isolated (Lattanzio, 2013). The currently isolated phenolic compounds constitute about 10% of all aromatic compounds, and there are still hundreds of phenolic compounds yet to be discovered (Silva et al., 2005).

These compounds can be found at varying levels in different parts of the plant, influencing the taste, aroma, and color while also exhibiting antimicrobial and antioxidant properties. Additionally, they can inhibit various enzymes. Phenolic compounds are natural sources of antioxidants essential for metabolism and demonstrate antioxidant effects by scavenging free radicals or forming chelates with metals (Verma et al., 2009). Besides their antioxidant properties, plants have various benefits such as antiallergenic, antimutagenic, anticarcinogenic, antiglycemic, anticholesterol, antimicrobial, anti-inflammatory, antithrombotic, vasodilatory, and sedative effects. Due to these properties, plants have a wide range of applications, from cosmetics to medicine and the food industry (Naczki and Shahidi, 2006).

Flavonoids, representing a significant group of phenolics, are widely distributed in the plant flora. They are secondary metabolites with substantial antioxidant activity and chelating properties and cannot be synthesized by humans (Sivam et al., 2010). The literature reports that flavonoid compounds possess a range of bioactive properties, including antioxidant, anti-inflammatory, antiallergic, antiviral, anti-aging, and anticancer (cytotoxic) effects. Regular consumption has been associated with a reduced incidence of certain diseases, such as prostate and breast cancer. Additionally, these bioactive flavonoids, also known as vitamin P, have been reported to prevent bleeding and ruptures in capillaries (Skowrya et al., 2014). Besides phenolic compounds, many other compounds with different structures but bioactivity are present in plants.

1.4. Antimicrobial Properties of Herbal Extracts

Antimicrobial agents are chemical and biological compounds that control the growth of pathogenic microorganisms by inhibiting their growth or killing them. Antibiotics are widely used worldwide, particularly for treating mild to moderate infections. However, the improper and excessive use of antibiotics has led to microorganisms developing resistance to these drugs. Resistant pathogens make treating AIDS, cancer, and other infectious diseases more difficult, which perpetuates the search for new antimicrobial agents (Rempe et al., 2017).

Plants with antimicrobial activity have the potential to be comparable to modern medicines and are considered a significant resource for treating various infectious diseases. Herbal phenolic compounds can inhibit the growth of certain bacteria and mold species and prevent infectious diseases caused by these microorganisms. For example, *Calendula officinalis* has shown the highest inhibition against *Pseudomonas aeruginosa*. Additionally, plants containing capsaicin have effects against some pathogens comparable to commercial antibiotics. The mechanisms of action of antimicrobial components in plants differ from those of synthetic antimicrobials and inhibit bacterial growth through various metabolic reactions. For instance, phenolic compounds like chlorogenic acid and quercetin exert their effects by disrupting bacterial cell membranes or damaging DNA structure. These mechanisms highlight why plants are a powerful tool against pathogens (Li et al., 2014).

1.5. Anti-Inflammatory Properties of Herbal Extracts

Anti-inflammatory agents exert their effects by scavenging active oxygen radicals in inflamed areas or inhibiting the formation of these radicals. Enzymes such as lipoxygenase (LOX) and xanthine oxidase (XO), which play a role in the inflammation process, can lead to the development of various diseases in the body. Lipoxygenase enzymes catalyze the oxidation

of polyunsaturated fatty acids, leading to the formation of free radicals and compounds like hydroperoxyeicosatetraenoic acid (HPETE) that contribute to inflammation. Similarly, xanthine oxidases convert xanthine into uric acid, causing inflammation and hyperuricemia. Compounds that inhibit LOX and XO enzymes have anti-inflammatory properties, and herbal compounds capable of inhibiting these enzymes are significant in treating inflammation-related diseases.

Phenolic compounds and essential oils in plants exhibit anti-inflammatory effects by inhibiting LOX and XO enzymes. For instance, while XO inhibitors like allopurinol are used in the treatment of gout, they can also have some serious side effects. It has been reported that the enzyme inhibition capacity of herbal extracts varies depending on the dose of the plant used, with higher concentrations showing stronger inhibition effects. Therefore, developing new inhibitors with fewer side effects and discovering natural sources remain important research areas in inflammation treatment (Wisastira and Dekker, 2014; Ben-Nasr *et al.*, 2015).

1.6. Immune System In Fish

The immune system of teleost fish is fundamentally similar to that of mammals. However, factors such as the variability in the physical and chemical properties of the water they live in, their cold-blooded nature, and the dependence of their body temperature on the surrounding environment lead to some differences in their immune system. In fish, the effectiveness and speed of antigenic molecules that stimulate the immune system are limited, particularly due to the reduced capacity of pathogens to proliferate at lower temperatures. This results in a weaker immune response and the inability to provide complete protection. The most significant difference between the immune systems of fish and mammals is the absence of bone marrow and lymph nodes in fish. The primary lymphoid organs in fish are the kidney, spleen, and thymus. These differences significantly affect the response of the fish's immune system to environmental factors and pathogens (Baba, 2017).

The immune system in fish is divided into two main parts: nonspecific (innate) immunity and specific (acquired) immunity. The nonspecific immune system, as in mammals, includes humoral (fluid) and cellular defense mechanisms. This type of innate immunity provides a general defense against all foreign substances entering the body and is not specific to any particular pathogen. Specific immunity, on the other hand, is an acquired immunity against specific pathogens over time. This type of immunity relies on the body's ability to develop specialized cellular and humoral responses against certain microorganisms and provides a more effective defense against pathogens that have been previously encountered.

2. CONCLUSION

Aquaculture is a rapidly growing sector worldwide, playing a significant role in the production of marine, freshwater, and shellfish products. However, intensive production conditions lead to infectious diseases and associated losses. In addition to traditional methods such as antibiotics, chemotherapy, and disinfection, the use of plant-based products has also increased in recent years. Plants and plant derivatives are used as immunostimulants that strengthen the immune system and provide protective effects against diseases, thanks to their phenolic, polyphenolic, alkaloid, and terpenoid components. These plant-based products are seen as more effective and environmentally friendly alternatives to antibiotics and other synthetic compounds. They can prevent infections through their antimicrobial properties, support fish growth, and enhance their ability to cope with stress. Various plant-based immunostimulants provide effective protection against diseases by enhancing natural and adaptive immune responses in different fish species.

In conclusion, the use of natural immunostimulants in fish farming has become an increasingly preferred approach for preventing diseases and improving fish health. These natural products support aquaculture by offering environmentally friendly and sustainable alternatives.

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The Link between Biotechnology, Biodiversity and Artificial Intelligence: A Bibliometric Study

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Abstract

Although there has been an increase in the number of studies on biotechnology, biodiversity and artificial intelligence in recent years, the link between biotechnology, biodiversity and artificial intelligence has not been examined with bibliometric mapping techniques. Therefore, it is thought that a bibliometric study on the link between biotechnology, biodiversity and artificial intelligence will contribute to the literature. Therefore, this study aims to reveal the link between biotechnology, biodiversity and artificial intelligence through bibliometric analysis. For this purpose, a search was made through the advanced search of the Web of Science (WoS) database as ((TS=(Biotechnology* or Biotech*)) AND TS=(Artificial Intelligence*)OR (QMTS=("Biotechnologies*")) OR (QMTS=("Artificial Intelligence*")) OR (QMTS=("Biotechnology*")) AND TS=(Biodivers*)). In this context, various parameters such as country, etc. related to a total of 1,532 publications reached as a result of WoS search were subjected to bibliometric mapping technique with VOSviewer and R Studio Bibliometrix programs. Within the framework of the results of the research, it is recommended that researchers who plan to conduct research on the subject should carry out studies in different disciplines. However, a bibliometric analysis that includes publications in different databases such as ProQuest and compares them with the results of this study can be suggested to be realized. This research provides an overview of Biotechnology, Biodiversity and Artificial Intelligence and provides researchers with an opportunity to It can be said that it is a guide for studies.

Keywords: WoS, biotechnology, biodiversity, artificial intelligence, bibliometrics

1. INTRODUCTION

The integration of biotechnology, biodiversity and artificial intelligence plays an important role in the development of both the sharing and standardization of biological-ecosystem data and the provision of multidisciplinary collaboration, biotechnological tools and technological infrastructure in these fields.

Biotechnology, the dictionary meaning of which is the science of living production; This term, which is formed by the combination of the words bio-techno. and logy, means the production of various products using living materials (Şahin, 1987). Biological diversity (biodiversity), which refers to the diversity of species in a region, can mean that the number of animal and plant species in a region is high and biodiversity is rich (Çakmak, 2008). Artificial intelligence is defined as a modeling system inspired by the behavior of living things (Sucu and Ataman, 2020).

Although there has been an increase in the number of studies on biotechnology, biodiversity and artificial intelligence in recent years, the link between biotechnology, biodiversity and artificial intelligence has not been examined with bibliometric mapping techniques. Therefore, it is thought that a bibliometric study on the link between biotechnology, biodiversity and artificial intelligence will contribute to the literature. This study aims to reveal the link between biotechnology, biodiversity and artificial intelligence through bibliometric analysis.

2. MATERIAL and METHODS

In this study, the interaction between biotechnology, biodiversity and artificial intelligence was analyzed by bibliometric analysis. Because bibliometric analysis is a method of analyzing and evaluating printed and electronic materials (Güzel et al., 2024). TS "title,

abstract, keyword” was selected from the Advanced Search Query Builder section of the Web of Science (WoS) database and searched as follows: ((TS=(Biotechnology* or Biotech*)) AND TS=(Artificial Intelligence*)OR (QMTS=("Biotechnologies*")) OR (QMTS=("Artificial Intelligence*")) OR (QMTS=("Biotechnology*"))) AND TS=(Biodivers*). The data obtained regarding scientific researches were subjected to bibliometric mapping technique with Sankey diagram, R Studio Bibliometrix and VOSviewer programs. In the light of all this information, the following analyses were carried out within the scope of this research:

- Times cited and publications over time,
- WoS Index,
- WoS category,
- Citation topics,
- Research areas,
- Publication language,
- Open access status,
- Countries/Regions,
- Abstract, title and keywords
- Citation & organizations analysis

3. RESULTS and DISCUSSION

The lack of a bibliometric study on the interaction of biotechnology, biodiversity and artificial intelligence has revealed the importance and originality of this research. In this context, since there is no bibliometric study on the subject, a comparison with the results in the literature could not be made. This result supports the study of Yenisoy and Hassan (2024).

Figure 1. Citation report

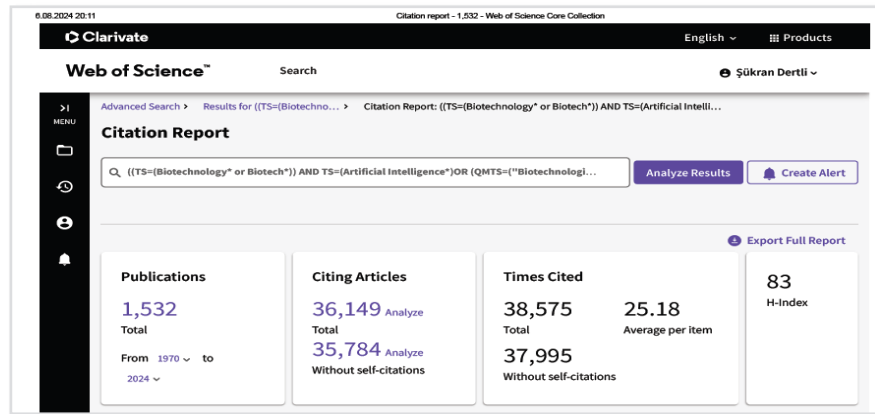


Figure 1 shows that a total of 1,532 publications were reached as a result of the WoS search.

Figure 2. Times cited and publications over time

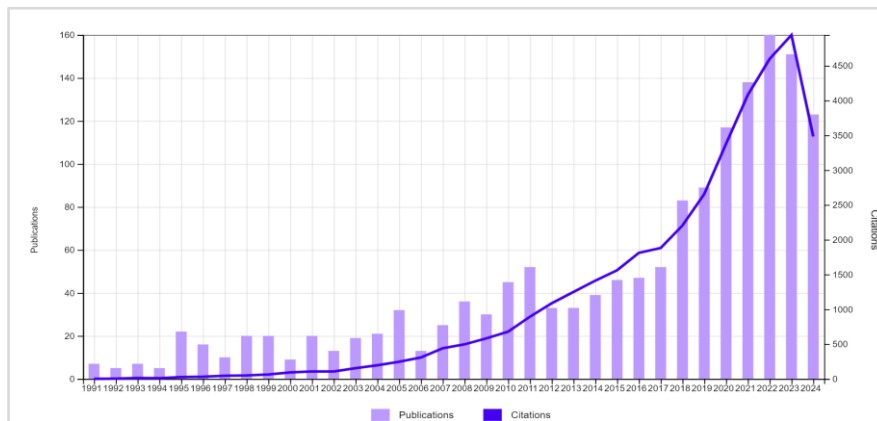


Figure 2 shows that the first research on biotechnology, biodiversity and artificial intelligence was conducted in 1991. When the annual scientific production values were analyzed, it was found that 141 publications were prepared between 1991-2001, 319 publications between 2002-2012, and 1072 publications in 2013 and the following years. The low number of publications in the field of biotechnology, biodiversity and artificial intelligence in the period between 1991-2001 shows that research infrastructures and databases were not sufficiently developed. It reflects the fact that the field of biotechnology, biodiversity and artificial intelligence became more widespread and accessible in the period between 2002 and 2012. After 2013, there has been a steady increase in the number of publications, demonstrating that there has been significant evolution and transformation in the field of biotechnology, biodiversity and artificial intelligence.

When the annual average citation values were analyzed, it was found that 141 citations were received between 1991-2001, 319 citations were received between 2002-2012, and 1072 citations were received in 2013 and following years. This finding was interpreted in parallel with the annual scientific production values. In fact, it can be considered as a consequence of the fact that the field of biotechnology, biodiversity and artificial intelligence was less recognized in the period between 1991 and 2001. In the period between 2002 and 2012, an increase in the number of citations was observed with the entry into a process in which significant changes and developments in the fields of biotechnology, biodiversity and artificial intelligence began to be experienced. After 2013, the rapid increase in the number of citations in the fields of biotechnology, biodiversity and artificial intelligence can be attributed to factors such as the change/development of digital technologies, the increase in the number of publications, and the increase in the number of open access journals.

All of these results are interpreted as the scientific-technological developments and investments since 1991 have played an important role in increasing the annual production and average number of citations in the fields of biotechnology, biodiversity and artificial intelligence.

Figure 3. Open access status



Figure 3 shows that the majority of publications related to biotechnology, biodiversity and artificial intelligence were accessed. This was interpreted as playing an important role in increasing the visibility/accessibility, number of citations, etc. of publications on biotechnology, biodiversity and artificial intelligence.

Figure 4. WoS Index

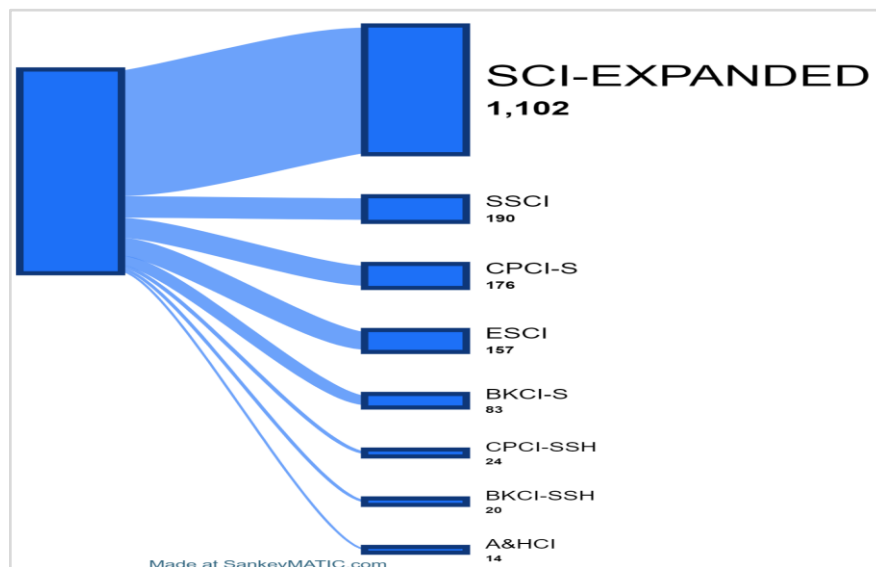


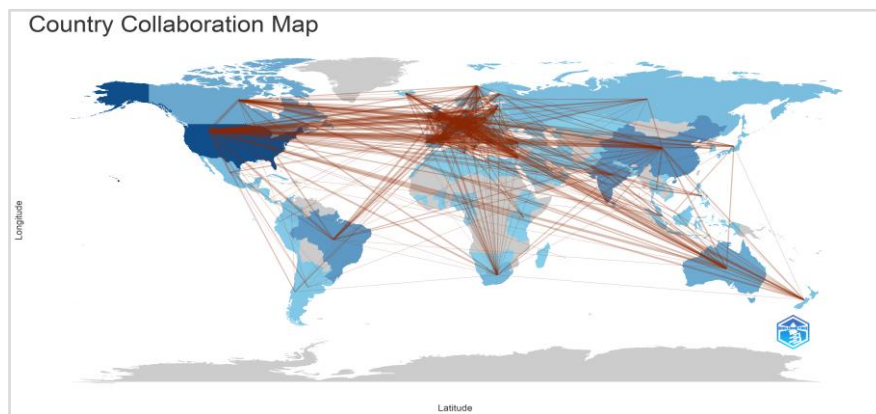
Figure 4 shows that studies on biotechnology, biodiversity and artificial intelligence are published in journals listed in more than one index. It was found that 1,102 of the studies were included in SCI-EXPANDED, 190 in SSCI, 176 in CPCI-S, 157 in ESCI, 83 in BKCI-S, 24 in CPCI-SSH, 20 in BKCI-SSH and 14 in A&HCI indexes. This shows that the studies were mostly published in SCI-EXPANDED. This reveals that the issue is mostly evaluated from the perspective of engineering and natural sciences.

Figure 5. Examples from countries/regions



When the distribution of the countries/regions where the most studies on biotechnology, biodiversity and artificial intelligence were prepared is analyzed in Figure 5, it is found that 286 of the studies were published in the USA, 142 in England, 128 in Italy, 122 in India, 117 in Peoples R China, 113 in France, 111 in Brazil, 79 in Canada, 76 in Spain, 73 in Australia, 51 in the Netherlands and 49 in Portugal. The reason for more research on the subject in these countries is the high number of scientific publications, high quality journals, strong research infrastructure and resources.

Figure 6. Countries' collaboration world map



When the distribution of countries in the cooperation world map in Figure 6 is analyzed; it is observed that the flow of cooperation is higher in countries such as USA-UK (n:38), UK-Germany (n:29), UK-France (n:26), UK-Italy (n:24), USA-Germany (n:24), Germany-France (n:21), USA-Canada (n:19), Italy-Spain (n:18), USA-China (n:18), USA-France (n:18). It can be said that this cooperation between countries will contribute both to the promotion of knowledge sharing and scientific innovation with a strong global impact and to the achievement of interdisciplinary quality research that increases the impact on the international scientific community.

Figure 7. Languages

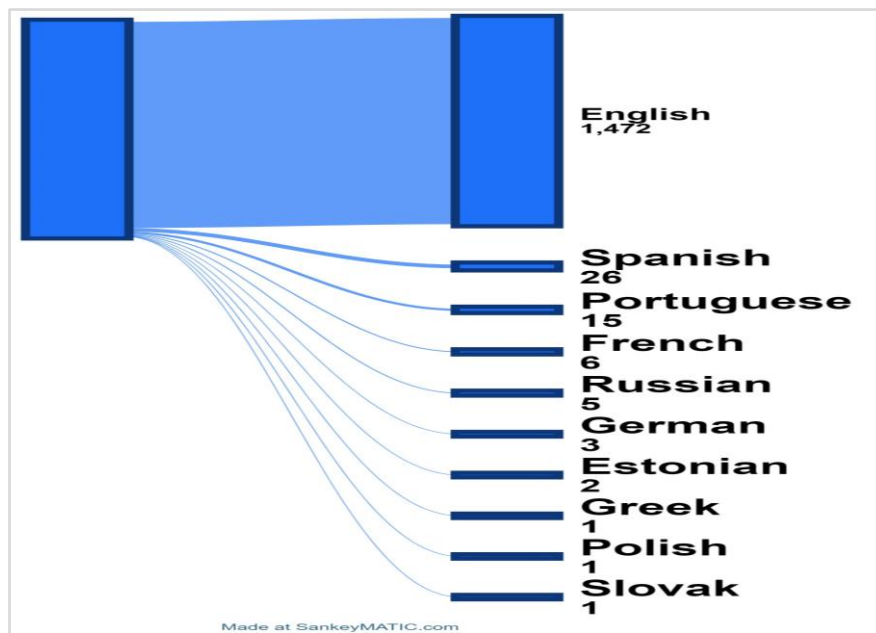


Figure 7 shows that 1,472 studies on biotechnology, biodiversity and artificial intelligence were published in English, 26 in Spanish, 15 in Portuguese, 6 in French, 5 in Russian, 3 in German, 2 in Estonian, 1 in Greek, 1 in Polish and 1 in Slovak. The fact that most of the studies were prepared in English was associated with the fact that English is the main language of publication of WoS, that it publishes journals in English to increase access to the world, and that it is accepted as a global language in the world of science and education.

Figure 8. Thematic map of abstracts

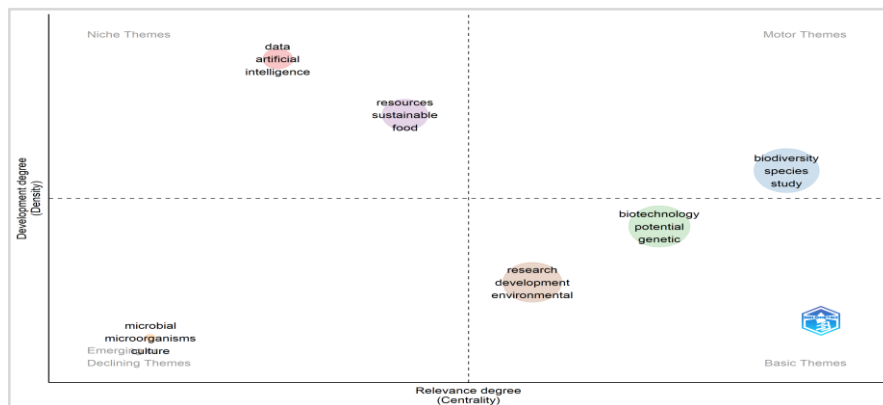
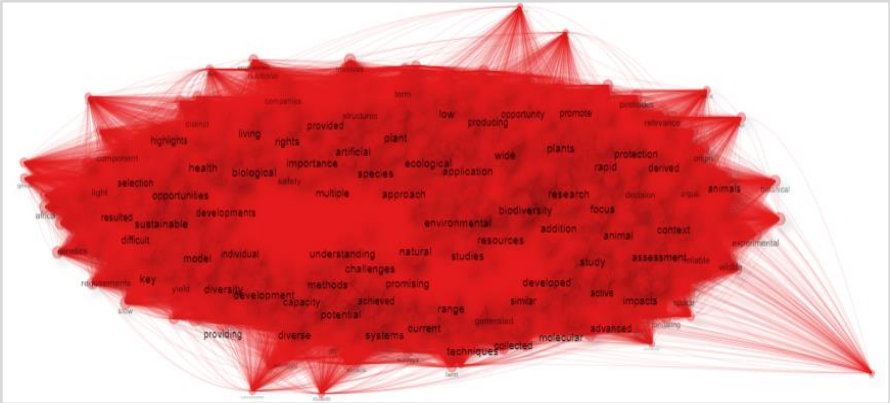


Figure 8 shows that words such as biodiversity, species, study have well-developed and strong connections with other themes, while words such as biotechnology, potential, genetic have strong connections with other themes.

Figure 9. Network map of abstracts



In the network map of the abstracts in Figure 9, it is observed that words such as “biodiversity”, “biotechnology”, “species”, “research”, “potential”, “development”, “environmental”, “genetic”, “conservation”, “diversity”, “biological”, “sustainable”, “ecological”, “global”, “technology”, “artificial intelligence” are used the most. This relationship between biotechnology, biodiversity and artificial intelligence plays an important role in the development of innovative solutions and the conservation of biodiversity.

Figure 10. Conference titles



Figure 10 shows that words such as “international”, “congress”, “intelligence”, “environmental”, “workshop”, “biotechnology”, “biodiversity”, “biology”, “technology” were used the most in conference titles. This revealed that international congresses on biodiversity, biology and artificial intelligence were held.

Figure 11. Book series titles



Figure 14. Examples of citation topics

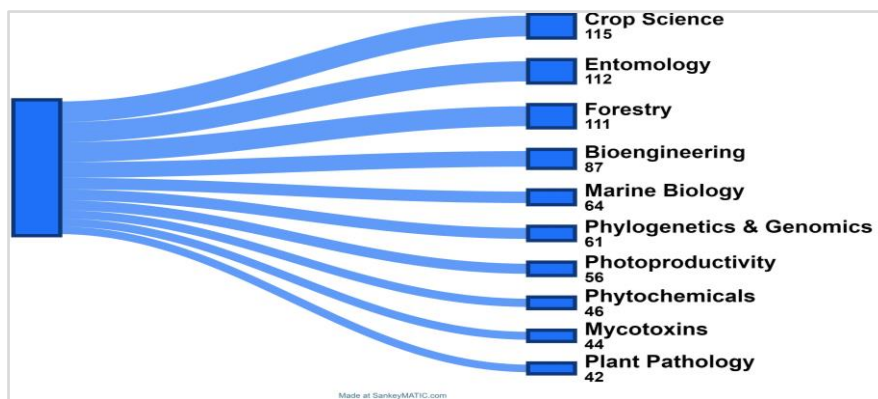


Figure 14 shows that 115 of the studies were examined in citation topics such as Plant Science, 112 in Entomology, 111 in Forestry, 87 in Bioengineering, 64 in Marine Biology, 61 in Phylogenetics and Genomics, 56 in Photoproductivity, 46 in Phytochemicals, 44 in Mycotoxins and 42 in Plant Pathology. These findings can be said to be the main points in terms of showing the impact and importance of the research topic and references.

Figure 15. Examples of research areas

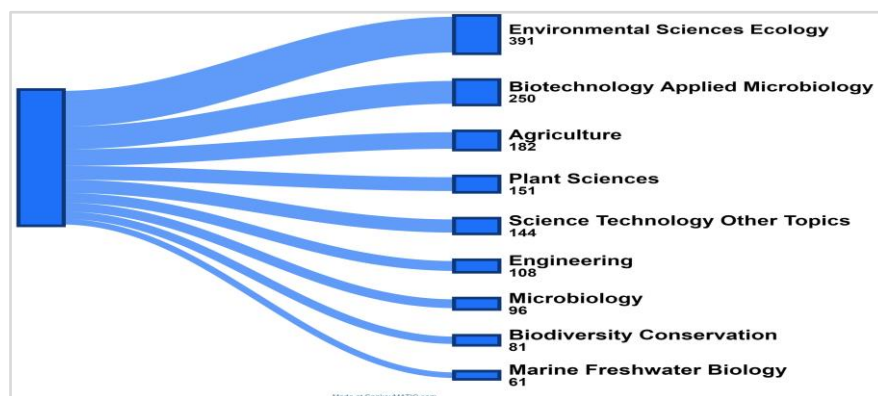


Figure 15 shows that 391 of the studies were in research areas such as Environmental Sciences Ecology, 250 in Biotechnology Applied Microbiology, 182 in Agriculture, 151 in Plant Sciences, 144 in Science Technology Other Topics, 108 in Engineering, 96 in Microbiology, 81 in Biodiversity Conservation, 61 in Marine Freshwater Biology. This finding can be said to be the main points both in terms of determining the areas that draw attention to the research topic and in terms of determining the interaction between disciplines.

Figure 16. Common keyword analysis by year

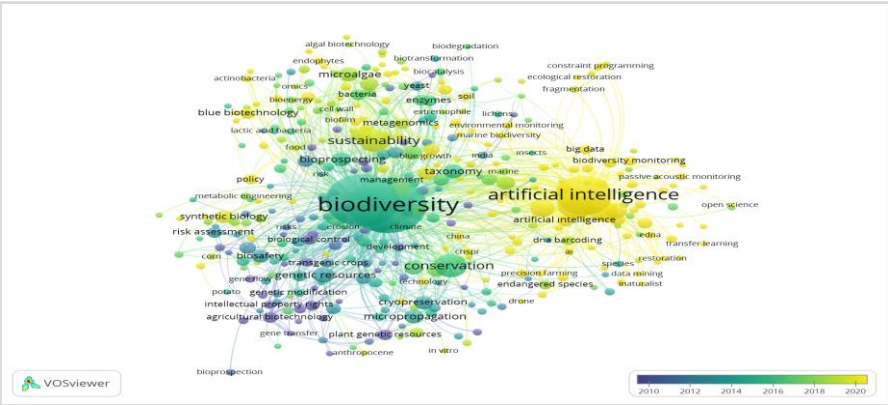


Figure 16 shows that studies on biotechnology, biodiversity and artificial intelligence have 384 items, 17 clusters, 2566 links and 3685 total link strength. It was observed that 266 of these studies used common words such as biodiversity, 235 biotechnology, 135 artificial intelligence, 64 machine learning, 47 conservation, 44 sustainability, 38 deep learning, 29 agriculture, 27 climate change, 26 remote sensing. The yellow colors in the common vocabulary network indicate topics covered in recent years. In this context, it has been determined that words such as artificial intelligence, big data, sustainability and blue biotechnology have been used in recent years. The common words associated with biotechnology, biodiversity and artificial intelligence are presented in Figures 17-19.

Figure 17. Interaction of biotechnology

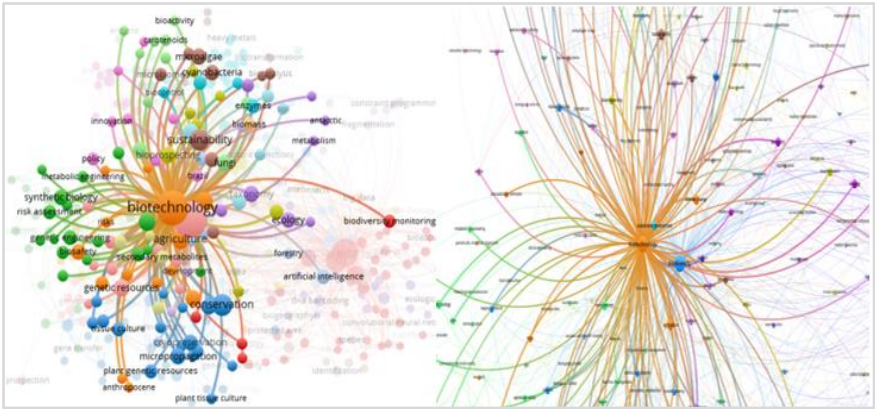


Figure 17 shows that biotechnology interacts with agriculture, conservation, artificial intelligence, biodiversity, genetics, biosafety interaction, sustainable development, climate change, biopesticides, microbial biodiversity.

Figure 18. Interaction of biodiversity

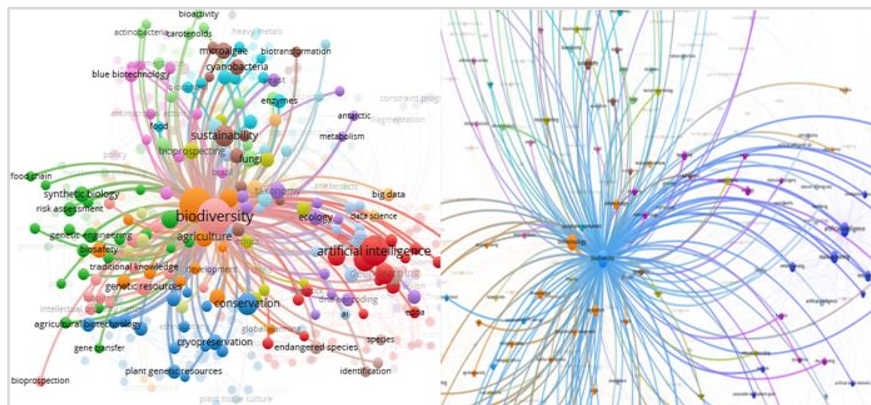


Figure 18 shows that biodiversity interacts with synthetic, biology, ecology, genetics, big data, identification, agriculture, invasive species, biotechnology, enzymes, blue biotechnology, artificial intelligence, molecular biology, phylogenetics.

Figure 19. Interaction of artificial intelligence

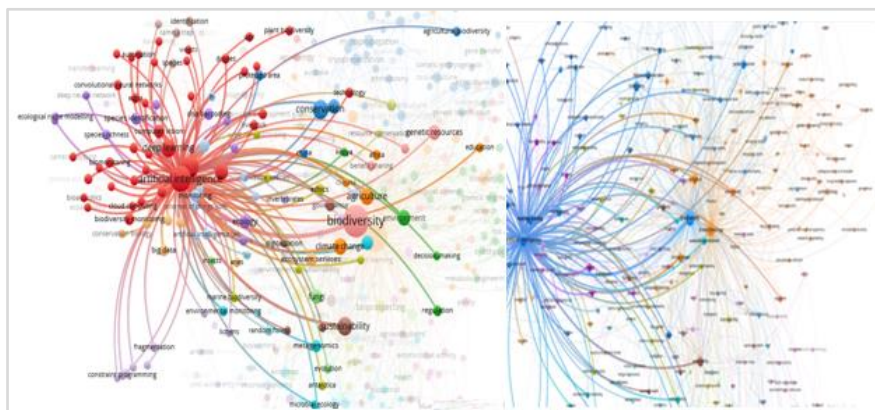


Figure 19 shows that artificial intelligence interacts with biodiversity, biotechnology, biodiversity conservation, ecosystems services, sustainability, genetic resources.

Figure 20. Thematic map of author keywords

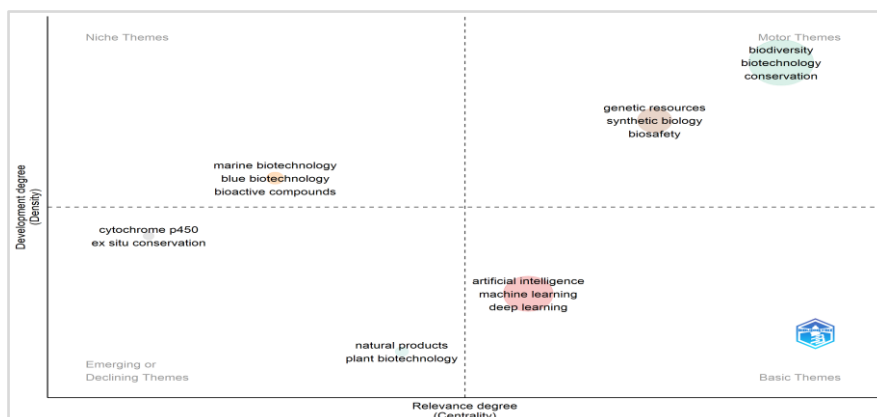
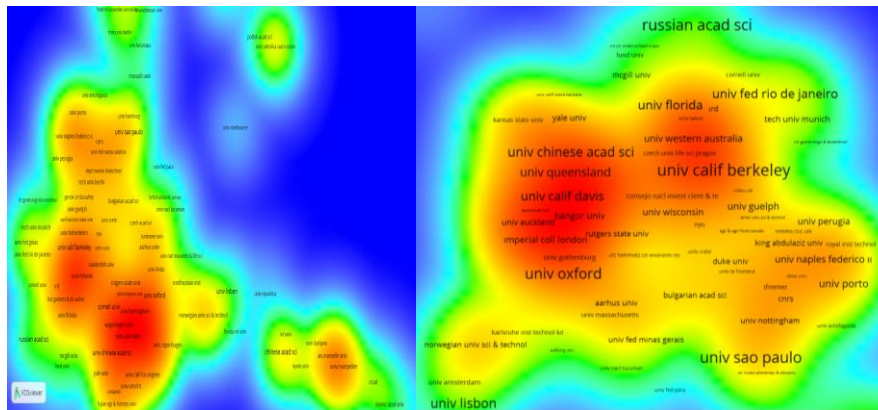


Figure 20 shows that words such as genetic resources, biosafety, biodiversity have well-developed and strong links with other themes, while words such as artificial intelligence, machine learning have strong links with other themes.

1300 citations, Pondicherry Univ with 1191 citations, Chinese Acad Sci with 1158 citations, Carl Von Oss with 844 citations, etzky Univ Oldenburg, Univ Calif Berkeley with 830 citations, Univ Munster with 801 citations, Univ Putra Malaysia with 672 citations, Hebrew Univ Jerusalem with 660 citations, Univ Florida with 656 citations. Therefore, it can be said that these institutions play a very important role in identifying the most prominent trends in the interaction between biotechnology, biodiversity and artificial intelligence.

Figure 24. Citation & organizations density map



In Figure 24, it is observed that Chinese Acad Sci, Mae Fah Luang Univ, Univ Oxford, Chiang Mai Univ, Yale Univ, etc. are intensely related institutions.

4. CONCLUSION

This research provides an overview of Biotechnology, Biodiversity and Artificial Intelligence and provides researchers with an opportunity to It can be said that it is a guide for studies. As a result, it was determined that the first research on biotechnology, biodiversity and artificial intelligence started in 1991. It was concluded that the distribution of publications and citations increased in parallel with each other. When the distribution of the publication types of these studies was examined, it was determined that most studies were published in article type. it was concluded that the studies were mostly published in "Environmental Sciences Ecology", "Biotechnology Applied Microbiology", "Agriculture", "Plant Sciences", "Science Technology Other Topics", "Engineering", "Microbiology", "Biochemistry Molecular Biology", "Biodiversity Conservation", "Marine Freshwater Biology". When the distribution of citation topics meso is analyzed according to their categories, it is seen that "Crop Science", "Entomology", "Forestry", "Bioengineering", "Marine Biology", "Phylogenetics & Genomics", "Photoproductivity", "Phytochemicals", "Mycotoxins", "Plant Pathology" Citation topics meso stand out the most. At the same time, when the distribution of research areas was analyzed, it was concluded that the studies were mostly published in "Environmental Sciences Ecology", "Biotechnology Applied Microbiology", "Agriculture", "Plant Sciences", "Science Technology Other Topics", "Engineering", "Microbiology", "Biochemistry Molecular Biology", "Biodiversity Conservation", "Marine Freshwater Biology". When the distribution of Web of Science indexes was analyzed, it was found that the studies were mostly published in "SCI-EXPANDED", "SSCI", "CPCI-S", "ESCI" indexes.

It has been concluded that countries such as USA, England, Italy, India, Peoples R China, France, Brazil, Brazil, Canada, Spain, Australia, Netherlands, Portugal have a significant impact in this field by carrying out more studies in the field of biotechnology, biodiversity and artificial intelligence. At the end of the study, it was determined that there is a flow of cooperation towards countries such as USA-UK, UK-Germany, UK-France, UK-Italy, USA-Germany, Germany-France, USA-Canada, Italy-Spain, USA-China, USA-France. Within the

framework of the results of the research, it is recommended that researchers who plan to conduct research on the subject should carry out studies in different disciplines. However, a bibliometric analysis that includes publications in different databases such as ProQuest and compares them with the results of this study can be suggested to be realized.

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Utilizing Stable Isotope Analysis in Marine Turtle Conservation

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Abstract

The sea turtle species inhabiting the Mediterranean waters, *Chelonia mydas* and *Caretta caretta*, are globally listed Endangered (EN) and Vulnerable (VU), respectively, according to the IUCN Red List. This demonstrates the urgent need for extensive conservation initiatives. Sea turtles are not only migratory species, but they also primarily inhabit aquatic environments throughout their life cycle, making it exceedingly challenging to gather information about all the essential aspects of their life cycles and distribution. While safeguarding nesting sites is crucial for the conservation of their populations, these species also face various anthropogenic pressures in their feeding areas and along their migration routes. Therefore, understanding their distribution in seas, feeding grounds, and migratory routes is crucial for effective conservation. Utilizing tools like drones and satellite tracking devices can aid pursuing such information, but they are not always feasible or cost-effective. Stable isotope analysis emerges as a solution in the absence of these tools, utilizing the different incorporation and turnover rates of light elements (C, H, N, O and S) in different tissues (blood, skin, carapace). In this study, we explain how stable isotope analysis can be used to determine the migratory paths, feeding grounds and habitat shifts of sea turtles in order to establish effective conservation projects.

Keywords: Stable Isotope Analysis, Conservation, Migratory Species, Marine Turtles

1. INTRODUCTION

The marine turtle species inhabiting the Mediterranean, *Chelonia mydas* (Linnaeus, 1758) and *Caretta caretta* (Linnaeus, 1758), are globally listed as Endangered (EN) and Vulnerable (VU), respectively, by the International Union for Conservation of Nature (IUCN) (Casale & Tucker, 2017; Seminoff, 2023). The current status of the Mediterranean subpopulations of these species are Near Threatened and Least Concern, respectively (Broderick, et al., 2023; Seminoff, 2023). This demonstrates the urgent need for immediate and extensive conservation initiatives, aiming to protect these species and their habitats. While ongoing initiatives that protect the nesting beaches, a crucial aspect of conservation efforts, are relatively widespread, it is clear that such efforts do not suffice to establish stable populations (Eckert et al., 1999; Rees et al., 2016). Mortality rates among marine turtles are aggravated by various direct or indirect anthropogenic factors, requiring a holistic approach that comprises not only nesting sites but also foraging grounds (Casale et al., 2018; Hamann et al., 2010; Mazor et al., 2016; Poloczanska et al., 2009). Nevertheless, the efficiency of conservation efforts is impaired by the limited data on the spatial distribution of these essential habitats, as sea turtles show migratory behavior, along with the predominantly aquatic life cycles where they go ashore solely for nesting purposes (Heppell et al., 2003). Our understanding of their ecological dynamics remains constrained to narrow temporal windows, despite their remarkable longevity. Hence, discovering the migratory routes, identifying key foraging grounds, and trophic relationships are critical for the targeted allocation of conservation efforts.

Various extrinsic approaches have been employed to track sea turtles and complete this data gap, such as aerial surveys and satellite telemetry (Crossin et al., 2014; Dickson et al., 2022). While each of these methods offers its own advantages, when such methods pose challenges due to their high cost, intrusive nature, or logistical complexities; bulk tissue stable

isotope analysis (SIA) emerges as a viable, cost-effective, and minimally invasive approach to answer the questions about the distribution of the species.

Bulk tissue stable isotope analysis is based on two fundamental principles: (1) The isotopes of an element possess differing atomic weights and react at varying rates, thus engendering spatial and temporal gradients in isotopic composition within the environment. These gradients, expressed in water chemistry and resource utilization, impact the isotopic ratios observed in animal tissues by altering ratios in both the water itself (for oxygen and hydrogen isotopes) and the organisms (mainly carbon, nitrogen, and sulfur) they consume. And (2) Different tissues within organisms exhibit distinct turnover rates (Reich et al., 2008). The varying turnover rates of different tissues provide various time windows that provide insights into an organism's dietary history and spatial distribution over different lengths of periods (Tieszen et al., 1983).

Common elements used in stable isotope analysis are carbon (C), nitrogen (N), oxygen (O), and sulfur (S). Carbon isotope ratios in tissues provide insight into the diet and movement patterns of marine turtles, aiding in the identification of foraging grounds (Haywood et al., 2019; Haywood et al., 2020; Peterson, 1987) whereas nitrogen and sulfur isotopes, which change during protein catabolism, allow distinguishing migratory routes based on feeding activity (Haywood et al., 2019; Peterson, 1987). Nitrogen fractionation has also been utilized to differentiate trophic levels in aquatic migratory species (Peterson, 1987). Not only tissue samples from individuals but also ectoparasites can be utilized (Detjen et al., 2015; Killingley & Lutcavage, 1983). Stable isotope analysis of oxygen, samples being from barnacle shells on marine turtles, reflects the salinity and temperature of ambient waters as barnacles grow, providing a record of the animals' movements (Detjen et al., 2015).

Based on these principles, stable isotope analysis can address various questions, including the determination of feeding grounds, migration routes, dietary information, trophic relationships, feeding ground fidelity, identification of life cycle stages associated with specific zones, recognition of subpopulations utilizing the same feeding grounds, and numerous other ecological inquiries. In this study, we aim to answer the question of how stable isotope analysis can be utilized in uncovering such questions.

2. MATERIAL and METHODS

2.1. Sample Collection and Preparation

Sampling procedures differ depending on the type of tissue being sampled. Keratin is sampled from the carapace through scraping with a scalpel, with consistent sampling of the same scute in all animals to minimize potential variation among scutes (Reich et al., 2008). Whole blood samples are collected from the dorsal cervical sinus, transferred into a non-heparinized container, and placed on ice (Seminoff et al., 2009). To separate red blood cells and plasma, whole blood samples are centrifuged. Epidermal tissue is typically sampled from the right shoulder region, using a 2-5-mm disposable biopsy punch, (Ceriani et al., 2014; Vanderklift et al., 2020) once more emphasizing the importance of consistent sampling from the same body part of the animal.

Samples are prepared using standard methods, following Ceriani et al. (2014). Skin and keratin samples are rinsed with distilled water and immersed in 70% ethanol for cleansing, subsequently being dried at -60°C for 48 hours. Red blood cell, whole blood, and serum samples are subjected to freeze-drying for 24-72 hours, followed by making into a powder using a mortar and pestle. Lipids were extracted from all tissues utilizing a Soxhlet apparatus, and petroleum ether is used as the solvent.

2.2. Stable Isotope Analysis

The dry samples are weighed with a microbalance, and sealed into sterile tin capsules of $0.4\text{-}0.7 \pm 0.1$ mg for carbon (C) and nitrogen (N) isotope analysis. Subsequently, they undergo combustion for percent carbon and percent nitrogen isotope determination in an element analyzer, converting the samples into N_2 and CO_2 . The analysis of sulfur (S) isotopes requires a larger mass of sample, typically around 5 ± 0.5 mg. Additionally, a minute quantity of vanadium pentoxide is introduced into the powder in order to catalyze the combustion.

The gasses produced in the combustion process are then separated with a gas chromatography column and analyzed with a continuous-flow isotope ratio mass spectrometer. The stable isotope values are then expressed in the following delta (δ) notation:

$$(1) \quad \delta X = [(R_{\text{sample}} / R_{\text{standard}}) - 1] \times 1000$$

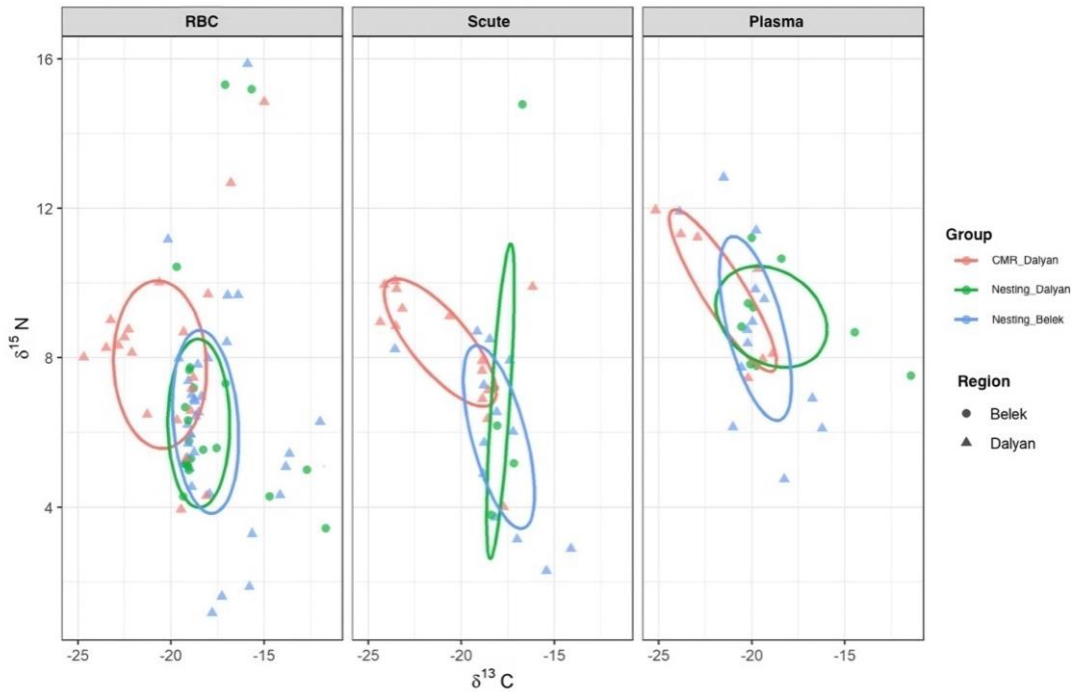
where X is ^{13}C , ^{15}N or S^{34} , and R represents the heavier isotopes (^{13}C , ^{15}N or ^{34}S) over the lighter isotopes (^{12}C , ^{14}N or ^{32}S) in both the sample and the international measurement standard. By this equation, the raw measurements are calibrated using certified reference materials by interspersing the samples with reference materials. The reference materials are renewed intermittently in order to counteract any drift, ensuring that the sample is calibrated correctly.

2.3. Data Analysis

Depending on the research question, either the isotope ratios of different tissues or a pooled value per individual for each element analyzed are used in the analysis. Combining data from various tissue types such as keratin, epidermis, and blood, is used when the bias stemming from tissue-specific temporal variations in isotope ratios needs to be eliminated and is based on the assumption that these animals exhibit constant feeding behavior over the long and short term (Özdilek et al., 2023).

Plots were constructed using the “SIBER” package (Stable Isotope Bayesian Ellipses) on R (Jackson et al., 2011), for evaluating the isotopic niches and the degree of overlap between clusters. Standard ellipses were used to depict the isotopic niche. The Wilcoxon–Mann–Whitney test was employed to examine whether there were notable differences in the distribution of δ values among each pair of clusters and among various isotope ratios. The mentioned analyses conducted by Sözbilen (2022) on *C. caretta*, RBC, scute and plasma samples collected from wintering individuals and nesting females in Dalyan and Belek beaches, resulted in Figure 1.

Figure 1. Standard ellipses plotted, comparing the nitrogen and carbon isotope ratios, each ellipse representing a cluster (wintering individuals sampled with CMR, nesting females from the beach Dalyan, and nesting females from Belek beach) from Sözbilen (2022) for RBC, scute and plasma samples.



3. RESULTS and DISCUSSION

Stable isotope analysis can be conducted to address numerous questions about foraging ecology, migration and habitat shift of sea turtles.

Godley et al. (1998) has investigated the trophic status of *C. caretta* and *C. mydas* in the Mediterranean Sea and the European Atlantic Ocean by analyzing the isotope ratios of carbon and nitrogen in bone collagen, egg proteins, and keratin from epidermal carapace scutes. As a result of this study, they have found that the isotope ratios in proteins of *C. caretta* suggest that they occupy a higher trophic position than that of *C. mydas*.

Özdilek et al. (2023) has assessed the foraging ecology of *C. mydas* nesting in the Eastern Mediterranean by analyzing the stable isotope signatures of C and N in five different tissues sampled from five major breeding areas in Türkiye. As the result of this study, they suggest a dichotomy of the foraging habitats of the *C. mydas* nesting on the Eastern Mediterranean.

Cardona et al. (2024) have utilized stable isotope analysis along with satellite telemetry in order to identify the foraging grounds of *C. caretta* that has recently colonized the Spanish beaches for nesting. The study has analyzed stable isotope ratios of carbon (C), nitrogen (N) and sulfur (S), and proposed that the population has shifted to oceanic foragers in their results.

In the study conducted by Bradshaw et al. (2017), 230 *C. mydas*'s epidermal tissues from a rookery in Alagadi beach were sampled to analyze C, N and S ratios, along with utilizing satellite telemetry turtles from a rookery in Alagadi beach. The study compares the relative impact of 4 feeding grounds on the *C. mydas* populations.

On the other hand, examining the spatial distribution of marine turtles temporally does not have to require samples from the animals themselves. Ectoparasites can also provide such

information. In a study conducted by Detjen et al. (2015) sampled barnacles (*Platylepas* sp.) living commensally on the carapace of the *C. mydas* in the central Pacific. The study analyzed carbon and oxygen isotopes in calcite layers of the barnacles. Their results on oxygen isotopes suggest that there exists regional movement patterns.

Different tissues having discrete turnover rates widens the range of investigations that stable isotope analysis can address. In studies sampling different tissues, it has been found that blood serum exhibit the highest turnover rate, providing information on a more recent diet (Reich et al., 2008), while tissues such as whole blood, red blood cells, epidermis, and scutes provide insight over a much longer time period, scutes being the longest as they remain inert after synthesis (Reich et al., 2008; Vander Zanden et al., 2010). Due to this characteristic, experimental designs can be devised to ascertain both recent and past feeding locations of turtles.

4. CONCLUSION

This study explains how stable isotope analysis can be performed. Stable isotope analysis can be utilized to answer a wide array of questions, whether coupled with satellite telemetry or not, regarding the migratory paths, feeding grounds and habitat shifts of sea turtles. Such information is crucial for an effective conservation strategy for the species *C. caretta* and *C. mydas*, as despite extensive conservation effort on land for their nesting grounds, any action in the seas lacks due to insufficient data on the details of their life cycles in the sea. Stable isotope analysis is useful for completing that knowledge gap, therefore is crucial in order to set effective conservation strategies.

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Advances in Female Germline Stem Cell Biology in Different Mammalian Species

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Abstract

The idea that females lose the ability to produce oocytes at birth was disproved by the exploration of female germline stem cells (FGSCs). The function of FGSCs is to support postnatal gametogenesis in the ovaries. FGSCs are crucial to maintain the oocyte pool and ensure reproductive capability. Understanding these cells' biology offers insights into reproductive health, fertility preservation, and advancements in reproductive technologies. This knowledge is especially valuable for women facing conditions or treatments that could compromise their fertility, such as chemotherapy. The follicular renewal stops at a certain age, and it causes the onset of the premature ovarian failure or natural menopause. In aging ovaries, the lack of follicular renewal can cause environmentally induced or spontaneously arising genetic alterations of oocytes. Besides, this condition causes various symptoms such as osteoporosis, sleep problems, mood changes and hot flashes. In such cases, FGSCs are important in the renewal of the oocyte pool and endocrin functions. Studies in this field will also contribute to the reproduction of endangered animals and the increase in the reproductive efficiency of commercially produced animals. This study reviews FGSCs in humans, mice, rats, monkey, cattle and pigs, highlighting their unique characteristics and contributions to reproductive biology.

Keywords: Female Germline Stem Cell, Ovarian Stem Cell, Re-oogenesis, Oogonial Stem Cell, Mammalian Female Germline Stem Cell

1. INTRODUCTION

In the past, it was believed that women are born with a fixed number of oocytes that deplete over time, leading to ovarian aging and infertility as they are getting older. However, the mitotically active germ cells (ovarian stem cells) in ovaries of various adult female mammals was discovered. Recent evidence suggests that mammalian females may be capable of generating new oocytes during adulthood (Johnson et al., 2004; Martin, Woods, & Tilly, 2019; Truman, Tilly, & Woods, 2017). These rare oogonial stem cells (OSCs) or female germline stem cells (FGSCs) are analogous to spermatogonial stem cells in testes (Brinster, 2007; White et al., 2012).

Later the isolation and culture of FGSCs from human and mouse ovaries, handling fluorescence activated and magnetic activated cell sorting, further supported the concept of postnatal oogenesis (White et al., 2012; Kang Zou et al., 2009).

FGSCs of mice, rats, pigs, cows, monkeys, and humans indicates that they exist widely in mammals (Bai et al., 2013a; Dunlop, Bayne, McLaughlin, Lancet, & 2014, n.d.; X. Li et al., 2022a; Martin et al., 2019; Zhou et al., n.d.).

2. MATERIAL and METHODS

We review the FGSCs of different mammalian species such as mouse, rat, monkey, pig, cattle and human. At Pubmed database and Google Scholar with the keywords were used to obtain relevant literature ranging from 2004 until 2024. Key words are Female Germline Stem Cell, Ovarian Stem Cell, Re-oogenesis, Oogonial Stem Cell, Humans, Mice, Rats, Monkey, Cattle and Pigs.

3. RESEARCHES ON FGSC OF MICE

FGSCs were discovered by chance in a study on female mice, in 2004. Researchers found out the existence of FGSCs and the continuation of oocyte production or neo-oogenesis in adult mouse ovaries. Additionally, a few groups of ovoid cells in the ovarian surface epithelium, which was not encircled by squamous epithelial cells and lacked any other type of follicle, were observed in histologic analysis. In dual-immunofluorescence analysis, it was established that these cells expressed DNA proliferation marker BrdU and the germ cell-specific marker Mvh (Johnson et al., 2004). Additional investigation by Niikura and co-workers showed atrophied ovaries of aged mice performed oogenesis when they were put in the ovaries of young mice (Niikura, Niikura, NY, & 2009, n.d.).

FGSCs were thereafter isolated from postnatal mouse ovaries and successfully cultured. These cells have the ability to rebuild oogenesis and generate offspring after transplantation (Kang Zou et al., 2009). Fragilis protein is more effective protein than Mvh protein to isolate the FGSCs (K Zou et al., 2011). Other studies also revealed that the cells taken from ovarian cortex express many sorts of stem cell or germ cell markers, like Oct4, SSEA-1, Mvh and SCF-R, when they were cultured. Besides, they had a proliferation activity (Niikura et al., n.d.; Virant-Klun, Zech, Rožman, Differentiation, & 2008, 2008a; Zhang et al., 2008).

The study by Pacchiarotti et al. used transgenic mice expressing GFP to track putative FGSCs. These cells were sorted, cultured, and found to form colonies with germ cell and pluripotent markers, maintaining telomerase activity and ordinary karyotype after many passages. Some cells differentiated into oocyte-like cells and even formed follicle-like structures when combined with granulosa cells, indicating the potential of FGSCs to generate oocytes (Pacchiarotti et al., 2010).

Terraciano et al. demonstrated that transplanting FGSCs into cisplatin-treated mice increased the number of follicles, suggesting potential therapeutic effects for ovarian dysfunction. Xiong et al. showed that FGSCs contributed to the restoration of ovarian function and even assisted in the production of offspring in mice treated with cyclophosphamide chemotherapy (Xiong et al., 2015).

Wang et al. further showed that FGSCs, when cultured in specific conditions, could be converted into female embryonic stem-like cells, highlighting the potential for clinical regenerative applications (Terraciano et al., 2014).

The presumed scarcity of ovarian stem cells (OSCs) aligns with findings that the germ cell-specific gene *Stra8*, which plays a crucial role in meiosis, is widely expressed in embryonic ovaries during oogenesis adult and testes but they are infrequently found in the ovaries of adult mice (Baltus et al., 2006; Bowles & Koopman, 2007; Menke, Koubova, & Page, 2003; Niikura et al., n.d.; Oulad-Abdelghani et al., n.d.; “Wang: Epigenetic Status Determines Germ Cell Meiotic... - Google Akademik,” n.d.). Even though the presence of *Stra8* positive cells in adult ovaries strongly indicates ongoing oocyte formation, latest genetic evidence supports the idea of ovarian follicle renewal and postnatal oogenesis by showing that older mice have more traceable mitotic divisions in their oocytes compared to youngsters (Reizel et al., 2012).

Original research in mice described on FSGCs the expression of *Ddx4*, a oogonial germline marker exposed as the transmembrane protein (Fujiwara et al., 1994). *Ddx4* protein has a potential extracellular region located at the protein's C terminus (Park & Tilly, 2015). Extracellular matrix proteins impact the differentiation of FGSCs in vitro in a species specific way (MacDonald et al., 2019).

LIF-induced activation of STAT3 plays a crucial role in promoting the proliferation and maintaining the undifferentiated state of mouse FGSCs (Gu et al., n.d.). Bone morphogenetic protein 4, a recognized regulator of embryonic primordial germ cell specification, can promote meiotic gene expression and stimulate oogenesis in cultured FGSCs via SMAD1/5/8 signaling (Chuva De Sousa Lopes et al., 2004; Lawson et al., 1999; Park, Woods, & Tilly, 2013). FGSCs belong to adult stem cells at chromatin structure level (Tian et al., 2022).

The ovarian estrogen (E2) and E2 receptor- α signaling pathway plays a crucial physiological role in promoting FGSC differentiation, serving as a potential mechanism to remain sufficient numbers of ovarian follicles throughout reproductive life (Satirapod et al., 2020).

Metformin enhances the proliferation of mouse FGSSCs by modifying histone acetylation of Traf2 (Wang et al., 2023). *Cistanche deserticola* polysaccharides, the extract of *Cistanche deserticola* Y.C. Ma (Traditional Chinese herbal medicine) promote the differentiation of mouse FGSCs in vitro (Qiu et al., 2022).

4. RESEARCHES ON FGSC OF RATS

Rats are used as an animal model in various researches such as nutrition, physiology, behavior, immunology and toxicology for over 100 years. The rat FGSC cell line were established with same features to the FGSCs of mice. Furthermore, Zhou et al. demonstrated that the fat-1 gene into a new research model is more closely aligned with humans, and creating fat-1 transgenic rats. Besides, they showed that FGSCs are an powerful materials for animal gene manipulation. In order to verify their ability to undergo oogenesis in vivo, cultured FGSCs were applied with green fluorescent protein (GFP) vectors, then transplanted into ovaries of the sterilized rat receivers. After two months, GFP expressing oocytes were detected in the ovaries of the transplanted rats. Besides, fertile rat offspring expressing GFP were generated after receiver rats were mated with wild-type rats, indicating that FGSCs can restore fertility in sterilized recipients by regenerating oocytes (reproduction & 2014, n.d.; Zhou et al., n.d.).

Zuogui Pill, a traditional formula of Chinese Medicine, protected against cyclophosphamide induced ovarian aging by alleviating oxidative stress in aging FGSCs, restoring normal ovarian function, promoting FGSCs proliferation and restoring their stemness, perchance through regulating the Nrf2/HO-1 pathway (Z. Li et al., 2024).

Abundant differences in follicular renewal are available between adult rat and human ovaries (Bukovsky et al., 2008).

5. RESEARCHES ON FGSC OF MONKEYS

Non-human primates are physiologically closely related to humans. Li et al. found the presence of FGSCs in the ovaries of adult cynomolgus monkeys for the first time. Besides they showed that testosterone promoted the self-renewal of these stem cells (X. Li et al., 2022b).

Unlike other species, the neonatal ovary of marmoset monkey contains a large number of oogonia. These cells strongly express pluripotency markers such as OCT4A, SALL4, and LIN28 along with the proliferation marker KI-67 and the germ cell marker VASA (B Fereydouni, Drummer, ..., & 2014, n.d.). The cells with these pluripotency markers has not been detected in the ovaries of one-year-old and adult marmosets, indicating that rapid postnatal oogonial atresia also occurs in this non-human primates (Bentolhoda Fereydouni et al., 2016).

6. RESEARCHES ON FGSC OF CATTLE

Germline stem cells were isolated from bovine ovaries. These cultured cells differentiated into oocyte-like cells. BMPs and follicular fluid were found to be effective in inducing mRNA

expression for germ cell and oocyte markers (de Souza et al., 2017). A rare group of VASA-positive cells exhibiting mitotic activity was isolated from cattle. They expressed some germline markers, such as IFITM3, POU5F1, DPPA3, PRDM1, and KIT (Dunlop et al., n.d.).

Lavranos et al. applied *in situ* hybridization histochemistry to bovine ovaries, and observed that telomerase RNA is available in the granulosa cells of growing follicles but not primordial follicles. So they thought that in mature ovarian follicles, granulosa cells arise from a group of stem cells by division and differentiation (Lavranos, Mathis, ..., & 1999, n.d.).

7. RESEARCHES ON FGSC OF PORCINE

Germline stem cells of pig ovary were mostly located at the thecal area (Bai et al., 2013b). Bui et al. have cultured pig FGSC from ovarian tissue. In cell culture, the cells can differentiate into oocyte like cells under appropriate culture conditions. FGSCs of adult porcine ovaries are heterogeneous, depending on cell dimension and c-kit expression, and expresses germline and stem cell markers. Cells with features of early primordial germ cells are available in the adult porcine ovaries (Bui et al., 2014).

Bai et al. demonstrated that cultured pig FGSCs differentiated into lots of cell types such as adipocyte-like cells, desmin, PDX1 positive (endoderm marker), cardiac α -actin and NSE (ectoderm marker) cells (Bai et al., 2013b).

Pig FGSC lines can differentiate into oocytes when injected into tissue grafts, including human ovaries (Hou et al., 2018).

8. RESEARCHES ON FGSC OF HUMAN

The FGSCs offer the potential for stem cell therapy to address premature ovarian aging and female infertility by undergoing postnatal neo-oogenesis. In 2012, FGSCs were cultured from the ovarian cortical tissue of reproductive women (Cheng, Shang, therapy, & 2022, n.d.; White et al., 2012). In 2018, ovarian stem cells expressing DDX4 is isolated from adult female human ovary (Clarkson, McLaughlin, Waterfall, reports, & 2018, n.d.). Ovarian surface scarping was employed to isolate FGSCs from the ovarian surface epithelium of ovaries. At first the early yield of cells obtained through these methods was quite low, and the harvested cells (presumed fGSCs) spontaneously differentiated not only into oocyte-like cells but also into other cell types, such as neural-like cells (Bukovsky, Caudle, Svetlikova, & Upadhyaya, 2004; Parte et al., 2011; Virant-Klun, Zech, Rožman, Differentiation, & 2008, 2008b). DDX4+ stem cells were isolated from the ovaries of postmenopausal women and these stem cells have the capacity to differentiate into oocytes (Wu et al., 2022). Besides, oocyte-like cells can be produced from the FGSC *in vitro* (Silvestris et al., 2018). DDX4+ stem cells could play a role not only in effectively restoring female fertility in various cases of ovarian failure but also in offering a fertility preservation strategy for cancer patients undergoing gonadotoxic treatments (Silvestris, D'Oronzo, Cafforio, D'Amato, & Loverro, 2015; Wu et al., 2022).

In 2022, Saber and colleagues developed the differential adhesion method to isolate FGSCs from mouse and human ovaries. In culture, the OSCs expressed germ cell-specific markers and showed active proliferation over time. Notably, these cells were also capable of differentiating into oocyte-like cells *in vitro* (Saber, Tavakol, & Esfandiari, 2022).

In the ovarian cortex, DDX4+ stem cells could hold significant potential for future applications in regenerative medicine.

9. CONCLUSION

The study of FGSCs have progressed dramatically since the first discovery of mice FGSCs in 2004. It is now clear that FGSCs can differentiate to oocyte like cells in culture. Moreover, it is possible to transplanted differentiated these cells to ovaries. The eventual goal of

using FGSCs for regenerative medicine will be contribute to human female fertility, the reproduction of endangered animals and the increase in the reproductive efficiency of commercially produced animals.

Researches on in vitro ovarian formation in mammalian species serve as a preliminary method for in vitro gametogenesis, aiming to understand the variations in culture systems and underlying mechanisms across different species.

In order to deepen our understanding of the mechanisms behind re-oogenesis, comprehensive research comparing different types of female germline stem cells in mammals is necessary. This will advance the use of these stem cells in fundamental reproductive biology, drug discovery, and potential clinical applications in the future.

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Identification of Secondary Metabolite Biosynthetic Gene Clusters in *Punica granatum* L. Using Bioinformatics Analysis

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Abstract

Plants produce two categories of metabolites: primary metabolites and secondary metabolites. Secondary metabolites are responsible for the medicinal properties of plants. Secondary metabolite gene clusters are the regions that contain the genes encoding all the enzymes and related proteins necessary for the production of a specific secondary metabolite. *Punica granatum*, belonging to the Lythraceae family, is used in the treatment of various ailments such as heart disease, cancer, diabetes, ulcers, Alzheimer's disease, and obesity. The aim of this study is to identify the secondary metabolite biosynthetic gene clusters in *P. granatum* and to reveal the enzyme categories involved in these gene clusters. The plantiSMASH software was used to determine the secondary metabolite biosynthetic gene clusters. A total of 43 gene clusters were identified as a result of the analysis, with the highest observed on the 4th and 5th chromosomes, and the lowest on the 6th, 7th, and 8th chromosomes. In addition, enzyme categories such as Amino oxidase, Aminotransferase, BAHD acyltransferase, Cellulose synthase-like, CoA-ligase, COesterase, Copper amine oxidase, Cytochrome P450, Dirigent enzymes, Epimerase, Fatty acid desaturase, Glycosyltransferase, Ketosynthase, Lipoxygenase, Methyltransferase, Pictet-Spengler enzyme (Bet v1), Prenyltransferase, Polyprenyl synthetase, Oxidoreductase, Scl acyltransferase, Strictosidine synthase-like, and Terpene synthase have also been detected. The data obtained from this study provide a significant potential resource for future pharmacological applications.

Keywords: bioinformatic, gene cluster, plantiSMASH, *P. granatum*, secondary metabolite

1. INTRODUCTION

Plants are exposed to a variety of biotic stresses such as fungi, insects, and viruses, as well as abiotic stresses such as temperature, salinity, and drought (Ramegowda & Senthil-Kumar, 2015). Secondary metabolites are produced by plants to protect against stress conditions (Humbal & Pathak, 2023). These metabolites function in various fields such as agriculture, cosmetics, pharmaceuticals, and nutrition (Elshafie et al., 2023). Secondary metabolites such as resveratrol, lycopene, phytoestrogens, terpenoids, phytosterols, polyphenols, and carotenoids are used as nutraceuticals, while compounds like pelargonidin, papain, sinapic acid, betulin, beta carotene, rubixanthin, and kaempferol are used as nutricosmetics (Murthy et al., 2024). Medically, Atropine is antimuscarinic and anticholinergic; Codeine is anti-diarrheal, antidepressant, and analgesic; Quinine is antimalarial and antipyretic; Berberine is antibacterial/viral, anti-inflammatory, and antidiabetic; Theaflavins and thearubigins have anti-clastogenic and anti-carcinogenic effects; and Quercetin reduces atherosclerotic plaques and the risk of coronary heart disease (Badyal et al., 2020).

Secondary metabolites are synthesized through pathways such as glycolysis and the shikimic acid pathway, and are subsequently categorized into various groups based on these biosynthetic pathways, such as terpenes and steroids, phenolic compounds, and nitrogenous compounds (Patra et al., 2013; Reshi et al., 2023). The synthesis of terpenes occurs through the 2-C-methylerythritol 4-phosphate (MEP) and mevalonic acid (MVA) pathways, while the synthesis of phenolic compounds occurs through the shikimic acid and malonic acid pathways (Khare et al., 2020). Biochemical and genetic research has shown that the pathways involved in the production of these secondary metabolites can vary at the species and genus level. These studies indicate that secondary metabolism can involve the formation of physical gene clusters,

which are described as being adjacent to at least three non-homologous genes in a genome's secondary metabolite biosynthetic pathway (Rabara et al., 2023). Gene clusters involved in the production of secondary metabolites contain signature genes and, in addition, genes for tailoring enzymes required for the conversion of skeleton structures into final products, including cytochrome P450s, methyltransferases, oxidoreductases, acyltransferases, and sugar transferases (Chu et al., 2011).

Bioinformatics is a field that uses computational approaches to analyze complex datasets, and numerous tools are being developed for bioinformatics analysis (Banimfreg, 2023). In the analysis of biosynthetic gene clusters, software tools such as antiSMASH 4, CASSIS, FunGeneClusterS, fungiSMASH, MIBiG, plantiSMASH, PRISM 3, and (SEARCHPKS)/SBSPKS v2 are utilized (Blin et al., 2018).

Punica granatum L. (Pomegranate) belongs to the Lythraceae family and is a fruit with high economic, medicinal, and nutritional value (Yoon et al., 2024). *P. granatum* contains compounds such as ellagic acid, ascorbic acid, caffeic acid, gallic acid, catechin, epigallocatechin-3-gallate, quercetin, rutin, punicalagin, punicalin, punicalin, punicalin, punicalin, flavones, flavanones, flavone glycosides, cyanidin-3-glucoside, pelargonidin, delphinidin, luteolin, apigenin, ursolic acid, maslinic acid, ellagitannin, and triterpenoids (Khadivi et al., 2024). These compounds contribute to the plant's antiviral, antiproliferative, anti-inflammatory, anti-atherosclerotic, and antioxidant effects, playing a role in lowering cholesterol levels and preventing cardiovascular and neurological diseases, cancer, and asthma, as well as in the treatment of stomach ulcers, diarrhea, and estrogen-related disorders (Himel et al., 2024). The aim of this study is to identify gene clusters at the chromosomal level involved in the biosynthesis of secondary metabolites responsible for such medicinal effects of *P. granatum* and to reveal the enzyme categories present within each gene cluster. As is well known, plant-based medicines are currently used in the treatment of many diseases, and studies conducted on plants of this nature have the potential to contribute to advanced pharmacological research. Furthermore, identifying secondary metabolite biosynthetic gene clusters at the chromosomal level, along with their locations, sizes, and the enzymes they contain, will pave the way for selecting specific gene clusters for more targeted research.

2. MATERIAL and METHODS

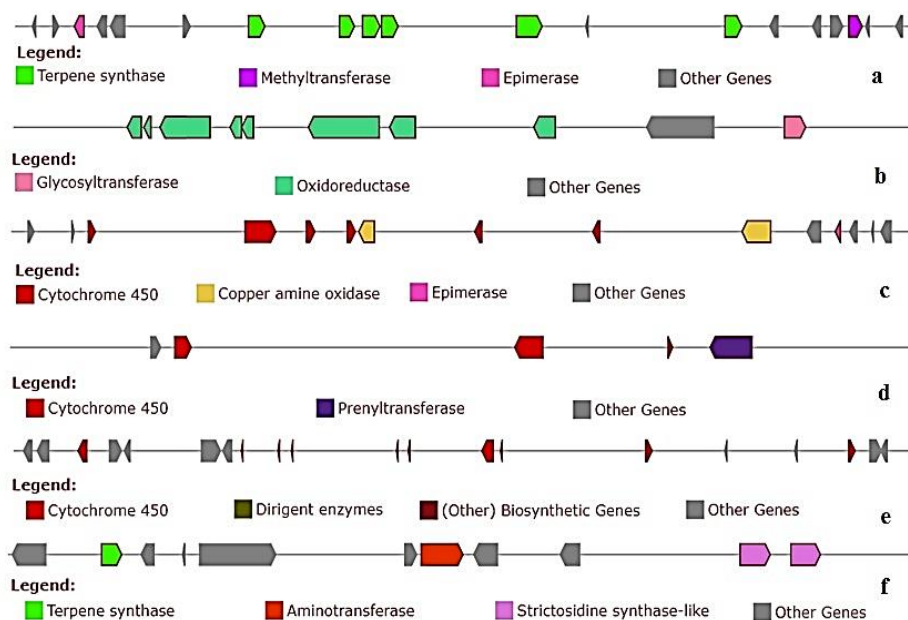
To identify the secondary metabolite biosynthetic gene cluster in the *Punica granatum*, a search was first conducted for the species in the National Center for Biotechnology Information (NCBI). Then, from ten genomes, the Reference Sequence (RefSeq) labeled ASM765513v2 was selected. Following this process, the amino acid sequences for each chromosome were downloaded in FASTA format and uploaded to the plantiSMASH program (Kautsar et al., 2017) for the analysis of secondary metabolite biosynthetic gene clusters. The data obtained from the analysis were downloaded and filed. The secondary metabolite gene clusters on each chromosome were visualized in figures.

3. RESULTS and DISCUSSION

P. granatum has eight chromosomes, and as a result of the analysis conducted, secondary metabolite biosynthetic gene clusters have been identified on all chromosomes. Six gene clusters responsible for secondary metabolite biosynthesis have been found on chromosome 1. Cluster 1 is of the terpene type and is located between 4,673,917 nt and 4,889,708 nt. It spans a size of 215.79 kb, and within this cluster, the enzyme categories Epimerase, Terpene synthase, and Methyltransferase have been observed. Cluster 2 is of the saccharide type and is located from 44,560,514 nt to 44,560,514 nt. The size of the cluster is 80.14 kb, and it contains enzyme categories such as Oxidoreductase and Glycosyltransferase. Cluster 3 has been determined to be of the alkaloid type, located between 47,149,935 nt and 47,364,273 nt, with a size of 214.34 kb. The enzyme categories are Cytochrome P450, Copper amine oxidase, and Epimerase. It has been observed that Cluster 4 is of the putative type, Cluster 5 is of the lignan type, and Cluster 6 is of the alkaloid type. The locations of these clusters are as follows:

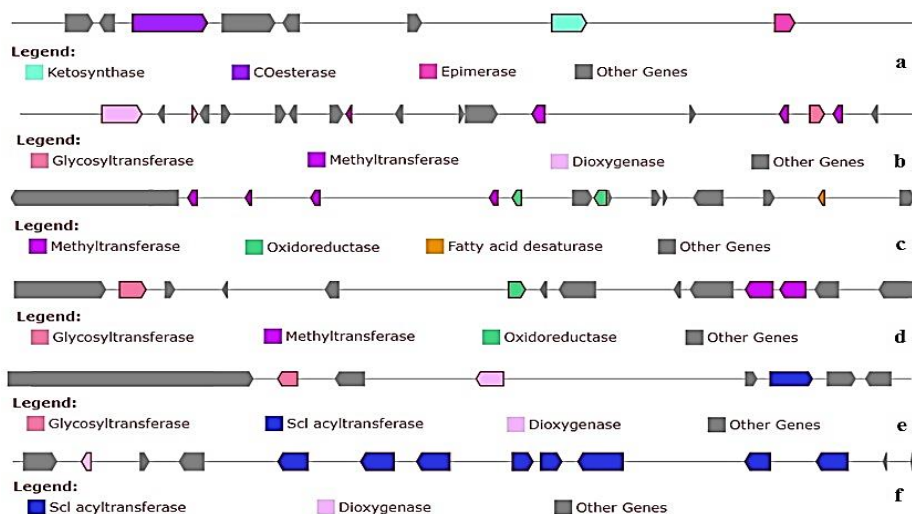
from 47,546,282 to 47,640,263; from 49,422,260 to 49,708,455; and from 53,383,685 to 53,453,218, respectively. Moreover, the clusters have sizes of 93.98 kb, 286.19 kb, and 69.53 kb. Additionally, Cluster 4 includes the enzyme categories Cytochrome P450 and Prenyltransferase; Cluster 5 features Cytochrome P450 and Dirigent enzymes; and Cluster 6 contains Terpene synthase, Aminotransferase, and Strictosidine synthase-like enzyme categories (Figure 1).

Figure 1. a) Cluster 1, b) Cluster 2, c) Cluster 3, d) Cluster 4, e) Cluster 5, f) Cluster 6



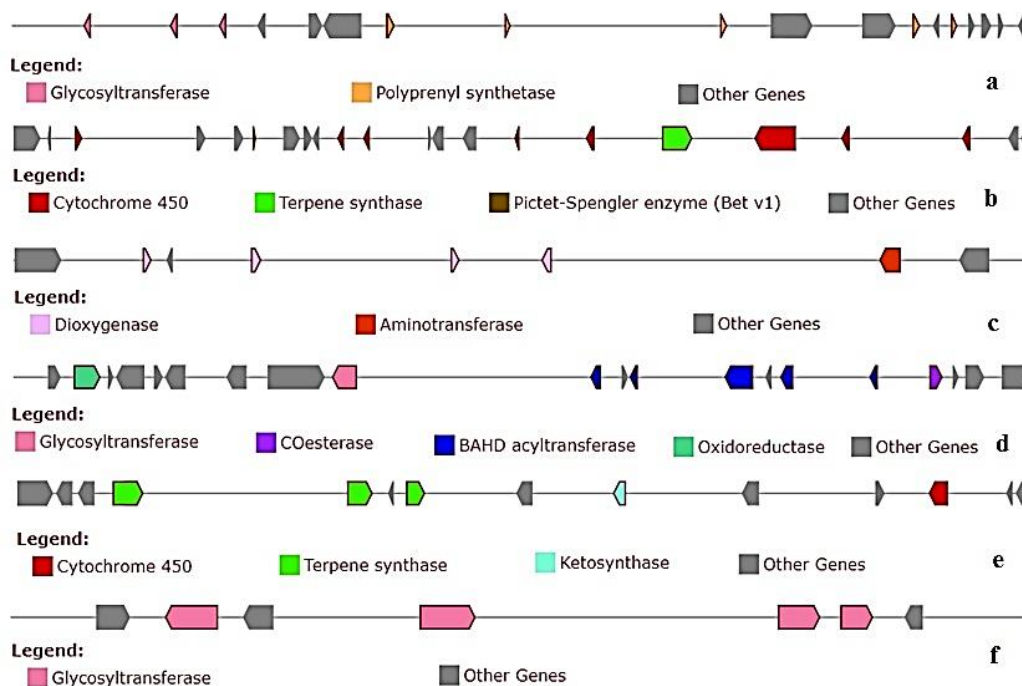
On Chromosome 2, six secondary metabolite biosynthetic gene clusters have been identified: Cluster 1 is classified as polyketide, Clusters 2, 4, and 5 as saccharide, and Clusters 3 and 6 as putative. Clusters have been observed at the following nucleotide ranges: Cluster 1 between 1,511,803 and 1,584,043 nt; Cluster 2 between 12,698,482 and 12,893,933 nt; Cluster 3 between 28,912,444 and 29,126,791 nt; Cluster 4 between 32,897,064 and 32,989,574 nt; Cluster 5 between 35,045,071 and 35,100,746 nt; and Cluster 6 between 38,288,214 and 38,412,627 nt. Additionally, the sizes of the clusters are as follows: Cluster 1 is 72.24 kb, Cluster 2 is 195.45 kb, Cluster 3 is 214.35 kb, Cluster 4 is 92.51 kb, Cluster 5 is 55.67 kb, and Cluster 6 is 124.41 kb. Furthermore, Cluster 1 includes enzymes from the COesterase, Ketosynthase, and Epimerase categories, whereas Cluster 2 comprises enzymes belonging to the Dioxygenase, Methyltransferase, and Glycosyltransferase categories. In Cluster 3, enzymes from the Methyltransferase, Oxidoreductase, and Fatty acid desaturase categories have been observed, while Cluster 4 contains enzymes from the Glycosyltransferase, Oxidoreductase, and Methyltransferase categories. Moreover, Cluster 5 encompasses enzymes from the Glycosyltransferase, Dioxygenase, and Scl acyltransferase categories, while Cluster 6 includes enzymes from the Dioxygenase and Scl acyltransferase categories (Figure 2).

Figure 2. a) Cluster 1, b) Cluster 2, c) Cluster 3, d) Cluster 4, e) Cluster 5, f) Cluster 6



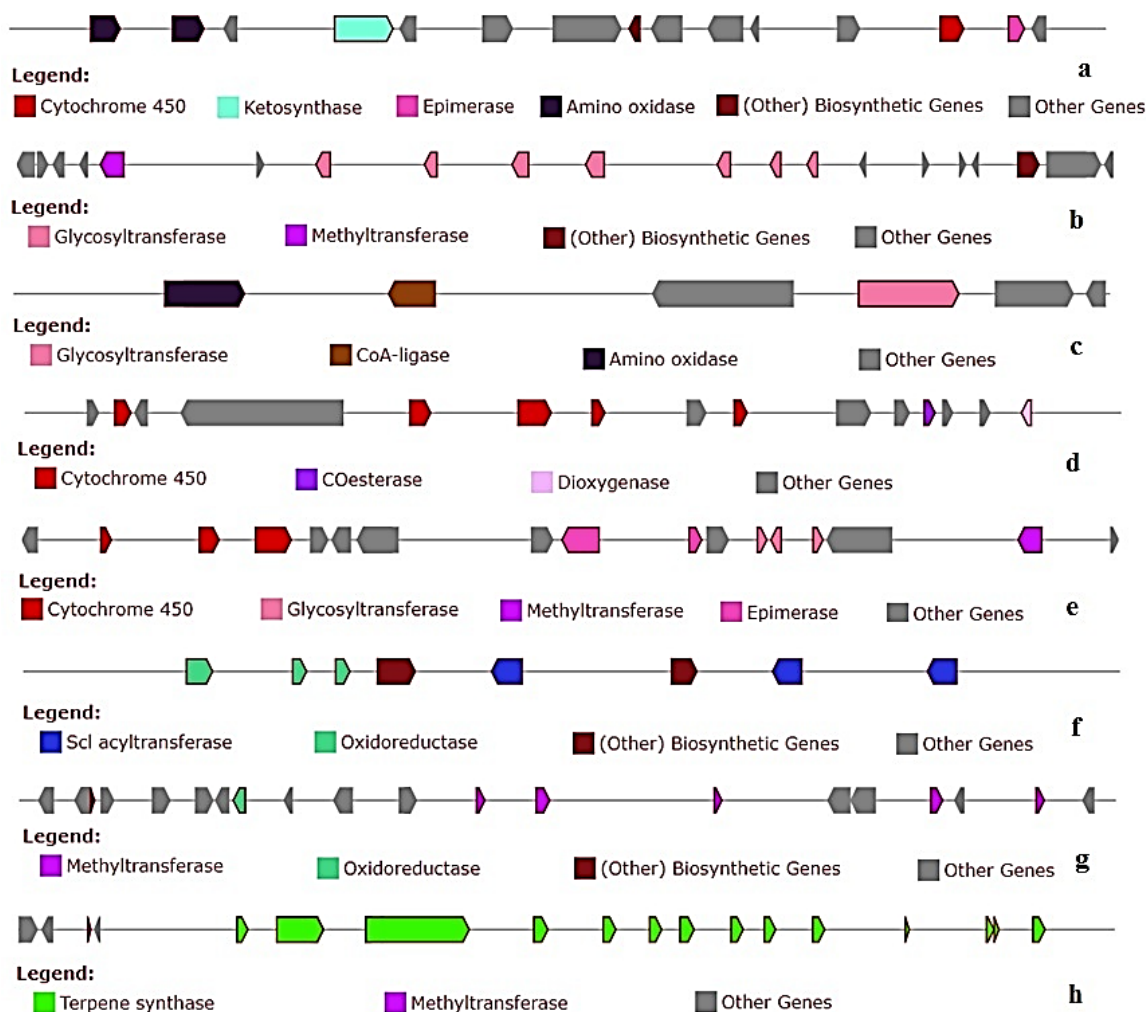
On chromosome 3, a total of six secondary metabolite biosynthetic gene clusters have been detected: Cluster 1, Cluster 4, and Cluster 6 are of the saccharide type; Cluster 2 is of the terpene-alkaloid type; Cluster 3 is of the putative type; and Cluster 5 is of the terpene-polyketide type. Cluster 1 is located between 6,943,623 and 7,183,089 nt and has a size of 239.47 kb, while Cluster 2 is located between 10,613,974 and 10,891,783 nt and has a size of 277.81 kb. Cluster 3 is found between 14,772,187 and 14,935,159 nt, with a size of 162.97 kb. Additionally, the locations and sizes of Clusters 4, 5, and 6 are as follows: Cluster 4 is between 35,278,217 and 35,453,760 nt, with a size of 175.54 kb; Cluster 5 is between 38,310,575 and 38,431,662 nt, with a size of 121.09 kb; and Cluster 6 is between 39,064,032 and 39,093,378 nt, with a size of 29.35 kb. Furthermore, the enzyme categories are as follows: Cluster 1 features Glycosyltransferase and Polyprenyl synthetase; Cluster 2 includes Cytochrome P450, Pictet-Spengler enzyme (Bet v1), and Terpene synthase; Cluster 3 has Dioxygenase and Aminotransferase; Cluster 4 contains Oxidoreductase, Glycosyltransferase, BAHD acyltransferase, and COesterase; Cluster 5 consists of Terpene synthase, Ketosynthase, and Cytochrome P450; and Cluster 6 has Glycosyltransferase (Figure 3).

Figure 3. a) Cluster 1, b) Cluster 2, c) Cluster 3, d) Cluster 4, e) Cluster 5, f) Cluster 6



Chromosome 4 has been observed to have eight secondary metabolite biosynthetic gene clusters. Cluster 1 is classified as Polyketide type, Clusters 2, 3, and 5 are classified as Saccharide type, Clusters 4, 6, and 7 are classified as Putative type, and Cluster 8 is classified as Terpene type. Cluster 1 is located between 1,970,025 and 2,060,382 nt, Cluster 2 is between 2,931,639 and 3,102,789 nt, Cluster 3 is between 6,050,378 and 6,094,554 nt, Cluster 4 is between 11,914,940 and 12,071,563 nt, Cluster 5 is between 12,277,897 and 12,438,428 nt, Cluster 6 is between 32,875,871 and 32,962,050 nt, Cluster 7 is between 36,009,140 and 36,172,213 nt, and Cluster 8 is between 36,433,216 and 36,663,109 nt. The sizes of the clusters, in order, are as follows: 90.36 kb, 171.15 kb, 44.18 kb, 156.62 kb, 160.53 kb, 86.18 kb, 163.07 kb, and 229.89 kb. Besides these, Cluster 1 includes enzyme categories Amino oxidase, Ketosynthase, Cytochrome P450, and Epimerase, whereas Cluster 2 contains enzymes belonging to the Methyltransferase and Glycosyltransferase categories. Additionally, Cluster 3 includes Amino oxidase, CoA-ligase, and Glycosyltransferase enzymes, while Cluster 4 contains Cytochrome P450, COesterase, and Dioxygenase enzymes. The enzyme categories in the other clusters are as follows: Cluster 5 contains Cytochrome P450, Epimerase, Glycosyltransferase, and Methyltransferase; Cluster 6 includes Oxidoreductase and Scl acyltransferase; Cluster 7 has Oxidoreductase and Methyltransferase; and Cluster 8 contains Methyltransferase and Terpene synthase (Figure 4).

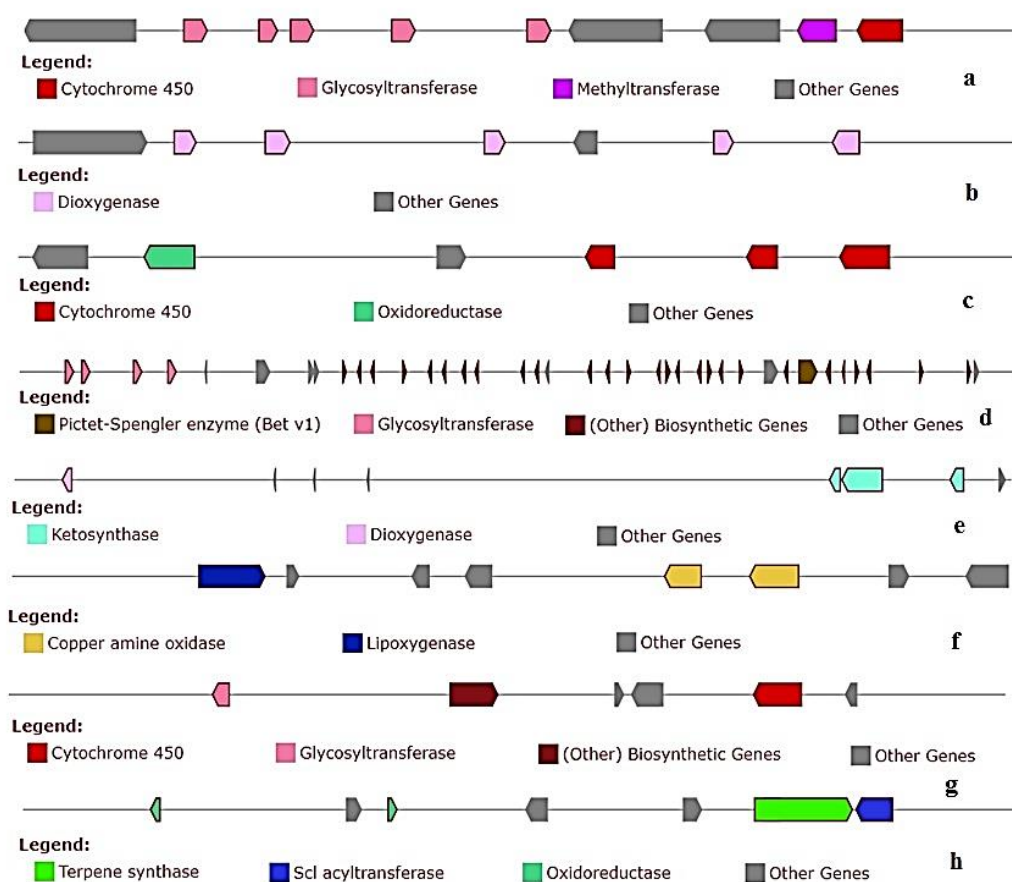
Figure 4. a) Cluster 1, b) Cluster 2, c) Cluster 3, d) Cluster 4, e) Cluster 5, f) Cluster 6, g) Cluster 7, h) Cluster 8



Eight secondary metabolite gene clusters were identified on chromosome 5. It was observed that Cluster 1 and Cluster 7 are of the Saccharide type, Cluster 2 and Cluster 3 are of the putative type, Cluster 4 is of the Saccharide-Alkaloid type, Cluster 5 is of the Polyketide type, Cluster 6 is of the

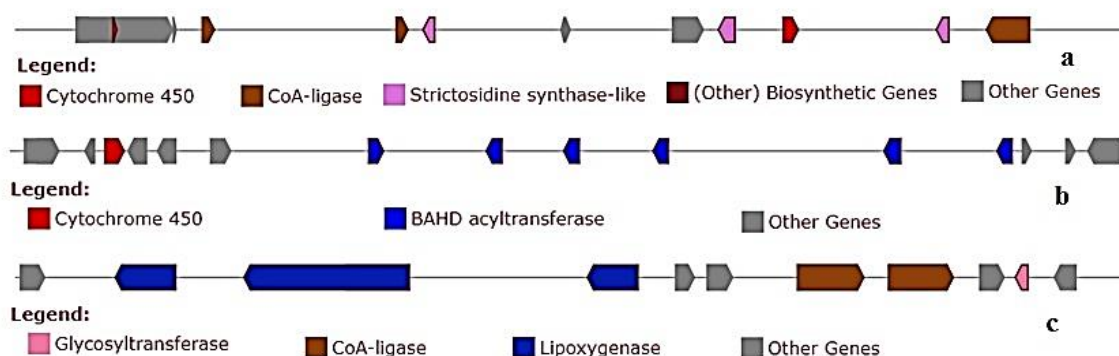
Alkaloid type, and Cluster 8 is of the terpene type. Cluster 1 is located between 3,397,300-3,458,221 nt, Cluster 2 between 4,615,880-4,678,243 nt, Cluster 3 between 8,636,880-8,701,610 nt, Cluster 4 between 10,965,775-11,134,882 nt, Cluster 5 between 11,968,666-12,271,779 nt, Cluster 6 between 13,264,476-13,349,851 nt, Cluster 7 between 26,064,458-26,145,122 nt, and Cluster 8 between 27,348,825-27,514,260 nt. The size of Cluster 1 is 60.92 kb, Cluster 2 is 62.36 kb, Cluster 3 is 64.73 kb, Cluster 4 is 169.11 kb, Cluster 5 is 303.11 kb, Cluster 6 is 85.38 kb, Cluster 7 is 80.66 kb, and Cluster 8 is 165.44 kb. Additionally, the enzyme categories observed are as follows: Cluster 1 contains Glycosyltransferase, Methyltransferase, and Cytochrome 450; Cluster 2 contains Dioxygenase; Cluster 3 contains Oxidoreductase and Cytochrome 450; Cluster 4 contains Glycosyltransferase and Pictet-Spengler enzyme (Bet v1); Cluster 5 contains Dioxygenase and Ketosynthase; Cluster 6 contains Lipoxygenase and Copper amine oxidase; Cluster 7 contains Glycosyltransferase and Cytochrome 450; and Cluster 8 contains Oxidoreductase, Terpene synthase, and Scl acyltransferase (Figure 5).

Figure 5. a) Cluster 1, b) Cluster 2, c) Cluster 3, d) Cluster 4, e) Cluster 5, f) Cluster 6, g) Cluster 7, h) Cluster 8



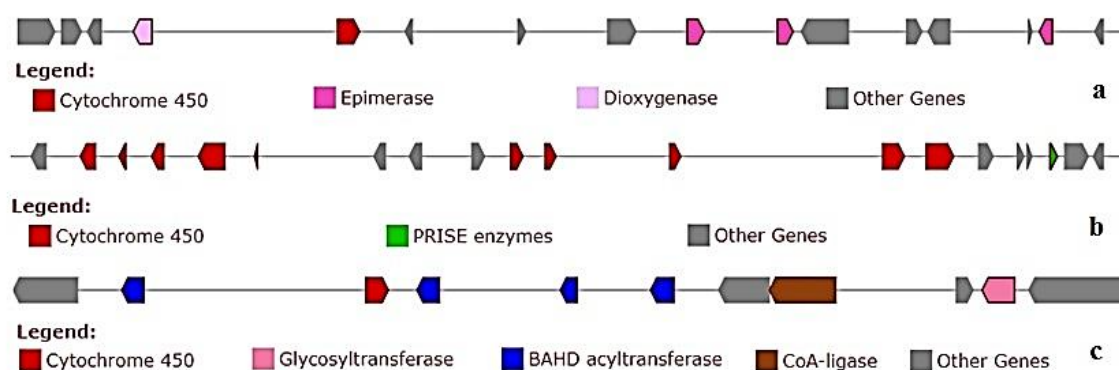
Chromosome 6 has been found to contain three clusters: Cluster 1 is of the Alkaloid type, Cluster 2 is Putative, and Cluster 3 is of the Saccharide type. Cluster 1 is located from 3,877,489 to 4,066,771 nt, with a size of 189.28 kb. Cluster 2 is located from 23,195,186 to 23,287,343 nt, with a size of 92.16 kb. Cluster 3 is located from 24,760,960 to 24,894,575 nt, with a size of 133.62 kb. The enzyme categories are distributed as follows: Cluster 1 includes CoA-ligase, Strictosidine synthase-like, and Cytochrome P450; Cluster 2 contains Cytochrome P450 and BAHD acyltransferase; while Cluster 3 features Lipoxygenase, CoA-ligase, and Glycosyltransferase (Figure 6).

Figure 6. a) Cluster 1, b) Cluster 2, c) Cluster 3



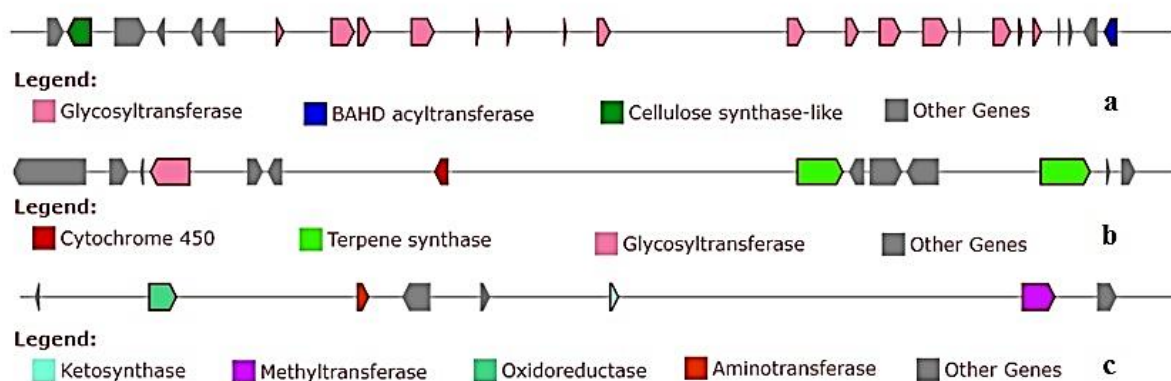
On chromosome 7, three secondary metabolite biosynthetic gene clusters have been detected: Cluster 1 is of the Putative type, Cluster 2 is of the Terpene type, and Cluster 3 is of the Saccharide type. The locations of the clusters are as follows: Cluster 1 is from 21,557,612 to 21,681,893 nt; Cluster 2 is from 23,325,929 to 23,529,866 nt; and Cluster 3 is from 25,007,782 to 25,073,881 nt. The sizes of the clusters are as follows respectively: 124.28 kb, 203.94 kb, and 66.10 kb. Additionally, Cluster 1 contains the enzyme categories Dioxygenase, Cytochrome P450, and Epimerase. Cluster 2 has been observed to include Cytochrome P450 and PRISE enzymes. Furthermore, Cluster 3 has been identified with the categories BAHD acyltransferase, Cytochrome P450, CoA-ligase, and Glycosyltransferase (Figure 7).

Figure 7. a) Cluster 1, b) Cluster 2, c) Cluster 3



As a result of the analysis, three types of secondary metabolite biosynthetic gene clusters have been identified on chromosome 8. Cluster 1 is classified as Saccharide, Cluster 2 is categorized as Saccharide-Terpene, and Cluster 3 is classified as Polyketide. Cluster 1 is located from 4,138,774 to 4,412,423 nt, Cluster 2 is from 9,413,345 to 9,575,574 nt, and Cluster 3 is from 11,013,814 to 11,229,978 nt. When examined in terms of size, Cluster 1 is 273.65 kb, Cluster 2 is 162.23 kb, and Cluster 3 is 216.16 kb. The enzyme categories are as follows: In Cluster 1, the categories are Cellulose synthase-like, Glycosyltransferase, and BAHD acyltransferase; in Cluster 2, they are Glycosyltransferase, Cytochrome P450, and Terpene synthase; and in Cluster 3, the categories include Oxidoreductase, Aminotransferase, and Methyltransferase (Figure 8).

Figure 8. a) Cluster 1, b) Cluster 2, c) Cluster 3



Based on the analysis, a total of 43 secondary metabolite biosynthetic gene clusters were identified in *P. granatum*. Among these, the Saccharide type has the highest number of gene clusters (15), followed by the putative type (11). The least represented are the Saccharide-Alkaloid, Saccharide-Terpene, Terpene-Alkaloid, and Terpene-Polyketide types, each with only one gene cluster. When evaluated in terms of chromosomes, it was observed that the highest number of clusters are found on chromosome 4 and chromosome 5, while the lowest number are on chromosome 6, chromosome 7, and chromosome 8. There are not many studies available on the analysis of secondary metabolite biosynthetic gene clusters in plants. In a study (Al-Salihi & Ford, 2023), 46 gene clusters were reported in *Vitis vinifera* L. (10 terpene, 3 polyketide, 12 saccharide, 2 lignan, 5 alkaloid, 1 saccharide-terpene, 1 lignan-terpene, 1 saccharide-alkaloid, and 11 putative), 33 gene clusters in *Fragaria vesca* L. (12 terpene, 2 polyketide, 14 saccharide, 3 alkaloid, 2 putative), and 16 gene clusters in *Olea europaea* L. (2 terpene, 1 polyketide, 7 saccharide, 1 lignan, 1 alkaloid, 1 saccharide-polyketide, 3 putative). In another study (Öz, 2024), 40 gene clusters were found in *Citrus sinensis* (L.) Osbeck, including 12 saccharide, 11 putative, 6 terpene, 3 lignan, 3 alkaloid, 2 polyketide, and one each of the terpene-alkaloid, terpene-saccharide-polyketide, and saccharide-terpene types. In research on *Camelina sativa* (L.) Crantz (Siddiqui et al., 2024), 89 secondary metabolite gene clusters were detected. In addition, the number of secondary metabolite gene clusters reported for other plants are as follows: 45 in *Arabidopsis thaliana* (L.) Heynh., 34 in *Beta vulgaris* L., 29 in *Brachypodium distachyon* (L.) P.Beauv., 68 in *Brassica napus* L., 34 in *B. oleracea* L., 23 in *Cajanus cajan* (L.) Huth, 28 in *Cicer arietinum* L., 18 in *Elaeis guineensis* Jacq., 76 in *Glycine max* (L.) Merr., 51 in *Malus domestica* (Suckow) Borkh., 36 in *Manihot esculenta* Crantz., 46 in *Oryza sativa Japonica*, 36 in *Phaseolus vulgaris* L., 48 in *Populus trichocarpa* Torr. & A.Gray ex Hook., 33 in *Prunus persica* (L.) Batsch, 45 in *Solanum lycopersicum* L., and 48 in *Theobroma cacao* L. (Kautsar et al., 2017). When compared to other studies, the number of secondary metabolite biosynthetic gene clusters in *P. granatum* has been assessed as either higher or lower depending on the plant species.

In this study, the enzyme categories contained within the secondary metabolite biosynthetic gene clusters in *P. granatum* were also identified. The analysis revealed the following enzyme categories: Amino oxidase, Aminotransferase, BAHD acyltransferase, Cellulose synthase-like, CoA-ligase, COesterase, Copper amine oxidase, Cytochrome 450, Dioxygenase, Dirigent enzymes, Epimerase, Fatty acid desaturase, Glycosyltransferase, Ketosynthase, Lipxygenase, Methyltransferase, Oxidoreductase, Pictet-Spengler enzyme (Bet v1), Polyprenyl synthetase, Prenyltransferase, PRISE enzymes, Scl acyltransferase, Strictosidine synthase-like, and Terpene synthase. Among these enzymes, BAHD acyltransferases play a role in abiotic and biotic stress responses and have important roles in the physiology of plant growth and development (Xu et al., 2023). Cytochrome P450s (CYPs) in plants are involved in the synthesis of sterols, hormones, fatty acids, cell wall components, and substances such as alkaloids, terpenoids, flavonoids, and allelochemicals. Additionally, they contribute to the plant's defense against challenging environmental conditions (Pandian et al., 2020). Apart from that, CYPs function as biocatalysts in phytoremediation and pharmacology as well (Singh et al., 2021). Terpene synthases play a crucial role in terpene biosynthesis, and terpenoids not only contribute aroma and flavor

to plants but also perform important functions in plant development and defense (Zhang et al., 2022) . It is considered that the enzymes in *P. granatum* carry out the mentioned similar functions and play a crucial role in the development of its medicinal properties.

4. CONCLUSION

In this study, the secondary metabolite biosynthesis gene clusters on the chromosomes of *P. granatum* were examined in detail. The analysis identified a total of 43 secondary metabolite biosynthesis gene clusters in *P. granatum*. These clusters contain genes involved in the production of important compounds that support the plant's various medicinal properties. The findings of this study demonstrate that a comprehensive analysis of the biosynthesis gene clusters and enzymes in *P. granatum* provides a crucial foundation for a better understanding of the plant's medicinal potential. The data obtained will enable more in-depth investigation of *P. granatum*'s secondary metabolites and facilitate targeted research into their pharmacological applications.

Acknowledgements

GPT-3.5 was used to check for grammar errors in the sentences translated into English and to generate alternative sentences. Thank you for the assistance provided by the GPT-3.5 software.

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Field Deployable and Disposable Multi-Walled Carbon Nanotube-based Screen-Printed Electrode Sensors: Application in Bisphenol A Detection in Tap Water

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Abstract

Field deployable and disposable screen-printed electrochemical sensors (pSPE) have gained a significant attention due to various advantages such as cost-effectiveness, portability, rapid analysis, minimal sample requirement, and environmental sustainability. These sensors offer affordable solutions for diagnostics and monitoring, making them accessible alternatives to traditional technologies. Here, a novel multi-walled carbon nanotube (MWCNT) conductive ink/paste was developed to fabricate field deployable, disposable as well as flexible electrochemical sensors via screen printing. The ink/paste composed of MWCNT and acrylic paint, and sodium dodecyl sulfate, was used for printing upper parts of the working (WE) and counter (CE) electrodes on an acetate and A4 paper. A silver ink/paste was used for the bottom part of the WE and CE electrodes and the reference electrodes. Hydrophobic insulating layers were printed to insulate the electrodes during measurements. The sensors were characterized electrochemically and physically, showing mechanical durability after prolonged liquid exposure. The sensors successfully detected Bisphenol A (BPA) in tap water, with a limit of detection (LOD) of 0.084 μM and a sensitivity of 1.3 $\mu\text{A}\cdot\text{mM}^{-1}\cdot\text{cm}^2$. Detecting BPA is crucial due to its potential health risks, including hormone disruption and increased cancer risk. Accurate and cost-effective BPA detection helps assess exposure risks and develop regulatory measures. The results indicate that the disposable sensors developed in this study can contribute to low-cost monitoring of toxic compounds like BPA.

Keywords: Electrochemical detection, screen-printed electrode, paper sensor, bisphenol A.

1. INTRODUCTION

Electrochemical sensors represent devices that detect the presence or concentration of some chemical compounds by electrochemical reactions (Pohanka & Skládal, 2008). Electrochemical sensors have gained significant attention in various fields due to their ability to provide rapid, accurate, and cost-effective analysis. Today, a wide sphere of applications in environmental monitoring, medicine, food safety, and industrial process control and security is opened for electrochemical sensors (Keene, Wen, & Martin, 2022). These sensors are particularly useful for detecting and monitoring environmental pollutants, such as Bisphenol A (BPA), a common contaminant found in plastics and resins (Shahrbabaki, Jalali, & Bayat, 2020). BPA exposure has been linked to numerous health issues, including hormonal imbalances, reproductive disorders, and an increased risk of cancer (Alamri et al., 2022). Therefore, developing reliable and affordable methods for detecting BPA is crucial for public health and environmental protection (Rehman & Butt, 2020). Recent advances in nanotechnology, particularly the utilization of carbon nanomaterials, have significantly enhanced the performance characteristics of electrochemical sensors (Stepniak & Czerwińska, 2017). Multi-Walled Carbon Nanotubes (MWCNTs), with their unique structural, electrical, and mechanical properties, have shown great promise in improving sensor sensitivity and selectivity (El Bakkali et al., 2021). Their high surface area, excellent conductivity, and ability to facilitate electron transfer make MWCNTs an ideal candidate for the fabrication of high-

performance electrochemical sensors (Azimian & Amirabadi, 2018). Screen-printed electrodes (SPEs) are widely used in the fabrication of disposable electrochemical sensors due to their simplicity, low cost, and scalability (Talukder et al., 2022). However, the choice of conductive materials and the substrate on which these materials are printed plays a crucial role in the performance of the sensors. Paper-based SPEs (pSPEs) have emerged as a promising alternative to traditional substrates, offering advantages such as flexibility, portability, and environmental friendliness (Zhang et al., 2021).

2. MATERIAL and METHODS

2.1. Materials

MWCNT (with an outside diameter of 48-78 nm) sourced from Nanografi Nano Technology in Turkey, Potentiostat (Autolab PGSTAT204), BPA, Hydrochloric acid (37%), Ferrocenemethanol (FcCH₂H) (FMA) ($\geq 97\%$), Ferricyanide/Ferrocyanide [Fe(CN)₆]^{3-/4-}, phosphate-buffered saline (PBS), AgNO₃ (silver nitrate), C₆H₈O₇ (citric acid), FeSO₄ (iron(II) sulfate), toluene, polystyrene, dimethyl sulfoxide (DMSO), SDS (purity $\geq 99\%$) obtained from Sigma-Aldrich in Germany, liquid paraffin (Tekkim, Turkey), wax printer (Xerox ColorQube 8500S), distilled water, acrylic paint (Rich Multi Surface), A4 paper (80 g/m²), acetate paper (Temat, Turkey).

2.2. Synthesis of Conductive Silver Paste/Ink

Silver nanoparticles (AgNPs) were synthesized by dissolving 1 g of AgNO₃ and 70 mg of C₆H₈O₇ in deionized water, followed by 30 minutes of sonication. Concurrently, 4 g of FeSO₄ was dissolved in 50 ml of deionized water. The AgNP solution was gradually added to the FeSO₄ solution, and the mixture was sonicated for 2 hours. The resulting AgNP ink was then centrifuged at 5000 rpm for 10 minutes. The supernatant was decanted, and the precipitate was washed three times with deionized water and ethanol to purify the nanoparticles. For silver paste preparation, 40 mg of the AgNP solution was mixed with 88 μ L of a polystyrene-toluene solution, prepared by dissolving 1 g of polystyrene in 5 ml of toluene. The mixture was vortexed for 5 minutes to ensure even dispersion of AgNPs, resulting in the final silver paste.

2.3. Formulating a Screen-printable Carbon-Based Conductive Paste/Ink

Conductive paste for screen printing was prepared by dispersing 1500 mg of MWCNTs in 50 ml of DMSO containing 100 mg of SDS. The dispersion was sonicated for one hour to achieve homogeneity. Subsequently, acrylic paint was added to the dispersion in a 1:6 ratio and mixed using a homogenizer until a uniform consistency was obtained. This process resulted in a smooth and continuous conductive ink suitable for screen printing.

2.4. Fabrication of Paper-Based SPE (pSPE)

A wax printer was first used to create a hydrophobic and insulating stencil to protect the paper electrodes during liquid measurements. Three screen printing stencils were designed in Microsoft PowerPoint to produce electrodes, each corresponding to the application of carbon-based ink/paste, silver paste, and insulation polymer. First, the carbon-based paste was applied to the paper substrate using the initial stencil to print the upper parts of working (WE) and counter (CE) electrodes. The second stencil was used to apply silver paste to print the lower parts of WE and CE along with the reference electrode (RE). Both pastes were applied using serigraphy, and the silver electrodes were dried at room temperature. The third stencil was set up to insulate the electrodes by applying a non-conductive dielectric polymer material to specific areas, defining the detection areas of the electrodes. The electrode patterns printed on paper were then separated using a cutting tool, completing the production process. Selected samples of the produced electrodes were subjected to electrochemical characterization.

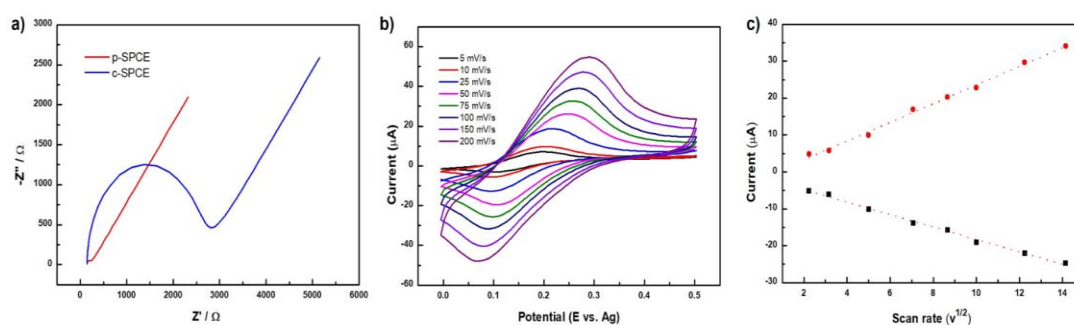
2.5. Electrochemical Characterization and BPA Sensing Performance of pSPE

Electrochemical characterization of the pSPE involved cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). CV was performed from 0 to 0.5 V (E vs. Ag) in 1 mM FMA solution, while EIS measured R_s , C_{dl} , and R_{ct} in a diffusion-controlled Randles circuit using AUTOLAB PGSTAT204 in a 50 mM $[\text{Fe}(\text{CN})_6]^{3-/4-}$ and 0.1 M KCl solution. The impedance spectra were recorded from 10 to 10^5 Hz with a 10 mV AC signal, and data fitting was done with AUTOLAB 302 Nova software. For BPA detection, differential pulse voltammetry (DPV) was used in a potential window of -0.1 to 1.0 V (E vs. Ag), with BPA solutions prepared in tap water at various concentrations. Selectivity was assessed by applying DPV in a 50 μM mixture of K^+ , Na^+ , Cl^- , Fe^{3+} , and BPA in PBS at pH 7, confirming the sensor's specificity towards BPA without interference from other ions.

3. RESULTS and DISCUSSION

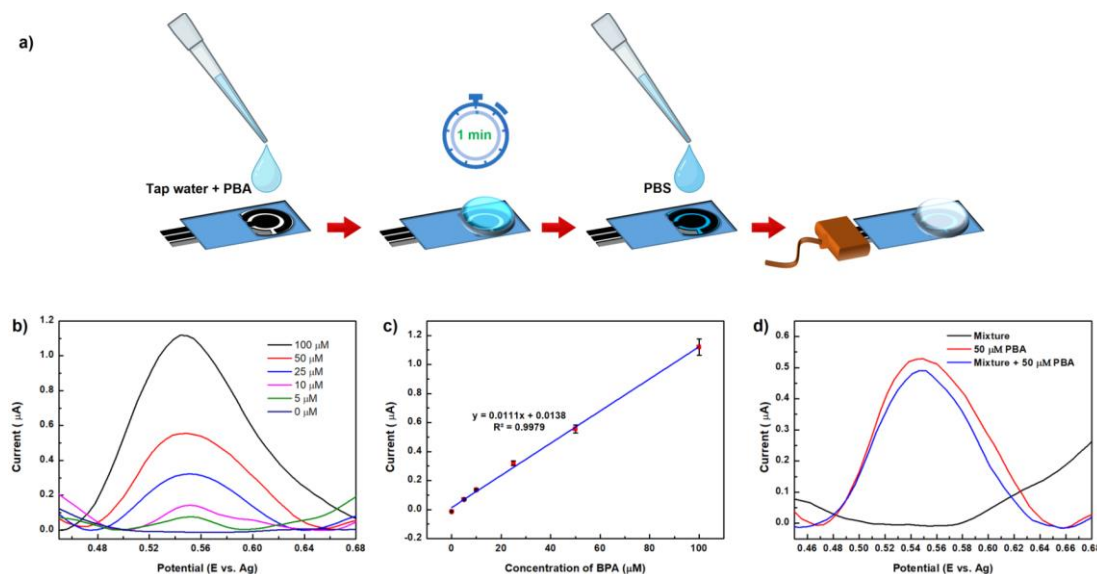
The electrochemical characterization of the paper-based screen-printed electrodes (pSPEs) was conducted using cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). EIS analysis showed a low charge transfer resistance (R_{ct}) of 453 Ω , significantly lower than the typical 2000 Ω observed for commercial screen-printed electrodes (cSPE), indicating high electron transfer efficiency (Figure 1a). CV measurements in a PBS solution with 1 mM FcCH_2OH revealed a ΔE_p of 103 mV, indicating a slower electron transfer rate compared to the theoretical 59.2 mV (Figure 1b). The scan rate dependency of the peak current (I_p) showed a linear relationship with the square root of the scan rate, consistent with diffusion-controlled processes (Figure 1c). The ratio $I_{p,a}/I_{p,c}$ was 0.811, confirming diffusion-controlled electrode reactions.

Figure 1. EIS measurement results obtained with pSPE and cSPE. CV graphs of the pSPE obtained at scan rates ranging from 5 to 200 mV/s (b), and a graph showing the relationship between scan rate and the peak currents (c).



A novel procedure was adopted for the measurement of BPA in tap water (Figure 2a). Briefly, 5 μL of the solutions prepared in tap water were dropped onto the sensor and allowed to settle on the surface for 1 minute to allow BPA molecules to adhere. Subsequently, the solution on the sensor was carefully withdrawn, and measurements were carried out following the addition of PBS. DPV was used to measure BPA in tap water containing varying concentrations of BPA (5-100 μM). As can be seen in Figure 2b, the DPV current proportionally increased with increasing BPA concentration. The calibration curve given in Figure 2c clearly demonstrated the relationship between the current and the BPA concentration was linear with R^2 value of 0.99. Based on the calibration curve, the LOD and sensitivity of pSPE for the detection of BPA was calculated as 0.084 μM and a sensitivity of 1.3 $\mu\text{A}\cdot\text{mM}^{-1}\cdot\text{cm}^{-2}$, respectively. Selectivity tests showed that the sensor can perform measurements in the presence of different ions and the sensor was selective (Figure 2c).

Figure 2. DPV curves were recorded in tap water containing varying concentrations of BPA in a range of 0 to 100 μM (a). A calibration curve illustrating the correlation between the measured peak currents in DPV and the corresponding concentrations of BPA (b) and selectivity test results (c).



4. CONCLUSION

This study introduces a cost-efficient measurement of BPA in tap water. Basically, a novel and low-cost carbon nanotube-based conductive ink/paste and a silver-based ink/paste were first developed for large-scale fabrication of paper-based screen-printed electrodes (pSPE) using screen printing technology. The formulations of the two ink/paste were carefully optimized to achieve ideal texture and conductivity, enabling the production of WE, CE and RE on a standard A4 paper. Next, the pSPEs were used to measure BPA in tap water. The electrochemical performance of the sensors was thoroughly evaluated, demonstrating their excellent ability to detect BPA in tap water. The production cost per pSPE is approximately €0.14, with a batch capacity of 36 electrodes. The use of paper substrates offers significant advantages in terms of cost efficiency and scalability. Future improvements to this sensor could further enhance detection limits and sensitivity, making it a promising tool for a range of environmental and biological monitoring applications.

Acknowledgments

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Factors Disrupting the Ecological Balance of the Vegetation of Okchuchay Area of Zangilan Region

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Abstract

The Zangilan region has fascinating beauty and rich nature due to its geographical location, soil and climate. The territory of the region is located in mid-mountain and low-mountain areas and has a complex valley-hilly surface structure. The Bergushad ridge (Mount Susan, 1304 m), entering the territory from the northwest, descends and forms the sloping Ag-Oyug plain (height 400-600 m) between Bazarchay and Okchuchay. The ecological conditions, forest types and vegetation of the Okchuchay territory of the Zangilan region were studied. The steppe formation occupies a large place in the vegetation. Dry desert, mountain xerophyte plants, thickets, and broad-leaved forests are widespread in the mountainous part. Here, the main composition of the forest consists of *Quercus arachina* A. Grossh., *Platanus orientalis* L., *Populus* L. and the rest consists of mixed forests. Alluvial soils along the river bed and on small terraces are mainly under sycamore forests (*Platanetum*). The composition includes *Juglans regia* L., *Celtis glabrata* Steven ex Planch., *Ulmus arachina* Takht., *Carpinus orientalis* Mill. The limited area of forests and the uniformity of forest growing conditions do not allow the formation of a wide range of forest types. Each forest formation has its own phytocenosis of the plant community. Recently, increased drought stress due to climate change has led to a decline in forest species in some areas of Okchuchay district. At the same time, during the occupation, the ecosystems of the river basin were subjected to serious landscape and environmental impacts. As a result of research, it has been established that the area of forest biocenoses has decreased by 30-40% and, according to some data, has undergone more natural structural changes as a result of climate change and anthropogenic factors.

Keywords: ecological conditions, formations, vegetation, climate, anthropogenic factors

1. INTRODUCTION

The territory of Okchuchay, within a very short distance within the Eastern Zangezur region, has a plain, low and medium mountainous relief, and a rich vegetation has been formed due to the interaction with different climate types (Guliyev 2014). There are 2 climate cycles in the area. It has a semi-desert and dry desert climate with dry winters, and a mild warm climate with dry winters in slightly higher areas. The annual amount of precipitation is 600 mm (Khidyrov 2021).

Quercus arachina A. Grossh. covers more of the area (10 thousand hectares). In the plains and dashes (*Paliurus* Mill., *Prunus amygdalus* Batsch, *Rhamnus* L., *Crataegus* L., *Rosa* L., *Juniperus* L.) blackthorn, almond, tobulga, murdarcha, hawthorn, rose hip, juniper, etc. thickets formed (Huseynova 2023). On the fragmented islands in the delta of the river, moisture-loving (*Platanus orientalis* L., *Populus* L., *Salix* L., *Ulmus* L.) oriental sycamore, poplar, willow, elm, etc. mixed meadow-forest vegetation has developed. *Platanus orientalis* L. which grows naturally in Okchuchay territory, is also widespread in other areas (Mammadov, Khalilov 2002). On the shores of Okchuchay, it grows in the areas where the groundwater moistens enough along the valleys up to 1000 meters above sea level. The climatic conditions of the region are very favorable for the natural regeneration and development of *Platanus orientalis* L. Here, their height is approximately 35-45 m, and the diameter reaches 1.5-2.5 m. *Platanus orientalis* L. single large-bodied specimens are found along the length of 30 km of the Okchuchay area. Here too (*Platanus orientalis* L., *Juglans regia* L.) sycamore grows together with common walnut. *Platanus orientalis* L. is a relict species whose stock is declining (Akhundov 1973). In the areas along Okchuchay, sedges and sometimes arid woodlands, phryganids, and sedge- grass plants can be found in relatively low-lying areas (Hasanov 2004).

2. MATERIAL and METHODS

Intra-country analysis of the distribution and development of vegetation in the Okchuchay district of the Zangilan district, assessment of the environmental situation, the results of factors disturbing the ecological balance of forest formations were clarified. Ecological characteristics, Mamedov (1988), Asadov (2010), relief - Guliyev (2014), vegetation- Mamedov, Khalilov (2002), dominant species - Asadov (1981), endemic and relict plants- Akhundov (1973), Asadov, Mamedov (2003), rare and vulnerable to extinction - Iskanderov (2010), forest tiers - flora of Azerbaijan (1950-1961), slope territories- of Huseynova (2023), formations- Mamedov, Khalilov (2002), climatic factors - Khidyrov (2021), Huseynova (2023), Summer pastures of Hasanov (2004), Anthropogenic amnyl - the end of environmental terror! (2015). During the research, plants and altitudes characteristic of the study area were identified using Garmin GPS.

3. RESULTS and DISCUSSION

Due to the gradual change of natural landscapes from dry steppes to mountain forests and the influence of Okchuchay, which plays the role of an ecological corridor between them, a biodiversity of unique importance and richness has been created in the basin. The main component of the forest in the Okchuchay area is *Quercus arachina* A.Grossh., *Platanus orientalis* L., *Populus* L. and the rest consists of mixed forests. On the dry stony slopes of the forest area *Quercus arachina* Grossh., *Celtis* L., *Carpinus orientalis* Mill., *Pistacia lentiscus* L., *Acer* L., *Ulmus* L., *Pyrus salicifolia* Pall., *Juniperus foetidissima* Willd sparse forests are spread (Asadov 2010). Xerophytic bushes are found singly and in clumps among sparse trees. Among xerophytic shrubs in these forests: *Atraphaxis spinosa*, *Lonicera iberica*, *Cerasus microcarpa*, *Ephedra intermedia* Schrenk. Do. C.A.Mey., *Jasminum fruticans*, *Rhamnus pallasii* and *Paliurus spina-christi* are distributed naturally (Figure 1).

Figure 1. *Quercus arachina* A. Grossh. *Ephedra intermedia* Schrenk. Do. C. A. May.



In forests, the first tier *Platanus orientalis* L., *Juglans regia* L., *Populus* L. the second tier *Quercus arachina* A.Grossh., *Ulmus* L., *Celtis* L. and the third tier *Corylus* L., *Punica granatum* L., *Pistacia lentiscus* L. and other plants included. (Flora of Azerbaijan 1950-1961). *Platanus orientalis*

L. sometimes forms a pure forest (in a small area). In mixed plane trees *Juglans* L., *Ulmus* L., *Celtis* L., *Morus* L., *Salix* L. *Populus* L. and other trees *Crataegus* L. *Rosa* L., *Rhamnus* L., *Paliurus* Tourn. ex Mill).) etc. bushes are registered. At the same time *Prunus Padus* L., *Carpinus* L. *Vitis vinifera* subsp. *sylvestris* (C.C.Gmel.), *Tulipa karabachensis* Grossh., *Alcea sachsachanica* Iljin Okchuchay's habitat is widespread in forests. Among the medicinal plants widely used in medicine on its territory, the most common are shrubs *Glycyrrhiza glabra* L., *Astragalus* L. (Iskanderov2010).

Pistacia lentiscus L. is occasionally found in wormwood semi-deserts in the Okchuchay area. Such a semi-desert creates a 15-20 km wide belt and is replaced by xerophytic thickets in the area above 600 m above sea level. It also grows in Okchuchay basins against the background of sedges *Celtis* L., *Pyrus salicifolia* Pall. and in valleys protected from the wind *Platanus orientalis* L. This type of shingle forms a special belt at an altitude of 600-800 (1000) m.

The presence of *Pistacia lentiscus* L., *Pyrus salicifolia* Pall., *Juniperus* L., *Celtis* L. against the background of xerophilous sedges confirms that sedges were formed after the influence of climate change and anthropogenic factors and that they are a derived plant group. The territory of the steppe plateau was once covered with sparse arid forests in some places and dense forests in some places. This is proved by the remains of trees and forests in different parts of the plateau area (Gasnov 2004).

Shrubs form a special layer and usually grow under trees. Since they occupy a lower position in the vegetation, they are strongly influenced by trees. In one part of the forest, shrubs are dense, while in the other part, they are sparse and poorly developed. Such diversity is explained by the fact that tree cover is not equally dense in different parts of the forest. Where trees are rare, shrubs receive a lot of light and grow quickly.

During the monitoring, 27 trees, 18 shrubs and 11 grass species were recorded, of which 18 trees, 3 shrubs, 3 grass species and 5 endangered trees - *Platanus orientalis* L., *Juglans regia* L., *Pyrus communis* L., *Populus euphratica* Oliver, *Punica granatum* L., 2 bushes - *Crataegus tournefortii* Griseb, and *Alcea sachsachanica* Iljin are relict and endemic plants (Asadov, Mammadov 2003).

32.2% of the territory of Okchuchay consists of forests-shrubs, 32.1% xerophytic steppes, 12% dry steppes and 6.9% river-valley meadow forests.

Due to the recent climate changes, increased drought stress has led to the decline of forest tree species in some areas of the Okchuchay area. Although some forest formations may benefit from climate change, most formations are affected. Warm climatic conditions, forming xerophytic forest - *Paliurus* Mill., *Prunus amygdalus* Batsch, *Rhamnus* L., *Crataegus* L., *Rosa* L., *Juniperus* L.) blackthorn, almond, tobulga, murdarcha, hawthorn, hip, juniper, sedge, etc. although the conditions are more favorable for the species, it is ecologically less favorable for the moisture-loving (*Platanus orientalis* L., *Populus* L., *Salix* L., *Ulmus* L.) oriental sycamore, poplar, willow, elm, etc. species (Huseynova 2023). (Figure2).

Figure 2. General view of Okchuchay area and *Platanus orientalis* L. on the edge of Okchuchay



It is with great regret that we note that the nature of Okchuchay and the surrounding areas - climate change and the Armenian military aggression that has been going on for almost 30 years - have caused serious damage to its biological diversity and water bodies. Forests were brutally plundered, industrially important species - *Quercus arachina* A.Grossh., *Juglans regia* L., *Fraxinus ornus* L., *Platanus orientalis* L. etc. was broken, and other types of trees and bushes were used as fuel. Currently, these forests, which create a green appearance, actually consist of ball-shaped trees growing on the roots of trees that were cut down by the Armenians.

Exposure of forest covers to anthropogenic influences and changes in the composition of most tree species, in the first case, affects the conditions of forest growth, and in the second case, leads to serious changes in the conditions of forest growth. At best, it may be possible to restore the original naturalness of the forest by taking preventive measures against most of the vegetation cover of the derived group that occurs in the forest. If the rules of afforestation are violated too much, it becomes impossible for the forest to return to its former state and to restore it (End ecological terror!" 2015).

2 types (forest, thicket), 7 formations, 35 associations were determined for the vegetation of the forest ecosystem. Although the dominant species of the broad-leaved forests of the mountainous area is *Quercus arachina* A.Grossh., *Platanus orientalis* L. the subdominant species are *Juglans regia* L., *Celtis* L., *Carpinus orientalis* Mill., *Pistacia lentiscus* L., *Ulmus* L., *Pyrus salicifolia* Pall. ., *Juniperus foetidissima* Willd species are of special importance in forest formation (Asadov 1981). Xerophytic sparse forests - such forests, consisting of drought-resistant trees and shrubs, developed in arid areas.

4. CONCLUSION

The remaining part of the river basin between the city of Zangilan and the Susendag ridge is covered with mountain xerophyte (phrygonoid) vegetation. On the slopes of Susan, Pilesar and Asgulum mountain ranges facing the river bed, there are mainly (*Quercus arachina* A.Grossh., *Platanus orientalis* L. *Carpinus orientalis* Mill.) Araz oak, eastern sycamore, mixed

dry sparse forest and shrubs. As a result of the conducted research and analysis, it was determined that the territory of Okchuchay is divided into xerophytic thickets, forest-shrubs, forest and forest-shrub areas. As a result of climate change, the reduction of steppe and forest areas was observed (Khidyrov 2021). In current years, steppes and steppes decreased by 3.6%, and forests by 25.3%. The dynamic change of vegetation and especially the reduction of forest area is related to climate change and environmental terrorism during famine.

2 types (forest, thicket), 7 formations, 35 associations were determined for the vegetation of Okchuchay area. Although the dominant species of the broad-leaved forests of the mountainous area are Araz oak, Eastern sycamore, poplar (*Quercus arachina* A.Grossh., *Platanus orientalis* L., *Populus* L.), the subdominant species are *Juglans regia* L., *Celtis glabrata* Steven ex Planch., *Ulmus arachina* Takht., *Fraxinus excelsior* L., *Crataegus meyeri* Pojark., *Pyrus salicifolia* Pall. species are of special importance in the formation of the forest. Xerophytic sparse forests - such forests, consisting of drought-resistant trees and shrubs, developed in arid areas. Tree xerophyte coenoses in themselves combine very tolerant climate-adapted associations.

79.4% of the territory of Okchuchay is covered with forest and 14.02% is not covered with forest, 6.54% is unforested area, and 6.54% is sand dunes and stone piles.

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"An end to national-cultural and environmental terrorism in our occupied territories!". (2015)



Geological and Natural Formations Ornithofauna of Erzurum (Türkiye)

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Abstract

This study was obtained as a result of field studies for one year between April 2023 and April 2024 in the 'Erzurum Geological and Natural Formations' area, which has the status of 'Sensitive Area to be Definitively Protected' by the Ministry of Environment, Urbanisation and Climate Change. Point observation and along the line observation methods were used to identify bird species in the area. Observation studies were intensified during migration and breeding periods and these field studies were generally carried out between 6:00-11:00 and 15:00-19:00 hours when individuals were active. As a result of these observations and analyses, 40 bird species belonging to 11 orders (Ordo) and 22 families (Familia) were identified. As a result of the study, 5 of the species observed in the area are native (12.5%) and 35 of them are summer migrants (87.5%). When the IUCN categories of the species detected in the area are analysed, it was revealed that the Lesser Vulture (*Neophron percnopterus*) is in the endangered (EN) category, the Maidenbird (*Vanellus vanellus*) and the Steppe Flicker (*Circus macrourus*) are in the near threatened (NT) category, and the other 37 species are in the least concern (LC) category. As a result of the findings obtained in this study; it was determined that this area is a very important area in terms of ornithofauna.

Keywords: Geological and natural formations, ornithofauna, protected area, Erzurum, Türkiye

1. INTRODUCTION

The diversity of ornithofauna in an area is influenced by factors such as the area being on bird migration routes, habitat characteristics of the area (different habitats such as forests, meadows, wetlands, deserts, mountains, sea or ocean coasts), climatic conditions, feeding resources, breeding and nesting areas, competition and prey. These factors need to be evaluated together to understand the presence and diversity of bird species.

Turkey is a very rich country in terms of bird species diversity. Turkey is located on the migration route of many bird species due to its location at the intersection of Europe, Asia and Africa, having various habitats and different climatic conditions. Turkey has a total of 496 bird species and an important position worldwide in terms of ornithofauna. (URL-1, 2024). Many migratory birds use Turkey as a breeding ground, while others visit Turkey as short-term stopping points on their migration routes.



Figure 1. Map of migratory bird routes passing through Turkey (Kiziroglu et al., 2011).

Erzurum is a very important city in terms of ornithofauna because it has various habitats and is located on the migration routes of migratory birds. Erzurum and its surroundings have alpine habitats as it is a mountainous and high altitude region. These habitats offer a suitable environment for unique bird species. In addition, there are many important wetlands in Erzurum where both native and migratory bird species shelter. These wetlands are the feeding and breeding points of various bird species, especially during migration periods. In Turkey, great importance is attached to the protection of wildlife habitats through protected areas with various statuses.

Located within the borders of Hınıs district of Erzurum province, it was registered as a ‘Sensitive Area to be Definitely Protected’ within the scope of Ecologically Based Scientific Research Project on 29.06.2021 (URL-2, 2021). Erzurum Geological and Natural Formations protected area is an important wetland consisting of many large and small lakes. The geological and natural formations protected area, locally known as ‘Bingöller Yöresi’, is very rich in ornithofauna. It is an area with a wide variety of habitats due to the fact that it has a wetland habitat consisting of many lakes and valleys formed by rivers at high altitude, it also shows pasture ecosystem characteristics, and there is a forest ecosystem in the regions close to the area.

Erzurum Geological and Natural Formations protected area also falls within the boundaries of the ‘Bingöl Mountains’ important nature area (ÖDA). This area, where ornithofauna studies were carried out, is protected under two different statuses (URL-7, 2015).

Figure 2. The location of Bingöl Mountains Important Natural Area within Turkey's Important Natural Areas and the location of Erzurum Natural and Geological Formations Protected Area within Bingöl Mountains Important Natural Area (●).



2. MATERIAL and METHODS

The studies were carried out in the sensitive area of ‘Erzurum Geological and Natural Formations’ near Güzeldere village in Hınıs district of Erzurum province. It was carried out by counting and observing for a year between April 2023 and April 2024, in 15-day periods, usually between 6:00-11:00; 15:00-19:00 hours when the species are active, with a total of 13 field studies. A professional camera (83x optical zoom, 16 Megapixel) and camouflage clothing were used to photograph the area and the species seen during the field studies. During the studies, 10x42 binoculars and 20-60x60 telescope were used for observation of the field and species.

Figure 3. Use of camera, telescope and camouflage clothing in field work.



Located at the northern foot of the ‘Bingöl Mountains’ at an altitude of 2700 metres above sea level, this area is a very important geological and natural formation consisting of many large and small lakes, locally known as the ‘Bingöller Region’. This protected area is located northwest of Hınıs. It is 170 km to Erzurum city centre and 28 km to Hınıs district centre. It is almost equal distance to Güzeldere and Meydanköy neighbourhoods. The vegetation of the research area consists of species belonging to the Iran-Turanian Plant Geography Region, generally steppe species and species growing in wetlands in the area dominated by alpine meadows and wetland vegetation around the lakes, the vegetation can remain green until mid- summer. It does not have a rich diversity in terms of natural vegetation due to unfavourable ecological reasons, annual low average temperature and frost events lasting from October to the end of May.

Figure 4. Images of the work area.



3. FINDINGS

Field studies were carried out between April 2023 and April 2024 in the protected area of 'Erzurum Geological and Natural Formations' located within the borders of Hınıs district of Erzurum province and its immediate surroundings. Only one field study was carried out in April 2023, when it was not possible to reach the area due to the freezing and snow cover of the area, and between November 2023 and April 2024, observations were made in a region close to the area, but no species were found.

As a result of the field studies in other months, 40 bird species belonging to 11 orders (Ordo) and 22 families (Familia) were identified.

Figure 5. Long-legged Buzzard (*Buteo rufinus* Cretzschmar, 1829), Eurasian Coot (*Fulica atra* Linnaeus, 1758).



Among the bird species observed in the study area;

According to IUCN criteria; 1 species is endangered, 2 species are close to endangered and the other species are not endangered.

In the Bern category, 11 species are under protection and 23 species are under strict protection.

Within the scope of Cites; 7 species are not threatened with extinction, their trade is subject to certain principles, and 1 species is one of the species whose trade is subject to strict legislation and authorisation is mandatory only in exceptional cases.

According to the decisions of the Central Hunting Commission, 9 species are permitted to be hunted for certain periods of time and 6 species are protected and prohibited to be hunted.

In the category of the Ministry of Agriculture and Forestry, 22 species are protected game animals and 18 species are designated as game animals.

The distribution of 40 bird species according to families is as follows:

4 species from Anatidae, 2 species from Phasianidae, 2 species from Emberizidae, 2 species from Passeridae, 1 species from Fringillidae, 2 species from Corvidae, 2 species from Muscicapidae, 1 species from Sturnidae, 4 species from Alaudidae, 1 species from Phylloscopidae, 1 species from Laniidae, 1 species from Remizidae, 2 species from Motacillidae, 1 species from Falconidae, 1 species from Columbidae, 1 species from Cuculidae, 5 species from Accipitridae, 3 species from Scolopacidae, 1 species from Charadriidae, 1 species from Upupidae, 1 species from Rallidae, 1 species from Strigidae.

Figure 6. Ratios of species diversity at the family level of the species observed in the research area.

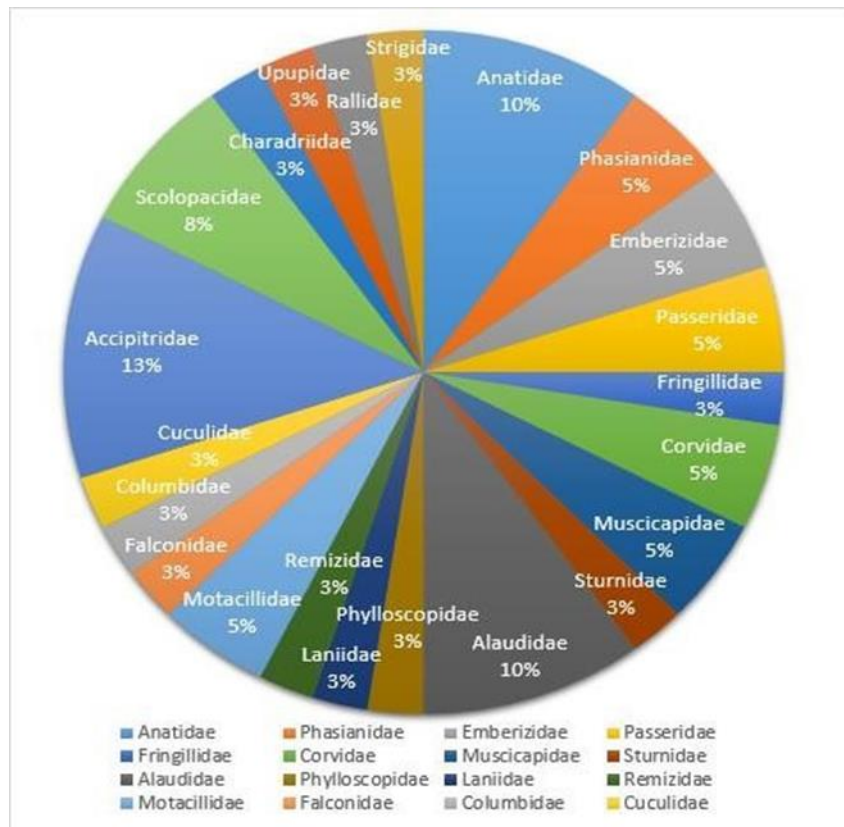


Figure 7. Representation of the total number of species observed in the research area at family level.

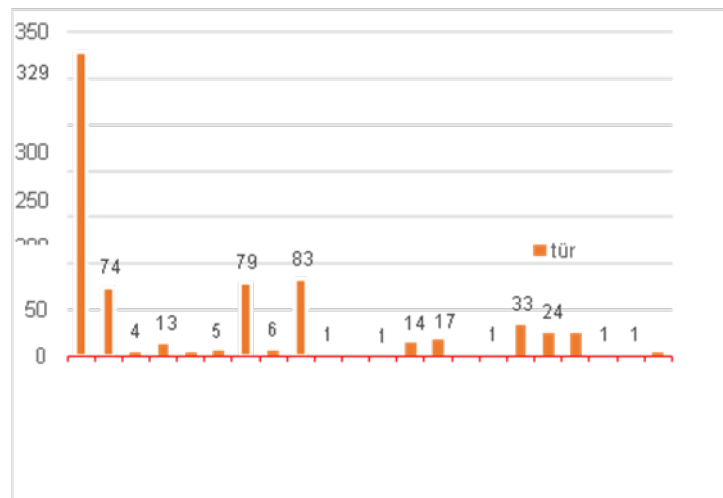


Table 1. Protection and presence status of observed species in the area.

OBSERVED SPECIES	IUCN	BERN	CITES	MAK	TOB	A.STATUS	R.STATUS
Angıt (Ruddy Shelduck)(<i>Tadorna ferruginea</i> Pallas, 1764)	LC	Ek -II	-	-	Ek-III	YG	YG
Çil Keklik (Grey Partridge) (<i>Perdix perdix</i> Linnaeus, 1758)	LC	Ek-III	-	Ek-II	Ek-II	Y	Y
Doğu Kirazkuşu (Grey-necked Bunting) (<i>Emberiza buchanani</i> Blyth, 1845)	LC	Ek-III	-	Ek-I	Ek-II	YG	YG
Serçe (House Sparrow) (<i>Passer domesticus</i> Linnaeus, 1758)	LC	-	-	Ek-II	Ek-II	Y	Y
Yeşilbaş (Mallard) (<i>Anas platyrhynchos</i> Linnaeus, 1758)	LC	Ek-III	-	Ek-II	Ek-II	YG	YG
Ketenkuşu (Common Linnet) (<i>Linaria cannabina</i> Linnaeus, 1758)	LC	Ek-II	-	-	Ek-III	YG	YG
Küçük Karga (Western Jackdaw) (<i>Corvus monedula</i> Linnaeus, 1758)	LC	-	-	Ek-II	Ek-II	YG	Y
Kerkenez (Common Kestrel)(<i>Falco tinnunculus</i> Linnaeus, 1758)	LC	Ek-II	Ek-I	-	Ek-III	YG	YG

Kuyrukkakan (Northern Wheatear) (<i>Oenanthe oenanthe</i> Linnaeus, 1758)	LC	Ek-II	-	Ek-I	Ek-II	YG	YG
Sığırcık (Common Starling) (<i>Sturnus vulgaris</i> Linnaeus, 1758)	LC	-	-	Ek-I	Ek-II	YG	YG
Tahtalı (Common Wood Pigeon) (<i>Columba palumbus</i> Linnaeus, 1758)	LC	-	-	Ek-II	Ek-II	Y	YG
Kaya Serçesi (Rock Sparrow) (<i>Petronia petronia</i> Linnaeus, 1766)	LC	Ek-II	-	-	Ek-III	YG	YG
Tepeli Toygar (Crested Lark) (<i>Galerida cristata</i> Linnaeus, 1758)	LC	Ek-III	-	Ek-I	Ek-II	YG	YG
Kulaklı Toygar (Horned Lark) (<i>Eremophila alpestris</i> Linnaeus, 1758)	LC	Ek-II	-	-	Ek-III	YG	YG
Boğmaklı Toygar (Calandra Lark) (<i>Melanocorypha calandra</i> Linnaeus, 1766)	LC	Ek-II	-	-	Ek-III	YG	YG
Kara Başlı Çinte (Black-headed Bunting) (<i>Emberiza melanocephala</i> Scopoli 1769)	LC	Ek-II	-	-	Ek-III	YG	YG
Guguk (Common Cuckoo) (<i>Cuculus</i>	LC	Ek-III	-	-	Ek-III	YG	YG

canorus Linnaeus, 1758)								
Kara aylak (Black Kite) (<i>Milvus migrans</i> Boddaert, 1783)	LC	Ek-II	Ek-II	-	Ek-III	YG	YG	
Yeşil Ddkun (Green Sandpiper) (<i>Tringa ochropus</i> Linnaeus, 1758)	LC	Ek-II	-	-	Ek-III	YG	YG	
Kk Akbaba (Egyptian Vulture) (<i>Neophron percnopterus</i> Linnaeus, 1758)	EN	Ek-II	Ek-II	-	Ek-III	YG	YG	
Kızılbaşak (Common Redshank) (<i>Tringa totanus</i> Linnaeus, 1758)	LC	Ek-III	-	Ek-I	Ek-II	YG	YG	
Kızkuşu (Northern Lapwing) (<i>Vanellus vanellus</i> Linnaeus, 1758)	NT	Ek-III	-	Ek-I	Ek-II	YG	YG	
Tepeli Patka (Tufted Duck) (<i>Aythya fuligula</i> Linnaeus, 1758)	LC	Ek-III	-	Ek-II	Ek-II	YG	KZ	
Kafkas ıvgını (Mountain Chiffchaff) (<i>Phylloscopus sindianus</i> W.E. Brooks, 1880)	LC	-	-	-	Ek-III	YG	YG	
Dere Ddkun (Common Sandpiper) (<i>Actitis hypoleucos</i> Linnaeus, 1758)	LC	Ek-II	-	-	Ek-III	YG	YG	

Şahin (Common Buzzard) (<i>Buteo buteo</i> Linnaeus, 1758)	LC	Ek-II	Ek-II	-	Ek-III	YG	YG
Kızıl Şahin (Long-legged Buzzard) (<i>Buteo rufinus</i> Cretzschmar, 1829)	LC	Ek-II	Ek-II	-	Ek-III	YG	YG
İbibik (Eurasian Hoopoe) (<i>Upupa epops</i> Linnaeus, 1758)	LC	Ek-II	-	-	Ek-III	YG	YG
Sakarmeke (Eurasian Coot) (<i>Fulica atra</i> Linnaeus, 1758)	LC	Ek-III	Ek-II	-	Ek-II	Y	YG
Kızılsırtlı Örümcekkuşu (Red-backed Shrike) (<i>Lanius collurio</i> Linnaeus, 1758)	LC	Ek-II	-	Ek-I	Ek-II	YG	YG
Kınalı Keklik (Chukar Partridge) (<i>Alectoris chukar</i> Gray, JE 1830)	LC	Ek-III	-	Ek-II	Ek-II	Y	Y
Boz Kuyrukkakan (Isabelline Wheatear) (<i>Oenanthe isabellina</i> Temminck, 1829)	LC	Ek-II	-	Ek-I	Ek-II	YG	YG
Çıkrıkçın (Garganey) (<i>Spatula querquedula</i> Linnaeus, 1758)	LC	Ek-III	-	Ek-II	Ek-II	YG	YG
Bozkır Delicesi (Pallid Harrier) (<i>Circus macrourus</i>	NT	Ek-II	Ek-II	-	Ek-III	YG	YG

S. G. Gmelin, 1770)									
Kukumav (Little Owl) (<i>Athene noctua</i>) Scopoli, 1769)	LC	Ek-II	Ek-II	-	Ek-III		YG	Y	
Çulhakuşu (Eurasian Penduline Tit) (<i>Remiz pendulinus</i>) Linnaeus, 1758)	LC	Ek-III	-	-	Ek-III		YG	YG	
Küçük Boğmaklı Toygar (Bimaculated Lark) (<i>Melanocorypha bimaculata</i>) Menetries, 1832)	LC	Ek-II	-	-	Ek-III		YG	YG	
Alakarga (Eurasian Jay) (<i>Garrulus glandarius</i>) Linnaeus, 1758)	LC	-	-	Ek-II	Ek-II		YG	YG	
Kır İncir Kuşu (Tawny Pipit) (<i>Anthus campestris</i>) Linnaeus, 1758)	LC	Ek-II	-	-	Ek-III		YG	YG	
Ak Kuyruksallayan (White Wagtail) (<i>Motacilla alba</i>) Linnaeus, 1758)	LC	Ek-II	-	-	Ek-III		YG	YG	

4.DISCUSSION AND CONCLUSION

As a result of this study, 40 bird species belonging to 11 orders (Ordo) and 22 families (Familia) were identified. As a result of the evaluation of the area and regional status of the detected bird species, 35 of them are summer migrants (87.5%) and 5 of them are native species (12.5%). According to IUCN criteria; 1 species is endangered, 2 species are close to endangered and the other species are not endangered. When the total number of species at the family level observed during the study is analyzed, the families with the highest number of species observed in the area are as follows;

Anatidae (Duck family), Alaudidae (Hoover family), Muscicapidae (Flycatcher family) and Phasianidae (Pheasant family).

As a result of the observations, the families with the highest species diversity at the family level are Accipitridae (Hawks), Alaudidae (Hooves) and Anatidae (Ducks) and the most common bird species with a total number of 119 individuals is the Crested Patka (*Aythya fuligula*). Since the research area is located at an altitude of 2700 m, the lakes freeze completely in winter and the area is completely covered with snow. This situation causes the absence of any bird species in the area in winter. Therefore, bird species with winter visitor status could not be detected in the area. Some bird species seen in the wetlands in and around Erzurum have not been seen in this area due to unfavorable ecological reasons, low annual average temperature, lack of a rich diversity in terms of natural vegetation due to frost events lasting from October to the end of May. The activities of migrants, intensive grazing activities and the fact that the area is open to hunting adversely affect the visit of some bird species to the area and stress the birds that visit the area and adversely affect their breeding and feeding activities. The period when the migrants are in the area and grazing activities are intensive coincides with the breeding period of the birds that visit the area; therefore; it poses a great threat to the bird species in the area. Among the birds of prey in the area, Accipitridae (Hawks) family has the highest species diversity compared to other bird species, which again poses a threat to other bird species.

As a solution to these threats;

The nomads in the area and the surrounding villagers should be informed about the importance of the area and the threats that will harm the ecological values of the area. In addition, the grazing activities of the migrants coming to the area during the migration periods of birds and the grazing activities of the surrounding villagers should be gradually reduced, the area, which is a 'general hunting ground', should be declared as a hunting closed area and should be declared as a wetland of local importance. The aim of this study was to determine the ornithological value of Erzurum Geological and Natural Formations protected area, to contribute to conservation efforts, to obtain scientific data on the ornithofauna of the area, and to contribute to the science of ornithology in the light of these data. The findings of this study are expected to have a positive impact on improving the management and legal status of the protected area, as well as contributing to conservation efforts for both the area and the species.

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Applications of Mixed Stock Analysis to Sea Turtles

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Abstract

It is widely recognized that the examination of haplotypes among sea turtles inhabiting nesting beaches holds significant importance. Yet, an effective conservation effort of a population also requires the investigation of where the stranded sea turtles have originated. Genetic studies coupled with Bayesian statistics provide us insight into the origin of sea turtles. DNA is isolated from samples collected from stranded individuals and analysed by polymerase chain reaction (PCR) using appropriate primers. The PCR product is sequenced using Sanger sequencing. The sequences are analysed and haplotypes are determined. Once haplotypes have been obtained, the diversity of these haplotypes can be subjected to Bayesian statistics for Mixed stock analysis (MSA), yielding percentages based on assumptions regarding whether there has been an addition to the existing population. This process aids in determination of whether new individuals have been introduced into a population or the origins of deceased animals found in an area.

Keywords: Bayesian statistics, mtDNA, sea turtle, mixed stock analysis, haplotype

1. INTRODUCTION

Sea turtles are a slow-maturing species and are threatened by numerous and severe anthropogenic pressures (Margaritoulis et al., 2003). These threats include deliberate or by-catch, chemical contaminants, collisions with boats, macroplastics (Margaritoulis et al., 2003; Casale, 2010; Campani et al., 2013; Casale et al., 2015; Casale et al., 2018). For this reason, the conservation of organisms with relatively small populations is particularly important (Hitchings & Beebee, 1997). Genetic studies and haplotype analysis are of great importance in understanding the distribution patterns of migratory marine populations and directing conservation efforts accordingly (Bolten et al., 1998).

In genetic analysis, the use of mitochondrial DNA (mtDNA) is particularly widespread and provides information on ancestry. Haplotype analyses can be performed using the non-coding short and long regions of the mtDNA fragment. Historically, a non-coding mtDNA fragment of about 380 bp has been the most commonly used in Mediterranean studies. However, this short mtDNA fragment provides only limited information on ancestry that cannot be evaluated in detail (Carreras et al., 2007; Casale et al., 2008; Carreras et al., 2011; Garofalo et al., 2013). In subsequent studies, a longer part of the mitochondrial control region (815 bp) was analysed to increase the resolution of the genetic structuring. This approach allows the understanding of origins at a fine-scale (Abreu-Grobois et al., 2006; Shamblin et al., 2012; Clusa et al., 2013). In particular, determining the origins of individuals in foraging areas is crucial for developing effective conservation strategies, as it illuminates the connections between various life stages of the species (Rees et al., 2016; Turkozan et al., 2018). Within this framework, employing Mixed Stock Analysis (MSA) is recommended to determine the origin of individuals in foraging areas (Bowen & Karl, 2007; Bjorndal & Bolten, 2008). Mixed stock analysis recognizes the importance of using a relatively large sample size, which is more likely to contain rare and more informative mtDNA haplotypes, in order to obtain more accurate results. Small sample sizes can reduce the power of the analysis, thereby negatively impacting the reliability of the results (Bolker et al., 2003).

The main objective of this study is to determine the origin of stranded sea turtles, which is critical for the conservation of a population. This method can also be used to analyze the origin of

bycatch, illegally killed and injured turtles. The study also details the use of the Bayesian statistical method to determine the mixed stock structure in the origin determination process.

2. MATERIAL and METHODS

2.1. Sampling and molecular analysis

Tissue samples should be collected from stranded individuals under appropriate conditions. The collected tissue samples should be stored in an appropriate fixative solution until genetic analysis is performed. In general, storage in 70% or 96% ethanol is appropriate.

Molecular analysis begins with the extraction of total DNA using DNA isolation methods. DNA can be extracted using different methods, following the manufacturer's instructions. It is important to check the amount of DNA extracted before proceeding to PCR. DNA levels can be measured using appropriate methods. The Qubit Flex Fluorometer can be used for this purpose.

2.2. Mitochondrial DNA

A fragment of the mtDNA control region is amplified using the polymerase chain reaction. It is important to use appropriately designed primers during the amplification step. For instance, primers LCM15382 (5'-GCTAACCCCTAAAGCATTGG-3') and H950 (5'-TCTCGGATTTTAGGGGTTG-3') are commonly used for *Caretta caretta* (Linnaeus, 1758) (Abreu-Grobois et al., 2006). Common primers for the *Chelonia mydas* (Linnaeus, 1758): Forward CM-D-1 (5'-AGC CCA TTT ACT TCT CGC CAA ACC CC-3') and Reverse CM-D-5 (5'-GCT CCT TTT ATC TGA TGG GAC TGT T-3') (Tikochinski et al., 2012). Many PCR techniques can be used for amplification and it is necessary to choose the most appropriate one. An example of the procedure used to amplify *C. caretta* mtDNA can be found in Clusa et al. (2013); 94 °C for 5 min, followed by 35 cycles of 94 °C for 1 min, 52 °C for 1 min and 72 °C for 90 s, with a final extension period of 72 °C for 10 min. The PCR cycling program that can be used for *C. mydas*: 4 minutes at 94 °C, 30 cycles of 45 seconds at 94 °C, 60 seconds at 62 °C, 1 second at 72 °C and 5 minutes at 72 °C (Tikochinski et al., 2012). The amplification products were then separated by agarose gel electrophoresis in TBE buffer and visualized under UV light.

2.3. Data analysis

Firstly, DNA purification and sequencing of amplification products should be performed. Sanger sequencing can be preferred for this. After sequencing, it is important to align the sequences appropriately and evaluate the gene quality. Alignment and evaluation can be done with SeqScape3 software (Figure 1).

Specific programs are used to edit aligned sequences. An example is BioEdit version 7.2.5 (Hall, 1999). BioEdit software allows sequences to be edited and nucleotide differences to be viewed (Figure 2). Nucleotide differences indicate haplotype differences. Sequences can be uploaded to GenBank BLAST (<http://ncbi.nlm.nih.gov/Blast.cgi>) and compared with existing haplotypes. As a result of this comparison, haplotypes can be determined.

Figure 1. Alignment and quality assessment with SeqScape3 software.

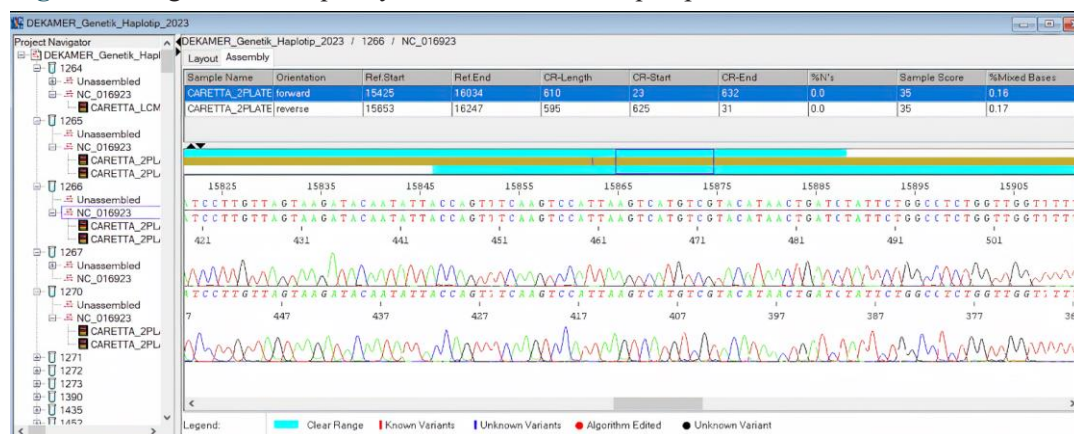
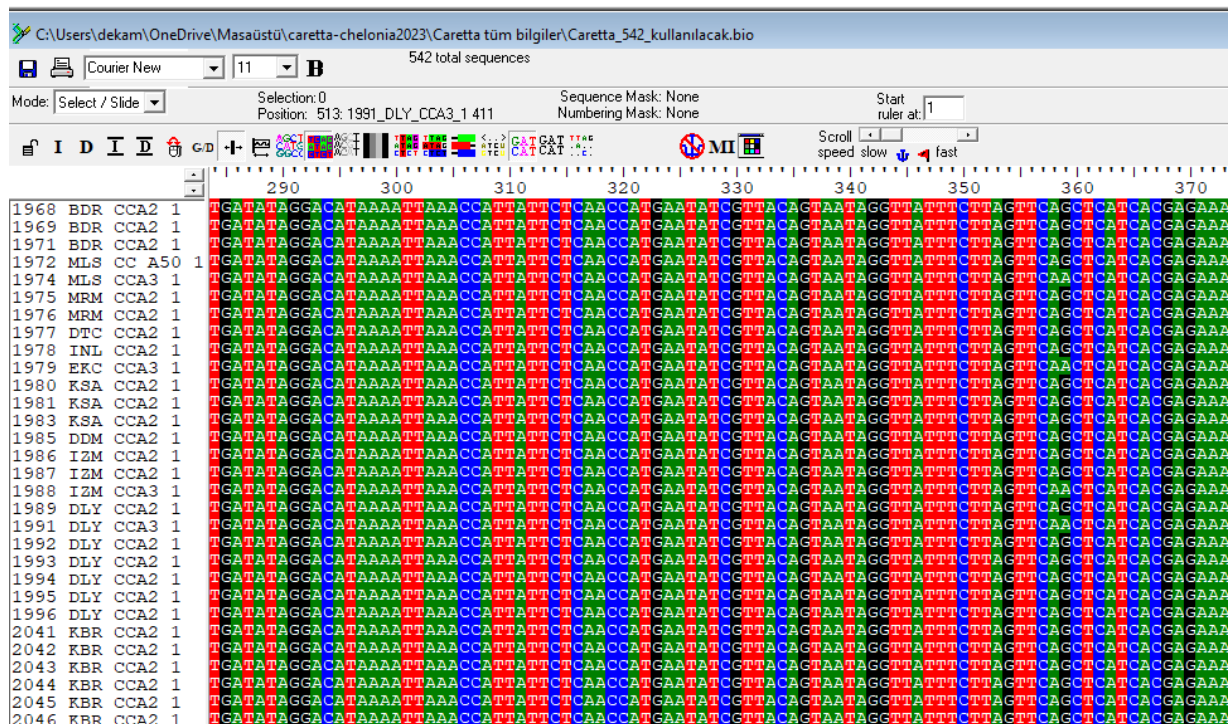


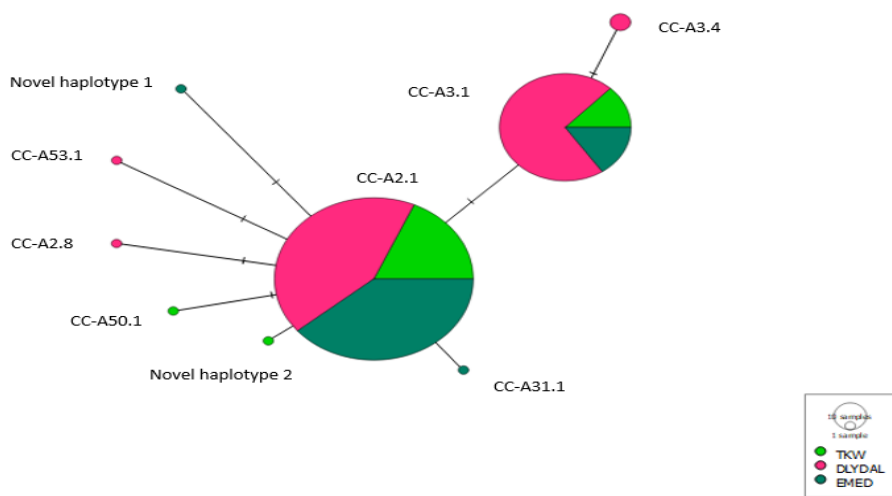
Figure 2. BioEdit software nucleotide differences.



2.4. Haplotype Network Analysis

Haplotype networks help us understand the distribution and relationships among various haplotypes. There are different programs available to create haplotype networks. An example of these is the PopART version 1.7 (Leigh & Bryant, 2015) program. Figure 3 presents a network of mtDNA haplotypes of stranded *C. caretta* from different management units in the Mediterranean from unpublished data from Kaska et al. The size of each circle in the graph corresponds to the sample size of the specific haplotype.

Figure 3. Haplotype network displayed in PopART program.



2.4. Mixed Stock Analysis

Mixed stock analysis is a widely used analytical method for estimating the origin of individuals across different stocks, with the Bayesian statistical method being a common preference in this regard.

The Bayesian method plays an important role in statistical analysis and estimation. Fundamentally, the mixed stock analysis is based on Regional Management Units (RMUs), with a baseline of 10 Atlantic and 13 Mediterranean RMUs. Depending on the assumptions of the analysis, it is also possible to deduct the contribution of Atlantic nests from the established baseline.

The Bayesian method conducts the analyses by extracting a Markov Chain Monte Carlo (MCMC) sample of genetic parameters based on stock proportions. The Bayesian software package consists of three files named BAYES.EXE, LF90.EER and DISDLL.DLL. These three files must be in the directory in which the program is to be run.

The most critical stage in mixed stock analysis is the correct preparation of the input files. There are three basic input files for this analysis: Baseline, Mixed and Control files.

The Baseline File contains haplotype data for the base populations. The Mix File contains data for the mixed populations. The Control File consists of a separate file for each population and allows each chain to be evaluated separately during the analysis.

Initially, the program package and the three files should be in the same folder. In particular, a separate control file should be created for each population. When the "Bayesian" program is started, each control file must be loaded individually and the program is run. The results of the analyses are presented in the summary file, showing the percentage contribution of each population (Table 1).

Table 1. Bayesian statistical result showing the contribution of populations.

Chains combined:

STOCK	MEAN	SD	2.5%	MEDIAN	97.5%	MCMC SAMPLE
Stock Group 1	0.0113	0.0432	0.0000	0.0000	0.1442	32500
Stock Group 2	0.0005	0.0020	0.0000	0.0000	0.0057	32500
Stock Group 3	0.0002	0.0019	0.0000	0.0000	0.0004	32500
Stock Group 4	0.0062	0.0398	0.0000	0.0000	0.0669	32500
Stock Group 5	0.0201	0.0536	0.0000	0.0001	0.2084	32500
Stock Group 6	0.0293	0.0631	0.0000	0.0005	0.2302	32500
Stock Group 7	0.0744	0.0970	0.0000	0.0323	0.3448	32500
Stock Group 8	0.0622	0.1194	0.0000	0.0005	0.4252	32500
Stock Group 9	0.4548	0.2633	0.0000	0.5376	0.8212	32500
Stock Group 10	0.2118	0.3481	0.0000	0.0000	0.9352	32500
Stock Group 11	0.0115	0.0221	0.0000	0.0010	0.0742	32500
Stock Group 12	0.1176	0.0922	0.0002	0.1001	0.3441	32500
Stock Group 13	0.0000	0.0005	0.0000	0.0000	0.0000	32500

3. RESULTS and DISCUSSION

For sea turtle conservation studies, genetic analyses and subsequent mixed-stock analyses utilizing the Bayesian method are important for estimating the origins of individuals (Tolve et al., 2018). Therefore, there is a critical need to expand the number of studies to obtain more information.

In a study examining the rookeries in the Mediterranean, Northwest Atlantic and Cape Verde, Clusa et al. (2014) employed Bayesian methods to estimate contributions of different rookery populations to various foraging areas. The results of the analysis clearly showed that there were significant differences in the relative contributions of Atlantic and Mediterranean hatchlings to each foraging area. For sea turtles of Mediterranean origin, hatchlings from Libya were found to be widespread in foraging areas in the central and western Mediterranean.

The study by Tolve et al. (2018) focuses on the foraging population of *C. caretta* living in the Adriatic region by conducting a mixed stock analysis. Using the Bayesian method, differences in genetic diversity among regions of the Adriatic were identified and the probabilities associated with different

nesting sites contributing to the Adriatic stock were calculated. As a result of the study, nesting sites in Greece and Crete emerged as the main contributors to the Adriatic foraging population.

Türkozan et al. (2018) conducted a mixed stock analysis to determine the origin of *C. caretta* nesting and foraging in the eastern Mediterranean. Utilizing the Bayesian approach, their analysis concluded that the majority of turtles in the foraging area on the Eastern Mediterranean coast of Türkiye originated from nesting populations in western Türkiye, while the origin of foraging *C. caretta* was mainly from Cyprus.

4. CONCLUSION

Mixed stock analysis is a valuable tool for discovering the relative contributions of individual rookeries to particular foraging areas. The analysis of haplotype diversity within sea turtle populations is crucial for effective conservation efforts. However, focusing solely on analyzing the haplotypes of individuals at nesting beaches is insufficient; it is equally critical to investigate the origins of stranded individuals. Determining the origin rookeries of individuals, therefore their haplotypes, is crucial for conservation efforts.

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Histopathological Features and Experimental Approaches in Gastric Ulcer Research

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Abstract

Gastric ulcers are defined as open sores or lesions that develop on the inner lining of the stomach wall. These sores are caused by the erosion of the mucosal barrier by stomach acid, leading to severe pain and discomfort. Symptoms of gastric ulcers include pain, nausea, vomiting, weight loss, bloating, belching, and bleeding. The primary causes of ulcers are *Helicobacter pylori* infection, nonsteroidal anti-inflammatory drugs (NSAIDs), excessive stomach acid production, and the use of tobacco and alcohol.

The histopathology of gastric ulcers involves mucosal damage and necrosis, inflammation, vascular changes, fibrosis, scarring, and microscopic findings of *Helicobacter pylori* infection. Experimental methods for inducing gastric ulcers in rats include stress, chemical agents, physical methods, and bacterial infections. Specifically, NSAID-induced gastric ulcer models are explained by mechanisms such as inhibition of prostaglandin synthesis, increased gastric acid and pepsin, decreased mucosal blood flow, reduced mucus and bicarbonate secretion, and direct mucosal toxicity. Gastric ulcers are a significant health concern caused by various factors and mechanisms. Experimental rat models provide essential insights into the pathophysiology and treatment strategies for gastric ulcers. These models offer valuable information for treating and preventing gastric ulcers in humans. Detailed examination of the mechanisms by which NSAIDs induce gastric ulcers can aid in developing strategies for the safe use of these drugs.

Keywords: Gastric ulcers, experimental models, histopathology, NSAIDs

1. INTRODUCTION

The stomach is a vital organ in the digestive system, responsible for the chemical and mechanical digestion of food (1). It consists of four main layers: mucosa, submucosa, muscularis, and serosa (2). A stomach ulcer is an open wound or lesion that develops on the inner surface of the stomach wall due to stomach acid eroding the mucosal barrier (3). These sores usually worsen when they come into contact with stomach acid and can cause serious discomfort.

Symptoms of ulcers include pain, nausea, vomiting, weight loss, bloating and belching, and bleeding (3). Causes include *Helicobacter pylori* infection, nonsteroidal anti-inflammatory drugs (NSAIDs), excessive stomach acid production, smoking, and alcohol use (4).

Histopathology examines the structural changes and damage to the stomach mucosal layer, providing detailed information about the formation, progression, and healing process of the ulcer (5). The histopathology includes erosion and ulceration, necrosis, inflammation, vascular changes, fibrosis, scarring, and bacterial colonization (6).

Erosion and ulceration in the gastric mucosa are indicative of mucosal damage, beginning at the surface and resulting in the loss of epithelial cells. As the damage progresses, it extends into the submucosa and deeper layers (7). In the ulcerated area, cell necrosis occurs, with necrotic tissue situated at the base of the ulcer crater, surrounded by inflammatory cells. The acute inflammatory response in the ulcer region is characterized by a dense infiltration of inflammatory cells, including polymorphonuclear leukocytes (PMNs) and macrophages, which migrate to the site in response to the necrotic tissue (8).

In chronic ulcers, the predominance of lymphocytes, plasma cells, and fibroblasts is indicative of chronic inflammation. Granulation tissue develops at the base and margins of the ulcer. Edema and minor hemorrhages may be observed in the ulcer area as a consequence of inflammation. The proliferation of new capillaries within the ulcer region, as part of the granulation tissue, marks an essential component of the healing process (8, 9).

During the ulcer healing process, fibroblasts become activated and begin producing collagen, leading to fibrosis and the formation of scar tissue at the ulcer site. Healed ulcers are typically covered with fibrotic scar tissue, which replaces the normal mucosal structure (8, 10).

In patients with *Helicobacter pylori* infection, the bacteria are often localized at the ulcer margins and adjacent mucosal regions, contributing to mucosal inflammation and damage. Microscopically, *H. pylori* can be detected through silver staining or immunohistochemistry techniques, providing critical insights into the underlying pathology (11, 12).

Gastric ulcer formation in rats can be triggered by various chemical, physical, and pharmacological methods. Stress-induced ulcers are caused by cold-compression stress, while chemically induced ulcers involve high concentrations of ethanol and acid/pepsin. Nonsteroidal Anti-inflammatory Drugs (NSAIDs) like ibuprofen and indomethacin can cause damage and ulcer formation by inhibiting prostaglandin synthesis. Physically induced ulcers can be caused by surgical procedures like vagotomy that increase stomach acidity and promote ulcer development. *Helicobacter pylori* infection can also trigger inflammation and ulcer formation in the gastric mucosa (13-15).

NSAIDs inhibit cyclooxygenase (COX) enzymes, reducing prostaglandin production, leading to damage to the gastric mucosa. These mechanisms include inhibiting prostaglandin synthesis, increasing gastric acid and pepsin, decreasing mucosal blood flow, reducing mucus and bicarbonate secretion, and direct mucosal toxicity (16). Topical irritation, cell membrane disruption, mitochondrial dysfunction, and neutrophil-mediated damage are some of the mechanisms NSAIDs can cause (17).

Topical irritation can cause immediate damage to epithelial cells, initiating ulceration. Cellular membrane disruption compromises the mucosal barrier's integrity, making it more susceptible to acid and pepsin-induced damage. Mitochondrial dysfunction in gastric mucosal cells can lead to oxidative stress and apoptosis, further contributing to the breakdown of the mucosal barrier and ulcer formation. Neutrophil-mediated damage can induce neutrophil adherence to the vascular endothelium, releasing reactive oxygen species and proteases, exacerbating the ulceration process (17, 18).

2. DISCUSSION

Gastric ulcers represent a significant medical challenge, primarily driven by the erosion of the mucosal barrier due to factors such as *Helicobacter pylori* infection, NSAID use, and excessive gastric acid production. The histopathological features of these ulcers, including mucosal damage, inflammation, vascular changes, and bacterial colonization, offer critical insights into the disease's progression and potential therapeutic targets. Experimental models in rats have been invaluable in elucidating the underlying mechanisms of gastric ulcer formation, particularly those induced by NSAIDs.

Understanding the pathophysiology of NSAID-induced gastric ulcers has highlighted the multifaceted damage these drugs can inflict on the gastric mucosa, including the inhibition of prostaglandin synthesis, increased gastric acid secretion, and direct mucosal toxicity. The insights gained from these studies are crucial for developing safer therapeutic strategies that minimize the gastrointestinal risks associated with NSAID use while preserving their anti-inflammatory benefits.

3. CONCLUSION

The detailed study of gastric ulcer pathogenesis through histopathological examination and experimental models not only advances our knowledge of the disease but also paves the way for more effective treatments and preventive measures. Continued research in this area is essential for improving patient outcomes and enhancing the safety profiles of commonly used medications like NSAIDs.

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Some differences in the setal structures of *Eustigmaeus aminiae* (Acariformes: Stigmaeidae) in Türkiye

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Abstract

In the present work, seven adult female specimens identified as *Eustigmaeus aminiae* (Nazari and Khanjani) previously collected from Sansa Gorge were examined. During the examination of the specimens collected, some morphological differences in their some setae were found. In addition, adult female specimens collected from Sansa Gorge were briefly described here, with some comparative illustrations.

Keywords: Mite, *Eustigmaeus*, Morphology, Sansa, Variation

1. INTRODUCTION

The family Stigmaeidae (Acari: Raphignathoidea) currently comprises over 640 species in 33 valid genera (Fan *et al.* 2016, 2019; Beron 2022; Khaustov *et al.* 2023; Doğan *et al.* 2024; Doğan and Doğan 2024). The genus *Eustigmaeus* Berlese is one of the mite genera in the family, with 140 known species in the world (Fan *et al.* 2016, 2019; Beron 2020, 2022; Bagheri and Mohammad-Doustaresharaf 2024; Doğan *et al.* 2024; Doğan and Doğan 2024). By now, 33 species of this genus have been reported from Türkiye (Doğan 2019; Doğan and Doğan 2020a, 2024; Doğan *et al.* 2024).

Adult female of *Eustigmaeus aminiae* (Nazari and Khanjani) is characterised by: dorsal idiosoma with punctures and its anterior and lateral margins bearing pits, metapodosomal and opisthosomal shields incompletely separated, humeral shields anteriorly divided, palp tibial accessory claw seta-like, coxisternal shields fused along the midline, aggenital shield with three pairs of setae, femora I and II with 6 and 4 setae respectively, genua I and II each bearing 3 (+1κ) setae (Nazari and Khanjani 2017; Doğan and Doğan 2020b; Doğan *et al.* 2021).

During the examination of the Turkish specimens of *E. aminiae*, collected from Sansa Gorge, some morphological differences in their some setae were found. This study aimed to provide new data on the variations observed in *E. aminiae*.

2. MATERIAL and METHODS

The mite specimens were extracted by using Berlese-Tullgren funnels, cleared in 60% lactic acid and mounted on microscopic slides in Hoyer's medium. The specimens of *E. aminiae* were examined and illustrated by using a Leica DM 4000B phase-contrast microscope. The measurements were taken in micrometers (µm) with the aid of the Leica Application Suite (LAS) Software Version 3.8. Mean values of the measurements were given first and the ranges were given in parenthesis. Dorsal and leg setal designations follow Kethley (1990) and Grandjean (1944, 1946), respectively. Specimens examined were deposited in EBYU (Acarology Laboratory of Erzincan Binali Yıldırım University, Erzincan, Türkiye).

3. RESULTS and DISCUSSION

Superfamily: Raphignathoidea Kramer

Family: Stigmaeidae Oudemans

Genus: *Eustigmaeus* Berlese

***Eustigmaeus aminiae* (Nazari and Khanjani)**

Ledermuelleriopsis aminiae Nazari and Khanjani, 2017: 194.

Ledermuelleriopsis aminiae Nazari and Khanjani: Fan *et al.*, 2019: 91; Doğan and Doğan, 2020b: 226; Doğan *et al.* 2021: 456.

Ledermuelleriopsis aydinensis Akyol and Gül, 2019: 16 (syn. by Doğan *et al.*, 2021).

Eustigmaeus aminiae (Nazari and Khanjani): Doğan and Doğan, 2024: 728; Erman *et al.*, 2024: 88.

Figure 1. Dorsal view of *Eustigmaeus aminiae* (Female) – A. The Sansa specimens, B. The specimens previously known from Türkiye (scale bar 100 µm)

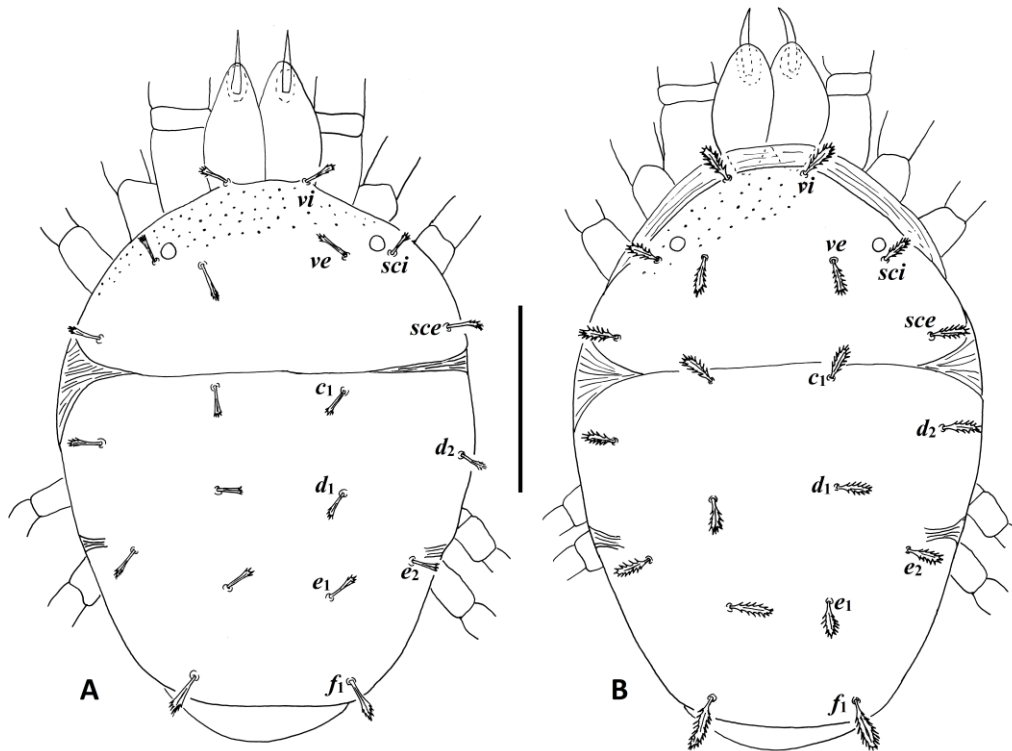


Figure 2. Dorsal setae of *Eustigmaeus aminiae* (Female) – A. The Sansa specimens, B. The specimens previously known from Türkiye (scale bar 40 µm)

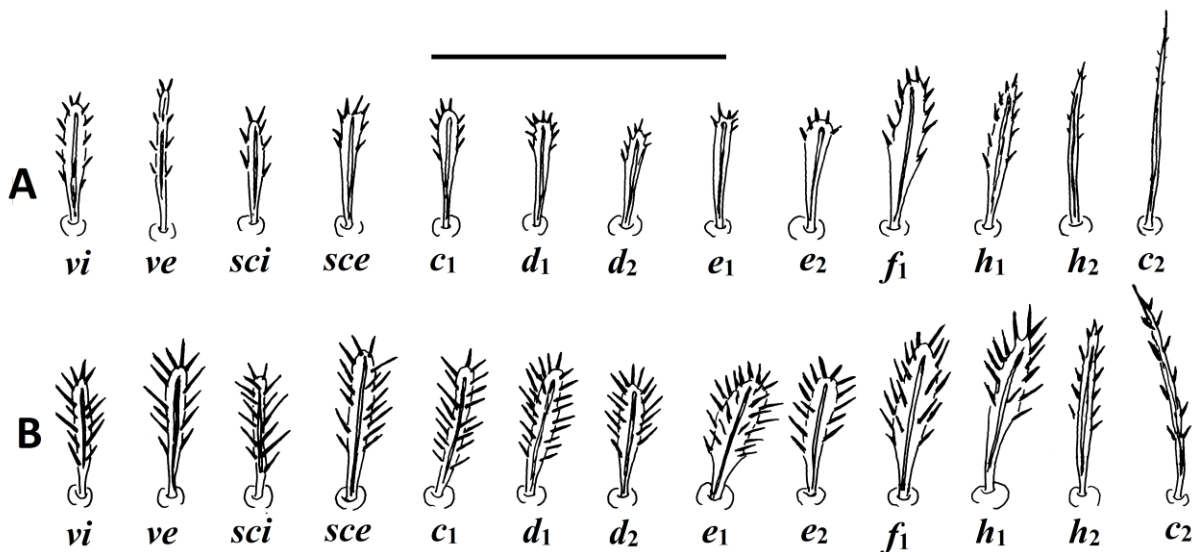
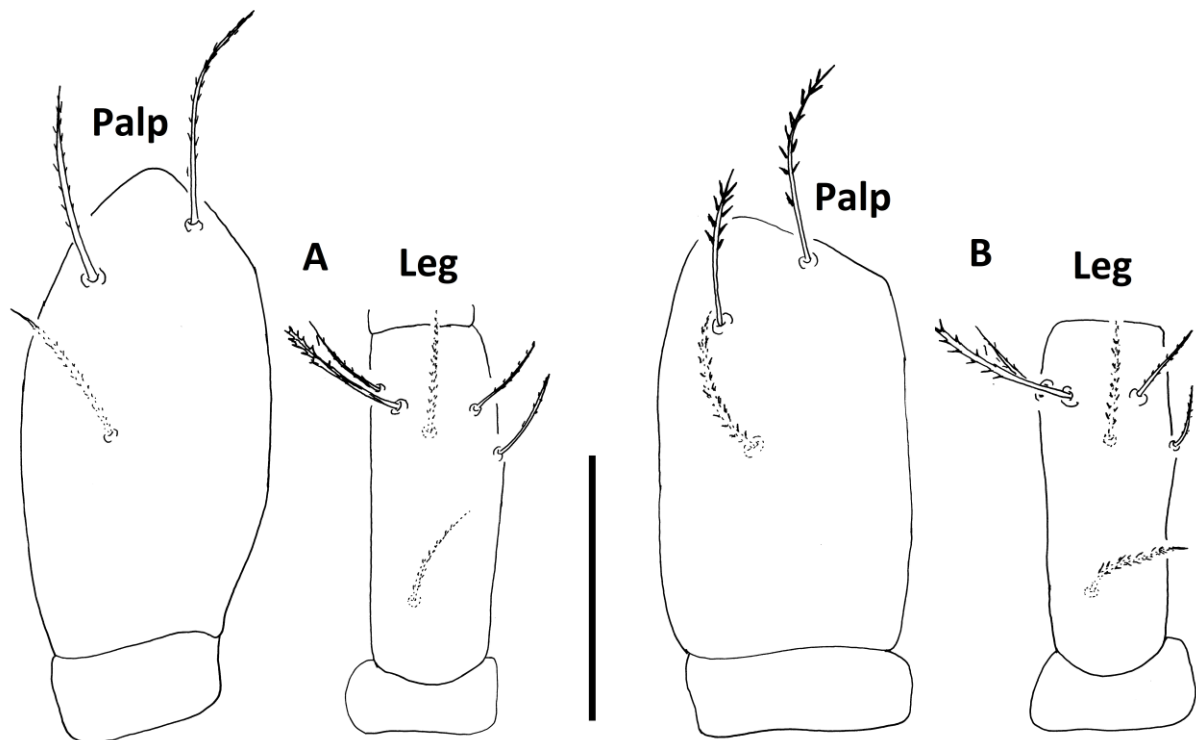


Figure 3. Palp and leg femur of *Eustigmaeus aminiae* (Female) – A. The Sansa specimens, B. The specimens known from Türkiye (scale bar 40 µm)



Description

Female (Figures 1-3).

Length of body 301 (281-310), width 227 (211-234).

Dorsum of body (Fig. 1A). Side anterior and lateral of idiosoma with pits. Propodosomal shield carrying setae *vi*, *ve*, *sci* and a pair of eyes. Eyes 8 (7-9) in diameter. Metapodosomal and opisthosomal shields partially separated. Setae *c*₁, *d*₁, *d*₂ on the metapodosomal shield, opisthosomal shield bearing setae *e*₁, *e*₂, *f*₁. Suranal shield with two pairs of setae (*h*_{1,2}). All dorsal setae barbed distally and slightly widened except suranal setae (*h*_{1,2}) pointed and barbed (Fig. 2A). Lengths and distances of dorsal setae as follows: *vi* 18 (16-19), *ve* 20 (19-21), *sci* 15 (14-16), *sce* 18 (17-19), *c*₁ 17 (16-17), *c*₂ 28 (27-30), *d*₁ 15 (14-16), *d*₂ 15 (14-16), *e*₁ 16 (15-17), *e*₂ 14 (14-15), *f*₁ 22 (21-23), *h*₁ 21 (19-22), *h*₂ 20 (19-21), *vi-vi* 42 (41-43), *ve-ve* 88 (76-104), *vi-ve* 42 (41-43), *sci-sci* 130 (128-132), *ve-sci* 24 (23-26), *sce-sce* 191 (188-193), *sci-sce* 49 (46-51), *c*_{1-c}₁ 67 (63-71), *d*_{2-d}₂ 193 (189-199), *c*_{1-d}₁ 57 (54-62), *c*_{1-d}₂ 72 (70-73), *d*_{1-d}₁ : 70 (68-73), *d*_{2-d}₁ 67 (66-69), *e*_{2-e}₂ 155 (152-159), *d*_{2-e}₂ 61 (60-62), *d*_{1-e}₁ 53 (51-59), *d*_{1-e}₂ 50 (49-53), *e*_{1-e}₁ 59 (57-61), *e*_{2-e}₁ 49 (48-51), *f*_{1-f}₁ 79 (78-81), *e*_{1-f}₁ 46 (45-47), *e*_{2-f}₁ 75 (73-77), *h*_{1-h}₁ 38 (36-39), *h*_{2-h}₂ 78 (77-80), *h*_{1-h}₂ 21 (20-21).

Venter of body. Humeral shields situated ventro-laterally. Setae *c*₂ on the humeral shields and pointed, spiny. Coxisternal shields undivided and bearing three pairs of intercoxal setae (1*a*, 3*a* and 4*a*). Three pairs of aggenital setae (*ag*₁₋₃) present on the aggenital shield. Anal shields bearing three pairs of pseudanal setae (*ps*₁₋₃). Lengths and distance of these setae: 1*a* 13 (12-15), 3*a* 12 (11-13), 4*a* 10 (10-11), 1*a*-1*a* 24 (23-25), 3*a*-3*a* 38 (35-41), 4*a*-4*a* 26 (25-27), *ag*₁ 9 (9-10), *ag*₂ 9 (9-10), *ag*₃ 9 (9-10), *ps*₁ 16 (15-17), *ps*₂ 15 (14-16), *ps*₃ 12 (11-13).

Gnathosoma. 73 (69-76), chelicerae 93 (92-94), palp 112 (111-113) long (Fig. 3A). Lengths and distance between subcapitular setae, *m* 10 (9-10), *n* 10 (10-11), *m-m* 17 (16-18), *n-n* 24 (23-25), *m-n* 11 (10-11).

Legs. Leg I 172 (167-179) (Fig. 3A), leg II 132 (130-137), leg III 140 (133-148), leg IV 158 (151-166) long. Counts of setae on legs I-IV: coxae 2–2–2–2, trochanters 1–1–2–1, femora 6–4–3–2, genua 3(+1κ)–3(+1κ)–1–1, tibiae 5(+1φρ+1φ)–5(+1φρ)–5(+1φρ)–5(+1φρ), tarsi 13(+1ω)–9(+1ω)–7(+1ω)–7.

Specimens examined. Seven females from litter and soil under *Juniperus oxycedrus*, Pelitli village, Sansa Gorge, Türkiye, 39°35'36.3"N 39°56'45.9"E, 1436 m a.s.l., 6 June 2020, coll. Salih Doğan.

Remarks

Eustigmaeus aminiae (Nazari and Khanjani), was firstly described from Iran, and it was later recorded from Türkiye (Nazari and Khanjani 2017; Fan *et al.* 2019; Akyol and Gül 2019; Doğan and Doğan 2020b, Doğan *et al.* 2021). In Türkiye, this species was firstly recorded from Aydın (as *Ledermuelleriopsis aydinensis*) (Akyol and Gül 2019) and then from Pülümür Valley (Tunceli) and Sansa Gorge (Doğan and Doğan 2020b; Doğan *et al.* 2021).

The Aydın and Pülümür specimens of the species are morphologically very similar to Iranian specimens. However, when seven of the female specimens previously collected from the Sansa Gorge and identified as *E. aminiae* were compared with the type specimens based on the original literature and other known specimens from Türkiye, it was observed that all of the specimens examined had some differences in setae structures compared to other specimens of this species. The dorsal body setae (Figs 1A, 2A), palp and leg setae (Fig. 3A) of the examined specimens were thinner than those of the other specimens (Figs 1B, 2B, 3B). Also, some dorsal body setae of the specimens examined are barbed only near the tip of the setae, whereas the setae are barbed almost all sides in the type specimens and other known specimens from Türkiye (Fig. 2). It is reasonable to posit that the Sansa specimens may represent a new species, given the notable divergence in their setae. However, to designate it as such, additional characters would be required. Genetic and molecular studies are essential to elucidate the taxonomic status of this species. Until a molecular analysis is conducted, these differences in setae structure have been interpreted as intraspecific variation.

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Determination of Some Biological Activities of Methanol and Ethanol Extracts of *Picnomon acarna* (L.) Cass.

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Abstract

Picnomon acarna (L.) Cass. is a plant belonging to the Asteraceae family within the Asterales order. Phenolic compounds are main metabolites found in plants. Due to its presence in plants, phenolic compounds has led to numerous studies and has been considered a good biological agent due to its antioxidant, anti-inflammatory, antidiabetic, and antitumor activities evaluated both in vitro and in vivo. It is known that the secondary metabolites found in the *Picnomon acarna* plant contribute to the plant's antioxidant, antimicrobial, and anthelmintic activities. In this study, the antioxidant, antimicrobial, and anthelmintic activities of the plant's aboveground ethanol and methanol extracts were investigated, and substance quantification experiments were conducted. In order to determine the properties of the plant tested in the study, total tannin content, flavonoid content and total phenolic content were examined. The antioxidant activities were determined by FRAP, CUPRAC, DPPH and ABTS assays. The antimicrobial activities were evaluated by the disc diffusion method and by determining the Antibiotic Sensitivity. *Staphylococcus aureus* ATCC 6538/P, *Bacillus cereus* CCM 99, *Escherichia coli* ATCC 35218, *Pseudomonas aeruginosa* ATCC 27853 and *Candida albicans* test microorganisms were used for antimicrobial and antifungal activity and antibiotic resistance tests. Ampicillin (APX), Erythromycin (E), Streptomycin (S), Ceftriaxone (CRO), Chloramphenicol (C) and Nystatin (NY) antibiotics were used to test the resistance levels of bacteria. In this study, the tannin content in aerial methanol and ethanol extracts of *P. acarna* was found to be 3.43 ± 0.03 mg CEs/g and 1.91 ± 0.09 mg CEs/g, respectively. Different experiments (FRAP, CUPRAC, DPPH, and ABTS) were conducted to assess the antioxidant activities of the extracts. When compared, aerial methanol and ethanol extracts exhibited different reduction capacities in the FRAP (Ferric Ion Reducing Antioxidant Power) and CUPRAC (Cupric Ion Reducing Antioxidant Capacity) assays. Methanol extract showed higher reduction capacity than ethanol extract in the FRAP and CUPRAC assays. Antibacterial and Antifungal Activity Analyzes are observed that the methanol extract of *P. acarna* does not exhibit an effect on gram-positive bacteria. However, the ethanol extract of *P. acarna* is more effective against gram-negative bacteria compared to gram-positive bacteria. Considering the study results, it was found that the ethanol extract was effective in antimicrobial activity and flavonoid experiments, while the methanol extract was more effective in antioxidant, tannin, phenolic, and anthelmintic experiments. In light of this information, the *P. acarna*, the plant can provide significant contributions to research and medical applications due to its biological activities and chemical components.

Keywords: Secondary metabolites, Plant extracts, Antimicrobial, Antioxidant, Phenolics

1. INTRODUCTION

Plants have played a significant role in the development of medicine for a long time due to their capacity to synthesize potentially important secondary metabolites. Plant-derived medicines used in traditional medicine have garnered close attention due to their easy availability, low cost, and minimal side effects (Cathrine L. et al., 2010). *Picnomon acarna* is an annual herbaceous plant in the Asteraceae family, also known as soldier thorn. It is widespread in the Mediterranean, Caucasus, Iran, Iraq, and Afghanistan regions (Zand et al. 2009). It is an annual herb that grows up to 50 cm and has 10 to 15 mm long yellow spines on its leaves (Assadi et al., 1989). It is also known that it is not consumed by living creatures, and *Picnomon acarna* is known to be a more serious weed than other weeds in fields and uncultivated grasslands (Mirdavoodi et al. 2013). Most of the members of the Asteraceae family have therapeutic applications and have been used in traditional medicine for many years. Some members of the Asteraceae family have been cultivated for edible and medicinal purposes for more than 3000 years (J. Achika et al. 2014). Despite the potential of plants belonging to the Asteraceae family as sources of

antimicrobial and antioxidant agents, the bioactivity of some Asteraceae family species has not yet been investigated. Numerous phytochemicals found in plants are effectively consumed to treat various diseases. The World Health Organization has identified globally used medicinal plants and categorized them into more than 20,000 species. Most medicinal plant parts can be consumed as crude drugs due to their various medicinal effects (Mahesh B. et al., 2009).

In stress conditions such as extreme temperatures, drought, heavy metals, nutrient deficiencies, and high salinity for plants, they produce high concentrations of reactive oxygen species (ROS) that can cause oxidative stress. To prevent this, cells have a complex antioxidant system consisting of enzymatic and non-enzymatic elements. Among these systems, compounds derived from secondary metabolism, especially phenolic compounds, play a fundamental role against oxidative stress. It is known that these compounds act as antioxidants not only because of their ability to donate hydrogen or electrons, but also because they are stable radical intermediates. Phenolic compounds also have protective effects on humans when plants are consumed as food (Barua, C., et al. 2014; Pang Y., et al. 2018). Phenolic compounds are one of the main classes of secondary metabolites in plants. At low concentrations, they act as antioxidants and protect food from oxidative stress (Karakaya et al. 2004). The antioxidant capacity of phenolic compounds depends on the number and arrangement of hydroxyl groups in the required molecules. Many phenolic compounds are an important part of the human diet and are also used medicinally. Most of the protective effects of phenolic compounds on health have been attributed to their antioxidant, anticancer, antimutagenic, antimicrobial, anti-inflammatory and other biological properties. The most common plant phenolic compounds are phenolic acids, flavonoids, tannins, lignans, and terpenes (Nazck and Shahidi 2006; Shahidi and Ambigaipalan 2015). Phenolic compounds are plant secondary metabolites that occur in almost all plant materials, including plant food products.

The treatment of diseases caused by microorganisms has been a major problem for humanity since ancient times. Antimicrobial agents are drugs used in the treatment of infections caused by bacteria, viruses, fungi, and other microorganisms. However, in recent years, the widespread prevalence of antimicrobial-resistant microorganisms has reduced the effectiveness of drugs used in the treatment of infections (Spellberg B. et al., 2008). Plants, which have traditionally been a source of antimicrobial compounds, continue to be highly effective against microbial infections. However, Antimicrobial resistance (AMR) the ability of microorganisms to resist antimicrobials is a significant infectious health problem in EU/EEA (European Union/European Economic Area) countries and is one of the major concerns in public health. Unconscious use of antibiotics in hospitals and inadequate infection prevention and control contribute significantly to the development of AMR (OECD, 2019). Despite the potential of *Asteraceae* family plants as sources of antimicrobial and antioxidant agents, the bioactivities of some species of the *Asteraceae* family have not yet been investigated. This study reports the in vitro antimicrobial, substance quantity determination, and antioxidant properties of ethanol and methanol extracts from the *Asteraceae* family's *P. acarna* species.

2. MATERIAL and METHODS

2.1. Plant Material and Extraction

P. acarna specimens were collected from Muğla province (37.156023, 28.359691, 300m, Gülagzı, Mentese) in June 2022, and taxonomic identification was performed by Dr. Olcay CEYLAN (Muğla Sıtkı Koçman University, Turkey). The collected samples were dried at room temperature in a shaded area for extraction. Dried samples were extracted with methanol and ethanol solvents at 50°C for 6 hours in a water bath. After filtration, the solvents, methanol, and ethanol were removed using a lyophilizer. The obtained crude extracts were stored at -20°C (Mammadov et al., 2011).

2.2. Determination of Total Phenolic, Flavonoid, and Tannin Contents of Extracts

The total phenolic contents of *P. acarna* methanol and ethanol extracts were determined according to the method described by Singleton and Rossi (1965) and expressed as gallic acid equivalents (mg GAE/g extract). The total flavonoid contents of the extracts were determined according to the method by Aryal et al. (2019) and expressed as quercetin equivalents (mg QE/g

extract). The determination of total tannin content in the extracts was carried out according to the method by Bekir et al. (2013) and expressed as catechin equivalents (mg CEs/g extract).

2.3. Determination of Antioxidant Activity

The antioxidant activity of the extracts was determined using the ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) radical scavenging activity method developed by Re et al. (1999) and the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging activity method according to the procedure by Turan and Mammadov (2018). The IC₅₀ values (half-maximal inhibitory concentration) for DPPH and ABTS experiments were calculated. The FRAP (ferric reducing antioxidant power) assay was calculated according to the method by Benzie and Strain (1996), while the CUPRAC (cupric reducing antioxidant capacity) assay was calculated according to the method by Apak et al. (2004). The results of the FRAP and CUPRAC assays were expressed as Trolox equivalents (mg TE/g extract).

2.4. Antibacterial and Antifungal Activity Testing

Testing for antibacterial and antifungal activity is crucial in various fields, especially in medicine, to identify substances that can inhibit or kill pathogenic bacteria and fungi. Such tests form the basis for the development of new antibiotics or antifungal agents. For reliable results, these tests should be performed under standard conditions, typically according to guidelines provided by organizations such as the Clinical and Laboratory Standards Institute (CLSI) or the European Committee on Antimicrobial Susceptibility Testing (EUCAST). Finally, it is important to remember that in vitro test results may not always directly translate to in vivo efficacy due to various factors such as the absorption, distribution, metabolism, and excretion of the drug in living organisms.

2.4.1. Disk Diffusion Assay

The antibacterial activity of *P. acarna* methanol and ethanol extracts was tested using the paper disk diffusion technique (Collins and Lyne, 1987; Bradshaw, 1992; Karaalp et al., 2009; Kaya et al., 2010). The extracts were dissolved in 10% DMSO and then impregnated onto sterile filter paper disks (6 mm diameter, Schleicher & Schüll, Nr 2668, Dassel, Germany) to achieve a final concentration of 300 µg/disk for each extract. To obtain a standard inoculum, the turbidity of bacteria and fungi was prepared according to the McFarland 0.5 scale, and 0.1 mL of each test organism was inoculated onto Mueller-Hinton Agar plates using a Drigalski spatula. Sterile disks impregnated with different extracts were then placed on the plates. Plates prepared for antibacterial activity were incubated at 37 ± 0.1 °C for 24 hours, while plates prepared for antifungal activity were incubated at 25 ± 0.1 °C for 48 hours. The inhibition zones (mm) against test organisms for antibacterial and antifungal activities were measured and evaluated. All experiments were conducted in duplicate under sterile conditions. Erythromycin, Ampicillin, and Nystatin (Oxoid) (10 mg/disc) were used as positive controls, while DMSO was used as a negative control.

2.4.2. Antibiotic Sensitivity Test

The antibiogram test is a laboratory method used to determine the sensitivity or resistance of a microorganism to specific antibiotics. This test helps identify which antibiotics the microorganism causing an illness is sensitive to. The antibiogram test method, showing inhibition zones of plant extracts against different antibiotics, was adapted from Çinar (2018). After incubation, the presence of an inhibition (suppression) zone where the microorganism did not grow around each antibiotic disk was observed. If the microorganism does not grow around an antibiotic disk, it means that the microorganism is sensitive to that antibiotic. If growth is not suppressed, it indicates resistance of the microorganism to that antibiotic. Different antibiotics were used to test the resistance levels of bacteria, including Ampicillin (APX),

Erythromycin (E), Streptomycin (S), Ceftriaxone (CRO), Chloramphenicol (C), and Nystatin (NY). The antibiogram test can vary over time due to microorganisms developing resistance. Therefore, performing such a test is recommended, especially for recurrent or treatment-resistant infections.

2.5. Determination of Antihelminthic Activity

The antihelminthic activities of the extracts were performed according to the method described by Dutta et al. (2012). Tubifex tubifex (Annelida) measuring 1-2 cm in size was used in the study. Different concentrations (2.5-20 mg/mL) of the extracts dissolved in distilled water were transferred to petri dishes (20 ml per dish), and six worms were added to each dish. Albendazole (20 mg/mL) was used as a reference standard. The mobility of the worms was evaluated. After a certain period, petri dishes containing immobile worms were vigorously shaken, and paralysis and death times were recorded based on their movement capability.

2.6. Statistical Analysis

Antimicrobial and antifungal activity experiments were performed in duplicate.

3. RESULTS and DISCUSSION

3.1 Total Phenolic, Total Flavonoid, and Tannin Contents of Extracts

In this study, the tannin content in aerial methanol and ethanol extracts of *P. acarna* was found to be 3.43 ± 0.03 mg CEs/g and 1.91 ± 0.09 mg CEs/g, respectively. The total phenolic content was found to be 4.49 ± 0.44 mg GAE/g and 2.33 ± 0.05 mg GAE/g, respectively, while the total flavonoid content was found to be 5.35 ± 0.13 mg QE/g and 6.57 ± 0.12 mg QE/g, respectively. The substance quantity contents were found to be higher in the methanol extract except for the flavonoid assay. (Table 1).

Table 1. Substance Quantity Determination Results of *P. acarna* Plant Extracts

Plant Extracts	Tannin (mg CEs/g)	Total Phenolic (mg GAE/g)	Total Flavonoid (mg QE/g)
<i>P. Acarna</i> Methanol	$3,43 \pm 0,03$	$4,49 \pm 0,44$	$5,35 \pm 0,13$
<i>P. Acarna</i> Ethanol	$1,91 \pm 0,09$	$2,33 \pm 0,05$	$6,57 \pm 0,12$

3.2 Antioxidant Activities of Extracts

Different experiments (FRAP, CUPRAC, DPPH, and ABTS) were conducted to assess the antioxidant activities of the extracts (Table 2).

Table 2. Antioxidant Activity Results of *P. acarna* Plant Extracts

Plant Extracts	FRAP (mgTE/mL)	CUPRAC (mgTE/mL)	ABTS (IC50,mg/mL)	DPPH (IC50,mg/mL)
<i>P. Acarna</i> Methanol	$1,09 \pm 0,03$	$0,93 \pm 0,004$	$0,21 \pm 0,014$	$1,24 \pm 0,02$
<i>P. Acarna</i> Ethanol	$0,94 \pm 0,06$	$0,53 \pm 0,014$	$0,18 \pm 0,003$	$0,91 \pm 0,03$
BHA	-	-	$0,018 \pm 0,01$	$0,18 \pm 0,01$

-; not tested

When compared, aerial methanol and ethanol extracts exhibited different reduction capacities in the FRAP (Ferric Ion Reducing Antioxidant Power) and CUPRAC (Cupric Ion Reducing Antioxidant Capacity) assays. Methanol extract showed higher reduction capacity

than ethanol extract in the FRAP and CUPRAC assays. However, in the DPPH (2,2-diphenyl-1-picrylhydrazyl) and ABTS (2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)) radical scavenging assays, aerial ethanol extract demonstrated higher scavenging activity compared to aerial methanol extract.

3.3. Antibacterial and Antifungal Activity Analyses

It is observed that the methanol extract of *P. acarna* does not exhibit an effect on gram-positive bacteria. However, the ethanol extract of *P. acarna* is more effective against gram-negative bacteria compared to gram-positive bacteria. Studies suggest that gram-negative bacteria are more resistant to antibiotics compared to gram-positive bacteria. This is attributed to the thicker peptidoglycan layer in the outer membrane of gram-positive bacteria. Nevertheless, despite the presence of the outer membrane, periplasmic space, and peptidoglycan structure in gram-negative bacteria, the effectiveness of the ethanol extract of *P. acarna* on gram-negative bacteria enhances the value of the study. The ethanol extract of *P. acarna* was shown to be more effective than the methanol extract against all bacteria tested. It was found that *C. albicans* exhibited greater sensitivity with an inhibition zone (0.9 ± 0.00 mm) and MIC value (32 ± 0.00 $\mu\text{g/mL}$) compared to all tested bacteria (Table 3).

Table 3. Disc Diffusion Results of *P. acarna* Extracts. Antibacterial and antifungal activity of ethanolic extracts of *P. acarna* by disk diffusion method. Amp.: Ampicillin (10 mg), Eritres.: Erythromycin (10 mg), Nys: Nystatin (30 $\mu\text{g/disc}$), DMSO: Dimethyl sulfoxide, Eth.: Ethanol. The values (average of the two repetitions) indicate the zone of inhibition in mm and include the filter paper disc diameter (6 mm); G: gram reaction; "0": no blocking

Microorganisms	<i>P. acarna</i> Ethanol	<i>P. acarna</i> Methanol	Erythromycin	Ampicillin	Nystatin	DMSO
<i>Staphylococcus aureus</i> ATCC 6538/P	12 mm	8 mm	28 mm	21 mm	*	-
<i>Bacillus cereus</i> CCM 99	14 mm	10 mm	32 mm	24 mm	*	-
<i>Escherichia coli</i> ATCC 35218	14 mm	8 mm	36 mm	27 mm	*	-
<i>Pseudomonas aeruginosa</i> ATCC 27853	14 mm	11 mm	32 mm	11 mm	*	-
<i>Candida albicans</i> ATCC 10239	10 mm	9 mm	*	*	22 mm	-

DMSO: Dimethyl sulfoxide, - : zone diameter was not observed, *: not tested

3.4. Antibiotic susceptibility test

Ampicillin (APX), Erythromycin (E), Streptomycin (S), Ceftriaxone (CRO), Chloramphenicol (C) and Nystatin (NY) antibiotics were used to test the resistance levels of bacteria. The resistance zone diameters of PAE and PAM extracts were calculated by measuring them compared with different antibiotics. In this context, PAM extract appears to be more effective against *Pseudomonas aeruginosa* ATCC and *Bacillus cereus* CCM 99 bacteria than other bacteria. PAM extract has been shown to be more effective on *Pseudomonas aeruginosa* ATCC

27853 bacteria than Oxoid™ Ampicillin antibiotic. The table below provides antibiotic resistance test results for PAM (Table. 5).

Table 5. Antibiotic susceptibility test *P. Acarna* Methanol extract

Microorganisms	Oxoid™ Ampicillin	Oxoid™ Erythromycin	Oxoid™ Streptomycin	Oxoid™ Ceftriaxone	Oxoid™ Chloramphenicol	Oxoid™ Nystatin	<i>P. Acarna</i> Methanol
<i>Escherichia coli</i> ATCC 35218	10 mm	36 mm	21 mm	24 mm	19 mm	-	9 mm
<i>Staphylococcus aureus</i> ATCC 6538/P	9 mm	27 mm	22 mm	29 mm	21 mm	-	8 mm
<i>Pseudomonas aeruginosa</i> ATCC 27853	9 mm	16 mm	22 mm	27 mm	23 mm	-	10 mm
<i>Bacillus cereus</i> CCM 99	18 mm	26 mm	20 mm	26 mm	20 mm	-	10 mm
<i>Candida albicans</i> ATCC 10239	-	-	-	-	-	22 mm	9 mm

5 bacterial species were tested against 6 different antibiotics and *Staphylococcus aureus* ATCC 6538/P and *Pseudomonas aeruginosa* ATCC 27853 showed resistance to ampicillin and erythromycin antibiotics against PAE extract. In *Escherichia coli* ATCC 35218, PAE plant extract showed resistance only to Ampicillin antibiotic and was sensitive to other antibiotics. The table below provides antibiotic resistance test results for PAE (Table. 6).

Table 6. Antibiotic susceptibility test *P. Acarna* ethanol extract

Microorganisms	Oxoid™ Ampicillin	Oxoid™ Erythromycin	Oxoid™ Streptomycin	Oxoid™ Ceftriaxone	Oxoid™ Chloramphenicol	Oxoid™ Nystatin	<i>P. Acarna</i> Ethanol
<i>Escherichia coli</i> ATCC 35218	8 mm	33 mm	22 mm	25 mm	19 mm	-	13 mm
<i>Staphylococcus aureus</i> ATCC 6538/P	12 mm	26 mm	23 mm	29 mm	22 mm	-	14 mm
<i>Pseudomonas aeruginosa</i> ATCC 27853	11 mm	12 mm	24 mm	28 mm	25 mm	-	14 mm
<i>Bacillus cereus</i> CCM 99	19 mm	25 mm	23 mm	29 mm	19 mm	-	11 mm
<i>Candida albicans</i> ATCC 10239	-	-	-	-	-	22 mm	10 mm

3.5 Anthelmintic Activities of the Extracts

Tubifex tubifex, belonging to the same annelid group as the intestinal roundworm parasites found in humans, was used in this study due to its anatomical and physiological

similarities to those found in humans. It was observed that the anthelmintic activity increased with the increasing concentration of the tested extract (Table 7).

Table 7. Antihelmintic activity results of *P. acarna* plant extracts

Plant Extracts	Concentration (mg/ml)	P (sn)*	D (sn)**
<i>P. Acarna</i> Methanol	2,5	93	101
	5	60	65
	7,5	45	55
<i>P. Acarna</i> Ethanol	2,5	105	110
	5	70	80
	7,5	50	60
Negative Control	-	-	-
Positive Control	10	37	120

The aerial methanol and ethanol extracts of the plant exhibited lower activity compared to the control albendazole. The methanol extract showed higher anthelmintic activity than the ethanol extract

4. CONCLUSION

In this study, the biological activities of *P. acarna* plant have been investigated for the first time. The determination of substance content supported by various experiments contributes to a better understanding of its composition. Assessing the antioxidant activities of the plant is crucial, and although the effects may not be very pronounced, it can be considered as a natural source of antioxidants. The results of anthelmintic activity indicate that the methanol extract has a better effect, serving as a preliminary study for experiments with different parasites. Furthermore, the higher efficacy of the plant against gram-negative bacteria compared to gram-positive bacteria opens the door for the production of composite ingredients and obtaining higher effects with further supported studies. The widespread presence of the plant in various regions of Turkey, its easy accessibility, natural growth, and the fact that it is being studied for the first time underscore its importance for future research. While the effectiveness of the plant may not be very high according to the study results, its investigation for biological activities for the first time is valuable and is expected to contribute to science. It is anticipated that in the future, various other activities will be uncovered, and it will become suitable for use in pharmacological studies.

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A Review on the Morphological Structure of the Larynx, Trachea and Syrinx in Birds

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Abstract

The respiratory system in birds is structurally and functionally similar to the respiratory system in mammals, but it shows significant differences. The main reason for these differences is that birds, unlike mammals, have the ability to fly. The larynx, located at the base of the pharyngeal cavity, consists of cartilages called cartilago cricoidea, cartilago arytenoidea and cartilago procricoidea. The trachea, on the other hand, consists of cartilage rings called cartilago trachealis, which connect the larynx to the syrinx and vary in number (100-130) in different bird species, called Cartilagine trachealis. The syrinx is the vocal organ that creates an aerodynamic-myoelectric sound source for birds and converts the aerodynamic energy here into acoustic energy. The syrinx is located between the trachea and the bronchus primarius, just before the bifurcation of the trachea, at the level of the second and third thoracic vertebrae. It is formed by the combination of cartilages called cartilagine syringeales. In addition to the morphological differences of the larynx, trachea and syrinx in various bird species, there are also many similarities. It is thought that the structural differences of the larynx, trachea and syrinx in different bird species vary according to the environmental conditions in which the birds live, the families they belong to and the different sounds they make.

Keywords: Larynx, trachea, syrinx, bird, morphology.

1. INTRODUCTION

In birds, the respiratory system, while structurally and functionally similar to that of mammals, shows significant differences (Heard et al., 1997). The primary reason for these differences is that, unlike mammals, birds possess the ability to fly (Nickel et al., 1977). The presence of a dual larynx, an elongated trachea, and air sacs are the main structural features that distinguish the respiratory system of birds from that of mammals (Çalışlar, 1977; Ocal and Erden, 2002). The larynx, located at the base of the pharyngeal cavity, is composed of three cartilages: cartilago cricoidea, cartilago arytenoidea, and cartilago procricoidea. These cartilages are made of hyaline tissue, which may undergo ossification with age. The trachea, connecting the larynx to the syrinx, consists of cartilaginous rings known as cartilagine tracheales, which range in number from 100 to 130 depending on the bird species (Ocal and Erden, 2002).

Figure 1. General anatomical and histological views of the larynx in the Eurasian magpie (*Pica pica*) (Hülya et al., 2016). A: Macro-anatomical dorsal view of the larynx. Gl: Glottis, Ca: Cartilago arytenoidea (arytenoid cartilage), Cp: Cartilago procricoidea (procricoid cartilage), Cc: Caudal part of the cartilago cricoidea (cricoid cartilage), Black arrow: Vertical lateral papilla, Arrowhead: Caudoventral pharyngeal papillae.

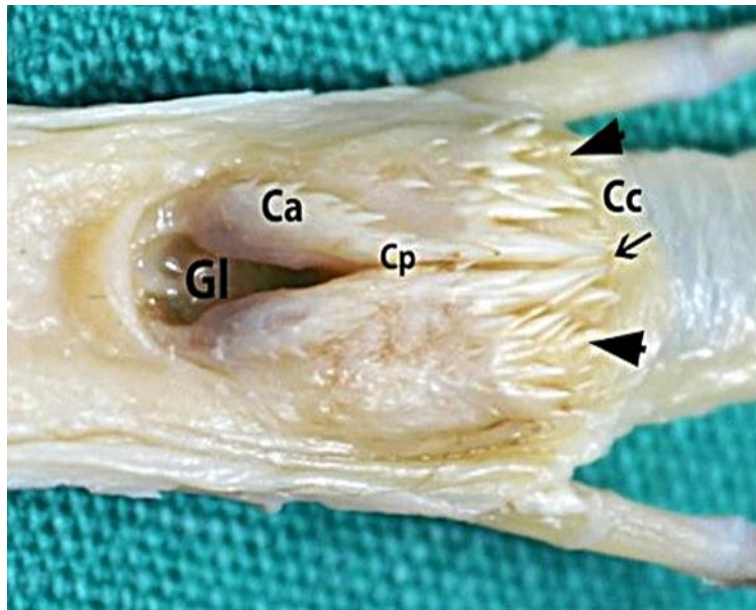
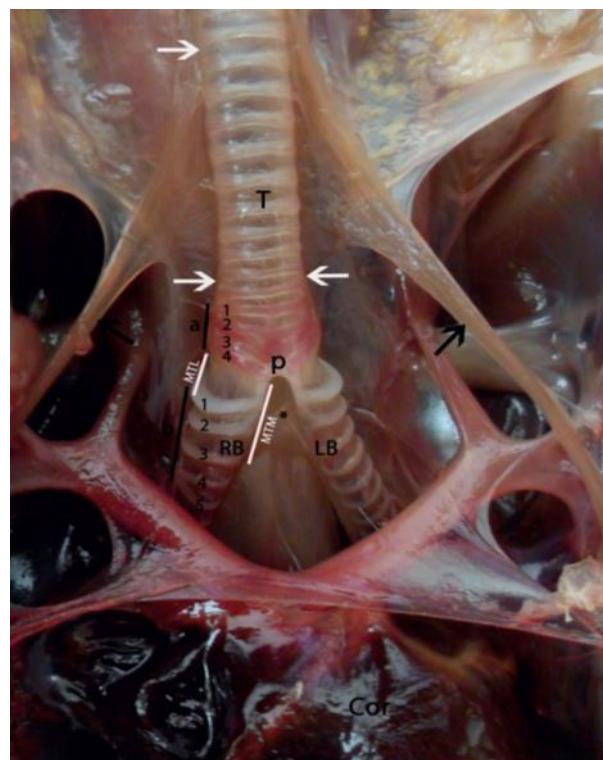


Figure 2. Dorsal view of the syrinx (Ozudogru et al., 2015). a1-a4: Cartilagine tracheales syringis, a2-a4: Tympanum, b: Cartilagine bronchiales syringis, Black arrows: Musculus sternotracheal, White arrows: Musculus tracheolateral, MTM: Membrana tympaniformis medialis, MTL: Membrana tympaniformis lateralis, P: Pessulus, RB: Right bronchus (Bronchus Dexter), LB: Left bronchus (Bronchus sinister), T: Trachea.



The syrinx is the vocal organ of birds and exhibits histological and anatomical differences across bird species. The sounds produced by different bird species play a significant role in distinguishing them, and birds are even classified as songbirds or non-songbirds based on the structural differences in their syrinx (Frank et al., 2007; Fitch, 1999). The syrinx functions as an aerodynamic-myoelectric sound source in birds, converting aerodynamic energy into acoustic energy. The labials extending laterally are held in a preparatory position by the syringial muscles, which generate vibrations as air passes through, playing a crucial role in sound production (Larsen and Goller, 1999).

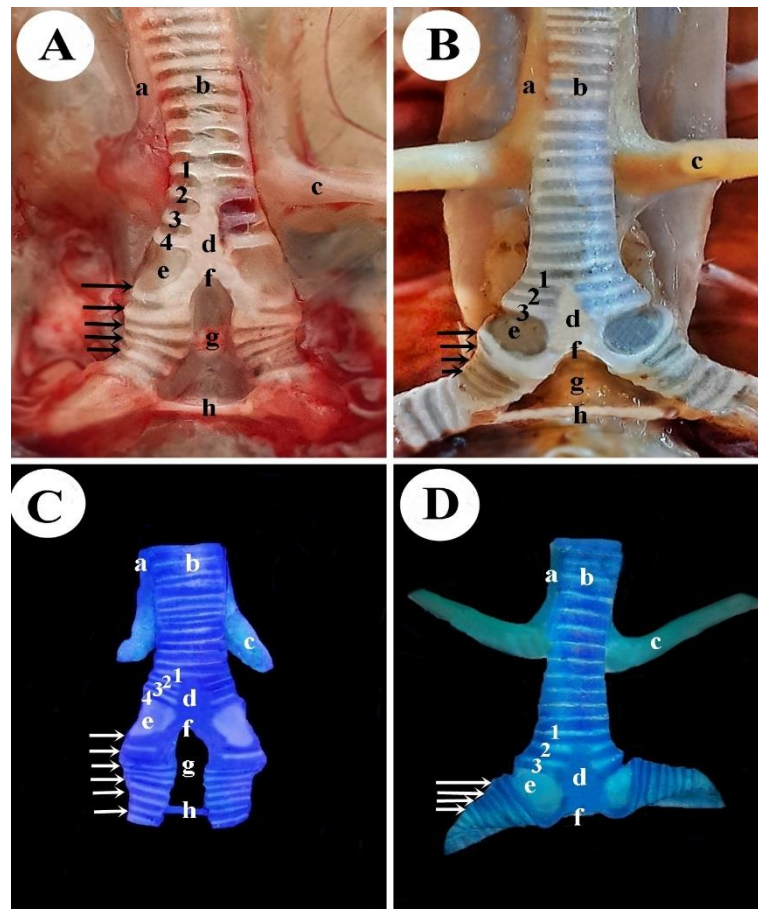
The syrinx is located between the second and third thoracic vertebrae, just before the bifurcation of the trachea, and is positioned between the trachea and the primary bronchi (Dursun, 2002). It is formed by the fusion of cartilage structures known as cartilagine syringeales. If the cartilage originates from the trachea, it is called cartilagine tracheales syringis, and if it originates from the tympanum, it is termed cartilagine bronchiales syringis. The fusion of the cartilagine tracheales syringis results in a cylindrical structure known as the tympanum, while the cartilages originating from the tympanum form the C-shaped cartilagine bronchiales syringis. These cartilages are supported by membranous structures known as the membrana tympaniformis medialis on the inside and the membrana tympaniformis lateralis on the outside (Dursun, 2002). These two thin membranes play an active role in sound production (King and McLelland, 1984; Frank et al., 2007; Kabak et al., 2007; Baumel and Club, 1993).

The syrinx is classified into three types based on the type of cartilage involved: tracheal syrinx, bronchial syrinx, and tracheobronchial syrinx (Fitch, 1999; Baumel and Club, 1993; Frank et al., 2007; Kabak et al., 2007; Scala et al., 1990). Most bird species possess a tracheobronchial syrinx (Ocal and Erden, 2002).

Below the tympanum, at the median position, lies a cartilage structure called the pessulus, which directs air from the trachea into the primary bronchi (Baumel and Club, 1993; Ocal and Erden, 2002). Some studies suggest that the pessulus plays a role in sound production and that the elastic fibers in its structure control frequency (Riede and Goller, 2010; Savart, 1826), while other studies argue that the pessulus does not have vibratory properties and does not contribute to sound production (Warner, 1972). The general consensus is that sound is produced by the vibration of the membrana tympaniformis lateralis and medialis and occurs only during expiration (Dursun, 2002).

The musculi syringeales are divided into two types: musculus tracheolateral and musculus sternotracheal (King, 1989). In songbirds, there are five pairs of syringial muscles: musculus tracheobronchialis, musculus tracheobronchialis brevis, musculus tracheobronchialis ventralis, musculus syringealis dorsalis, and musculus syringeales ventralis (Dursun, 2002). The mucosal epithelium of the syrinx varies among bird species and consists of pseudostratified columnar, stratified columnar, or squamous epithelium (Bacha and Bacha, 2000; Scala et al., 1990). The structure of the pessulus within the cavum syringis is in the form of a double-layered mucosal membrane and extends dorsoventrally toward the primary bronchi (Baumel and Club, 1993; Ocal and Erden, 2002).

Figure 3. Macroanatomical view of the syrinx in Japanese quail (*Coturnix coturnix japonica*) and Chukar partridge (*Alectoris chukar*). (Kara et al., 2023): **A:** Syrinx in Japanese Quail; **a:** musculus tracheolateralis, **b:** trachea, **c:** musculus sternotrachealis, **d:** tympanum, **e:** membrana tympaniformis lateralis, **f:** pessulus, **g:** foramen interbronchialis, **h:** ligamentum interbronchialis, **1,2,3,4:** cartilagine tracheales syringis, **arrows:** cartilagine bronchiales syringis. **B:** Syrinx in Chukar Partridge; **a:** musculus tracheolateralis, **b:** trachea, **c:** musculus sternotrachealis, **d:** tympanum, **e:** membrana tympaniformis lateralis, **f:** pessulus, **g:** foramen interbronchialis, **h:** ligamentum interbronchialis, **1,2,3,4:** cartilagine tracheales syringis, **arrows:** cartilagine bronchiales syringis. **C:** Syrinx with methylene blue staining in Japanese Quail; **a:** musculus tracheolateralis, **b:** trachea, **c:** musculus sternotrachealis, **d:** tympanum, **e:** membrana tympaniformis lateralis, **f:** pessulus, **g:** foramen interbronchialis, **h:** ligamentum interbronchialis, **1,2,3,4:** cartilagine tracheales syringis, **arrows:** cartilagine bronchiales syringis. **D:** Syrinx with methylene blue staining in Chukar Partridge; **a:** musculus tracheolateralis, **b:** trachea, **c:** musculus sternotrachealis, **d:** tympanum, **e:** membrana tympaniformis lateralis, **f:** pessulus, **g:** foramen interbronchialis, **1,2,3,4:** cartilagine tracheales syringis, **arrows:** cartilagine bronchiales syringis.



2. CONCLUSION

In various bird species, both differences and similarities are observed in the morphological structures of the larynx, trachea, and syrinx. It is believed that the structural differences these organs display in different bird species vary according to the environmental conditions they live in, the families they belong to, and the diversity of sounds they produce. The syrinx, in particular, plays a fundamental role in birds' sound production and is directly related to vocal differences. The complex anatomical structure of the syrinx stands out as a determining factor in the formation of different sound types. Additionally, it is thought that environmental factors and the evolutionary adaptations of species are influential in the morphological diversity of these structures, and that this diversity plays a significant role in

birds' adaptation to their habitats. In this context, the structural differences in the larynx, trachea, and syrinx are demonstrated to have not only anatomical but also ecological and functional foundations. The evolutionary shaping of the syrinx's anatomy in sound production is closely linked to biological processes such as interspecies communication, reproductive behaviors, and habitat preferences.

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The Price of the Modern World: Evaluating the Relationship Between Air Pollution and Autism

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Abstract

Air pollution is one of the biggest environmental hazards threatening public health in the modern world. Increasing air pollution due to industrialisation and urbanisation is associated with autism spectrum disorder (ASD), one of the neurodevelopmental disorders. It is known that autism is linked to genetic and environmental factors. Exposure to air pollutants, especially during pregnancy and early childhood, may increase the risk of ASD, and PM 2.5 and other pollutants have negative effects on synaptic connections and neurodevelopmental processes in the brain. This association between ASD and air pollution is explained by biological mechanisms such as gene-environment interactions and neuroinflammation. These findings emphasise the importance of policies to reduce air pollution and suggest that controlling environmental pollutants will support healthy neurodevelopment of future generations.

Keywords: Air Pollution, Autism, Environment, Pollutants

1. INTRODUCTION

Air pollution is currently identified as one of the largest environmental threats adversely affecting public health (Lam et al., 2016). The rapid industrialization and urbanization of the modern world have led to a significant increase in air pollution, posing various health risks to the global population (Canha et al., 2021; Sierra-Vargas & Teran, 2012). Among these risks, the potential impact of air pollution on autism spectrum disorder (ASD), a neurodevelopmental disorder, is particularly concerning (Jung et al., 2013). Autism is a complex neurodevelopmental condition characterized by difficulties in social interaction, communication, and repetitive behaviors (Ritz et al., 2018; Volk et al., 2013). While genetic factors play a significant role in the etiology of autism, recent studies suggest that environmental factors, especially exposure to air pollutants, may also contribute to the development and severity of ASD (Ritz et al., 2018; Weisskopf et al., 2015).

This review aims to synthesise the existing literature on the association between air pollution and autism, exploring possible mechanisms, epidemiological evidence and implications for public health policy.

2. MATERIAL and METHODS

2.1. AIR POLLUTION

2.1.1 Components of Air Pollution

Air pollution is the pollution of the indoor or outdoor environment by any chemical, physical or biological agent that alters the natural properties of the atmosphere (WHO, 2024). An air pollutant is a substance that harms human health or the wider environment when it is emitted into the atmosphere. Air pollutants can be found in the atmosphere as gases or particles. Examples of gaseous air pollutants include sulphur dioxide, nitrogen oxides, carbon monoxide, carbon dioxide, methane and other organic compounds. Examples of particulate air pollutants include smoke, soot, fine particles from traffic and coarse particles such as sea salts and windblown dust (Pearson & Derwent, 2022). In addition, domestic combustion appliances, motor vehicles, industrial plants and forest fires are common sources of air pollution. The most common pollutants of major public health concern include particulate matter (PM), carbon

monoxide (CO₂), ozone (O₃), nitrogen oxides (NO_x) and sulphur dioxide (SO₂) (Kerin et al., 2018; WHO, 2024). The values of air pollutants are determined by WHOm (Table 1).

Table 1. WHO Air Quality Guideline values and interim targets for various pollutants (HEI, 2024).

Pollutant	Average Time	AQG	IT-4	IT-3	IT-2	IT-1	Change Compared to 2005 AQG
PM _{2.5} (µg/m ³)	Annual	5	10	15	25	35	Tightened
	24 hour**	15	25	37.5	50	75	Tightened
PM ₁₀ (µg/m ³)	Annual	15	20	30	50	70	Tightened
	24 hour**	45	50	75	100	150	Tightened
Ozone (µg/m ³)	Pik season*	60	70	100	-	-	New
	8 hour	100	120	160	-	-	Unchanged
NO ₂ (µg/m ³)	Annual	10	20	30	40	50	Tightened
	24 hour**	25	30	120	-	-	New
SO ₂ (µg/m ³)	24 hour**	40	50	125	-	-	Loosened
CO (mg/m ³)	24 hour**	4	7	-	-	-	New

AQG: Air quality guideline; IT-4 IT-3 IT-2 IT-1: Specific interim objective, *Average of the daily maximum 8-hour average ozone concentration in the 6 consecutive months with the highest 6-month average ozone concentration, **No more than 4 days per year exceeded.

Among the pollutants considered criteria for air quality, particulate matter (PM) is generally divided into two categories in atmospheric measurements: PM₁₀ and PM_{2.5}. In recent years, PM1 (fine particles smaller than 1 micrometer in diameter) has also been included in this classification. However, PM1 is not yet fully integrated into air quality measurement systems or regulatory frameworks. PM₁₀ refers to inhalable coarse particles with a diameter of 10 micrometers (µm) or less, while PM_{2.5} is used for inhalable fine particles with a diameter of 2.5 µm or smaller (Karakas et al., 2013; Pearson & Derwent, 2022).

2.1.2 Effects of Air Pollution on Health

The size of particulate matter (PM) determines its potential to cause health issues. Particulate matter with diameters between 2.5 and 10 micrometers (PM₁₀) accumulates in the upper respiratory tract, while particulate matter with a diameter of 2.5 micrometers or smaller (PM_{2.5}) can penetrate deeper into the lower respiratory tract and reach the alveoli (Zencirci & Işıklı, 2017). Consequently, exposure to these particles affects both the lungs and the circulatory system. Studies have shown that exposure to PM pollution is associated with an increased incidence of respiratory symptoms such as early death in individuals with heart or lung disease, heart attacks, arrhythmias, asthma, reduced lung function, airway irritation, coughing, or difficulty breathing (Çilingir, 2016; Fu et al., 2022; Garcia et al., 2021). Individuals with heart or lung conditions, children, and the elderly are identified as the most affected groups by PM pollution (Fu et al., 2022; Tosun, 2017; Zencirci & Işıklı, 2017). Additionally, increased PM_{2.5} concentrations have been positively associated with mental health issues such as anxiety, depression, schizophrenia, and reduced cognitive function (Gao et al., 2017). Recent studies also highlight concerning findings regarding the impact of air pollution on cognitive development in children (Gündoğdu et al., 2016; İbadullayeva et al., 2019).

2.2. Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that causes difficulties in social interaction, communication, and behavior (Jung et al., 2013; Weisskopf et al., 2015). The global prevalence of ASD is estimated to be between 6.2 and 7.6 per 1,000

individuals, and it is noted to impose a significant social and economic burden throughout the lifespan (Weisskopf et al., 2015). According to estimates from the Centers for Disease Control and Prevention's (CDC) Autism and Developmental Disabilities Monitoring (ADDM) Network, one in 36 children is diagnosed with ASD (Maenner et al., 2023). Research in Turkey indicates that 1 in 69 children is diagnosed with ASD, with an estimated total of around 600,000 individuals with ASD in the country. Globally, the prevalence of ASD has increased rapidly; for example, in the United States, the rate was one in 2,500 children in 1970, and it surged to one in 44 children by 2021 (Özdemir et al., 2023). Autism is three to four times more common in males than females and is often associated with comorbid conditions such as epilepsy, depression, anxiety, and attention deficit hyperactivity disorder (ADHD), as well as challenging behaviors like sleep disturbances and self-harm. Individuals with autism exhibit atypical cognitive deficits, including impaired social cognition and perception, executive function deficits, and atypical perception and information processing. These characteristics are supported by atypical neurodevelopment at the system level (Wang et al., 2023).

ASD is a neurobiological disorder highly influenced by genetic factors and encompasses a broad list of possible etiologies. This disorder exhibits a range of heterogeneous changes in neuronal architecture, connectivity, and synaptogenesis. The origins of ASD point to environmental, immunological, genetic, and other factors. It presents with characteristic clinical symptoms, but specific biomarkers have not yet been validated (Gaona, 2024). Genetic factors are reported as one of the common causes of ASD (Şener & Özkul, 2013) (Table 2).

Table 2. List of some ASD-related genes

Gene	Function	Effects	Reference
SH3 and multiple ankyrin repeat domains 3 (SHANK3)	Regulates synaptic connections.	It can cause autism by disrupting the communication between nerve cells.	(Pagani et al., 2019)
Chromodomain helicase DNA binding protein 8 (CHD8)	Regulates gene expression by binding to DNA.	It may cause impairments in brain development and function.	(Weissberg & Elliott, 2021)
Neurexin-1-alfa (NRXN1)	It is critical for synaptic connections.	It may impair communication between nerve cells.	(Xu et al., 2023)
Methyl CpG binding protein 2 (MECP2)	Regulates gene expression.	May affect neurological development and synaptic plasticity.	(Wen et al., 2017)
Sodium channel, voltage-gated, type II, alpha subunit (SCN2A)	Regulates the electrical activity of nerve cells..	May affect the function of nerve cells.	(Daghsni et al., 2018)
Phosphatase and tensin homolog (PTEN)	Regulates cell growth and proliferation.	May affect neurological development and the function of nerve cells.	(Cummings et al., 2022)
Oksitosin (OXTR)	Reseptör Regulates social behaviour, attachment, stress responses.	May affect social interaction and attachment, stress management, emotional regulation, neurodevelopmental processes.	(Emam et al., 2020)

Mesenchymal Epithelial Transition (MET)	It plays a critical role in nervous system development and synaptic connections.	Supports healthy neurodevelopment and brain function.	(Elsen et al., 2009)
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The exact causes of autism are not fully understood, but it is believed that, in addition to genetic and familial factors, nutrition and environmental influences play a role due to the vulnerability of developing brains to environmental toxins (Gündoğdu et al., 2016). Studies in the literature have identified air pollution as a significant environmental risk factor for both ASD and Attention Deficit/Hyperactivity Disorder (Jung et al., 2013; Lewandowski et al., 2009), and have shown that the impact of air pollution on ASD is substantial (Guxens & Sunyer, 2012; Lam et al., 2016).

2.2.1 Air Pollution and Autism Spectrum Disorder

Children are particularly vulnerable to air pollution, which can lead to health issues starting in the womb and potentially lasting a lifetime (HEI, 2024). In recent years, research into the relationship between prenatal exposure to air pollution and ASD has become a significant focus of scientific studies (Lin et al., 2021; Oudin et al., 2019). Specifically, exposure to PM pollution has been suggested to impact newborns' immune systems, with impaired immunity potentially being linked to ASD. Additionally, exposure to air pollution may damage the prefrontal cortex of children, which could be associated with cognitive function impairments (de Prado Bert et al., 2018; Kar et al., 2019). Therefore, studies have indicated that exposure to pollutants, particularly PM_{2.5}, during pregnancy and the early postnatal period is associated with an increased risk of ASD in newborns, with these periods being the most critical (Becerra et al., 2013; Dutheil et al., 2021; Volk et al., 2013).

Exposure to air pollution during pregnancy has been associated with an increased prevalence of ASD. For instance, living near industrial facilities that report emissions of arsenic, lead, and mercury has been linked to higher ASD prevalence (Dickerson et al., 2015). Mothers who were exposed to higher levels of air pollution during the first trimester of pregnancy and reported lower folic acid (FA) intake in the first month were found to be at a higher risk for having children with ASD compared to those exposed to lower levels of air pollution with higher FA intake (Goodrich et al., 2018). A population-based birth cohort study reported a relationship between exposure to nitric oxide (NO) and ASD, although no significant associations were found with PM_{2.5} or NO₂ (Pagalan et al., 2019). McGuinn et al. (2020) found a positive relationship between exposure to PM_{2.5} and ozone (O₃) during early life and ASD, supporting previous findings related to sensitive windows in the late prenatal and early postnatal periods (McGuinn et al., 2020).

Studies in the literature have indicated that exposure to particulate matter (PM) pollution is associated with ASD during the postnatal period. Exposure to PM₁, PM_{2.5}, and PM₁₀ during the first three years of life has been linked to an increased risk of ASD, with stronger effects observed during the second and third years postnatally (Chen et al., 2018). Additionally, a study by Jung et al. (2013) reported that exposure to ozone (O₃), carbon monoxide (CO), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂) between the ages of 1 and 4 years may increase the risk of an ASD diagnosis (Jung et al., 2013).

Toxicological research has revealed that particulate matter (PM) components affect brain activity and function (Chen et al., 2018; Oudin et al., 2019). Although direct epidemiological evidence linking PM_{2.5} exposure to neurological disorders is limited, toxicological studies have indicated negative effects on fetal development, ASD, anxiety, attention deficit, reduced cognitive function, and schizophrenia. This has led to PM_{2.5} being considered a suspected

neurodevelopmental toxin (Becerra et al., 2013; Gao et al., 2017; Kalkbrenner et al., 2010; Lee et al., 2019). The most significant reported effects of air pollution on the central nervous system are related to oxidative stress and neuroinflammation, followed by microglial activation (Cole et al., 2016; Costa et al., 2017). Therefore, disruptions in microglial interactions with synapses may play a crucial role in the onset and progression of neurodevelopmental disorders like ASD (Fan et al., 2023). Indeed, diesel exhaust particles have been shown to activate microglia, and oxidants and pro-inflammatory cytokines like interleukin-6 (IL-6) produced by microglia have been linked to neuronal toxicity (Roque et al., 2016).

In a study involving animal models, exposure to traffic-related air pollution was found to elevate the methylation levels of the SHANK3 and MECP2 genes, leading to a reduction in protein levels. Rats exposed to traffic-related air pollution exhibited abnormal social behavior preferences and social novelty, while non-exposed rats displayed normal behaviors (Zhou et al., 2021). The lack of Triggering Receptor Expressed on Myeloid Cells-2 (TREM2) was associated with abnormal neuronal synaptic reorganization, imbalances in excitatory/inhibitory neurotransmission, disrupted neuronal connections, and behaviors similar to ASD. Notably, a significant reduction in TREM2 was observed in individuals with pronounced ASD symptoms, and there was an inverse relationship between TREM2 levels and the severity of ASD symptoms (Filipello et al., 2018). Another animal study suggested that OXTR protein could serve as a biological pathway explaining the potential link between air pollution and autism. It was proposed that air pollutants might cause changes in the OXTR gene or protein, potentially influencing neurodevelopmental processes and social behaviors, thereby contributing to the development of autism (Emam et al., 2020). A study examining both pollution and genetic effects found that individuals with the MET rs1858830 CC genotype exposed to high levels of air pollutants had an increased risk of ASD. The same study indicated that the MET CC genotype was ineffective at low pollution levels, suggesting a gene-environment interaction between MET genotype and air pollution affecting autism risk (Volk et al., 2014).

3. CONCLUSION

Air pollution stands out as one of the most serious environmental health threats facing the modern world, drawing attention to its potential effects on neurodevelopmental disorders. Complex neurodevelopmental conditions, such as ASD, reveal that both genetic and environmental factors play a significant role. This review deeply examines the relationship between air pollution and ASD, emphasizing how exposure to pollutants can affect neurodevelopment and increase ASD risk.

Current research indicates that exposure to air pollutants, particularly during pregnancy and early childhood, may increase the risk of developing ASD. This is explained by the adverse effects of PM_{2.5} and other pollutants on synaptic connections and neurodevelopmental processes in the brain. Biological mechanisms such as oxidative stress and neuroinflammation caused by air pollution emerge as key components in the complex interactions underlying neurodevelopmental disorders like ASD. Furthermore, given the critical role of gene-environment interactions in ASD development, further research is needed to explore how genetic predispositions combine with environmental exposures and how these interactions contribute to neurodevelopmental disorders. For instance, findings that specific genotypes, such as MET rs1858830, increase ASD risk when combined with high levels of air pollution highlight the need to consider genetic and environmental factors together.

These findings underscore the urgent need for global and local policies aimed at reducing air pollution. Controlling environmental pollutants will not only protect public health but also support the healthy neurodevelopment of future generations. An integrated approach to health

and environmental policies will enable societies to move towards a healthier and more sustainable future.

4. REFERENCES

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Spirulina Extract as a Potential Anticancer Agent in SKBR-3 Breast Cancer Cells

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Abstract

Spirulina (SP) is a food that stands out due to its rich content of protein, vitamins, and minerals and has recently shown promising results in cancer research. Various studies have revealed that Spirulina possesses strong antioxidant properties and has the capacity to inhibit cancer cells. This study examines the anticancer effects of Spirulina platensis water extracts on the human breast cancer cell line (SKBR-3). The effect of Spirulina water extract on the viability of SKBR-3 cells was investigated using the WST-1 cytotoxicity assay. Different doses (50, 100, 150, and 200 µg/mL) and durations (12, 24, and 48 hours) were applied. A statistically significant decrease in cell viability was observed in the 12-hour SP application at doses of 150, and 200 µg/mL compared to the control group. However, this cytotoxic effect was not maintained in the 24 and 48-hour applications. In the 24-hour application, only the 200 µg/mL doses showed a statistically significant decrease compared to the control group. The effectiveness of SP decreased when comparing the 24-hour application to the 12-hour application. No cytotoxic effect was observed at any dose in the 48-hour application. The IC₅₀ value of SP against SKBR-3 cells was found to be 104.8246 µg/mL at 12 hours and 147.1391 µg/mL at 24 hours. The results of the study indicate that Spirulina water extract exerts a cytotoxic effect on SKBR-3 cells, and this effect varies depending on the treatment dose and duration. The 12-hour SP application showed the most pronounced cytotoxic effect, while this effect was not observed in the 24 and 48-hour applications. These findings suggest that the efficacy of SP decreases over time. For future research, it is recommended that SP application be renewed every 12 hours to enhance the cytotoxic effect. It has been determined that Spirulina water extracts can have a lethal effect on human breast cancer cell lines.

Keywords: Spirulina, Cancer, Cytotoxicity, SKBR-3

1. INTRODUCTION

Spirulina is a dietary supplement derived from algae. It provides significant contributions to human health due to its anti-inflammatory, cytotoxic, hepatoprotective, antioxidant, antimutagenic, and anticancer properties. The capacity of spirulina to combat cancer and oxidative stress using its pharmacological properties has increased scientists' interest in spirulina (Akeel, 2023). Cancer is one of the most significant health issues today, with breast cancer being a common type of cancer in women.

Spirulina has been shown to significantly reduce the viability and proliferation of lung cancer cells (A549) by inhibiting the cell cycle at the G1 phase and inducing apoptosis. It has been demonstrated to increase the Bax/Bcl-2 ratio in A549 cells. Furthermore, no cytotoxic effect was observed on normal skin fibroblasts when treated with the tested spirulina extract (Czerwonka et al., 2018). In a study evaluating the cytotoxic effects of hot methanolic extracts of Spirulina platensis on human breast cancer cell line (MCF7), it was found that applying different concentrations of spirulina extracts (mg/mL) obtained with methanol to the MCF7 cell line for 24 and 48 hours showed significant cytotoxicity (Fayyad et al., 2019). Another study investigated the efficacy of breast cancer treatment in mice bearing 4T1 breast tumors using a braun-type lipoprotein enriched with spirulina extract. In this study, mice were treated with 40 mg/kg SP daily, and compared to the control group, a significant increase in the infiltration of NK, CD4+, CD8+, and T lymphocytes was observed, along with the ability to activate the immune system against the tumor. Reactive oxygen species (ROS) can damage molecules such as nuclei and DNA, proteins, carbohydrates, and lipids. With its potential antioxidant properties, spirulina may protect against free radicals that cause cell damage (Hernández et al.,

2015; Siddik et al., 2022). Numerous studies have revealed the anticancer effects of SP against various types of cancer (Hafe et al., 2011; Kawanishi et al., 2013; Śmieszek et al., 2017).

The findings in the literature suggest that SP may have anticancer properties. In this study, the cytotoxic effects of water extracts of spirulina on human breast cancer cell lines were investigated using the WST-1 method to evaluate their anticancer activity.

2. MATERIAL and METHODS

2.1. Extraction and Lyophilization of Spirulina Extract

Spirulina (1 g) was dissolved in 40 mL of water and stirred at room temperature using a magnetic stirrer at 1000 rpm for 1 hour. The mixture was then sonicated (60 amplitude) while kept in an ice bath to achieve homogeneity. After sonication, the mixture was stirred again at room temperature at 1000 rpm for an additional hour, then transferred to a falcon tube and centrifuged at 500 g for 10 minutes. The obtained supernatant was carefully transferred to a new falcon tube and filtered twice through a 100 μm filter. After filtration, the solution was centrifuged at 3000 g for 30 minutes. The supernatant was then passed through a 0.45 μm filter and centrifuged at 5250 g for 1 hour. The filtered solution was stored at +4 °C in a refrigerator until the lyophilization process. In the final step, the samples were dried using a lyophilizer (Millrock Technology, Kingston, NY) at -49 °C under a 3000 mT vacuum.

2.2. Cell Culture Applications

The SKBR-3 cell line (ATCC) was cultured in DMEM medium with high glucose content, supplemented with 10% fetal bovine serum, 1% L-glutamine, and 10,000 U/mL - 10,000 $\mu\text{g}/\text{mL}$ penicillin-streptomycin. These cells were placed in an incubator at 37 °C with 5% CO₂. Cell viability and growth rates were monitored through microscopic observations. The cell culture materials used include DMEM (Sigma, D6429-500ML), fetal bovine serum (Biowest, S181H-500), L-glutamine (Gibco, 25030081), and penicillin-streptomycin (Gibco, 10378016).

2.3. Cytotoxicity Analysis on Cell Viability (WST-1)

The WST-1 assay, used to evaluate cell viability and cytotoxicity, was conducted to investigate the anticancer effects of SP. WST-1 (Abbkine, KTA1020) was used according to the instructions. This method measures mitochondrial dehydrogenase activity in living cells. Mitochondrial dehydrogenases play a fundamental role in the energy production of cells, and this activity provides information about the cells' metabolic state and overall health. WST-1 is used to determine the activity of these enzymes, and after being reduced by the cells, a colored formazan product is formed. This color change is used to measure the number and viability of live cells in the sample. After WST-1 was applied to SKBR-3 cells, they were incubated at 37 °C for 4 hours, and absorbance was measured at 450 nm using a microplate reader (Tecan Infinite 200 pro). This test was used to quantitatively determine the cytotoxic effects of SP treatment and to evaluate the impact of different doses and application times on cell viability. In this study, the anticancer effect of spirulina water extracts on the human breast cancer cell line was investigated using the WST-1 method at different doses (50, 100, 150, and 200 $\mu\text{g}/\text{mL}$) and time points (12, 24, and 48 hours).

2.4. Statistical Analysis

The statistical analysis of cytotoxicity data was performed using the GraphPad Prism 9 software. Comparisons between groups were conducted using one-way analysis of variance (ANOVA). Prior to ANOVA, normality tests such as Shapiro-Wilk and Kolmogorov-Smirnov tests were applied to determine whether the data followed a normal distribution. The threshold for statistical significance was set at $p < 0.05$.

2.5. Figures

Figure 1. The 12-hour cytotoxic effect of SP on SKBR-3 cells was significant ($*p < 0.05$)

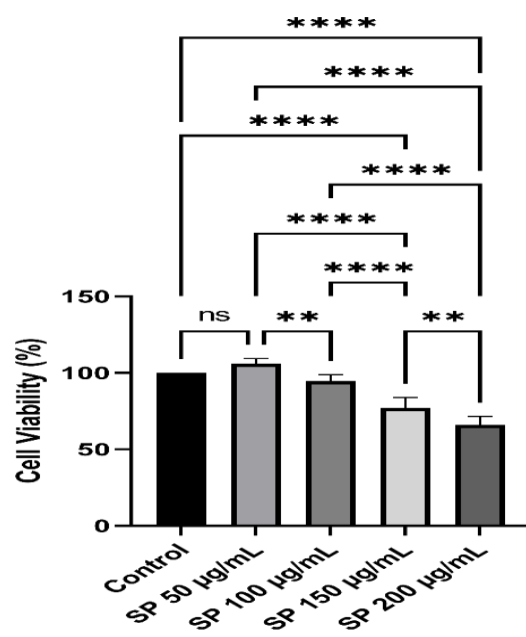


Figure 2. The 24-hour cytotoxic effect of SP on SKBR-3 cells was significant ($*p < 0.05$)

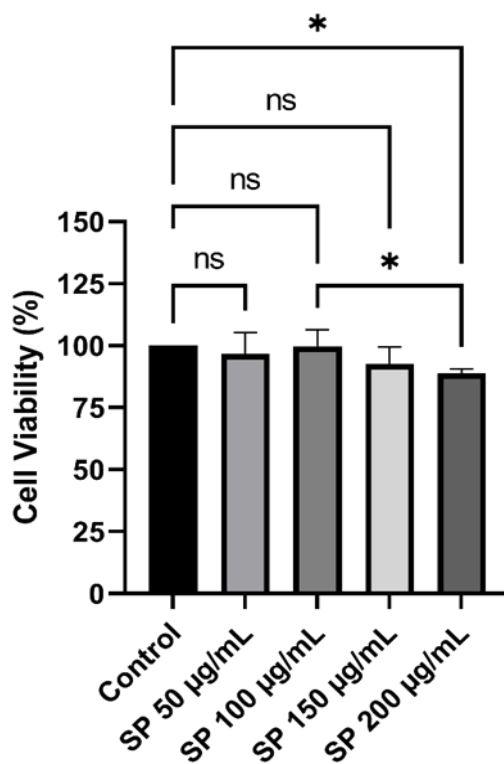
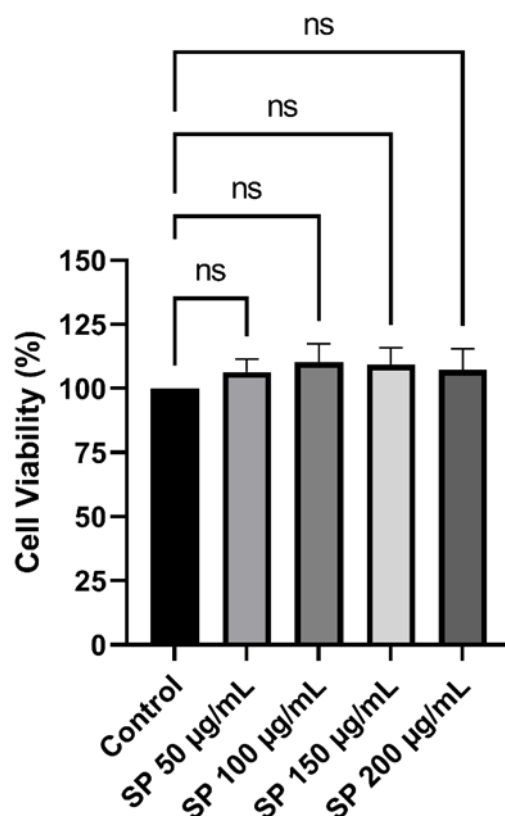


Figure 3. The 48-hour cytotoxic effect of SP on SKBR-3 cells was significant ($*p < 0.05$)



3. RESULTS and DISCUSSION

3.1. Findings on Cell Viability

Our study investigated the effects of spirulina water extract on SKBR-3 cell viability using the WST-1 cytotoxicity assay, with different doses (50, 100, 150, and 200 µg/mL) and durations (12, 24, and 48 hours).

A statistically significant decrease in cell viability was observed at 150 and 200 µg/mL doses after 12 hours of SP treatment compared to the control group. However, no significant difference was observed at 50 and 100 µg/mL doses compared to the control. The 200 µg/mL SP treatment for 12 hours showed greater cytotoxicity than the 150 µg/mL SP treatment. The IC₅₀ value of SP against SKBR-3 cells was found to be 104.8246 µg/mL at a 12-hour incubation period (Figure 1).

A statistically significant decrease in cell viability was observed at the 200 µg/mL dose after 24 hours of SP treatment compared to the control group. However, the 50, 100, and 150 µg/mL doses did not show a statistically significant difference from the control group after 24 hours. Compared to the 12-hour treatment, the effectiveness of SP was reduced after 24 hours. The IC₅₀ value of SP against SKBR-3 cells at a 24-hour incubation period was found to be 147.1391 µg/mL (Figure 2).

The cytotoxic effects of SP observed at 12 and 24 hours were not evident at 48 hours. No cytotoxic effect was observed for any dose after 48 hours of SP treatment (Figure 3).

4. CONCLUSION

The spirulina water extract demonstrates cytotoxic effects on SKBR-3 cells, with this effect varying depending on the treatment dose and duration. The cytotoxic effect of a 12-hour

SP application was not observed in the 24 and 48-hour applications. These findings suggest that the efficacy of SP decreases over time. For future studies, we recommend repeating SP applications every 12 hours to enhance cytotoxic effects. It has been determined that spirulina water extracts can have a lethal effect on human breast cancer cell lines. These data indicate that spirulina water extract could aid in developing new treatment strategies as an effective anticancer agent against human breast cancer cells.

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Evaluation of Bioinformatics, Energy and Artificial Intelligence Theses in ProQuest™ Database

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Abstract

Artificial intelligence offers a wide range of applications in many aspects such as biological data processing, medicine and energy. For this reason, determining the interaction of artificial intelligence with each other in the field of energy and bioinformatics is extremely important in terms of revealing the interdisciplinary interaction. The main objective of this research is to provide a bibliometric profile of theses and dissertations in the international literature on bioinformatics, energy and artificial intelligence. In this context, the data of the study were obtained from ProQuest™ Dissertations & Theses Citation Index in the Search in section of the Web of Science (WoS) database. Advanced search was performed using the keywords ((Ts=(Bioinformatic* OR Biocomputing*)) AND Ts=(Energy*)) AND Ts=(Artificial intelligence*). As a result of the search, 48 thesis studies published between 2005 and 2024 were reached. The data of the study were analyzed by bibliometric analysis method. Looking at the literature, it has been determined that there is a lack of bibliometric analysis of thesis studies in the field of bioinformatics, energy and artificial intelligence. This study has a unique value in terms of providing a wide resource that can be used in terms of suggestions for the most studied and can be studied in bioinformatics, energy and artificial intelligence thesis studies, as well as filling the gap for the examination of graduate theses in the field of bioinformatics, energy and artificial intelligence by bibliometric analysis method. It was suggested that bibliometric studies be conducted in different databases on the subject.

Keywords: ProQuest™, bioinformatics, energy, artificial intelligence, bibliometrics

1. INTRODUCTION

With increasing technological applications and the development of modern technology (Arslan, 2023), the interaction between bioinformatics, energy and artificial intelligence has started to arouse curiosity. The relationship of AI with energy and bioinformatics plays an important role in modern science technology. Because the integration of AI with energy and bioinformatics highlights multidisciplinary and technological developments, offering a wide range of applications in many aspects such as health, sustainability, biotechnology, energy efficiency.

Bioinformatics is defined as an interdisciplinary science based on the combination of biology, medical science, information technology, mathematics and biostatistics to analyze and evaluate data generated from biological systems (Keklik and Özcan, 2022). Energy, defined as the capacity to do work, is a quantity and power that can realize changes in physical systems (Güneş and Akdağ, 2016). Artificial intelligence is defined as the general name of a modeling system inspired by the behavior of living things (Sucu and Ataman, 2020).

Although bioinformatics, energy and artificial intelligence offer many innovations in their respective fields, it is believed that in the future technologies will play an extremely important role in the connection or interaction between these disciplines in connecting across borders. In this respect, the interaction between bioinformatics, energy and artificial intelligence is one of the most important aspects of modern technology and science and can have a significant impact in many areas such as health and energy management.

The main objective of this research is to provide a bibliometric profile of theses and dissertations in the international literature on bioinformatics, energy and artificial intelligence. Looking at the literature, it has been determined that there is a lack of bibliometric analysis of thesis studies in the field of bioinformatics, energy and artificial intelligence. This study has a

unique value in terms of providing a wide resource that can be used in terms of suggestions for the most studied and can be studied in bioinformatics, energy and artificial intelligence thesis studies, as well as filling the gap for the examination of graduate theses in the field of bioinformatics, energy and artificial intelligence by bibliometric analysis method.

2. MATERIAL and METHODS

In this study, the relationship between bioinformatics, energy and artificial intelligence was analyzed by bibliometric analysis method. Because the bibliometric analysis method helps to summarize and interpret the available information on the characteristics of scientific studies written on specified topics (Sayiner, 2023). In this context, the data of the study were obtained from ProQuest™ Dissertations & Theses Citation Index in the Search in section of the Web of Science (WoS) database. Advanced search was performed using the keywords ((Ts=(Bioinformatic* OR Biocomputing*)) AND Ts=(Energy*)) AND Ts=(Artificial intelligence*). As a result of the review, data on 48 thesis studies published between 2005 and 2024 were analyzed by bibliometric analysis method and presented through Sankey diagram. The following parameters in the analyze results section of Web of Science were examined:

- Year,
- Thesis type,
- Countries/regions,
- Languages,
- Universities,
- Research areas,
- Thesis subjects

3. RESULTS and DISCUSSION

The lack of bibliometric research on the interaction of bioinformatics, energy and artificial intelligence in the literature reveals the importance and originality of this study. According to Yenisoy and Hassan (2024), when there is no bibliometric study on the research topic, a comparison cannot be made with the results in the literature. Within the scope of this research, no comparison could be made since there is no bibliometric study in the literature.

Figure 1. Citation report

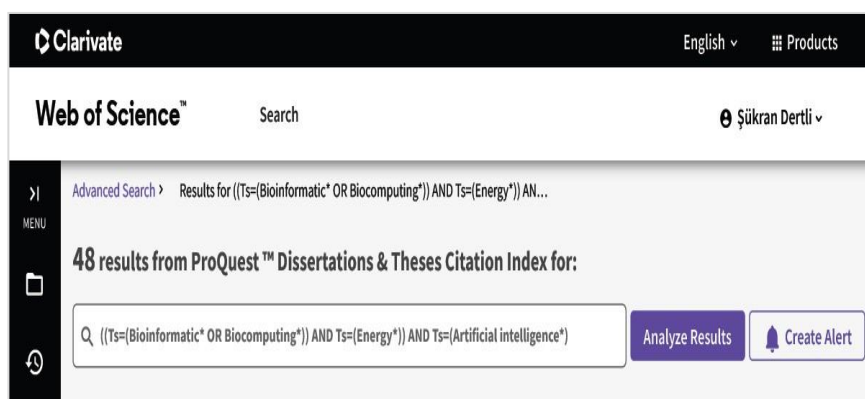


Figure 1 shows that bibliometric analysis was realized with a total of 48 thesis studies as a result of the ProQuest search.

Figure 2. Citation report

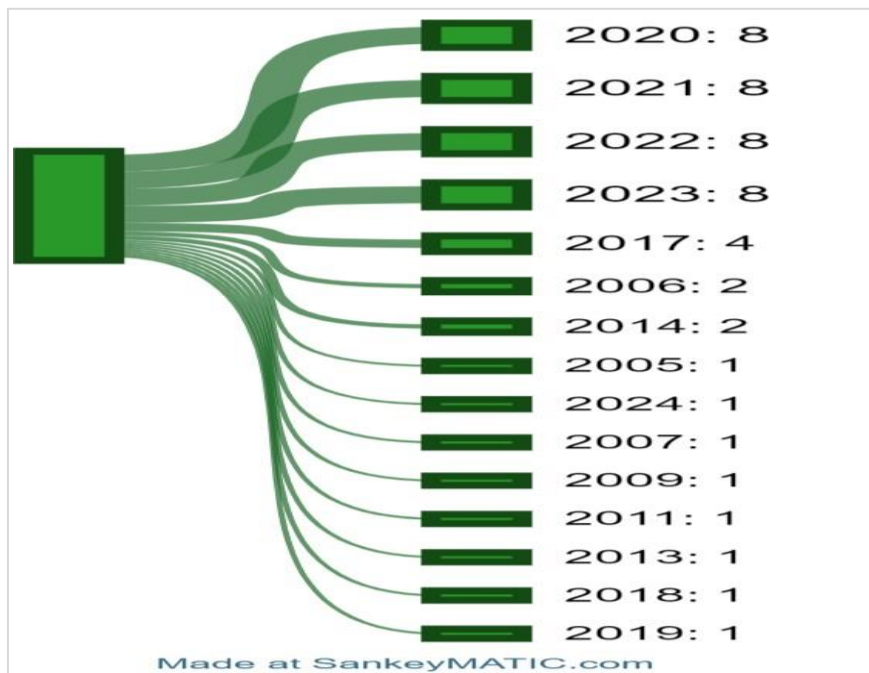


Figure 2 shows that the first thesis on bioinformatics, energy and artificial intelligence was prepared in 2005. When the annual scientific production values are analyzed, it was found that 8 thesis studies were prepared in 2020, 2021, 2022 and 2023, 4 thesis studies in 2017, 2 thesis studies in 2006 and 2014, and 1 thesis study each in 2005, 2007, 2009, 2011, 2013, 2018, 2019 and 2024. This finding was interpreted as the research topic became more widespread and popular from 2005 to the present.

Figure 3. Thesis type

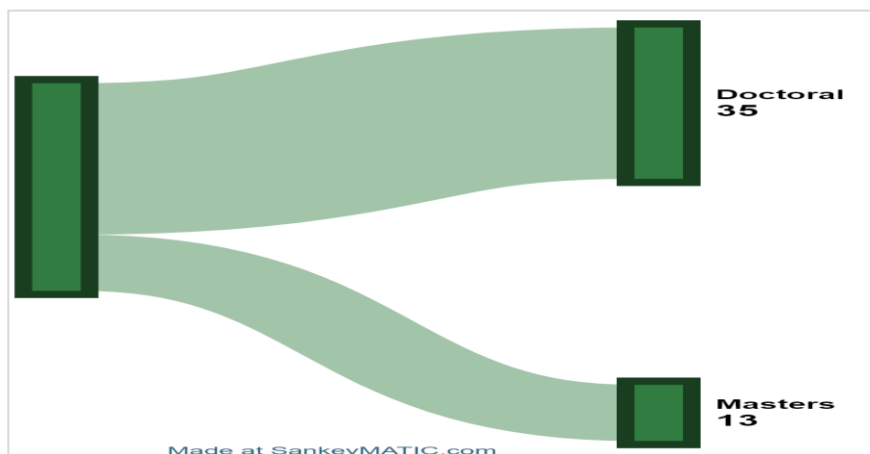


Figure 3 shows that out of 48 graduate theses prepared in the field of bioinformatics, energy and artificial intelligence, 35 were doctoral theses and 13 were master's theses. This finding reflects the fact that the research topic has become more widespread and accessible in doctoral theses.

Figure 4. Countries/regions

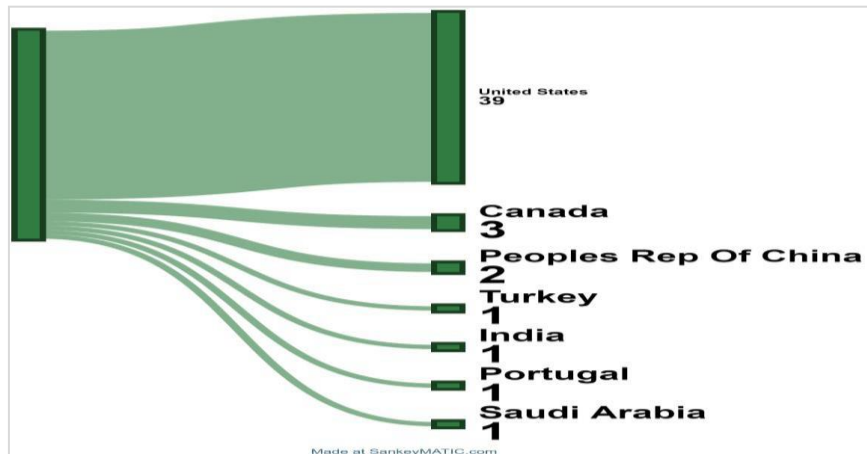


Figure 4 shows that 39 of the countries/regions with the highest number of studies on bioinformatics, energy and artificial intelligence were prepared in the United States, 3 in Canada, 2 in Peoples R China, 1 each in Turkey, India and Saudi Arabia. It is thought that the high number of thesis studies on bioinformatics, energy and artificial intelligence in the United States is due to its research infrastructure and strategic priorities.

Figure 5. Languages

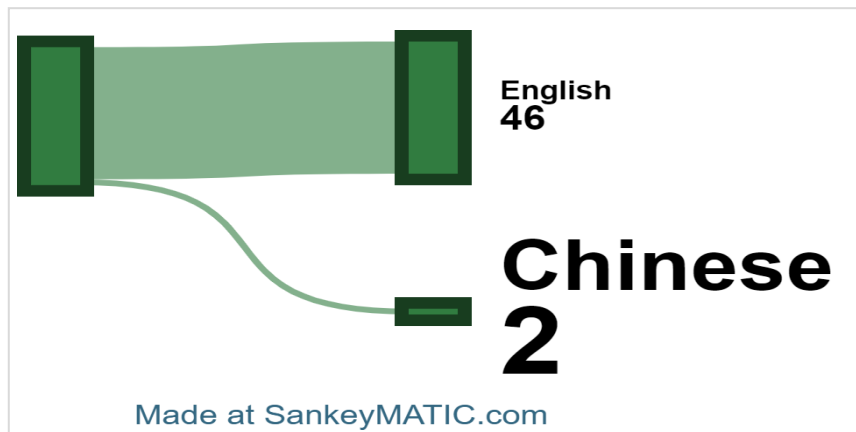


Figure 5 shows that out of 48 postgraduate theses on bioinformatics, energy and artificial intelligence, 46 were written in English and 2 were written in Chinese. This is explained by the fact that English is considered a global language.

Figure 6. Examples of dissertation and thesis subjects

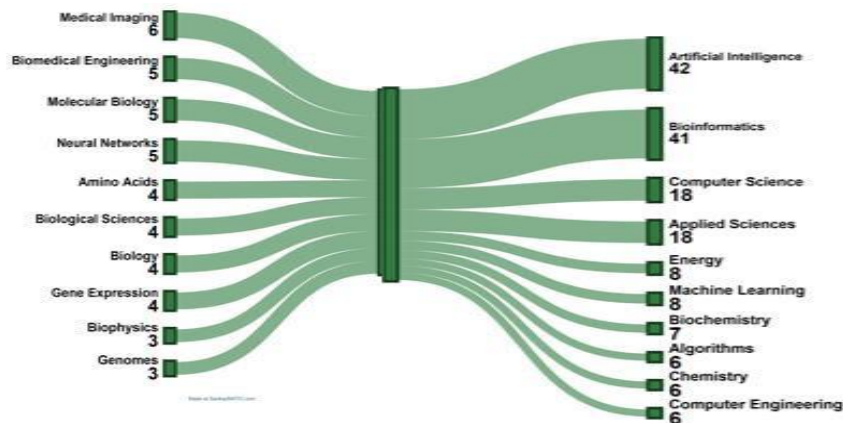


Figure 6 shows that 42 of the studies on bioinformatics, energy and artificial intelligence are in Artificial Intelligence, 41 in Bioinformatics, 18 in Computer Science, Applied Sciences, 8 in Energy, Machine Learning, 7 in Biochemistry, 6 in Chemistry, Computer Engineering, Medical Imaging, 5 each in Biomedical Engineering, Molecular Biology, Neural Networks, 4 each in Amino Acids, Biological Sciences, Biology, Gene Expression, 3 each in Biophysics and Genomes. All these findings revealed that the research topic consisted of more than one thesis topic. It can be said that this situation will play an important role in determining the trends in the prominent disciplines related to bioinformatics, energy and artificial intelligence.

Figure 7. Examples of Universities where these are published

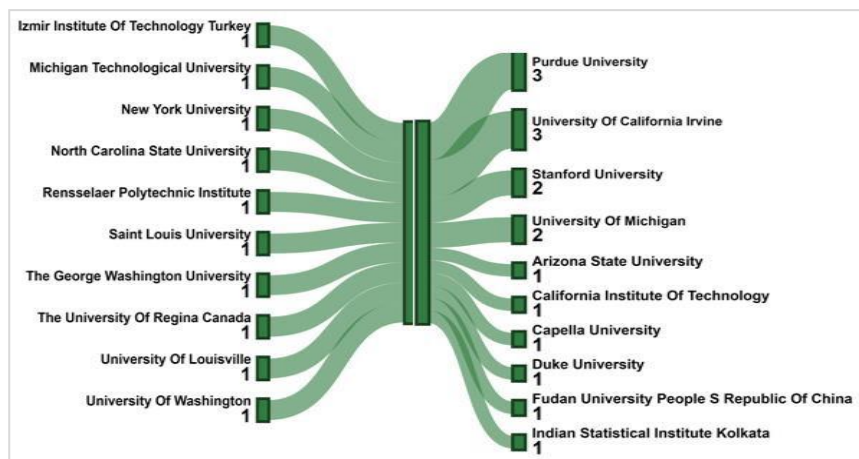


Figure 7 shows that 3 of the studies on bioinformatics, energy and artificial intelligence were conducted at Purdue University, University Of California Irvine, 2 each at Stanford University, University Of Michigan, 1 each at Arizona State University, California Institute Of Technology, Capella University, Duke University, Fudan University People's Republic Of China, Indian Statistical Institute Kolkata, Izmir Institute Of Technology Turkey, Michigan Technological University, New York University, North Carolina State University, Rensselaer Polytechnic Institute, Saint Louis University, The George Washington University, The University Of Regina Canada. bioinformatics, energy and artificial intelligence, these institutions play a crucial role in identifying emerging trends in the field.

Figure 8. Examples of research areas

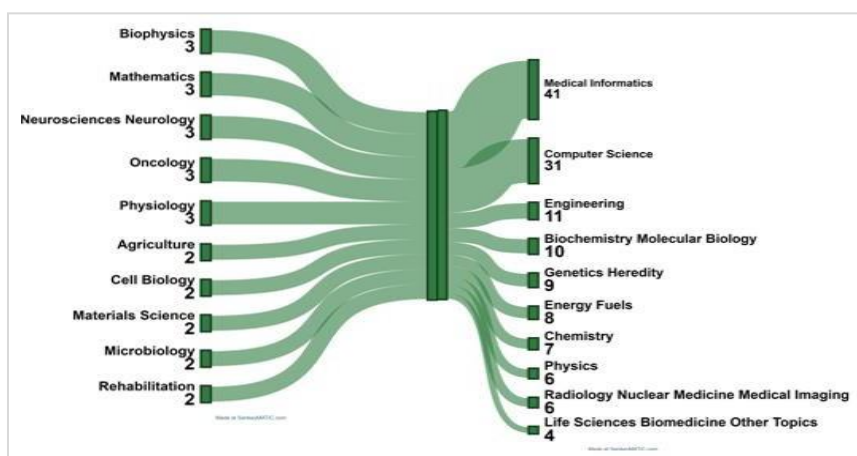


Figure 8 shows that 41 of the studies on bioinformatics, energy and artificial intelligence were conducted in Medical Informatics, 31 in Computer Science, 11 in Engineering, 10 in Biochemistry Molecular Biology, 9 in Genetics Heredity, 8 in Energy Fuels, 7 in Chemistry, 6 in Physics, Radiology Nuclear Medicine Medical Imaging, 4 in Life Sciences Biomedicine Other Topics, 3 in Biophysics, Mathematics, Neurosciences Neurology, Oncology, Physiology, 2 in Agriculture, Cell Biology, Materials Science, Microbiology Rehabilitation. It can be said that this finding will play an important role in determining the areas of attention in bioinformatics, energy and artificial intelligence.

4. CONCLUSION

It was concluded that 35 of the international theses were doctoral theses and 13 were master's theses. It was found that most of the studies were prepared in thesis and dissertation subjects such as "Artificial Intelligence", "Bioinformatics", "Computer Science", "Genetics", "Applied Sciences", "Energy", "Machine Learning", "Biochemistry", "Algorithms", "Computer Engineering". However, it was concluded that the studies were least prepared in thesis and dissertation subjects such as "Agricultural Production", "Agriculture", "Agronomy", "Animal Sciences", "Antibiotics", "Applied Mathematics", "Education", "Statistics", "Biomechanics", "Electromagnetics". At the same time, it was determined that theses in the fields of bioinformatics, energy and artificial intelligence were written in English and Chinese. It has been observed that the institutions producing the most studies in this field are "Purdue University", "University Of California Irvine", "Stanford University", "University Of Michigan", "Arizona State University", "California Institute Of Technology", "Capella University", "Duke University", "Fudan University People S Republic Of China", "Indian Statistical Institute Kolkata". It was determined that the studies were mainly produced in "Medical Informatics", "Computer Science", "Engineering", "Biochemistry Molecular Biology", "Genetics Heredity", "Energy Fuels", "Chemistry", "Physics", "Radiology Nuclear Medicine Medical Imaging", "Life Sciences Biomedicine Other Topics" research areas.

No thesis on bioinformatics, energy and artificial intelligence were found in Yöktez database. For this reason, only the bibliometric analysis of theses in the ProQuest™ database was performed. In this context, it has been suggested that the studies in Yöktez (in the national literature) should focus on studies that address the link between bioinformatics, energy and artificial intelligence. It was also suggested to increase the number of thesis studies related to

the research topic in ProQuest™. At the same time, studies on agricultural bioinformatics applications were recommended. Only the data obtained from the ProQuest database constitute the results of the study.

From this point of view, in order to guide the researchers who will conduct studies on Bioinformatics, Energy and Artificial Intelligence, it is suggested to compare the data obtained from national and international databases such as “Web of Science”, “Scopus”, “Sobiad”, “Dergipark”, “Ulakbim” and to address the issue on a larger scale.

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Classification, Cultivation, Distribution, Uses and Importance as a Medicinal Plant of Saffron Plant

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Abstract

The flora of the both world and Azerbaijan, is rich in medicinally important spice plants. The use of spices has a long history. The presented article provides information about the saffron plant, which has a special place in Azerbaijani cuisine and is considered the king of spices. The article provides brief information about the history of saffron use, its botanical classification, the species growing in Azerbaijan, the method of cultivation, chemical composition, possibilities of use, benefits and importance in medicine. People have been using medicinal and spice plants since ancient times. According to available historical data, the history of their use and cultivation goes back at least 5000 years. The history of using these plants in Azerbaijan is ancient. Our people use saffron, cumin, cumin, ginger, sesame, mint, coriander, basil, fennel, thyme, thyme, fenugreek, saffron, anise, basil, cinnamon, cardamom, cloves, sumach, pepper, mustard, garlic, allspice, mint, wormwood. , tarragon, etc. since ancient times, dozens of spice plants have been successfully used in the preparation of various dishes, flavoring them, flavoring them, coloring them with eye-catching colors, and decorating some foods (for example, bread).

Keywords: Spice plants; systematics; saffron; dyes; flavoring.

1. INTRODUCTION

People have been using plants since ancient times. Primitive people engaged in gathering collected edible fruits, seeds, flowers, leaves, bark, roots and rhizomes of plants for the purpose of nutrition. About 10-12 thousand years ago, some of these plants - wheat, peas, grapes, etc. they started to cultivate. Over time, people who are in constant contact with nature have discovered that some of these plants have other useful properties besides food. They observed that some plants (for example, catnip) relieve headaches, some have anti-inflammatory properties, some are rich in valuable vitamins, some are dyes and dyes, some are aromatic and flavoring, some are refreshing and even uplifting, some plants and it is too poisonous and can even kill a person. The information obtained about these plants was originally transmitted orally from generation to generation. After the emergence of writing, this information began to be reflected in written books. In the Middle Ages, the renaissance period brought about a number of sciences, including physics, chemistry, botany, biology, etc. such sciences developed. After some time, starting from the middle of the 9th century, the chemical composition of such plants began to be systematically studied at the scientific level. Many useful plants were already widely cultivated by this time.

People have been using medicinal and spice plants since ancient times. Plants like saffron, cumin, cumin, ginger, sesame, mint, coriander, basil, fennel, thyme, thyme, fenugreek, saffron, anise, basil, cinnamon, cardamom, cloves, sumach, pepper, mustard, garlic, allspice, mint, wormwood. , tarragon, etc. are used in the form of infusions - teas, stewed or fried in oil, added to the composition of salads, and used in the form of additives. Some of them are pickled, some are added to other pickles as an antimicrobial agent, some are dried and stored for the winter, many of them are used year-round against colds, coughs, shortness of breath, diaphoretic, hemostatic, astringent, astringent, pain reliever, anti-inflammatory, etc. used for purposes. Honey, yogurt, dough, etc. for medicinal purposes. ointments and poultices are prepared with.

Purpose: The purpose of this presented article is to provide information about the saffron plant, rich in biologically active and secondary synthetic valuable substances, which has been used as a spice plant since ancient times in Azerbaijani cuisine and household, with medicinal properties.

Classification: Saffron is a representative of the *Crocus* genus of the Crocoideae subfamily of the Iridaceae family of the Asparagales order (tribe) of the Angiosperm family of the Eukaryota domain. About 70 genera of crocuses include up to 1800 species.

The classification of saffron, an extremely polymorphic genus, has been revised many times, the last classification was made by Brian Matthews in 1982, dividing the genus into two subgenera (*Crocus* and *Crociris*), two sections (A and B) and series (A – 6, B – 9) with 85 species. described. Below is a list of those types.

1. *Crocus* subgenus

A. *Crocus* section

***Crocus* series**

- *Crocus asumaniae* B.Mathew & T.Baytop – *Asuman saffron*
- *Crocus cartwrightianus* Herb. – *Cartwright's saffron*
- *Crocus sativus* L. – *Plant saffron (considered a hybrid of C. cartwrightianus)*
- *Crocus hadriaticus* Herb. – *Adriatic saffron*
- *Crocus mathewii* H.Kemdorff & E.Pasche – *Matthew's saffron*
- *Crocus moabiticus* Bornm. & Dinsmore ex Bornm.
- *Crocus oreocreticus* B.L. Burt
- *Crocus pallasii* Goldb. – *Pallas saffron*
- *Crocus thomasii* Ten. – *Tomassi saffron*

***Kotschyani* series**

- *Crocus autranii* Albov. – *Otran saffron*
- *Crocus gilanicus* B. Matthew
- *Crocus karduchorum* Kotschy ex Maw – *Karduchor saffron*
- *Crocus kotschyanus* K. Koch – *Kochi saffron*
- *Crocus ochroleucus* Boiss. & Gaill. – *Ochrolake saffron*
- *Crocus scharojanii* Rupr. - *Sharoyan saffron*
- *Crocus vallicola* Herb. – *Valley saffron*

***Longiflori* series**

- *Crocus goulimyi* Turrill – *Gulimi saffron*
- *Crocus longiflorus* Raf. – *Long-flowered saffron*
- *Crocus medius* Balb. – *Medium saffron*
- *Crocus niveus* Bowles – *Niveus saffron*
- *Crocus nudiflorus* Smith. – *Bare-flowered saffron*
- *Crocus serotinus* Salisb. – *Late (maturing) saffron*

***Scardici* series**

- *Crocus pelistericus* Pulevic – *Pleisteric saffron*
- *Crocus scardicus* Kos. – *Scardika saffron*

***Verni* series**

- *Crocus baytopiorum* Mathew – *Baytopi saffron*
- *Crocus etruscus* Parl. – *Etruscan saffron*
- *Crocus kosaninii* Pulevic – *Kosanini saffron*
- *Crocus tommasinianus* Herb. – *Tomazini saffron*
- *Crocus vernus* (L.) Hill – *Spring saffron*

***Versicolores* series**

- *Crocus cambessedesii* J. Gay – *Cambesdes saffron*

- *Crocus corsicus* Vanucchi ex Maw – Corsican saffron
- *Crocus imperati* Ten.
- *Crocus malyi* Vis. - Mal saffron
- *Crocus minimus* DC. - Little saffron
- *Crocus versicolor* KerGawl. - Ornamental saffron

B. Nudiscapus section

Aleppo series

- *Crocus aleppicus* Baker
- *Crocus boulosii* Greuter
- *Crocus veneris* Tappein ex Poech

Biflori series

- *Crocus adanensis* T.Baytop & B.Mathew – Adan saffron
- *Crocus aereus* Herb. – Airy saffron
- *Crocus almehensis* C.D.Brickell & B.Mathew – Almeen saffron
- *Crocus biflorus* Mill. – Two-flowered saffron (= *Crocus tauricus* (Trautv.)

Puring. – Crimean saffron)

- *Crocus caspius* Fischer & Meyer – Caspian saffron
- *Crocus chrysanthus* Herb. – Golden saffron
- *Crocus cyprius* Boiss. & Kotschy – Cypress(with) saffron
- *Crocus danfordiae* Maw – Danfordia saffron
- *Crocus hartmannianus* Holmboe – Hartmannianus saffron
- *Crocus kerndorffiorum* Pasche – Krendorfii saffron
- *Crocus leichtlinii* (Dewar) Bowles
- *Crocus paschei* H.Kerndorff
- *Crocus pestalozzae* Boiss.
- *Crocus wattiorum* B.Mathew

Carpetani series

- *Crocus carpetanus* Boiss. & Reut. – Freckled (warty) saffron
- *Crocus nevadensis* Amo. – Snow saffron

Flavi series

- *Crocus antalyensis* Mathew – Anatolian saffron
- *Crocus candidus* E.D.Clarke – White saffron
- *Crocus flavus* Weston – Yellow saffron
- *Crocus graveolens* Boiss. & Reut. - Sad saffron
- *Crocus hyemalis* Boiss. & Blanche – Winter Saffron
- *Crocus olivieri* J.Gay – Oliveri saffron
- *Crocus vitellinus* Wahl. – Yellowish saffron

Intertexti series

- *Crocus fleischeri* Gay. – Fleischer's saffron

Series Laevigatae

- *Crocus boryi* J.Gay – Bori saffron
- *Crocus laevigatus* Bory & Chaub. – Smooth saffron
- *Crocus tournefortii* Gay. – Tournefort saffron

Orientales series

- *Crocus alatavicus* Semenova & Reg. – Alatava saffron
- *Crocus korolkowii* Regel ex Maw – Korolkov saffron
- *Crocus michelsonii* B. Fedtsch. – Michelson saffron

Reticulati series

- *Crocus abantensis* T.Baytop & B.Mathew – Abanten saffron
- *Crocus ancyrensis* (Herb.) Maw – Anchor saffron

- *Crocus angustifolius* Weston – *Narrow-leaved saffron*
- *Crocus cancellatus* Herb.
- *Crocus cvijicii* Kos.
- *Crocus dalmaticus* Vis. – *Dalmatian saffron*
- *Crocus gargaricus* Herb. – *Gargara saffron*
- *Crocus hermoneus* Kotschy ex Maw – *Hermoneus saffron*
- *Crocus reticulatus* Steven ex Adams – *Reticulated saffron*
- *Crocus robertianus* C.D.Brickell – *Robertian saffron*
- *Crocus rujanensis* Randjel. & D.A. Hill – *Ruyan saffron*
- *Crocus sieberi* J.Gay – *Siber saffron*
- *Crocus sieheanus* Barr ex B.L. Burt

Speciosi series

- *Crocus pulchellus* Herb. - *Beautiful saffron*
- *Crocus speciosus* M. Bieb. - *Beautiful saffron*

2. Subgenus Crociris

- *Crocus banaticus* J. Gay – *Banat saffron*

However, there are a number of serious differences in the classification given by different authors of this extremely polymorphic genus. Serious differences occur when some hybrid forms, subspecies are raised to the level of species or, conversely, some species are canceled from species status.

There are 6 types of common saffron in Azerbaijan: Common saffron - *C. sativus* L., Caspian saffron - *C. caspicus* Fischer&Meyer, Adam's saffron - *C. adamii* J. Gay, Artvin saffron - *C. artvinensis* (J. Philippov) Grossh., Beautiful saffron - *C. speciosus* M. Bieb., Multi-flowered saffron – *C. polyanthus* Grossh.

Cultivation: The history of saffron cultivation is ancient - it is believed to have been cultivated in the Middle East ~3500 years ago as a valuable medicinal and spice plant. There is information about the use of embalming mummies in ancient Egypt. His name is mentioned in the Bible (Old Testament) in the "Song of Songs" and is found in Homer's "Iliad". It is believed that the first place where it was cultivated was Mino on the island of Crete in the Mediterranean Sea during the Bronze Age. In the Middle Ages, the demand for this valuable spice led to its cultivation on a larger scale.

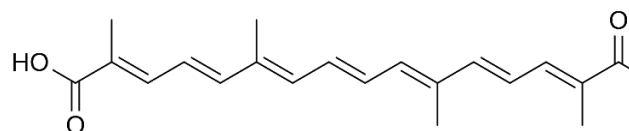
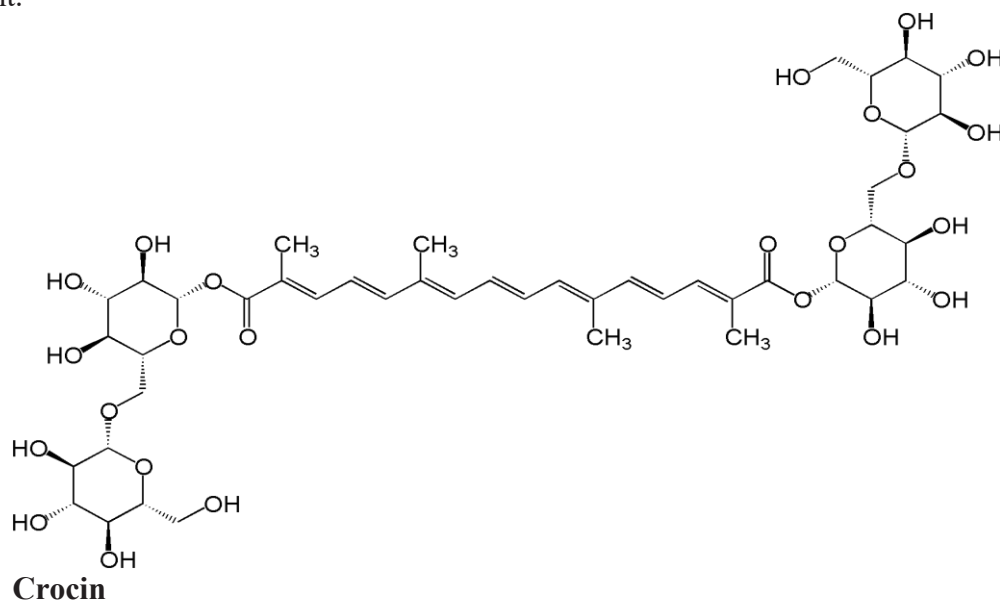
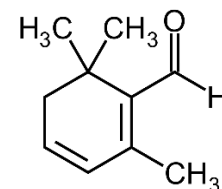
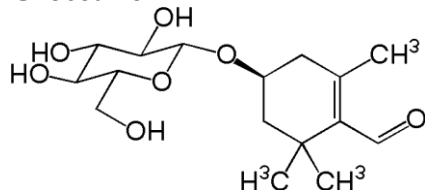
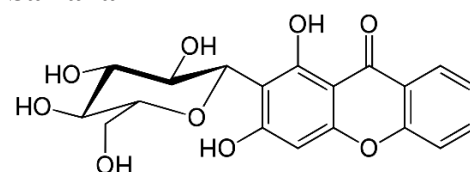
A typical type is the common or cultivated saffron – *Crocus sativus* L. Saffron is a bulbous plant with roots. It can be said that it is spread in almost all continents of the world (Asia, Europe, Australia, Africa, as well as South and North America as an invasive plant). In India, Iran, Pakistan, Afghanistan, Egypt, Morocco, Azerbaijan, Spain, Turkey, USA, Mexico, etc. It is widely cultivated in countries mainly under irrigation conditions. The largest producer of saffron is Iran - up to ~200 tons are exported annually, that is, up to ~60-65% of the total production. It is cultivated mainly through bulbs. In Azerbaijan, it is mainly cultivated on the Absheron Peninsula, in the villages of Baku, using onions. Although saffron is cultivated in early spring in many areas of the world, it is planted in autumn (September-November) in Azerbaijan. Currently, they are dealing with the problem of increasing its cell culture by biotechnological method (Karagezov and Dr., 2005).

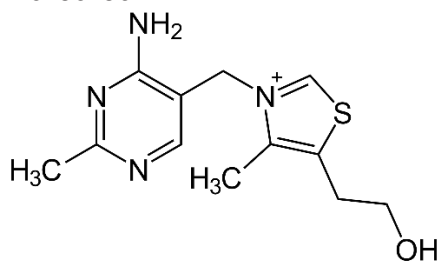
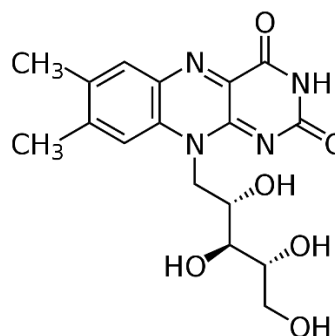
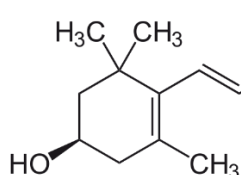
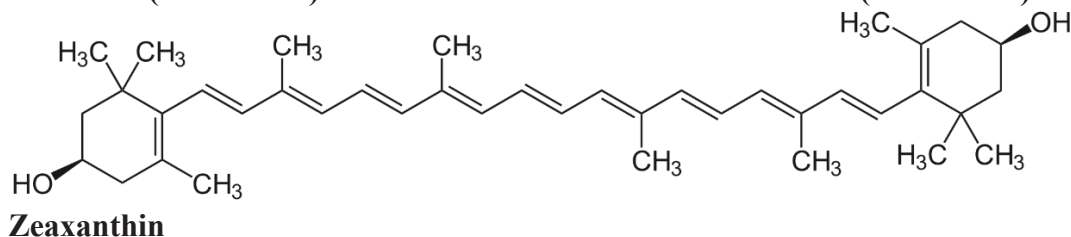
Phytochemistry, beneficial properties and use: chemical composition and beneficial properties of saffron in Azerbaijan by the late F.Y. Gasimov and others. (2005), F.I.Abdullayev (1993, 2002), E.N.Novruzov and others. (2018) and investigated by others. The composition of saffron is antioxidant, antibacterial, antiradical, antimicrobial, restorative, etc. essential oil with properties is rich in biologically active polyphenols - carotenoids, flavonoids, anthocyanins (table 1).

Table 1. Chemical composition of saffron (by whole plant, abbreviated)

Essential oil (~0,6-0,9%)	1) Pinene; 2) Cineol; 3) 2,2,6-trimethylcyclohexadiene-4-6-aldehyde
Volatile compounds (~150 names)	Thiamine vitamin (B group vitamin)
Picrocrocin glycoside (~4,2-28%)	Riboflavin vitamin (B group vitamin)
Safronal glycoside (~0,4-0,48%)	Group A and C vitamins
Crocin glycoside	Crocin (yellow dye, ~18-37%)
Fatty oils	Kaempferol
Isoramnetin	Ascorbic acid
Anthocyanin	Protocrocin
Carotenoids	Crocetone
Magniferin	Lycopene
Zeaxanthin	Resin (gum)
Elements (Fe, Zn, Se, Mn, etc.)	Nitrogen compounds
Sugars	Salts (potassium, calcium, selenium, phosphorus)

Below are the formulas of substances included in the composition of saffron and which play a key role in the biosynthesis of a number of valuable biologically active substances in the plant.

**Crocetin****Safranal**

Picrocrocin**Magniferin****Thiamine (vitamin B1)****Riboflavin (vitamin B2)**

The color of saffron species is due to crocins (crocin (digentibioside), β -crocetin (monomethyl ether), γ -crocin (dimethyl ether)), which are derivatives of the water-soluble carotenoid crocetin, as well as various glycosides of crocin (gentibioside, glucogentibioside, mono- and diglucosides). The taste of saffron is determined by picrocrocin glycoside and its hydrolysis products. The fact that it has a bright and attractive color, pleasant aroma and taste makes its use invaluable in coloring, flavoring and flavoring various food products and dishes.

Among the flavonoids, 6-hydroxyflavones are found naturally and freely only in saffron. Saffron is considered to be one of the plants that most absorb the element selenium from the soil, which has the valuable property of keeping the body young by increasing the regeneration of cells. The substances contained in saffron, especially essential oils and glycosides, significantly improve the quality of all foods to which they are added, besides making the food attractive not only in terms of taste and aroma, but also increase the activity of the digestive organs, increase the antiseptic and bactericidal values of the food, improve the sense organs of taste and smell (mouth, nose) improves its activity, regulates overall metabolism by speeding up.

Saffron is an indispensable regulator of the nervous and cardiovascular systems - the substances contained in it eliminate nervous tension, psychosis and neurosis, normalize the rhythm of the heart, strengthen the activity of the heart, and improve mood. It is no coincidence that in ancient times, nobles belonging to the ruling class eliminated depression and improved their psychological state by smelling (inhalation) the aromatic threads of the plant (A. El Midaoui et al., 2022). There is also information in the literature about the use of sexual weakness in the treatment of diseases such as infertility and infertility (A.Goyal et al., 2024).

Mainly strands of saffron are used. 1 kg of saffron thread with a price of 6500-10000 dollars is obtained from ~60-80 thousand plants or ~180-200 thousand plant flowers. The strands, flowers and leaves of saffron are used for various purposes both in our household and in non-traditional medicine, as well as in official medicine and pharmacology. In the household, mainly the fibers of the plant are used as spices - as a flavoring, flavoring and coloring additive in pilaf, piti, some soups, etc. is added to the composition. Infusions made from the strands of the plant are used to treat general fatigue, heart weakness, loss of appetite, vision, etc. It is useful for people with problems, especially children. Infusions are prepared with hot and warm

water, as well as with cold water to eliminate the thermal decomposition of valuable substances in the strands. Washing/wiping the eyes with such an infusion (extract) before going to bed relieves eye fatigue and helps restore vision. It is considered one of the effective natural substances in conjunctivitis. This is explained by the fact that the extract improves the growth of eye stem cells and regulates their regeneration (Гашимова и др., 2018). Both oral intake of the extract and eye washes (wipes) or compresses/lotions prevent insomnia, headaches and prolonged migraines, oral loss of appetite and digestive problems.

Saffron is used in the treatment of (chronic) bronchitis, bronchial asthma and many diseases related to breathing. The strands, leaves and flowers of saffron are not only dyes and fragrances, but preparations rich in strong antiradical, antioxidant and antimicrobial substances obtained from them are already used in official medicine in the treatment of some types of cancer (e.g. cystitis), ophthalmological (eye) diseases (Z. Khorasanchi et al., 2018). Saffron extract and crocin have positive effects in the treatment of type II diabetes (P.P.G. Amatto et al., 2024), neurodegenerative diseases (W. Yang et al., 2023).

Saffron relieves spasms and energy stagnation in the small pelvic organs by improving blood circulation and boosting local immunity. This, in turn, normalizes the state and function of the organs of the urinary tract and genital tract (genitourinary). It improves the quality of both spermatozoa (fertilization ability) and ovum (fertilization ability). Improves blood circulation, especially liver function. By increasing immunity and regulating metabolism, it has a positive effect on people with chronic colds and kidney stones. It is useful for convulsions and convulsions.

But the "King of Spices" like other natural herbal remedies to be taken strictly in proper order and quantity. E.g. A single intake of 0.5 grams of saffron powder can cause severe poisoning with even fatal outcome. Long-term use of the threads as a medicinal perfume can also lead to damage to the airways and lungs. In both cases, as a result of over-excitation of the nerves, heart attacks, spasms of the vessels of the brain, etc. can cause serious unpleasant situations. Before going to sleep, it is not recommended to take any preparation of the plant orally. In addition, if there is a sensitivity to saffron, it is strictly prohibited to take saffron spices and preparations during pregnancy or breastfeeding. This also applies to children up to 10 years of age who show contraindications to saffron.

2. CONCLUSION

Currently, there are numerous saffron preparations for use in various diseases and body problems. These recipes contain only saffron and its combination with other herbs, raisins, honey, butter, eggs, rose water (gulab), cranberry juice, orange juice, ginger, black tea, etc. they consist of complex preparations with additives.

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First record of *Prozercon semiseparatus* from Türkiye (Acari: Mesostigmata: Zerconidae)

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Abstract

Various biological materials, such as humus, plant litters, soils and moss samples are collected between February 2021 and May 2023 period from Gaziantep province, southern Türkiye. Based to collected materials mite specimens belonging to the family Zerconidae are extracted by using stereo-microscope. Then, zerconid mites are placed in 60% lactic acid. According to update literatures, these mites are identified using light-microscope. Among identified species, *Prozercon semiseparatus* is recorded for the first time from Türkiye. Descriptions, measurements, figures of the female, male, deutonymph and protonymph specimens are given. Geographical distribution of the species are also presented.

Keywords: mite, new record, Gaziantep

1. INTRODUCTION

Mites are invertebrate animals belonging to Arachnida class of Arthropoda phylum, ranging in size from 0,1 to 10 milimeters, living in debris and soil, in water, stored products, house dusts, plants and animals as internal and external parasites. They have a wide spreading range from the poles to the deserts, also show great differences in terms of body structure, size and behavior.

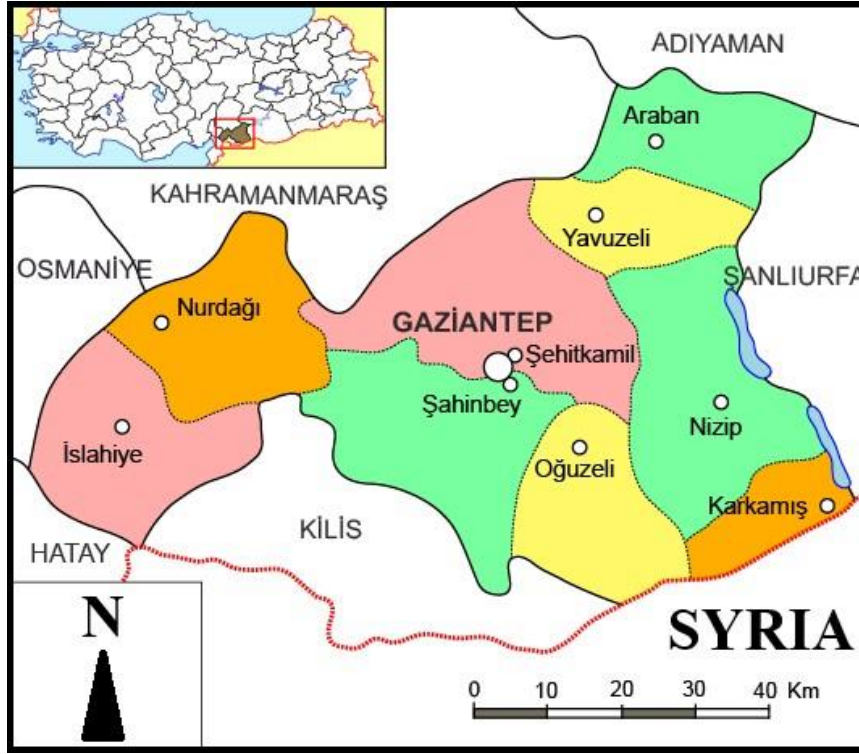
Soil mites are one of the richest invertebrate groups in terms of both species and number of individuals in soil ecosystems (Ghilarov, 1963). There are many small arthropods in the litter on the forest floor, most of them are mites. Mites form an 80% group of among microarthropods in the soil fauna (Petersen, 1982). Soil mites play important roles in soil biological efficiency by contributing to the decomposition of organic matter, the synthesis of humus, the protection of biological elements, and the stimulation of fungal and bacterial metabolism (Ghilarov, 1963).

Members of the family Zerconidae are called as zerconid mites. They can colonise in various soil substrates and their idiosomal length varying between 200-700 µm. These mites are weakly sclerotized and their life cycle include four active stages; larva, protonymph, deutonymph and adult. They are free-living and mostly associated with humus and soil, decomposed litter, leaf mould, plant parts, and among mosses. Zerconids are oligophagous predators and their diet include nematodes (Martikainen & Huhta, 1990). These small, predatory mites feed on the eggs, larvae and nymphs of other mites and springtails (Shereef et al., 1984).

The family Zerconidae is well known from the Holarctic region (Krantz, 1978). In present, 47 genera which are comprised of more than 500 species. Only two genera, *Prozercon* and *Zercon*, are known from Türkiye. Until now, 92 species of the genus *Zercon* and 39 species of the genus *Prozercon* have been recorded from Türkiye (Urhan & Karaca, 2024). Most of them are endemic species to the country.

The genus *Prozercon* is the second richness genus of zerconid mites both in Türkiye and the Holarctic region. Previously, species records of the genus were given from different habitats (mostly from moss and litters of pine, oak and juniper trees) from the country. In order to reveal Zerconidae fauna of Gaziantep province of Türkiye, litter and moss samples were collected and investigated. Specimens of *Prozercon semiseparatus* Ujvári, 2009, which is the new record for Turkish fauna, was defined according to the samples collected from Gaziantep province (Figure 1).

Figure 1. Location of Gaziantep province on Türkiye map and its counties (Url-1).



2. MATERIAL and METHODS

2.1. Materials

The main material of this study is soil, litter and moss samples collected from various habitats of İslahiye county (Gaziantep province) between 15 February 2021 and 28 March 2022. Samples with mites were placed into plastic bags, labelled and transferred to the acarology laboratory for identification processes

2.1.1 List of Collected Materials

27-02-04: Soil, litter and moss samples under Turkish pine (*Pinus brutia*), 37° 1.948' N, 36° 38.008' E, 525 m. a.s.l., vicinity of Atatürk avenue, 15.02.2021, leg. C. Bostancı.

27-02-19: Soil and litter samples under Turkish pine (*Pinus brutia*), kermes oak (*Quercus coccifera*) and common hawthorn (*Crataegus monogyna*), 37° 03.604' N, 36° 36.977' E, 538 m. a.s.l., vicinity of Hanağzı village, 28.03.2022, leg. C. Bostancı.

2.2. Methods

Samples were placed into combined Berlese funnels, and mites were extracted for 5-7 days according to their humidity. Zerconid mites were separated under a stereomicroscope (Olympus SZ51) using a forceps, needle and dropper. They were placed in 60% lactic acid for clearing and mounted onto permanent microscope slides using a glycerine medium. The examination of mites were done using an Olympus CX41 microscope with DP25 camera. After identification processes, zerconid mites were photographed, their shapes were drawn and different idiosomal parts were measured. Then, examined materials were put in stock bottles containing 70 % alcohol and 1-3 drops glycerine and labelled. All materials are deposited at the

PAU (Acarology Laboratory of Pamukkale University, Denizli, Türkiye). The terminology of setae follows that of Sikora (2014). Abbreviations of F, M, DN and PN were used for female, male, deutonymph and protonymph specimens, respectively. All measurements are given as micrometers (μm).

3. RESULTS and DISCUSSION

After identification processes, it is understood that the following specimens of *P. semiseparatus* found in two different locations in the study area.

27-02-04: 30 F, 28 M, 26 DN, 12 PN.

27-02-19: 51 F, 10 M, 4 DN.

3.1. Taxonomy

Phylum: **Arthropoda** von Siebold, 1848
Class: **Arachnida** Cuvier, 1812
Subclass: **Acari** Zakhvatkin, 1952
Superorder: **Parasitiformes** Reuter, 1909
Order: **Mesostigmata** G. Canestrini, 1891
Suborder: **Monogynaspida** Camin & Gorirossi, 1955
Infraorder: **Gamasina** Kramer, 1881
Superfamily: **Zerconoidea** G. Canestrini, 1891
Family: **Zerconidae** G. Canestrini, 1891
Genus: **Prozercon** Sellnick, 1943
Type species: **Zercon fimbriatus** C. L. Koch, 1839
For detailed diagnosis of the genus, see Urhan & Karaca, 2023.

3.2. Descriptions of the Specimens

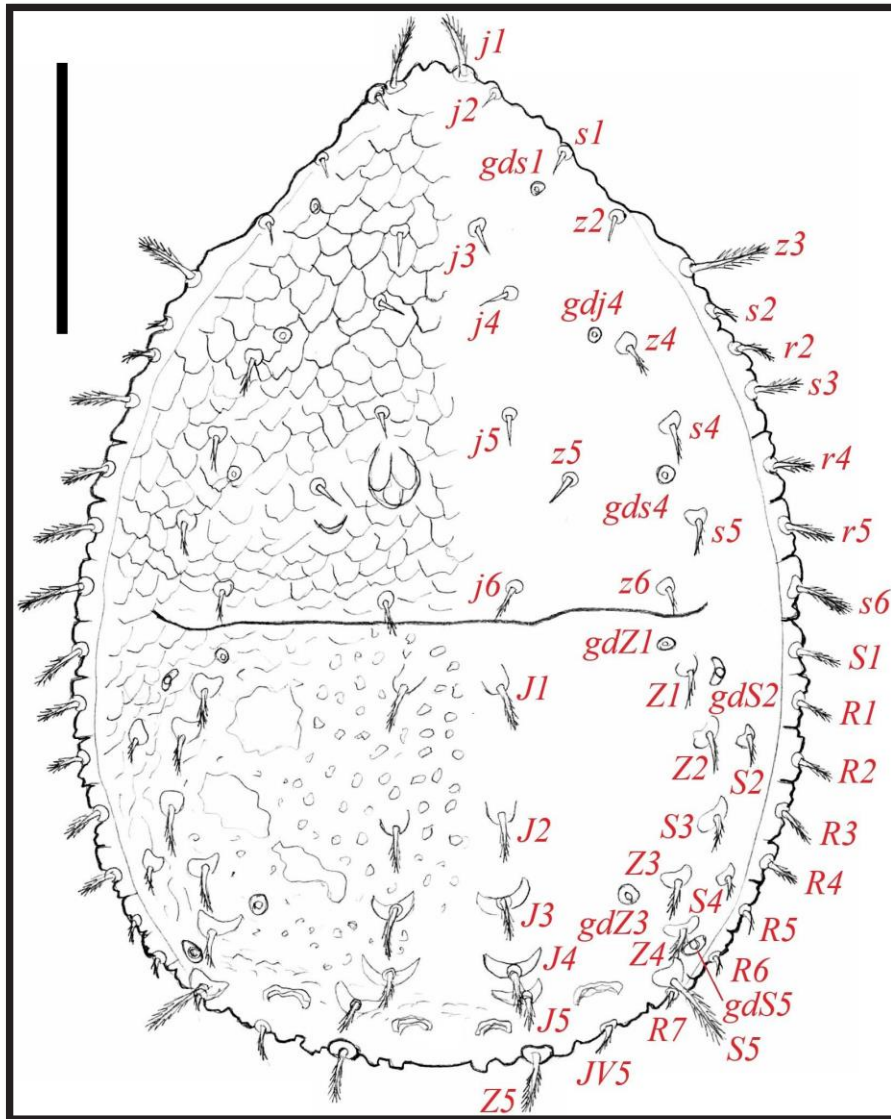
3.2.1 Female

Length 350–362 and width 249–262 of idiosoma, without gnathosoma (n: 10)

Dorsum (Figure 2). There are 20 pairs of setae present on podonotal shield, including *j1–6*, *z2–6*, *s1–6*, *r2* and *r4–5*. Bases of setae *r1* and *r3* on peritrematal shields, both of them inserted ventrally. Setae *j1* and marginal setae of podonotum (*z3*, *s2–3*, *r2* and *r4–5*) densely plumose. Setae *j6*, *z4*, *z6* and *s4–5* pilose, remaining setae (*j2–5*, *z2*, *z5* and *s1*) short, smooth and needle-like. Setae *j6* and *z6* extend the margin of posterior part of podonotum. Tile-like patterns present on podonotal shield. There are 22 pairs of setae present on opisthonotal shield, including *J1–5*, *Z1–5*, *S1–5* and *R1–7*. All opisthonotal setae pilose or plumose. Setae *Z5* and *S5* densely plumose and brush-like. Remaining opisthonotal setae (*J1–5*, *Z1–4* and *S2–4*) pilose and shorter. In the marginal row, setae *S1* and *R1–4* plumose and longer than pilose setae *R5–7*. Not any of opisthonotal setae reaching the following's bases. Only setae *Z5* and *S5* extend beyond the margin of opisthonotum. The intervals between *Z5–Z5* and *Z5–JV5* 65–71 and 20–27, respectively. Irregular punctate patterns present on opisthonotum.

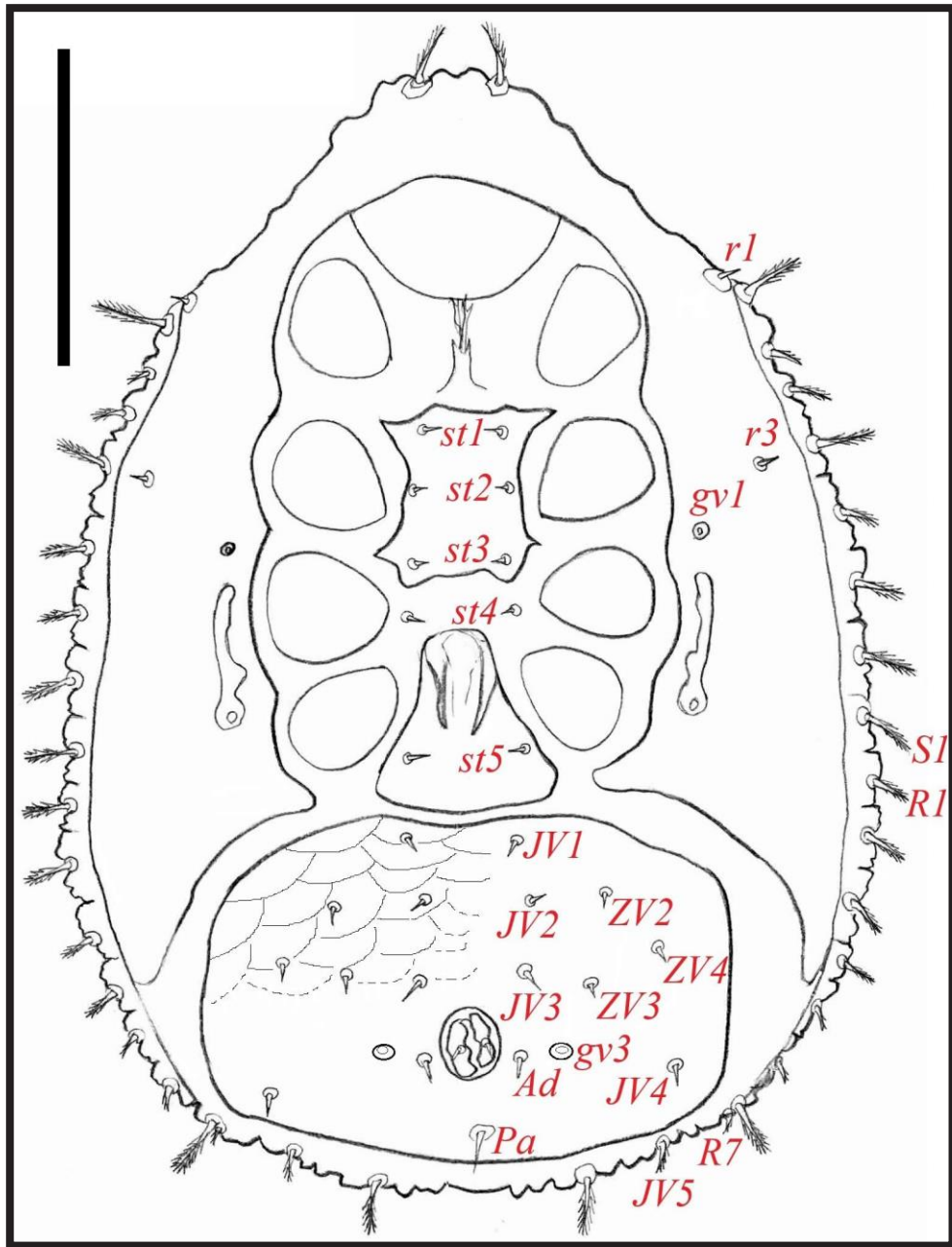
Pores (Figure 2). Gland pores *gds1* situated among setae *j3* and *s1*, closer to *s1*, *gdj4* situated among setae *j4* and *z4*, closer to *z4*, *gds4* situated among setae *z6* and *s4*, closer to *s4*, *gdZ1* situated above the base of seta *Z1*, *gdS2* situated among setae *Z1* and *S1*, closer to *Z1*, *gdZ3* situated among setae *J4* and *Z3*, closer to *Z3*, *gdS5* situated below the base of seta *S4*.

Figure 2. Dorsal view of *Prozercon semiseparatus*, female (scale: 100).



Venter (Figure 3). All morphological characters (ornamentation, poroidotaxy, chaetotaxy etc.) of ventral side of the female specimens are characteristic for the genus. On the peritrematal shield, the posterolateral parts extend the level of seta *R4–5*. Two setae present on peritrematal shield, *r1* and *r3*, both of them short, smooth and needle-like. Peritreme is shaped like inverted comma. Gland pore *gv1* situated above the anterior part of peritreme, at the level of between coxae 2–3. There are three pairs of setae (*st1–3*) present on sternal shield. Only one pair of setae (*st5*) present on epigynal shield. Seta *st4* situated among sternal and epigynal shields, at the level of coxa 3. All the above-mentioned setae (*st1–5*) short, smooth and needle-like. Gland pore *gv2* absent. Because of the absence of seta *ZV1*, there are two setae on the anterior margin of ventrianal shield. All of the setae (*JV1–4*, *ZV2–4* and *Ad*) on ventrianal shield short and smooth. Gland pore *gv3* situated closer to the base of adanal seta. Postanal seta (*Pa*) is single. Seta *JV5* plumose. Anterior part of ventrianal shield with squamous patterns and these extend the level of setae *JV3* and *ZV4*, remaining parts of ventrianal shield smooth.

Figure 3. Ventral view of *Prozercon semiseparatus*, female (scale: 100).



3.2.2. *Male* (Figures 4–5)

Length 291–304 and width 208–221 of idiosoma, without gnathosoma (n: 10).

Chaetotaxy of idiosomal setae, location of gland pores, ornamentation of dorsal and ventral shields similar to those of female. The intervals between Z5–Z5 and Z5–JV5 53–61 and 13–20, respectively. Sternogenital shield with four pairs (*st1–4*) of setae.

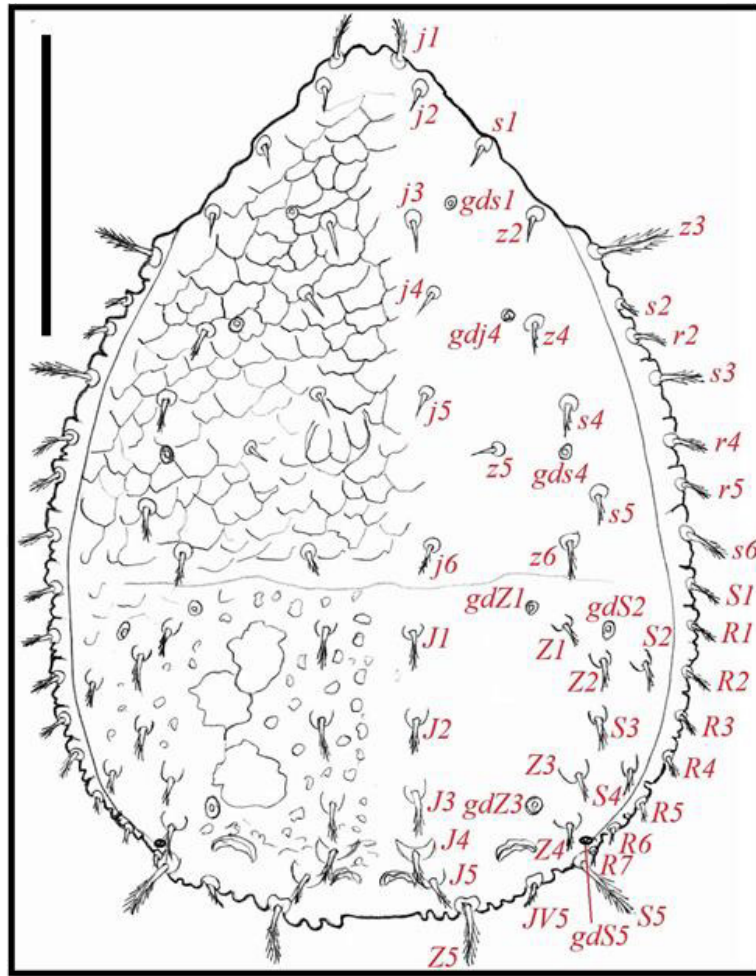
3.2.3. *Deutonymph* (Figure 6)

Length 290–299 and width 206–217 of idiosoma, without gnathosoma (n: 10).

Dorsum. There are 20 pairs of setae present on podonotal shield, including *j1–6*, *z2–6*, *s1–6*, *r2* and *r4–5*. Bases of setae *r1* and *r3* on peritrematal shields, both of them inserted ventrally. Setae *j1*, *z3*, *s3*, *s6* and *r5* densely plumose, remaining podonotal setae (*j2–6*, *z2*, *z4–6*, *s1–2* and *s4–5*) short and

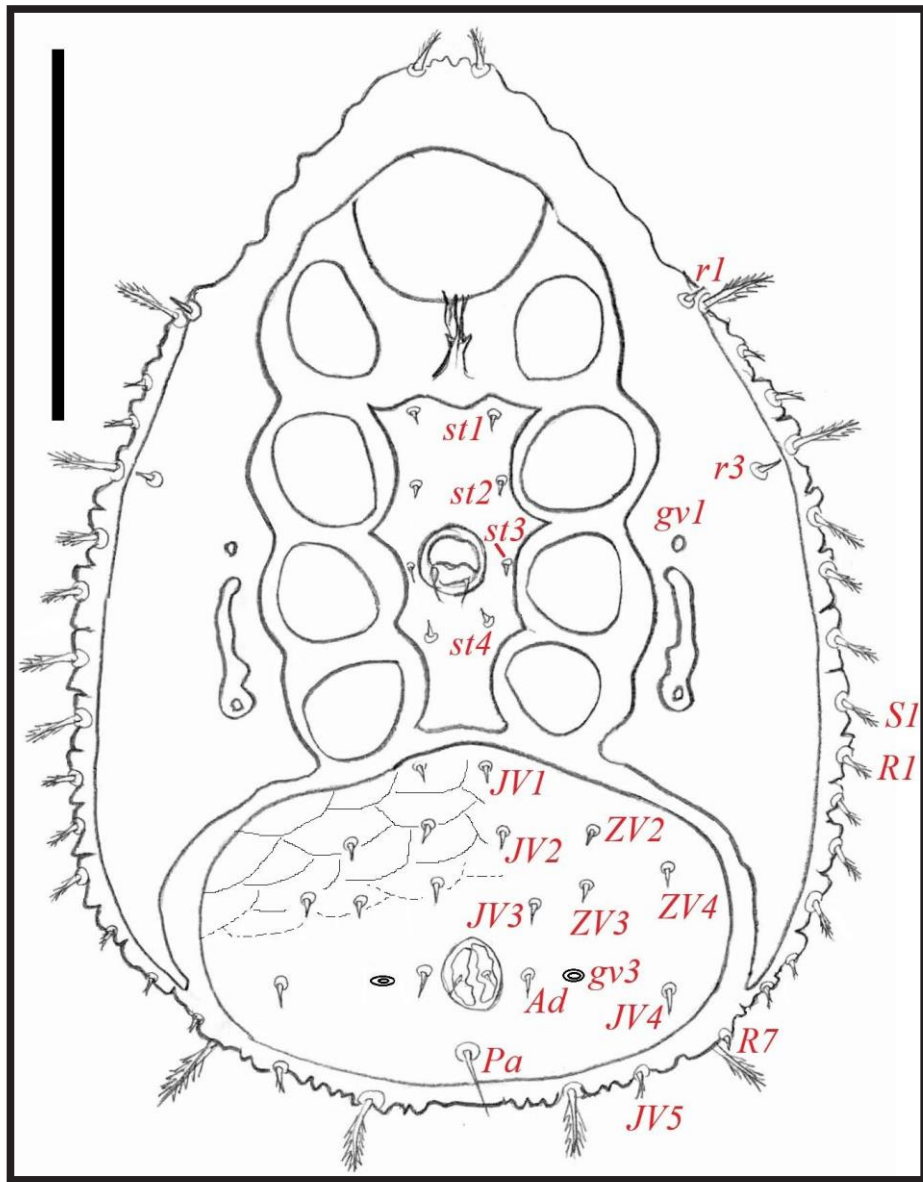
smooth. None of setae extend the margin of posterior part of podonotum. Ambiguous tile-like patterns present on podonotal shield. There are 22 pairs setae present on opisthonotal shield, including *J1–5*, *Z1–5*, *S1–5* and *R1–7*. All opisthonotal setae pilose or plumose, except marginal setae. Setae *Z5* and *S3–5* densely plumose, brush-like and extend beyond the margin of opisthonotum. Remaining opisthonotal setae (*J1–5*, *Z1–4* and *S2–4*) shorter and finely plumose or pilose. In the marginal row, all setae (*S1* and *R1–7*) short, smooth and needle-like. Only setae *J3–4* reaching the following's bases. The intervals between *Z5–Z5* and *Z5–JV5* 59–65 and 11–16, respectively. Opisthonotal shield smooth with a few ambiguous punctate patterns.

Figure 4. Dorsal view of *Prozercon semiseparatus*, male (scale: 100).



Pores. Gland pores *gds1* situated among setae *j3* and *s1*, *gdj4* situated among setae *j4* and *z4*, closer to *z4*, *gds4* situated among setae *s4* and *s5*, *gdZ1* situated above the base of seta *Z1*, *gdS2* situated among setae *Z1* and *R1*, closer to *Z1*, *gdZ3* situated among setae *J4* and *Z3*, closer to *Z3*, *gdS5* situated below the base of seta *S4*.

Figure 5. Ventral view of *Prozercon semiseparatus*, male (scale: 100).

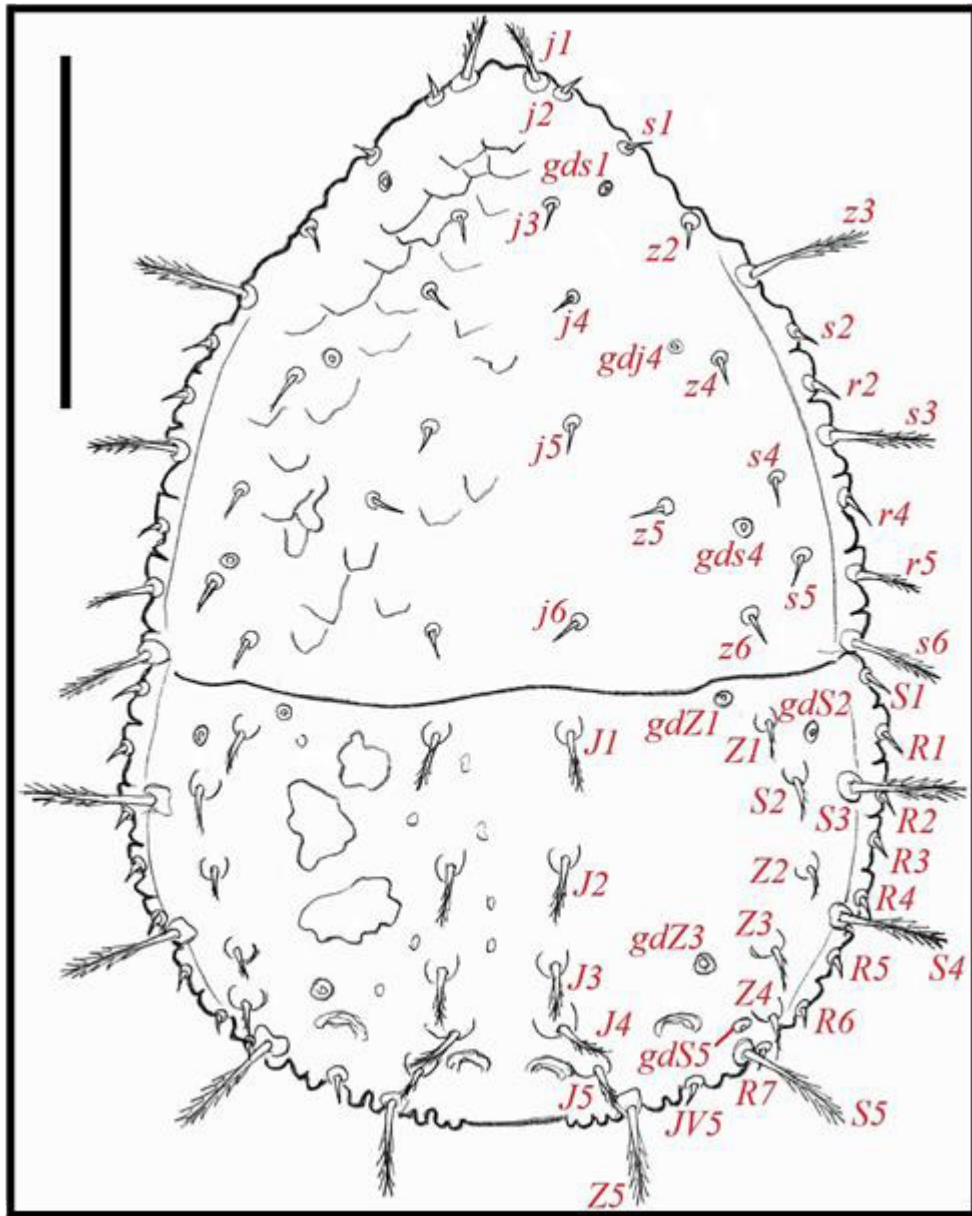


3.2.4. Protonymph (Figure 7)

Length 233–245 and width 151–168 of idiosoma, without gnathosoma (n: 10).

Dorsum. There are 12 pairs of setae present on podonotal shield, including j1–6, z4–6, s4, s6 and r2. Setae j1, z4, s4 and r2 longer and densely plumose, remaining podonotal setae (j2–6, z5–6 and s6) short, smooth and needle-like. None of setae extend the margin of posterior part of podonotum. Podonotal shield with smooth patterns. There are 14 pairs of setae present on opisthonotal shield, including J1–5, Z1–5 and S2–5. Longer opisthonotal setae (Z5 and S3–5) densely plumose and extend beyond the margin of opisthonotum. Remaining opisthonotal setae (J1–5, Z1–4 and S2) short, smooth and needle-like. In the marginal row, all setae invisible. None of opisthonotal setae reaching the following's bases. The intervals between Z5–Z5 and Z5–JV5 48–55 and 11–16, respectively. Opisthonotal shield with smooth patterns.

Figure 6. Dorsal view of *Prozercon semiseparatus*, deutonymph (scale: 100).



Pores. All gland pores on podonotum invisible. On opisthonotum, gland pores *gdZ1* situated above the base of seta *Z1*, *gdZ3* situated among setae *J2* and *Z3*, closer to *Z3*, remaining opisthonotal gland pores (*gdS2* and *gdS5*) invisible.

Remarks. According to the original description, *P. semiseparatus* has an interesting distinguishing character among all *Prozercon* species. Podonotal and opisthonotal shields

not clearly separated, seem to be fused laterally, fissure between shields on lateral parts hardly perceptible (Ujvári, 2009). This distinctive feature was also observed in the samples we collected from Gaziantep province (Figures 2, 4, 6–7)

3.3. Measurements for Opisthonotal Setae

Average lengths and ranges of the opisthonotal setae in *P. semiseparatus* specimens were given in Table 1.

Figure 7. Dorsal view of *Prozercon semiseparatus*, protonymph (scale: 100).

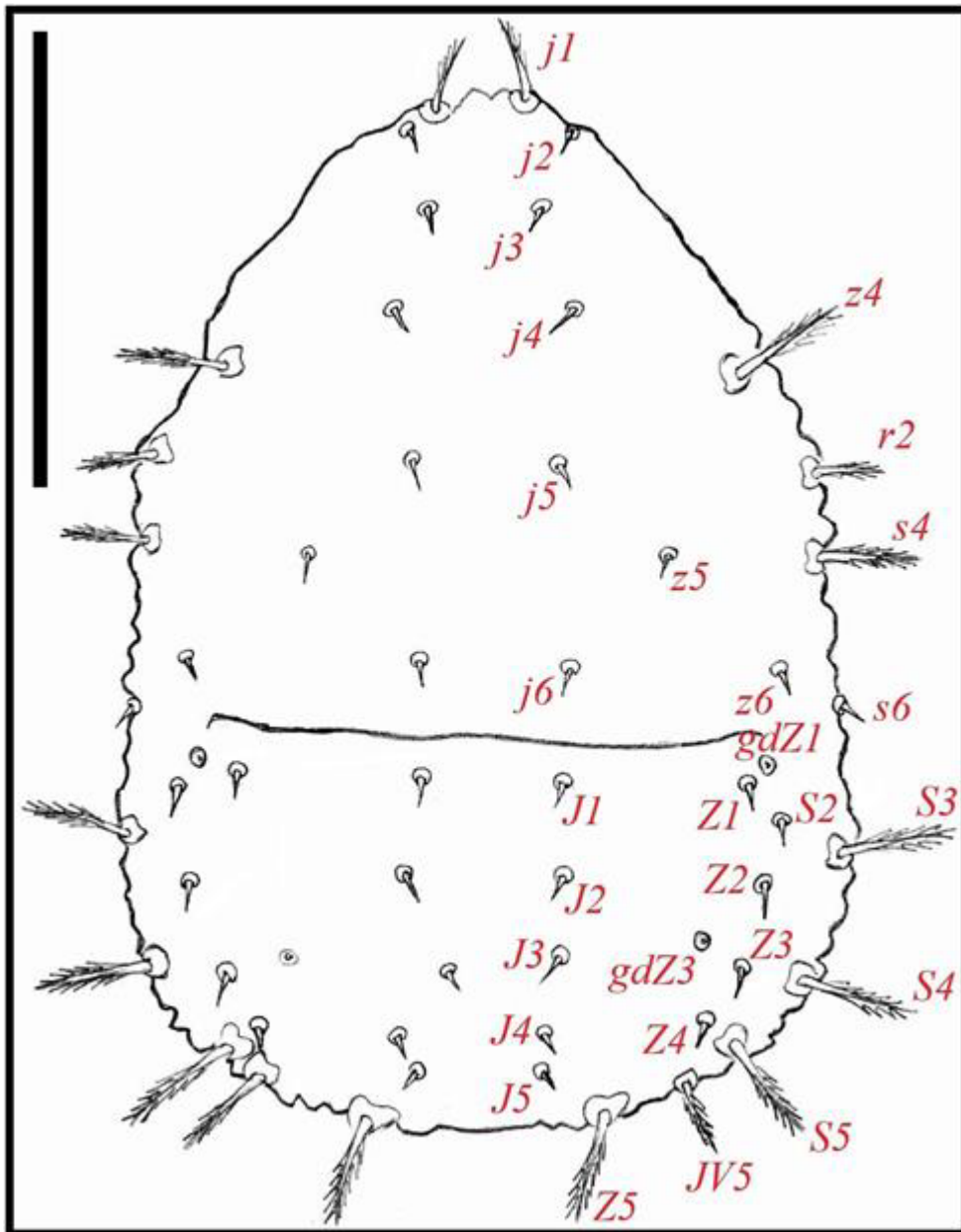


Table 1. Average lengths of opisthonotal setae in female male, deutonymph and protonymph specimens.

Setae	♀	♂	DN	PN	Setae	♀	♂	DN	PN	Setae	♀	♂	DN	PN
<i>J1</i>	22	17	19	10	<i>Z1</i>	23	13	13	8	<i>S1</i>	17	15	8	-
<i>J1-2</i>	35	33	36	30	<i>Z1-2</i>	41	38	36	31	<i>S1-2</i>	31	42	33	-
<i>J2</i>	18	17	17	11	<i>Z2</i>	20	15	15	7	<i>S2</i>	20	14	14	8
<i>J2-3</i>	26	27	28	29	<i>Z2-3</i>	25	31	26	24	<i>S2-3</i>	16	18	19	17
<i>J3</i>	18	17	16	10	<i>Z3</i>	18	18	15	13	<i>S3</i>	15	14	34	33
<i>J3-4</i>	26	18	17	24	<i>Z3-4</i>	17	20	14	20	<i>S3-4</i>	45	40	36	33
<i>J4</i>	15	13	17	10	<i>Z4</i>	14	19	16	31	<i>S4</i>	17	16	36	31
<i>J4-5</i>	15	15	14	17	<i>Z4-5</i>	71	61	42	37	<i>S4-5</i>	44	41	42	38
<i>J5</i>	12	18	12	8	<i>Z5</i>	28	30	32	32	<i>S5</i>	31	30	36	28

3.4. Distribution

According to the published literature, it was determined that this species reported from Cyprus Island (Kakopetria village, Trodos Mountains) previously and this is the first record from Türkiye (Figure 8).

Figure 8. Known distribution of *Prozercon semiseparatus*.



4. CONCLUSION

Several systematic studies are going on zerconid mites in the different part of Türkiye. Although these mites are well-studied in the western part of Anatolia, there are many areas in other parts of the country that have not yet been studied, especially in the Eastern and Southeastern Anatolia regions. There is the potential to discover many new species and new records with new systematic studies to be conducted in the mentioned regions, and species diversity for the Zerconidae fauna of the country will increase.

Among the Zerconidae specimens which were collected from Gaziantep province, 81 female, 38 male, 30 deutonymph and 12 protonymph specimens of *P. semiseparatus* were found. After identification process, different body parts of the specimens were measured and drawn. In addition, geographic distribution of this species was presented based on current literatures. Also, immature specimens (deutonymph and protonymph) are found and described for the first time in this study. The number of *Prozercon* species known from Türkiye rised to 39.

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Altitude and habitat preferences of zerconid mites (Acari: Zerconidae) in Akdağ National Park, Türkiye

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Abstract

Mites, one of the microscopic living groups in the soil ecosystem, have important roles such as humus formation and stimulation of fungal and bacterial metabolism. Akdağ National Park covering the study area is one of the 49 national parks in Türkiye. Zerconidae mites fauna of this protected area was determined as a result of studies carried out in 2018. Accordingly, 11 different species of zerconids were previously reported from Akdağ National Park. Although systematic/taxonomic studies on zerconids come into prominence, ecological data for this group are quite limited. In this context, the altitude and habitat preferences of all zerconid mites reported from the area were presented herein. Totally 6198 specimens were noted from 74 different localities, altitudinal ranges were marked between 867 and 1941 meters a.s.l. and 18 different habitat types were also recorded in the study area. As a result, it is predicted that zerconid mites have various altitude and habitat preferences. Detailed investigations are also needed to clarify the reasons for these preferences. This study aimed to contribute to the ecology of zerconid mites.

Keywords: Mesostigmata, ecology, Afyonkarahisar, Denizli

1. INTRODUCTION

Akdağ is a protected area which has a rich flora and fauna elements and is a home for several endangered species. The area of approximately 15 thousand hectares located within the borders of Çivril district of Denizli and Sandıklı district of Afyonkarahisar was designated as “Akdağ Nature Park” by the Ministry of Agriculture and Forestry on June 29, 2000 due to its natural and cultural values. This area gained national park status with the Presidential Decree published on January 18, 2024 and became the 49th national park of Türkiye (Figure 1).

Figure 1. An aerial view from the Akdağ National Park (Url-1).



Mite fauna of the family Zerconidae of this protected area was determined as a result of studies carried out in 2018. In that study, 11 different species (2 species of them belonging to genus *Prozercon*: *P. banazensis* and *P. bulbiferus*; remaining 9 species belonging to genus *Zercon*: *Z. afyonensis*, *Z. beleviensis*, *Z. cokelezicus*, *Z. colligans*, *Z. hispanicus*, *Z. huseyini*, *Z. inonuensis*, *Z. kallimcii* and *Z. ozkani*) of zerconids were previously recorded from Akdağ National Park (Urhan et al., 2018). Although systematic/taxonomic studies on zerconids come into prominence, ecological data for this group are quite limited. In this context, the altitude and habitat preferences of all zerconid mites reported from the area were presented herein. This study aimed to contribute to the ecology of zerconid mites.

2. MATERIAL and METHODS

Based on the biological materials which were collected in 2018 year (Figure 2), all Zerconidae specimens were reviewed. Totally 6198 specimens were noted from 74 different localities in the Akdağ National Park, altitudinal ranges of the specimens were marked between 867 and 1941 meters a.s.l. and 18 different habitat types were also recorded in the study area. Abbreviations of F, M, DN, PN were used for female, male, deutonymph and protonymph specimens, respectively.

Figure 2. Various photographs from the field studies carried out in Akdağ National Park in 2018.



3. RESULTS and DISCUSSION

Totally, 11 species of zerconid mites were reported from the study area previously (Table 1). All specimens of these species were reviewed again for reveal the altitudinal and habitat preferences. According to the presence of Zerconidae specimens in the different altitudinal ranges and habitat preferences, results were presented in this section. Occurrences of specimens were marked in Tables 2 and 3.

Table 1. Species diversity of zerconid mites in the study area and number of examined specimens.

Species	Number of examined specimens	Total
<i>P. banazensis</i>	13 F, 4 M, 2 DN, 4 PN	23
<i>P. bulbiferus</i>	3 F, 3 M, 1 DN	7
<i>Z. afyonensis</i>	306 F, 133 M, 67 DN, 48 PN	554
<i>Z. beleviensis</i>	6 F	6
<i>Z. cokelezicus</i>	1468 F, 370 M, 267 DN, 118 PN	2223
<i>Z. colligans</i>	832 F, 294 M, 185 DN, 90 PN	1401
<i>Z. hispanicus</i>	91 F, 39 M, 40 DN, 12 PN	182
<i>Z. huseyini</i>	87 F, 34 M, 21 DN, 2 PN	144
<i>Z. inonuensis</i>	796 F, 352 M, 238 DN, 109 PN	1495
<i>Z. kallimcii</i>	54 F, 41 M, 28 DN, 6 PN	129
<i>Z. ozkani</i>	5 F, 18 M, 11 DN	34

3.1. Altitude preferences of the specimens

All localities where biological materials collected were divided into 100-meters intervals shown in Table 2. The altitudinal preferences of all zerconid mites found after identification process carried out in acarology laboratory are marked in Table 1.

Table 2. Altitudinal preferences of the specimens in the Akdağ National Park.

Altitudinal ranges (meters above sea level)	Species										
	<i>P. banazensis</i>	<i>P. bulbiferus</i>	<i>Z. afyonensis</i>	<i>Z. beleviensis</i>	<i>Z. cokelezicus</i>	<i>Z. colligans</i>	<i>Z. hispanicus</i>	<i>Z. huseyini</i>	<i>Z. inonuensis</i>	<i>Z. kallimcii</i>	<i>Z. ozkani</i>
867-900			x			x		x			
900-1000						x					
1000-1100						x					
1100-1200			x			x		x	x		
1200-1300		x		x		x	x	x			
1300-1400			x			x		x	x		x
1400-1500			x		x	x	x	x	x	x	
1500-1600					x	x	x	x	x		
1600-1700			x		x	x		x	x	x	
1700-1800	x		x		x	x			x		
1800-1900			x		x				x	x	
1900-1941			x		x				x		

According to Table 2, specimens of *P. banazensis*, *P. bulbiferus*, *Z. beleviensis* and *Z. ozkani* were found in a single altitudinal range. It was determined that specimens of *Z. afyonensis* have the widest vertical distribution (between 869-1947 m). Additionally, specimens of *Z. cokelezicus* and *Z. kallimcii* have only been found at altitudes of 1400 meters and above. For the remaining species, there is no certain preferences in terms of altitudinal ranges. Also, specimens belonging to at least one species were detected in each altitudinal ranges. In other words, there is no elevation range where Zerconidae species were not detected in the study area.

3.2. Habitat preferences of the specimens

For obtaining materials which containing zerconid mites, samples were collected in suitable habitats (usually forestland areas) within borders of Akdağ National Park. During field studies, all zerconid mite materials were collected from 18 different habitats (milkvetch, Lebanese cedar, laurel-leaved rock rose, hawthorn, walnut, undescribed juniper, common juniper, prickly juniper, garland thorn, Turkish pine, black pine, blackthorn, oleaster-leaved pear, oak, dog rose, blackberry, willow and undescribed moss), The habitat types of all zerconid mites found in the research area were shown in Table 3.

Table 3. Habitat preferences of the specimens in the Akdağ National Park.

Habitat types	Species										
	<i>P. banazensis</i>	<i>P. bulbiferus</i>	<i>Z. afyonensis</i>	<i>Z. beleviensis</i>	<i>Z. cokelezicus</i>	<i>Z. colligans</i>	<i>Z. hispanicus</i>	<i>Z. huseyini</i>	<i>Z. inonuensis</i>	<i>Z. kallimcii</i>	<i>Z. ozkani</i>
<i>Astragalus</i> sp.			x			x			x		
<i>Cedrus libani</i>						x					
<i>Cistus laurifolius</i>			x		x			x	x		
<i>Crataegus monogyna</i>								x			
<i>Juglans regia</i>											
<i>Juniperus</i> sp.	x		x		x	x			x		
<i>Juniperus communis</i>			x		x	x			x		
<i>Juniperus oxycedrus</i>		x				x		x		x	
<i>Paliurus spina-christi</i>			x		x	x		x	x	x	
<i>Pinus brutia</i>			x	x		x					
<i>Pinus nigra</i>			x		x	x	x		x		
<i>Prunus spinosa</i>									x		
<i>Pyrus elaeagrifolia</i>											
<i>Quercus</i> sp.			x	x	x	x	x	x			x
<i>Rosa canina</i>			x		x	x	x		x		
<i>Rubus fruticosus</i>					x				x		
<i>Salix</i> sp.					x				x		
Moss (undescribed)			x		x	x	x	x	x	x	

According to Table 3, specimens of *P. banazensis*, *P. bulbiferus* and *Z. ozkani* found in a single habitat type, specimens of *Z. beleviensis* found in two different habitat types, specimens of *Z. kallimcii* found in three habitat types, specimens of *Z. hispanicus* found in four habitat types. In addition, specimens of *Z. colligans* and *Z. inonuensis* were matched with 11 habitat types, specimens of *Z. afyonensis* and *Z. cokelezicus* were matched with 10 habitat types, specimens of *Z. huseyini* were matched with 6 habitat types, respectively. Considering the Zerconidae species hosted by different habitat types in the study area, the highest diversities were observed in moss and oaks habitats (both 7 species), garland thorn habitats (6 species), juniper, black pine and dog rose habitats (each 5 species), respectively. On the other hand, specimens of only one zerconid species were found in Lebanese cedar and blackthorn habitats. Additionally, no individuals of any zerconid species were found in walnut and oleaster-leaved pear habitats.

4. CONCLUSION

According to the recent Turkish literature, several systematic studies were conducted on zerconids and species lists of various provinces were revealed. For example, İstanbul (Duran and Urhan, 2017), Afyonkarahisar, Uşak, Kütahya (Urhan and Duran, 2019), Manisa (Urhan and Karaca, 2022), İzmir (Urhan and Karaca, 2023a), Aydın (Urhan and Karaca, 2023b), Balıkesir (Karaca and Urhan, 2023a), Tekirdağ (Karaca and Urhan, 2023b), Kırklareli (Karaca and Urhan, 2023c) and Edirne (Karaca and Urhan, 2023d) provinces were considered in this context. However, there is still a gap in ecological studies on this group.

In the present study, altitude and habitat preferences of the Zerconidae specimens in the Akdağ National Park were investigated. Although the diversity of zerconids was known previously in this protected area, some unrecorded ecological data on the species were revealed. From this aspect, present study has contributed to ecology of this family. As a result, it is predicted that zerconid mites have various altitude and habitat preferences. More detailed research is needed to clarify the reasons for these preferences.

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Green Bangle Project and Movement for Biodiversity, Environmental Conservation, and Sustainable Development

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Abstract

The Green Bangle Movement (GBM) is a pioneering grassroots initiative in Bangladesh, inspired by the principles of the Chipko and Green Belt movements. It focuses on empowering women through leadership in environmental conservation and promoting ecofeminism and ecopreneurship. The project aims to combat climate change and enhance biodiversity by planting 30,000 mangrove and palm trees in coastal areas like Guliakhali in Sitakunda, Chattogram. It addresses environmental issues such as soil erosion, species loss, and rising sea levels, with a selection of plant species including *Nypa fruticans*, *Borrossus flabelifer*, *Phoenix sylvestris*, and others. So far, 9,500 trees have been planted, contributing to landscape restoration and protecting threatened plant species. GBM also operates a nursery at AUW to nurture saplings for these initiatives. The movement has successfully engaged local women in environmental activities, training them in sustainable agriculture, nursery management, and handicrafts. Women in Guliakhali use their homes to grow saplings and create crafts from palmyra leaves, promoting eco-friendly livelihoods. GBM also plans to provide microloans and technical support to further empower women's eco-friendly businesses, strengthening the economic resilience of local communities. By raising awareness and fostering proactive conservation efforts, GBM aims to inspire widespread adoption of sustainable practices across Bangladesh and Asia, creating a future where environmental conservation and sustainable living are core values.

Keywords: Mangrove plantation, Women empowerment, Biodiversity conservation, Eco-feminism, Eco-preneurship

1. INTRODUCTION

The world boasts an average of over 420 trees per person, while Bangladesh struggles with a mere 89 trees per person, highlighting the pressing disparity in global tree distribution (8 Billion Trees, 2024). So increasing the number of plants in Bangladesh is the need of the hour. The Green Bangle project (GBP), a project funded by the Swiss Philanthropy Foundation in Bangladesh, is dedicated to tree plantation endeavors to advance economic turn of events, ecological protection and sustainable development and inspired by the Chipko Movement and the visionary environmentalist Wangari Maathai, founder of the Green Belt Movement. We have founded the Green Bangle movement as a Bangladesh-Asian initiative, that aims to address pressing challenges the country faces, including rising sea water levels, deforestation, biodiversity loss, and the impacts of climate change. This movement aims to address the pressing challenges faced by this region, including deforestation, biodiversity loss and the impacts of climate change. Project details are as follows:

The Green Bangle Project, administered by the Asian University for Women (AUW), is spearheaded by Dr. Mosae Selvekumar Paulraj, an Associate Professor at AUW. This ambitious initiative is supported by the Swiss Philanthropy Foundation and collaborates with several esteemed organizations, including Young Power in Social Action (YPSA), the Bangladesh Sugar Crop Research Institute (BSRI), and the Bangladesh Forest Department. The project is set to span three years, from 2023 to 2026, with its primary activities centered in the Guliakhali Area of Sitakunda Upazila. This framework places importance on the engagement of local communities, empowering women, and incorporating sustainable approaches to effectively tackle environmental issues (Muhamad Khair et al., 2020).

2. Goals and Objective of GBM

As a coastal nation, Bangladesh confronts various environmental challenges that demand immediate attention. These challenges include deforestation, biodiversity decline and the adverse consequences of climate change. In response to these issues, the Green Bangle Movement has emerged as a leading force promoting tree plantation and environmental conservation across the country and Asia. The primary goal of this initiative is to advocate for mangrove and palm tree plantations (30,000 palm and mangrove plants) throughout Bangladesh to fight against climate change, particularly, in the Sitakunda area. By doing so, they aim to combat problems such as soil erosion, waterlogging and biodiversity loss that have ecological implications for our nation. Moreover, this movement strives to increase awareness among the population about the importance of preservation. Furthermore, planting palm trees can safeguard humans and animals from thunderbolts. To truly grasp the importance and efficacy of the Green Bangle Movement, it is crucial to delve into the framework that supports community-based initiatives.

Project Objectives:

- a. Promote mangrove and palm tree plantation and conservation in the region.
- b. Raise awareness about the importance of environmental preservation.
- c. Provide sustainable livelihood opportunities for women in the community.

The Green Bangle Movement is an example of this framework's application, as it collaborates with diverse stakeholders and encourages the active involvement of women from across Asia. The main goals of this paper are to investigate the initiatives and aims of the Green Bangle Movement, analyze the plant species chosen for planting, evaluate how the movement tackles challenges in Bangladesh and explore the potential advantages in restoring ecosystems, improving people's lives and promoting sustainable development.

3. Ecofeminism and Ecopreneurship: The Pillars of GBM

Ecofeminism is central to GBM's mission, advocating for an inclusive approach to environmental stewardship that empowers women. GBM engages women in every aspect of its activities, from planting and nurturing saplings to leading workshops on sustainable practices. By doing so, GBM not only promotes gender equality but also fosters a deeper connection between women and the natural environment, emphasizing the role of women as stewards of ecological health.

GBM actively encourages ecopreneurship, offering women opportunities to explore sustainable business models. This includes training in the production of eco-friendly palm bags made from Palmyra leaves, which serve as biodegradable alternatives to polythene bags. By equipping women with the skills and knowledge to produce and market these products, GBM supports both environmental conservation and economic empowerment, enabling women to generate income and achieve financial independence.

Fig. Workshops with Rural YPSA Women in Sitakunda, Guliakhali



4. The Shyamol Churi Nursery: A Model for Sustainable Agriculture and Education

4.1. Nursery Operations and Impact

The Shyamol Churi Nursery on the AUW Main Campus located in Bayezid Link Road, Chittagong, Bangladesh is a cornerstone of GBM's efforts to promote environmental awareness and sustainable agriculture. Over 20 students, known as Nursery Warriors, participate in hands-on training in nursery management, learning techniques for planting, weeding, and composting. This practical experience enhances students' understanding of plant care and instills a commitment to sustainability.

4.2. Promoting Eco-Friendly Practices

The nursery emphasizes using sustainable materials, such as palm bags, rather than harmful polythene nursery bags. GBM's research assistants are actively involved in this initiative, which helps reduce plastic waste and pollution, supporting GBM's broader mission to promote environmentally responsible practices. By cultivating over 1,000 Palmyra Palm saplings, 200 Sugar Date Palm saplings, and 700 Portia and Palm species, the nursery not only enhances local biodiversity but also contributes to the greening of the AUW campus.

Fig. Sapling Nurture Training on GBM Nursery and Promotion of Eco-Friendly Products



5. Home Nurseries and Women's Empowerment

5.1. Establishing Home Nurseries

GBM's initiative to establish home nurseries is a strategic approach designed to achieve both environmental and social objectives. These home nurseries serve as a practical and

impactful tool for empowering local women while contributing to environmental conservation. The initiative begins with comprehensive training provided to local women, covering essential skills such as selecting suitable native plant species like Nypa, Gewa, Kewra, Sugar Date, and Palmyra. The training includes preparation techniques for soil, planting procedures, and nursery maintenance. Women learn how to monitor plant growth, manage pests, and apply organic fertilizers, equipping them with the knowledge needed to run a successful nursery.

The choice of plant species is critical in this initiative. Nypa palms play a significant ecological role in coastal areas, Gewa and Kewra are important for mangrove ecosystems, and Sugar Date and Palmyra palms offer multiple benefits including food, construction materials, and economic opportunities. By growing these species, women contribute to local biodiversity and help restore and sustain various ecosystems. GBM supports these women by providing necessary resources such as seeds, saplings, and basic nursery equipment, ensuring they have the tools needed to start and succeed in their ventures.

The establishment of home nurseries also fosters community engagement. Women often interact with their neighbors and local communities, sharing their knowledge and encouraging broader participation in environmental conservation efforts. This creates a ripple effect, extending the benefits of GBM's initiatives throughout the community.

Fig. Home Nursery of the Local Women in Guliakhali, Sitakundo.



5.2. Economic and Social Benefits

The home nursery initiative provides significant economic and social benefits, reflecting GBM's holistic approach to empowerment. Managing home nurseries allows women to earn an income through the sale of saplings and eco-friendly products, which is crucial for their financial independence and improvement of their standard of living. The opportunity to sell plants and related products also stimulates local economies and creates new business opportunities. Running it involves acquiring various skills, including horticulture, business management, and marketing. These skills are valuable not only for nursery management but also for broader economic activities. Women who participate in this initiative often gain confidence and competence in these areas, enhancing their roles within their communities.

Home nurseries act as a platform for empowerment. Women who manage these nurseries become role models, demonstrating the potential of combining environmental stewardship with economic activity. This empowerment fosters greater gender equality and enhances women's involvement in decision-making processes at both household and community levels. It contributes directly to environmental stewardship. The growth of native plants and the establishment of these nurseries help mitigate environmental degradation and promote sustainable practices. Women's efforts in managing nurseries improve soil health, increase plant diversity, and support ecosystem resilience. The presence of home nurseries also benefits

community well-being. The greening of local areas, combined with increased biodiversity, enhances the quality of life for residents. Social networks formed around these nurseries contribute to a sense of community and collective responsibility towards environmental conservation.

6. The Ecological and Socio-Economic Impact of Planting Mangrove Species and Palms

6.1. Palmyra and Sugar Date Palms

Palmyra palms (*Borassus flabellifer*) and Sugar Date palms (*Phoenix sylvestris*) are highly valuable in both ecological and socio-economic contexts. These palms offer multiple environmental benefits, including providing shade, which helps to reduce heat stress in their surroundings. They also contribute to sustainable agricultural practices by improving soil quality and preventing erosion. Palmyra palms are renowned for their versatility; they provide food, such as sap and fruit, and materials for various uses, including construction and handicrafts. Sugar Date palms similarly offer nutritional benefits and income opportunities through their fruit and sap. By supporting these palm species, GBM contributes to food security and economic stability in local communities, making them a significant part of GBM's planting initiatives (Davis & Johnson, 1987; Selvakumar, Monichan, & Thevamirtha, 2021).

6.2. Palmyra and Sugar Date Palms

The planting of *Nypa* seedlings (*Nypa fruticans*) plays a crucial role in coastal ecosystem restoration. These mangrove palms are instrumental in stabilizing coastlines and preventing soil erosion, which is vital for protecting coastal areas from the impacts of sea-level rise and storm surges. *Nypa* palms create dense, interlocking root systems that trap sediments and build up the land, thus reducing erosion and maintaining shoreline integrity. Furthermore, they provide essential habitats for a variety of wildlife, including fish, birds, and insects. By supporting biodiversity, *Nypa* palms enhance the overall resilience of coastal ecosystems, making them more adaptable to environmental changes and contributing to the sustainability of local marine and terrestrial life (Siddiqui & Rahman, 2020).

6.3. Palmyra and Sugar Date Palms

Gewa (*Sonneratia apetala*) and Kewra (*Sonneratia caseolaris*) trees are integral to the health of mangrove ecosystems. These species are highly effective in carbon sequestration, which helps mitigate climate change by absorbing and storing atmospheric carbon dioxide. Gewa and Kewra trees also aid in soil stabilization by binding the soil with their complex root systems, which reduces erosion and enhances soil fertility. Their role in pollination is crucial for maintaining the reproductive cycles of other plant species, thereby supporting a diverse and balanced ecosystem. Additionally, these trees improve water quality by filtering pollutants and providing habitats for various marine species, which in turn supports local fisheries and enhances the overall health of the environment (Islam et al., 2016).

6.4. Portia Tree Saplings

The planting of Portia tree saplings (*Thespesia populnea*) is an important aspect of enhancing local biodiversity and ecological balance. Portia trees are known for their ability to improve soil health through their leaf litter, which enriches the soil with nutrients and supports the growth of other plants. Additionally, Portia trees provide habitats for a range of wildlife, including birds and insects, which contributes to a diverse and thriving ecosystem. The economic benefits of Portia trees are also significant; their durable wood is used for construction and crafting, while their leaves can be utilized for various purposes, including traditional medicine and weaving. By integrating Portia trees into GBM's planting initiatives, the project

not only supports ecological balance but also promotes sustainable livelihoods for local communities (Pratap et al., 2014).

Fig. GBM Plantation Programs (Palmyra, Nypa, and Portia)



7. Implementation of GBM's Planting Initiatives

GBM's planting initiatives start with thorough planning and preparation, encompassing site selection and species identification based on environmental assessments. This process ensures that species such as Nypa seedlings, Gewa, Kewra, Palmyra, Sugar Date palms, and Portia trees are well-suited to local conditions and offer maximum ecological benefits. To date, GBM has successfully planted approximately 9,500 mangrove species, including Nypa seedlings, Gewa, Keora, Sugar Date, and Palmyra palms, in the Guliakhali and Sitakunda regions. Additional plantings have also been carried out on the AUW main campus and in the surrounding Chittagong cities. The success of GBM's initiatives relies on collaborative efforts with local authorities, community members, and organizations. Partnerships with entities such as the Forest Department of Bangladesh and YPSA provide crucial resources and expertise, enabling effective plantation activities and fostering community support. The involvement of student representatives from across Asia, who are part of the Asian University for Women, enhances these efforts by bringing diverse perspectives and additional support to the initiative.

Training and capacity equips participants with essential skills for sustainable agriculture and nursery management. Workshops and training sessions led by experts provide practical knowledge on planting techniques, nurturing seedlings, and creating eco-friendly products. Plantation activities involve the coordinated efforts of volunteers, community members, and students who work together to plant seedlings and saplings at designated sites. Regular maintenance tasks, such as weeding, watering, and applying organic fertilizers, ensure the healthy growth of the planted species. And continuous monitoring and maintenance carries on for the long-term success of GBM's initiatives. Regular assessments and community involvement in the care of planted areas ensures the sustainability of the plantation efforts and promote environmental stewardship. Student representatives from AUW and the women of YPSA in Guliakhali play significant roles in this ongoing process, contributing to the project's effectiveness and sustainability.

8. CONCLUSION

The Green Bangle Movement (GBM) project not only facilitates biodiversity conservation through tree plantation at Guliakhali and Sitakunda area but also helps in preventing deaths caused by lightning strikes by the Palmyra plantation, halting saline water intrusion through mangrove tree plantation, alongside empowering AUW students and creating job and livelihood opportunities for local women. Through examining these aspects, this paper aims to make the reader understand that the Green Bangle Movement is significantly promoting environmental conservation, sustainable livelihoods and overall well-being in Bangladesh and

Asia. It also aims to spread its message worldwide through its student representatives. These representatives will motivate people all across Asia to join hands in planting and preserving mangroves and Palmyra trees. By raising awareness and encouraging action, GBM hopes to inspire communities to take proactive steps in safeguarding our natural environment. Through these collective efforts, GBM will create a future where environmental conservation and sustainable living are embraced and upheld across Bangladesh, Asia, and beyond.

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A Preliminary Study on the Amylolytic Activity of *Plectosphaerella cucumerina* Isolate OZ-08

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Abstract

Alpha-amylase enzymes, highly preferred in the industry, are produced by many living things in nature. Wild-type species can be genetically modified and improved to produce more alpha-amylase. Therefore, new strains need to be discovered for more efficient alpha-amylase production. This study aimed to discover new producer fungi species to improve the production capacity of the enzyme and increase its quality. For this purpose, samples were taken from potato fields and a flour factory in Erzurum. The samples were incubated in media containing starch as the sole carbon source for the selective isolation of fungi. Then, it was treated with iodine vapor, and the zone diameters were examined. Isolate OZ-08 was selected with the largest zone diameter. The zone diameter of isolate OZ-08 was similar to that of pure amylase. Isolate OZ-08 was incubated with shaking in a liquid culture for 5 days for protein extraction. The amylase enzyme was partially purified by TCA method and the optimum temperature and pH were determined. The SDS-PAGE determined that the enzyme was approximately 70 kDa in size, and it showed optimum activity at 45 °C (201.84 U/ml) and pH 5 (227.03 U/ml). The OZ-08 isolate was then identified at the molecular level based on its ITS regions. ITS sequence analysis showed that isolate OZ-08 was identified as *Plectosphaerella cucumerina* using the BLASTN program. The sequence data was deposited in the GenBank database with accession number OR291433. This is the first report in the literature on the amylase activity of *P. cucumerina*. Isolate OZ-08 can be used as a template for future recombinant enzyme production studies.

Keywords: Amylolytic activity, *Plectosphaerella cucumerina*, Amylase

1. INTRODUCTION

α -amylases are starch hydrolyzing enzymes widely used in industry, cleaving the α -(1,4)-D-glucosidic bond to form simple sugars such as glucose and maltose. This group of enzymes has diverse biotechnological applications such as starch processing, detergent production, textile, paper and pharmaceutical production. It also has some novel applications such as drug delivery, bioremediation agent and biofilm inhibitor. α -amylases account for about 25-30% of the global enzyme market. Various organisms such as bacteria, fungi, plants and animals can produce α -amylases. However, microorganisms have been prominent in producing α -amylase in high volumes. Moreover, with easy genetic manipulation, α -amylases with novel properties can be produced from microorganisms and their production can be easily optimized. Due to the widespread application of α -amylase in industry, many optimization methods and genetic engineering methods have been used to improve the production of the enzyme and produce enzymes with higher stability.

Amylases can be divided into 3 groups according to their mode of action: endoamylases (α -amylase), which initiate the breakdown of starch (liquefaction process) to produce maltodextrins; exoamylases (β -amylase), which break down maltodextrins into glucose and maltose (saccharification process); and glucoamylases (γ -amylase) (Gupta et al. 2003; Anitha and Muralikrishna, 2009; Chai et al. 2012; Paul et al. 2021). Microbial-derived α -amylases stand out because they are cheaper to produce on an industrial scale, are stable, and are easy to manipulate at the genetic and protein level. (Gupta et al. 2003; El-Kady et al. 2017). The higher stability of microbial amylases compared to plant and animal α -amylases has made them widely used in industrial applications. For this reason, starch hydrolysis steps are nowadays performed more cost-effectively by using microbial-derived amylases instead of chemical hydrolysis of starch (Rana et al. 2013).

Most organisms in the 3 domains of living organisms produce α -amylase, but most applications in industries are derived from microbial sources (El-Kady et al 2017). The most commonly used α -amylase is derived from various *Bacillus* species, but industrial grade α -amylase requires α -amylases that are resistant to heat and alkaline pH, and in these cases α -amylases from archaea are preferred. (Kathiresan and Manivannana 2006).

Wheat bran and rice flakes, waste potato starch, soybean meal, corn protein, corn protein, hazelnut meal and whey are among the substrates used as cheap and efficient carbon sources for amylase production. Other agricultural by-products used include corn cobs, vegetable and fruit peels, sugarcane bagasse and coconut (Paul et al. 2021). The α -amylase enzyme is produced by two fermentation techniques, solid-state fermentation (SSF) and submerged fermentation (SmF). SmF is the oldest method used for enzyme production and most commercial production of α -amylase is carried out in SmF (Rana et al. 2013). SSF is now widely used to overcome certain limitations of SmF. In SmF, the growth of microorganisms occurs in liquid medium and all physicochemical parameters relevant for large-scale microorganism incubation are optimized. The most commonly used substrates for SmF are soluble starch, molasses, fruit and vegetable juices. The disadvantages of using SmF are the high cost of the medium, low enzyme yield and high amount of wastewater (Allala et al. 2019; Paul et al. 2021). On the other hand, in SSF, the substrate can provide only support or both support and nutrients. The metabolites produced in SSF are concentrated and the purification procedures are less costly, making it a good alternative.

The production of α -amylase in fungi depends on both the physical and biological state of the culture. In particular, the amount of mycelium development in fungi is important for extracellular enzymes such as α -amylase. Various chemical and physical factors such as temperature, pH, incubation time, surfactants, carbon, nitrogen and phosphate sources, metal ions, humidity and agitation rate are known to affect α -amylase production (Dharania and Kumaran 2012). pH affects the metabolism of the microorganism and plays an important role in the level of enzyme production, enzyme activity and growth of the organism (Paul et al. 2021). Therefore, pH is an important factor to be evaluated in order to increase enzyme yield. The pretreatment of starch is carried out at a low pH of about 4-5 (Rana et al. 2013) The extreme conditions needed for such pretreatment require the use of enzymes resistant to high temperature and low pH. Amylases have been isolated at an optimum pH ranging from 2 to 12; α -amylases from most bacteria and fungi have an optimum pH of pH 7 and below (Pandey et al. 2000). Temperature is one of the most important factors affecting the rate of enzyme hydrolysis. It can significantly alter enzyme production by affecting the growth and vital activities of the microorganism. Each microbial strain can grow and produce enzymes within a certain temperature range. High temperature inhibits cell viability and enzyme production, while low temperature suppresses the metabolism of the microorganism and reduces enzyme yield (Amoozegar et al. 2003).

With the increase in applications of these enzymes, the demand has shifted to enzymes with specificity in certain aspects. Research has focused on producing α -amylases from microorganisms that are resistant to high temperatures and can work in different pH ranges, genetically manipulating them or applying site-directed mutagenesis. Site-directed mutagenesis plays an important role in altering the catalytic and structural aspects of an enzyme through the addition, modification or removal of amino acids specific to the catalytic site. In recent years, enzyme engineering approaches such as directed evolution and rational or quasi-rational design have made it possible to achieve desired properties such as enhanced thermostability, extreme pH stability, substrate specificity and tolerability to various chemicals (Dubey et al. 2019).

Isolation and characterization of local organisms are a vital tool for discovering industrial enzymes such as α -amylase with remarkable properties under harsh environmental conditions, can be used to generate tolerant strains and can serve great applications in industries.

2. MATERIAL and METHODS

2.1. Materials

2.1.1 Isolation and enzyme production medium

10 g soluble starch, 5 g tryptone, 3 g K_2HPO_4 , 2.5 g $(NH_4)_2SO_4$, 0.2 g $MgSO_4$, 0.13 g $CaCl_2$, 0.02 g $FeSO_4$, 0.06 g Trypan Blue and 30 g agar were added to 1000 ml distilled water and dissolved thoroughly in a heated magnetic stirrer. Then, the pH was adjusted to 5. For enzyme production, the same medium was prepared without the addition of agar (Xian et al. 2015).

2.1.2 Buffers and solutions for activity measurement

The buffer and substrate solution for enzyme activity measurement were prepared according to Fossi et al. 2005. DNSA solution was prepared according to Carrasco et al. 2017. Iodine solution was prepared according to Ouédraogo et al. 2012.

2.2. METHODS

2.2.1 Collection of samples

Erzurum, which has a continental climate and differs from other parts of the country in terms of both altitude and cold, was chosen as the sampling region. This choice was also influenced by the presence of districts with intensive potato production. For this purpose, soil, rotten potato tubers and flour factory residues were taken from the fields where potato cultivation was carried out between April 2022 and June 2022 and brought to the laboratory in sterile bags (Oudraogo et al. 2012). 1 g of the samples were weighed and suspended in 10 ml of sterile physiological water and 0.1 ml of the prepared serial dilutions were used for inoculation. Potato tubers were homogenized in 10 ml sterile physiological water after cutting 1 g with a sterile scalpel and 0.1 ml of the prepared serial dilutions were used for inoculation.

2.2.2 Isolation and selection of amylolytic isolates

For this purpose, selective isolation was performed on media containing soluble starch as the sole carbon source. The isolated organisms were placed in liquid medium containing starch and incubated at 30°C at 150 rpm for 5 days. At the end of the period, 5 ml of the liquid culture was taken and centrifuged in a falcon tube at 9000 rpm at 4°C for 10 minutes. Then 80 μ l of the supernatant was loaded into the holes made in starch agar containing trypan blue and incubated at 37°C for 2 hours. These media were then subjected to trypan blue discoloration zones or iodine solution and isolates were selected according to the size of the hydrolysis zones around the colonies and the selected colonies were purified by successive passages. The culture filtrates obtained were stored at -20 °C for enzyme activity and protein purification in subsequent experiments (Xian et al. 2015).

2.2.3 Molecular characterization of fungi

Isolates were grown in 5ml PDB medium in falcon tubes for 48 hours. Genomic DNA was extracted using phenol-chloroform method. The universal ITS 1 primer (5' TCC GTT GGT GAA CCA GCG G 3') and ITS 4 primer (5' TCC TCC GCT TAT TGA TAT GC 3') were used to amplify the Internal Transcribed Spacer (ITS) region, which is more commonly in fungal systematics. After amplification by 18S rDNA PCR, PCR products were purified with a commercially available PCR purification kit (EcoTech Biotechnology) to remove salts, primers and polymerase enzyme from PCR products. The purified PCR products were sequenced by BM Labosis (Turkey). The sequenced samples were analysed using Bioedit software program.

2.2.3 Determination of enzyme activity

The amylase activities of the isolates were determined by DNSA method (Bernfeld 1955), a colorimetric method. The standard curve was prepared with 5 mM pure maltose and absorbance measurements were performed at 540nm. For this purpose, a stock solution was prepared by dissolving 180 mg maltose in 100 ml distilled water. Then serial dilutions were prepared and solutions were obtained at concentrations of 0.25mM-5mM.

For enzyme activity, 400µl of substrate solution was mixed with an equal volume of culture supernatant or partially purified enzyme dissolved in citrate phosphate buffer and incubated at 50°C for 5 minutes. At the end of the time, 200µl of DNSA solution was added to the mixture and boiled at 95°C for 15 minutes. The samples were placed directly on ice, 1 ml of distilled water was added and absorbance measurements were performed at 540nm.

2.2.4 Partial purification and SDS-PAGE

10 ml of culture filtrate was mixed with an equal volume of 20% TCA by pipetting and kept at -20 °C for 2 hours. At the end of the time, proteins were precipitated by centrifugation at 13,500 rpm for 10 minutes. It was washed 3 times with 70% ethanol, centrifuged again at 13,500 rpm for 5 minutes and finally washed with acetone. The pellet was dried at room temperature, dissolved in citrate-phosphate buffer and stored at -20 °C for further studies (Fossi *et al.* 2005).

A 15% polyacrylamide gel was prepared to determine the molecular weight of the partially purified enzyme. For this purpose, protein samples were mixed with loading dye by pipetting and boiled at 95 °C for 5 minutes. The samples loaded on the prepared gel were run at 90 V until the dye was removed from the gel. When the running was completed, the gel was removed from the cassette, stained with coomassie R-250 stain and kept in washing solution for 2 hours to visualize the proteins. The image of the traceable gel was captured by Bio-Rad gel imaging system.

2.2.5 Effect of temperature and pH on the amylase activity

In order to determine the effect of temperature on enzyme activity, 400µl substrate solution and 400µl citrate-phosphate buffer containing enzyme were mixed and incubated at different temperatures (25, 30, 35, 40, 45, 50, 55 and 60 °C) for 30 minutes. At the end of the time, 200µl DNSA solution was added to the mixture and boiled at 95 °C for 15 minutes. The samples were taken directly on ice, 1 ml of distilled water was added and absorbance measurements were performed at 540 nm (Fossi *et al.* 2005).

In order to determine the effect of pH on the activity of amylase, the partially purified enzyme pellet was dissolved in citrate-phosphate buffer adjusted to pH 3-7 (Xian *et al.* 2015), mixed with 400µl of substrate solution containing soluble starch adjusted to the same pH and incubated at 50 °C for 30 minutes. At the end of the time, 200µl of DNSA solution was added to the mixture and boiled at 95°C for 15 minutes. The samples were taken directly on ice, 1 ml of distilled water was added and absorbance measurements were performed at 540nm (Fossi *et al.* 2005).

2.2.6 Statistical analysis

All experiments were conducted with three replications. The significance of the differences between the experimental results was calculated at p0.05 level of significance using one-way ANOVA in SPSS statistical program.

3. RESULTS and DISCUSSION

3.1. Isolation, Selection and Molecular Characterization of Fungi

A total of 5 different isolates were obtained, 2 yeasts and 3 filamentous fungi. All isolates gave a zone in the medium containing trypan blue as indicator; however, only OZ1 and OZ8 isolates showed a zone after treatment of this medium with iodine. OZ8 isolate was found to have the same zone diameter as pure amylase. These results show that iodine treatment gives more reliable results in the pre-selection of isolates according to their amylase activities.

The genomic DNA of the isolate OZ8 was used as a template in the PCR reaction, and ITS 1, and ITS 4 primers were used to amplify the target region. Sequencing reactions were performed in duplex with the ITS1 and ITS4 primers used for PCR, and the obtained sequence was compared to all known sequences in the GenBank (by use of BLASTN 2.10.0+ program). Based on percentage identity and query coverage, the isolate OZ8 identified as *Plectosphaerella cucumerina* and sequence data deposited in the GenBank database under the accession number OR291434.

3.2. Determination of Enzyme Activities of Culture Filtrate from Isolate OZ8

In order to determine the enzyme activities, the standard curve was prepared by taking measurements at 540nm as a result of the treatment of standards prepared with 7 different concentrations of pure maltose in the range of 0.25-5 mM with DNSA reagent. The equation of the standard graph was $y=0.298x+0.0382$ and the regression coefficient was calculated as $R^2=0.997$.

For the measurement of enzyme activity, 400 μ l of the culture filtrate obtained by incubating in the enzyme production liquid medium at 30 °C at 150 rpm for 5 days during the selection phase was mixed with 400 μ l of substrate solution and incubated at 50 °C for 5 minutes. At the end of the time, 200 μ l of DNSA solution was added to the mixture and boiled at 95°C for 15 minutes. The samples were taken directly on ice, 1 ml of distilled water was added and absorbance measurements were performed at 540nm. The enzyme activities of the isolates were performed using the standard curve of maltose in U/ml and the enzyme activity of the culture filtrate was determined as 187,58 U/ml.

3.3. SDS-PAGE

A 15% polyacrylamide gel was prepared to determine the molecular weight of the partially purified enzyme. The protein sample was mixed with the loading dye by pipetting and boiled at 95°C for 5 minutes. The gel was loaded with 30 μ l of culture filtrate and partially purified enzyme and run at 90 V. At the end of the run, the gel was removed from the cassette, stained and left in the washing solution for 2 hours to visualize the proteins. The image of the traceable gel was photographed with a Bio-Rad gel imaging system and is shown in Figure 1.

Figure 1. SDS-PAGE image (1st well marker, 2nd well culture filtrate, 3rd well band of partially purified enzyme)

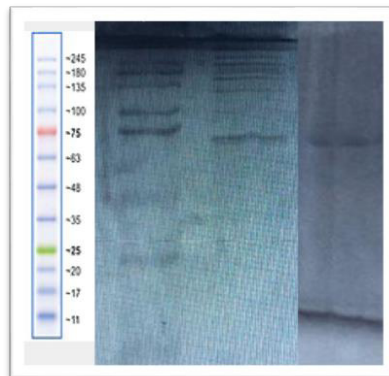
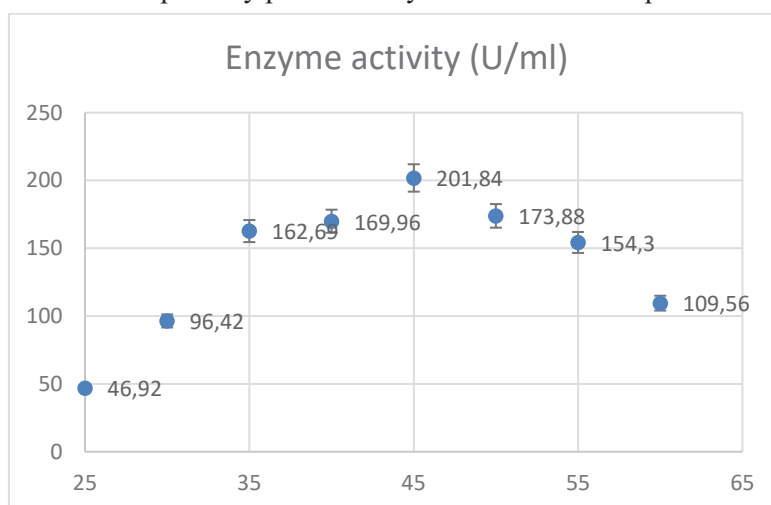


Figure 1 shows that the thickest band of approximately 70 kDa in well 2 of the culture filtrate is also present as a single band in the image obtained as a result of partial purification of the enzyme in well 3. The difference in intensity observed between the bands here is due to the fact that the culture filtrate was not visualized with 2x laemmli sample buffer in previous studies, so the culture filtrate was loaded with 10x laemmli sample buffer. In addition, the fact that the partially purified enzyme solution gave positive results in the activity assays and gave a single band in the SDS-PAGE image led to the conclusion that this band was responsible for the activity. Although no amylase enzyme belonging to both *P. cucumerina* and its anamorph *Fusarium tabacinum* was found in the literature, two different hypothetical amylases, 50.8 kDa (A0A8K0TJL4) consisting of 461 aa and 66.8 kDa (A0A8K0XA50) consisting of 589 aa, were found in the UNIPROT protein database.

3.4. Effect of Temperature and Ph on the Activity of Partially Purified Enzyme of Isolate OZ8

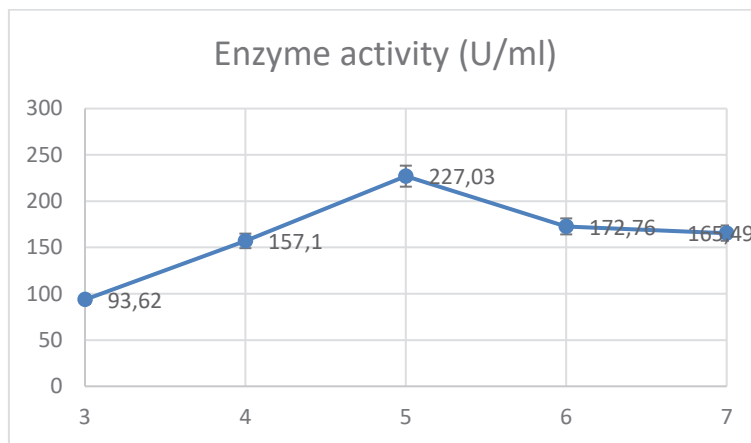
In order to determine the effect of temperature on enzyme activity, 40 µl of partially purified enzyme was mixed with 360 µl of citrate-phosphate buffer, 400 µl of substrate solution was added and incubated at different temperatures (25, 30, 35, 40, 40, 45, 50, 55 and 60 °C) for 30 minutes on dry block. Enzyme unit calculations were then performed according to the maltose standard graph prepared previously (Figure 2).

Figure 2. Enzyme activities of partially purified enzyme at different temperatures



In order to determine the effect of pH on enzyme activity, 40 µl of partially purified enzyme was mixed with 360 µl of citrate-phosphate buffer adjusted to pH 3-7 and 400 µl of substrate solution containing soluble starch adjusted to the same pH was added and incubated at 50 °C for 30 min on a dry block. Enzyme unit calculations were then performed according to the maltose standard graph prepared previously (Figure 3).

Figure 3. Enzyme activities of partially purified enzyme at different pHs



As shown in Fig. 2, partially purified enzyme showed optimum activity with 201.84 U/ml at 45 °C and Activity decreased as temperature increased. As shown in Fig. 3, partially purified enzyme showed optimum activity with 227.03 U/ml at pH 5.

4. CONCLUSION

The SDS-PAGE determined that the enzyme was approximately 70 kDa in size, and it showed optimum activity at 45 °C and pH 5. The OZ-08 isolate was then identified at the molecular level based on its ITS regions. ITS sequence analysis showed that isolate OZ-08 was identified as *Plectosphaerella cucumerina* (OR291433). This is the first report in the literature on the amylase activity of *P. cucumerina*. Isolate OZ-08 can be used as a template for future recombinant enzyme production studies. In future studies, it is suggested to determine the amino acid sequence of the enzyme belonging to the OZ8 isolate, compare it with other amylases in the data banks, and reveal the coding region by amplification with primers produced based on the sequence obtained. By revealing these data, it will be possible to study other kinetic parameters required in the characterization of enzymes by paving the way for recombinant production of the enzyme in future studies

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Antibacterial activity of 2-methoxy phenethylamine-based imine and β -lactam derivative in nosocomial infections

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Abstract

β -lactam antibiotics are in the most prescribed class of drugs due to their broad spectrum of action and low toxicity. A cyclic amide or lactam ring with three carbon atoms connected and nitrogen is present in the structure of β -lactam antibiotics. It is significant in medicinal chemistry because of this lactam ring. Dopamine-like monoamine alkaloid phenethylamine has a variety of biological effects. Infections acquired in hospitals result in deadly diseases. These diseases are treated with antibiotics. However, the recent emergence of antibiotic resistance in hospital-acquired infections has rendered antibiotic treatment ineffective. Therefore, there is a demand for novel, potent compounds. For this purpose, a 2-methoxy phenethylamine-based (*E*)-*N*-benzylidene-2-(2-methoxyphenyl)ethanamine (**1**) imine derivative and 1-(2-methoxyphenyl)-2-oxo-4-phenylazetidin-3-yl acetate (**2**), a β -lactam derivative, were synthesized before. The antibacterial activity of these compounds was studied on *Streptococcus salivarius* (*S. salivarius*), *Lactobacillus casei* (*L. casei*), *Pseudomonas aureginosa* (*P. aureginosa*), *Enterococcus faecium* (*E. faecium*), and *Streptococcus pneumoniae* (*S. pneumoniae*) bacteria. Antibacterial activity was determined by disc diffusion analysis. As a result of this analysis, zone formation was observed in compound **2**, but no zone formation was observed in compound **1**. Zone diameters of compound **2** were measured between 0.8-1.5 cm in all bacteria. As a result of this study, it is predicted that the novel β -lactam derivative may be an antibacterial agent for *S. salivarius*, *L. casei*, *P. aureginosa*, *E. faecium*, and *S. pneumoniae*.

Keywords: 2-methoxy Phenethylamine, β -lactam, Imine, Antibacterial activity, Nosocomial infection

1. INTRODUCTION

β -lactam antibiotics are biologically potent compounds with a broad spectrum of activities, including antibacterial, antiviral, anticancer, antidiabetic, anti-inflammatory, antiparkinsonian, and antituberculous properties (Lima et al., 2020). The synthesis of β -lactam derivatives has been extensively studied, with numerous reports in the literature. Following the initial report by Staudinger in 1907 on the synthetic methodology (Staudinger, 1907), various β -lactams have been synthesized by modifying the side groups of the β -lactam ring. Among the most prevalent are compounds synthesized via the reaction of ketenes with imines derived from aliphatic or aromatic amines and aromatic aldehydes (Decuyper et al., 2019; Payili et al., 2018).

The discovery of the penicillin compound by Alexander Fleming from the fungus marked a significant advancement in the development of β -lactam antibiotics. The β -lactam ring, a cyclic amide consisting of one nitrogen and three carbon atoms, is a key structural feature of these antibiotics (Noel et al., 2010). The primary target of β -lactam antibiotics is the peptidoglycan layer in bacterial cell walls, a crucial component that maintains the mechanical integrity of bacterial cells. These antibiotics function by inhibiting the transpeptidase enzyme, which forms cross-peptide linkages in peptidoglycan (Decuyper et al., 2019; Meegan et al., 2008). When the transpeptidase enzyme is inhibited, the transpeptidation process is disrupted, leading to a blockage in peptidoglycan synthesis, ultimately causing the bacterial cell to undergo autolysis and lysis (Kong et al., 2010).

Phenethylamine is a monoamine alkaloid that occurs naturally in various plants, animals, and humans (Wang et al., 2022). It can also be synthesized in vitro through chemical processes. It exerts stimulating effects on the brain by promoting the release of neurotransmitters such as dopamine, noradrenaline, and serotonin (Sabelli & Javaid, 1995). As a result, phenethylamine is sometimes used to enhance energy levels, alertness, attention, and overall well-being.

Moreover, phenethylamine derivatives are well-documented for their potent anticancer, antibacterial, and antioxidant activities (Nieddu et al., 2022).

Nosocomial infections, also known as hospital-acquired infections or healthcare-associated infections, are infections that develop in individuals receiving treatment or care within hospitals and other healthcare facilities. These infections typically result from exposure to pathogenic microorganisms within the hospital environment, including bacteria, viruses, fungi, and parasites (Magill et al., 2018). Nosocomial infections can affect various organs or systems. For example, they may lead to bloodstream infections, pneumonia and other respiratory tract infections, surgical site infections, and urinary tract infections (Smith et al., 2018);(Gupta & Datta, 2019). Moreover, nosocomial infections can have severe complications, such as bacteremia and sepsis, which significantly contribute to increased morbidity and mortality. *E. faecalis*, *S. salivarius*, *L. casei*, *P. aeruginosa*, *E. faecium*, and *S. pneumoniae* are bacterial pathogens known to cause nosocomial infections (Bocella et al., 2021; Mukagendaneza et al., 2019; Weiner et al., 2016). These pathogens are responsible for severe infections that are typically managed with antibiotics. However, the increasing prevalence of antibiotic resistance in recent years has significantly limited treatment options.

E. faecium is a Gram-positive bacterium that is either gamma-hemolytic or non-hemolytic, belonging to the *Enterococcus* genus. While it can exist as a commensal organism in the gastrointestinal tracts of humans and animals, *E. faecium* may also become pathogenic, leading to serious conditions such as neonatal meningitis and endocarditis. A particularly concerning strain is vancomycin-resistant *Enterococcus faecium* (VRE), which poses significant challenges in clinical treatment (Krawczyk-Balska et al., 2012).

L. casei is a Gram-positive, rod-shaped bacterium belonging to the lactic acid bacteria group. It is widely recognized as a probiotic commonly found in the human gastrointestinal tract and fermented foods such as yogurt and cheese. Although *L. casei* is predominantly associated with beneficial health effects, it is rarely implicated in hospital-acquired infections (Huang et al., 2018).

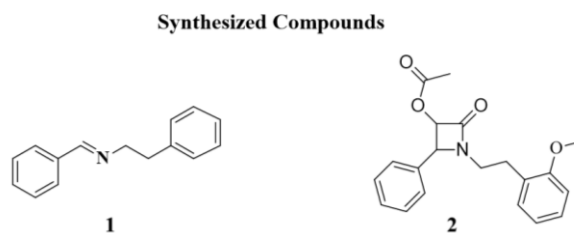
S. salivarius is a Gram-positive, facultatively anaerobic bacterium predominant in the human oral cavity. It plays a crucial role in maintaining oral health by contributing to the balance of the microbial community and producing substances that inhibit the growth of pathogenic bacteria (Begić et al., 2023).

S. pneumoniae is a Gram-positive, diplococcal bacterium belonging to the family Streptococcaceae. Although it is a component of the normal microflora of the human upper respiratory tract, *S. pneumoniae* is an opportunistic pathogen that frequently causes infections globally. It is also a leading cause of severe invasive diseases, including sepsis, meningitis, bacteremia, and pneumonia. Patients with lung cancer are particularly susceptible to infections caused by *S. pneumoniae*. While antibiotics are commonly used to treat *S. pneumoniae* infections, the emergence of antibiotic-resistant strains has significantly complicated the treatment process (Aljicevic et al., 2015).

P. aeruginosa is a Gram-negative, opportunistic pathogen renowned for its versatility and resilience across diverse environments, including healthcare settings. It is a major contributor to hospital-acquired infections and is particularly noted for its significant antibiotic resistance, posing substantial treatment challenges (Qin et al., 2022).

The study aimed to investigate the antibacterial activity of previously synthesized imine (**1**) and its β -lactam derivative (**2**) (Figure 1) (Yildirim et al., In press). The activity of these compounds against pathogenic bacteria (*S. salivarius*, *L. casei*, *P. aeruginosa*, *E. faecium*, and *S. pneumoniae*) known to be associated with antibiotic resistance and serious infections is being investigated.

Figure 1. Structure of synthesized compounds



2. MATERIAL and METHODS

2.1. Material

Benzaldehyde, 2-methoxyphenethylamine, acetoxy acetyl chloride, ethyl acetate, methylene chloride, molecular sieve (4Å), n-hexane, sodium sulfate, triethylamine, deuteriochloroform, Luria-Bertani agar (LBA), dimethyl sulfoxide, Mueller-Hinton agar, Mueller-Hinton broth, and netilmicin discs were obtained from commercial suppliers.

2.2. Methods

2.1.1 Chemistry

The β -lactam and imine compounds (**1-2**) utilized in this study were previously synthesized and reported by (Yildirim et al., 2022). The synthesis followed the protocol outlined in their study. In brief, the process began with the chemical reaction between benzaldehyde and 2-methoxy phenethylamine to produce imine. This imine was subsequently reacted with acetoxy acetyl chloride under reflux conditions overnight. After the reaction, the mixture was processed, and the solvent was removed using an evaporator. The pure products were then isolated and purified via column chromatography to obtain the target compounds (Yildirim et al., In press)

2.1.1 Antibacterial Activity Studies

Bacterial isolates, including *S. salivarius* ATCC 13415, *L. casei* ATCC 334, *P. aeruginosa* ATCC 27853, *E. faecium* ATCC 49452, and *S. pneumoniae* ATCC 49619, were obtained from the Molecular Microbiology Laboratory culture collection at Erzurum Technical University. These isolates were cultured on Luria-Bertani Agar (LBA) and incubated at 37°C for 24 hours to assess the antibacterial activity of the synthesized compounds.

2.1.1.1 Disc Diffusion Test of Compounds on Bacteria

Bacterial inoculums were prepared to achieve a 0.5 McFarland standard and were evenly distributed across the agar medium using a sterile swab. The synthesized compounds were dissolved to a concentration of 200 μ M, and 10 μ L aliquots were applied to sterile paper discs. These discs were subsequently placed onto the inoculated agar plates and incubated at 37°C for 24 hours. The antibacterial susceptibility of the isolates was evaluated by measuring the diameters of the inhibition zones around the discs. Netilmicin discs served as the positive control, while dimethyl sulfoxide (DMSO) was used as the negative control. The activity of the compounds was determined based on the inhibition zone diameters observed in the disc diffusion test, following the methodology of (Ozgeris, 2021).

3. RESULTS and DISCUSSION

3.1. Study on the Antibacterial Activity of Imine (1) and β -Lactam Derivative (2)

The antibacterial activities of the synthesized imine (1) and β -lactam derivative (2) were evaluated using the disc diffusion method. During the disc diffusion assay, the β -lactam derivative (2) demonstrated the formation of an inhibition zone, indicating its potential to suppress bacterial growth. In contrast, the imine compound did not exhibit any zone of inhibition against the tested bacterial isolates. The diameters of the bacterial inhibition zones were measured and are presented in Table 1.

Table 1. Disc diffusion analysis results of compounds

Bacteria Strain	(1)	(2)	Netilmicin
<i>S.salivarius ATCC 13415</i>	No zone	0.8	1.3
<i>L. casei ATCC 334</i>	No zone	0.9	1.7
<i>P. aureginosa ATCC 27853</i>	No zone	0.9	2.0
<i>E. faecium ATCC 49452</i>	No zone	0.8	No zone
<i>S. pneumoniae ATCC 49619</i>	No zone	0.9	1.0 (Bacteriostatic)

Imine compounds have attracted considerable interest due to their diverse pharmacological properties, particularly their potential antibacterial activities. Studies have shown that various imine derivatives exhibit promising antibacterial effects against pathogens (Sztanke et al., 2024). For example, novel imine derivatives synthesized from imidazo[1,2-a]pyridine have demonstrated significant antimicrobial activity, effectively inhibiting bacterial and fungal strains (Moutaouakil et al., 2024). Moreover, imine derivatives have exhibited strong binding affinities in molecular docking studies, indicating their potential as effective antibacterial agents. Notably, one study identified a specific imine compound with favorable pharmacokinetic properties, suggesting its viability for further development against *Staphylococcus aureus* (Frimayanti et al., 2024). However, it is important to note that our study did not observe antibacterial activity in the imine derivative tested. This lack of activity can be attributed to the distinct variable groups in the imine derivatives studied.

The antibacterial activity of β -lactam derivatives remains a critical area of research, particularly in light of the increasing threat of antibiotic resistance. Recent studies have shown that various modifications to the β -lactam structure can significantly enhance their efficacy against bacterial pathogens. For example, Yildirim et al., (2022) reported that phenethylamine-based β -lactam derivatives exhibited antibacterial activity against *P.aeruginosa*, *E. faecium*, and *S. salivarius*. Furthermore, research has highlighted that certain β -lactam antibiotics selectively inhibit penicillin-binding proteins (PBPs) in *S. pneumoniae*, specifically targeting PBP2x and PBP3. Notably, carbapenems such as doripenem and meropenem have been shown to co-selectively inhibit multiple PBPs, whereas certain penicillins demonstrate a preference for inhibiting PBP2x and PBP3 (Kocaoglu et al., 2015; Sharan & Carlson, 2022). In our study, the β -lactam derivative also displayed antibacterial activity against the tested pathogens. These findings are consistent with the existing literature, further supporting the potential of β -lactam derivatives as effective antibacterial agents.

4. CONCLUSION

As a result, a novel β -lactam derivative was synthesized from an imine compound with a structure previously unreported in the literature. The antibacterial activities of both the imine and the β -lactam derivative were evaluated. Notably, antibacterial activity was observed only

with the β -lactam derivative (**2**), which demonstrated effectiveness against pathogenic bacterial strains, including *S. salivarius*, *L. casei*, *P. aeruginosa*, *E. faecium*, and *S. pneumoniae*. These findings suggest that the newly synthesized β -lactam derivative holds promise as a potential antibacterial agent for treating infections caused by these pathogens.

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Impacts of ZnO Nanoparticles on Callus Formation of Triticale Under *In Vitro* Conditions

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Abstract

Nanoparticles play a significant role in plant response to growth parameters. In this study, the physiological and biochemical responses of ZnO nanoparticles (NPs) applications on callus tissues developed from two triticale cultivars (Ümran Hanım and Alper Bey) were evaluated under *in vitro* culture. The ZnO NPs were synthesized from the extracts obtained from healthy walnut shells, using the green synthesis approach and then characterized by Scanning Electron Microscopy (SEM) and X-ray diffraction analysis (XRD). For callus initiation, mature embryos in the MS medium containing appropriate hormones were used, and the developed callus was obtained in the MS medium containing 0.8 ppm of ZnONPs for 1 month. ZnO was very effective in terms of callus growth and development compared to control callus. Malondialdehyde (MDA) content was lower in the callus treated with 0.8 ppm ZnO+ NP compared to ZnO- treatments. A significant decrease in MDA was observed in the presence of ZnO⁺. The callus initiation stage with ZnO+ treatments indicated the best result in 0.8 ppm ZnO NPs for DNSA and proline value compared to the without ZnO- NPs. More proline and sugar were accumulated in these two triticale cultivars than in the control callus when all were subjected to ZnO⁺. Antioxidant enzyme activities exhibited a decreasing trend in the presence of ZnO⁺ whereas soluble sugar and proline activities exhibited an increasing trend in the presence of ZnO⁺.

Keywords: Triticale, ZnO NPs, Callus, Antioxidant

1. INTRODUCTION

Triticale is a very important animal feed grain, inhabitants of many regions including Poland, Germany, and Belarus, use triticale and the product of the triticale to fulfil their nutritional requirements (Yazıcılar et al., 2021). The importance of triticale as a staple food necessitates utilizing modern technologies to improve triticale production and nutritional values (De Zutter et al., 2023).

Nanotechnology is a modern discipline of science that has implementations in nearly many fields such as agriculture (Hoballah et al., 2019). The use of nano-fertilizers, nano-pesticides, nano-biosensors, and nano-metrological tools assists producers in not only improving the crop yield and quality by enhancing the soil conditions but also helps by noticing the weather estimate of a region and using sensors for automation of agriculture system (Fraceto et al., 2016; Manjunath et al., 2019). The green synthesis of metal nanoparticles has benefits over using hazardous chemicals owing to the simplicity of reaction conditions, energy-intensive, cost-effective, and results in the synthesis of biocompatible nanoparticles (Usman et al. 2020). The nanoparticles advance the uptake of nitrate reductase enzyme in the embryo which improves the abilities of seeds' to absorb large quantity of water and other nutrients. Zinc oxide nanoparticle is one of the most abundant oxides after iron and it is low toxicity, and high UV absorption (Kalpana et al., 2018). Zinc oxide nanoparticle has many advantages in the agriculture field such as plant growth and development, environmental stress factors, and biomass production. The impact of ZnO+ nanoparticles on plants has been the subject of growing interest and research due to their potential applications in agriculture, such as in fertilizers, pesticides, and growth enhancers. However, the effects of these nanoparticles on plants can be complex and vary depending on several factors, including the concentration of nanoparticles, the plant species, and environmental conditions.

In vitro cultures offer a promising of method for the fast multiplication and suspension of culture production in plants in a short time. Among *in vitro* culture methods, callus culture is one of the most suitable techniques for the feasible production of entire plant material (Manjkhola et al. 2005). So far no previous research study is available in the literature to exhibit the effect of ZnO on callus development and enzyme activity in callus cultures of *Triticale*. Therefore this study aimed to determine the possible effect of ZnO on callus development and some biochemical activities.

2. MATERIAL and METHODS

2.1. Plant Material and ZnO Treatment

In this experiment, two *Triticale* cultivars (*Ümran Hanım* and *Alper Bey*) were used as the material for the response to ZnO NPs nanoparticulate. *Ümran Hanım*, *Alper Bey* mature embryos were used for callus formation in MS (Murashige and Skoog, 1962) medium including 4 mg L⁻¹ 2,4-D (2,4-dichlorophenoxyacetic acid) for one month. Then, good quality callus samples were transferred 4 mg L⁻¹ 2,4-D (2,4-dichlorophenoxyacetic acid) in the presence of 0.8 ppm ZnO nanoparticulate. There is no ZnO in the control samples. The total culture duration was one month.

2.2. Proline Content

To quantify proline content, a 100 mg callus sample was taken and homogenized using liquid nitrogen. Subsequently, 10 mL of 3% sulphosalicylic acid was introduced to the homogenized samples. The resulting homogenate underwent centrifugation at 15,000 rpm for 15 min, with the pellet discarded. Next, 2 mL of the supernatant was transferred to a separate tube, and 2 mL of acid ninhydrin was added. The mixture was incubated in a water bath at 90 °C for 1 h, followed by cooling in an ice bath. Subsequently, 4 mL of toluene was added, and vortexing was performed. The absorbance of the samples was measured at a wavelength of 520 nm in triplicate. The proline content in the samples was determined by referencing a standard chart prepared using pure proline (Ahmad et al., 2012).

2.3. Determination of Soluble Sugar Content

The determination of water-soluble sugars was conducted using the 3,5-dinitrosalicylic acid (DNSA) method. In this approach, the protocol for reducing sugar determination proposed by Krivorotova and Sereikaite in 2014 was adopted.

2.4. MDA (Malondialdehyde)

Malondialdehyde was measured using the method of Heath and Packer (1968) using liquid nitrogen. 0.4 g of ground callus material was dispersed in 0.5% (w/v) thiobarbituric acid solution containing 20% (w/v) trichloroacetic acid. The sample was boiled at 98°C for 30 min and then quickly taken into an ice bath. The sample content was centrifuged at 3000 × g for 10 min and the value of the supernatant was monitored at 532 and 600 nm (Heath and Packer, 1968; Jaleel et al., 2007; Erdal, 2012).

2.5. H₂O₂ (Hydrogen Peroxide)

H₂O₂ (hydrogen peroxide) content was measured using the method of Sergiev et al. (1997). 0.4 g of callus material was homogenized in 4 mL of trichloroacetic acid and centrifuged at 4 °C for 15 min at 13,000 rpm. 2 mL of extract was mixed with 0.8 mL of KH₂PO₄ and 1.6 mL of KI in test tubes. The absorbance of the callus sample product was measured at 390 nm using a standard curve with H₂O₂ solutions (Velikova et al., 2000).

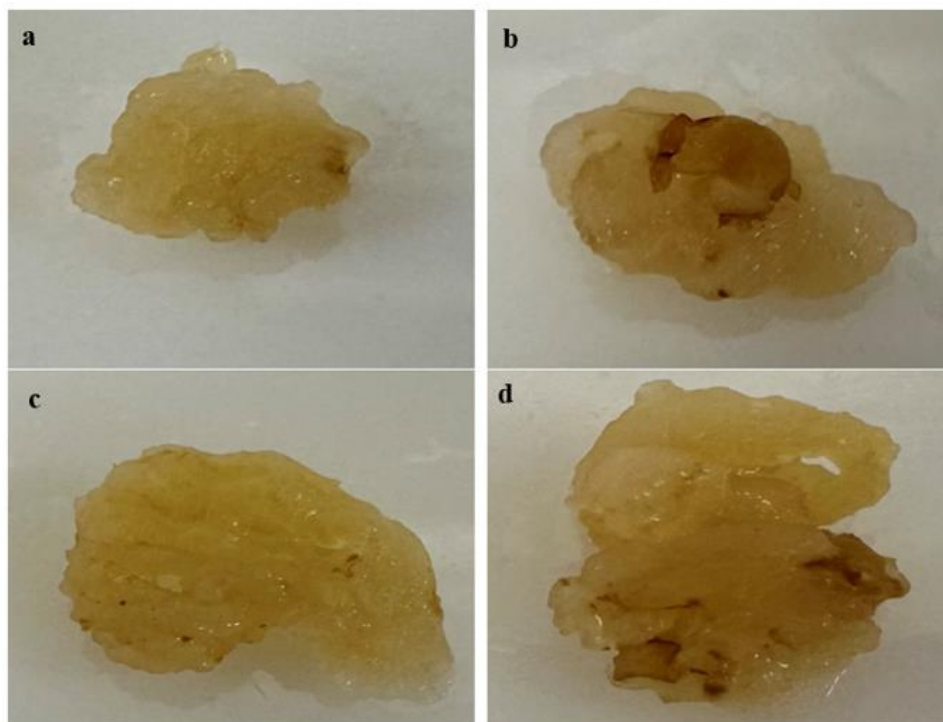
2.6. SDS PAGE Analysis

Triticale samples (0.2 g) were homogenized to powder in a mortar using liquid nitrogen. Sample buffer [0.1 M NaPO₄ (pH 6.5), 1 M EDTA, 0.5 mM PMSF] was prepared to the eppendorf tube and mixed by vortex. The extracts were centrifuged at 13000 rpm for 10 min at 4 °C. The concentration of the sample was performed by employing the method of Bradford (1976), and 30 µg of the protein was separated in 12 % sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS PAGE) (Laemmli, 1970).

3. RESULTS and DISCUSSION

Plant growth and development participate in all cellular events by greatly causing morphological and physiological processes in plant tissues and metabolomic functions in the plasma membrane, altering enzymatic reactions, and interactions among macromolecules (Hwang et al., 2013; Zhu, 2001). Previous reports have shown that a nanoparticulate can be used by applying the external environment in various plant cultivars (El-Sharkawy et al., 2017). However, the roles of ZnO⁺ in tissue culture response are not well known. Zinc oxide nanoparticle is also known for its inexpensive, safe, and easily prepared making it a good candidate to be used in plant science (Bala et al., 2015). Assessment of callus induction and development in the presence of ZnO⁺ NPs was based on the determination of MDA (malondialdehyde) H₂O₂, DNSA, proline, and protein. Callus induction was detected after two weeks in nearly all explants. Necrosis and blackening also occurred after 17 days in some callus samples. The experiment found that necrosis and blackening occurred less in explants cultured in MS medium including 0.8 ppm ZnO rather than control (Figure 1). A similar response of callus induction and necrosis without nanoparticle treatments under plant growth regulators (BAP and NAA) was also reported (Sagharyan et al., 2020). This is consistent with earlier reports showing that plant growth regulators and nanoparticles rather than 2,4-D have a recovering effect on callus necrosis.

Figure 1. Callus images of ZnO accumulation in triticale explants. (a: *Alper Bey* ZnO NPs Treatments, b: *Alber Bey* control, c: *Umran Hanım* ZnO NPs Treatments, d: *Umran Hanım* control)



The proline content of *Umran Hanım* and *Alper Bey* calli was shown to increase remarkably in the presence of ZnO⁺. It was detected that the degree of proline in calli was greatly linked to nanoparticle concentration under *in vitro* conditions (Figure 2). Under tested conditions, proline contents reached about 0.216 $\mu\text{mol/g DW}$ 0.8 ppm ZnO⁺ in the *Umran Hanım* cultivar, Moreover, proline contents reached about 0.265 $\mu\text{mol/g DW}$ 0.8 ppm ZnO⁺ in *Alper Bey* cultivar which represented an increase significant difference for the nontreated controls. Two of the triticale cultivars showed highly different sugar accumulation in *in vitro* culture. The sugar level of the triticale cultivars in tissue culture media compared to nanoparticule varied from 0,213 to 0,486 mg/g. Both cultivars exhibited higher ZnO NPs accumulation after nanoparticle application (Figure 3). These outcomes are consistent with those published by Yazıcılar et al. (2024) in the study on *alfalfa* callus drought at different mannitol concentrations. This confirmed that the concentration and applied-time effects of ZnO are directly linked to the interactions of plant growth regulation in an *in vitro* medium.

Figure 2. The effect of basal medium on the amount of proline. (1: *Alper Bey* ZnO NPs Treatments, 2: *Alper Bey* control, 3: *Umran Hanım* ZnO NPs Treatments, 4: *Umran Hanım* control)

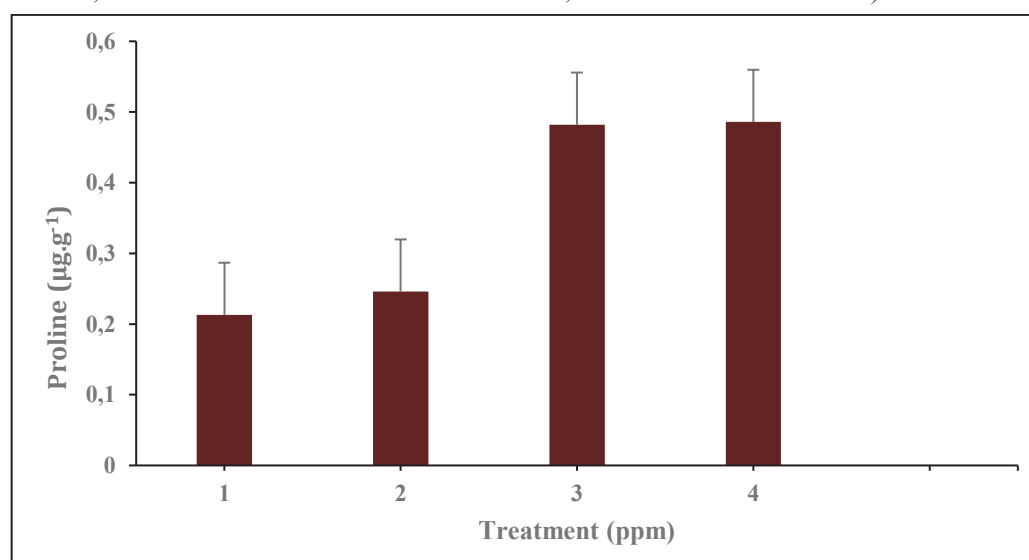
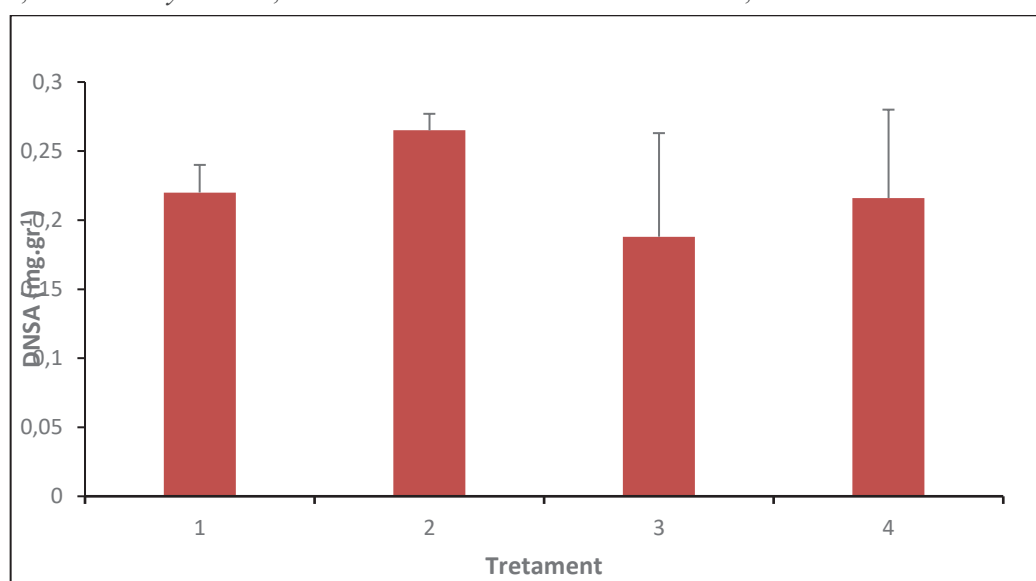


Figure 3. The effect of basal medium on the amount of soluble sugars. (1: *Alper Bey* ZnO NPs Treatments, 2: *Alper Bey* control, 3: *Umran Hanım* ZnO NPs Treatments, 4: *Umran Hanım* control)



Under nanoparticle treatments, free radicals and reactive oxygen species including H_2O_2 , and OH . (hydroxyl radical), and O_2^- (superoxide anion) increases with oxidative damage. Therefore, they cause damage to membranes by causing lipid peroxidation (Foyer and Noctor, 2005). MDA and H_2O_2 levels decreased in both *Umran Hanım* and *Alper Bey* cultivars compared to the control. Notably, the *Umran Hanım* cultivar showed MDA levels ranging from 0.188 to 0.216 nmol/mL whereas *Alper Bey* ranging from 0.220 to 0.265 nmol/mL. H_2O_2 concentration varied between 0.213 and 0.486 $\mu\text{g}/\text{gr}$ (Figure 4 and 5). In this experiment, decreased H_2O_2 and decreased MDA contents for both cultivars with 0.8ppm concentrations of ZnO^+ treatment emerged as a result of the response of triticale cultivars to callus development and necrosis recovering. These results suggest a significant positive relationship between MDA and H_2O_2 under both ZnO^+ and control conditions. Moreover, there was protein band that accumulated in the presence of ZnO^+ NPs. compared to control callus (Figure 6).

Figure 4. The effect of basal medium on the amount of H_2O_2 . (1: *Alper Bey* ZnO NPs Treatments, 2: *Alber Bey* control, 3: *Umran Hanım* ZnO NPs Treatments, 4: *Umran Hanım* control)

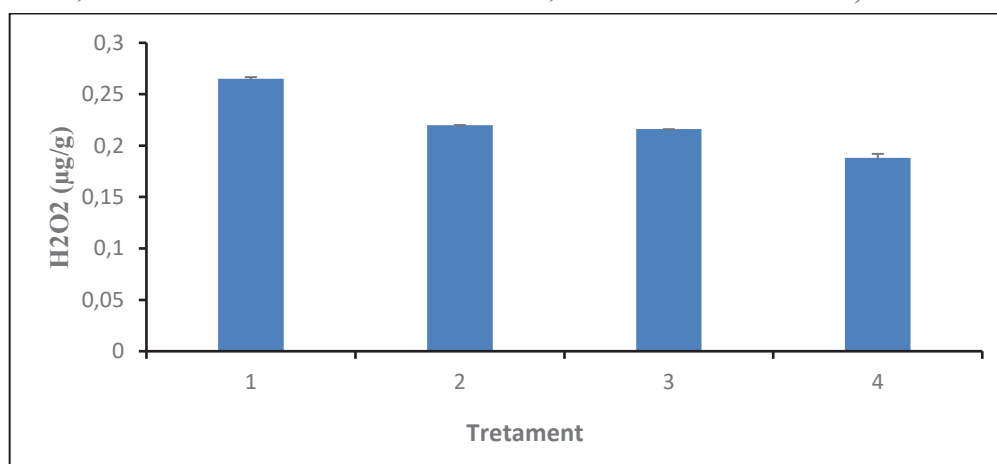


Figure 5. The effect of basal medium on the amount of MDA. (1: *Alper Bey* ZnO NPs Treatments, 2: *Alber Bey* control, 3: *Umran Hanım* ZnO NPs Treatments, 4: *Umran Hanım* control)

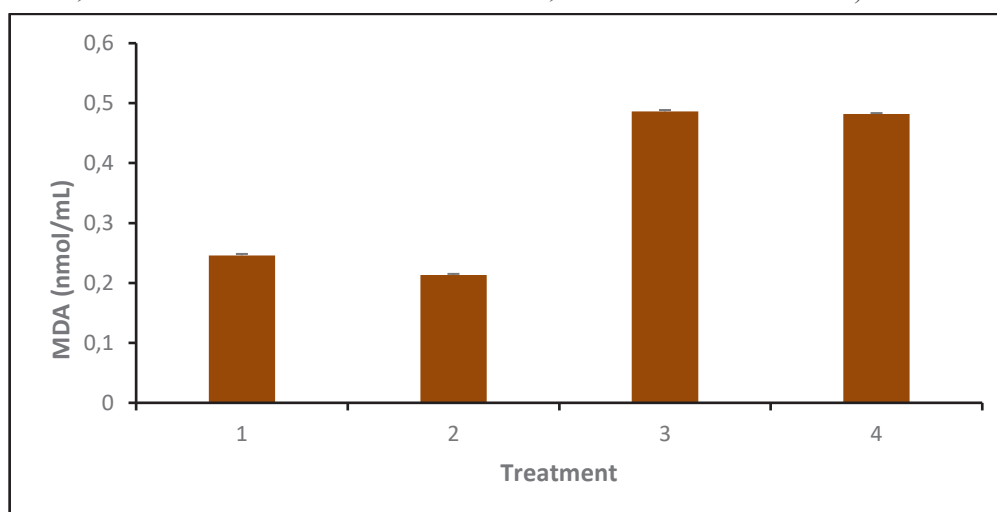
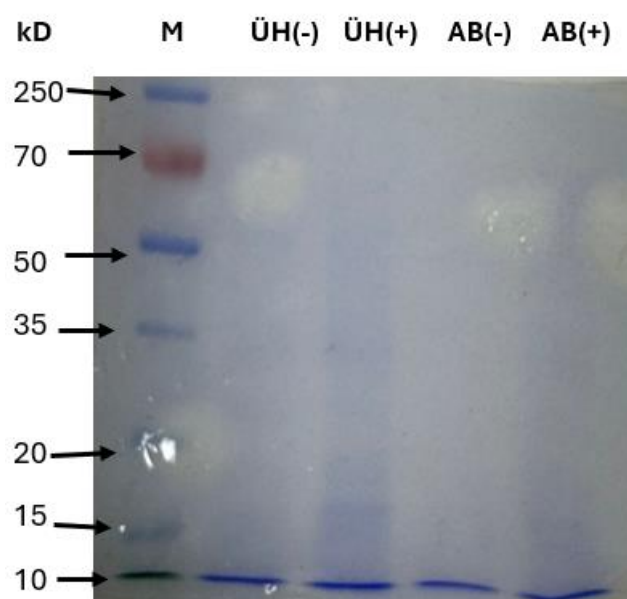


Figure 6. SDS PAGE profiles of total proteins from *Triticale*.



4. CONCLUSION

We detected that ZnO^+ NPs *Triticale* callus displayed stronger affect than control *Triticale* callus and that the bands of SDS page analysis displayed that protein accumulation in callus cells is likely an active process induced protein synthesis.

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Evaluation of Bee Breeds and Ecotypes in Türkiye in terms of Biodiversity

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Abstract

Türkiye has more genotypes than many other countries in terms of genetic diversity in honey bee (*Apis mellifera*) races. There are twenty-seven different honey bee races in the world. Türkiye is in a remarkable position in terms of honey bee genotypes in the world with its two honey bee races and six ecotypes. In addition, Türkiye is among the top three countries in the world in terms of colony presence and ranks second in terms of annual honey production. According to the "Communiqué on the Registration of Domestic Animal Breeds and Lines" (Communiqué No: 2004/39), bee breeds are classified as Caucasian Bee (*Apis mellifera caucasica*) and Anatolian Bee (*Apis mellifera anatolica*) and ecotypes are Efe Bee Ecotype (*Apis mellifera anatolica*), Gökçeada Bee Ecotype (*Apis mellifera anatolica*), Hatay Bee Ecotype (*Apis mellifera syriaca*), Trakya Bee Ecotype (*Apis mellifera carnica*), Muğla Honey Bee Ecotype (*Apis mellifera anatolica*) and Yığılca Honey Bee Ecotype (*Apis mellifera anatolica*). The fact that Türkiye has honey bee breeds and ecotypes adapted to different climatic conditions shows the richness of Türkiye beekeeping in terms of biodiversity in honey bee gene resources. The richness in this field shows the existence of an important potential for successful, economic and sustainable bee breeding. It is a necessity to preserve these indigenous breeds that constitute Türkiye's honey bee diversity in order to be used in bee breeding today and in the future. The continuity of genetic diversity in honey bee populations is extremely important in terms of the existence and breeding of highly productive bee breeds adapted to regional conditions for different regions. However, the situation of moving bee colonies from their locations according to seasonal conditions, also known as itinerant beekeeping, causes negative situations such as the loss of genetic characteristics of bee breeds and ecotypes. Therefore, beekeepers should be informed about the possible unwanted damages caused by uncontrolled itinerant beekeeping and unconscious crossbreeding. In conclusion, although Türkiye has a rich population in terms of honey bee genetic diversity, it should be protected against the negative effects of uncontrolled and unconscious crossbreeding of existing native bee races and ecotypes. On the other hand, genotype performances should be improved through breeding studies. Otherwise, it should be kept in mind that honey bee colonies of unknown genetic origin and poor quality may adversely affect our existing gene resources more and more and the whole beekeeping sector will suffer economically due to this genetic degeneration.

Keywords: Honey bee, Biodiversity, Race, Ecotype, Türkiye.

1. INTRODUCTION

Honey bee (*Apis mellifera* L.) farming is very important for reasons such as food safety, which is essential for human health, healthy living, clean environment, pollination of plants and contributing to the economy of individuals. Moreover, the demand in the world market for honey and other bee products has increased tremendously in recent years, as it is important for various uses and applications that aid alternative medicine (Wakgari et al., 2021). According to the Food and Agriculture Organization of the United Nations (FAO), the number of bee colonies in the world has doubled in the last 50 years. This increase is even greater in Asian countries, including Türkiye, which has the largest share in bee farming. While there are a total of 101,624,052 honey bee colonies in the world, there are 45,265,044 honey bee colonies in Asia, 25,071,804 in Europe, 18,245,999 in Africa and 11,635,818 in America (FAO, 2022).

Table 1. Number of beekeeping enterprises and colonies, honey and beeswax production in Türkiye by year (TUIK, 2024).

Years	Number of farms (Number)	Number of colonies (Number)	Honey (Ton)	Beeswax (Ton)
2013	79 934	6 641 348	94 694	4 241
2014	81 108	7 082 732	103 525	4 053
2015	83 475	7 748 287	108 128	4 756
2016	84 047	7 900 364	105 727	4 440
2017	83 210	7 991 072	114 471	4 488
2018	81 830	8 108 424	107 920	3 987
2019	80 675	8 128 360	109 330	3 971
2020	82 862	8 179 085	104 077	3 765
2021	89 361	8 733 394	96 344	3 766
2022	95 386	8 984 676	118 297	4 165
2023	100 399	9 224 881	114 886	3 971

Türkiye ranks third in the world after India and China with approximately 9 million bee colonies and ranks second in the world after China with approximately 115 thousand tons of honey production (TÜİK, 2024). The fact that Türkiye is at the forefront in this ranking shows that it has a great importance in the world in terms of honey bee breeding and bee gene resources. In recent years, the number of honey bee colonies has increased in Türkiye as in the world. In parallel with this increase, the fact that there is not the same or more increase in honey production makes us think about our situation in bee breeding.

Researchers have presented different ideas about the origin and spread of the honey bee. Wilson and Brown (1953) reported that honey bees originated in Africa and spread through the Middle East. Some researchers stated that honey bees originated in southeast Asia and India, from where they spread throughout the world (Rothenbuhler and Kerr, 1968). Another researcher reported that honey bees originated in the south of the Caspian Sea and spread through Anatolia (Ruttner, 1988).

There are 27 subspecies of honey bee races (*Apis mellifera* L.) currently recognized in the world. It has been stated that the differences that cause the formation of these races are due to different geographical conditions, isolated regions that cause adaptation, and differences such as climate change affected by these regions (Smith, 2002). Türkiye has more genotypes than many countries in terms of genetic diversity in honey bee (*Apis mellifera* L.) races. Türkiye is in a remarkable position in terms of honey bee genotypes in the world with its 2 honey bee races and 6 ecotypes.

Honey bee breeds have a very high adaptability in general. In this way, they have a very wide habitat in the world. Honey bee races, whose history is thought to be older than human history, have survived in the regions where they have lived for years without human intervention and have survived until today (Genç and Dodoloğlu, 2003).

In Türkiye, native honey bee races and ecotypes have survived in the regions where they have been living for a long time and have adapted to the environmental conditions of their environments (Burucu and Gülse Bal, 2017). The honey bee races and ecotypes that have realized their adaptation ability have the ability to show the highest yield performance even under poor climatic and environmental conditions in their regions (Köseoğlu et al., 2017).

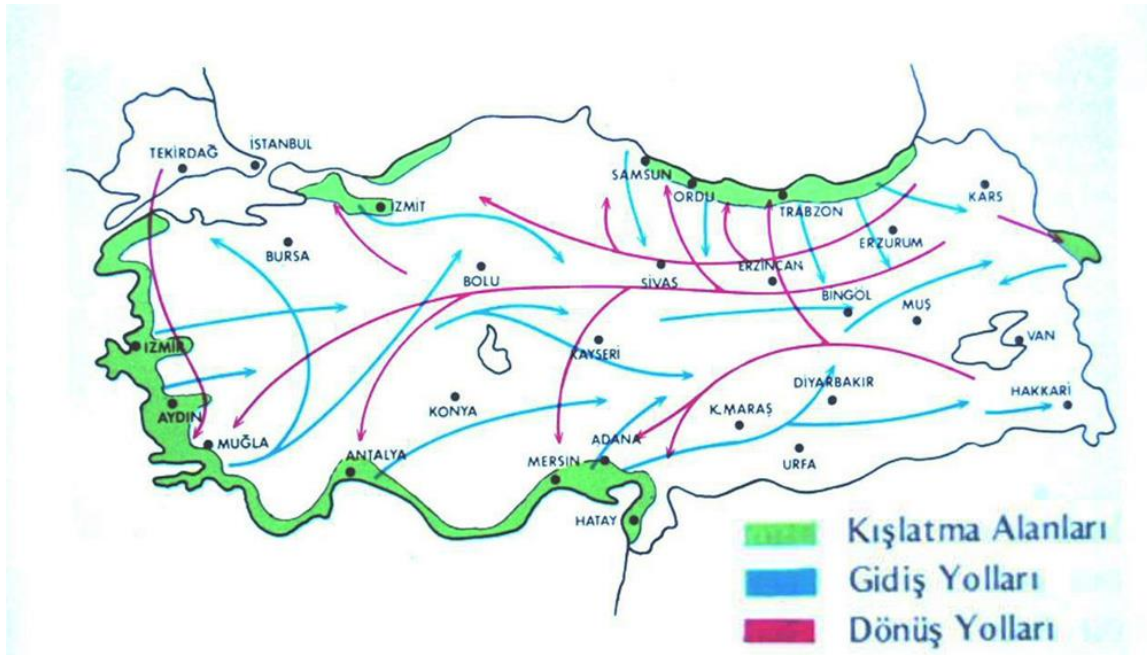
Türkiye has played an important role in the differentiation of many species and increasing biodiversity due to the fact that each region in Türkiye has its own important plant flora and

different climate structure due to its different geological structure, as well as being a natural bridge between two major continents. Honey bees have also made significant contributions to this biodiversity and have adapted to the environmental and climatic conditions and flora of the region where they are located. Humans have turned this situation into an economic advantage in bee breeding and carried it forward (Kence, 2006).

One of the problems in honey bee breeding in Türkiye in recent years is the inability to maintain the genotypic characteristics of pure honey bee breeds. The most important reasons for this are the widespread use of queen bees in a careless manner and the mixing of gene sources in existing honey bee populations due to the uncontrolled practice of migratory beekeeping in Türkiye (Uçak Koç, 2008).

Also known as itinerant beekeeping, the situation where bee colonies move from their locations according to seasonal conditions causes negative situations such as the loss of genetic characteristics of bee races and ecotypes. Depending on the vegetation periods and physiological developments of nectar plants, itinerant beekeepers go to the transition regions starting from March-April, that is, from the highlands in the interior and central parts of Anatolia to the coastal regions. With the warming of the weather, they move towards the high plateaus of Southeastern and Eastern Anatolia regions (Yeninar et al., 2010; Çevrimli and Sakarya, 2018).

Figure 1. Round trip routes of migratory beekeepers (Anonymous1, 2024).



Itinerant beekeeping activities are very important in terms of transforming existing plant resources in nature into honey and other valuable bee products without any expense, reducing unemployment by contributing to economic income and creating added value to the national economy by contributing to production (Çevrimli and Sakarya, 2018). However, uncontrolled and unconscious honey bee breeding causes the genotypic characteristics of honey bee races and ecotypes, which are part of the richness of biodiversity, to be mixed or lost (Sıralı, 2016). In Türkiye, uncontrolled proliferation of colonies as a result of itinerant beekeeping activities carried out over very long distances and unconscious crossbreeding between honey bee races lead to confusion in gene resources in honey bee populations and genetic diversity is gradually facing the danger of extinction (Çevrimli and Sakarya, 2018).

According to its dictionary meaning, biodiversity covers all or some of the meanings such as “the diversity of living things, genes, characters, species and ecosystems”. As it is known, the English term 'biodiversity' is the result of shortening and combining the words 'biological diversity' or 'biotic diversity' (Faith, 2021). Biodiversity, which also refers to the richness of genes, species and ecosystems in a region, forms the basis of the life support systems necessary for the continuation of life and humanity on earth. It is an important source of wealth and power for Türkiye as it is important for all countries of the world. Türkiye has a very important place in terms of its location at an important point connecting the continents of Asia and Europe, its rich flora, which has a geographical importance, and its favorable climatic conditions. In addition, the flora of Türkiye has approximately twelve thousand plant species, one third of which are endemic. While this situation offers many opportunities for bee breeding, it also imposes important responsibilities for the protection of biodiversity (Avcı, 2005).

In this study; it was aimed to evaluate the current status of honey bee breeds and ecotypes in Türkiye in terms of biodiversity.

2. BEE BREEDS AND ECOTYPES IN TÜRKİYE

In Türkiye, according to the “Communiqué on the Registration of Domestic Animal Breeds and Lines” (Communiqué No: 2004/39), bee breeds are defined as Caucasian Bee (*Apis mellifera caucasica*) and Anatolian Bee (*Apis mellifera anatolica*) and ecotypes are Efe Bee Ecotype (*Apis mellifera anatolica*), Gökçeada Bee Ecotype (*Apis mellifera anatolica*), Hatay Bee Ecotype (*Apis mellifera syriaca*), Trakya Bee Ecotype (*Apis mellifera carnica*), Muğla Honey Bee Ecotype (*Apis mellifera anatolica*) and Yığılca Honey Bee Ecotype (*Apis mellifera anatolica*). This Communiqué covers the domestic animal breeds and lines registered in accordance with the principles of the Animal Breeding Law No. 4631 dated 28/2/2001 and the “Regulation on the Registration of Animal Breeds” published in the Official Gazette No. 25141 dated 17/6/2003 (Anonymous2, 2024).

2.1. Caucasian Bee (*Apis mellifera caucasica*)

The homeland of this race is known as Caucasus. In Türkiye, the Caucasian Bee is one of our local bee races registered within the Honey Bee (*Apis mellifera* L.) species. Although it is cultivated in many parts of the Northeastern Anatolia Region, it is intensively distributed in a significant part of Ardahan, Artvin and Kars provinces (Kayaboynu, 2022). Northeastern Anatolia is the homeland of the Caucasian race. There are differences in many characteristics within the honey bee population raised in the same region. For example; there are differences between the Süngülü Caucasian bee bred in Ardahan Posof region and Camili Caucasian bee bred in Artvin Borçka in terms of morphological, performance and reproductive characteristics. In the regions bordering Georgia, *Apis mellifera remipes* is similar to the honey bee race in terms of some characteristics. In the low altitude regions of the region, *Remipes* honey bee breed is cultivated while Caucasian honey bee breed is cultivated in the high altitude regions (Güler, 2006).

2.1.1. Morphological characteristics

The abdomen is slender and graceful. The chitin color is dark. There are brown spots on the first bands of the abdomen. Scutellum color is black. The hair cover, the tomentum, is large. The hair color of worker bees is lead-gray and the hair color of drones is black. It is the bee race with the longest tongue and the tongue length is up to 7.2 mm. For this reason, bees of this race benefit more from the nectar of deep-tubed plants (Genç and Dodoloğlu, 2003; Anonim2, 2024).

2.1.2. Behavior and physiological characteristics

Its temperament is quite docile. The pup-rearing rhythm is slow and develops slowly in spring. It does not reach full colony strength before mid-summer. Poor wintering ability in northern regions. It is more susceptible to Nosema disease. The tendency to produce sons is not very high. It is the honey bee race that uses propolis the most. It has a high tendency to raiding. It is characterized by disorientation and disorientation. It makes very good use of plants such as clover. Can work in low temperatures and unfavorable climatic conditions. It has a tendency to make irregular-bridge honeycombs. When glazing the honeycombs, it does not leave an air gap between the honey and the glaze, so the honeycombed honey has a dark and moist appearance. It is not aggressive and stinging and is a docile breed. During the nectar flow period, it can visit other flowers in the morning and other flowers in the afternoon. It starts to work when the sugar content in the nectar of the flowers is 10%. This rate is around 18% in other races (Genç and Dodoloğlu, 2003; Anonim2, 2024).

2.2. Anatolian Bee (*Apis mellifera anatolica*)

The Anatolian Bee is a registered native bee race of the Honey Bee (*Apis mellifera* L.) species that is bred in many regions of Türkiye. Its distribution area is almost all of Anatolia. There are also ecotypes bred in different environmental and climatic conditions. It was identified as *Apis mellifera anatolica* by Maa (1953) and its taxonomic classification was made. Anatolian bee is an important genetic resource used in some researches in Europe and America. Although there are different genotypes in different regions, it has been subjected to a large amount of genetic mixture (Kayaboynu, 2022).

2.2.1. Morphological characteristics

Anatolian honey bee has a morphologically medium-sized body structure. Wings and legs are short. Chitin color, scutellum is usually dark orange. Although it looks dirty yellow, body color is not uniform. It is characterized as low cubital index and medium-sized tomentum. The color of the rings on the abdomen varies from orange to brown. Morphologically and especially color characteristics are similar to Italian honey bee (Kayaboynu, 2022; Anonymous2, 2024).

2.2.2. Behavior and physiological characteristics

Nectar collection power, thriftiness, wintering ability and adaptability to unfavorable environmental conditions are high. Offspring rearing activity is low outside the incubation season. When favorable conditions occur, it starts a very intense and fast brood rearing activity. It is adapted to Anatolian conditions. It can survive under difficult conditions during periods of scarcity. It has high wintering ability under severe wintering conditions. They are resistant to extreme conditions. The tendency to bear sons is at medium level. Tends to collect more propolis especially in regions with harsh climatic conditions. They have a low predatory tendency. Their ability to determine direction and adapt to the environment is very developed. Surprised behavior is low (Kayaboynu, 2022; Anonymous2, 2024).

2.2.1. Efe Bee Ecotype

Efe Bee Ecotype is a sub-ecotype of the Anatolian Bee (*Apis mellifera anatolica*). Its distribution area is West Aegean, South-West Marmara and West Mediterranean Regions. Pine honey production is higher in these regions (Anonymous2, 2024).

2.2.1.1. Morphological characteristics

The abdomen is of medium size. The chitin color varies from light brown to dark brown. The hair cover of worker bees is brown and gray, while the hair color of drones is between yellow and black. Tongue length is of medium length (Anonymous2, 2024).

2.2.1.2. Behavior and physiological characteristics

Temperament is moderately docile. Hatching performance is high. Development rate is very high in spring. It processes combs until August. Prepares itself for pine honey. Good overwintering ability in its own territory. It can reach spring even with little available. It is more resistant to diseases than Nosema. Son tendency is low. The tendency to use propolis increases or decreases according to the need of the period. Very low tendency to raiding. The incidence of situations such as disorientation and disorientation is low. High ability to collect pollen and nectar from cotton, sunflower, bee grass (faselia), eucalyptus and natural flora in the region. It utilizes pine and cedar flora very well and honey production is high. Honeycomb processing speed is high. It shows great development in every region in May, June and July. It is especially suitable for pollen and royal jelly production (Anonymous2, 2024).

2.2.2. Gökçeada Bee Ecotype

Gökçeada Bee Ecotype is a sub-ecotype of the Anatolian Bee (*Apis mellifera anatolica*). It is a local ecotype with high reproduction and good honey yield in the Gökçeada island area of Çanakkale Province (Anonymous2, 2024).

2.2.2.1. Morphological characteristics

It has a large body structure (T3+T4). Body cover color, black chitin and scutellum, gray long hair cover. It has a long tongue structure (Anonymous2, 2024).

2.2.2.2. Behavior and physiological characteristics

It grows fast. Forms strong colonies. Produces high amounts of wax. Has a high propensity for sons and aggressive behavior. It also has a high honey making ability. It can produce more honey than Muğla, Anatolian, Thracian and Caucasian bees. Queen bees have high oviposition capacity (Anonymous2, 2024).

2.2.3. Muğla Honey Bee Ecotype

Muğla Honey Bee Ecotype is a sub-ecotype of the Anatolian Bee (*Apis mellifera anatolica*). It is intensively cultivated in South West Anatolia, especially in Muğla Province. Since the Mugla bee is adapted to the pine honey known as basura secretion in September-October, it increases the number of adult bees by slowing down the brood development in this season (Yücel and Köseoğlu, 2011).

2.2.3.1. Morphological characteristics

The abdomen is of medium size. Scutellum is usually dark orange. The body color is not uniform, although it looks dirty yellow. The color of the rings on the abdomen can be different shades of orange. Tongue length is of medium length (Anonymous2, 2024).

2.2.3.2. Behavior and physiological characteristics

Temperament depends on the conditions and is aggressive in adverse conditions (lack of nectar, bad weather conditions). Nectar collection power is high. Incubation performance is very good. Adult bee development is high. Survival and adaptation ability is high. Wintering ability is high in the regions where it is mainly distributed. Resistance to diseases is at medium level. Predation is at medium level. Propolis utilization is at medium level. Orientation and adaptation to the environment are very well developed. Surprise behavior is moderate. Low brood rearing activity outside the brood rearing season, but when favorable conditions occur, it starts a very intensive and rapid brood rearing activity. It can survive in difficult conditions during periods of scarcity. The pine honey production period in the fall when it adapts is the main honey production period. In this period, even colonies with small populations show proportionally high performance (Yücel and Köseoğlu, 2011; Anonim2, 2024).

2.2.4. Yiğilca Honey Bee Ecotype

Yığılca Honey Bee Ecotype is a sub-ecotype of Anatolian Bee (*Apis mellifera anatolica*). It is a high viability ecotype that is grown locally in Yığılca District of Düzce Province (Anonymous2, 2024).

2.2.4.1. Morphological characteristics

The abdomen is of medium size. The scutellum is usually dark gray. It has a black chitin color and long hairs. The color of the rings on the abdomen can be different shades. Tongue length is longer than normal. In a study, samples were taken from 56 different locations and the wing and leg lengths of the samples taken from Yığılca district of Düzce province were found to be longer than the morphological dimensions of other bee populations (Kekeçoğlu, 2007). Yığılca honey bees, which are reported to have the shortest tongue structure among the honey bee populations in the Western Black Sea Region, overlap to some extent with the honey bees of Bolu and Sakarya regions in terms of morphological characteristics (Güler et al., 2011).

2.2.4.2. Behavior and physiological characteristics

It has a high ability to utilize *Rhododendron ponticum* (rhododendron). In terms of nectar collection behavior, it adjusted its biological clock according to the flowering period of *Castanea sativa* and *Rhododendron ponticum* (Anonymous2, 2024).

2.3. Trakya Bee Ecotype

Trakya Bee Ecotype is a sub-ecotype of the Carniolan Honey Bee (*Apis mellifera carnica*). It is distributed in the Trakya region. Since the Trakya region is an extension of the Balkans, the bees in the region are similar to the bees distributed in the Balkans. Although some researchers initially identified the bee of the region as the Carniolan honey bee race, Ruttner identified the bee of the Trakya region as the Anatolian honey bee. However, in the morphological and performance determination studies carried out later, it was stated that the bee of this region was different from the Anatolian honey bee and molecular genetic studies were carried out and it was stated that the bee of the region was similar to the Carniolan honey bee race. Compared to the Carniolan honey bee race, it has a shorter and narrower wing size and a smaller body (Güler, 2006).

2.3.1. Morphological characteristics

The body structure is medium-sized and the body color varies between gray and dark gray. Chitin color is black. Tongue length is longer than normal (Anonymous2, 2024).

2.3.2. Behavior and physiological characteristics

Temperament is docile and hardworking. Colony population growth is high, with high brood area and comb processing efficiency. It is extraordinarily adapted to changing weather conditions and rapidly develops populations in spring. Good wintering ability. While wintering is normal in modern hives, wintering ability is high in local type hives. Resistance to diseases is at medium level. The tendency to sire sons is high. Propolis utilization is at medium level. Predatory tendency and disorientation are low (Anonymous2, 2024).

2.4. Hatay Bee Ecotype

Hatay Bee Ecotype is a sub-ecotype of the Syrian Honey Bee (*Apis mellifera syriaca*). It is distributed in Hatay province and neighboring provinces.

2.4.1. Morphological characteristics

Body morphologically it has a medium-sized body. Chitin-colored feathers cover the chest and wings with yellowish corners. There are pale colored stripes on the three segments of the abdomen. The length of the tongue is longer than normal (Anonymous2, 2024).

2.4.2. Behavior and physiological characteristics

Temperament is hardworking, aggressive and has a high stinging tendency. Colony development and fecundity are high. Wintering ability is high. Disease resistance, especially to parasites and predators. It has a high tendency to give offspring (Anonymous2, 2024).

3. CONCLUSION

Although Türkiye has a rich population in terms of honey bee genetic diversity, it should be protected against the negativities caused by uncontrolled and unconscious crossbreeding of existing native bee races and ecotypes. On the other hand, genotype performances should be improved through breeding studies. Otherwise, it should be kept in mind that honey bee colonies of uncertain genetic origin and of poor quality may adversely affect our existing gene resources more and more and the whole beekeeping sector will suffer economically due to this genetic degeneration. Breeding studies should be continued in terms of superior yield characteristics of the existing domestic honey bee breeds and ecotypes registered in Türkiye and it is recommended to protect the gene resources in the regions where they are adapted to breeding.

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Based On Milk Functional Appointed Food of Their Products of Technology Processing and Safety Research

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Abstract

Milk and milk products human to his body protein the giver food from their products is one In our day of stores on the shelves milk of their products wide variety , both raw materials , both too ready product in the form of according to you can It is obvious that, their in the composition human body for many important elements is available . Milk based functional cottage cheese products one many characteristics according to from milk superior is considered From milk different as this products contained nutritious of components organism by more easy appropriation provided is doing Milk based functional cottage cheese products in hand make for biological food in addition to additives, also use various herbal natural additives possible. The subject of our research is sour milk products type of curd products. And the object determined during the research functional based, prepared on the basis of fruit and berry processing products cottage cheese product was. Cottage cheese in production natural fruit and of berries the application of enrichments obtained from processing is scientifically justified. Usage done of raw materials quality and quantity indicators, as well too wants to of raw materials if he wants too ready of the product retention conditions cottage cheese of the product quality indicators effect proof has been done. According to the results obtained on the basis of research as cottage cheese products in preparation fruit and of berries processing the appropriateness of the use of products has been studied.

Keywords: food, milk, cottage cheese, pumpkin powder and puree

1. INTRODUCTION

Dairy products, like bread, have been widely used in human nutrition since ancient times. In modern times, as a result of the development of science and technology, new functional dairy products, unlike traditional dairy products, have been produced. The taste of fresh milk is pleasant and sweet, the color is yellowish-white, and it has a unique smell. Milk boils at a temperature of 100.20C, and freezes at a temperature range of 0.540C -0.580C. Milk and milk products are important in human nutrition. The most valuable component of milk and milk products are proteins. Amino acids formed from the breakdown of proteins are used to perform various functions in the body. Milk and dairy products are a source of high-grade proteins, fats, carbohydrates, vitamins, minerals and extractive substances in terms of biological and energy value in human food. The nutritional value of milk depends on the ratio of the amount of protein, fat, essential amino acids, polyunsaturated fatty acids, B group vitamins, micro- and macroelements, as well as on the organoleptic properties of milk. The quality of milk is also characterized by water-protein, fat-protein and water-fat ratio. There is an inverse relationship between water-oil ratio (Antipova L.V., 2001). Milk contains almost all vitamins. The composition of milk can be grouped as follows: Water in the range of 87.5-88.7; 2.4%-5.5% milk fat; 3.25% protein, $\frac{3}{4}$ of which is casein; 4.6% lactose; 0.65% mineral substances (Ca, Mg, K, P, Fe, Na, Zn, Cl, etc.); 0.18% acids (oxalate, citrate, acetate, etc.); peroxidase, catalase, lipase, phosphatase, etc. enzymes; oxygen and nitrogen gas; A, D, C, riboflavin, thiamine, etc. vitamins. Milk is used in the production of cottage cheese. Curd production is carried out in the following stages. The first stage is the preparation of milk for fermentation. This includes the following: reception and preparation of raw materials; heating and separation of milk; normalization of milk and preparation of mixture; pasteurization and cooling of the mixture. Three main components are distinguished among biological food additives: nutraceuticals, paraformaceuticals, eubiotics. The second stage refers to the fermentation of the mixture. Pasteurized milk is cooled in a cooling unit to the fermentation temperature (this temperature

ranges from 28-30°C in hot seasons and 30-32°C in cold seasons). From here, the milk is transferred to the 6th section for fermentation. Pure cultures of mesophilic lactic acid streptococci are mainly used for curd production and are added to the composition of milk in the range of 1-5%. After that, its ripening period is 6-8 hours. In order to accelerate the fermentation process, the milk is transferred to the 10th part, where up to 2.5% of the primary culture of mesophilic streptococci and 2.5% of the primary culture of thermophilic streptococci are added to the milk. This process is carried out at a temperature of 35°C in hot seasons and 38°C in cold seasons. With this method, the process of milk fermentation takes place within 4-4.5 hours. At the end of ripening, the preparation of the punch is determined by its acidity. This acidity is 58-600T for fat and medium-fat cottage cheese, and 66-700T for low-fat cottage cheese. The obtained product is transferred to the 7th section, where it is compressed under the influence of its own mass at a temperature of 16°C for 1 hour. In order to prevent the rise of acidity, pressing should be carried out in a place with a temperature of 3-6°C, and after the process is finished, the curds should be transferred to section 8, which has coolers of different designs, to cool at a temperature not exceeding 8°C. The finished product is a large and small parchment, cardboard, plastic, etc., with an output part of 9. comes in the form of packaging (Azimov A. M., Akhundova N. A., Gadimova N. S., 2016).

2. MATERIAL and METHODS

In the experimental part of the research work, necessary methods were presented for conducting the research related to the improvement of the technology and recipes of cottage cheese semi-finished product, which is a high-calorie product, and which is a functional dairy product made from pumpkin grown in Azerbaijan and various fruit juices.

2.1. The Object of The Study

Curd products, a type of sour milk products, are a source of high-value protein, easily absorbed by the human body. Curd is one of the first products that experts use in the treatment courses. It is a key nutrient in the treatment of obesity, liver, digestion and blood circulation. This feature shows that curd products are one of the most important foods and are very useful for both healthy and sick people. Like many food products, curd products are divided into several types: fat, low-fat, fat-free, fruit and berry, etc. Curd products are usually prepared using 2 methods: the 1st method is the preparation of the product by acid method; The 2nd method is preparation of the product with the help of acid-stomach enzyme. During the production, a certain part of the fat is separated along with the whey, so they prepare mostly fat-free curd products using the acid method. Curd products made on the basis of pumpkin, apple, blackcurrant, and cherry juices, which are milk-based functional products used in nutrition by any age group of the population, were taken as the research object. A number of raw materials were used in the recipe for the production of cottage cheese, a functional dairy product made on the basis of milk. Because it has a number of useful properties for the human body and it is considered appropriate to use pumpkin puree as a food supplement to prepare healthy food.

2.2. Research Method

Scientific information and experiences related to people's healthy nutrition, life activities and problems arising during nutrition are summarized from the scientific works and literature of various local and foreign authors. During the research, experiments were conducted on whey-based and dietary fiber-based functional curd products. Analyzes were conducted in order to study the benefits of these products consumed by the population and their effects on health. During the research, a number of methods were used for the initial evaluation and safety of curd products. These include organoleptic, physical-chemical, microbiological analysis methods. The main purpose of determining the quality and safety indicators of the cottage cheese product

is to study its effect on the body in human nutrition and to check compliance with the requirements of state standards.

3. RESULTS and DISCUSSION

Traditional technology and recipe of products in this part of research work by improving milk based products diet fibers with new varieties to the creation scientific and experience approaches present has been done. Diet character preventive nutrition a number of raw materials to create a range of products we selected: fruit juices, fruit puree, whey, berry juices, sweeteners (natural sweeteners and fructose). According to the modern classification, whey belongs to non-fat raw milk and has nutritional and biological importance. It also has unique properties and chemical composition (Mikhneva V. A., 2011).

Whey and fruit added to curd products during organoleptic evaluation proportions of juice certain has been done (Table 1).

Table 1. Whey and fruit of juices composition ratios

Usage done type of juice and whey	Whey and fruit respectively of juices ratio
Black currant juice and whey	2:1
Apple juice and whey	2:1
Cherry juice and whey	1:1
Pumpkin juice and whey	3:1

Nutrition and energy of curd products made on the basis of whey value about informations opposite has been done (Table 2).

Table 2. Serum based on prepared don't cut nutrition and energetic value

Serum hydrolyzate, %-with	0	1	2	3
Nutrition cost, %-with				
Carbohydrate	6.0-8.0	6.0-8.0	6.0-8.0	6.0-8.0
Oil	0.25	0.25	0.25	0.25
Protein	0.25	0.50	0.75	1.00
Energy cost, kcal	27.25-35.25	28.25-36.25	29.25-37.25	30.25-38.25

In the course of the study, powder and puree obtained from the pumpkin fruit, which is used as an enrichment during curd production, was prepared. The process begins with washing the pumpkin, then the pumpkin fruit is peeled and cut into two parts. After cleaning the seeds, they are pressed and crushed to extract the juice. As a result, the remaining part becomes a lath part, which we dry in a drying cabinet at a temperature of 65°C. At the beginning of the drying process, a high temperature regime (100°C) was used to prevent the development of unwanted enzymatic processes (Tong JL, Ran ZH, Shen J, Zhang CX, Xiao SD., 2007). The process took 5 minutes. It is crushed in a coffee grinder to obtain a dry powder with a moisture content of 8-12%. In addition to pumpkin powder, pumpkin puree was also prepared. First, the pumpkin fruit was washed and peeled, as in the process of making pumpkin powder. After cutting into two parts and removing the seeds, cube-shaped parts were divided. After cooking the chopped raw materials for 15-20 minutes, they were cooled and passed through a meat grinder. A number

of indicators characterizing their organoleptic properties and chemical composition were investigated in order to justify the suitability of using pumpkin powder and pumpkin puree in curd production. Table 3. - provides information on the organoleptic indicators of pumpkin powder and pumpkin puree.

Table 3. Pumpkin powder and pumpkin of mash organoleptic indicators

Indicators	Features
Pumpkin mash	
Color	Yellow orange to the shades up to
Consistency	homogeneous, mashed
Taste and fragrance	Outside smell and taste without pumpkin owned specific
Pumpkin powder	
Color	Yellow orange to the shades up to
Consistency	In the form of a fine dry powder. Easily during mechanical impact since it is rubbed small into pieces is allowed. Dust grinding it `s degree0.08-0.16 mm organize does.
Taste and fragrance	Outside smell and taste without pumpkin owned specific

Based on the data obtained as a result of the research, pumpkin powder and puree obtained as a result of pumpkin fruit processing are characterized by high mass fractions of vital micro- and macroelements, including calcium, magnesium, calcium, iron, and pectin. In addition to these, pumpkin processing products are characterized by a high content of β -carotene and vitamin C, which belong to the group of natural flavonoid compounds and antioxidants, which play an important role in the production of food products. During the production and storage of fatty products, oxidation processes occur under the influence of various factors (the effect of light, the effect of oxygen, temperature rise, etc.), which leads to a decrease in the nutritional and biological value of the products (Grigoryev D., 2005). Since the products obtained from the processing of pumpkin fruit have a great role in preventing these processes, their use in curd products is of great importance. Evaluation of organoleptic properties of cottage cheese semi-baker made on the basis of pumpkin powder and puree, which are pumpkin processing products, was carried out and its chemical composition and energy value were determined. Semi-finished cottage cheese with 5-7% pumpkin powder and 3-5% pumpkin puree were taken as examples (Lenoir-Wijnkoop I, Sanders ME, Cabana MD, et al., 2007). Organoleptic evaluation of cottage cheese semi-finished products made on the basis of pumpkin processing products was carried out on a 5-point scale. The results of studies on the organoleptic indicators of cottage cheese semi-finished products are listed in Table 4.

Table 4. Cottage cheese made on the basis of pumpkin processing products semi-finished products organoleptic indicators

of the product name	Indicators			
	Color	Consistency	Good	The taste
Sample 7%,pumpkin powder with	In the whole crowd evenly distributed golden color	Large grains without homogeneous	Outside smell without, sour milk and pumpkin the smell	Outside taste from me sour milk and pumpkin full
Sample 5%,pumpkin powder with	In the whole crowd evenly distributed yellowish color	Large grains without homogeneous	Outside smell without, sour milk and pumpkin the smell	Outside taste from me sour milk and pumpkin full
Sample 5%,pumpkin with mash	In the whole crowd evenly distributed yellow color	Tight and homogeneous	Outside smell without, sour milk and pumpkin the smell	Outside taste from me sour milk and pumpkin full
Sample 3%,pumpkin with mash	In the whole crowd equal distributed white and little yellowish color	Tight and homogeneous	Foreign smell without, sour milk the smell	Outside taste from olam, sourmilk the taste

Based on the results of the organoleptic evaluation, it is appropriate to add the dose of pumpkin powder in the range of 3-7%, and the dose of pumpkin puree in the range of 3-5% for the preparation of curd semi-finished products. Addition of more than 10% dose of pumpkin powder and more than 5% dose of pumpkin puree resulted in the taste and aroma of pumpkin, which led to the deterioration of consumption characteristics in curd semi-finished products (Shenderov B.A., 2013).

The chemical composition and energy value of curd products made on the basis of pumpkin processing products are shown in Table 5.

Table 5. Pumpkin powder and mash prepared on the basis of cottage cheese of the product chemical composition and energy value

of products name	The mass of the protein share, %-with	Carbohydrates mass share, %-with	Fatness mass share, %-with	Energy cost, kcal with/in 100 g
Sample 7%, pumpkin powder with	12.1±0.01	16.0±0.2	4.0±0.3	145.2
Sample 5%, pumpkin powder with	12.5±0.02	17.5±0.1	4.0±0.2	152.5
Sample 5%, pumpkin mash with	13.0±0.03	18.3±0.3	4.0±0.3	157.5
Sample 3%, pumpkin mash with	13.5±0.01	18.5±0.1	4.0±0.2	160.3

Based on the obtained indicators, it was concluded that pumpkin powder and puree are suitable for curd production.

As a result of the research, it was concluded that the use of pumpkin puree and pumpkin powder in the preparation of curd products does not have a negative effect on their microbiological and safety indicators.

4. CONCLUSION

Based on the results obtained from the conducted research, it was concluded that the use of functional curd products made on the basis of fruits and berries is appropriate. The composition and production characteristics of enriched curd products have been determined. The addition of fruit and berry juices and pumpkin fruit to curd products helped to enrich the curd products with many vitamins, pectin, proteins, dietary fibers, micro and macro elements. The organoleptic indicators of curd products were evaluated on a 5-point scale. According to the organoleptic evaluation of curd products, positive results were obtained. It was determined that the permissible amount of pumpkin powder added as an enrichment to the curd product is 10%, and the permissible amount of pumpkin puree is 5%. Excessive use of the mentioned indicators has worsened the organoleptic properties of curd products, the taste, smell and color of pumpkin have prevailed.

The results obtained during the determination of the chemical composition and energy value of curd products made on the basis of pumpkin powder and pumpkin puree showed that their use in nutrition is more important and they play a major role in providing important indicators such as daily protein, fat and carbohydrates.

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Time and Dose-Dependent Repellent Effect of *Brassica nigra* Essential Oil Against *Musca domestica* L. (Diptera: Muscidae)

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Abstract

Musca domestica L. (Diptera: Muscidae), also known as the house fly, is an important vector living in close proximity to humans and playing a role in the spread of many diseases with the microorganisms it carries. It is generally found in many septic environments such as garbage, carrion, and feces. Since it poses a threat to human health and transmits pathogens and parasites, it is very important to ensure its control. In addition, it is clearly known that the chemical repellents used negatively affect human health and the environment. Natural repellents play a major role by minimizing this damage and repelling house flies without affecting their life. The study conducted is on the time and dose-dependent repellent effect of *Brassica nigra* L. oil, from essential and volatile oils, on *M. domestica* and examines this effect in detail. In this study, cotton fabrics that did not contain essential oil and were exposed to 0.5 mL and 1 mL *B. nigra* oil were used as the control group. In addition, three separate cabins were provided for each concentration group, including the control group. The study shows that *B. nigra* oil has a time- and dose-dependent repellent effect on *M. domestica*. The findings support the use of natural repellents in pest control and provide very important results for the continuation of studies in this direction.

Keywords: *Musca domestica*, *Brassica nigra*, natural repellent, mustard oil

1. INTRODUCTION

Repellent effect, more commonly known as repellent effect, defines the ability to repel unwanted guests. Natural oils contain components with this repellent ability and contribute to the studies on this subject (Benelli et al., 2017). These components in its structure are effective in repelling flies or other unwanted pests by triggering their odour sensitivity. The components in the essential oils used are active and change the perception of target organisms and remove them from unwanted areas.

Musca domestica, highly disturbing, septic creatures that pose a threat to the environment and the health of many living things worldwide. Due to the diseases carried by these pests, major problems are encountered (World Health Organization, 2020). Therefore, it is of great importance to combat them. Studies conducted for some time show that natural oils provide great help in this regard and are used more frequently in studies due to their repellent effect (Khan et al., 2019). The article you are reading will be on the repellent effect of *Brassica nigra*, one of the vegetable oils and known as mustard oil, on house flies. Our aim is to contribute to environmental and human health by providing information on the effect of *B. nigra* essential oil on *M. domestica* control.

2. MATERIAL and METHODS

2.1. Material

The study was conducted as an experimental type of research and the results were recorded. 60 pieces of *M. domestica*, *Brassica nigra* essential oil, 3 experimental cabinets, cotton fabrics, micropipette, timer.

2.2. Methods

In the study, 60 *M. domestica* grown under equal conditions were divided equally into three separate cabinets. They were disinfected beforehand to create favourable conditions for the flies. The booths

were divided into two in the middle and the boundaries were determined. Half of the cabins were left empty and cotton fabrics were hung on the other half. Mustard oil was added 0.5 ml to one of these fabrics in the cabinets and 1 ml to the other. While the cotton fabrics in two cabinets were exposed to essential oil, one cabin was analysed as a control group. At this stage, it was observed and recorded whether the cotton fabric would show a repellent effect alone. The flies in the booths were counted at 15-minute intervals for 120 minutes without any external influence and the repellent effect of mustard oil was recorded and noted.

3. RESULTS and DISCUSSION

3.1. Results

As a result of the findings obtained, the repellent effect of mustard oil on house fly is examined. These findings show the repellent effect of mustard oil. Suitable conditions were created for the experiment and as a result, it was observed that it showed an average repellent effect on house flies. During this experiment, as long as the dose of oils was increased, the repellent effect increased to a certain extent, but it was also observed that time did not have much effect. In addition, it was noted that the cotton fabric in the control group did not show a repellent effect alone and it was among the findings that the cotton fabric had no effect.

3.2. Discussion

When the findings are considered, the repellent effect of the natural oil used on flies is clearly observed and it is argued that it can be used as an important alternative.

The effective and active components in the composition of these oils adversely affect the sense of smell of the targeted house flies, supporting the ideas in this direction and arguing that studies should continue. In addition, the fact that other natural oils are a much more appropriate repellent tool than chemicals and do not harm living life shows that they are more preferable in terms of their use.

There is no clear information that this experiment, which was carried out in a controlled manner in a laboratory environment, will give the same result in natural environments. In addition, the concentration of oils and time are factors that can change this effect. In addition, the use of different oils together and the effectiveness of these mixtures are among the subjects that can be investigated in future studies. To make a general evaluation, the repellent effect of natural oils should be further investigated due to minimising the damage to the environment and living things.

4. CONCLUSION

Table 1. Table of time and dose dependent repellent effect of *B. nigra* essential oil on *M.domestica*

	Control	0.5ml	1ml
15 th minutes	8-12	14-6	14-6
30 th minutes	10-10	13-7	13-7
45 th minutes	6-14	17-3	11-9
60 th minutes	0-20	15-5	13-7
75 th minutes	2-18	15-5	5-15
90 th minutes	0-20	17-3	15-5
105 th minutes	2-18	15-5	16-4
120 th minutes	6-14	17-3	16-4

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AFL And EFL teaching and learning through translanguaging: Global climate change context using IT technology

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Abstract

Language learning in the face of climate change aims to empower individuals to effectively communicate and address environmental challenges. Objectives include developing environmental awareness and sustainability vocabulary, communicating climate change issues and advocating for sustainable behaviors, expressing eco-friendly habits and persuading others to adopt environmental conscious behaviors, thinking critically and proposing innovative solutions, understanding diverse cultural perspectives on sustainability, and advocating for climate justice and biodiversity conservation. Additionally, learners will develop Environmental awareness skills to analyze and evaluate eco-friendly language practices, promote sustainable development goals, and foster global citizenship and cooperation to address the urgent need for environmental actions. By achieving these objectives, language learners will become informed, engaged, and active global citizens, equipped to mitigate and adapt to climate change impacts. As the world grapples with the challenges of climate change, language teaching and learning can play a vital role in fostering global understanding and collective actions. This paper explores the intersection of language education and climate change, highlighting innovative approaches to teaching and learning languages through the lens of sustainability and environmental stewardship during 2023-2024 in Odlar Yurdu University Foundation group 7.

Keywords: Global Climate change context, AFL and EFL teaching and learning, IT technology

1. INTRODUCTION

Formation of bilingual communicative competence through translanguaging is one of the possible ways of realization. Translanguaging is a necessary condition for successful communication in the formation of bilingual communicative competence. There are very few works that study the pedagogical conditions of the formation of bilingual communicative competence through translanguaging in the teaching process. Both the formulation of the problem of finding resources and mechanisms for the implementation of students' BCC formation, and its solution are not comprehensive. This gives the right to say that the ways and methods of developing students' bilingual communicative competence are not developed enough. Nowadays, the Global climate change is an important topic should be included in the Curriculum of every educational system. Being AFL and EFL teacher at Odlar Yurdu University Foundation 7 course, highlighting its significance in the education, explaining the real situation to students we need good language, Global Climate Change and information technology skills for fostering the students' climate change and language skills. This study focuses on conducting a need analysis related to the use of audiovisuals, reading, and writing materials in learning climate change within the course of AFL and EFL classrooms as needs analysis will inform us what is suitable for Foundation 7 course students who have just started learning Azerbaijani as Foreign language and English as Foreign Language. Specifically, the research investigates the requirements for audiovisuals, reading and writing resources to enhance climate change literacy (Maskana and et.all, 2024, Kirkwood A, & Price L. 2016).

The relevance of the problem, its theoretical and practical importance, understanding of the accumulated experience and the need to formulate a justified theoretical approach and practical recommendations conditioned the selection of the topic of the research. The purpose of the study is to theoretically base and develop the model of formation of students' bilingual

communicative competence and to experimentally test a set of pedagogical conditions that contribute to its effective implementation. The object of the study is the process of formation of bilingual communicative competence of language faculty students in the Higher School with translanguism. The subject of the research is a set of pedagogical conditions that ensure the implementation of the model of formation of bilingual communicative competence of language faculty students. The tasks of the research are to study the impact of translanguism on the process of formation of bilingual communicative competence of students. To justify, develop and include the model of formation of bilingual communicative competence of students with translanguism in the educational process. To justify the criteria, develop indicators and levels of bilingual communicative competence of students formed through translanguism in higher school. Based on the proposed model and certain pedagogical conditions, to experimentally verify the effectiveness of the formation of bilingual communicative competence of students in the Higher School through translanguism.

All goals and tasks set for the performance of the work are fully covered. The presented topic is given as an innovation in pedagogical theory and practice with translanguism in the educational process. Principal arguments of the work is the integration of language, information technology studies, and climate change education is pivotal for understanding the scientific terminology, proficiency in language helping students grasp complex scientific terminology and concepts related to climate change, enabling more effective learning. Effective language skills are essential for articulating climate change issues, solutions, and actions clearly to diverse audiences, including multilingual students. Language education fosters critical literacy, allowing students to critically evaluate climate change information from various sources, discerning credible information from misinformation. Language studies can incorporate cultural perspectives on climate change, reflecting how different communities understand and respond to environmental challenges.

Teaching climate change in multiple languages ensures inclusive, making education accessible to non-native speakers and marginalized communities promoting broader engagement and understanding in 4 aspects:

- 1- Language skills empower students to advocate for climate action, write persuasive arguments, and engage in public discourse, influencing policies and practices.
- 2- Language proficiency enables cross-border collaboration, allowing students to participate in international dialogues, share best practices, and learn from global perspectives on climate change. Integration language, information technology, and climate change education encourages interdisciplinary learning, bridging humanities and sciences, and fostering holistic education.
- 3- Language and information technology studies can enrich climate change education by incorporating literature, media, and narratives that illustrate the human impact of climate change, making the topic more relatable and compelling.
- 4- Integrating language and information technology studies with climate change education not only enhances comprehension and communication but also fosters cultural inclusive, empowers advocacy, and enriches interdisciplinary learning. This holistic approach ensures that students are well-equipped to understand, articulate, and address the multifaceted challenges of climate change in a global context.

By examining case studies from diverse linguistic and cultural contexts, we demonstrate how language instruction can:

- Raise climate change awareness and literacy;
- Promote eco-friendly behaviors and sustainable practices;

- Foster global citizenship and collaboration;
- Enhance linguistic and cultural competence;

We argue that language education can contribute to a more informed, engaged, and sustainable global community, equipping learners to address the complex challenges posed by climate change. By integrating climate-focused content and pedagogy into language teaching, we can empower learners to become active participants in the global effort to mitigate and adapt to climate change (Ellis, M. (2019).

Language learning in the face of climate change refers to the process of acquiring a new language in a world where climate change is having a significant impact on individuals, communities, and societies. It involves: Language learning in the face of climate change refers to the process of acquiring a new language in a world where climate change is having a significant impact on individuals, communities, and societies. It involves:

1. **Environmental awareness**: Learning about climate change, sustainability, and environmental issues in the target language.
2. **Eco-friendly communication**: Developing language skills to discuss environmental topics, advocate for sustainability, and promote eco-friendly behaviors.
3. **Cultural exchange**: Sharing perspectives and experiences related to climate change with native speakers and learning about their cultural practices and beliefs.
4. **Vocabulary and terminology**: Acquiring specialized language related to climate change, sustainability, and environmental science.
5. **Critical thinking and problem-solving**: Developing language skills to analyze and discuss climate-related issues, propose solutions, and engage in sustainable practices.
6. **Intercultural understanding**: Fostering empathy and understanding of diverse cultural responses to climate change.
7. **Language for sustainable development**: Learning language to support sustainable development goals, such as education, renewable energy, and sustainable cities.

By integrating climate change awareness and sustainability into language learning, individuals can become more informed, engaged, and active global citizens, prepared to address the challenges of a changing world (Veisi, H., Lacy, M., Mafakheri, S., & Razaghi, F. (2019).

During researches have been explored various aspects of language learning and climate change, including the integration of sustainability into language curricula, the role of language education in promoting environmental awareness, and the impact of climate *change* on language teaching and learning (Mutlu, G., & Yıldırım, A. (2019).

2. MATERIAL and METHODS

The study reveals students' great desire to learn about climate change through audiovisuals by using a mixed-method approach that combines quantitative and qualitative data collection approaches, such as questionnaires and interviews Beach, R.W., & Smith, B. (2020). Methodologies for language learning in the face of climate change include task-based learning, content and language integrated learning (CLIL). These approaches focus on authentic contexts, such as sustainable development projects, environmental debates, and climate change research. Learners engage in activities like role-plays, simulations, and problem-solving, using language to achieve specific goals. This learner-centered approach develops language skills, critical thinking, and environmental awareness, preparing learners to address climate change challenges in their communities (Choi, J. (2020).

3. RESULTS and DISCUSSION

They also support providing teachers with the necessary skills to use audiovisual, reading and writing materials as an effective teaching tools. By addressing the needs of teachers and students, this study makes a substantial contribution to the field of climate change education. It also provides guidance for the development of effective teaching strategies and instructional materials.

4. CONCLUSION

Students have developed not only their language skills but also their environmental awareness and critical thinking abilities. They have learned to effectively communicate climate change issues, advocate for sustainable practices, and collaborate on projects that address real-world environmental challenges. Their language learning journey has empowered them to become informed, engaged, and active global citizens, ready to make a positive impact in their communities and contribute to a more sustainable future. They have discovered that language learning can be a powerful tool for creating positive change, and they are committed to continuing their journey towards linguistic and environmental proficiency.

It also reveals a predilection for audiovisual media over conventional text-based materials and emphasizes instructors' support for incorporating climate change education into AFL and ESL lesson plans. The researches show creating audiovisual materials designed to make it easier for AFL and ESL teachers and students to incorporate climate change education into their lessons in light of these findings.

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