



4<sup>th</sup> INTERNATIONAL CONGRESS ON ENGINEERING AND LIFE SCIENCE  
**ICELIS** 17-19  
NOVEMBER  
2023  
COMRAT - MOLDOVA

# PROCEEDINGS

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**4<sup>TH</sup> INTERNATIONAL CONGRESS ON ENGINEERING  
AND LIFE SCIENCE**

**“Life in the Grip of Pandemic and War:  
Agriculture and Nature”**

**17-19 November 2023**

**Comrat – Moldova**

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**4<sup>TH</sup> INTERNATIONAL CONGRESS ON ENGINEERING AND LIFE SCIENCE**

*“Life in the Grip of Pandemic and War: Agriculture and Nature”*

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**Editors**

**Prof. Dr. Stepan VARBAN**

**Assoc. Prof. Dr. Adem Yavuz SÖNMEZ**

**Republic of Moldova**

**Comrat State University - 2023**

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## GENERAL COORDINATOR'S PREFACE

Dear Researchers,

The wars taking place in different parts of the world today and the pandemic, the effects of which we have not yet left behind, have negatively affected the world food supply, as in every sector, in the last few years. This problem in production and distribution prevents healthy and sufficient food transportation in many parts of the world nowadays. Undoubtedly, this is one of the important issues addressed by scientists. In this context, we have organized the 4<sup>th</sup> International Congress on Engineering and Life Sciences this year with the theme “Life in the Grip of Pandemic and War: Agriculture and Nature”. Scientists participating from 13 different countries presented 102 papers at the congress, hosted by Comrat State University, held in Comrat, an ancient Turkish town in Gagauzia, Moldova. The cultural tour of the congress, where substantial problems regarding the agricultural effects of the pandemic and war were discussed, was made towards the history of ancient Turkish villages.



Hereby, I would like to thank Comrat State University for organizing and hosting the congress, the partner and participating universities for providing both scientific and physical support to the congress, and the organizing committee for working with great devotion from the beginning to the end.

Hope to meet you at the 5<sup>th</sup> International Congress on Engineering and Life Science, which will be held in a different part of the world with a different topic.

Best Regards

**Assoc. Prof. Dr. Adem Yavuz SÖNMEZ**

General Coordinator

## HONORARY CHAIR'S PREFACE

Dear Scientists,

In recent years, humanity has faced many global problems. Especially the Pandemic process, which affected all geographies in the world and brought a new dimension to all habits from production to supply along with all the losses experienced, and the war that followed brought along great problems.

History has shown that humanity always prioritizes health care and access to food in tough times. Likewise, today, with the effects of the Covid-19 global epidemic and the Russia-Ukraine war; Concerns about the disruption of access to food are gradually increasing due to the inadequacies and disconnections that may arise in the agri-food chain, the inevitable low income experienced by those working in these sectors, and the rapid price fluctuations caused by the changes in food demand and supply. This situation further increases the importance of agricultural production and those working in agriculture. These global issues bring along not only the problems of agricultural production but also the destruction of nature.

These negative developments in the whole life cycle draw attention to researchers working in this direction. Scientists and researchers carry out important studies to reduce the effects, to reveal the magnitude of the effects, and to rehabilitate the destructions of these events that are on the world agenda.

For this reason, we wanted to draw attention to the effects of pandemic and war on agriculture and nature by organizing our 4<sup>th</sup> congress with the theme of “Life in the Grip of Pandemic and War: Agriculture and Nature” this year.

I would like to present my sincere appreciation to all the participants who contributed to this beautiful organization.

It was a great pleasure to welcome you all in Comrat city of Moldova...



Kind Regards

**Prof. Dr. Serghei ZAHARIA**

Rector of Comrat State University

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## KEYNOTE SPEECH

### The Use of Locally Sanitized Grape Varieties for the Production of White and Red Wines in the Republic of Moldova

*Nicolae TARAN, Boris MORARI, Olga SOLDATENCO*✉

*Public Institution Scientific-practical Institute of Horticulture and Food Technologies, Chisinau, Moldova*

✉ *Correspondence:* olea\_g@rambler.ru

**Abstract:** The main directions of viticulture development in the Republic of Moldova involve transitioning to the production of sanitized grapevine planting material and using local varieties for the production of high-quality wines. To achieve this goal, it is necessary to study methods for the devirusing of grapevine planting material and to develop innovative grape processing technologies for making wines from local varieties. The study utilized local grape varieties, including newly selected ones, cultivated in the vineyards of the 'Prebase' and 'Base' biological categories within the Scientific-Practical Institute of Horticulture and Food Technologies. Modern methods of vineyard sanitation, in vitro microclonal grapevine propagation, and modern physico-chemical wine analysis were employed. In 2022, the 'Prebase' biological category mother plantation of the Institute was enriched with sanitized planting material obtained during the growing season using the in vitro microclonal grafting method. The following grape varieties were included "Codrinschii", "Muscat de Ialoveni", "Alb de Onițcani", "Autumn Royal", and rootstock "Freedom", covering an area of 0.30 hectares. As a result of the conducted research, the 'Base' biological category mother plantation of the Institute in 2022 was supplemented with sanitized grapevine varieties, including "Viorica", "Florica", "Legenda", "Telti Curuc", "Crîmpoșie", "Feteasca Neagră", "Copceac", and "Plăvaie", totaling 2176 plants. Various treatment regimes involving hot water (45 - 54°C) and hot air (37 - 38°C) were studied for the sanitation of grapevine planting material against viroid diseases and bacterial cancer. Research was also conducted on devirusing grapevine planting material affected by different viroid diseases using the viricide "Viron". Experimental batches of dry white wines were produced from sanitized grape varieties "Viorica", "Florica", "Riton", and "Plăvaie" from the 2022 harvest, exhibiting optimal physico-chemical characteristics. Was determined that use of oak wood during must fermentation process have positive effect on the physico-chemical indicators and the organoleptic notes of dry white wines produced from the Riton and Viorica grape varieties. Experimental batches of bottled dry white wines were produced from the 2021 harvest in micro-winemaking conditions. Experimental batches of dry red wines were obtained from sanitized local grape varieties: Copceac, Negru de Căușeni, and Feteasca Neagră from the 2022 harvest. Dry red wines from local varieties are characterized by high concentrations of phenolic substances (ranging from 2670 to 2920 mg/dm<sup>3</sup>) and anthocyanins (ranging from 288 to 349 mg/dm<sup>3</sup>), as well as high alcohol concentrations (12.7 - 14.4% vol). Have been determined optimal production regimes for both dry white and red wines from newly selected and local grape varieties. Based on the obtained results, were developed four technological instructions for wine production. Additionally, sparkling white wines were produced from new and local selection grape varieties: "Viorica", "Florica", "Riton", and "Plăvai". The content of biologically active substances in dry white and red wines obtained from sanitized new and local grape varieties (rutin, quercetin, resveratrol, ascorbic acid, (+) catechin (-) epicatechin) was determined. High content of biologically active substances was established in dry red wines from "Copceac" and "Codrinschii" varieties (h.y. 2021 - 2022).

**Keywords:** Local Grape Varieties, Treatment Regimes, Dry White and Red Wines.



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## KEYNOTE SPEECH

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### Revolutionizing Food Production: Digitalization for a Greener Future

**Sandeep JAGTAP**✉

*Lund University, Faculty of Engineering, Division of Engineering Logistics, Sweden*

✉**Correspondence:** sandeep.jagtap@tlog.lth.se

**Abstract:** This keynote presentation explores the transformative potential of digital technologies, with a specific focus on the Internet of Things (IoT), in revolutionizing food production for a more sustainable and efficient future. It delves into the critical issue of solid food waste and how digitization, through IoT, provides valuable insights to curtail waste and enhance resource efficiency in food manufacturing. Additionally, it highlights the power of Big Data analytics in the development of new food products, enabling more informed decision-making and rapid recipe creation, ultimately expediting product delivery to the market. Through these advancements, it paves the way for a greener, more environmentally conscious food production landscape.

**Keywords:** Food Waste, New Product Development, Internet of Things, Big Data, Resource Efficiency.

## KEYNOTE SPEECH

### State and Prospects of Agricultural Production in Ukraine under the War Conditions

**Mykhailo BROSHKOV**✉

*Odesa State Agrarian University, Odesa, Ukraine*

✉ **Correspondence:** bu.dasha.bu@gmail.com

**Abstract:** Ukraine is currently in difficult conditions: war, loss of territory with high agricultural resources, degradation of personnel and technical potential of agricultural production, blockade of logistics and international trade, manifestation of climatic transformations. World society does not know historical analogies and experience of overcoming such a crisis. The solution of such questions lies in the scientific plane of mainly political, economic and military solutions. However, the peculiarity of the situation is that, according to the expert assessment of the Ministry of Agrarian Policy and Food of Ukraine, today our country has production volumes of wheat for 2 years, oil for 5 years, and corn for 1.5 years. In this way, Ukraine is not threatened by a food crisis, while the world food market will be very 'feverish'. When forecasting the volume of cultivation of agricultural crops, it is necessary to take into account the main risks and challenges: violation of the integrity and enhancement of supply chains of agricultural production resources and agricultural products; violation of the price balance and parity on the world and domestic market; limited financial and production resources, technological capabilities of manufacturers; the need to maintain an appropriate level of production profitability at each stage; expected large losses of finished grain due to rafales and attacks; mandatory condition for reproduction of soil fertility; compliance with environmental requirements. According to preliminary estimates presented in the Government Courier of Ukraine, the potential direct damage to the domestic agricultural infrastructure as a result of the war exceeds 6 billion dollars, additional economic losses are estimated at 22 billion. In the short term, a change in the structure of cultivated crops is expected from cereals to more valuable oil crops, as well as niche legumes, cereals and vegetables. It is not about months, but about years of the recovery period, and therefore the probable initial decrease in the production of wheat and sunflower on 30%, barley – on 40%, corn – on 10%, soybeans – on 15%, vegetables and melon crops – on 50%, - in the future will effect on food sustainability of many countries in the world. The war showed Ukraine's role in world food security. Most of the logistical routes by which Ukraine exports grain are waterborne, and therefore the state of war makes it impossible the full-fledged export of agricultural products. This leads to its surplus on the domestic market, a decrease in prices, and, as a result, the impossibility of full-fledged economic activity by farmers who cultivate land with an area of less than 2,000 hectares. In addition, there are regions of risky farming, such as Southern Bessarabia. Improvement of material and technical base, implementation of the principles of precision agriculture, land reclamation systems and innovative methods of conducting relevant economic activities in the respective regions will allow to increase the volume of agricultural products of our country, which will have a positive effect on global food security.

**Keywords:** Agricultural Production, War Conditions in Ukraine, Global Food Security, Logistic.



## KEYNOTE SPEECH

### Biochar-Based Fertilizers: An Emerging Technology for Sustainable Food Security

**Dilfuza EGAMBERDIEVA**✉

*Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg, Germany*

✉ **Correspondence:** [dilfuza.egamberdieva@zalf.de](mailto:dilfuza.egamberdieva@zalf.de)

**Abstract:** In recent decades ecological problems increased in many regions of the world, and these conditions are likely to contribute to increased food security and health risks. The low technological development, improper agricultural methods and policies are major hindrances against agricultural development in many developing economies. Climate change may lead to even more degraded landscapes in many non-irrigated regions since it is accompanied by less rainfall and higher temperatures. These facts represent a serious threat to sustainable food production and to our natural resources. Owing to population growth and increasing food demand, intensive and environment-friendly agricultural techniques such as application of bio-fertilizers have become a promising model for many countries in the world. Biofertilizers contribute environmental benefits and help to conserve resources for crop cultivation, especially for poor farmers. The reduction of chemical fertilizers by using biological fertilizers is one of the effective steps in sustainable agriculture. The application of biochar produced through pyrolysis in the absence or limited oxygen to improve soil fertility and plant growth is gained attention worldwide. The application of biochar to soil is considered to mitigate climate change by increasing carbon storage in soils, improve fertility of degraded soils, plant growth and development, increase fertilizer efficiency, and suppress soil pathogens. In addition soil amendment with biochar increased soil biological activity, such as microbial biomass and enzyme activities. There are also several reports on the improved plant stress tolerance to drought by biochar application. Biochar-type materials have been also suggested as inoculant carriers and will remain stable in the soil and thus may positively influence abundance of the inoculant organisms such as rhizobia, or plant growth promoting rhizobacteria. Efforts to better understand the role of biochar-based biofertilizers in nutrient uptake and plant response to environmental stress is more compelling now, since a continuous use of high amounts of chemical inputs are generating environmental problems and not sustainability.

**Keywords:** Biochar, Biofertilizers, Crops, Abiotic Stress, Food Security.

## KEYNOTE SPEECH

### Relationship between Plant Biodiversity and Plant Breeding

**Sezai ERCISLI**<sup>✉</sup>

*Atatürk University, Agricultural Faculty, Department of Horticulture, Erzurum, Türkiye*

<sup>✉</sup>**Correspondence:** sercisli@gmail.com

**Abstract:** Plant biodiversity and plant breeding are among the most emphasized issues in world agriculture in recent years. Our planet is experiencing a significant loss of biodiversity due to reasons such as dam and road construction, pollution, and the prevalence of invasive species resulting from human activities around the world. As a result of these losses, the Earth is losing one of its most important treasures, plant biodiversity. On the other hand, general breeding purposes are gradually giving way to special breeding purposes. Among the special breeding objectives, obtaining varieties with higher nutritional and bioactive content and developing varieties that are resistant to abiotic and biotic environmental conditions are at the top of the list. In this context, there is a close relationship between plant breeding and biodiversity, as in the past, current and in the future. Most of the plants suffer from biodiversity loss, and on the other hand, by using mutations etc. it is possible to increase biodiversity with these methods. During the human history, the milestones of plant breeding are selective breeding, mutation breeding, transgenic breeding and genome editing.

**Keywords:** Biodiversity, Horticulture, Gene Pool, Characterization.

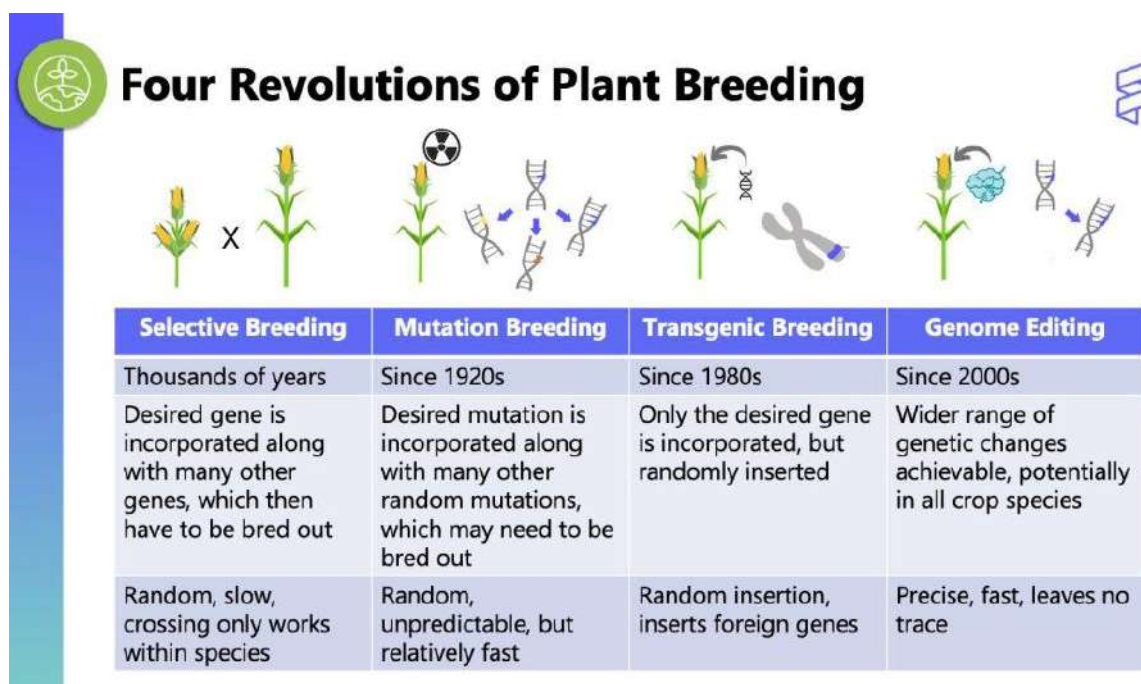
#### 1. PLANT BREEDING

Plant Breeding, is an art to obtain desired traits in any plant species to changing its genetic structure. It is the general term to obtain new plant varieties with desired characteristics by applied hybridization, selection, mutation etc. (Wang vd., 2023).

It is possible to summarize the milestones of plant breeding as selective breeding, mutation breeding, transgenic breeding and genome editing (Ahmad, 2023) (Figure 1).

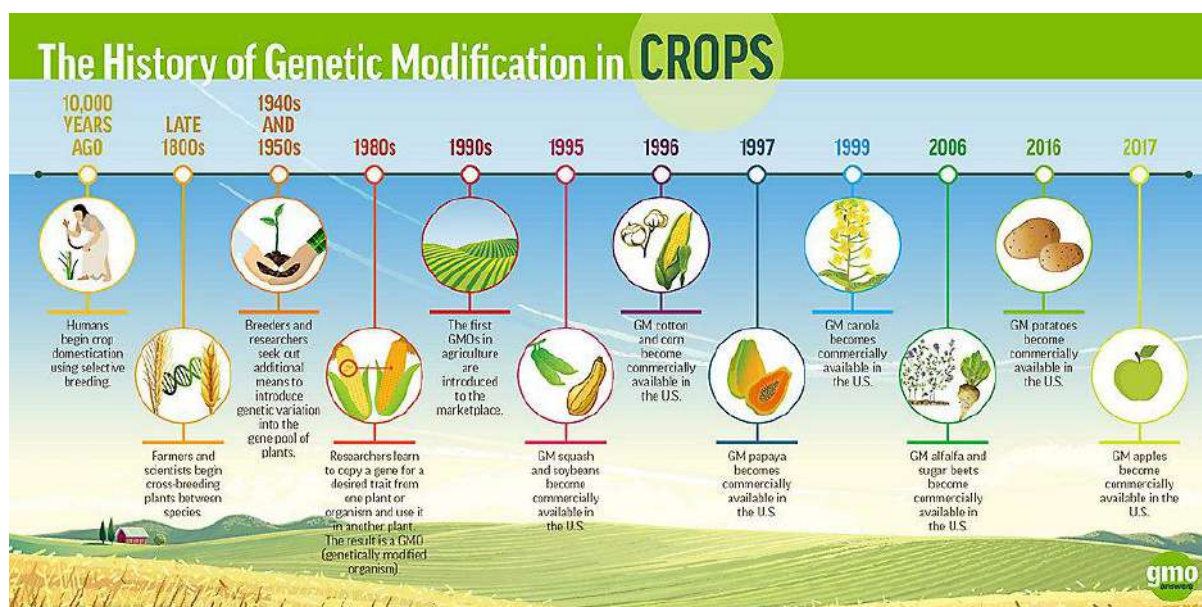
The main purposes of plant breeding since the beginning of human beings are to ensure adaptation (Tester and Langridge, 2010).

- Increasing efficiency
- Quality improvement
- Ensuring durability
- To diseases
- To pests
- Adverse environmental conditions



**Figure 1.** Milestone of plant breeding.

The history of genetic modification in plants is shown in Figure 2. As indicated in Figure 2, 10,000 years ago human begin crop domestication using selective breeding. Late 1800s farmers and scientists begin cross-breeding. The enlargement of gene pool was started 1940s and 1950s. In 1990s first GMOs in agriculture are introduced to the marketplace.



**Figure 2.** The history of genetic modification in plants.

The stages of plant breeding including (Crosbie vd., 2008).

- Parental Selection
- Hybridization
- Selection

- Tests (Yield, Disease, Quality, Response to environmental conditions)
- Registration
- Elite (breeder) varieties
- Production

Sources of variation in plant breeding are

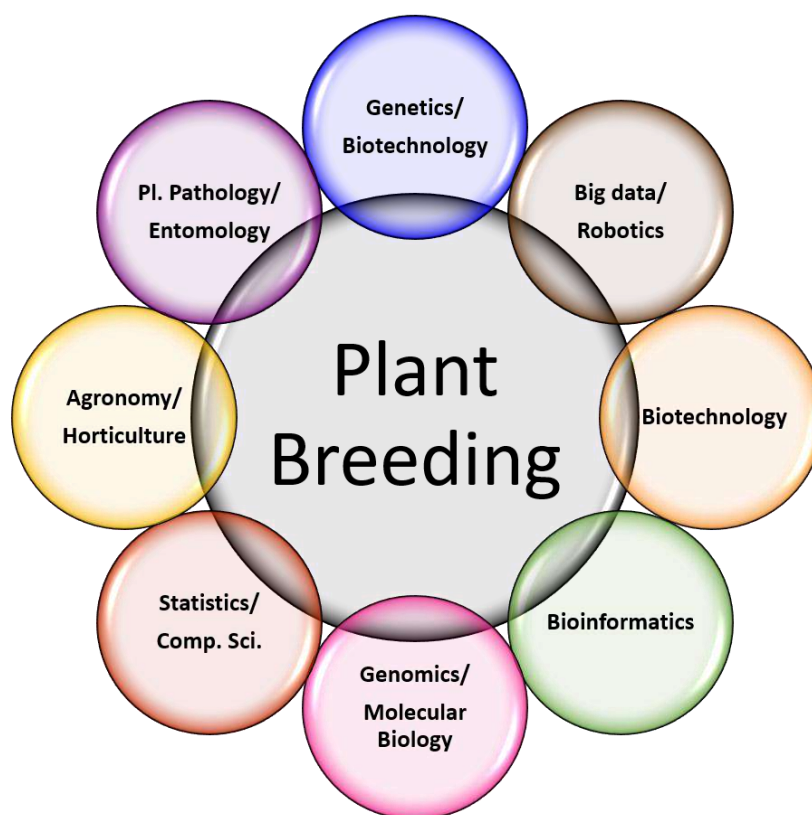
- Wild species
- Closely related species
- Local varieties
- Commercial varieties

In the past, crop improvement through breeding has been the major tool to lift people out of poverty and increase global food supply. To adequately address these food security challenges, new improved crop varieties need to be developed and reach farmers sooner as a partial solution (Lenaerts vd., 2019).

Plant breeding is a time-consuming process due to the biology of crop species. It generally takes at least 10 years to develop and release a new variety. The breeding process generally consists of three stages: hybridization, early evaluation and field trials. Plant breeding is a large-scale logistical operation involving thousands to hundreds of thousands of plants in the initial evaluation stage, but numbers are greatly reduced to a small selected number of advanced breeding lines by the end of the breeding process. Selection takes place during the breeding process, such that approximately 99% of the original starting material in a breeding program is rejected and discarded. Most countries have an independent government-led system for evaluating the “best” advanced breeding lines compared with the current varieties, which usually requires two years of testing.

Regarding variety development, it is important to emphasize key points regarding the time to develop a new variety. One time-consuming component is the “pre evaluation” stage. This is due to biology (i.e. genetics) as breeding material is not genetically uniform or “stable” (i.e. plants are not homozygous) until at least 6 to 8 generations (i.e. self-pollination events). Homozygous lines are required for testing in advanced field trials. Furthermore, time is required to produce enough seed during the breeding process (i.e. for subsequent field trials) because seed of a new breeding line originates from only a single plant. It generally takes about 10 years to develop a new field crop variety, although there are differences between crop species and varietal testing requirements across countries (Acquaah, 2007).

Since plant breeding is an applied multidisciplinary science, a solid education to become a plant breeder should include learning experiences in the following disciplines (Figure 3).



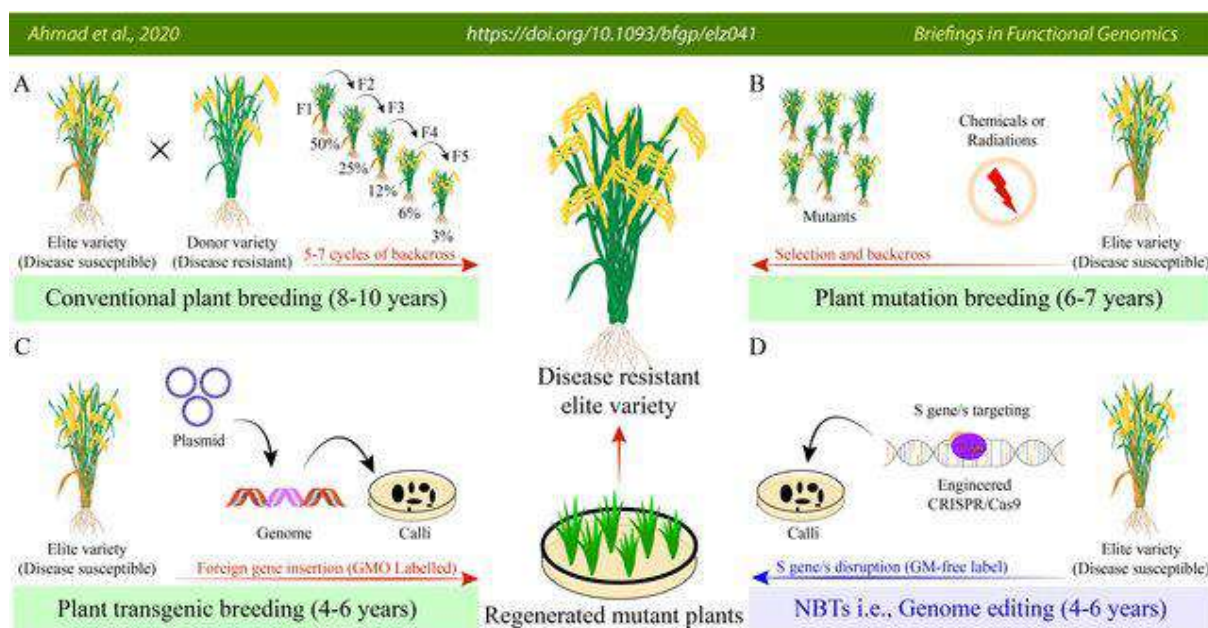
**Figure 3.** Related areas with plant breeding.

## 2. PLANT BREEDING TECHNIQUES

Plant breeding can be classified into two main types based on the methods and available tools, conventional and unconventional plant breeding.

- Backcrossing or introgression breeding. Crop breeders sometimes use a process called backcrossing
- Inbreeding
- Hybrid breeding
- Mutation breeding
- Molecular marker-assisted selection
- Genetic engineering
- Gene editing





### 3. IMPORTANCE OF BIODIVERSITY (VARIATION) IN PLANT BREEDING

It utilizes the genetic variation between individuals within a plant species and combines the desired properties into new and improved varieties. Plant breeding is dependent on genetic variation, and new variation is fundamentally important for introduction of new traits in breeding programs.

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## ORAL PRESENTATION

### Effects of Aqueous Methanolic Extract of *Ephedra alata* on Growth Performance, Digestive Enzymes and Immune Parameters of Rainbow Trout (*Oncorhynchus mykiss*)

Mohamed Omar Abdalla SALEM<sup>1✉</sup>, Adem Yavuz SÖNMEZ<sup>2</sup>, Yiğit TAŞTAN<sup>3,4</sup>, Soner BİLEN<sup>5</sup>

<sup>1</sup>Bani Waleed University, Faculty of Education, Department of Biology, Bani Waleed, Libya

<sup>2</sup>Kastamonu University, İnebolu Vocational School, Department of Transport Services, Kastamonu, Türkiye

<sup>3</sup>Kastamonu University, Faculty of Engineering and Architecture, Department of Environmental Engineering, Kastamonu, Türkiye

<sup>4</sup>Kastamonu University, Institute of Science, Department of Aquaculture, Kastamonu, Türkiye

<sup>5</sup>Kastamonu University, İhsangazi Vocational School, Department of Veterinary, Kastamonu, Türkiye

✉Correspondence: mhomar1988@gmail.com

**Abstract:** The effects of *Ephedra alata* supplementation on the growth performance, digestive enzyme activities, and immune responses of rainbow trout (*Oncorhynchus mykiss*) were assessed in this study. R. trout were supplemented with an aqueous methanolic extract of *Ephedra alata* at doses of 0% (control), 0.1%, 0.5%, or 1% over the duration of 45 days. The average weight of the fish at the beginning of the experiment was 15±0.05 g. At every 15<sup>th</sup>, 30<sup>th</sup> and 45<sup>th</sup> days of the study, respiratory burst, lysozyme and myeloperoxidase activities, hematological responses, and digestive enzyme activity, and growth performance was examined at the end of the study. The final weight (FW), weight gain (WG), and specific growth rate (SGR) were all considerably higher in the 1% group than in the other groups at the conclusion of the research. In the 0.1% groups, the feed concentration ratio was lower than in the control group ( $P < 0.05$ ). All experimental groups had significantly higher trypsin, amylase, and lipase activity than the control group ( $P < 0.05$ ). Compared to the control group, all treated groups showed a significant improvement in myeloperoxidase activity and respiratory burst ( $P < 0.05$ ). The 0.5% and 1% extract groups had the highest levels of lysozyme activity. Dietary *E. alata* extract had an impact on hematological parameters ( $P < 0.05$ ). Antioxidant enzyme activities were affected by *E. alata* extract intake ( $P < 0.05$ ). These findings showed that rainbow trout treated with an *E. alata* aqueous methanolic extract had an immunostimulatory and growth-promoting effect as well as increased digestive enzyme activity and immune responses.

**Keywords:** Rainbow Trout, *Ephedra alata*, Growth Performance, Digestive Enzymes, Immune Parameters.

## ORAL PRESENTATION

### Seaweed Aquaculture in the Philippines: Current Status, Production Trends, and Key Challenges

**Albaris B. TAHILUDDIN<sup>1,2✉</sup>, Ertugrul TERZI<sup>3</sup>**

<sup>1</sup>Mindanao State University, Tawi-Tawi College of Technology and Oceanography, College of Fisheries, Bongao, Philippines

<sup>2</sup>Kastamonu University, Institute of Science, Aquaculture Department, Kastamonu, Türkiye

<sup>3</sup>Kastamonu University, Devrekani TOBB Vocational School, Department of Veterinary Medicine, Kastamonu, Türkiye

✉Correspondence: albarist20@gmail.com

**Abstract:** Seaweeds are the top aquaculture species in the Philippines. In 2021, they accounted for approximately 60% of the total aquaculture production, equivalent to 1.34 million tons. Consequently, in global seaweed production, the Philippines ranked fourth in 2020. Seaweed farming, particularly of eucheumatoid seaweeds (*Kappaphycus* and *Eucheuma* spp.), provides a livelihood for coastal inhabitants. Mariculture is the primary eucheumatoid seaweed aquaculture activity, employing mainly modified fixed-off-bottom and floating methods. The major seaweed-producing provinces are located in the southern part of the country, primarily Tawi-Tawi and Sulu, followed by Palawan province. Over 10 years, seaweed production fluctuated from 1.84 million tons in 2011 to 1.34 million tons in 2021. The end products of eucheumatoid seaweeds are carrageenans (semi and refined forms) and raw forms, primarily exported to the USA, Mexico, Belgium, Thailand, Denmark, Australia, Russia, Spain, France, Brazil, Argentina, and China, providing significant economic income to the country. However, the seaweed aquaculture industry in the country faces some key challenges, including pests and diseases (e.g., ice-ice disease and epiphyte infestation), a lack of quality seedlings, insufficient capital, and unstable prices.

**Keywords:** Aquaculture, Carrageenan, Eucheumaoids, Philippines, Seaweeds.

## ORAL PRESENTATION

### Proximate Composition of Some Edible Seaweeds in Tawi-Tawi, Philippines

**Kingpu O. AJIK<sup>1</sup>, Albaris B. TAHILUDDIN<sup>1,2</sup>**

<sup>1</sup>Mindanao State University, Tawi-Tawi College of Technology and Oceanography, College of Fisheries, Bongao, Philippines

<sup>2</sup>Kastamonu University, Institute of Science, Aquaculture Department, Kastamonu, Türkiye

✉Correspondence: albarist20@gmail.com

**Abstract:** Seaweeds have been a part of human diets since ancient times, showcasing the enduring importance of this marine resource in culinary traditions. The nutritional richness of these edible seaweeds is highly esteemed by consumers, as they provide a wide array of vital nutrients essential for personal health and well-being. This study examined the proximate composition of two edible seaweeds, namely *Kappaphycus alvarezii* and *Caulerpa* cf. *macrodisca* ecad *corynephora*, which are readily available in the public market of Bongao, Tawi-Tawi, Philippines. The results revealed that these two edible seaweeds differ significantly on their proximate compositions. The moisture content was remarkably higher ( $p < 0.05$ ) in *K. alvarezii* ( $16.96 \pm 0.02$  g/100 g) than *Caulerpa* cf. *macrodisca* ecad *corynephora* ( $10.49 \pm 0.08$  g/100 g). *Caulerpa* cf. *macrodisca* ecad *corynephora* contained significant crude protein ( $7.14 \pm 0.80$  g/100 g) than *K. alvarezii* ( $2.73 \pm 0.40$  g/100 g). The carbohydrates of *K. alvarezii* ( $44.82 \pm 0.34$  g/100 g) was significantly higher ( $p < 0.05$ ) than in *Caulerpa* cf. *macrodisca* ecad *corynephora* ( $38.09 \pm 0.71$  g/100 g). The ash content was greater ( $p < 0.05$ ) in *Caulerpa* cf. *macrodisca* ecad *corynephora* ( $44.00 \pm 0.66$  g/100 g) than in *K. alvarezii* ( $34.91 \pm 0.39$  g/100 g). The total fat was substantially higher ( $p < 0.05$ ) in *K. alvarezii* ( $0.60 \pm 0.30$  g/100 g) than *Caulerpa* cf. *macrodisca* ecad *corynephora* ( $0.28 \pm 0.01$  g/100 g). This study indicates that edible seaweeds (*Kappaphycus alvarezii* and *Caulerpa* cf. *macrodisca* ecad *corynephora*) are crucially important in providing nutritional options for consumers.

**Keywords:** Edible Seaweeds, *Caulerpa* cf. *macrodisca* ecad *corynephora*, *Kappaphycus alvarezii*, Proximate Composition.

## ORAL PRESENTATION

### Rheological Properties, Moisture Content, and Carrageenan Yield of Macroalga *Kappaphycus alvarezii* using Freshwater and Marine Water as Pre-Treatment

Adzmon J. GARAMON<sup>1</sup>, Nour Aley T. YANGSON<sup>1✉</sup>, Jurmin H. SARRI<sup>1,2</sup>

<sup>1</sup>Mindanao State University, Tawi-Tawi College of Technology and Oceanography, College of Fisheries, Sanga-Sanga, Bongao, Tawi-Tawi 7500, Philippines

<sup>2</sup>Kastamonu University, Institute of Science, Department of Aquaculture, 37200 Kastamonu, Türkiye

✉Correspondence: princealey08@gmail.com

**Abstract:** A variety of seaweed post-harvest techniques have been developed using the same method of washing the seaweed with marine and drying it under the sun; however, a method of washing the seaweed with freshwater has not yet to be developed. This study investigates the effect of freshwater and marine water as soaking solutions on the moisture content, carrageenan yield, and rheological properties of macroalga *K. alvarezii*. The seaweed was soaked in freshwater and marine water for 10 minutes with triplicates before being dried in a solar dryer for 7 days. Extraction of seaweed was done after drying. Results revealed that the dried *K. alvarezii* soaked in freshwater had significantly lower ( $p < 0.05$ ) moisture content than *K. alvarezii* soaked in marine water. Additionally, the carrageenan yield of *K. alvarezii* significantly increased ( $p < 0.05$ ) by 14.48% when soaked in freshwater compared to the yield in marine water. Considering the rheological properties of the seaweed, the gelling temperature and melting temperature of *K. alvarezii* soaked in freshwater did not differ significantly ( $p > 0.05$ ) from those of *K. alvarezii* soaked in marine water. However, other rheological properties such as the syneresis, viscosity, and gel strength of *K. alvarezii* greatly improved ( $p < 0.05$ ) when they were soaked in freshwater with significant increases of 2.21%, 1.84 cPs, and 13.22 g cm<sup>-2</sup>, respectively. Thus, this study indicates that macroalga *K. alvarezii* immersed in freshwater showed substantial improvements in their carrageenan quality.

**Keywords:** Carrageenan Yield, *Kappaphycus alvarezii*, Moisture Content, Seaweeds, Rheological Properties.

## ORAL PRESENTATION

### **Assessment of Heavy Metal and Trace Element Accumulation in *Gobius cephalarges* from the Sinop Coast of the Black Sea: Implications for Consumer Health and Environmental Conservation**

**Barış BAYRAKLI**✉

*Sinop University, Vocational School, Department of Fisheries, Sinop, Türkiye*

✉ **Correspondence:** barisbayrakli@gmail.com

**Abstract:** Seafood consumption plays a pivotal role in the diets of coastal communities worldwide, but concerns regarding the quality and safety of marine resources have risen due to environmental pollution. Heavy metals and trace elements, as contaminants, can accumulate in marine organisms, posing potential risks to human health. The *Gobius cephalarges*, a locally consumed fish species along the Sinop coast of the Black Sea, is susceptible to environmental pollution due to its unique habitat and dietary habits. This study aimed to assess the levels of heavy metal and trace element accumulation in *Gobius cephalarges* and evaluate potential health implications for human consumers. Additionally, it sought to address the scarcity of literature on heavy metal accumulation in this rare species. *Gobius cephalarges* specimens were collected from the Sinop coast, and their tissues were analyzed for heavy metal (e.g., mercury, cadmium, lead) and trace element (e.g., selenium, zinc, copper) concentrations using advanced analytical techniques. Human health risk assessments were conducted based on estimated dietary exposure. Specimens of *Gobius cephalarges* were collected from Sinop's Adabaşı region in May 2021. Trace metals analysis and health risk assessment were conducted using various formulas and reference data, aligning with recent scientific works. The concentrations of trace elements and heavy metals in the fish meat were analyzed, revealing distinct rankings and concentrations compared to previous records. Assessment of health risks revealed potential concerns, especially for children due to elevated As and Hg levels. The cancer risk (CR) for As indicated potential health risks in daily consumption. However, based on the worst-case scenario involving As, weekly *Gobius cephalarges* consumption for children and adults did not pose significant health risks. This research underscores the significance of monitoring and managing the quality of seafood products, especially those from regions vulnerable to pollution. It highlights the need for regulatory measures to ensure consumer safety and protect marine ecosystems. Furthermore, this study serves as a valuable contribution to the limited body of literature on *Gobius cephalarges*, emphasizing its role as a bioindicator species for environmental monitoring.

**Keywords:** *Gobius cephalarges*, Heavy Metals, Trace Elements, Seafood Safety, Human Health, Black Sea, Environmental Conservation.

## 1. INTRODUCTION

Marine resources are a crucial source of sustenance for millions of people worldwide, forming a fundamental component of human diets (Canonico et al., 2019; Bayrakli, 2021, Yildiz et al., 2023; Duyar et al., 2023). However, environmental pollution has emerged as a significant threat to the quality and safety of seafood products. Marine organisms can accumulate various toxic substances as a reflection of environmental pollution, with heavy metals and trace elements holding a prominent place among these contaminants (Tanjung et al., 2019). The accumulation of heavy metals and trace elements in marine organisms poses a significant concern for consumer health (Lü et al., 2021).

*Gobius cephalarges*, a rare fish species, is consumed by local communities along the Sinop coast of the Black Sea. Due to its unique environmental conditions and dietary habits, *Gobius cephalarges* is susceptible to environmental contamination. This study aims to determine the levels of heavy metals and trace elements in *Gobius cephalarges* found along the Sinop coast. However, there is limited information in the existing literature regarding the accumulation of heavy metals and trace elements in this species. Therefore, this study seeks to make a distinctive contribution by addressing this knowledge gap pertaining to the *Gobius cephalarges* species.

The primary objective of our study is to identify the levels of heavy metal and trace element accumulation in *Gobius cephalarges* from the Sinop coast of the Black Sea and to assess the potential health implications of these accumulations on human consumption. This assessment is of critical importance for the safe consumption of seafood products and is part of efforts to support environmental conservation.

By determining heavy metal and trace element accumulations in *Gobius cephalarges*, this study aims to highlight potential risks to both the environment and consumer health associated with this rare species. Furthermore, this research contributes to a broader understanding of ecosystem health in the Black Sea and the quality of marine products.

## 2. MATERIALS AND METHODS

At Adabaşı in Sinop, in May 2021, 44 *Gobius Cephalarges* specimens were collected from the gill nets with an average length of  $12.66 \pm 1.179$  cm, and an average weight of  $30.80 \pm 7.943$  g.

Trace metals analysis (As, Al, B, Be, Ba, Co, Cu, Cr, Ni, Fe, Li, Mo, Rb, Sb, Sr, Ti, V, Mn, Se, Hg, Cd, Pb, and Zn), health risk assesment (EDI, THQ, CRLim, CR and MS) formulas, weight and portion sizes of adults and children were applied according to Bayrakli (2021), Duyar et al. (2023) and Yildiz et al. (2023).

## 3. RESULTS AND DISCUSSION

In this study, the concentrations of trace elements and heavy metals in the meat of *Gobius Cephalarges* were analyzed. The results show the ranking and concentrations of trace elements and heavy metals in the meat of this species (Table 1). According to the results of the analysis, the ranking of the elements with the highest concentrations is as follows:  $Zn > As \geq Sr > Fe > Cu > Se > Rb > Al > B > Mn > Ti > Li > Ni > Hg > Pb > V > Ba \geq Cr > Cd > Co$ . In addition, Be, Mo and Sb values were found below the detection limits.

Focusing specifically on the concentrations of heavy metals, As was the element with the highest concentration, followed by Hg, Pb and Cd. Trace elements other than As were found to be below the limits specified by the Turkish Food Codex and the EU Commission.

The results of this study provide a detailed analysis of trace elements and heavy metals in the species *Gobius cephalarges*. Compared to previous records, this study shows differences compared to the study by Nisbet et al. (2010). Nisbet et al. reported Cu (Copper), Mn (Manganese), Fe (Iron), Ni (Nickel), Zn (Zinc), Pb (Lead), and Cd (Cadmium) values as 2.69-2.75, 7.68-9.44, 25-27.34, 3.54-5.96, 21.40-25.20, 0.50-0.52, 0.016-0.024 mg kg<sup>-1</sup> dw, respectively. In particular, this study shows that Zn and Cu levels are higher than in the study by Nisbet et al. (2010). In terms of other trace elements and heavy metals, this study indicates lower concentrations than the findings of Nisbet et al. (2010).

It should be noted that the levels of trace elements and heavy metals may vary depending on factors such as time, size of the fish, fishing area and sex. This study helps us to understand the sensitivity of *Gobius cephalarges* to environmental factors and how these factors may affect the accumulation of trace elements and heavy metals.



**Table 1.** Trace metal values of *Gobius Cephalarges* (mg kg<sup>-1</sup> ww).

Elements	mg kg <sup>-1</sup> ww			Elements	mg kg <sup>-1</sup> ww		
Zn	7.18	±	0.063	Ti	0.26	±	0.031
As	6.61	±	0.049	Li	0.13	±	0.007
Sr	3.06	±	0.138	Ni	0.09	±	0.001
Fe	2.16	±	0.052	Hg	0.05	±	0.001
Cu	0.98	±	0.007	Pb	0.02	±	0.001
Se	0.95	±	0.045	V	0.02	±	0.005
Rb	0.80	±	0.015	Ba	0.02	±	0.002
Al	0.80	±	0.056	Cr	0.01	±	0.003
B	0.68	±	0.023	Cd	0.00	±	0.000
Mn	0.65	±	0.007	Co	0.00	±	0.000
Be	NDL						
Mo	NDL						
Sb	NDL						

**Table 2.** EDI per meal size, THQ, CR<sub>lim</sub>, CR for the studied metals in adults and children based on the consumption of *Gobius Cephalarges* meat (RfD in mg kg<sup>-1</sup> day<sup>-1</sup>).

_____	RfD mg kg <sup>-1</sup> ww	EDI (mg kg <sup>-1</sup> ww)		THQ		CR <sub>lim</sub> (kg)		CR		MS	
		Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child
Al	1	8×10 <sup>-4</sup>	3×10 <sup>-3</sup>	8×10 <sup>-4</sup>	3×10 <sup>-3</sup>	>10	>10			>10	>10
As	0.0003	2×10 <sup>-4</sup>	<b>8×10<sup>-4</sup></b>	0.6	<b>2.62</b>	<b>0.11</b>	<b>0.02</b>	<b>3×10<sup>-4</sup></b>	<b>1×10<sup>-3</sup></b>	<b>0.46</b>	<b>0.21</b>
B	0.2	6×10 <sup>-4</sup>	3×10 <sup>-3</sup>	3×10 <sup>-3</sup>	1×10 <sup>-2</sup>	>10	>3			>10	>10
Ba	0.2	2×10 <sup>-5</sup>	8×10 <sup>-5</sup>	1×10 <sup>-4</sup>	4×10 <sup>-4</sup>	>10	>10			>10	>10
Cd	0.001	1×10 <sup>-6</sup>	5×10 <sup>-6</sup>	1×10 <sup>-3</sup>	5×10 <sup>-3</sup>	>10	>10	7×10 <sup>-6</sup>	3×10 <sup>-5</sup>	>10	>10
Co	0.0003	1×10 <sup>-6</sup>	4×10 <sup>-6</sup>	3×10 <sup>-3</sup>	1×10 <sup>-2</sup>	>10	>10			>10	>10
Cr	1.5	1×10 <sup>-5</sup>	5×10 <sup>-5</sup>	8×10 <sup>-6</sup>	3×10 <sup>-5</sup>	>10	>10	6×10 <sup>-6</sup>	2×10 <sup>-5</sup>	>10	>10
Cu	0.04	9×10 <sup>-4</sup>	4×10 <sup>-3</sup>	2×10 <sup>-2</sup>	1×10 <sup>-1</sup>	>3	0.66			>3	>3
Fe	0.7	2×10 <sup>-3</sup>	9×10 <sup>-3</sup>	3×10 <sup>-3</sup>	1×10 <sup>-2</sup>	>10	>3			>10	>10
Hg	0.0001	5×10 <sup>-5</sup>	<b>2×10<sup>-4</sup></b>	0.5	<b>2.07</b>	<b>0.14</b>	<b>0.03</b>			<b>0.59</b>	<b>0.27</b>
Li	0.002	1×10 <sup>-4</sup>	6×10 <sup>-4</sup>	6×10 <sup>-2</sup>	3×10 <sup>-1</sup>	1.14	0.26			4.40	2.00
Mn	0.14	6×10 <sup>-4</sup>	3×10 <sup>-3</sup>	4×10 <sup>-3</sup>	2×10 <sup>-2</sup>	>10	>3			>10	>10
Ni	0.02	8×10 <sup>-5</sup>	3×10 <sup>-4</sup>	4×10 <sup>-3</sup>	2×10 <sup>-2</sup>	>10	>37			>10	>10
Pb	0.0003	2×10 <sup>-5</sup>	8×10 <sup>-5</sup>	6×10 <sup>-2</sup>	3×10 <sup>-1</sup>	1.11	0.25	2×10 <sup>-7</sup>	7×10 <sup>-7</sup>	>3	1.98
Se	0.005	9×10 <sup>-4</sup>	4×10 <sup>-3</sup>	0.2	8×10 <sup>-1</sup>	0.38	<b>0.09</b>			1.52	<b>0.69</b>
Sr	0.6	3×10 <sup>-3</sup>	1×10 <sup>-2</sup>	5×10 <sup>-3</sup>	2×10 <sup>-2</sup>	>10	>3			>10	>10
V	0.005	2×10 <sup>-5</sup>	1×10 <sup>-4</sup>	5×10 <sup>-3</sup>	2×10 <sup>-2</sup>	>10	>3			>10	>10
Zn	0.3	7×10 <sup>-3</sup>	3×10 <sup>-2</sup>	2×10 <sup>-2</sup>	1×10 <sup>-1</sup>	2.96	0.68			>3	>3

In this study, target threshold of harm (THQ), cancer risk (CR) and maximum daily intake for cancer risk (CR<sub>lim</sub>) values were determined based on data from other studies where the amount of metals accumulated in *Gobius Cephalarges* fish meat was calculated as 70 kg for adults and 16 kg for children. These values were calculated assuming a serving of fish consumption of 227 g for adults and 114 g for children (US Environmental Protection Agency 2000; Naji et al. 2016). In

the calculations, it was taken into account that the amount of metal would not change with cooking (US Environmental Protection Agency 1989).

The EDI value for metals other than As and Hg in children was found to be lower than the RfD value. However, the THQ value for As and Hg in children is above 1, indicating that they may pose a health risk (See Table 2). In terms of CRLim, it is recommended not to consume As and Hg in both the child and adult groups and Se only in the child group as it is less than the serving value.

The cancer risk (CR) ratio has been used to estimate the likelihood of cancer as a result of an individual's potential lifetime exposure (Ahmed et al. 2015). CR was calculated for As, Cd and Pb only, as the US Environmental Protection Agency has not published a CSF for Hg (US Environmental Protection Agency 2010). Acceptable risk levels for carcinogens range from  $10^{-4}$  (human lifetime risk of developing cancer 1 in 10,000) to  $10^{-6}$  (human lifetime risk of developing cancer 1 in 1,000,000). In this study, the cancer reference level of  $10^{-5}$  was used (US Environmental Protection Agency 2010). The CR for As showed a value of  $>10^{-4}$  in daily consumption and thus posed a health risk.

From Table 3, it can be concluded that in the worst-case scenario based on As heavy metal, consumption of *Gobius cephalarges* meat for one meal per week for children and three meals per week for adults would not pose a health risk.

This assessment illustrates the potential impacts of *Gobius Cephalarges* fish consumption on human health in specific situations. It should be emphasized that the calculations and analyses can help to understand the risks for specific groups and to take relevant precautions.

**Table 3.** Values of As, Cd, Cu, and Hg trace metals in a weekly and monthly meal consumption, where potential health risks are detected in a daily meal consumption.

	As		Hg		Se	
	Adult	Child	Adult	Child	Adult	Child
EDI	$2 \times 10^{-4}$	$8 \times 10^{-4}$	$5 \times 10^{-5}$	$2 \times 10^{-4}$	$9 \times 10^{-4}$	$4 \times 10^{-3}$
EWI	$3 \times 10^{-5}$	$1 \times 10^{-4}$	$7 \times 10^{-6}$	$3 \times 10^{-5}$	$1 \times 10^{-4}$	$6 \times 10^{-4}$
EMI	$6 \times 10^{-6}$	$3 \times 10^{-5}$	$2 \times 10^{-6}$	$7 \times 10^{-6}$	$3 \times 10^{-5}$	$1 \times 10^{-4}$
THQ <sub>day</sub>	0.60	2.62	0.47	2.07	0.18	0.80
THQ <sub>week</sub>	0.09	0.37	0.07	0.30	0.03	0.11
THQ <sub>month</sub>	0.02	0.09	0.03	0.11	0.01	0.03
CR <sub>day</sub>	$3 \times 10^{-4}$	$1 \times 10^{-3}$				
CR <sub>week</sub>	$4 \times 10^{-5}$	$2 \times 10^{-4}$				
CR <sub>month</sub>	$9 \times 10^{-6}$	$4 \times 10^{-5}$				
MS <sub>/day</sub>	0.46	<b>0.21</b>	0.59	<b>0.27</b>	<b>1.52</b>	<b>0.69</b>
MS <sub>/week</sub>	3.24	1.47	4.09	1.86	10.63	4.84
MS <sub>/month</sub>	13.91	6.33	17.56	7.99	45.59	20.75

#### 4. CONCLUSION

This study sheds light on the concentrations of trace elements and heavy metals in *Gobius Cephalarges*, an under-researched fish species found along the Sinop coast of the Black Sea. The findings revealed distinctive accumulations of various metals within this species, notably differing from previous records, particularly the concentrations of Zinc (Zn) and Copper (Cu) in comparison with the study conducted by Nisbet et al. (2010).

The analysis presented an understanding of the potential health risks associated with consuming *Gobius Cephalarges*. Specifically, findings pointed to elevated levels of Arsenic (As) and Mercury (Hg), raising concerns regarding potential health implications for consumers, particularly in the case of children. These results highlight the significance of assessing the accumulation of heavy metals and trace elements, emphasizing the necessity of stringent measures and guidelines to ensure safe seafood consumption, especially for vulnerable age groups.

The risk assessment conducted in this study showed that certain metal concentrations, particularly As and Hg, exceeded the acceptable threshold for safe daily intake, indicating potential health risks. However, when considering the worst-case scenario, the frequency of *Gobius Cephalarges* consumption poses no immediate health risk. Nonetheless, continued monitoring and further research are crucial to comprehensively understand the potential risks and ensure the safety of seafood products derived from this species.

This study stands as a significant contribution, providing essential insights into the accumulation of heavy metals and trace elements in *Gobius Cephalarges* and their potential implications for consumer health. It underlines the importance of ongoing research and vigilant monitoring to safeguard public health and foster environmental conservation practices in the context of seafood consumption.

Overall, the comprehensive analysis conducted in this research paves the way for more in-depth investigations and subsequent measures aimed at ensuring the safety of marine products and preserving environmental integrity in the Black Sea region.

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## ORAL PRESENTATION

### Effects of Inclusion Levels of Fish Waste Meal as Replacement for Fish Meal in the Diet of Blue Swimming Crab, *Portunus pelagicus*

**Rizal Jhunn Falcatan ROBLES<sup>✉</sup>, Saburaiya A. ABDULYASIL, Khasmer N. BALLAO, Cherry T. NIAN, Melodina D. HAIROL, Marhamin H. JUMSALI**

Mindanao State University, Tawi-Tawi College of Technology and Oceanography,  
Sanga-Sanga, Bonagao, Tawi-Tawi 7500, Philippines

<sup>✉</sup>**Correspondence:** rizaljunnrobles@msutawi-tawi.edu.ph

**Abstract:** Fish waste (FW) is a by-product from any fish species, composed of internal organs, gills, heads, and bones not being sold or utilized in the market and typically end up in the garbage. Using FW to substitute fish meal is both a cost-effective and environmentally responsible solution. The FW can be turned into a high-quality feed ingredient and can contribute to reducing overfishing and by-catch but also practically use available resources to make quality feed and promote sustainable aquaculture practices. With this, the study was carried out to determine the effect of a fish waste meal (FWM) to replace the fish meal (FM) in the diet of blue swimming crabs, *Portunus pelagicus* in its specific growth rate (SGR), survival rate (SR), feed conversion ratio (FCR) and feed intake (FI). The fish waste was collected from the local market. It was processed in the feed mill laboratory at the College of Fisheries, Mindanao State University Tawi-Tawi College of Technology and Oceanography. The FWM was then incorporated into the formulated diets and substituted for the fish meal. Crabs were fed with seven treatments composed of 5 formulated diets: T1 – 0%, T2 – 25%, T3 – 50%, T4 – 75%, and T5 – 100% of FWM, and 2 natural food: T6 – spider conch and T7 – trash fish. After 45 days of culture, the results showed no significant difference among the treatments ( $p < 0.05$ ) in SGR, SR, and FCR except for the FI, where the T7 was significantly higher ( $p > 0.05$ ) than the rest of the diets. These findings suggest that FWM can be a cost-effective alternative to FM in the *Portunus pelagicus* diet, reducing the cost of feeds for the culture crab.

**Keywords:** Fish Waste, Fish Meal, Blue Swimming Crab, *Portunus pelagicus*, Specific Growth Rate.

## ORAL PRESENTATION

### Unveiling the Vital Role of Women in Gleaning Marine Resources in Tawi-Tawi: An Empirical Study on Sustainability and Social Impact

**Gerly-Ayn TUPAS<sup>1</sup>✉, Soner BİLEN<sup>2</sup>**

<sup>1</sup> Mindanao State University, Tawi-Tawi College of Technology and Oceanography, College of Fisheries, Tawi-Tawi, Philippines

<sup>2</sup> Kastamonu University, İhsangazi Vocational School, Department of Veterinary, Kastamonu, Türkiye

✉ **Correspondence:** gerlyayntupas@msutawi-tawi.edu.ph

**Abstract:** In many coastal communities, women have been instrumental in perpetuating the practice of gleaning for generations. With profound knowledge of the local marine ecosystems and an innate understanding of sustainable harvesting practices, women have actively engaged in gleaning to utilize remaining marine resources that are not targeted by the commercial fishing industry. This current study seeks to explore the often underappreciated and indispensable role of women in gleaning, focusing on their contributions to sustainability and social impact specifically women who are involved in the collection or gleaning in marine environments in Tawi-Tawi. The study was meticulously conducted at two major landing sites in Tawi-Tawi: the vibrant Bongao wet market and the bustling Batu-Batu, Panglima Sugala wet market. Gleaners (n=35) were interviewed and guided through a questionnaire. The results showed that most of the gleaners (37%) fell within the age range of 31 to 40. Ninety-one percent identified themselves as regular gleaners, while the remaining respondents indicated occasional engagement. Seventy-one percent cited gleaning to acquire additional income and food. When asked about gleaning's contribution to economic empowerment and livelihood, all participants highlighted its role in supporting daily consumption and generating a consistent income through sales. Additionally, 86 percent of respondents identified adverse weather conditions and surplus inventory post-marketing as the primary obstacles to income generation from gleaning. Furthermore, 71 percent recognized the role of gleaning in bolstering coastal sustainability and conserving resources, both in terms of food supply and supplementary family income. Regarding the awareness of natural resources preservation, 63 percent answered negatively. Notably, 91 percent of gleaners were not involved in decision-making processes. When queried about their potential contribution to coastal conservation through increased participation in decision-making, all respondents expressed uncertainty. Regarding challenges faced by women engaged in gleaning, 27 percent cited heavy workloads and time constraints. Lastly, all participants expressed a lack of access to government credit due to uncertainty about the necessary procedural requirements. This results sheds light on gleaning practices in our community, revealing its diverse motivations and contributions.

**Keywords:** Gleaning, Women, Marine Resources, Sustainability, Conservation.

## ORAL PRESENTATION

### Investigating the Impact of Salt Concentration on the Moisture Content of Solar-Dried Split and Whole Big-Eyed Round Scad (*Selar crumenophthalmus*)

**Sitti Jumaiza S. SALA, Normina A. ABUBAKAR, Jaro O. AJIK, Merilyn Q. AMLANI<sup>✉</sup>**

*Mindanao State University, Tawi-Tawi College of Technology and Oceanography, Sanga-Sanga, Bongao, Tawi-Tawi, Philippines*

<sup>✉</sup>**Correspondence:** merilynamlani@msutawi-tawi.edu.ph

**Abstract:** This research investigates how different salt concentration affect the moisture content (MC%) of solar-dried split and whole big-eyed round scad (*Selar crumenophthalmus*), a common fish species found in Tawi-Tawi, Philippines. In response to the increasing need for sustainable food preservation methods, solar drying has emerged and is still used today as an environmentally friendly and economical approach. The experimental procedure entailed the exposure of both forms of fish samples to solar drying techniques, with varying concentrations of salt (20%, 35%, and 50% of the total fish weight) used as the treatment variable. The study examined the MCs% in the dried fish products, in comparison with control groups that underwent traditional solar drying without the addition of salt. The MC% was recorded daily until the drying process reached its equilibrium point, allowing for the determination of the ideal drying period. However, temperature control was not implemented in this study due to the unstable weather conditions. The results showed that adding 20% salt concentration during the solar drying process significantly decreased the moisture content, resulting in lower MC%. Conversely, the use of 50% salt, relative to the total fish weight, showed a higher MC% than the 20% salt treatment. This discrepancy may arise from the fact that the additional salt contributed to the overall weight of the fish, affecting the calculation of MC%. Furthermore, it was observed that the different forms in which the fish samples were dried also had an impact on the MC% of the fish. This study makes a significant contribution to the field of food preservation, specifically within the context of sustainable and environmentally friendly drying methods. The results emphasize the importance of salt concentration as a critical factor in reducing the MC% of dried fish products, thereby promoting their shelf life and nutritional value.

**Keywords:** Solar Drying, Drying Kinetics, Equilibrium, Salt Concentrations, Moisture Content.



## ORAL PRESENTATION

### A Survey on the Traditional Fishing Practices in Lake Holon, T'Boli, South Cotabato, Philippines

**Dimas III TANCO<sup>1</sup>, Maria Liza B. TORING-FARQUERABAO<sup>1,2</sup>✉, Albaris B. TAHILUDDIN<sup>2,3</sup>**

<sup>1</sup>University of the Philippines Visayas, College of Fisheries and Ocean Sciences, Institute of Marine Fisheries and Oceanology, Iloilo, Philippines

<sup>2</sup>Mindanao State University, Tawi-Tawi College of Technology and Oceanography, College of Fisheries, Bongao, Philippines

<sup>3</sup>Kastamonu University, Institute of Science, Aquaculture Department, Kastamonu, Türkiye

✉Correspondence: marializafarquerabao@msutawi-tawi.edu.ph

**Abstract:** Traditional fishing practices for sustainable and productive fisheries are commonly observed in indigenous communities and are one of the good factors in biodiversity management. The Municipality of T'Boli in the Province of South Cotabato, Philippines, houses the indigenous people (IP) known as the T'Boli, who are well-known for their traditional fishing practices for tilapia species, specifically in crater lake known as Lake Holon. However, the availability of the records and documents is limited for this matter on this particular site. Hence, a qualitative assessment was done using a semi-structured questionnaire to identify the traditional fishing practices, including its fishing operation and fishing gear specification used at Lake Holon, T'boli, South Cotabato, Philippines. A socio-demographic profile survey on the fishermen and the catch-per-unit effort (CPUE) in terms of biomass (kg/hr) using specific traditional fishing gears and methods within the lake were also determined. Results showed that traditional fishing operations in the area used spear, bottom set gillnet, and handline; spear as the major fishing gear (68.18% of the respondents) used in the lake. As for the CPUE, it was observed that the bottom set gill net could have the highest catch for catching tilapia with an average catch of 4 kg/hr, followed by spear (2.39 kg/hr) and simple handline (0.3 kg/hr). With respect to the people's socio-demographic profile, data gathered revealed that most of the respondents were living lower than the poverty threshold and could barely survive on a day-by-day basis, which is true for most fishing communities in the country. The study also noted no available data on catch monitoring of tilapia caught from the lake. Moreover, fisherfolks in the study site were not registered with any organizations related to fisheries. Hence, it was also noticed that the knowledge and awareness of the fisherfolks and the locals in the area were limited with regard to fisheries conservation for sustainability. Thus, it is strongly recommended to assist the IP in engaging in such activities and their record catch data.

**Keywords:** Traditional Fishing Practices, Fishing Gears, Lake Holon, T'Boli, CPUE.



## ORAL PRESENTATION

### **Implementation of an Agrisharing GIS Platform on the Basis of Bioeconomic Approach to Overcome Global Food Problems Due to the War in Ukraine**

***Daria BULYSHEVA<sup>✉</sup>, Oksana MALASCHUK, Iryna LEONIDOVA, Olga PANASYUK, Serhii TOLKACHENKO***

*Odesa State Agrarian University, Faculty of Geodesy, Land Management and Agricultural Engineering, Department of Geodesy, Odessa, Ukraine*

<sup>✉</sup>**Correspondence:** bu.dasha.bu@gmail.com

**Abstract:** The study emphasizes Ukraine's role in the world food system and the need to implement urgent measures to improve the state of its agro-industrial complex to meet the world's food needs. The key factor in restoring Ukraine's position in the global food system is how quickly and extensively Ukraine will be able to restore its production and logistics infrastructure. A quick solution to the above-mentioned problems after the end of the war in Ukraine can become a reality if the agrisharing GIS platform will be implemented on the basis of the bio-economic approach. The purpose of the study was to determine the place of the bioeconomic approach and GIS-platform in the agrisharing model. The global challenges, global opportunities and goals of the implementation of the above model have been identified and the closed cycle of the agrisharing platform based on the bio-economic approach has been determined. The indisputable argument that makes GIS the only possible platform for the development of agrisharing is that almost all data have a spatial (geographic) reference and certain information about the corresponding object. The study presents the functions and tasks of the agrisharing GIS platform and defines the advantages of the corresponding system for each sphere of cooperation.

**Keywords:** Agrisharing, GIS-Platform, Bioeconomy, Global Food Problem.



## ORAL PRESENTATION

### The Impact of Choline Chloride Biostimulant on Development and Productivity of Bee Families

*Nicola EREMIA<sup>1✉</sup>, Olga COȘELEVA<sup>1,2</sup>, Fliur MACAEV<sup>3</sup>*

<sup>1</sup>*Technical University of Moldova, Chisinau, Moldova*

<sup>2</sup>*Comrat State University, Comrat, Moldova*

<sup>3</sup>*Institute of Chemistry, Chisinau, Moldova*

✉*Correspondence:* eremia.nicolae@gmail.com

**Abstract:** Nowadays, considerable attention is dedicated to the search for new biostimulants intended to accelerate the growth of bee families during spring period and increase their productivity. The aim of our research was to study the impact of choline chloride biostimulant on the development and honey production of bee families. Feeding bees with a mixture of syrup in concentration of 1:1 and 1.25-3.25 ml/l biostimulant, amounting to 1.0 liter of the mixture per bee family every 7 days from March to the main honey collection, increased strength by 4.12-17.65%, the brood rearing by 17.48-43.98% and honey productivity by 22.88% during the spring period.

**Keywords:** Bee Families, Biostimulant, Sugar Syrup, Morphoproductive Indices.

## ORAL PRESENTATION

### Fish Gelatin

**Pınar OĞUZHAN YILDIZ<sup>✉</sup>, Gökhan ARSLAN**

*Atatürk University, Fisheries Faculty, Erzurum, Türkiye*

<sup>✉</sup>**Correspondence:** pinaroguzhan@atauni.edu.tr

**Abstract:** Gelatin is a product with many functions obtained by hydrolysis of the natural structural protein collagen, which is found in dense amounts in the bones and skin of animals such as cattle, fish, pigs and chickens. In recent years, the production of gelatin from bone and skin sourced from fish and chicken developments in the field are also increasing rapidly. In particular, gelatin production from fish skin constitutes an alternative source for halal products. Approximately 22% of the total weight, including bones and skin, is wasted during the processing of fish. Fish skin is an important by-product of the fish processing industry, causing waste and pollution, and is a valuable source of gelatin. Fish gelatin is considered an alternative to pork and beef gelatin. Gelatin consists of 51% carbon, 25% oxygen, 17% nitrogen and 7% hydrogen molecules. Chemical composition of gelatin consists of 85-92% collagen protein and the remaining part consists of minerals and moisture remaining after drying. Gelatin, in addition to its biocompatibility and biodegradability properties, is toxic it is one of the most widely used food additives today due to its positive properties such as being non-addictive and non-addictive. While this additive is used especially for gel formation in the pharmaceutical, cosmetic and photography industries; It can also provide various functional properties such as emulsifier, clarifying agent and coating material in the food industry. Since gelatin has a wide range of uses, its economic value is also quite high. It can also be used to produce fish gelatin, various microencapsulated foods and dried products such as vitamins and other pharmaceutical additives.

**Keywords:** Gelatin, Fish, Pollution, Waste.

### 1. INTRODUCTION

Recently, many new products have been obtained by recycling fish, bony structures and other wastes that have not been reused. Modern aquaculture enterprises utilize by-products obtained from waste for various purposes with the help of biotechnology. With the new by-products obtained through these methods, it also contributes to the solution of organic waste, which is one of the important environmental problems of beaches, large dams and wetlands (Tekle, 2006).

As in every branch of the food industry, large amounts of waste are generated in fish processing factories. It is known that 30% of this waste consists of skin and bones. As in other animals, the skin, bone and cartilage tissues of fish are rich in collagen and gelatin (Yanar and Gökçin, 2016).

Gelatin is a protein produced from collagen obtained from the skin of animals such as pigs and cattle, and from poultry such as chicken and fish. In general, production is made from pigs, cattle, poultry and fish, respectively, according to the size of the production amount (Tekle, 2006).

Gelatin is an additive generally recognized as safe (GRAS). There is no restriction on its use (Pancar, 2013).

Obtaining gelatin from animal tissues dates back to ancient times. It was first used for glue production. In the 16th century, in England VIII. It is stated that gelatin was used in special ceremonial meals during the reign of Henry VIII. Gelatin production has been transferred to industry over time and today it has found countless applications from food to photography industry. Gelatin can be used in the food industry for purposes such as gelling, thickening, water binding, emulsifying, foaming and film forming (Erge and Zorba, 2016; Huang et al., 2017).

Since gelatin has a wide range of uses, its economic value is also quite high. Global gelatin demand is increasing. Today, approximately 400 thousand tons of gelatin is produced in the world. The highest proportion in production belongs to pigskin derivatives with 46%, followed by cowhide with 29.4%, bones with 23.1% and other sources with 1.5%. Around

15000 tons of gelatin will be used in our country in 2022, and approximately 90% of this will be imported. According to the research of Grand View Research (GME, 2016), it is thought that the share of gelatin in the world market will exceed 4 billion dollars in 2024 (Tekle, 2016).

Gelatin is a food additive in protein structure obtained as a result of the hydrolysis of collagen, a basic and structural protein of animal tissues. The most important differences that distinguish gelatin from other hydrocolloids are that it can reversibly melt at temperatures below the human body temperature and that it has a natural protein structure of animal origin (Demir, 2022).

The functional properties of gelatin are very important. Functional properties are the physical and chemical properties of gelatin that influence its role in food throughout processing, storage, preparation and consumption. Physical aspects of gelatin include gel point, melting point, gel strength, viscosity, emulsion, activity, stability, while chemical properties include water, ash, fat, protein, amino acid, heavy metal content and pH. It includes fat, protein, amino acid, heavy metal content and pH (Siburian, et al., 2020).

Gelatin obtained from fish waste is both cheap and gives the same consistency and flexibility (Bozkurt and Yüksel, 2019).

It is especially used in sports foods and special foods for obesity and diabetes. It is stated that since it is easy to digest, it is completely destroyed in metabolism. It is used in serums, capsules and vitamin coating materials in the pharmaceutical industry. It is known that it is also used in hair and skin care products in the cosmetic industry. On the other hand, various studies indicate that gelatin has a regenerative effect on the skeletal and spinal cord systems (Erge and Zorba, 2016).

In this review, the general structure, functional properties and usage areas of gelatin and fish gelatin will be examined.

## 2. FISH GELATIN

Gelatin from marine sources (skins, bones, and fins of warm- and cold-water fish) is a possible alternative to bovine gelatin (Karim and Bhat, 2009).

Gelatin, which is obtained mostly from terrestrial animals and their waste, has become popular in recent years. It has started to be produced in significant quantities from seafood and waste, and it is safer for health than beef gelatin and it has become popular as an alternative source of gelatin in recent years due to its suitability for consumption according to religious beliefs. In addition, the fact that aquaculture waste contains high amounts of collagen (49-52%) and the gelatin obtained is of high quality increases the importance of gelatin originating from aquaculture (Çolakoğlu and Künili, 2016).

Approximately 22% of the total weight, including bones and skin, is wasted during the processing of fish. Fish skin is an important by-product of the fish processing industry, causing waste and pollution, and can be a valuable source of gelatin (Yılmaz, 2021).

Since gelatin production from poultry has a lower yield than fish gelatin, this has increased the interest in fish gelatin production. Gelatin production from fish is not new and has been carried out by the acid extraction method since 1960. Gelatin production and characterizations have been made using the skin of many fish species (Yanar and Gökçin, 2016).

Fish gelatin is a class of biopolymers obtained from the hydrolysis of fish collagen and contains abundant amino acids for nutritional uses as dietary products. The natural properties of fish gelatin mean that fish gelatin products are relatively harmless to the body compared to clinical treatments and medications. Therefore, the use of fish gelatin in the diet may potentially have excellent benefits for people with chronic diseases such as hypertension, osteoporosis, and diabetes (Lv et al., 2019).

Fish gelatin is considered an alternative to pork and beef gelatin, but there are some differences between fish gelatin and mammalian sources of gelatin. Fish are caught and/or fed primarily for human consumption. In this context, general sources of fish gelatin production are bone and skin waste. Fish gelatin is less preferred in the food industry due to its disadvantages. However, recent studies have shown that the disadvantageous properties of fish gelatin compared to bovine and pork gelatin, such as lower gel strength, lower stability and lower rheological properties such as gelation temperature and melting temperature, can be improved by different processes and/or additives (Yılmaz, 2023).

The main limitations of fish gelatin are its low melting point and gel strength. Compared to mammalian gelatin, fish gelatin has a relatively high viscosity and its applications are limited as the gels formed tend to be less stable and have poorer rheological properties (Lin et al., 2017).

Collagen and gelatin obtained from fish and shellfish provide softness to the skin and prevent skin irritation. Peptides, which can also be obtained from fish and shellfish, increase collagen synthesis and protect the skin against UV radiation (Metin ve Baygar, 2018).

The functional properties of fish gelatin are divided into two main groups. In the first group, there are properties related to the gelling ability of gelatin, such as gel formation, structure correction, binding and water retention capacity. In the second group, there are features related to surface behavior such as emulsion and foam formation, stabilization, adhesion and cohesion functions, film formation capacity and protective colloidal functions (Karayannakidis and Zotos, 2016; Demir, 2022).

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## ORAL PRESENTATION

### Use of Algae in Human Nutrition

**Gökhan ARSLAN<sup>✉</sup>, Pınar OĞUZHAN YILDIZ**

*Atatürk University, Fisheries Faculty, Erzurum, Türkiye*

<sup>✉</sup>**Correspondence:** gokhan.arslan@atauni.edu.tr

**Abstract:** Algae can be found in many areas of the earth. But the main 70% its habitat is wetland habitats. They can survive in wetlands, clinging to soil, trees and rocks, thanks to their trunks or root-like structures with similar functions. Algae are the most important producers in the food chains of aquatic creatures. Approximately 160 species of algae are used by humans as a food source in the food industry. Algae are used in almost every field of industry. Especially in the Far East and South Asian countries, algae, which has a wide range of uses as a nutrient, as well as in medicine, pharmacy, cosmetics industry, and fertilizer production in agriculture, are not only collected naturally, but also cultivated and cultivated in the seas like the land. Algae, which make up 90-95% of the aquatic ecosystem, contain high protein content, as well as components such as polysaccharides, vitamins, minerals, lipids, fatty acids, amino acids, carotenoids in significant amounts, and are suitable for use as food thanks to the bioactive components they produce, have the potential to meet the need for alternative food sources. Additionally, algae can meet environmentally friendly growth conditions and have a very large biomass. Algae show biological activities such as antioxidant, antibacterial, antiviral, antifungal, prebiotic, neuroprotective, anti-inflammatory, immunomodulatory, antidiabetic, anticoagulant and anticancer. It forms a part of traditional meals in many countries around the world and edible algae, which are not very much known to our people, contain a high level of nutrients for a balanced diet when consumed regularly.

**Keywords:** Algae, Health, Nutrition, Wetland Habitats.

## 1. INTRODUCTION

Nutrition is one of the basic needs of living things and is of great importance for the body (Ünsal 2019). Nutrition is one of the most important issues emphasized today. Today, while millions of people in the world are constantly fighting against death and diseases caused by hunger and malnutrition, others lose their lives at an early age due to disorders caused by excessive and malnutrition. Thus, inadequate and unbalanced nutrition problems are among the main factors that deteriorate people's health (Baysal 2004).

Making products that are not used by humans as food usable as food, evaluating food waste, producing some microorganisms in abundance and using this biomass as nutrients, food production from cellulose with biofermentation technology, protein production from different microbial sources (single cell protein), in vitro meat, non-farm dairy beverages and ensuring the use of insects, which are a part of the diet in some countries in the world, as food by developing new food processing techniques can be considered as the main alternatives. Another alternative food source is algae (Taşkın, 2019).

Algae are one of the most important producers in the food chain. Interest in algae is increasing due to their use as food in island countries and the Far East. Studies show that seaweed has high nutritional value. It seems possible that algae will be an important source of meeting nutritional needs in the future due to reasons such as their ability to increase their weight 2-3 times a day under suitable conditions, their production being easy and economical, and their lack of side effects (Sasa et al., 2020).

Although there are more than 200,000 different known algae species, only approximately 200 of them are used on an industrial level (Akyl et al., 2016). Algae are the most important producers of the food chains of aquatic creatures (Kaba and Çağlak, 2006).

Algae have been used for various purposes in many areas from past to present. Agriculture, animal nutrition, waste treatment, aquaculture, cosmetics, biodiesel production, medicine and pharmacy are areas where algae are widely used. It has been a part of traditional foods for many years in some countries, where it can be used in different areas such as animal feed, fertilizer, natural food coloring, food additive, wastewater treatment and cosmetic industry. Many algae species are used as a food source by humans in various parts of the world. Sea algae are consumed fresh (in the form of salad), dried and cooked (in the form of meals, soups, sauces, spices) (Ünver Alçay et al., 2017).

Algae stand out as food and as sources suitable for use in foods, due to their high content of components such as proteins, polysaccharides, lipids, vitamins, minerals, amino acids, fatty acids and carotenoids, and the bioactive components they produce (Nale, 2021).

Algae contain many bioactive molecules such as antioxidant, antibacterial, antiviral, anticarcinogenic with broad biological activities. Phycocolloids, which are used as active and auxiliary substances in pharmacy, are obtained from marine algae. In addition, the antioxidant compounds contained in algae play an important role in the fight against free radicals, which are formed during the functioning of metabolism and are the initiators of some chronic diseases. (Sasa et al., 2020).

## 2. ALGAE

Algae are mostly eukaryotic creatures that can be observed in different morphologies in terms of their external appearance, from single-celled and filamentous microscopic forms to plants a few meters tall, with a cellulose wall, a simple structure, a thallus structure that does not show a real root, stem and leaf structure. It is usually found in oceans, rivers, freshwater lakes, streams, streams, arctic lakes, puddles, etc. Algae, which can live in a wide range of areas in aquatic and semi-aquatic environments, are autotrophic and photosynthetic organisms (Sasa et al., 2020).

They can establish symbiotic relationships with other living species. They can live in glacial areas, at temperatures of 70°C or above, in very salty environments, in waters under low light intensity and high pressure, in short, in environments where they can receive light for photosynthesis. Algae are simple living creatures and contain chlorophyll. They are single-celled and multi-celled and can form colonies. Their sizes vary from 3-10µ to 70 cm. Algae reproduce vegetatively, sexually and asexually. They usually reproduce by vegetative propagation. Some species first form colonies and then divide as a result of normal growth. In some species, vegetative reproduction occurs with the growth of the parent plant (İrkin, 2020).

### 2.1. Classification of Algae

Algae are generally classified into two different types: macroalgae and microalgae according to their size, and brown, red, green algae and cyanobacteria according to the pigment substances they contain. Macroalgae are multicellular, fast-growing, large-sized algae that are visible to the naked eye. Macroalgae, also known as seaweeds, can be divided into four different groups: brown algae (Phaeophyta), red algae (Rhodophyta), green algae (Chlorophyta) and blue-green algae (Cyanophyta). The colors they have come from the different pigments they contain (Oğur, 2006; Wu et al., 2023).

Microalgae have rich protein, carbohydrate and fatty acid content. These organisms, which have high nutritional value, are the most important source of macronutrients, vitamins and trace elements for aquatic animals. The main ingredient in the composition of microalgae is crude protein. It is also noteworthy that microalgae are rich in vitamins, especially the high amount of vitamin B12. Protein-rich microbial algae contain abundant mineral substances such as K, Na, Mg, Ca, P, S, Fe (Christaki et al., 2011; Koyande et al., 2019).

### 2.2. Use of Algae in Human Nutrition

It is known that algae has been consumed for many years in Far Eastern countries, especially in Japan. Brown and red algae are more dominant than green algae. Laminaria, Undaria and Hizikia species are the main brown algae and are usually sold dried. Sea algae are used fresh (in the form of salad), dried, or cooked (in the form of food, soup, sauce). In Japan, it is sold as a ready-made food product under names such as asoksanari, amonani, kanten, konbu, and is also drunk

as tea. In our country's seas, there are Ulva, Porphyra, Gelidium, Rhodymenia and Laurencia types of algae that can be used for these purposes. The importance of algae, which is an important source of nutrients, has increased even more today, when the population is rapidly increasing and the problem of hunger is increasing. To date, in Western European countries and the USA, algae have been extracted and consumed in the kitchen, even if they are not eaten directly, except for mandatory periods (war, disasters, etc.). Agar-agar, alginat, carrageenan, with its gelling, thickening and suspending properties, is used in jam, marmalade, cream, jelly making and as an inhibitor of crystal formation in ice cream. These substances are also used in the preparation of sausage casings. Iodine, found in the structure of all marine algae, is an important nutrient source, especially in mountainous regions that are deficient in iodine. A substance in the structure of Betoin, found in the marine alga Porphyra, reduces the amount of cholesterol in the blood. In addition, alginat, found in all brown algae, is the only substance that can retain and expel radioactive substances in the body (Kaba and Çağlak, 2006; FAO, 2023).

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## ORAL PRESENTATION

### Status of Crabbing Industry in Tawi-Tawi, Philippines

**Ariel J. RICABLANGCA<sup>1✉</sup>, Rizal Jhunn F. ROBLES<sup>1</sup>, Almaida J. JULJANI<sup>1</sup>, Nurisa A. SUHAILI<sup>1</sup>, Sabturaiya A. ABDULYASIL<sup>1</sup>, Shaima J. SUBAN<sup>1</sup>, Eric I. ESON<sup>1</sup>, Emilko J. MALANGKAHI<sup>1</sup>, Abdurasa L. HUSHIN<sup>1</sup>, Albaris B. TAHILUDDIN<sup>1,2</sup>**

<sup>1</sup>Mindanao State University, Tawi-Tawi College of Technology and Oceanography, College of Fisheries, Bongao, Philippines

<sup>2</sup>Kastamonu University, Institute of Science, Aquaculture Department, Kastamonu, Türkiye

✉Correspondence: arielricablangca@msutawi-tawi.edu.ph

**Abstract:** The crabbing industry is one of the significant sources of income for local communities in Tawi-Tawi, Philippines. Tawi-Tawi is considered one of the provinces in the Philippines rich in natural resources, including crabs, and there are two significant crab species: the blue swimming crab (*Portunus pelagicus*) and the mangrove crab (*Scylla serrata*). However, studies on the status of the crabbing industry in Tawi-Tawi remain lacking. Thus, this study aimed to assess the crabbers and the different methods and practices used. The mixed-methods approach was utilized through a survey and follow-up with interviews with the local crabbers (N=40). The results revealed that 37.5% of the respondents were aged between 21-30 years, while 22.5% fell into the 31-40 age group. The majority of respondents, comprising 37.5% of the total, reported the highest family sizes of both 2-4 members and 5-7 members, respectively. Among the respondents, 75% were married, while 22.5% were single. Furthermore, 45% of the participants had less than 5 years of experience in the crab industry. Due to the unstable supply and high competition, the crabbing industry is one of many sources of income for local crabbers. They are also engaged in fishing, seaweed farming, sea cucumber gleaning, driving, and owning a *sari-sari* store as an alternative source of income. Crabbers used lift net or *bintol* (33.9%), crab pot or *panggal* (27.12%), steel hook (23.73%), and spear gun or *panah* (5.08) for catching crabs. Crabs sold in the market are either in a deceased state (blue swimming crabs) or a live state (mangrove crabs). On a daily basis, each crabber caught an average of  $4.67 \pm 0.31$  crabs for blue swimming crabs, and  $3.95 \pm 0.24$  crabs for mangrove crabs. The increasing number of crabbers has led to a decline in catch, as well as the frequent catching of small crab sizes. Additionally, the destruction of crab habitats by human activities, particularly in mangroves and rocky areas, is likewise a significant factor contributing to decreased crab populations.

**Keywords:** Crabbing, Demographic Profile, Income, Market, Gender.

## ORAL PRESENTATION

### Thermal, Textural and Color Properties of Hazelnut Oil Oleogels Produced with Different Waxes

**Mine KIRKYOL, Ahmet AKKÖSE**✉

*Atatürk University, Faculty of Agriculture Food Engineering, Erzurum, Türkiye*

✉*Correspondence:* akkose@atauni.edu.tr

**Abstract:** Oleogelation enables oils to be obtained in a solid-like structure using oleogelators. In oleogels, the degree of unsaturation of oils is preserved, and trans-fat formation does not occur. Oleogels can be used instead of solid fat in the production of various foods as an innovative approach. The oils and oleogelators used in oleogelation are the main factors that determine the properties of oleogels. In this study, hazelnut oil oleogels were constituted with carnauba or candelilla waxes, and the thermal, textural, and color properties were determined. The use of different oleogelators had a significant effect on the melting peak temperatures of hazelnut oil oleogels ( $P<0.05$ ). The mean peak temperatures of hazelnut oil oleogels formed with carnauba and candelilla waxes were determined as  $75.72\pm0.02$  °C and  $73.92\pm0.33$  °C, respectively. In addition, the enthalpy values of the oleogels were significantly affected by the oleogelator used ( $P<0.01$ ). While the mean melting enthalpy for the oleogel formed with carnauba wax was found to be  $14.16\pm0.67$  J/g, the mean melting enthalpy for the oleogel formed with candelilla wax was determined as  $3.87\pm0.55$  J/g. The hardness, adhesiveness, and gumminess of the oleogels were significantly affected by the oleogelators ( $P<0.05$ ), however, the cohesiveness and springiness were not affected ( $P>0.05$ ). Higher hardness, adhesiveness, and gumminess values were determined in hazelnut oil oleogels formed with carnauba wax. The color properties ( $L^*$ ,  $a^*$ ,  $b^*$ ) of the oleogels were also affected by the use of carnauba or candelilla waxes. While the  $L^*$  and  $b^*$  values were higher in oleogels with candelilla wax, the  $a^*$  values were lower. These results showed that the oleogelator used in oleogelation affects the properties of hazelnut oil oleogel, and the oleogelator should be selected according to the intended use of hazelnut oil oleogel.

**Keywords:** Hazelnut Oil Oleogel, Carnauba, Candelilla, DSC, TPA.

## 1. INTRODUCTION

Fats used in the production of foods play a critical and direct role in the taste, texture, and appearance of food products. For this reason, solid fats contribute to the development of the physicochemical and textural properties of processed foods. However, excessive consumption of these fats may have undesirable effects on human health due to their saturated and trans fatty acids. It has been determined that saturated and trans fats increase the concentration of low-density lipoprotein (LDL) cholesterol while reducing high-density lipoprotein (HDL) cholesterol (Siri-Tarino et al., 2010). Additionally, epidemiological studies have shown that excessive intake of saturated and trans fats increases the risk of cardiovascular diseases, obesity, and diabetes (Estadella et al., 2013; Restrepo and Rieger, 2016). For these reasons, it is becoming increasingly important to develop new alternatives to obtain oils in a solid form that does not contain saturated and trans fatty acids.

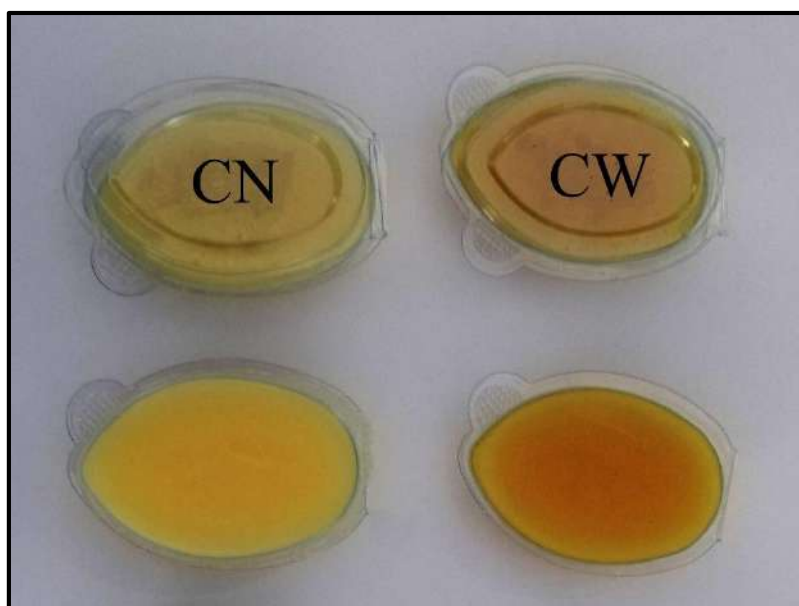
Oleogelation is the process of restructuring oils in a gel form using oleogelators to obtain products like margarine and solid fats. In the oleogels obtained as a result of this process, the degree of unsaturation is preserved, and trans-fat formation does not occur (Pehlivanoğlu et al., 2018; Li et al., 2022). Oleogels could be used structuring edible oils for margarine and shortening-like products, emulsion-based products, and other processed food applications such as bakery, processed meat, dairy, confectionery, and edible films (Öğütçü and Yılmaz, 2014). The oils and oleogelators used in oleogel formation are the main factors that determine the properties of oleogels. Physicochemical, thermal, and textural characterization of oleogels to be formed using different oils and oleogelators are very important in determining the functionality of these oleogels and choosing their usage areas. There are some studies in the literature where the thermal, textural, and color properties of oleogels prepared using different oils and waxes are determined (Öğütçü and Yılmaz,



2014; Lim et al., 2017; Shi et al., 2021; Pang et al., 2021; Thakur et al., 2022; Pang et al., 2023). However, no study has been found to determine the thermal, textural, and color properties of hazelnut oil oleogels prepared with carnauba or candelilla waxes. In this study, the melting peak temperatures and enthalpies and the color properties of hazelnut oil oleogels formed with carnauba or candelilla waxes were determined, and texture profile analysis was performed.

## 2. MATERIALS AND METHODS

The hazelnut oil and the carnauba and candelilla waxes used in the research were obtained from commercial companies. Hazelnut oil oleogels were prepared to contain 10% wax (Figure 1). Candelilla and carnauba waxes and hazelnut oil were weighed and mixed, kept in a water bath at 90°C until wholly melted, then taken from the water bath and vortexed. After the samples cooled to room temperature, stored in the refrigerator at 4°C for 24 hours (Choi et al., 2020). Thermal, textural, and color properties of hazelnut oil oleogels prepared with carnauba or candelilla waxes were determined. All analyses were performed at room temperature.



**Figure 1.** Hazelnut oil oleogels prepared with candelilla (CN) and carnauba (CW) waxes.

### 2.1. Thermal Properties

The thermal properties of the samples were determined by Differential Scanning Calorimetry (DSC-60; Shimadzu Corporation, Japan). Samples were taken from the prepared hazelnut oil oleogels, and their melting peak temperatures and enthalpies were determined. For this purpose, samples were weighed approximately 3-4 mg into aluminum sample pans and heated from room temperature to 120°C with a heating rate of 5°C/min using an empty pan as a reference. Nitrogen gas was used as the ambient atmosphere in the measurements, and the flow rate was set to 50 ml/min. Peak temperatures and enthalpies were determined from the melting peaks observed from the thermograms obtained as a result of the measurements.

### 2.2. Textural Properties

Texture profile analysis (TPA) of the samples was performed using a texture analyzer (CT3, Brookfield Engineering Laboratories, USA). Hazelnut oil oleogels were analyzed at room temperature with two compression cycles using a 12.7 mm cylindrical probe (TA 10, Brookfield Engineering Laboratories, USA). In the analysis, the test speed was set to 1 mm/s, compression distance to 10 mm, and recovery time to 5 s. From the obtained force-time curves, hardness, adhesiveness, springiness, cohesiveness, and gumminess values were calculated.

## 2.3. Color Properties

Color intensities of the hazelnut oil oleogels were detected according to the criteria given by CIE (Commission Internationale de l'Eclairage) based on three-dimensional ( $L^*$ ,  $a^*$ , and  $b^*$ ) color measurements using a colorimeter (CR-400, Minolta Co).  $L^*$  defines the color lightness (ranging from 0 for black to 100 for white),  $a^*$  indicates the degree of color between red and green (negative values indicate green color and positive values indicate red color), and  $b^*$  indicates color degree between yellow and blue (negative values indicate blue colors and positive values indicate yellow colors).

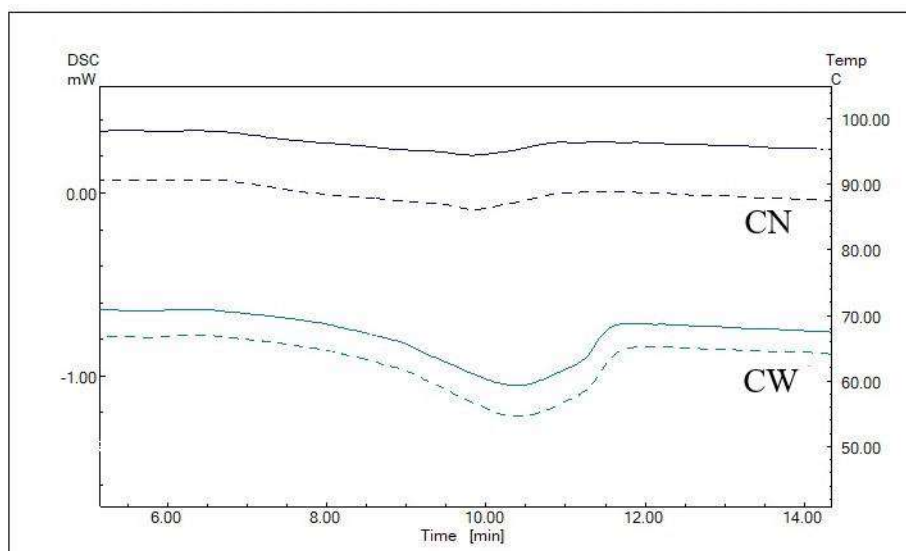
## 2.4. Statistical Analysis

The study was conducted according to the completely randomized design. Two measurements were performed in thermal and color analyses. However, six measurements were performed in the TPA analysis. The analysis of variance was applied to the obtained data (one-way ANOVA), and differences between means were compared by Duncan's multiple comparison test at the 95 % confidence level ( $P < 0.05$ ) (IBM SPSS Statistics 20). All data were given as mean values  $\pm$  standard error in the tables.

## 3. RESULTS AND DISCUSSION

### 3.1. Thermal Properties

DSC thermograms of hazelnut oil oleogels prepared with candelilla or carnauba waxes are presented in Figure 2. The melting onset, endset, and peak temperatures and enthalpy values obtained from these thermograms are given in Table 1. It has been observed that the use of different waxes in the formation of hazelnut oil oleogels had a significant effect on the melting peak and endset temperatures ( $P < 0.05$ ). The melting temperatures of hazelnut oil oleogels formed using carnauba wax were higher than those prepared with candelilla wax. It was determined that the melting peak temperature of oleogel formed with carnauba wax was  $75.72 \pm 0.02$  °C and the melting endset temperature was  $81.87 \pm 0.23$  °C.



**Figure 2.** DSC thermograms of hazelnut oil oleogels formed with carnauba and candelilla wax.

The use of different oleogelators had a significant effect on the melting enthalpy of hazelnut oil oleogels ( $P < 0.01$ ). The melting enthalpy of the hazelnut oil oleogel formed with carnauba wax was determined as  $14.16 \pm 0.67$  J/g, while the melting enthalpy of the oleogel prepared with candelilla wax was detected as  $3.87 \pm 0.55$  J/g. From these results, it was concluded that carnauba wax increases the latent heat of melting in oleogelation and provides a more stable oleogel.

**Table 1.** Melting peak temperatures and enthalpy values of hazelnut oil oleogels prepared with carnauba or candelilla waxes

	CW	CN	Significance
<b>Onset (°C)</b>	65.59±0.66 <sup>a</sup>	61.49±2.27 <sup>a</sup>	ns
<b>Peak (°C)</b>	75.72±0.02 <sup>b</sup>	73.92±0.33 <sup>a</sup>	*
<b>Endset (°C)</b>	81.87±0.23 <sup>b</sup>	79.09±0.15 <sup>a</sup>	*
<b>Heat (J/g)</b>	14.16±0.67 <sup>b</sup>	3.87±0.55 <sup>a</sup>	**

<sup>a-b</sup>: Means marked with different letters in the same line are statistically different from each other ( $P < 0.05$ ); CW, Carnauba wax; CN, Candelilla wax.

Various studies are determining the effect of oleogelators on the thermal properties of oleogels prepared from different oils (Lim et al., 2017; Winkler-Moser et al., 2019; Choi et al., 2020; Sahu et al., 2021; Kim et al., 2022). Shi et al. (2021) determined the thermal properties of oleogels prepared from camellia oil or medium-chain triglycerides with candelilla or carnauba wax. In the research, it was observed that the melting temperature and enthalpy values of oleogels formed with carnauba wax were higher than those prepared with candelilla wax for both oil types. Similarly, in a study in which oleogel was prepared with soybean oil and candelilla wax, thermal properties were determined, and the melting peak temperature of oleogels formed with candelilla wax was reported as  $46.31 \pm 0.26$  °C and the enthalpy value as  $5.34 \pm 0.09$  J/g (da Silva et al., 2019). In another study, the melting temperatures and enthalpies of oleogels prepared with sesame oil and 8% carnauba or candelilla waxes were determined. In the research, the melting peak temperature of sesame oil oleogel formed with carnauba wax was higher than that prepared with candelilla. However, when evaluated in terms of enthalpy values, it was reported that the enthalpy value of the oleogel prepared with candelilla wax was  $7.23 \pm 0.12$  J/g, and the enthalpy value of the oleogel formed with carnauba wax was  $6.12 \pm 0.11$  J/g (Pang et al., 2021). Borriello et al. (2021) determined the melting temperatures and enthalpy values in oleogels prepared with different proportions of carnauba or beeswax from pumpkin seed oil. In the research, the melting peak temperature of pumpkin seed oil oleogels containing 8% carnauba wax was determined as  $78.60 \pm 0.07$  °C, and the enthalpy value was  $14.78 \pm 1.98$  J/g. Ögütçü and Yılmaz (2014) determined the thermal properties of oleogel containing olive oil and carnauba wax and reported the melting peak temperature of the oleogel as  $76.00 \pm 0.13$  °C and the enthalpy value as  $14.81 \pm 1.56$  J/g.

### 3.2. Textural Properties

Textural parameters of hazelnut oil oleogels formed with carnauba or candelilla waxes are given in Table 2. The use of different oleogelators significantly affected the hardness of the oleogels ( $P < 0.01$ ). While the hardness of the oleogel formed using carnauba wax was  $1.84 \pm 0.10$  N, the hardness of the oleogel prepared using candelilla wax was determined as  $1.10 \pm 0.05$  N. It has been observed that using carnauba wax in the preparation of hazelnut oil oleogel results in the formation of a harder oleogel. Adhesiveness and gumminess were also significantly affected by the use of different oleogelators ( $P < 0.05$ ). It was determined that oleogels formed using carnauba wax had higher adhesiveness and gumminess values. On the other hand, using different waxes in oleogelation did not affect the cohesiveness and springiness properties ( $P > 0.05$ ).

**Table 2.** Textural properties of hazelnut oil oleogels prepared with carnauba or candelilla waxes.

	CW	CN	Significance
<b>Hardness (N)</b>	1.84±0.10 <sup>b</sup>	1.10±0.05 <sup>a</sup>	**
<b>Adhesiveness (mJ)</b>	4.17±0.30 <sup>b</sup>	3.30±0.26 <sup>a</sup>	*
<b>Cohesiveness</b>	0.27±0.02 <sup>a</sup>	0.28±0.03 <sup>a</sup>	ns
<b>Springiness (mm)</b>	11.29±0.94 <sup>a</sup>	9.59±0.45 <sup>a</sup>	ns
<b>Gumminess (N)</b>	0.51±0.06 <sup>b</sup>	0.31±0.03 <sup>a</sup>	*

<sup>a-b</sup>: Means marked with different letters in the same line are statistically different from each other ( $P < 0.05$ ); CW, Carnauba wax; CN, Candelilla wax.

There are various studies in which textural values are determined in oleogels formed with different waxes and oils (Shi et al., 2021; Thakur et al., 2022; Xia et al., 2022). In a study conducted by Lim et al., (2017), hardness, adhesiveness, cohesiveness, and gumminess properties were determined in oleogels formed using canola oil and carnauba or candelilla waxes. In the study, it was found that the use of different oleogelators was significantly effective for all textural parameters, and similar to this study, the adhesiveness of the oleogel formed with carnauba wax was higher; on the other hand, the gumminess and hardness values were found to be lower than the oleogel prepared with candelilla wax. Pang et al. (2021) compared the textural properties of oleogels formed with sesame oil and different oleogelators. In this research, the adhesiveness of the oleogel prepared with carnauba was higher than the oleogel formed with candelilla, but the hardness was lower. In another study, the textural properties of oleogel prepared with grape seed oil and candelilla wax were determined. It was stated that the hardness of the oleogels prepared with candelilla wax was determined as 2.4 N (Choi et al., 2020).

### 3.3. Color Properties

$L^*$ ,  $a^*$ , and  $b^*$  values of the hazelnut oil oleogels formed with carnauba or candelilla waxes are given in Table 3. While the  $L^*$  value of oleogel prepared with carnauba wax was determined as  $36.65 \pm 0.55$ , the  $L^*$  value of the oleogel formed with candelilla wax was detected as  $48.74 \pm 0.45$ . The  $a^*$  value was determined as  $-1.70 \pm 0.07$  and  $-3.87 \pm 0.03$  for oleogels formed with carnauba or candelilla waxes, respectively. The  $b^*$  value was higher in the oleogel prepared with candelilla wax than that formed with carnauba wax (Table 3). In a study where the color values of oleogels formed with rapeseed oil and candelilla wax were determined, the  $L^*$  value was detected as  $45.06 \pm 0.21$  and the  $a^*$  value as  $-3.11 \pm 0.02$ , similar to this study (Kupiec et al., 2020). Pang et al. (2023) determined the  $L^*$  value of oleogels formed with rice bran oil and carnauba wax as  $62.49 \pm 0.54$  and the  $a^*$  value as  $1.30 \pm 0.37$ . In this context, it is possible to say that the oils and oleogelators used in the oleogelation have remarkable effects on the color properties of oleogels.

**Table 3.** Color properties of hazelnut oil oleogels prepared with carnauba or candelilla waxes.

	CW	CN	Significance
$L^*$	$36.65 \pm 0.55^a$	$48.74 \pm 0.45^b$	**
$a^*$	$-1.70 \pm 0.07^b$	$-3.87 \pm 0.03^a$	**
$b^*$	$8.08 \pm 0.24^a$	$9.88 \pm 0.12^b$	**

<sup>a-b</sup>: Means marked with different letters in the same line are statistically different from each other ( $P < 0.05$ ); CW, Carnauba wax; CN, Candelilla wax.

## 4. CONCLUSION

In the research, the melting peak temperatures and enthalpies and hardness, adhesiveness, and gumminess of hazelnut oil oleogels were significantly affected by the oleogelator used. It has also been observed that oleogelators also affect the color properties. The hazelnut oil oleogels formed with carnauba wax were darker, harder, and more adhesive. Since the melting enthalpy of oleogels formed with carnauba wax is higher than those prepared with candelilla wax, it can be said that carnauba wax forms a thermally more stable oleogel in oleogelation. These results showed that the oleogelator used in oleogelation affects the properties of hazelnut oil oleogel, and the oleogelator should be chosen according to the intended use of hazelnut oil oleogel.

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## ORAL PRESENTATION

### Effects of Algae *Chaetomorpha* sp. Inclusion to Fishmeal Replacement on the Growth, Survival, and Feed Utilization of Flathead Grey Mullet (*Mugil cephalus*) Fry

**Marhamin H. JUMSALI<sup>✉</sup>, Iannie P. MARIBAO, Cherry T. NIAN, Jurmin H. SARRI**

Mindanao State University, Tawi-Tawi College of Technology and Oceanography, College of Fisheries, Sanga-Sanga, Bongao, 7500 Tawi-Tawi, Philippines

<sup>✉</sup>**Correspondence:** marx.moose@gmail.com

**Abstract:** Flathead grey mullet (FGM, *Mugil Cephalus*) is a species traditionally harvested and consumed in numerous Asian countries as a means of feeding populations in developing nations. In response to dwindling wild stocks and an increase in demand, there has been a growing interest in FGM production in hatcheries, considered critical to the growth of FGM aquaculture and the supply of fish fry. However, due to its farming dependence on expensive feeds associated with fishmeal as the main ingredient, feed development and quality are modest. This study examined to evaluate the interactive effects of different levels of *Chaetomorpha* sp. as algal meal (AM) to fishmeal (FM) replacement on growth, survival performance, proximate composition, and feed utilization of FGM, *M. cephalus* Fry. FGM fry was stocked in a plastic container with 70L water capacity at a rate of 30 fish per container. Three formulated diets were prepared: 0% AM and 20% FM (Feed diet 1), 10% AM and 10% FM (Feed diet 2), and 20% AM and 0% FM (Feed diet 3). Experiments were conducted in each group for 45 days with triplicates. The results of the study showed that the feed utilization and growth performance of FGM fry were not significantly affected ( $p>0.05$ ) by formulated feed diets containing various levels of AM and FM. However, in terms of survival rate, Feed diets 1 and 2 performed significantly better ( $p<0.05$ ) than Feed diet 3. Moreover, by incorporating different levels of AM and FM in formulated feed diets, significant improvements ( $p<0.05$ ) were observed in the proximate composition (moisture, crude protein, crude fat, ash, and crude fiber). Hence, this study suggests that FGM *M. cephalus* fry farmers can reduce their reliance on expensive feed by replacing it with 10% *Chaetomorpha* sp. as a replacement for fishmeal, thereby also improving growth, survival, and feed utilization.

**Keywords:** *Chaetomorpha* sp., Feed Utilization, Growth, *Mugil cephalus*, Survival.

## ORAL PRESENTATION

### Seaweed Farming Practices in the Sulu Archipelago, Philippines

**Abdel-Azeem M. ALSIM<sup>1✉</sup>, Darlyne L. BUGTONG<sup>1</sup>, Fatima Faiza T. AMIL<sup>1,3</sup>, Karen Joy B. SERAG<sup>1,2</sup>, Dahlia BURIAS<sup>2</sup>, Claudine Ann M. NAKILA<sup>1</sup>, Sarah-Mae A. SULBANI<sup>1</sup>, Sitti Zayda B. HALUN<sup>1,2</sup>**

<sup>1</sup>Seaweed Research and Development Center, Mindanao State University, Tawi-Tawi College of Technology and Oceanography, Sanga-Sanga, Bongao, Tawi-Tawi, Philippines

<sup>2</sup>Institute of Oceanography and Environmental Science, Mindanao State University, Tawi-Tawi College of Technology and Oceanography, Sanga-Sanga, Bongao, Tawi-Tawi, Philippines

<sup>3</sup>Research Office, Mindanao State University, Tawi-Tawi College of Technology and Oceanography, Sanga-Sanga, Bongao, Tawi-Tawi, Philippines

✉Correspondence: abdelazeemalsim@msutawi-tawi.edu.ph

**Abstract:** Seaweed farming is a major source of livelihood for coastal communities of the Sulu archipelago. Seaweeds farming in the Philippines has grown significantly for the past fifty years to meet the global demand for carrageenan. However, the seaweed industry has been beset with various issues and challenges such as declining production and poor quality of raw dried seaweeds (RDS). This study assessed the farming and post-harvest practices of seaweed farmers in Tawi-Tawi and Sulu using a mixed method approach-interview of key informants using a semi structured questionnaire, Focus Group Discussions (FGD), and household surveys. Farmers cultivate different varieties of *Kappaphycus* spp. and *Eucheuma denticulatum* using fixed-off bottom, floating and spring methods. Seedlings obtained from their previous harvest or bought from fellow farmers or seaweed traders in the nearby areas. A common problem in seaweed farming is ice-ice disease infection and epiphyte infestation. Ice-ice disease is observed during extreme changes in temperature while epiphyte growth occurs when wind speed decreases and water becomes stagnant. There was widespread use of inorganic fertilizer to enhance growth and prevent ice-ice disease infection. Fresh seaweeds are dried by sun drying them on platforms or by hanging method. These traditional methods of drying exposes seaweeds to contaminants and could lower RDS quality. Local traders ship the raw dried seaweed to Zamboanga or Cebu City because there is no seaweed processing plant in Tawi-Tawi and Sulu province. The findings highlight the complex factors affecting RDS quality and quantity such as overall seedling quality, farming methods, environmental conditions, and post-harvest practices.

**Keywords:** *Kappaphycus* spp., Farming Practices, Post-Harvest Practices, Fertilizer, Ice-Ice Disease.

## ORAL PRESENTATION

### An Assessment of Population Density and Species Composition of Sea Urchin Gleaning in Fisheries on Coastal Area of Bato-Bato, Indanan, Sulu, Philippines

Satra J. SAILADJAN<sup>1</sup>, Sherwina M. AROLA<sup>1</sup>, Enraida S. IMBUK<sup>1,3</sup>, Jurmin H. SARRI<sup>2,3</sup>✉

<sup>1</sup>Mindanao State University, Sulu, College of Fisheries, Patikul Site, 7400 Sulu, Philippines

<sup>2</sup>Mindanao State University, Tawi-Tawi College of Technology and Oceanography, College of Fisheries, Sanga-Sanga, Bongao, Tawi-Tawi 7500, Philippines

<sup>3</sup>Kastamonu University, Institute of Science, Department of Aquaculture, 37200 Kastamonu, Türkiye

✉Correspondence: jurminsarri@msutawi-tawi.edu.ph

**Abstract:** The Philippines practice gleaning for edible invertebrates on shallow reef flats primarily for subsistence as well as a supplementary source of income. One of the invertebrates that are being harvested from the wild for consumption and providing a livelihood for coastal communities is the sea urchin. This study investigated the population density, distribution, and species composition of sea urchins along the coastal region of Bato-Bato, Indanan, Sulu, Philippines. The sea urchins were collected every seven days along the shallow coastal area. Results revealed that there were a total of 438 sea urchins collected from the shallow coastal area. Additionally, this study recorded five species of sea urchins belonging to the genera *Tripneustes* (two species), *Diadema* (one species), *Toxopneustes* (one species), and *Pseudoboletia* (one species). The species of sea urchin with the most abundant harvested were from *Tripneustes gratilla* (58.45%, with average mean of  $25.60 \pm 4.23$  individual per 100 m<sup>2</sup>), followed by *Diadema antillarum* (17.35%, with average mean of  $7.60 \pm 4.15$  individual per 100 m<sup>2</sup>), and *Toxopneustes pileolus* (11.87%, with average mean of  $5.20 \pm 1.83$  individual per 100 m<sup>2</sup>). Moreover, the population densities varied from  $0.16 \pm 0.01$  to  $2.56 \pm 0.04$  individuals per 100 m<sup>2</sup>. Hence, this study serves as an initial assessment of the status of the sea urchin population in the coastal region of Bato-Bato, Indanan, Sulu, Philippines.

**Keywords:** Gleaning, Philippines, Population Density, Sea Urchin, Species Composition.

## ORAL PRESENTATION

### Lethal Concentrations of Glyphosate Isopropylamine Salt, Indoxacarb, and Cyprodinil Pesticides in Narrow-Clawed Crayfish (*Pontastacus leptodactylus* Eschscholtz, 1823)

Yiğit TAŞTAN<sup>1,2✉</sup>, Adem Yavuz SÖNMEZ<sup>3</sup>

<sup>1</sup>Kastamonu University, Faculty of Engineering and Architecture, Department of Environmental Engineering, Kastamonu, Türkiye

<sup>2</sup>Kastamonu University, Institute of Science, Department of Aquaculture, Kastamonu, Türkiye

<sup>3</sup>Kastamonu University, İnebolu Vocational School, Department of Transport Services, Kastamonu, Türkiye

✉Correspondence: yigittastan@gmail.com

**Abstract:** Pesticides are great tools to combat undesired organisms in agriculture. However, since they are designed and manufactured to kill organisms, non-target organisms that inhabit the environment which pesticides can contaminate also suffer from the deadly effects of pesticides. In this context, aquatic organisms are in danger as pesticides can mix into water resources from agricultural sites in various ways. Therefore, it is important to assess and understand how pesticides affect non-target organisms in order to take preventive measures and maintain sustainability of both natural aquatic populations and the agriculture industry. This study aimed to explore the toxicity levels of three different pesticides (i.e., glyphosate isopropylamine salt, indoxacarb, and cyprodinil) in narrow-clawed crayfish (*Pontastacus leptodactylus*). For this, commercial formulations of these pesticides (i.e., Knock Out<sup>®</sup>, Gremlin<sup>®</sup>, and Fragma<sup>®</sup> 50 WG, respectively) were purchased from a commercial company and used in a 96-h semi-static acute toxicity test. Median lethal concentration (LC<sub>50</sub>) values of these pesticides were estimated with probit analysis at the end of the test. The results showed that the LC<sub>50</sub> values of glyphosate isopropylamine salt, indoxacarb, and cyprodinil are 59.715 mg L<sup>-1</sup> (p=0.007), 13.133 mg L<sup>-1</sup> (p=0.033), and 18.402 mg L<sup>-1</sup> (p=0.009), respectively. This suggests that all three pesticides used can be classified as slightly toxic to *P. leptodactylus*.

**Keywords:** Pesticide, Acute Toxicity, Non-Target Organism, LC<sub>50</sub>.

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## ORAL PRESENTATION

### Microplastic Levels in Surface Waters and Sediments of Some Important Dam Lakes in Kastamonu, Türkiye

**Cansu BOZMA<sup>1</sup>, Yiğit TAŞTAN<sup>1,2</sup>, Adem Yavuz SÖNMEZ<sup>3</sup>**

<sup>1</sup>Kastamonu University, Institute of Science, Department of Aquaculture, Kastamonu, Türkiye

<sup>2</sup>Kastamonu University, Faculty of Engineering and Architecture, Department of Environmental Engineering, Kastamonu, Türkiye

<sup>3</sup>Kastamonu University, İnebolu Vocational School, Department of Transport Services, Kastamonu, Türkiye

✉Correspondence: aysonmez@kastamonu.edu.tr

**Abstract:** Plastic pollution is a growing concern due to insufficient waste management of vast amounts of plastics consumed worldwide. These plastics enter into aquatic environments in various ways, eventually breaking down and causing problems in habitats. Monitoring water resources in terms of plastic pollution is the first and one of the most essential steps to understand and assess the degree of the pollution. Therefore, we aimed to determine the microplastic (MP) amounts in some of the most important dam lakes in Kastamonu (Türkiye). To accomplish this, water and sediment samples were taken from three different locations on Beyler, Karadere, and Karaçomak Dam Lakes in duplicate in July, 2023. Water samples were filtered *in situ* and sediment samples were obtained from the lakes, and were brought to the laboratory immediately. After processing, MP particles were counted using a computer-assisted compound light microscope. Average MP sizes varied between 201.1 and 406.9 µm for all lakes. Beyler's sediment contained 492 MP particle/kg dry weight and surface water had 16,000 MP particle/ m<sup>3</sup>. Sediment and water from Karadere contained 463 MP particle/kg dry weight and 15,167 MP particle/ m<sup>3</sup>, respectively. Lastly, Karaçomak's sediment contained 518 MP particle/kg dry weight while the its water had 14,219 MP particle/m<sup>3</sup>. The most frequent particle type was fiber in Beyler (49.34%), followed by fragment (43.54%). On the contrary, in both Karadere and Karaçomak, the most frequent particle type was fragment (48.74 and 59.1%, respectively). These results suggest that Beyler, Karadere, and Karaçomak Dam Lakes, which are the three biggest lakes in terms of water storage capacity in Kastamonu, are facing plastic pollution stress. Although a standardized plastic pollution scale has not been established yet, the amounts detected in this study (14.2-16 MP particles per liter) can be considered as high when compared with the literature data. Therefore, required measures should be taken in these lakes.

**Keywords:** Microplastic, Pollution, Sediment, Surface Water, Contamination.

#### Acknowledgment

This study was produced by using the data from the first author's Master's thesis at Kastamonu University, Institute of Science, Department of Aquaculture.

## ORAL PRESENTATION

### A Natural Feed Additive, Curry Leaf Extract Modulates Biochemical Profile for Better Growth and Reproductive Performances in Highfin Barb, *Oreochromis crenuloides*

Siva N.<sup>1</sup>, Gouranga BISWAS<sup>2✉</sup>, Paramita B. SAWANT<sup>1</sup>, Sujata SAHOO<sup>2</sup>, Dilip Kumar SINGH<sup>2</sup>, Sweta PRADHAN<sup>2</sup>

<sup>1</sup>ICAR, Central Institute of Fisheries Education, Mumbai, India

<sup>2</sup>ICAR, Central Institute of Fisheries Education, Kolkata Centre, India

✉Correspondence: gouranga@cife.edu.in

**Abstract:** *Murraya koenigii*, commonly known as curry leaf is a tropical, tolerant, inexpensive plant species containing reproductive augmentative property and medicinal effects. In the current study, the phytobiotic benefits of curry leaf extract (CLE) on the biochemical parameters of an indigenous ornamental barb species, *Oreochromis crenuloides* (highfin barb) during captive maturation were investigated. Highfin barb juveniles (300.12±2.54 mg) were collected from the wild, acclimated, stocked and fed with varied doses of CLE at 0, 0.5, 1, 1.5 and 2% of diet for 60 days in captive condition. At the end of the trial period, the liver, intestine and muscle tissues were collected and processed for various biochemical analyses. The presence of potential phytochemicals in the CLE was confirmed by Orbitrap HR-LCMS. The results of biochemical analysis showed that the stress biomarkers, such as antioxidant enzymes (SOD and catalase) and relative glucose levels were significantly lower in the liver and muscle tissues at 0.5 and 1% CLE supplementations. The tissue cortisol was recorded the lowest at 1% CLE supplementation. The digestive performance due to CLE supplementation was explored by amylase, protease and lipase assays. The results exhibited better digestive performance at lower dose of 0.5% CLE supplementation. The metabolic enzymes, namely ALT (Alanine transaminase), AST (Aspartate transaminase) and ALP (Alkaline phosphatase) were recorded significantly lower in the liver and muscle tissues fed with 0.5 and 1% CLE supplementation, which is a sign of good hepatic health. The higher tissue lipid levels, especially HDL, triglyceride and cholesterol in the liver and muscle of 0.5% and 1% CLE fed fish validated the reproductive augmenting property of curry leaf extract. In conclusion, the supplementation of CLE in maturation diet improved the stress tolerance, digestive performance and metabolic performance of highfin barb, which contributed to better somatic and gonadal development. Thus, the present investigation confirmed the potency of eco-friendly phytochemical compounds with a wide spectrum of application in replacing the use of multiple synthetic therapeutics in aquaculture.

**Keywords:** Curry Leaf, Highfin Barb, Biochemical Parameters, Reproductive Performance.



## ORAL PRESENTATION

### Performance of Laying Hens Fed Diets Incorporated with Feather-Based Feed Additive

**Larisa CAISIN<sup>1✉</sup>, Alla CARA<sup>2</sup>**

<sup>1</sup>Technical University of Moldova, Moldova

<sup>2</sup>Comrat State University, Moldova

✉Correspondence: larisa.caisin@mpasa.utm.md

**Abstract:** A comprehensive and in-depth understanding of modern industrial poultry production technology is a vital condition for the development of poultry enterprises. Among the factors that determine poultry farming's development, the state and development of the feed base are of paramount importance. One of the promising directions for organizing rational poultry feeding based on self-produced feed is the use of new feed sources in compound feeds that have a multifaceted positive impact on poultry health. This study aimed to determine whether feeding feather meal induces changes in the body weight of laying hens, feed consumption, and egg production. The experiment was conducted on laying hens of the Hy-Line Brown W-36 breed without beak trimming, aged from 21 to 34 weeks at an industrial poultry farm. The chickens were placed in standard cages arranged in 6 tiers (with eight chickens per cage) and were distributed into five randomized groups. Four diets were formulated with the inclusion of feather-based feed additives in the base diet at levels of 2.0, 2.5, 3.0, or 3.5 kg per ton, while the control group was maintained on the standard diet. Research results using feather meal as part of the compound feed for laying hens have revealed that the inclusion of this additive had a positive impact on the live weight dynamics of Hy-Line Brown laying hens. Positive trends in absolute live weight gains were observed in the experimental groups compared to the control group, with EG1 showing an increase of 56.78g (4.8%), EG2 with 43.66g (3.7%), EG3 with 33.26g (2.8%), and EG4 with 25.75g (2.1%). The best flock retention during the experimental period was found in the first and second experimental groups, with 98.9% and 97.9%, respectively, representing a 4.1% difference for EG1 and a 3.1% difference for EG2 compared to the control group. The feather meal feed additive is an effective protein supplement, and research has revealed its positive influence on live weight gains and the survival of laying hens. The most effective level is 2 kg per ton of compound feed, which can be explained by the data observed in EG1.

**Keywords:** Poultry Production, Laying Hens, Feeding, Feed Additive, Live Weight Dynamics.

## ORAL PRESENTATION

### Effect of Hydrocolloids on Texture of Meat Products

**Mine KIRKYOL, Ahmet AKKÖSE**✉

*Atatürk University, Faculty of Agriculture Food Engineering, Erzurum, Türkiye*

✉ **Correspondence:** akkose@atauni.edu.tr

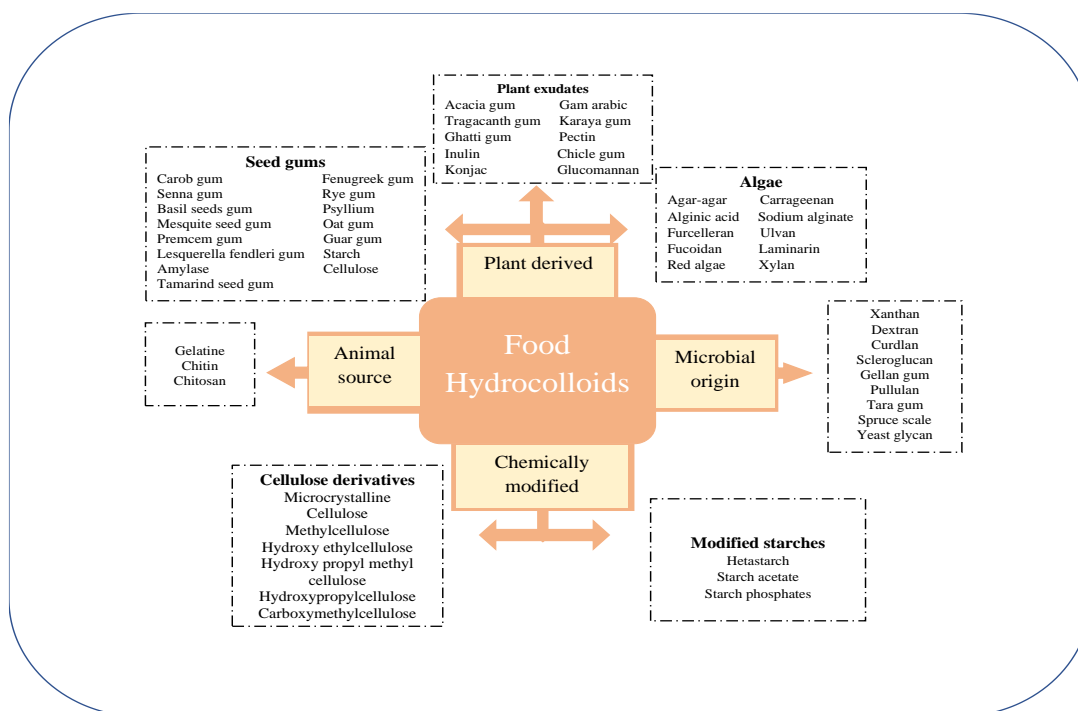
**Abstract:** Hydrocolloids are high molecular weight hydrophilic colloids, rich in hydroxyl groups (OH), and can retain high amounts of water. They are proteins or polysaccharides successfully used in food products as thickening, gelling, stabilizing, film-forming, dispersing, and texture-modifying agents. Hydrocolloids can be used to improve functional properties and compensate for undesirable effects of reformulation and freeze/thaw process in meat products. The reformulation of meat products (such as salt and fat reduction or substitution) can have negative effects, especially on the textural properties. It is reported that the salt and fat content of meat products should be reduced, taking into account their relationship with health. However, these components have significant effects on the textural properties of meat products, and their reduction leads to some negative effects on texture. In this context, to offset these undesirable effects, several investigations have been done about the use of non-meat ingredients such as hydrocolloids in meat products. In this review, the effects of hydrocolloids on the textural properties of meat, poultry, and seafood products were discussed. It has been observed that the hydrocolloids commonly used in meat products are carrageenan, xanthan gum, and konjac mannan. The use of hydrocolloids alone or in combination has provided successful results in various meat products. The effect of hydrocolloids on the textural properties of meat products was strongly related to protein gel matrix formation. In many studies, hydrocolloids improved textural properties, especially in reformulated meat products. However, it should be emphasized that the textural properties of the final products vary depending on the type and amount of hydrocolloid used in production.

**Keywords:** Hydrocolloid, Texture, Meat Products, Carrageenan.

## 1. INTRODUCTION

Hydrocolloids are high molecular weight hydrophilic colloids, rich in hydroxyl groups (OH) (Mahmood et al., 2017). It is known that they bind water more than 100-500 times their weight with their high hydrophilic properties (Luruena-Martinez et al., 2004). Hydrocolloids have been stated to provide some useful functions, including gelation, emulsion activity, dissolution stability, and viscosity in products (Danishefsky et al., 1970). Hydrocolloids can be divided into four groups: starch and its derivatives, cellulose and its derivatives, gums, and others (Luruena-Martinez et al., 2004). Hydrocolloids are also classified based on their biological origin (Figure 1).

Hydrocolloids are used in various industries to perform functions such as thickening, gelling and binding, coating, syneresis control, foam stabilization, emulsion and dispersion, pH stabilization, increasing heat resistance and salt tolerance, and formation of suspensions. To achieve the desired properties in products with reduced fat and salt content, the use of various hydrocolloids that can improve water binding and texture has also attracted the attention of the meat industry (Andres et al., 2006). Hydrocolloids can also contribute to the control of moisture in meat products during the processing, distribution, cooking, holding, and consumption stages. In addition, it was stated that it protects against freezing/thawing conditions that can lead to the destruction of muscle tissue, as well as reducing drip loss and preventing the formation of ice crystals (Mcardle and Hamill, 2011).



**Figure 1.** Classification of hydrocolloids based on their biological origin.

Hydrocolloids interact with proteins in meat products and improve the texture of cooked meat products by forming three-dimensional gels and affecting the thermal denaturation of meat (Amini Sarteshnizi et al., 2015; Saha and Bhattacharya, 2010). Thus, the texture properties of cooked meat products change in the presence of hydrocolloids (Pematilleke et al., 2021). It has also been reported that hydrocolloids can affect the microstructure of products, mouthfeel, structural disintegration, and deformation force during chewing (Sharma and Duizer 2019). The texture of the meat product can vary depending on the type and amount of hydrocolloid used (Mcardle and Hamill, 2011). Different hydrocolloids can affect the appearance, yield, texture, mouthfeel, and sensory properties of the product in different ways. On the other hand, hydrocolloids are generally added to products at relatively low concentrations due to their high molecular weight and technological functionality. Different concentrations of the same hydrocolloid can affect texture, color, pH, cooking efficiency, emulsion stability, sensory properties, and microstructure in different ways in the same product (Ayadi et al., 2009; Chatterjee et al., 2019; Nayak and Pathak, 2016). It is also a common practice to mix more than one hydrocolloid in cases where a single hydrocolloid cannot achieve the desired effect. This depends on understanding the properties of each polysaccharide as well as the synergistic effects of the mixture for optimal use (Pematilleke, 2021). For all these reasons, different hydrocolloids or their mixtures have found use in various meat products, and many studies have been conducted on this subject. In this review, studies on the use of different hydrocolloids in meat, poultry and seafood products were investigated, and their effects on textural properties were reported.

## 2. USE OF HYDROCOLLOIDS IN MEAT PRODUCTS

Many studies considered the effect of hydrocolloids on the quality and texture of red meat products (Table 1). In a study examining the effect of using konjac gel as a substitute for pork back fat in dry fermented sausages on production and quality characteristics, it was reported that there was an increase in hardness and chewiness and a decrease in cohesiveness (Ruiz-Capillas et al., 2012). In another study, it was determined that using tragacanth gum as a fat replacer in emulsified sausages caused changes in textural parameters (Abbasi et al., 2019). Another application was achieved by Wang et al. (2018) in emulsified sausages with reduced fat using cellulose nanofiber, resulting in improved texture in the study.

**Table 1.** Studies considering the effects of hydrocolloids on the textural properties of red meat products.

Product	Hydrocolloid	Results	Reference
Dry fermented sausage	Konjac gel	<ul style="list-style-type: none"> <li>• Increased hardness and chewiness</li> <li>• Decreased cohesiveness</li> </ul>	Ruiz-Capillas et al. (2012)
Meat emulsions	Hydroxypropylmethylcellulose Methylcellulose $\kappa$ and $\iota$ -carrageenans Xanthan and locust bean gums	<ul style="list-style-type: none"> <li>• Differences in textural properties depending on the hydrocolloid type</li> </ul>	Marchetti et al. (2013)
Cooked meat batters	$\beta$ -glucan Inulin	<ul style="list-style-type: none"> <li>• Using inulin gel and flour increased hardness</li> <li>• Changes in all textural parameters with using <math>\beta</math>-glucan</li> </ul>	Alvarez and Barbut (2013)
Harbin sausage	Cellulose nanofibers	<ul style="list-style-type: none"> <li>• Higher hardness and springiness</li> </ul>	Wang et al. (2018)
Emulsion type sausage	Tragacanth gum	<ul style="list-style-type: none"> <li>• Hardness decreased with the addition of 1%</li> </ul>	Abbasi et al. (2019)
Meat emulsion	Gelatine Alginate	<ul style="list-style-type: none"> <li>• Decrease in textural properties</li> </ul>	Kim et al. (2020)
3D printed cooked pork paste	Xanthan gum Guar gum	<ul style="list-style-type: none"> <li>• Highest hardness in the control</li> </ul>	Dick et al. (2020)
Meat product	Nanocellulose	<ul style="list-style-type: none"> <li>• Improvement in texture</li> </ul>	Marchetti and Andres (2021)
Beef patties	14 different hydrocolloids	<ul style="list-style-type: none"> <li>• Increased hardness and cohesiveness</li> </ul>	Pematilleke et al. (2021)
Hamburger	Polysaccharide hydrocolloids Fruit peel flours	<ul style="list-style-type: none"> <li>• Highest hardness, cohesiveness, and springiness with the combination of sodium carboxymethyl cellulose, gum arabic and pomegranate flour</li> </ul>	Mousa (2021)
Meat emulsion	Tapioca starch	<ul style="list-style-type: none"> <li>• Increased hardness and chewiness</li> </ul>	Zhao et al. (2023)

Pematilleke et al. (2021) examined the effects of 14 different hydrocolloids, commonly used in the meat industry as texture modifiers, on beef patties. Beef meatballs, each produced by adding 1% hydrocolloid, were compared to those without hydrocolloid added. In the study, the hardness value decreased significantly with the addition of different hydrocolloids, except  $\kappa$ - and  $\iota$ -carrageenan. The cohesiveness of the meatballs also decreased significantly with the addition of hydrocolloids, and the lowest cohesiveness value was determined in the group using xanthan gum. It was determined that most of the gums (gellan gum, xanthan gum, and locust bean gum) increased the adhesiveness of the samples, and most of the starches except tapioca starch decreased the adhesiveness compared to the control. Mousa (2021) used double and triple combinations of hydrocolloids and different fruit peel flours as fat substitutes in beef hamburgers. The highest hardness, cohesiveness, and springiness values were determined in the group containing sodium carboxymethyl cellulose, gum arabic, and pomegranate flour composite.

In another study, the effects of adding xanthan gum and guar gum alone and in combination on the microstructure, textural, and rheological properties of 3D-printed cooked pork paste were investigated. It was reported that control samples showed higher chewiness and cohesiveness values than hydrocolloid-added samples. The formulation without added hydrocolloid showed the highest hardness value, followed by the formulation with 0.36% guar gum (Dick et al., 2020). Marchetti et al. (2013) determined the effect of adding various mixtures containing hydrocolloids to low-fat meat emulsions prepared with fish oil. Researchers have reported significant differences in hardness between formulations. Kim et al. (2020) stated that hydrocolloids exhibit important properties that lead to improvement in the texture of meat products, such as the ability to form a strong matrix and high water retention capacity. Zhao et al. (2023) found that using tapioca starch as a fat replacer in meat emulsion caused an increase in hardness and chewiness.

### 3. USE OF HYDROCOLLOIDS IN POULTRY MEAT PRODUCTS

There are studies examining the effect of the use of hydrocolloids on textural properties in meat products obtained from many poultry animals such as chicken, duck, turkey, and ostrich (Table 2). Kim et al. (2018) determined the textural properties of ham produced from duck meat reformulated with various hydrocolloids (alginic acid, konjac, carrageenan). It was reported that hardness, cohesiveness, gumminess, and chewiness were lower in the reformulated samples than in the control. Springiness value was lower than the control in all groups except the group in which carrageenan was used. It was also stated that a softer texture was formed in all samples to which hydrocolloid was added. In another study, the optimum levels of fish gelatin and carrageenan addition to chicken breast meat were investigated in terms of textural properties and water retention capacity. The hardness of chicken meatballs produced under optimum conditions was determined as 62.59 N, springiness as 0.79 mm, cohesiveness as 0.625, and chewiness as 30.495 Nmm (Yasin et al., 2016). Polak et al. (2018) prepared different chicken breast meat emulsions using carrageenan, xanthan gum, and potato starch. It has been reported that the amount of hydrocolloid significantly affected hardness, cohesiveness, gumminess, chewiness, and resilience values. On the other hand, the springiness and adhesiveness of chicken breast emulsions were not affected by the use of different hydrocolloids.

**Table 2.** Studies considering the effects of hydrocolloids on the textural properties of poultry products.

Product	Hydrocolloid	Results	Reference
Chicken ball	κ - carrageenan Fish gelatin	• In optimum point; hardness: 62.59 N elasticity: 0.79 mm cohesiveness; 0.625, chewiness: 30.495 N mm	Yasin et al., (2016)
Chicken meat emulsions	Carrageenan Xanthan gum Potato starch	• Adhesiveness and springiness did not affect	Polak et al., (2018)
Restructured duck ham	Alginate Konjac Carrageenan	• Lower hardness, cohesiveness, gumminess, and chewiness values than the control	Kim et al., (2018)

### 4. USE OF HYDROCOLLOIDS IN SEAFOOD PRODUCTS

There are a limited number of studies determining the effect of the use of hydrocolloids in seafood products on textural properties (Table 3). Izadi et al. (2015) examined the effect of using different hydrocolloids as coating materials on textural properties in shrimps. They used carboxymethyl cellulose, guar gum, tragacanth gum, and zedo gum in coating the shrimps and found that there was a decrease in the hardness of the shrimps coated with hydrocolloid and fried. However, it was reported that the lowest hardness value was in samples containing 1.5% tragacanth gum. In another study, the effect of hydrocolloid addition on textural properties in surimi production was investigated, and sulfated polysaccharides obtained from the green alga *Ulva intestinalis* were used as hydrocolloids. It has been reported that as the rate of hydrocolloid usage increases, there is a significant decrease in hardness, cohesiveness, and chewiness parameters (Alipour et al., 2018). Alves et al. (2021) investigated the effect of transglutaminase and carrageenan on textural properties in fish ham samples. It was stated that carrageenan increased hardness, adhesiveness, and chewiness values, but transglutaminase decreased. On the other hand, in a study using konjac gum and xanthan gum in fish paste, hardness, springiness, cohesiveness, chewiness, and resilience values first increased and then decreased as the rate of konjac gum usage increased (Yu et al., 2023).

**Table 3.** Studies considering the effects of hydrocolloids on the textural properties of seafoods.

Product	Hydrocolloid	Results	Reference
Shrimps	Carboxymethyl cellulose Guar gum Tragacanth gum Zedo gum	<ul style="list-style-type: none"> <li>• Decreased hardness</li> <li>• Lowest hardness in samples containing 1,5% tragacanth gum</li> </ul>	Izadi et al., (2015)
Silver carp surimi	Sulfated polysaccharides from green alga <i>Ulva intestinalis</i>	<ul style="list-style-type: none"> <li>• Hardness, springiness, chewiness, and adhesiveness similar in the group containing 0.25g/100g UIP and the control</li> <li>• Hardness, cohesiveness, and chewiness decrease as the UIP usage rate increases</li> </ul>	Alipour et al., (2018)
Restructured Fish Cooked Ham	Carrageenan Transglutaminase	<ul style="list-style-type: none"> <li>• Decrease in hardness, springiness, and chewiness with carrageenan</li> <li>• Increase hardness, chewiness, and adhesiveness with transglutaminase</li> </ul>	Alves et al., (2021)
Fish paste	Konjac gum Xanthan gum	<ul style="list-style-type: none"> <li>• Hardness, springiness, cohesiveness, chewiness, and resilience first increased and then decreased with konjac gum</li> </ul>	Yu et al., (2023)

## 5. CONCLUSION

Common hydrocolloids used in the meat industry are carrageenan, xanthan gum, and konjac mannan. Carrageenan can be used alone or in combination with other gums to improve the texture of meat products. In addition, many of the hydrocolloids affected textural properties. It has been observed that hydrocolloids are used more widely to improve textural properties, especially in reformulated meat products. On the other hand, the textural properties of the final products may vary depending on the type and amount of hydrocolloid used in production.

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## ORAL PRESENTATION

### Decolorization of Aqueous Solutions Containing Reactive Blue 221 by Ozonation Process

**İbrahim CENGİZ**✉

*Bayburt University, Applied Sciences Faculty, Department of Emergency Aid and Disaster Management, Bayburt, Türkiye*

✉Correspondence: ibrahimcengiz@bayburt.edu.tr

**Abstract:** This study aimed to investigate the decolorization of reactive blue 221 (RB 221) dye by ozonation in a batch bubbling column reactor. The research focuses on examining the influence of ozone gas flow rate on the ozonation process and determining reaction degrees and rate constants. A synthetic RB 221 dye-containing aqueous solution was operated in a batch mode with ozone gas supplied through a diffuser located at the base of a bubble column reactor. The height of the circular bubble column reactor is 21 cm, and its inner diameter is 5 cm. Ozone gas, generated from dry air using an ozone generator, was introduced into the system at the desired flow rates through an analog flowmeter on the ozone generator. In the experimental studies, the concentration of the prepared RB 221 solution was 200 mg/L, the natural pH value was 5.30, the temperature was at ambient temperature, and the ozone gas concentration was 4.5 g/m<sup>3</sup>. In the study that examined the effect of gas ozone flow rate, RB 221 removal efficiencies, reaction degrees, and rate constants were determined for gas flow rates of 150, 200, and 250 L/h. The total reaction time in the experimental studies was set at 30 minutes. In the experimental studies, RB 221 removal efficiencies were over 98% for all gas flow rates after 30 min of reaction time. After a 10-minute reaction time, removal efficiencies of 81.65%, 88.02%, and 91.88% were obtained for gas flow rates of 150, 200, and 250 L/h, respectively. Kinetic calculations indicated that the removal of RB 221 dye followed a first-order reaction kinetics. Using an Excel solver add-in, the removal rate constants for ozone gas flow rates of 150, 200, and 250 L/h were calculated as 0.1516, 0.198, and 0.249 min<sup>-1</sup>, respectively. Both the 10-minute removal efficiencies and rate constants show that an increase in ozone gas flow rates results in an increased rate of RB 221 removal. It is possible to achieve high removal efficiencies in a short time for wastewater containing RB 221 dye at high gas flow rates by ozonation.

**Keywords:** Reactive Blue 221, Ozonation, Decolorization.

## 1. INTRODUCTION

In today's world, environmental pollution has reached a threatening level due to increasing population and industrial activities. The discharge of waste resulting from human activities without effective treatment processes contributes to air, water, and soil pollution. Particularly, wastewater containing significant amounts of dyes and colorants draws attention in this regard. Dyes and colorants have a wide range of applications, including textile, paper, leather, food, plastic, and cosmetic industries (N. Değermenci et al., 2019; Awais Iqbal et al., 2022; Tripathi et al., 2023; Yaqub et al., 2023). The discharge of these untreated wastewater into aquatic environments results in the formation of color in the water, leading to aesthetically negative consequences. The process of photosynthesis in aquatic environments is adversely affected due to the reflection and absorption of light caused by the generated color. It causes a decrease in the dissolved oxygen levels in water, both by hindering gas transfer and through biological decomposition. Additionally, dyes are carcinogenic, mutagenic, or teratogenic due to their chemical structures (G. D. Değermenci, 2021; N. Değermenci & Akyol, 2020; Awais Iqbal et al., 2022; Moneer et al., 2022; Yaqub et al., 2023).

Treatment of wastewater containing dye substances is important for environmental and public health. Various treatment processes, including physical methods (membrane, adsorption), chemical methods (coagulation, chemical oxidation), and biological methods (aerobic and anaerobic), have been investigated for these wastewaters. The use of traditional wastewater treatment processes for dye-containing wastewater with massive flow rates is both inefficient and highly

costly. These wastewater treatment processes stand out with disadvantages such as significant footprints, intensive energy consumption, operational issues, high sludge formation, and a substantial need for manpower. Therefore, there is a need for economically viable and flexible treatment strategies to meet water quality standards (Giwa et al., 2020; Tanveer et al., 2022; Xie et al., 2010).

Advanced oxidation processes appear to be quite successful in the treatment of containing dyes wastewater. Advanced oxidation processes rely on the generation of high levels of oxidative hydroxyl radicals for the degradation of pollutants. Hydroxyl radicals can be produced from processes such as  $O_3$ ,  $O_3/H_2O_2$ , Fenton,  $O_3/UV/H_2O_2$ ,  $H_2O_2/O_3$ , and  $O_3/UV$  (Çobanoğlu & Değermenci, 2022; Maleki et al., 2023; Rekhate & Srivastava, 2020; Tripathi et al., 2023). Ozonation is very successful in the removal of wastewater-containing dyes, especially reactive dyes (Aqsa Iqbal et al., 2023; Tripathi et al., 2023). Ozone is a very powerful oxidant that is widely used in wastewater treatment. Ozone is an odorless, colorless, highly unstable gas. Due to its unstable structure, it must be used in situ when it is produced. Oxidation in ozonation processes can occur with direct ozone and indirect hydroxyl radicals (Barlak et al., 2020; Rekhate & Srivastava, 2020).

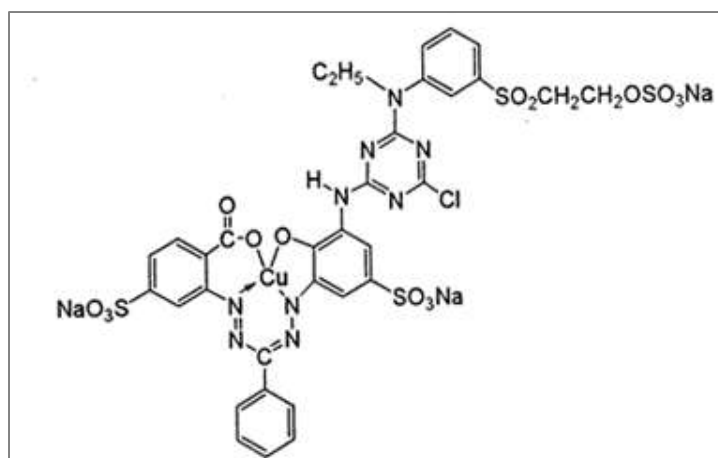
Reactive blue 221 is one of the most common dyes used in the textile industry. RB 221 cannot be effectively treated by simple decolorization processes or may form harmful by-products. (Bilińska et al., 2017; Kale & Chaudhari, 2017). There are some studies investigating physical, chemical, and biological processes for the removal of Reactive Blue 221 dyestuff in the literature. Kale and Chaudhari (2017) utilized zinc peroxide containing PEG as a catalyst in photocatalytic oxidation for the removal of Reactive Blue 221. Under optimal conditions, a removal efficiency of 85.52% was reported with zinc peroxide containing PEG as the catalyst, and a removal efficiency of 81.69% was obtained with zinc peroxide without the catalyst. Iqbal et al. (2022) investigated the decolorization of a mixture containing three reactive azo dyes (Reactive Blue 221, Reactive Yellow 145, and Reactive Red 195) at a concentration of 50 ppm using an attached growth bioreactor. Color removal efficiencies ranging from 85% to 94% were achieved after 192 hours of operation. Bilińska et al. (2017) investigated color removal in simulated industrial wastewater containing Reactive Yellow 145 (RY145), Reactive Red 195 (RR195), and Reactive Blue 221 (RB221) through advanced oxidation processes ( $O_3$ ,  $O_3/H_2O_2$ ,  $O_3/UV$ , and  $O_3/UV/H_2O_2$ ). It was reported that ozonation led to a rapid decolorization of textile wastewater, with only 10% of the color remaining after a reaction time of 10 minutes.

The literature review shows that the ozonation process for the removal of Reactive Blue 221 dyestuff has been studied in a limited number of studies. In this study, the performance of color removal through the ozonation process of Reactive Blue 221 in a batch-operated bubble column reactor was investigated. The influence of ozone gas flow rate on the decolorization of Reactive Blue 221 in the ozonation process was examined, and the reaction degree and reaction rate constant were determined.

## 2. MATERIALS AND METHODS

### 2.1. Chemicals and Analysis

The Reactive Blue 221 dye used in experimental studies was commercially sourced. The CAS registry number for Reactive Blue 221 is 93051-41-3, and its chemical structure is provided in Figure 1. The wastewater containing synthetically prepared dye was prepared using distilled water.



**Figure 1.** Chemical structure of reactive blue 221.

The determination of Reactive Blue 221 was carried out using a UV-VIS spectrophotometer (SpectroFlex 6600, WTW) at a wavelength of  $\lambda=610$  nm. The studies were conducted at the natural pH value of the dye solution, which was 5.30, and at room temperature. The color removal was calculated using Equation 1. The reaction degree and reaction rate constant were determined using the non-linear method with the Excel Solver add-in.

$$\% \text{ Removal} = \frac{C_0 - C_t}{C_0} \quad (1)$$

Where,  $C_0$  represents the initial concentration of RB 221, and  $C_t$  represents the remaining concentration of RB 221 at time  $t$ .

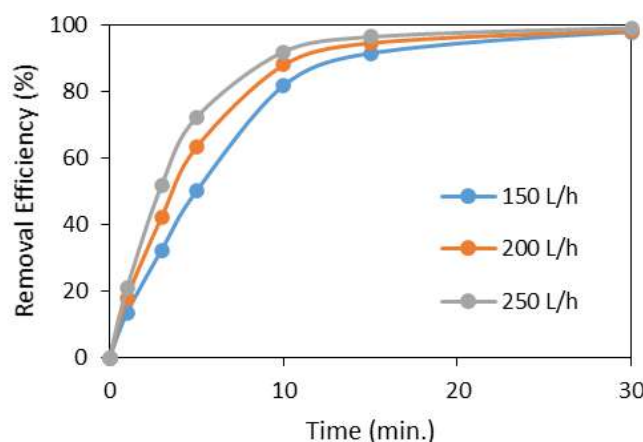
## 2.2. Experimental Procedure

Ozonation was performed by introducing ozone gas from the bottom through a diffuser into a glass reactor containing a 400 ml solution prepared from solid Reactive Blue 221. The reactor had an inner diameter of 5.0 cm and a height of 21.0 cm. The required ozone gas for the experimental setup was obtained by passing air from a compressor (Dalgakiran, DKC-150) through a humidity and dust filter and then through an ozone generator (Anseros, COM AD-08). The ozone gas flow rate was regulated using an analog flowmeter on the ozone generator. The ozone concentration in the gas phase was measured using an ozone gas analyzer (Anseros, GM-6000-OEM) integrated into the system.

## 3. RESULTS AND DISCUSSION

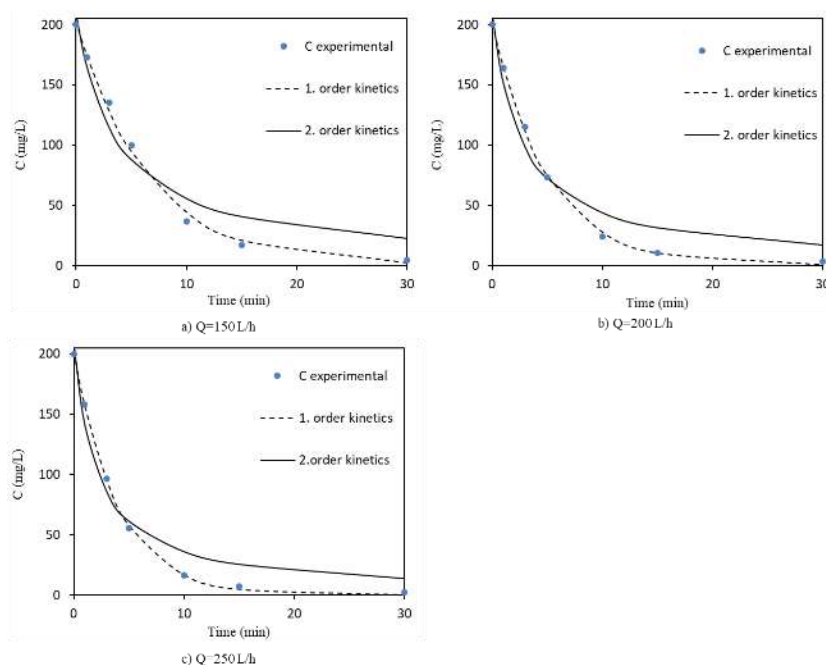
### 3.1. Results

The effect of gas flow rate on the ozonation removal of Reactive Blue 221 in solutions was investigated at flow rates of 150, 200, and 250 L h<sup>-1</sup>. A 400 ml solution with an initial RB 221 concentration of 200 mg/L was introduced into the reactor, and ozone gas with a concentration of 4.5 g/m<sup>3</sup> was supplied to the system through a diffuser located at the bottom, for the ozonation process. The system operated for a reaction time of 30 minutes. Experimental studies were conducted at room temperature, and the ozone gas flow rate was adjusted using an analog flowmeter on the ozone generator. Samples were taken over time for varying gas flow rates, and RB 221 concentrations were measured. The removal efficiencies over time for different gas flow rates are presented in Figure 2.



**Figure 2.** Variation of RB 221 removal efficiencies over time at different gas flow rates.

As observed in Figure 2, the color removal efficiencies increase with increased gas flow rates. The increase in removal efficiency can be explained in two ways: (i) an increase in the amount of ozone supplied to the system with the increasing gas flow rate, and (ii) the increased gas flow rate positively affects the ozone mass transfer, leading to improved removal efficiency. Studies in the literature support our findings. (Konsowa, 2003) reported that an increase in gas flow rate increased the mass transfer rate and a decrease in color removal time. (Gao et al., 2022) reported that an increase in gas flow rate led to an increase in mass transfer coefficient due to the increased interfacial area and turbulence enhancement. (Soares et al., 2006) investigated the removal of textile wastewater by ozonation and reported that the removal efficiency increased from 79% to 98% at increasing gas flow rates.



**Figure 3.** RB 221 removal kinetics at varying gas flow rates.

Kinetic analyses from Figure 3 indicate that the decolorization of Reactive Blue 221 follows first-order kinetics. The  $k$  values determined from the kinetic profile for Reactive Blue 221 decolorization are provided in Table 1. The rate constant for color removal is proportional to the ozone gas flow rate. It is possible to achieve high removal efficiency in short reaction times with increasing gas flow rates.



**Table 1.** Removal coefficients of RB 221 for varying gas flow rates.

Qg (L/h)	First order kinetics		Second order kinetics		Removal Efficiency (%) (t= 10 min.)
	R <sup>2</sup>	k <sub>1</sub> (min <sup>-1</sup> )	R <sup>2</sup>	k <sub>2</sub> (min <sup>-1</sup> )	
150	0.9958	0.1517	0.9457	0.00131	81.65
200	0.9988	0.1982	0.9578	0.0018	88.02
250	0.9995	0.2492	0.9627	0.0023	91.88

### 3.2. Discussion

In this study, the decolorization of Reactive Blue 221 in a batch-operated bubble column reactor was investigated through the ozonation process. The effect of ozone gas flow rate on color removal through the ozonation process was examined. Gas flow rates of 150, 200, and 250 L/h were studied to investigate their impact on color removal. The experimental conditions for the 30-minute reaction time were set as follows: ozone gas concentration of 4.5 g/m<sup>3</sup>, the solution's natural pH of 5.3, ambient temperature, and an initial RB 221 concentration of 200 mg/L. The color removal of Reactive Blue 221 is above 98% for each gas flow rate after a 30-minute reaction time. To better understand the impact of increasing gas flow rates, color removal efficiencies at 150, 200, and 250 L/h for 10-minute reaction times were determined to be 81.65, 88.02, and 91.88, respectively. The increase in gas flow rates resulted in an improvement in removal efficiency due to both the increased amount of ozone supplied to the system and enhanced ozone mass transfer efficiency. The kinetic analysis revealed that the reaction degree conforms to first-order kinetics. The calculated reaction rate constants for gas flow rates of 150, 200, and 250 L/h are 0.1517, 0.1982, and 0.2492 min<sup>-1</sup>, respectively. Considering both the reaction rate constants and the removal efficiencies at the 10th minute, it is observed that increasing gas flow rates accelerate color removal.

### 4. CONCLUSION

The results obtained indicate that the ozonation process is highly effective in the decolorization of Reactive Blue 221. It is seen that the ozonation process is suitable for the color removal of Reactive Blue 221, which is widely used in the textile industry, to obtain high color removal efficiency in short reaction times.

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## ORAL PRESENTATION

### Quality Characteristics of Kastamonu Pastırma

**Fatma Yağmur HAZAR SUNCAK<sup>1</sup>✉, Tuğba GİDER<sup>2</sup>, Merve ÇELİK<sup>1</sup>**

<sup>1</sup>Kastamonu University, Faculty of Engineering and Architecture, Kastamonu, Türkiye

<sup>2</sup>Atakum District Directorate of Agriculture and Forestry, Samsun, Türkiye

✉Correspondence: fyhazar@kastamonu.edu.tr

**Abstract:** The aim of this study is to determine the physical, chemical and microbiological properties of pastırma marketed in Kastamonu. For this purpose, pastırma samples was purchased from 8 different firms in 3 different periods. Pastırma samples were tested for microbiological analyzes (total aerobic mesophilic bacteria, yeast-mould, lactic acid bacteria, *Micrococcus/Staphylococcus*, Enterobacteriaceae), pH, moisture, residual nitrite, salt, and free fatty acid. Statistical analyzes were also applied to the obtained data. As a result of the analyses, it was determined that lactic acid bacteria and *Micrococcus/Staphylococcus* constitute the dominant flora in pastırma. The number of *Micrococcus/Staphylococcus* and lactic acid bacteria were detected between 5.60-7.69 log cfu/g and 4.85-8.39 log cfu/g, respectively. On the other hand, total aerobic mesophilic bacteria and yeast-mold were found to be 6.20-8.40 and 3.46-7.21 69 log cfu/g, respectively. While the number of Enterobacteriaceae showed values below the detectable limit in many firms, it was detected between 10<sup>2</sup>-10<sup>4</sup> cfu/g in some periods in C, D, F, G and K companies. The firm factor had a very significant (P<0.05) effect on all other microbiological characteristics except Enterobacteriaceae. The pH value of pastırma showed values between 5.25-6.42. The pH value of the samples was statistically significantly affected by the firm factor and the highest pH value was found in firm E. It is stated that the moisture value of pastırma should be at most 50%. Analyzes showed that the humidity value varied between 43.17% and 56.03%. Statistical differences were found between companies in terms of moisture value and the lowest value was determined in firm B. The salt values of pastırma samples varied between 2.98-8.78%. The firm factor also had a significant effect on the salt value and the lowest value was detected in company D. The average salt value of company E did not show any statistical difference from company D. The amount of free fatty acids in pastırma showed values between 0.021-0.242% and these values were affected by the company factor at the level of P < 0.01. The highest average free fatty acid value was found in company D with 0.118 g oleic acid/100 g. The residual nitrite value of pastırma also differed between companies. Company D gave the highest average value. As a result of this study, it was concluded that the analysis results of the pastırma sold in the Kastamonu market were generally similar to other studies and except for a few values, were in compliance with the Turkish Food Codex Communiqué on Meat, Prepared Meat Mixtures and Meat Products.

**Keywords:** Pastırma of Kastamonu, Residual Nitrite, Microbiology, Free Fatty Acid.

## ORAL PRESENTATION

### Effects of Nettle (*Urtica dioica*) Seed Oil to Zebra Cichlid (*Chiclasoma nigrofasciatum*) Feed at Different Ratios on Growth Performance

**Enraida IMBUK<sup>1,2</sup>, Keriman YÜRÜTEN ÖZDEMİR<sup>3✉</sup>, Rahmi Can ÖZDEMİR<sup>3</sup>**

<sup>1</sup>Kastamonu University, Institute of Science, Department of Aquaculture, Kastamonu, Türkiye

<sup>2</sup>Mindanao State University, College of Fisheries, Patikul Site, Sulu, Philippines

<sup>3</sup>Kastamonu University, Faculty of Engineering and Architecture, Kastamonu, Türkiye

✉Correspondence: kozdemir@kastamonu.edu.tr

**Abstract:** The present study evaluated the effects of dietary substitution of nettle (*Urtica dioica*) on the growth performance of zebra cichlid (*Chiclasoma nigrofasciatum*) after a 60-day feeding trial. For this purpose, Zebra cichlids (initial weight: 1.68±0.06 g) were divided into four experimental groups in triplicate and fed twice a day with the experimental diets ad-libitum by hand. The fish were fed with basal diet containing different concentrations of nettle seed oil: control (0), 1 (N1), 2 (N2), and 3 (N) g kg<sup>-1</sup> for 60 days, respectively. At the end of the feeding period, final weight and weight gain were significantly increased in N1 compared to the control and other experimental groups. The specific growth rate and condition factor were similarly found to be higher in the N1 group than in the control and other experimental groups. The feed conversion ratio was similar among all treatments. Viscerosomatic index and hepatosomatic index values, which are considered to be biological parameters and supportive of growth parameters, were higher in the control group than in the other groups. This study shows that the use of nettle seed oil at 1% in the feed of zebra cichlids has a positive effect on the growth of the fish.

**Keywords:** Zebra Cichlid, Nettle, Seed Oil, Growth.

## ORAL PRESENTATION

### Stability of Lactation of Holsteinized Cattle in the Conditions of Dairy Farms of ATU Gagauzia

**Stepan VARBAN<sup>1✉</sup>, Alla CARA<sup>1</sup>, Serghei SHTIRBU<sup>2</sup>**

<sup>1</sup>Comrat State University, Agro-Technological Faculty, Moldova

<sup>2</sup>SRL «ANATOLI GRUP», ATU, Gagauzia, Moldova

✉Correspondence: varban@mail.ru

**Abstract:** The purpose of this study was to study the compliance of resource and technological conditions of dairy farms for realizing the genetic potential of highly productive dairy cattle. The objectives of the study included studying the age-related dynamics of changes in live weight and milk yield, determining the coefficients of milk production and the stability of lactation. The object of the research was full-aged cows of the Holstein breed, which had at least three completed lactations, in the amount of 15 heads. It was established that the average live weight of first-calf heifers was 428 kg, which was significantly lower than that of the breed. The average milk yield for the dairy herd was 971 kg. The milk production coefficient was higher in cows during the second lactation - 996 kg and at the level of 975 kg was recorded in the first lactation. According to modern productivity standards, the identified milk yield indicators in our studies turned out to be clearly low, which indicates an insufficiently established technology for raising replacement heifers. At the same time, studies of the uniformity of lactation activity of cows revealed a relatively moderate decrease in milk yield during the height of lactation (4, 5 and 6 months) in relation to the milking period (1, 2 and 3 months). The lactation stability coefficient (LSC1) in the first lactation was 88.1%, in the second and third lactation 91.1% and 94.3%, respectively. The stability coefficient (LSC2) in the first lactation was 86.0%, in the second and third lactation 83.2% and 87.4%, respectively. The results obtained generally indicate a relatively stable lactation activity of cows, however, the lag in the growth of first-calf heifers indicates the presence of missed opportunities in realizing the productive potential of highly productive livestock.

**Keywords:** Cow, First-Calf, Milk Yield, Milk Production, Lactation Stability.

## ORAL PRESENTATION

### No Significant Differences in Soil Organic Carbon Between Postfire and Undisturbed *Pinus nigra* Forest Three Years After Wildfires

**Renato PACALDO<sup>1,3</sup>, Miraç AYDIN<sup>1</sup>, Randell Keith AMARILLE<sup>2,3</sup>**

<sup>1</sup>Faculty of Forestry, Kastamonu University, Kastamonu, Türkiye

<sup>2</sup>Graduate Student, Faculty of Forestry, Kastamonu University, Kastamonu, Türkiye

<sup>3</sup>College of Forestry and Environmental Studies, Mindanao State University-Main Campus, Marawi City, Philippines

✉Correspondence: randellkeith.amarille@msumain.edu.ph

**Abstract:** Wildfires have been known to alter soil properties, especially soil organic carbon, which is vital to some soil processes. This study aimed to compare the SOC contents of a postfire and undisturbed *Pinus nigra* Arnold forests at two depths (e.g., 0-15cm and 16-30cm). The study site was burned in a wildfire that occurred in 2020. An experiment in a split-plot design with four (4) replications was established with two treatments (postfire and control). Soil organic matter concentrations were determined using the Loss-on-Ignition and were converted to SOC by using a conversion factor of 1.724. Results revealed no significant differences in SOC stock between the postfire and undisturbed soils ( $p=0.95$ ), with values ranging from 24.4 to 124.6 Mg ha<sup>-1</sup> in control plots and 37.9 to 123.34 Mg ha<sup>-1</sup> in postfire plots. Conversely, analyses between depths revealed significant differences ( $p<.0001$ ), with the upper soil layer having higher SOC content ranging from 65.6 to 124.6 Mg ha<sup>-1</sup>, while the lower soil layer ranged from 24.4 to 61.8 Mg ha<sup>-1</sup>. However, the separation of means using the t-test revealed no significant differences between treatments in the upper soil layers ( $p=0.87$ ) and lower soil layers ( $p=0.89$ ). The lack of significant differences between postfire and undisturbed soils could be attributed to non-differentiated SOC contents across soil layers. The wildfire may not have affected the mineral layer but only the organic layer, and in three (3) years, given that no differences were observed in the organic layer across the treatments, we can conclude that the SOC content in postfire soil has already recovered to the same amounts of the undisturbed soils, possibly due to the slow decomposition of pine litters and compensatory effects of organic matter deposits from grasses and pioneering species invading the forest fire sites.

**Keywords:** Wildfire, Black Pines, Soil Organic Matter, Postfire.



## ORAL PRESENTATION

### Investigation of Antibacterial Activity of Coriander (*Coriandrum sativum*) and Grape (*Vitis vinifera*) Seeds Extracts Against Fish Pathogens

**Mustafa KARGA<sup>1✉</sup>, Soner BİLEN<sup>2</sup>, Osman Nezi KENANOĞLU<sup>3</sup>**

<sup>1</sup>Kastamonu University, İnebolu Vocational School, Kastamonu, Türkiye

<sup>2</sup>Kastamonu University, İhsangazi Vocational School, Kastamonu, Türkiye

<sup>3</sup>Kastamonu University, Faculty of Engineering and Architecture, Food Engineering, Kastamonu, Türkiye

✉Correspondence: mkarga@kastamonu.edu.tr

**Abstract:** Diseases are one of the most important factors in aquaculture. Recently, the usability of medicinal plants has been investigated due to the undesirable effects of methods such as vaccines and antibiotics used in the prevention or treatment of diseases. Therefore, in this study, we aimed to investigate the effects of aqueous methanolic extracts of coriander (*Coriandrum sativum*) seeds and grape (*Vitis vinifera*) seeds against *Vibrio anguillarum* and *Pseudomonas putida* pathogens using minimum inhibitory concentration (MIC). MIC values of coriander seed aqueous methanolic extract for *Vibrio anguillarum* were determined as 1600 µg/ml. Moreover, grape seed aqueous methanolic extract for *Vibrio anguillarum* were determined as 400 µg/ml. However, coriander did not show any activity against *Pseudomonas putida* in doses used. Also, grape did not show any activity against *Pseudomonas putida*. The results showed that aqueous methanolic extract of coriander seeds can be used against *Vibrio anguillarum* but grape seeds more usable. This in vitro study showed that both seeds extracts cannot be used against *Pseudomonas putida*. This study is important for future in vivo studies. Further in vivo studies should be performed to evaluate the usability of these herbs.

**Keywords:** Medicinal Plants, Aqueous Methanolic Extract, Antibacterial Activity, Minimum Inhibitory Concentration, *Coriandrum sativum*, *Vitis vinifera*, *Pseudomonas putida*, *Vibrio anguillarum*.

## 1. INTRODUCTION

Almost all of the terrestrial areas in the world are used for agricultural production. From this point of view, it is of great importance to use the existing capacities of sea and fresh waters for aquaculture production. Among the basic food sources, aquaculture and especially fish meet the basic food requirements of the body with both high protein content and polyunsaturated fatty acids. However, with its positive effect on biological and metabolic functions, it is one of the most essential foods to maintain a healthy life (Kaya, et al., 2004). The biological structure of the fish is the only thing that cannot be changed according to the developing conditions. Although technology, in particular, enables very intensive fish production (Bilen et al., 2015), it is inevitable that the immune system will weaken and fish will become more susceptible to diseases due to stress. Evaluation of the diseases that may occur and the losses that may occur due to them are perhaps one of the most important issues for the sector.

Various antibiotic and chemical applications are widely used in aquaculture for the treatment and prevention of diseases. However, the use of antibiotics in inappropriate dosages and continuous use, together with the development of antibiotic-resistant bacteria, causes environmental problems and problems that cannot be eliminated from the organism (Ringo et al., 2010). It is inevitable that the residues of antibiotics and various drugs used will have negative effects on human health. Although the use of vaccines is common, it should not be forgotten that the vaccine is only effective against the relevant pathogen. In addition, the vaccination process creates a problem in terms of cost and time, and it is thought that it reduces efficiency in terms of enterprises. In this context, vaccines have many disadvantages due to the disease agent specificity and difficulties in providing the most suitable conditions for the vaccine to be effective. Considering these disadvantages, it is not possible to control fish diseases only with vaccines.

Today, it is possible to minimize the diseases caused by environmental and artificial factors by adding various immunostimulants such as plant oil and plant extract to fish feeds. Medicinal and aromatic plants are used more in aquaculture because they are a more effective and inexpensive source for both treatment and combating bacterial diseases without causing less side effects and toxicity than other immunostimulants (Madhuri et al., 2012). However, herbal immunostimulants used in inappropriate concentrations can cause toxicity in fish.

The use of medicinal plants in fish diseases has recently become widespread. It is used in coriander and is also used in medicine. Coriander is a very old spice and has been highly valued in ancient times. Coriander is also used as a therapeutic agent (antimicrobial, antimutagenic, gastric mucosa protective) and as a fragrance in perfumery (Ulutaş et al., 2018). Nowadays, the coriander used in the construction and treatment of drugs in the field of medicine is a very useful plant species (Albayrak et al., 2020).

Different research showed the useful effects of grape seed extract including its anti-ulcer, anti-inflammatory and anti-microbial characteristics in some of animals and human (Amiot et al., 2016; Nowshehri et al., 2015; Nassiri-Asl and Hosseinzadeh, 2016; Nowshehri et al., 2015; Xia et al., 2010).

*Vibrio anguillarum* and *Pseudomonas putida*, known as bacterial pathogens, are ubiquitous pathogens that readily emerge in the appropriate environment and often infect both freshwater fishes and marine fishes.

*Vibrio anguillarum*, is the causative agent of vibriosis, a deadly haemorrhagic septicemic disease affecting various marine and fresh water fishes. In both aquaculture and larviculture, this disease is responsible for severe economic losses worldwide (Frans et al., 2021).

*Pseudomonas putida* is a Gram-negative, non-spore forming, straight or slightly curved rods bacterium. Typical clinical signs is ulceration on the dorsal surface of the fish.

Histologically, skin ulcer initially is characterized by sloughed off epithelia and epithelial necrosis. In the advanced form of the disease, almost all layers of the skin down to the epidermis is lost (Altinok et al., 2006).

In the current study, we researched to expose that in vitro the effects of aqueous methanolic extract of *Coriandrum sativum* and *Vitis vinifera* against fish pathogens of *Vibrio anguillarum* and *Pseudomonas putida*.

## 2. MATERIALS AND METHODS

### 2.1. Plants

Coriander (*Coriandrum sativum*) seeds and Grape (*Vitis vinifera*) seeds

The plants were purchased from herbalist in Kastamonu province. Aqueous methanolic extraction of the plants were performed as previously described (Bilen et al., 2016).

**Table 1.** The taxonomy of the coriander (*Coriandrum sativum*) and grape (*Vitis vinifera*) used in the study.

Scientific Name	Vernacular Name	Kingdom	Family	Order	Genus
<i>Coriandrum sativum</i>	Coriander	Plantae	Apiaceae	Apiales	Coriandrum
<i>Vitis vinifera</i>	Grape	Plantae	Vitaceae	Vitales	Vitis

### 2.2. Bacterial Strains

The plant extracts were tested against Gram negative bacteria, *Vibrio anguillarum* (SBVA1) and *Pseudomonas putida* (SBPP1) which are isolated from fish and identified using conventional and molecular methods.

### 2.3. Minimum Inhibitory Concentration (MIC) Determination with Broth Microdilution Method

Microdilution method, one of the Minimum Inhibition Concentration tests, was used in the study (CLSI, 2008). Pure cultures of *Pseudomonas putida* and *Vibrio anguillarum* bacteria were obtained from the laboratory of Faculty of Fisheries

of Kastamonu University. As a result of the study, it was aimed to stop the growth of *Pseudomonas putida* and *Vibrio anguillarum* bacteria in the methanolic extracts of coriander and grape seeds at certain concentrations. For this purpose, firstly 50 g. milled fenugreek seeds, 400 ml. methanol and 600 ml. distilled water was mixed. It was kept in a lightless environment for 48 hours. Afterwards, the methanol and distilled water of two different plant extracts was removed by evaporator. Then bacteria were prepared for microdilution method. Worked on 96-well plates and 150 µl strains per plate respectively at the concentrations of 3200 µg/ml<sup>-1</sup>, 1600 µg/ml<sup>-1</sup>, 800 µg/ml<sup>-1</sup>, 400 µg/ml<sup>-1</sup>, 200 µg/ml<sup>-1</sup>, 100 µg/ml<sup>-1</sup>, 50 µg/ml<sup>-1</sup>, 25 µg/ml<sup>-1</sup>, plant extracts and 3 µl of bacterium each well was added to the prepared wells. In addition, only the medium (broth) and 3 µl of the bacteria were added for the viability test of the bacteria in different wells (positive control) and only a mixture of nutrient and methanolic extract was added to see if the medium was contaminating during work (negative control). Each bacterium and all concentrations were studied in triplicate. The lid of the plate was closed and wrapped around with parafilm. The plate was then placed in the oven. It was kept at 25°C for 48 hours.

### 3. RESULTS

The results of the study were given in Table 2.

**Table 2.** Antimicrobial activity of aqueous methanolic extracts of the coriander (*Coriandrum sativum*) and grape (*Vitis vinifera*) used in the study.

Plant	<i>Vibrio anguillarum</i>	<i>Pseudomonas putida</i>
<i>Coriandrum sativum</i>	1600 µg/ml <sup>-1</sup>	-----
<i>Vitis vinifera</i>	400 µg/ml <sup>-1</sup>	-----

The MIC value of coriander aqueous methanolic extract at 1600 µg/ml<sup>-1</sup> showed the activity against *Vibrio anguillarum*. Moreover the MIC value of grape aqueous methanolic extract at 400 µg/ml<sup>-1</sup> showed the activity against *Vibrio anguillarum*. But both coriander and grape seeds extracts exhibited no activity against *Pseudomonas putida*.

These results showed us that the methanolic extract of coriander seed can be used at concentrations of 3200 µg/ml<sup>-1</sup>, 1600 µg/ml<sup>-1</sup> against *Vibrio anguillarum*. However, in our study, we demonstrated that the use of coriander seed methanolic extract at concentrations below 1600 µg/ml<sup>-1</sup> was not effective against *Vibrio anguillarum*. Moreover the methanolic extract of grape seed can be used at concentrations of 3200 µg/ml<sup>-1</sup>, 1600 µg/ml<sup>-1</sup>, 800 µg/ml<sup>-1</sup>, 400 µg/ml<sup>-1</sup> against *Vibrio anguillarum*. But we determined that the use of grape seed methanolic extract at concentrations below 400 µg/ml<sup>-1</sup> was not effective against *Vibrio anguillarum*.

### 4. DISCUSSION

Many medicinal plants have many different chemical composition and substance and novel mechanism of the plants haven't been proved yet. This study effectiveness of the coriander and grape seeds was demonstrated against *Pseudomonas putida* and *Vibrio anguillarum*.

Karga et al. (2020) at their work, aimed to investigate the effects of aqueous methanolic extracts of two different medicinal plants (*Laurus nobilis* and *Brassica nigra*) against *Vibrio anguillarum*, *Yersinia ruckeri*, *Pseudomonas putida*, and *Aeromonas hydrophila* by using minimum inhibitory concentration (MIC). They reported that MIC values of leaf aqueous methanolic extract of *Laurus nobilis* for *Aeromonas hydrophila* and leaf aqueous methanolic extract of *Brassica nigra* for *Vibrio anguillarum* were determined as 3.125 µg/ml<sup>-1</sup> and 100 µg/ml<sup>-1</sup>, respectively. However, similar to our study, the effectiveness of both medicinal plants against *Pseudomonas putida* could not be determined.

Effects of *Coriandrum sativum* immune responses and resistance of rainbow trout (*Oncorhynchus mykiss*) against *Yersinia ruckeri* was evaluated by Farsani et al. (2019). Significant improvement of lysozyme and alternative complement activity, were observed in 2% of CSE treatment (P < 0.05). After eight weeks post-feeding, 30 fish from each treatment were challenged with *Yersinia ruckeri* for 14 days. The results that fish fed with CES, especially 2% of CSE inclusion, improved survival rate of rainbow trout against *Y. ruckeri*; also, there were no significant differences between

control and treatment groups at the end of the eight weeks feeding with coriander seed extract. The present research showed that dietary incorporation of coriander extract can improve growth factors, immunological indices and resistance of rainbow trout against *Yersinia ruckeri* infection.

Mousavi et al. (2021) researched that mucosal immune parameters of rainbow trout after dietary administration of grape (*Vitis vinifera*) seed extract. The results showed that Feeding fish with low dose of GSE (100 mg kg<sup>-1</sup>) up-regulated the expression of some immune-relevant genes, lysozyme (Lys), interferon gamma (IFN- $\gamma$ ), and tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ) in different mucosal tissues. However, feeding fish the high dose of GSE (200 mg kg<sup>-1</sup>) mostly enhanced expression of these genes in the skin. Besides, skin mucus of fish fed GSE showed bactericidal activity against *Yersinia ruckeri*. It was concluded that GSE, especially at 100 mg kg<sup>-1</sup>, modulates the growth performance and mucosal immunity of rainbow trout.

The results of present study showed that aqueous methanolic extracts of fenugreek seeds at under 400  $\mu\text{g/ml}^{-1}$  concentrations were not effected on the production of *Vibrio anguillarum*. However, it was not effective at any concentration used against *Pseudomonas putida*.

## 5. CONCLUSION

According to the results of microdilution method analysis, coriander seeds aqueous methanolic extract can be used at a concentration of 1600  $\mu\text{g/ml}^{-1}$  for *Vibrio anguillarum* in vitro. Moreover, grape seed aqueous methanolic extract for *Vibrio anguillarum* were determined as 400  $\mu\text{g/ml}$ . However, each extracts did not show any activity against *Pseudomonas putida* in doses used. However, it reveals that the selection of plants for herbal therapy is complex and may depend on many in vivo criteria and should not be ignored. This study will be guide future studies on fish biology in vivo.

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## ORAL PRESENTATION

### Artificial Intelligence Applications in Field Crops Research and Cultivation: Benefits and Drawbacks

**Mustafa SÜRMEN<sup>✉</sup>, Emre KARA**

*Aydın Adnan Menderes University, Faculty of Agriculture, Aydın, Türkiye*

<sup>✉</sup>**Correspondence:** mustafa.surmen@adu.edu.tr

**Abstract:** Field crops have a lot of potential applications that artificial intelligence (AI) is opening up. These innovations have the potential to significantly boost agricultural productivity, promote sustainability, and enhance the quality of agricultural output. Different AI learning platforms can be used to learn a lot about field crop cultivation and research, production strategy and modeling. Artificial intelligence is a great help in soil analysis and data processing. Using sensors and satellite data, it provides access to soil properties, moisture levels, plant health and other important information. This data helps farmers make accurate and timely decisions. By analyzing this data, AI algorithms determine plant needs and enable more efficient use of resources such as fertilizers and irrigation. Thanks to image processing techniques, it may also identify pests and plant illnesses. Field crops are monitored for health by specialized cameras and artificial intelligence software, which also detects probable issues early on to enable prompt management. This lessens the need for chemical intervention and supports sustainable farming methods. Machine learning algorithms can also be used to predict the impacts of climate change. In this way, farmers can develop strategies to adapt to future weather conditions. Furthermore, AI systems integrated into automated tractors and other agricultural machinery automate farming operations and save manpower. The use of artificial intelligence applications in field crops brings with it some important risks. First, there is the risk of data security and privacy. It is imperative to protect personal or commercial information during the collection and analysis of agricultural data, otherwise there is a risk that this information could be compromised by malicious actors or subjected to cyber-attacks. Second, the risk of technology dependency needs to be considered. Over-reliance on AI technologies may lead farmers to subordinate their own experience and knowledge. Third, there is the risk of access to technology. The cost of AI applications can be high and this may limit access to these technologies for small or resource-limited farmers. Consequently, the use of AI applications in field crops requires being aware of and managing these risks. Informed policy adjustments and safety measures can help minimize these risks and contribute to the successful integration of AI technologies in the agricultural sector.

**Keywords:** Artificial Intelligence, Field Crops, Sensors, Applications.

## 1. INTRODUCTION

While agriculture used to shape production by providing raw materials to industry, with the impact of steam power, industry has started to shape agricultural production along with the entire production sector. It is possible to divide the development of the industrial sector into four stages. Accordingly, the introduction of steam-powered machines in the late 1800s is called industry 1.0, the transition to mass production with electrical energy in the early 1900s is called industry 2.0, the spread of automation thanks to electronic and information technologies since the 1970s is called industry 3.0, and finally, the widespread use of the internet and digital data processing since the early 2000s and the introduction of cyber physical systems in industry is called industry 4.0 (Numanoğlu & Eynehan, 2016).

The first period, called Agriculture 1.0, in which agriculture was carried out in a labor-intensive way using simple hand tools and animal power without much change throughout history, started in the late 1950s, when synthetic pesticides, fertilizers and self-propelled machines started to be used as a reflection of industrial developments and the Agriculture 2.0 period, which is described as the Green Revolution, began.



By the 1990s, with the use of GPS technology, the agriculture 3.0 era began, and precision agriculture, which is based on monitoring agricultural areas and considering the environment in the use of inputs, gained importance with the use of technologies that allow manual guidance thanks to GPS and VRA (Variable Rate Application) systems applied to harvesting machines, especially allowing fertilization processes to be monitored. Again, with the development process in the industry, the agriculture 4.0 era started in the 2010s with the introduction of smart technologies such as sensors, sensors, microprocessors, autonomous decision systems, cloud-based information and communication technologies in agriculture. The use of digital technologies in agriculture is referred to in different ways such as "Agriculture 4.0", "Smart Agriculture", "Digital Agriculture" (Saygılı et al., 2019).

## 2. TECHNOLOGIES USED IN AGRICULTURE

### 2.1. Wireless Communication Technologies

Wireless communication can be defined as the transfer of information between two points or over a network of more points without any wired conductor. Wireless communication, which is realized worldwide by satellite, is realized in smaller areas with technologies such as Bluetooth and Wi-Fi.

Wireless networks form wireless network technology by providing communication with sensors used in agriculture to determine the characteristics of climate, soil and plants and machine performance. Although wired sensor networks offer a secure and robust communication opportunity, wireless sensors are preferred considering the difficulty of using cables in field conditions and the disruption of data transmission due to cable breaks. In addition, the use of wireless sensor networks provides advantages such as higher data transmission speed, the ability to obtain data from moving systems, the ability to transmit the obtained data to remote computers and low cost (Ünal & Topakçı, 2013).

### 2.2. Internet of Things (IoT)

The concept of the Internet of Things describes the network between smart objects and sensors and is also referred to as IoT because it is referred to as "Internet of Things" in English (Öztaş Karlı, 2020). This system allows each of the objects to interact with each other and cooperate with smart components in the environment to serve a common purpose through their IP addresses (Akben & Avşar, 2018), and as a result, it is possible to receive, monitor and analyze data from anywhere at any time (Öztaş Karlı, 2020).

The ability of IoT technology to track and analyze the state of the physical environment and other objects, and to offer flexible solutions by connecting to a computer in the cloud over a wireless network, and thus to be used in data-driven smart agriculture applications (Dayıoğlu et al., 2016) has many benefits for agriculture. Gómez-Chabla et al. (2019), as a result of their literature review on the use of Internet of Things technologies in agriculture, found that the benefits of using this technology in agriculture are as follows;

- Community agriculture in urban and rural areas by utilizing hardware and software resources and large amounts of data,
- Traceability of food production, enabling the use of real-time data for decision-making, reducing costs and input waste,
- Creating business models that allow a direct relationship between producer and consumer,
- Enabling cost reduction through product monitoring and the prevention of theft,
- Automatic irrigation systems that work according to the temperature, air and soil moisture values obtained by sensors,
- Automatic collection of environmental parameters through the use of sensor networks for further processing and analysis,
- Decision support systems that analyze large amounts of data to increase operational efficiency and productivity.

### 2.3. Big Data and Data Mining

The meaning of data in information technology terminology can be defined as bits or knowns that are recorded, stored, processed or transported in digital media, but do not have a meaning on their own and have not been organized and

transformed into meaning. Thanks to the developments in computer and internet technologies, the data collected is more diverse, more abundant and faster constitutes big data (Küşbeci, 2021).

In order to analyze big data, it must first be organized and filtered and then made meaningful by supporting it with tables and graphics. By analyzing and making sense of big data in a good way, businesses have the chance to implement smart management strategies. For this, it is important for businesses to create a well-defined data management strategy. Big data cannot be processed successfully by an average database software tool due to its large size, complex structure and wide ranges (Akben & Avşar, 2018).

The process of converting raw big data into more meaningful information by completing missing data, eliminating repetitions, preprocessing with transformation, integration, dimension reduction, etc., and then interpreting it by establishing data mining models is called data mining (Sandıkçı & Aydılek, 2018). Data mining models can be categorized into three groups: classification and regression, clustering and association rules (Okur, 2015).

Big data tools in agriculture are used in precision agriculture to maximize productivity as data need to be collected, analyzed and processed. Global Positioning System (GPS), Geographic Information System (GIS) and Variable Ratio Technology (VRA) are among the technologies used in precision agriculture and based on big data. In smart agriculture, relationships between functions, variables and concepts are made sense of through big data analytics applications such as agricultural value chain and business processes (Sandeepanle, 2020).

#### 2.4. Artificial Intelligence

Artificial intelligence can be defined as the technology that determines the structure in which the existing data is formed in the best way with the help of various algorithms and predicts the most likely results by evaluating the results that may arise due to this structure together with the data that continues to come. In particular, humanoid robot technologies have accelerated the studies on artificial intelligence and artificial neural networks, and artificial neural networks were developed by being inspired by neural networks in living things (Öztürk & Şahin, 2018). Accordingly, computers first go through a learning process and then react to the situations they encounter with what they have learned (Batal, 2016).

The use of artificial intelligence in agriculture together with modeling and simulation techniques, real-time information generation, automated expert systems, autonomous tractors and robotic applications have been developed and used in the agricultural sector (Özgüven, 2018).

#### 2.5. Unmanned Aerial Vehicles (UAV)

Drones or UAVs are vehicles that can stay in the air under the influence of aerodynamic forces and can be controlled from the ground or pre-programmed by the user and are used in processes such as crop and land mapping, detection of plant diseases and pests, water stress, fertilization planning, agricultural spraying, yield and maturity predictions in agriculture. In addition, in the study carried out to investigate the possibilities of using unmanned aerial vehicles in pollination, it was determined that the developed unmanned aerial vehicle weighing 15 g can fertilize flowers without damaging the plant, and systems that can pollinate plants with automatic pilot are being studied (Aslan et al., 2022).

### 3. CONCLUSION

In a developing and changing world, digitalization is becoming indispensable for potential yield increases, optimization and cyber security in the agricultural sector, as well as for safe and sustainable agriculture. Many different devices and smart applications have been developed for this purpose. Although these applications have many advantages, they also have disadvantages. Being open to and keeping up with technological developments in a way to minimize these disadvantages will pave the way for sustainable and developable agriculture.

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## ORAL PRESENTATION

### Determination of Effective Improvement Methods on Common Rush (*Juncus effusus* L.) Invaded Floodplain Grassland in the Middle Black Sea Region

**Mustafa SÜRMEN<sup>1✉</sup>, Ali KOÇ<sup>2</sup>**

<sup>1</sup>Aydın Adnan Menderes University, Faculty of Agriculture, Aydın, Türkiye

<sup>2</sup>Eskişehir Osmangazi University, Faculty of Agriculture, Eskişehir, Türkiye

✉Correspondence: mustafa.surmen@adu.edu.tr

**Abstract:** The study was conducted in floodplain grassland invaded by *Juncus effusus* L. for three years (between 2007 and 2009) in Fener Village of Bafra District in Samsun. In the research, it was focused on the applications of control, mowing (M), burning (B), fertilization (F), herbicide (H) and rotary tiller (R) applications alone and their binary and ternary combinations. Botanical composition concerning weights were examined. According to botanical compositions concerning weights of plant species, grasses ranged from 24,40 to 46,57%, legumes varied between 19,56 and 53,32% and plant species belonging to other families changed between 19.08 and 56.89%. Botanical composition rates of *Juncus effusus* L. were between 5,17-6,40%. In the application of H+C+B and C+B+R, legume rates increased, however grass and other families decreased. According to obtained results, it was found that H+R ve C+B+R applications were effective on the pasture in the experimental area and similar ecologies invaded by *Juncus effusus* L., and monitoring plant species was very significant.

**Keywords:** Floodplain, Improvement, *Juncus effusus* L., Botanical Composition, Blacksea Region.

## 1. INTRODUCTION

The basic condition for meeting the increasing nutritional needs of the world population is to increase the production in tillage and natural (meadow-pasture) agricultural areas and to ensure its continuity. Failure to increase agricultural production in parallel with population growth leads to the problem of hunger. Since there is not much land left for agriculture in the world, the only way to solve this problem is to increase the yield obtained from unit area. Because plants are the only element that can transform the physical energy of the sun into chemical energy and thus provide the opportunity for the life of living organisms that are fed.

Animal products have a special place in meeting the important needs of human beings such as nutrition and clothing. Forage crops grown in agricultural areas and meadow and pasture areas are the main resources that provide raw materials for animal production. Pasture areas are of great importance because they produce twice as much energy as agricultural areas in the world (Laurenruoth 1979). Pastures not only provide fodder for animals, but also undertake various functions such as soil and water conservation, protection, and beautification of nature.

The total area of meadow pasture in Turkey is 21.745.700 ha, 974.300 ha of which is located in the Black Sea Region. The total surface area of 11 provinces in the Black Sea Region is 6.875.700 ha, of which 14,2% (974.300 ha) consists of meadow pasture and highland areas (Anonymous 1980). These values show that the region has an important potential in terms of animal husbandry. However, in most of the meadow and pasture areas of the region, the productivity has decreased significantly due to poor management. In some of these areas, there are few good quality plant species, and the majority of the vegetation cover consists of weeds, shrubs, thorny or poisonous species that are not preferred by animals. Although the cover is good especially in the coastal belt grasslands where rainfall is intense, species belonging to the genus *Juncus* have become dominant due to heavy grazing, making the use of these areas almost impossible.

Bottom pastures are grazing areas located between meadow and pasture vegetation, in other words, they are grazing areas consisting of a mixture of meadow and pasture vegetation. In these areas, which are mostly close to settlements, grazing

starts very early in spring and ends very late in autumn and heavy grazing continues, causing severe destruction of vegetation covers.

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In the Black Sea Region, as in Turkey in general, a large part of the roughage need of animals is provided from meadows and pastures. Because the amount of land that can be allocated for fodder crops production is very small in the region where land suitable for agriculture is limited. For this reason, closing the roughage deficit, which is an important problem, can be possible to a great extent by improving meadows and pastures.

Annual wheatgrasses and salinity and alkalinity tolerant weeds are dominant in grassland vegetation (Koç et al. 2005). Since these plants generally grow earlier and faster than other species, they create pressure on quality forage crops. In this case, the pressure on quality forage crops can be reduced by early mowing.

Alien plants in natural meadow pasture areas are plants that are harmful to the health of animals, negatively affect the quality of animal products, prevent the efficient use of the environment and make it difficult to implement management plans (Altın et al. 2005). The control of alien plants in pastures is based on the principle of removing unwanted species from the vegetation and replacing them with desirable species or developing them. As a matter of fact, in a study conducted in Erzurum, Gökkuş and Koç (1995) reported that the rate of desirable wheatgrass increased as a result of reducing the weed rate in the meadow by using selective herbicides. Removing the weeds and increasing the grazing species increases the utilisable grass ratio in the pasture. Thus, more live weight gain is obtained in grazing animals (Everett and Sharrow 1985).

Plants that are harmful to animal health, animal products and the environment can also be combated by burning. Fire has been a very important factor in the formation and development of plant and animal communities in many places because it burns away the organic matter in the environment and affects all living things in the ecosystem with the high heat generated. For this reason, many scientists have argued that fires are the main factor in the formation of pastures (Altın et al. 2005). Pasture burning has been used to provide better fodder for animals or to encourage the presence of certain plants that are food sources for humans (Gliessman 2000). Burning is the oldest known breeding method, especially in the regulation of grazing areas. At the same time, this method provides a great advantage in the control of shrub species, which are relatively difficult, time-consuming, and expensive to control with other methods (Altın et al. 2005).

One of the most effective control methods applied in pastures for breeding is mechanical control. Today, this method, which is generally done by using tools and machines, is not very common in our country. For this reason, tillage tools such as milling cutter, subsoiler, disc harrow and harrow are used by utilising the tractor tractive power. Especially milling cutter is used in the control of undesirable species of vegetatively growing stolon, rhizome, and tangled pasture plants. With the milling cutter, both these species can be destroyed by disintegration and the compaction in the root zone of the plant is eliminated by aerating the soil.

Fertilisation, which is an important application among the breeding methods, makes it possible to change the vegetation composition of meadows and pastures in the desired direction provided that the type and amount of fertiliser are well adjusted (Altın 1975). In terms of pastures, fertilisation is not only a production input but also an indispensable maintenance and breeding method. Because, with a correct and regular fertilisation, on the one hand, grass productivity can be increased and on the other hand, the quality of the grass obtained can be improved by increasing the proportion of quality plants in the botanical composition (Aydın and Uzun 2000). As a matter of fact, in fertilisation studies conducted in our country, it was noted that pastures responded well to nitrogen fertilisers and therefore fertilisation in pastures may be an alternative way to increase productivity (Altın 1975; Büyükbırç et al. 1989; Koç et al. 2003a).

The number of studies on the improvement of pasture areas both in our country and in our region is quite limited. In order to increase the yield and quality of pasture areas, it is necessary to determine the most appropriate and economical



breeding methods. In this study, the effects of mowing, herbicide, burning, milling and fertilisation processes and appropriate combinations of these processes were investigated by considering the pasture vegetation. In the study, it was aimed to increase the yield and quality of the pasture by determining the most appropriate control method against the species belonging to the genus *Juncus*, which is the priority problem of the grassland areas.

## 2. MATERIALS AND METHODS

### 2.1. Material

The research was carried out in the natural pasture of Fener Village in Bafra district of Samsun province. The research area is located at the coordinates 41° 41' 41.31" north 35° 53' 87.91" east. The area where the research was conducted is a grassland in the Bafra Plain at an altitude of 1 m above sea level. As a result of the poor utilisation of the pasture in the region, *Juncus* species are concentrated in the vegetation. In the vegetation cover, different plant species are encountered, especially alfalfa (*Medicago*) and clover (*Trifolium*) species and trefoil (*Lotus corniculatus*) from legumes, and Bermuda grass (*Cynodon dactylon*), perennial grass (*Lolium perenne*) and foxtail (*Alopecurus myosuroides*) species from wheatgrass. The research area is surrounded by three rows of barbed wire. The barbed wires were pulled at 40 cm intervals on wooden stakes planted at 5 m intervals.

Triple super phosphate and ammonium sulphate fertilisers were used as fertiliser sources. Total herbicide with glyphosate active ingredient was used as herbicide. In the burning application, each plot was sprayed with diesel oil using a ridge sprayer and then burnt. In the plots where milling was applied, a milling cutter powered by the tail shaft of the tractor was used. Chain mower was used for mowing.

### 2.2. General Characteristics of the Research Area

The research was carried out in the grasslands in the Kızılırmak delta between 2007 and 2009. Bafra district of Samsun province, where the research was conducted, is located in the Central Black Sea Region in the north of our country. Bafra district of Samsun province has an average annual average temperature of 13,5°C for many years and 791.2 mm of total annual precipitation falls. If we generalise the climatic characteristics of the research area, there is a humid period from January to July, a dry period from July to September and a humid period after September. However, since the research area does not show much dependence on annual precipitation due to ground water, it does not have a serious problem in terms of water. However, the increasing temperature from May onwards causes heat stress until October.

When the soil properties taken from 0-30 cm depth of the research area were analysed; it was determined that it had clayey texture, strongly alkaline (8,50), calcareous (2,80 kg/da) and salt-free (0,33%) in terms of pH. It was determined that the organic matter ratio was at medium level with 2,85%, the amount of plant available phosphorus (3,40 kg P<sub>2</sub>O<sub>5</sub>/da) was insufficient and the amount of plant available potassium (45,9 kg K<sub>2</sub>O/da) was in the sufficient class (Sezen 1991).

### 2.3. Method

A total of 20 treatments consisting of plain, double and triple combinations of mowing, herbicide, burning and ferze treatments were applied in addition to the control treatment in the base pasture area where the research was conducted. The experiment was established according to randomised blocks design with 4 replications. The area of a plot was planned as 4x5 m=20 m<sup>2</sup>, the distance between the plots was 1,5 m and the distance between the blocks was 6 m.

Mowing was carried out during the budding or first flowering period when the reserve nutrients in the storage organs were at the lowest level (Altın 1992; Altın et al. 2005). This application was repeated every year. For weed control, mowing was carried out twice a year, on 22.03.2007 at the beginning of growth and on 06.07.2007 during the summer period. Brand chain mower powered by the PTO of the tractor was used for mowing.

Herbicide was applied with a back sprayer on 11.04.2007 in the first year, and the changes in botanical composition were monitored in the following years. For this purpose, 1000 ml/da total herbicide with glyphosate active ingredient was applied. The herbicide was applied when the plants had 3-5 leaves. Because the best results are obtained with herbicide application when weeds are at their weakest (Gökkuş and Koç 1996a).



Burning in the pasture was carried out on 03.09.2007 after spraying diesel oil with a back sprayer in the plots determined in advance according to the plan of the experiment. For each plot (20 m<sup>2</sup>), 0.6 litres of diesel oil was used.

In fertilisation, 5,2 kg P<sub>2</sub>O<sub>5</sub> and 18 kg nitrogen were applied per decare according to the results of soil analyses performed before the experiment. Ammonium sulphate was used as nitrogen fertiliser and triple super phosphate commercial forms were used for phosphorus source. Phosphorus fertiliser was applied once in autumn on 31.10.2007 and nitrogen fertiliser was applied in early spring on 11.04.2007, 11.03.2008 and 16.03.2009.

Milling application was carried out on 01.06.2007, when the soil was at the levelling stage. In this application, the milling cutter powered by the tail shaft of the tractor was used.

It was determined based on the ratio of species to plant composition by weight. For this purpose, in order to find the dry matter yield, the harvested frames were separated into species, dried and weighed. The weight of each species was found by proportioning the weight of each species to the total weight (Gökkuş et al. 2000).

For the comparison of the values calculated from 20 different treatments in the study, after applying angle transformation to the proportional values, analysis of variance of the years individually according to the complete blocks experimental design with chance in the SPSS (1999) package programme, then the combined analysis of the years was applied in the same experimental design according to the time-divided plots arrangement recommended for perennial plants. Duncan Multiple Comparison Test was used to compare the means (Yıldız and Bircan 1994).

### 3. RESULTS AND DISCUSSION

#### 3.1. Botanical Composition

In order to reveal the effects of the applied breeding methods on the vegetation cover of the grassland, botanical composition analysis was carried out on the basis of plant groups (grasses, legumes, other families and the main problem *Juncus effusus* L.) by weight.

In the two-year averages, it was determined that the difference between the treatments on wheatgrass ratios was statistically very significant ( $p<0,01$ ). According to the two-year average, the highest wheatgrass ratio (46,57%) was determined in the B+R treatment, while the lowest ratio (24,40%) was determined in the burning treatment. Some double and triple combinations including control, mowing and milling, burning and mowing were in the same group. As a result of the high number of treatments in the multiple comparison test, there were many means that were similar to each other (Table 1).

Although not statistically significant in the combined analysis of the years, there was a significant increase in the wheatgrass ratio in the mowing, M+F, H+M, M+B, B+F, B+R, F+M+B treatments compared to the control. As a result of the fact that these treatments generally controlled *Juncus effusus* L. more effectively, an increase in wheatgrass occurred with the decrease in competition. As a matter of fact, it has been revealed in many studies that wheatgrass increased in the plant by controlling weeds (Gökkuş and Koç 1995; Aydın and Uzun 2000; Koç et al 2005).

In the first year results of the experiment, mowing, burning, B+R, F+M+F and some other treatments caused an increase in the proportion of wheatgrass compared to the control plots. This situation was caused by the rapid decrease in *Juncus effusus* L. ratio depending on the treatments. In the results of the studies carried out in our country, it was emphasised that the proportion of cereals in the vegetation cover of the pasture was between 24,40-46,57% (Tosun and Aydın 1990; Gökkuş and Koç 1995; Aydın and Uzun 2000; Akdeniz et al 2003; Çomaklı et al 2005; Mut 2009).

In the research area, the highest legume rate was recorded in the plots where M+B+R treatment was applied with 53,32%, while the lowest legume rate was recorded in the plots where bare burning was applied with 13,68%. Mowing, herbicide and burning treatments were statistically similar to the control in terms of legume rate. However, a significant increase in the legume rate was observed in the treatments including milling and especially milling. The legume ratio, which was 29,02% according to the two-year average, showed a very significant change over the years (Table 1).

The significant increase in the legume ratio in the plots where milling was applied in the study may have resulted from the fact that the milling loosened and mixed the soil and encouraged the germination of the seeds of the annual *Trifolium resupinatum* plant, which is common in the field. Because there is a significant increase in annual plants in loosened soils (Roux and Warren 1963; Bazzaz 1968; Gökkuş 1984; Bakır 1985; Gökkuş and Koç 1996b). On the other hand, since double and triple fertilisation treatments encouraged wheatgrasses, the rate of legumes in the botanical composition was lower than the other treatments. Similar results were obtained by Altın (1975), Gökkuş (1990), Aydın and Uzun (2008).

According to the average of the years, the rates of other families in the pasture plots showed a statistically significant difference ( $p < 0,01$ ). In the average of the years, the highest proportion of other families was determined in the burning treatment (56,89%) similar to the second year of the experiment, while the lowest proportion was obtained from the Mowing + Burning + Mowing treatment with 19,08%. The average proportion of plants belonging to other families was 33,05% (Table 1). Species belonging to other families are generally considered as weeds in terms of pasture management. For this reason, practices to reduce their ratios in pasture are frequently applied. According to the two-year results obtained from this study, burning alone did not cause a decrease in the proportion of species belonging to other families in the pasture, but a significant decrease was observed in double and triple combinations and in treatments involving milling.

**Table 1.** Proportions (%) of wheatgrass, legume, other families and juncus in the plant composition of grass pastures treated with different breeding methods.

Treatments	Grass**		Legume**		Other families**		Juncus**
Control (C)	33,43	A-E	19,56	B-G	36,50	A-C	44,22 A-C
Mowing (M)	38,47	A-E	24,06	D-G	35,61	A-C	31,61 B-E
Herbicide (H)	26,38	C-F	26,42	B-G	35,78	A-C	40,08 A-C
Burning (B)	24,40	F	13,68	G	56,89	A	60,40 A
Rotary tiller (R)	34,54	A-E	32,62	A-D	34,71	B-D	28,15 D-F
M+F	36,36	A-E	17,67	B-G	42,22	AB	40,71 A-C
H+M	45,93	AB	38,07	A-D	21,18	C-E	5,17 H
M+R	30,87	A-F	35,54	AB	34,90	A-C	29,68 B-E
M+B	39,72	A-C	31,59	A-E	28,68	A-D	25,35 C-F
B+F	44,60	AB	17,04	B-G	29,24	B-E	32,48 A-D
H+B	35,04	A-E	27,84	B-F	30,38	A-D	32,94 B-E
H+R	29,44	B-F	43,38	AB	25,90	D-E	16,21 FG
B+R	46,57	A	24,20	B-G	33,16	A-C	22,08 EF
F+H+M	38,67	A-D	26,66	B-G	34,67	A-C	29,90 B-E
F+M+B	40,84	A-E	33,47	C-G	24,32	B-E	16,93 FG
F+M+R	31,26	A-F	22,04	E-G	40,82	A-C	41,66 B-E
H+M+R	28,75	B-F	29,84	B-F	33,83	A-D	40,11 A-C
H+M+B	30,84	E-F	42,80	A-C	20,54	C-E	20,43 D-F
M+B+R	32,11	B-F	53,32	A	19,08	E	9,03 GH
F+H+B	24,84	D-F	20,55	F-G	42,52	AB	49,50 AB
Mean	34,65		29,02		33,05		30,83

\*\* The difference between means indicated by different letters is significant at 1%. F=Fertilization

The most significant effect of the treatments was observed in the increase in legumes. This was due to the spread of Anatolian clover, which was found intensively in the field. It is an expected result that an annual species is widely spread in the first stages of succession (Gökkuş and Koç 1996b; Gökkuş and Koç 2001; Holeček et al. 2004). The prevalence of Anatolian clover in seed stocks and the development of annuals caused a decrease in other perennial plants. Practices

such as herbicide, milling and fertilisation (Ayan 1997; Aydin and Uzun 2005; Bayram 2005; Mut 2009) and their combined application were effective in this regard.

According to the two-year average values, the highest *J. effusus* L. rate (60,40%) was recorded in the burned plots and the lowest *J. effusus* L. rate (5,17%) was recorded in the plots where herbicide and mowing were applied together. However, M+B+R treatment was also in the group with the lowest *J. effusus* L. rate. The results obtained show that burning alone encourages the spread of this plant in areas where *Juncus effusus* L. is a problem, and other treatments except mowing are not very effective. Especially H+M, H+R, F+M+B and M+B+R treatments were more effective in controlling *Juncus effusus* L. In these treatments, a significant decrease was observed in the rate of *Juncus effusus* L. in the plots in the second year compared to the first year (Table 1). This situation can be perceived as an indicator of the effectiveness of the treatments.

Co-applications may be more effective in the control of *Juncus effusus* L. Indeed, Rana and Seller (2009) emphasised that 2,4-D application after mowing gave good results in Florida grassland. Similarly, McCorry and Renou (2003) noted the effectiveness of a combination of drainage, mowing and herbicide applications instead of applying them alone.

In this study, it was observed that burning increased the rate of *Juncus effusus* L. In a similar study, Stevens (2010) reported that burning encouraged the spread of *Juncus effusus* L. This statement helps us to explain why *Juncus effusus* L. increased in the field after burning. When the results are evaluated as a whole, it is possible to state that H+M+R and H+R applications will be effective in the control of *Juncus effusus* L.

#### 4. CONCLUSION

In this study, the effects of 20 different treatments, including the control, on the vegetation cover of a coastal grassland infested with *Juncus effusus* L. were evaluated. Effective control of *Juncus effusus* L. was achieved in the majority of the treatments. However, it would be beneficial to select the treatment or treatments that provide effective control and cause the least damage to the environment. From this point of view, it is possible to summarise the results obtained and the appropriate breeding method recommendations based on these results as follows.

In general, breeding practices had a decreasing effect on dry matter yield in pasture. The decrease in herbage yield as a result of weed control is an expected situation and this situation has been demonstrated in many previous studies.

When the proportion of wheatgrass in the species composition was considered, B+F and F+H+M treatments came to the forefront in the second year of the experiment. However, the share of these treatments in the control of *Juncus effusus* L. seems to be weak.

Legume ratio had the highest value in M+B+R treatment. Especially in the second year, very high values were reached in H+M, H+M+B and M+B+R treatments. However, legumes, of which Anatolian clover, which is basically an annual legume species, constitutes the majority, appear as the pioneer plants of secondary succession in the years following the application of breeding methods.

The proportion of other family plants decreased significantly in the pasture in the second year. This situation can be perceived as the effectiveness of the applied breeding methods. Especially H+M, H+R and M+B+R treatments were very effective. However, H+M application was not as effective as the other two in controlling *Juncus effusus* L.

H+M, M+R, H+R and M+B+R treatments played an effective role in the reduction of *Juncus effusus* L. in the plant. Similarly, H+M, H+R and M+B+R treatments were more effective in decreasing the rate of *Juncus effusus* L. and weeds belonging to other families.

Since *Juncus effusus* L. is the main problem in this type of pastures, it is necessary to focus on the methods that effectively control *Juncus effusus* L. rather than the pasture condition and to put forward new applications that give results in favour of the desired plants during the recovery period. In summary, it should be emphasised that it would not be accurate to decide on the breeding method according to dry matter yield, botanical composition and other quality factors by ignoring the control of *Juncus effusus* L. From this point of view, it can be stated that H+R (by applying total herbicide with

glyphosate effective substance locally in spring, followed by milling in the period when tillage is suitable) and M+B+R (by milling in the period when tillage is suitable after controlled burning application following mowing in spring) applications will be effective in the improvement of kofa (*Juncus effusus* L.) problematic grasslands in the region. In addition to this, it is useful to continue measurements and observations and to develop other alternative breeding techniques for the problems that may occur again in the vegetation cover.

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## ORAL PRESENTATION

### The Impact of Dynamic Meteorological Conditions in the ATU Gagauzia on the Growth and Development of Grapevines

**Serghei CARA**✉

*Comrat State University, Agro-Technological Faculty, Moldova*

✉ **Correspondence:** sergey.kara@kdu.md

**Abstract:** The southern natural-climatic zone of the Republic of Moldova, where ATU Gagauzia is located, offers the most favourable conditions for cultivating grape varieties with various utilization directions of the harvest. This includes the production of high-quality wines, brandies, and juices, as well as for consumption in fresh or dried form. Grapevines are adaptable plants, but at the same time, they are highly responsive to changes in environmental factors and cultivation techniques. In this regard, our task was to analyze the dynamics of changing meteorological conditions in the ATU Gagauzia and their impact on the growth and yield of grapevines. Temperature and precipitation are environmental factors that influence the development and growth of plants and the quantity and quality of the harvest. The closer these factors align with the requirements of the grapevine at different stages of its development, the better the growth of all its organs will proceed, ultimately resulting in higher crop yields and grape quality. We have analyzed meteorological conditions from 2003 to 2022. It was revealed that the climate in ATU Gagauzia is warm, with temperatures of 10°C and above lasting for 179-187 days, significantly longer than in other parts of the Republic of Moldova. The sum of active temperatures is 3300°C. The annual amount of atmospheric precipitation varies from 258,9 mm (in 2022) to 569.3 mm (in 2016). It is noted that meteorological conditions in recent years of the study have changed towards an increase in the average annual temperatures and a decrease in precipitation. Thus, compared to the long-term average temperature of 9.8°C, there has been an increase of this indicator by 2.8°C in the last years of the study. In 2016, the average annual temperature was 13.2°C, in 2017- 12.5°C, in 2018- 11.5°C, in 2019- 12.5°C, in 2020- 13.1°C, in 2021- 11.1°C, in 2022- 12.3°C. We have established that recent years are also characterized by a lower amount of precipitation compared to the long-term averages. For example, in 2018, the annual precipitation amounted to 431.4 mm, in 2019 it was 380.6 mm, and in 2022, it was 258.9 mm, which is less than the long-term average values by 34.6 mm, 85.6 mm, and 207 mm, respectively. Along with this, there has been a change in the distribution of precipitation during the grapevine's growth and dormancy periods. It has been noted that grapevines experienced a moisture deficit during critical growth and development stages, which hurt the growth, development, and yield of the plants. It's important to highlight that meteorological conditions varied throughout the study years. They favoured the growth and development of grapevines in 2003, 2004, 2005, 2010, 2013, and 2017 but were less conducive in 2011, 2019, and 2020. This was attributed to a notable reduction in precipitation and elevated temperatures during the summer growing seasons. It has been determined that the productivity of the examined clones' shoots, when grown in the conditions of the ATU Gagauzia, is influenced by meteorological conditions, which vary from year to year during the research.

**Keywords:** ATU Gagauzia, Grapevines, Growth, Development, Meteorological Conditions.



## ORAL PRESENTATION

### The Functional Activity of the Photosynthetic Apparatus of Vioryka Grape Variety Leaves Growing on Slopes

**Antonina DERENDOVSKAIA<sup>1</sup>, Ana GRIBCOVA<sup>2</sup>✉**

<sup>1</sup>*Agro-Technological Faculty, Comrat State University, Comrat, Moldova*

<sup>2</sup>*Scientific-Practical Institute of Horticulture and Food Technologies, Chisinau, Moldova*

✉ **Correspondence:** agribcova@gmail.com

**Abstract:** We monitored the physiological state of Viorica grape plants while they were growing on slopes using the method of inducing chlorophyll fluorescence. Changes in the parameters of the primary processes of photosynthesis in leaves were analyzed in relation to their adaptation to environmental conditions. Our research aimed to assess the growth parameters of the assimilation surface, photosynthetic activity, and their correlation with the potential productivity of the Viorica grape variety when cultivated on a slope. The determination of growth parameters was conducted dynamically, encompassing the phases of flowering, berry growth, and ripening. Our research was conducted in the Central grape-growing region of the Republic of Moldova in 2022. Depending on the location of the bushes along the slope or on the plateau, changes in the growth parameters of the leaf surface (LS) were observed. Adaptive changes were noted in the growth and development of the leaf surface (LS) when growing vines on the lower slopes. These modifications included increasing the average number of leaves per shoot, increasing leaf blade area, and increasing both shoot LS and total leaf area of the bush. The findings highlight the influence of slope and shrub location on leaf surface (LS) parameters. Notably, adaptive changes in LS growth and development were evident when Viorica was placed in lower slope areas. These changes consisted of an increase in the number of leaves per shoot, an increase in the leaf blade area, and an increase in the shoot LS area and leaf area index (LAI) depending on the growing conditions. Also, the results of our research allow us to conclude that the parameters primary processes of photosynthesis in chloroplasts obtained using the induction method Chlorophyll fluorescence can be used to monitor the physiological state of grape plants when they grow on slopes and adapt to environmental conditions.

**Keywords:** Grapes, Viorica, Leaf Surface, Photosynthetic Apparatus, Slope, Ecological Conditions.



## ORAL PRESENTATION

### Analysis of the Degradation of Cork Oak Forests in North Atlantic, Morocco

**Said LAARIBYA** 

*Ibn Tofail University, Laboratory of Territories, Environment, and Development, Kenitra, Morocco*

 **Correspondence:** said.laaribya1@uit.ac.ma

**Abstract:** Like Mediterranean forests, Morocco's forest formations are highly diverse and comprise a wide range of species. Among the noble species, the cork oak (*Quercus suber* L.) occupies an important place in the Moroccan forest landscape. However, cork oak ecosystems have been almost completely degraded by anthropogenic and natural pressures. This study was carried out on the Maamora cork oak forest in north-west Morocco. The methodology adopted was based on a bibliographic, GIS cartographic and teledetection analysis of the forest area, socio-economic surveys, in order to assess the state of degradation of the forest areas and their evolution, and to investigate the causes in relation to anthropic pressure and the climate change factor. Progressive degradation is the result of a combination of climatic and anthropogenic factors that continue to intensify. The lack of natural regeneration is one of the most worrying problems, requiring advanced reforestation.

**Keywords:** Anthropogenic Pressure, Maamora, Morocco, *Quercus suber*, Regeneration.

## ORAL PRESENTATION

### Climate Change and Erosion Processes in Gagauz Yeri

**Liudmila FEDOTOVA<sup>1</sup>✉, Margarita DMITROGLO<sup>2</sup>**

<sup>1</sup>Comrat State University, Faculty of Agricultural Technologies, Comrat, Moldova

<sup>2</sup>Berlin School of Economics and Law, Faculty of International Security, Berlin, Germany

✉Correspondence: fedotovar298@gmail.com

**Abstract:** Soils are the main natural resource of the Republic of Moldova, upon which its food safety is based. Nevertheless, the soil is constantly exposed to negative climate change-related factors that can cause the fertility of black soils to lead to desertification. Water erosion takes the first place among soil degradation processes. Annually, the area of land resources per person decreases by 2%, and the area of productive land by 6-7%. Nowadays, there is a rapid increase in anthropogenic impact on land resources due to climate change. The agricultural profile of Moldova's farms determines the high vulnerability of its economy to weather and climate factors. The south of Moldova is more exposed to negative factors than other regions of the Republic, and primarily it affects the quality of soils, which affects cultivation of agricultural goods. Erosion is one of the most intensive and widespread processes, causing significant damage to land resources and, overall, to the national economy. The research was conducted on soils of agricultural usage in Comrat region. The total area of agricultural land in Gagauz Yeri amounts to 142675 ha, including 138102 ha of agricultural land, 107266 ha of arable land, 13022 ha of perennial plantations and 16724 ha of pastures. According to Comrat district statistics there are 49294 hectares of arable land, 2929 hectares of vineyards, 1516 hectares of orchards, 234 hectares of nut plantations. The Bujak steppe has been subjected to heavy plowing, which is unacceptable, as the steppe zone is more exposed to eroding processes. The number of degraded soils in Comrat district amounts to 2595,79 ha: 812,28 ha - saline soils, 1041,84 ha - waterlogged soils, 197,48 ha - polluted soils, 466,86 ha - eroded soils and ravines, and 129,91 ha of silty soils. Lightly washed soils amount to 11523 ha, medium washed soils-7800 ha, strongly washed soils - 2525 ha, and very strongly washed soils - 549 ha. Climate change has aggravated all processes, which encourage to take more active measures for preventing the deterioration of soil quality.

**Keywords:** Soil, Climate Change, Degradation, Erosion.

## ORAL PRESENTATION

### Evaluation of Forest Carbon Stock Change in Temporal and Spatial Perspectives; A Case Study from Türkiye

**Oytun Emre SAKICI<sup>✉</sup>, Fatih SİVRİKAYA, Döndü DEMİREL**

*Kastamonu University, Faculty of Forestry, Kastamonu, Türkiye*

<sup>✉</sup>*Correspondence:* oesakici@kastamonu.edu.tr

**Abstract:** Forest ecosystems are important carbon sinks in the fight against global climate change. Increasing and sustainable management of forest ecosystems plays a critical role in reducing carbon emissions. Determining the carbon stock of forest ecosystems impacts the global carbon budget and sustainable forest management. With this study, the temporal and spatial changes of the above- and below-ground carbon stock of the Şerifebacı Planning Unit, located in Araç Forest Enterprise of the Kastamonu region of Türkiye, for 1999-2014 planning periods were determined using ArcGIS 10.8 software. In addition, the carbon stock change over the 15 years was also examined depending on land use/land cover change. This study used forest stand cover maps of forest management plans dated 1999 and 2014, growing stock of stand types, biomass expansion factors (BEFs), and carbon conversion coefficients to determine the amount of above- and below-ground carbon storage. According to the results, the total forest area in the Şerifebacı Planning Unit increased by 431 hectares for the 15-year study period. Accordingly, the carbon stock in the study area increased by 23%. Additionally, in the planning unit, the carbon stock of coniferous forests increased while that of degraded forests decreased. The increase in total forest area, productive forest area, total growing stock, the decrease in degraded forest area, and different land use types are the main reasons for the increase in carbon stock in the planning unit.

**Keywords:** Above-Ground, Below-Ground, BEF, AGC, Carbon Storage, Land Use/Land Cover Change, Productive Forest.

## 1. INTRODUCTION

Significant changes have occurred in ecological systems due to unlimited resource use, accelerated industrial development, and rapid population growth. Global warming caused by the increase in greenhouse gases is one of the biggest problems facing humanity. It is mostly caused by fossil fuel combustions, forest fires, forest degradation and destruction, as well as the acceleration of the decomposition of organic matter in the soil (Ravindranath and Osrwald, 2007; Sivrikaya and Bozali, 2012; Kucuker and Tuyoglu, 2022). In this regard, slowing the rate of climate change (or global warming) is possible by increasing carbon absorption from terrestrial ecosystems and reducing greenhouse gas emissions. Thus, climate change's negative effects can be mitigated. (Haripriya, 2002; Sakici et al., 2018; Günlü et al., 2019; Demirel et al., 2023).

The global carbon sink is primarily distributed among four major stores: the atmosphere, oceans, fossil fuel deposits, and terrestrial ecosystems, including vegetation and soil (Houghton and Hackler, 2000; Houghton, 2007). Forest ecosystems are vital in the fight against global climate change as they are important carbon sinks. Improving and long-term maintenance of forest ecosystem management is crucial in reducing carbon emissions (Sivrikaya et al., 2007; Karahalil et al., 2018). Assessing carbon stocks in forest ecosystems has important implications for the global carbon budget and sustainable forest management practice. The majority of carbon in the forest ecosystem is stored in live biomass (53%) and soil (39%) (IPCC, 2001; FAO, 2015).

Many studies have been conducted in Türkiye examining the temporal and spatial changes in carbon exchange using these methods (Sivrikaya et al., 2007; Sivrikaya et al., 2012; Seki et al., 2017; Günlü et al., 2019; Mumcu Kucuker, 2020; Kocaman and Durkaya, 2020; Kucuker and Tuyoglu, 2022; Celik and Şahin, 2023; Yaman and Keleş, 2023). These studies were carried out for different planning periods. This method is widely used in Türkiye because forest inventory is

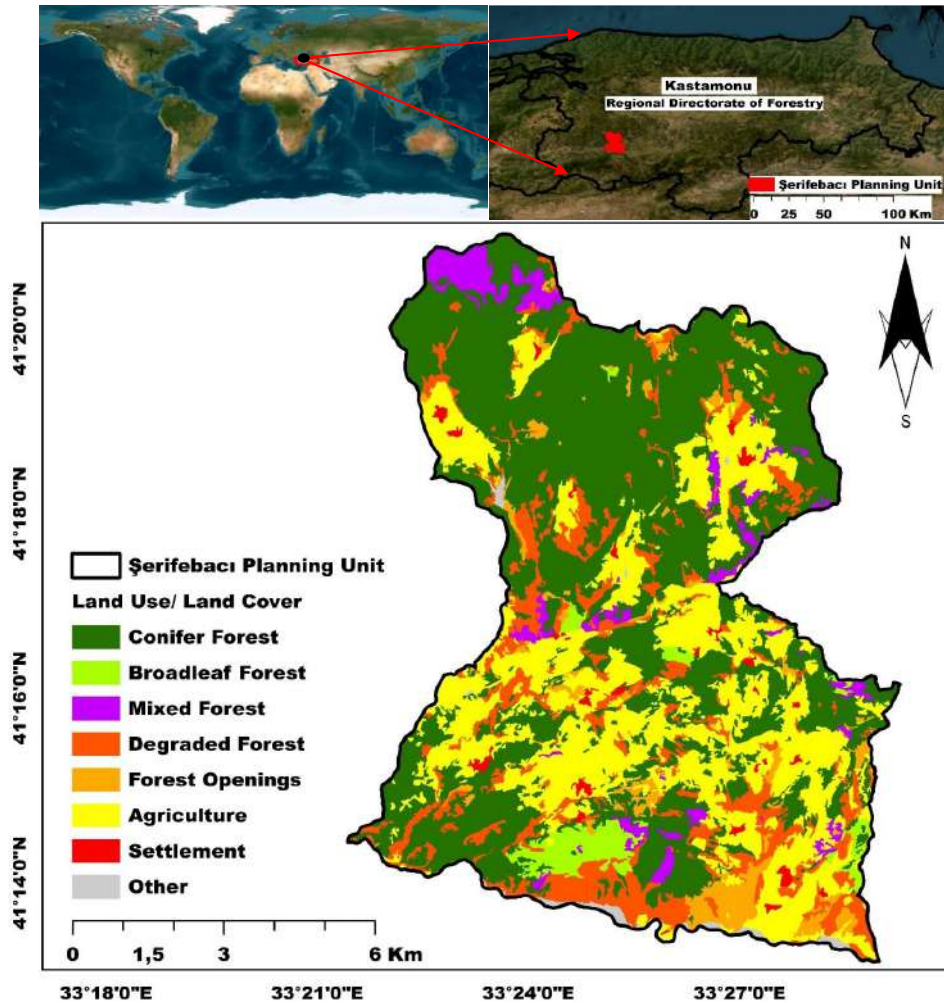
carried out periodically. In addition, using forest inventory data is a practical and reliable method for estimating carbon stocks (Hu and Wang, 2008; Sivrikaya and Demirel, 2022; Kucuker and Tuyoglu, 2022).

This study aims to analyze the carbon stock of the Şerifebacı Planning Unit (PU) in the Araç Forest Enterprise in Kastamonu Regional Directorate of Forestry (RDF) for the years 1999 and 2014. This was achieved using forest cover type maps, growing stock, and Geographic Information System (GIS) techniques. The study aimed to monitor temporal and spatial changes in carbon stock over the 15 years examined and to identify the causes of these changes.

## 2. MATERIALS AND METHODS

### 2.1. Study Area

The study area is the Şerifebacı Planning Unit (PU) in Kastamonu, characterized by a dominantly steep and rough terrain with varying an altitude from 605 to 1416 m (average 1010.5 m) above sea level. The study area is between 41°12'00"-41°22'00"N and 33°21'00"-33°30'00"E in the northwest Black Sea region of Türkiye (Figure 1). The total area is 9723.8 ha. The study area has a forest vegetation type, with *Pinus nigra* being the predominant tree species. *Pinus sylvestris*, *Quercus* and *Carpinus* communities are other locally separated tree species. The average temperature is 9.8°C; the annual mean precipitation is 449.6 mm.



**Figure 1.** The location of the study area and land use/land change distribution.



## 2.2. Estimation of Biomass and Carbon Stocks

The forest biomass in Şerifebacı PU was estimated using forest inventory data from 1999 and 2014. The inventory data comprises the measurements of the area and the amount of growing stocks per hectare for each forest stand type. The growing stock and area data for each stand type were acquired from the Şerifebacı forest management plans conducted in 1999 and 2014 (Anonymous, 1999, 2014).

Carbon storages of conifer and broadleaf species were estimated separately. To estimate above-ground biomass, species-specific biomass expansion factors (BEF) were multiplied by the growing stock of conifer and broadleaf. The BEFs for conifer and broadleaf stands were 1.212 and 1.310, respectively (Tolunay, 2019). The calculated fresh biomass of stand types were multiplied by the wood densities (0.446 for conifer stands and 0.541 for broadleaf stands) (Tolunay, 2013). The estimation of below-ground biomass was based on the above-ground biomass values. To account for this, the above-ground biomass was multiplied by root/shoot ratios. The ratios for productive conifer, degraded conifer, productive broadleaf, and degraded broadleaf stands are 0.29, 0.24, 0.40, and 0.46 respectively (FRA, 2010). The total biomass was calculated by summing the above- and below-ground biomasses. To determine the total amount of carbon stored in the stand, the dry weight biomass was multiplied by conversion factors of 0.51 for conifer stands and 0.48 for broadleaf stands (FRA, 2010) (Table 1).

The conversion factors used in this study are identical to the coefficients suggested in the Principles and Procedures for the Regulation of Ecosystem-based Functional Forest Management Plans guidelines (GDF, 2017).

**Table 1.** Coefficients and equations for estimating biomass and carbon stocks.

Carbon component	Stand type	Biomass (ton/ha)	Carbon (ton/ha)
Above-ground	Conifer	$AGB = V * 0.446 * 1.212$	$C = AGB * 0.51$
	Broadleaf	$AGB = V * 0.541 * 1.310$	$C = AGB * 0.48$
Below-ground	Conifer-productive	$BGB = AGB * 0.29$	$C = AGB * 0.51$
	Conifer-degraded	$BGB = AGB * 0.24$	$C = AGB * 0.51$
	Broadleaf-productive	$BGB = AGB * 0.40$	$C = AGB * 0.48$
	Broadleaf-degraded	$BGB = AGB * 0.46$	$C = AGB * 0.48$

## 2.3. Mapping Carbon Storage and Land Use/Land Cover

Digital forest cover type maps (1999, 2014) were obtained from the General Directorate of Forestry. The carbon storage in both above- and below-ground biomasses of Şerifebacı PU was determined by utilizing forest cover type maps for 1999 and 2014, employing GIS technology. Carbon storage maps were produced by reclassifying the calculated above- and below-ground carbon stocks in ArcGIS 10.8.

## 3. RESULTS AND DISCUSSION

In the study area, the broadleaf forest area increased by 63.1% (96 ha), and the conifer forest area increased by 10.1% (423 ha). While there was no mixed forest area in the 1999 forest management plan, 367 ha mixed forest area was identified in the 2014 plan. Degraded forest area decreased by 26.5% (455 ha), and non-forested area decreased by 11.8% (430 ha). According to TSI data, the population of Şerifebacı PU, located in the Araç of Kastamonu province, was reported to be 24180 in 2000, and it was determined that the population decreased to 19038 as of 2014. The increase in forest area in the study area can be explained by the decrease in population, agricultural activity areas, and human pressure on forest areas (TSI, 2023). The maps of land use and land cover classes of the study area in 1999 and 2014 are given in Figures 2 and 3.



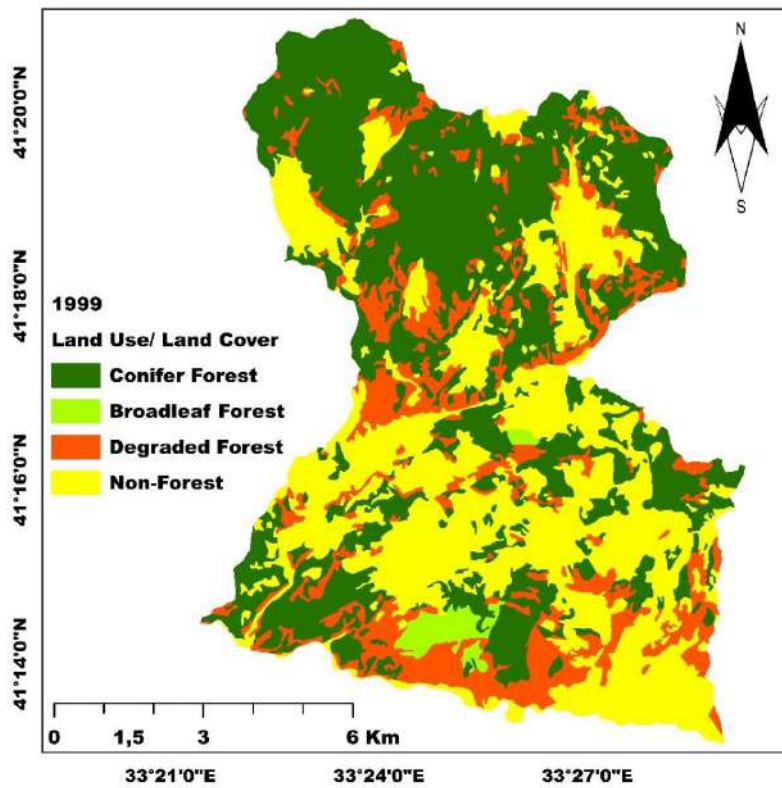


Figure 2. Land use/land cover map in 1999.

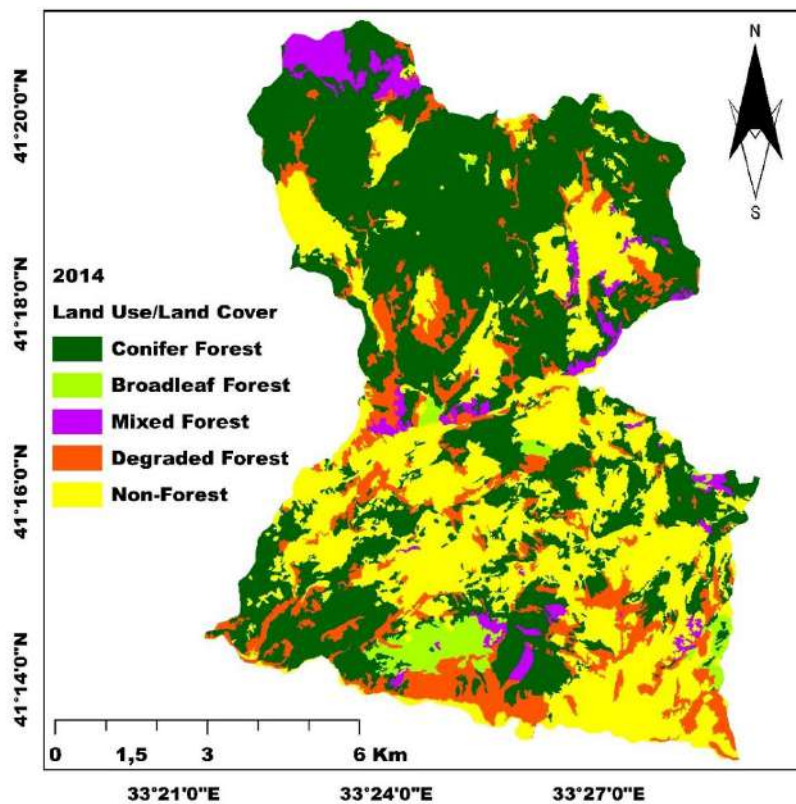


Figure 3. Land use/land cover map in 2014.

Total carbon storage increased significantly in 15 years (1999-2014). Although the total carbon of the first forest management plan (1999) was 275532.569 tons, it is 338925.170 tons for 2014. As a result, the total carbon storage increased by 23%. On the other hand, while carbon per hectare was 28 tons in 1999, it was 35 tons in 2014 in the study area. The main reason of this increase is the positive changes in forest areas and their growing stocks (Table 2).

In Şerifebaşı PU, 213439.750 tons of the carbon storage in the forest ecosystem in 1999 were above-ground, while 62092.819 tons were below-ground. However, in 2014, forest ecosystems were estimated to contain 338925.170 tons of carbon, of which 262375.490 tons were above-ground and 76549.680 tons below-ground. Carbon stores increased by 48935.74 tons above-ground and 14456.861 tons below-ground in the 15 years (Table 2). The distributions of carbon storages of the PU in 1999 and 2014 are shown in Figures 4 and 5.

**Table 2.** Changes in carbon storage according to land use/land cover.

	Land Use/Land Cover (LULC)	Total Growing Stock (m <sup>3</sup> )	Above-ground Biomass (AGB) (ton)	Above-ground Carbon (AGC) (ton)	Below-ground Biomass (BGB) (ton)	Below-Ground Carbon (BGC) (ton)	Total Carbon (ton)
1999	Conifer Forest	748776.772	405088.000	206595.000	117476.000	59912.500	266507.500
	Broadleaf Forest	10870.405	7707.120	3699.420	3082.850	1479.770	5179.190
	Mixed Forest	-	-	-	-	-	-
	Degraded Forest	10717.318	6289.240	3145.330	1965.440	700.549	3845.879
	<b>Total</b>	<b>770364.495</b>	<b>419084.360</b>	<b>213439.750</b>	<b>122524.290</b>	<b>62092.819</b>	<b>275532.569</b>
2014	Conifer Forest	911878.502	493326.000	251596.000	143065.000	72963.000	324559.000
	Broadleaf Forest	9004.731	6384.350	3064.490	2553.740	1225.800	4290.290
	Mixed Forest	18790.786	10552.900	5332.960	3240.010	1632.800	6965.760
	Degraded Forest	8145.787	4757.790	2382.040	1467.680	728.080	3110.120
	<b>Total</b>	<b>947819.806</b>	<b>515021.040</b>	<b>262375.490</b>	<b>150326.430</b>	<b>76549.680</b>	<b>338925.170</b>

In the study area, growing stock increased by 21.8% (approximately 163000 m<sup>3</sup>) in conifer forests and decreased by 17.2% (approximately 1870 m<sup>3</sup>) in broadleaf forests. In direct proportion to the growing stock, carbon stock increased by 21.8% (approximately 58000 tons) in conifer forests. It decreased by 17.2% (approximately 890 tons) in broadleaf forests in the study area (Table 2, 3 and Figure 6). Şerifebaşı PU was operated for maximum wood production until 1999, but later on, other purposes were focused on besides maximum wood production. Thus, forest production activities were reduced, and the growing stock increased. In addition, silvicultural interventions and changes in the stand structure were also effective in increasing the growing stock.

**Table 3.** Temporal change of carbon storage.

Class	1999		2014	
Carbon (ton/ha)	Total Growing Stock (m <sup>3</sup> )	Area (ha)	Total Growing Stock (m <sup>3</sup> )	Area (ha)
<20	23443.579	2321.732	41609.660	2330.924
21-40	80225.368	828.746	94476.561	1036.836
41-60	19881.004	168.993	91779.702	601.319
61-80	146501.577	795.866	4344.733	26.618
81-100	397045.080	1605.610	320410.133	1343.379
>100	103267.887	340.790	395199.017	1153.087
<b>Total</b>	<b>770364.495</b>	<b>9723.772</b>	<b>947819.806</b>	<b>9723.772</b>

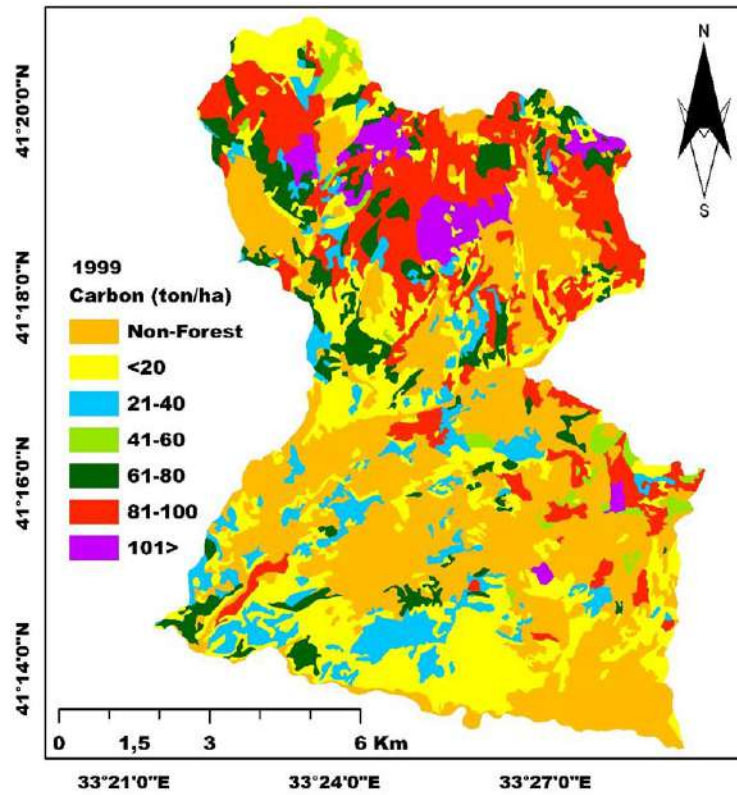


Figure 4. Carbon storage map from 1999.

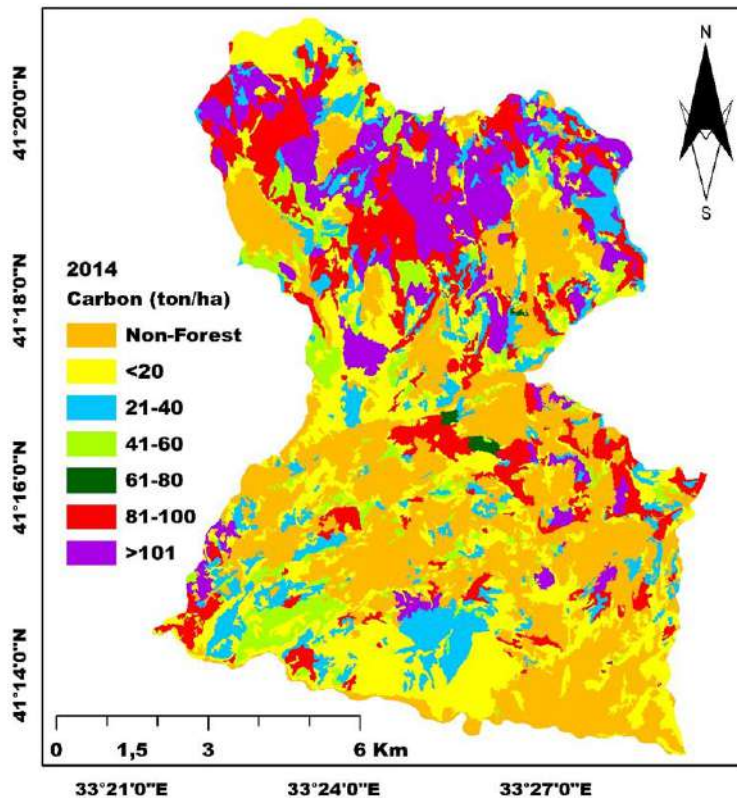
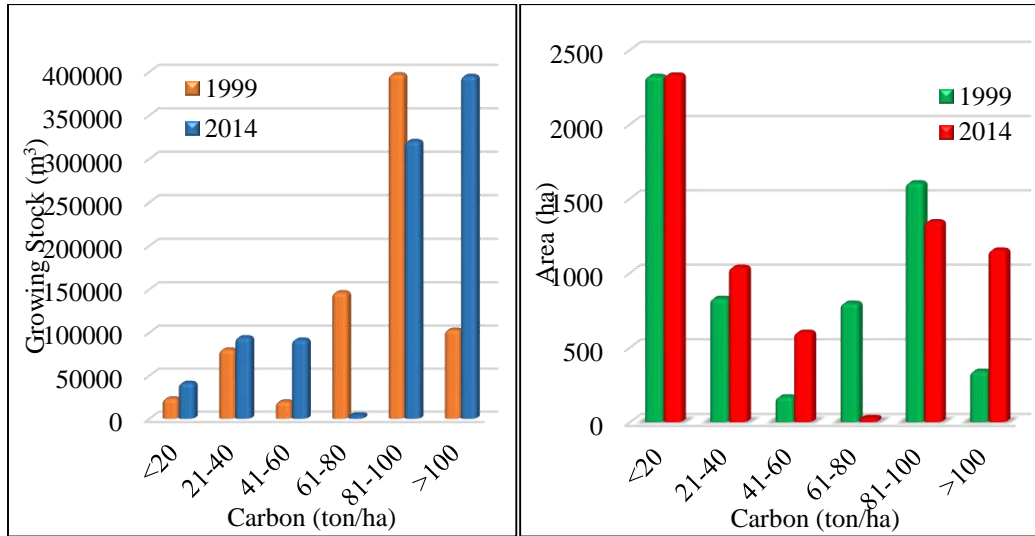


Figure 5. Carbon storage map from 2014.



**Figure 6.** Change of carbon stock per hectare according to growing stock and forest area.

It was determined that the total carbon stock in Şerifebacı PU forest ecosystems was 275532.569 tons in 1999 and 338925.170 tons in 2014. This increase in carbon stock is due to the increase in biomass with the increase in forest areas and growing stock in the study area between 1999 and 2014.

Temporal changes in carbon stock were determined in different study areas in Türkiye. Celik and Şahin (2023) concluded that biomass increased by 53.4%, approximately 417000 tons, and carbon stock increased by 26.4%, approximately 13000 tons, in Çaltepe PU, Kastamonu province, between 1999 and 2014. Değermenci and Zengin (2016) examined the carbon stock change in Daday PU in Kastamonu province between 1970, 1990, 1999, and 2012. They defined that between 1970 and 2012, the carbon stock increased by approximately 871000 tons, and the biomass increased by 1.1 million tons, as the productive forest areas in the study area increased and the degraded forest areas decreased. Seki et al. (2017) determined that the carbon stock increased by 37.4% in Taşköprü Forest Enterprise between 1989 and 2009. Seki and Atar (2021) revealed the carbon change in Alara PU in Antalya province in 1997, 2008, and 2018. During these 21 years, although the forest area decreased from 7497 hectares to 7344 hectares (2%), there was a significant rise of 12.7% in carbon stock. Yaman and Keleş (2023) concluded that the forest area decreased by 2.3% and the carbon stock increased by 10% between 1997 and 2018 in Alara PU, the study area of Seki and Atar (2021). Gunlu et al. (2019) investigated the change in the above-ground carbon stock of the Upper Göksu River Basin in Konya province between 1993 and 2015. During this 22-year period, it was determined that the above-ground carbon stock increased by 47600 tons, while a 0.9% decrease was observed in forest areas. Seki and Atar (2021), Yaman and Keleş (2023) and Günlü et al. (2019) showed in their studies that although the forest area decreased, the productive forest area increased in the study area, and the increase in carbon stock was attributed to this. Kucuker and Tuysoglu (2021) determined that it increased from 1434.49 Gg in 1973 to 1919.37 Gg in 2015 in Hisar PU, Erzurum province. It was reported that 71.6% and 69.4% of the total carbon stock came from soil in 1973 and 2015, respectively. In her study, Mumcu Kucuker (2020) determined that the total carbon stock in Bursa province Yeniköy PU between 1972 and 2016 increased from 1135.22 Gg to 1816.60 Gg, resulting in a net increase of 681.38 Gg. Durkaya et al. (2017) and Kocaman and Durkaya (2020) examined the temporal and spatial changes of PU carbon stock in Sarıalan and Demirciler PUs in Bolu province, respectively. When the 1986 and 2005 plan periods in Sarıalan PU were examined, it was determined that the carbon stock increased by an average of 15.5%. In Demirciler PU, between 1986 and 2009, above-soil carbon stock increased by 33.1% in conifers and 67.2% in broadleaves, while it decreased by 18.5% in mixed forests. Sivrikaya and Bozali (2012) determined that the carbon stock increased by 19.5% in the 11 years between 1991 and 2002 in Türkoğlu PU in Maraş province. Sivrikaya et al. (2007) determined that, with the increase in productive forest areas and the decrease in degraded forest areas, the carbon stock increased by 105446 tons in the Artvin PU of Artvin province between 1972 and 2002 and by 21553 tons in the Camili PU between 1984 and 2005.



#### 4. CONCLUSION

We mapped the carbon stock in the study region using growing stocks and forest cover type maps for 1999 and 2014. It also looked into how changes in land use/land cover affected carbon stocks. These maps offer essential background information on the distribution of forest biomass densities for forest managers and other decision-makers. According to the study results, between 1999 and 2014, the total amount of carbon storage increased by nearly 64 thousand tons (23%) due to an increase in productive forests and a decrease in degraded forests.

One of the main environmental problems in the fight against global climate change is the greenhouse effect, and one of the most important resources to fight is forest ecosystems. Considering CO<sub>2</sub>'s importance in the global carbon cycle, research should be done to improve the accuracy of carbon stock estimations. Various forestry activities impact the capacity of forests to sequester carbon. It's essential to determine how best to use forests in the fight against global climate change. Deforestation, a change in land cover, results in losses in carbon stock and biomass.

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## ORAL PRESENTATION

### Photocatalytic Removal of Reactive Orange 122 Using Zr-doped ZnO Photocatalyst

**Kübra ÇOBANOĞLU, Nejdet DEĞERMENCİ<sup>✉</sup>**

*Kastamonu University, Faculty of Engineering and Architecture, Department of Environmental Engineering,  
Kastamonu, Türkiye*

<sup>✉</sup>**Correspondence:** degermenci@kastamonu.edu.tr

**Abstract:** This study investigated the photocatalytic removal of reactive orange 122 (RO122) dye from aqueous solutions. The effect of photocatalyst dosage, one of the parameters affecting RO122 removal, was determined. The degree of reaction and rate constants were calculated with the help of experimental results. ZnO photocatalyst and Zr-doped ZnO photocatalyst were produced using the sol-gel technique. XRD and SEM devices were used to examine the characterization of the prepared photocatalysts. In the experiments, the RO122 concentration was 25 mg/L, the temperature was 20°C, the catalyst dosage was 1 g/L, the mixing speed was 600 rpm, and the pH value was 5. According to experimental results, in all photocatalysts (ZnO, 1.25% Zr-doped ZnO, 2.5% Zr-doped ZnO, 5% Zr-doped ZnO and 10% Zr-doped ZnO), the removal efficiency of RO122 dye reached 100% at the end of 60 minutes, achieving complete removal. As a result of the kinetic calculations, it was determined that the photocatalytic removal of the dyestuff followed the pseudo-first-order reaction kinetics. With increasing Zr contribution, the reaction rate constants were calculated as 0.1685, 0.2093, 0.2300, 0.2555 and 0.3608 min<sup>-1</sup>, respectively. It can be concluded that with the increase of Zr contribution, the time required to achieve the desired dye removal efficiency is shortened. For the photocatalytic removal of RO122, Zr-doped ZnO photocatalysts have resulted in faster removal than ZnO alone.

**Keywords:** Zinc Oxide, Zirconium, Photocatalyst, Reactive Orange 122.

## 1. INTRODUCTION

The continuous increase in the world population, the increasing demand for water resources, and the resulting water shortages necessitate the reusability and sustainability of water and wastewater. In the textile industry, dyeing and finishing processes consume large amounts of water, generating large quantities of wastewater (Ferreira et al., 2019). When discharged into receiving environments, these wastewaters containing dyes often prevent sunlight from reaching aquatic plants by reflecting and absorbing the colored water. Furthermore, releasing these dyes into the environment can cause adverse effects for humans, such as allergic reactions, dermatitis, and asthma. In addition, they have the potential to cause serious health problems, such as carcinogens and gene mutations (Darai et al., 2023; Değermenci, 2021). These dyes are classified according to their chemical or chromophore structure (Sadegh et al., 2024). The textile dyeing process is divided into various classifications, such as basic dyes, acid dyes, reactive dyes, disperse dyes, direct dyes, and vat dyes (Murugesan et al., 2007). Reactive dyes are predominantly driven by their capacity to bond with textile fibers through covalent bonding and their positive properties, such as water retention, color brightness, and simple application techniques (Saeed et al., 2015). However, being a stable polyaromatic molecule, they are difficult to degrade by conventional biological methods (Praipipat et al., 2022). Therefore, wastewater containing dyes must be treated before discharge into receiving water bodies.

Several methods have been developed for the treatment of dyes from aqueous solutions, including membrane filtration, coagulation-flocculation, biological treatment, advanced oxidation processes, and adsorption (Pak et al., 2023; Değermenci, 2023; Çobanoğlu & Değermenci, 2022; Değermenci et al., 2019a). Among these methods, coagulation-flocculation and adsorption methods are more preferred. However, the main disadvantage of these methods is the incomplete breakdown of pollutants. These traditional processes also create secondary hazardous pollution in solid form, which is a significant disadvantage (Chankhanittha et al., 2021). Biological treatment, which is one of the commonly used

methods, is not effective in removing resistant and toxic organic pollutants. Advanced oxidation processes (AOPs) are recognized as a viable option for the removal of pollutants, especially in drinking water and industrial wastewater (Değermenci et al., 2019b). The photocatalytic oxidation process is an advanced oxidation technique used to activate organic reactions and involves semiconducting metal oxides (Cheng et al., 2016). These photocatalysts are materials that can increase the reaction rate. Moreover, these photocatalysts can return to their initial chemical structure without any harmful effects and can also be used repeatedly. Therefore, they offer a more energy-efficient reaction pathway (Yılmaz & Dindar, 2023). This process also has the advantage that the whole process can be easily realized using natural sunlight. Therefore, it is considered as an environmentally friendly alternative for the treatment of organic pollutants (Zarei et al., 2023).

Photocatalysts have been used in recent years as a promising method for the removal of toxic pollutants from industrial wastewater as they mineralize pollutants into CO<sub>2</sub>, H<sub>2</sub>O, and mineral acids (Guz et al., 2023). Semiconductor photocatalysts such as ZnO and TiO<sub>2</sub> are the most widely investigated advanced oxidation processes for the removal of a wide range of organic pollutants. Their wide band gap (3.0-3.2 eV) limits their practical application. Moreover, the lack of effective surface area and low transfer rate of charge carriers also hinder photocatalytic activity (Subash et al., 2013). Nowadays, it is necessary to develop new photocatalysts with high photocatalytic activity. Metal or metal ion doping increases photocatalytic efficiency by reducing the recombination of electron-hole pairs (Teaoh et al., 2005). Metal doping has been produced by various methods such as photo-deposition method, sol-gel method, chemical bath deposition, hydrothermal method, and ultrasonic-assisted method (Vo et al., 2023; Akhtar et al., 2020; Vaiano et al., 2018).

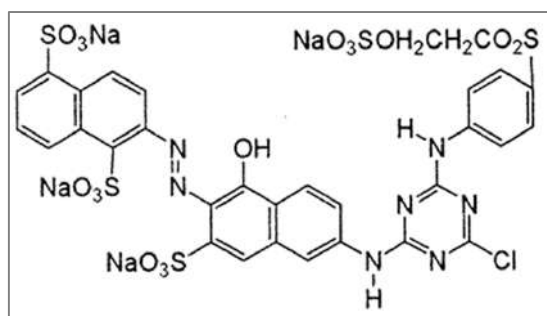
Zinc oxide (ZnO) is preferred as a photocatalyst because of its non-toxicity, widespread availability, and broadband gap energy similar to titanium dioxide (Christy et al., 2021). However, the use of ZnO has been limited due to factors such as photo-corrosion and rapid electron-hole recombination (Yassitepe et al., 2008). Therefore, the ZnO photocatalyst needs to be developed to have high visible light photocatalytic performance and less photo corrosion. Doping ZnO with transition metals can improve its photocatalytic behavior by increasing thermal stability and reducing electron-hole recombination (Shirzad-Siboni et al., 2017; Selvam et al., 2013). Zirconium (Zr) is considered a suitable dopant because it provides corrosion resistance and can prevent recombination by capturing excited electrons through empty d orbitals. The parallel atomic radii of Zr and Zn allow them to be easily integrated into the ZnO lattice. As a result, doping with Zr can increase the specific surface area and improve the photocatalytic performance of ZnO (Christy et al., 2021).

In this study, ZnO photocatalysts doped with ZnO and Zr at different weight ratios were fabricated using the sol-gel technique. The prepared photocatalysts were characterized by X-ray powder diffraction (XRD) and scanning electron microscopy (SEM). The photocatalytic performance of Zr-doped ZnO was realized through reactive orange 122 (RO122) degradation in an aqueous solution using UV-C light.

## 2. MATERIALS AND METHODS

### 2.1. Chemicals

Zinc acetate, oxalic acid dehydrate, zirconium oxychloride, and ethanol were used in the production of Zr-doped ZnO photocatalyst. The dyestuff used to investigate the photocatalytic effect was Reactive Orange 122 (RO122). UV-C radiation was used as a light source, and the decolorization of RO122 was investigated. The chemical structure of RO122 is shown in Figure 1 (Ferreira et al., 2019). This dye is mainly used for dyeing fabrics such as silk and cotton and is reported to be highly resistant to conventional wastewater treatment methods (Ferreira et al., 2019; Inchaurreondo et al., 2016; Saeed et al., 2015).



**Figure 1.** Chemical structure of RO122.

## 2.2. Synthesis of Photocatalysts

The Zr-doped ZnO photocatalyst was prepared by the sol-gel method (Christy et al., 2021; Hariharan, 2006). A mixture of 65 mL ethanol and 10 mL distilled water at 60°C was added to a beaker, and 2.745 g zinc acetate was added. The beaker was covered with parafilm and stirred for 0.5 h at 350 rpm on a heating magnetic stirrer. For Zr doping, 1.25%, 2.50%, 5.00%, and 10.0% Zr from the stock solution were added to the solution and stirred for about 15 min. Similarly, 3.15 g oxalic acid was dissolved in 50 mL ethanol at 40°C. The oxalic acid solution was added slowly (0.5 h) under the same stirring conditions to the ethanolic solutions containing zinc acetate and zinc acetate with zirconium and stirred for a further 0.5 h. The resulting solution was allowed to reach room temperature, and aerogel formation was observed. The aerogel was kept in an oven at 80°C for 24 h, and xerogel formation was observed. The xerogel was calcined at 500°C for 3 hours to obtain ZnO and Zr doped ZnO nanoparticles. The calcined nanoparticles were washed twice with distilled water. The washed samples were dried in an oven at 80°C for 24 hours. XRD and SEM were used for the characterization of the nanoparticles.

## 2.3. Photocatalytic Tests

Photocatalytic degradation experiments were carried out in a cylindrical jacketed reactor with an inner diameter of 6 cm and a height of 32 cm. A low-pressure mercury vapor lamp (LightTech, GPH 212T5/L4 10W, 254 nm) was placed in a quartz sheath coaxially aligned with the reactor. Photocatalytic activity tests were performed with RO122 in the presence of doped/un-doped ZnO nanoparticles. The solution volume used in the experiments was 600 mL. The temperature was controlled using a heated-cooled circulator (Labo, C200-H13). The mixing was carried out in a magnetic stirrer (JeioTech, TS-14S) at a constant speed (600 rpm). The experimental system is given in Figure 2. After adding 600 mg of photocatalyst to the reactor containing 25 mg/L RO122, samples were withdrawn at predetermined intervals and analyzed immediately after centrifugation. RO122 concentration was measured at 487 nm using a UV-vis spectrophotometer.

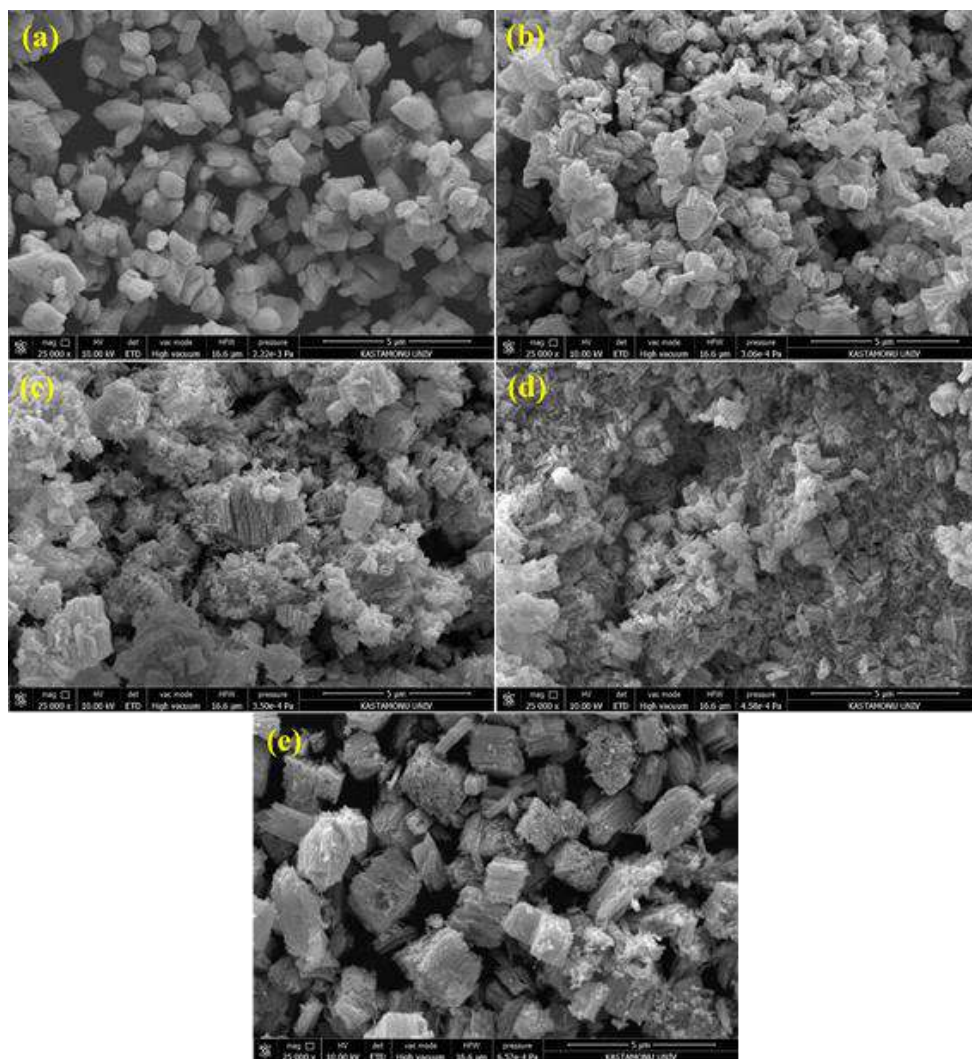


**Figure 2.** Experimental system.

### 3. RESULTS AND DISCUSSION

#### 3.1. SEM Analysis

SEM images of undoped and Zr-doped ZnO are shown in Figure 3. The morphology of the undoped ZnO produced has a hexagonal wurtzite structure in Figure 3(a). It can be seen that the microstructure is affected by the nature and size of the dopant; as the Zr doping ratio increases, the morphology of ZnO changes to a larger size (Figure 3(e)).



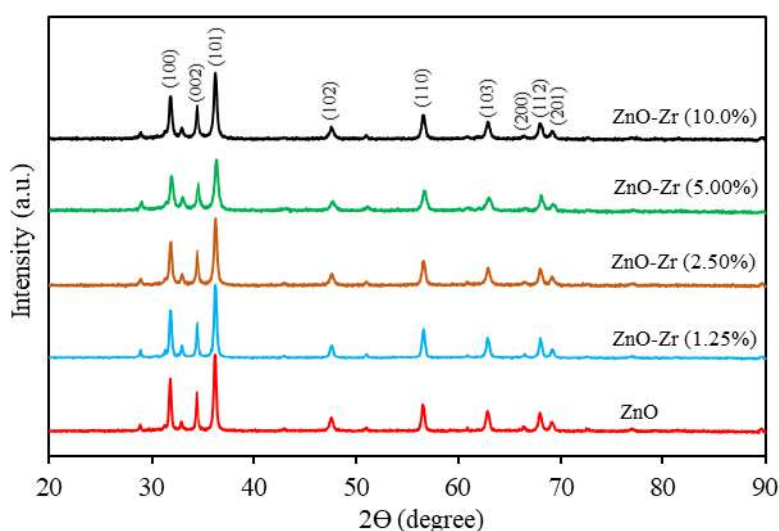
**Figure 3.** SEM images of synthesized undoped ZnO (a), 1.25% Zr-doped ZnO (b), 2.50% Zr-doped ZnO (c), 5.00% Zr-doped ZnO (d) and 10.0% Zr-doped ZnO (e) nanoparticles.

#### 3.2. X-ray Diffraction (XRD)

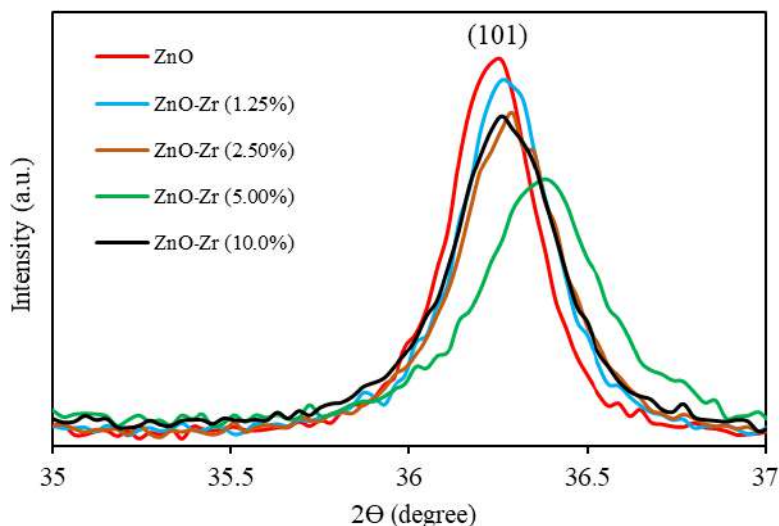
XRD analysis was used to determine the phase structure and purity of the photocatalysts. The XRD patterns of the synthesized ZnO and Zr-doped ZnO nanocomposites are shown in Figure 4. All prepared samples are associated with the typical hexagonal wurtzite phase of ZnO. The XRD pattern of ZnO shows well-defined characteristic peaks at  $2\theta = 31.76, 34.36, 36.24, 47.54, 56.54, 62.84, 66.34, 67.93, 69.01, 72.44$  and  $77.00$ , corresponding to (100), (002), (101), (102), (110), (103), (200), (112), (201), (004) and (202), respectively. When comparing the XRD pattern of the produced ZnO with the patterns of ZnO doped with different ratios of Zr, no new peak was detected. This indicates that Zr is present in the form of impurity and confirms that the hexagonal wurtzite structure of ZnO remains unchanged after Zr doping. The XRD



patterns of the synthesized nanoparticles showed peaks of some impurity phases at 28.82, 32.84, 42.98, 50.96, and 60.89. The maximum diffraction intensity of the produced ZnO was observed at 36.24. As can be seen in Figure 5, the peaks of the produced ZnO sample are the same as those of the Zr-doped ZnO samples, and the crystal structures of the produced ZnO samples did not undergo significant changes or distortions in the crystal structure of ZnO in the presence of the dopant (Zr). However, as seen in Figure 5, the presence of Zr doping changed the intensity of the diffraction peaks, and a shift in the  $2\theta$  angle was observed (Christy et al., 2021).



**Figure 4.** XRD patterns of produced ZnO and Zr-doped ZnO.

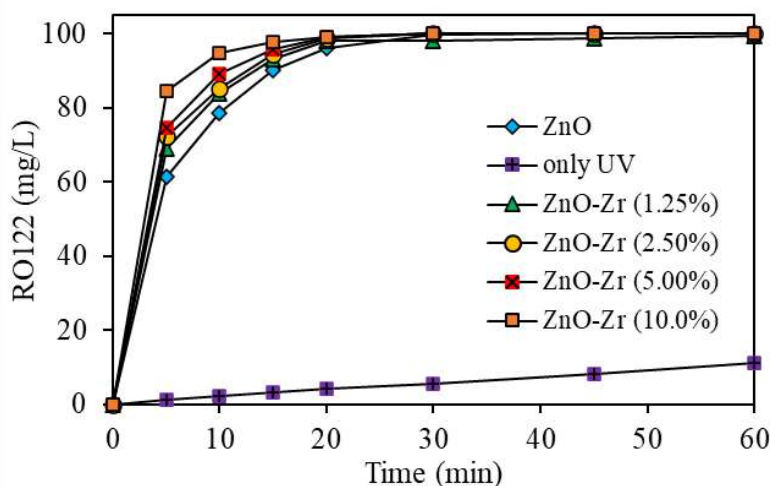


**Figure 5.** Magnified XRD pattern showing the shift associated with the Zr content in the main plane of ZnO (101).

### 3.3. Photocatalytic Activity Results

The effects of ZnO, 10.0% Zr-doped ZnO, 5.00% Zr-doped ZnO, 2.50% Zr-doped ZnO, and 1.25% Zr-doped ZnO catalysts produced by sol-gel method on the removal of RO122 pollutant by interacting with UV were tested. The experimental conditions were 25 mg/L RO122 concentration, 120 min experimental time, 1 g/L catalyst concentration, UV-C light source, 20°C temperature, 600 rpm stirring speed and solution pH 5. Experimental results are given in Figure 6. According to the results, for all catalysts (ZnO, 10.0% Zr-doped ZnO, 5.00% Zr-doped ZnO, 2.50% Zr-doped ZnO,

and 1.25% Zr-doped ZnO), the removal efficiency of RO122 dye reached 100% after 120 minutes and complete removal was achieved. The highest removal rate was obtained in 10.0% Zr-doped ZnO, and the dyestuff was removed after 30 minutes.



**Figure 6.** Photocatalytic removal of RO122 (RO122= 25 mg/L, Photocatalyst= 1 g/L, Temperature= 20°C, Stirring speed= 600 rpm).

As a result of the kinetic calculations, it was determined that the photocatalytic removal of the dyestuff complies with the first-order reaction kinetics. The reaction rate constants were calculated as 0.1685, 0.2093, 0.2300, 0.2555, and 0.3608  $\text{min}^{-1}$  with increasing Zr contribution, respectively. It was concluded that the times required to reach the desired dyestuff removal efficiencies shortened with increasing Zr contribution. For the photocatalytic removal of RO122, Zr-doped ZnO photocatalysts resulted in faster removal compared to ZnO alone.

#### 4. CONCLUSION

The effect of ZnO and Zr-doped ZnO photocatalysts produced by the sol-gel method for heterogeneous photocatalytic removal of RO122 was investigated. All prepared samples are associated with the typical Wurtzite hexagonal phase of ZnO. In the photocatalytic RO122 removal, 10% Zr-doped ZnO was determined as the photocatalyst with the highest removal rate. The data obtained from the experiment at 25 mg/L RO122 concentration, 1 g/L catalyst (10% Zr-doped ZnO) concentration, 20°C temperature, 600 rpm stirring speed, and initial pH value of 5 showed that 100% RO122 removal was achieved after 30 minutes.

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## ORAL PRESENTATION

### Shellfish Waste as Attractive Source of Glucosamine Production and Their Applications

**Ali Eslem KADAK<sup>1✉</sup>, Aygöl KÜÇÜKGÜLMEZ<sup>2</sup>, Mehmet ÇELİK<sup>3</sup>**

<sup>1</sup>Kastamonu University, Devrekani TOBB Vocational School, Kastamonu, Türkiye

<sup>2</sup>Çukurova University, Faculty of Fisheries, Adana, Türkiye

<sup>3</sup>Çukurova University, Faculty of Ceyhan Veterinary Medicine, Adana, Türkiye

✉Correspondence: alieslem@hotmail.com

**Abstract:** Glucosamine (2-amino-2-deoxy- $\alpha$ -D-glucose) is an amino monosaccharide whose fragments occur naturally in cartilage and serve as the cellular substrate of glycosaminoglycan chains. There are four common forms of glucosamine: glucosamine hydrochloride, glucosamine sulphate, and N-acetyl glucosamine. These glucosamine compounds are usually obtained from chitin by chemical and enzymatic hydrolysis. Glucosamine is a multifunctional and pharmacologically safe dietary supplement commonly taken for rheumatoid arthritis and osteoarthritis. Also, glucosamine has novel beneficial roles in various diseases, including cancer, cardiovascular and neurodegenerative diseases, skin disorders, and bacterial infection. Glucosamine has been designated as an “over-the-counter” dietary supplement by the US FDA. It has an annual consumption of 65 thousand tons in the world and a market volume of 3.5 billion dollars and is among the most preferred food products, with a share of 14 percent worldwide. Especially in the medical field, studies on glucosamine as a supplement are numerous and increasing. In this review study, the sources and extraction methods of glucosamine and its derivatives from shellfish waste, which have essential functions in many fields as well as in medicine, have been reviewed.

**Keywords:** Glucosamine, N-Acetyl Glucosamine, Glucosamine Sulphate, Glucosamine Hydrochloride, Shellfish Waste.

## ORAL PRESENTATION

### Antibiotic Utilization in Turkish Aquaculture: Present Status and Problems

**Ertugrul TERZI<sup>1</sup>✉, Albaris Beteh TAHILUDDIN<sup>2,3</sup>**

<sup>1</sup>Kastamonu University, Devrekani TOBB Vocational School, Department of Veterinary Medicine, Kastamonu, Türkiye

<sup>2</sup>Kastamonu University, Institute of Science, Department of Aquaculture, Kastamonu, Türkiye

<sup>3</sup>College of Fisheries, Mindanao State University, Tawi-Tawi College of Technology and Oceanography, Sanga-Sanga, Bongao, 7500 Tawi-Tawi, Philippines

✉Correspondence: eterzi@kastamonu.edu.tr

**Abstract:** Aquaculture is an important sector that aims to augment the scarcity of protein sources as the world's human population is exponentially increasing. In Turkey, aquaculture contributed about more than half of the total fishery production. In the course of increasing aquaculture production, intensive farming has brought about the widespread occurrence of infectious diseases. Hence, antibiotic use is thought to be one of the solutions to this problem. This work aimed to review the dispersed state of knowledge on the use of antibiotics in Turkish aquaculture using the available scholarly papers published from 2005 to 2023. Our findings revealed that numerous antibiotics dominated by oxytetracycline, florfenicol, enrofloxacin, sulfadiazine+trimethoprim, amoxicillin, and oxolinic acid are used in aquaculture in Turkey. Some side effects of aquaculture antibiotics on the aquatic environment are the development and spread of antibiotic-resistant genes to the surrounding bacteria in the sediment, water column, and organism-associated bacterial strains. The antibiotic-exposed organisms likewise face challenges, as some antibiotics are toxic to living organisms by affecting their morphological, developmental, and physiological aspects. Human risk is also highly likely due to the associated antibiotic residues in farmed fish or aquatic organisms via the food chain.

**Keywords:** Antibiotic, Antibiotic Use, Antibiotic residues, Aquaculture, Türkiye.

## ORAL PRESENTATION

### Use of Ridge Regression and Principal Component Analysis in the Multicollinearity in Animal Science

**Pınar ÖLMEZ<sup>✉</sup>, Aycan Mutlu YAĞANOĞLU**

*Ataturk University, Agriculture Faculty, Erzurum, Türkiye*

<sup>✉</sup>**Correspondence:** p.olmez@hotmail.com.tr

**Abstract:** Ridge and principal component regressions are analysis methods used to guide regression analysis, to make very convenient regression analysis. Although the least squares estimates are unbiased when multicollinearity occurs, the variances of the estimates can be quite far from their true values. Ridge and principal components regression standard errors are reduced by allowing one-level biased regression estimates. Therefore, when multicollinearity is present, ridge and principal component regression methods can be used as an alternative to the least squares method. In this study, it was aimed to develop a model that predicts various egg quality criteria obtained from 238 Lohmann LSL-white commercial laying hens at 46 weeks of age. Due to the multicollinearity between egg quality criteria, ridge and principal components regression analysis methods, which are alternatives to least squares regression, were applied and these three methods were compared for the same data set. The coefficient of determination ( $R^2$ ) and coefficient of variation were used as comparison criteria. According to these criteria, it was observed that the least squares ( $R^2=0.876$ ), ridge ( $R^2=86.9$ ) and principal component regression ( $R^2=0.856$ ) methods gave the best fit, respectively. As a result, it was concluded that it would be more accurate to use Ridge and principal component regression methods instead of using the least squares method in case of multicollinearity. In the datasets where the cause-effect relationships between the variables are investigated, if there are multiple correlations between the variables, it has been shown that the use of biased regression methods instead of least squares regression normalizes the standard errors of the regression coefficients and thus gives more reliable results.

**Keywords:** Ridge Regression, Principal Components Regression, Least Squares Method.

## ORAL PRESENTATION

### Development of Aquaculture in Kastamonu (Türkiye) Province

**Mahmut ELP<sup>1</sup>, Osman Nezi̇h KENANOĖLU<sup>2</sup>✉, ErtuĖrul AVDAR<sup>3,4</sup>**

<sup>1</sup>Kastamonu University, Ara Rafet Vergili Vocational Collage. Department of Forestry, Kastamonu, Türkiye

<sup>2</sup>Kastamonu University, Faculty of Engineering and Architecture, Kastamonu, Türkiye

<sup>3</sup>Kastamonu University, Faculty of Economics and Administrative Sciences, Kastamonu, Türkiye

<sup>4</sup>Kastamonu University, Institute of Science and Technology, Kastamonu, Türkiye

✉Correspondence: okenanoglu@kastamonu.edu.tr

**Abstract:** The aim of this study is to reveal the development process of aquaculture in Kastamonu province from past to present. In this context, data from the provincial directorate of agriculture and forestry were used and observations were made through field studies carried out throughout the province. Observations throughout the province were carried out by examining land facilities and cage facilities where breeding was carried out. Official production capacities and actual situation were determined by using both data received from institutions and interviews with producers. The restrictive factors on production were revealed and the necessary conditions for capacity increase were determined. As a result of the data of the Provincial Directorate of Agriculture and Forestry and field observations, it was determined that rainbow trout production in inland water resources in Kastamonu province increased regularly and a capacity of 1437 tons was reached. It was observed that only 620 tons of this capacity was converted into production. Within the scope of this capacity used, 565 tons of portions and 55 tons of rainbow trout over kilograms were produced. It has been observed that the main reason why the capacity is not fully used is changes in water temperature, turbidity and diseases due to rainfall in the spring. In addition to the losses caused by the damage caused to the cage nets by otters, which are distributed in many water resources, there are also cases of damage to the cages due to human factor hostility. As a result of the data received from official institutions and the interviews and observations made on the farms, it was determined that the water resources of Kastamonu province entered a period of rapid growth and capacity increase, especially after 2015. Another factor identified was that the current licensed capacity was not fully reflected in production and more than half of the capacity could not be converted into production.

**Keywords:** Rainbow trout, Karadere (Donalar) Dam, Germetepe Dam, Beyler Dam.

## 1. INTRODUCTION

In today's world, where 24% of the animal protein need is provided from fish, it is known that seafood products are the centre of attention in terms of "Nutrition Improvement Approaches and Strategies", but the fish obtained by fishing is no longer able to meet the intense demand (İrkin, 2020). In addition to its contribution to the diet and as a good source of energy, seafood has an important role to play in addressing micronutrient deficiencies due to its high quality, easily digestible animal protein structure. According to the FAO (2018), a 150 g fish provides about 50-60 percent of an adult's daily protein requirement. Aquaculture, it has a wide range from single-celled microalgae to macroalgae, zooplankton to arthropods, molluscs to fish (Eryalın, 2018; Yazıcı and Mazlum, 2019; Erbil et al., 2022; Tahiluddin et al., 2023). In 2016, 88 percent of total fish production was used directly for human consumption, thanks to more balanced catches, less waste and more aquaculture than in the past. During this period, global aquaculture production, including aquatic plants, reached 110.2 million tonnes and 20.3 kg per capita, also a record (FAO, 2018). The development of aquaculture in Turkey started in the 1970s with inoculation studies of carp in natural environments and continued at a low level that could not be included in the statistics until the early 1980s (Anonim, 1981). The aquaculture sector, which developed rapidly in the following years and now has a production capacity of 515,000 tonnes/year, has surpassed wild catch fisheries production (335,000 tonnes/year) (URL-1). Aslan and Yıldız (2021) stated, the wild catch fisheries in total fish production is decreasing, while that of aquaculture is increasing. This situation is due to the fact that the amount of product that can be obtained from fishing cannot be increased any further.



Kastamonu province is located in the catchment basin of the Devrez and Gökırmak branches of the Kızılırmak River. Kastamonu province, which is rich in terms of rivers due to its location, has 23 rivers originating from within its borders and flowing directly into the Black Sea. The Araç Stream, which is a tributary of the Filyos Stream, also originates within the borders of Kastamonu. There are no natural lakes in the province, and all existing bodies of standing water are ponds or reservoirs built for irrigation or flood control purposes. The rainbow trout (*Oncorhynchus mykiss*) is the only aquaculture species cultivated in the province of Kastamonu, and its production started in 1992 and has increased regularly until today. The aim of this study was to determine the development of rainbow trout cultured in Kastamonu province on the basis of farms.

## 2. MATERIALS AND METHODS

The information received from the Provincial Directorate of Agriculture and Forestry, the Fisheries and Aquaculture Branch Directorate and the producers was evaluated and analysed. Data on farms in the province of Kastamonu, licensed production capacities and production quantities of farms were obtained by contacting the Fisheries and Aquaculture Branch Directorate of the Provincial Directorate of Agriculture and Forestry.

Data on licensed production capacities and production volumes of farms in Kastamonu province were obtained by contacting the Aquaculture Branch Directorate of the Provincial Directorate of Agriculture and Forestry. In the second stage of the study, farm visits were made, information about production was obtained and field observations were made. In addition, the opinions of the producers about the problems they face and the advantageous aspects of the production areas were taken.

## 3. RESULTS AND DISCUSSION

### 3.1. Results

According to the data of the Provincial Directorate of Agriculture and Forestry, aquaculture activities in Kastamonu started in 1992 with the Yürekveren Trout Farm (11 tonnes/year). Yürekveren Trout Facility, which started its breeding activities in concrete ponds, continues to breed rainbow trout using the same method today. Yürekveren Trout Facility, the first facility established in Kastamonu province, also continues its hatchery activities by producing eggs from its own broodstock. One year after the Yürekveren Trout Plant started rainbow trout production, the Gürsu Trout Plant (10 tonnes/year) started operations in concrete ponds in 1993. This facility is located just below the Yürekveren Trout Facility and benefits from the same water source. In 1995, the Yürekveren Village Development Cooperative established a new rainbow trout farm named "Çağlayan Trout Facility" for aquaculture in concrete ponds (Figure 1). In the same year, the fourth aquaculture enterprise, Karasu Trout Farm, was started to operate with a capacity of 40 tonnes/year (Table 1). Between 2015-2021, there has been a rapid increase in the capacity and number of facilities established within the borders of Kastamonu province, so that the total trout production capacity licensed by the Ministry of Agriculture and Forestry in Kastamonu province has reached 1376.5 tonnes/year.



**Figure 1.** Çağlayan Trout Facility (concrete ponds), one of the first aquaculture production facilities established in Kastamonu province (Yürekveren 2015.09.16).

When the first four facilities mentioned above were established, they also established hatcheries to produce their own fry. However, these facilities had problems in hatchery management for a long time and generally preferred to outsource the supply of eyed eggs or fry. Although the first facilities were established in concrete ponds, they have continued their production activities in cage environment in dams over time (Figure 2).

There are rainbow trout production licences issued to aquaculture farms in Kastamonu Province with a total capacity of 1376.5 tonnes/year. However, production could not be realised in all of this capacity. According to the information received from the Provincial Directorate of the Ministry of Agriculture and Forestry, it is known that in 2022, a total of 620 tonnes/year production was made, 565 tonnes for portioned trout and 55 tonnes for Turkish salmon (fish larger than 1 kg). Turkish salmon production started after 2020 and its cultivation in cage facilities in the province has attracted considerable interest. However, at present, trout farms in Kastamonu province produce well below the total licensed annual capacity of 1376.5 tonnes.



**Figure 2.** Change in water level and cage facilities in Germeçtepe Dam Lake (Germeçtepe Dam 2017.09.08).

The interviews with the producers revealed that the water in the reservoirs where the net cages are located is turbid due to the spring rains and that this situation leads to fish deaths and diseases. The producers stated that, in addition to the turbidity of the water, sudden temperature changes were also a factor limiting production in the reservoirs.

The use of dam lakes, which were originally established for flood prevention and irrigation within the borders of Kastamonu province, for agricultural irrigation, especially in summer months, may cause sudden changes in the water levels of the lake (Figure 2). During the field observations, it was determined that the water level in the reservoirs decreased enough to touch the bottom of the cage nets due to the droughts experienced especially in the summer months. Due to the natural structure of Kastamonu province, otters are encountered in many water sources. From time to time, otters tear the cage nets and the fish escape, which is seen as a natural factor limiting aquaculture.

In addition to the natural factors limiting trout production, it has been determined that especially small capacity producers have difficulties in feed supply, feed quality and material supply. Especially due to the high transport costs, producers sometimes have to store their feed by purchasing their feed needs for several months at one time. As a result of this situation, the oils in the feed are oxidised and the feed quality is negatively affected. In addition, as a result of the fact that the sudden material needs of the producers cannot be met from Kastamonu province, ordering to other provinces may increase the financial losses even more. On the other hand, the supply of trained personnel is among the problems faced by fish farmers. There are difficulties in employing experienced personnel in the sector because the costs of trained personnel cannot be met in small-capacity fish farms, and in large-capacity farms because the personnel are not adequately remunerated.

Diseases can occur in fish farms after the transportation of eggs, fry or sometimes portion fish from different places, especially as a result of changes in environmental factors. Similar situations are experienced in fish farms in Kastamonu province, but thanks to the experience of local breeders, some diseases are successfully treated. In the fight against more advanced diseases, the aquaculture academicians at Kastamonu University help the breeders and the spread of diseases is prevented through interventions.

Although the licensed capacity for total fish production in Kastamonu is 1376.5 tons/year, the actual production is 620 tons/year (Table 1). The reason why the capacity cannot be used actively is due to the fact that the facilities with a capacity of 800 tons/year established in 2021 and 2022 did not start operating at full capacity. Cost problems are one of the underlying reasons for the ineffective use of capacity, and it has been observed that the increase in feed costs in particular is having a negative impact on production. As a result of the interviews with the producers, they expressed their expectations for the establishment of appropriate policies on fish feed prices. They also stated that they experienced bureaucratic problems when they wanted to increase their aquaculture capacity or establish new facilities.

**Table 1.** Aquaculture Facilities operating in Kastamonu Province (Edited with the help of URL-2).

	Project Name Province	Production Method	Farm Type Project	Capacity (Tons/year)	Foundation Year
1	Yürekveren Alabalık Tesisi	Concrete Pool	Hatchery + Grow-out	11	1992
2	Gürsu Alabalık Tesisi	Concrete Pool	Hatchery + Grow-out	10	1993
3	Çağlayan Alabalık Tesisi	Concrete Pool	Hatchery + Grow-out	50	1995
4	Germeçtepe Alabalık Tesisi	Net Cage	Grow-out	75	2005
5	Bey Alabalık Tesisi	Concrete Pool	Grow-out	1.5	2012
6	SÜFAK Trout Facility	Net Cage	Grow-out	29	2013
7	İlgaz Cage Trout Facility	Net Cage	Grow-out	170	2015
8	Ülker Deniz Ürünleri A.Ş.	Net Cage	Grow-out	60	2019
9	Başar Cage Trout Facility	Net Cage	Grow-out	170	2019
10	İlgaz-2 Cage Trout Facility	Net Cage	Grow-out	200	2020
11	Başar-2 Cage Trout Facility	Net Cage	Grow-out	200	2020
12	İlgaz-3 Cage Trout Facility	Net Cage	Grow-out	200	2021
13	Başar-3 Cage Trout Facility	Net Cage	Grow-out	200	2021
Total production capacity =				1376.5	

### 3.2. Discussion

There are a total of 13 fish farms in Kastamonu province and the first of these farms was established in 1992. While the first four farms were established, they also established hatcheries to produce their own fry, but they had problems in the management of these hatcheries for a long time. One of the main problems was the high level of lime in the plant water and the resulting mortality of eggs during the incubation process.

While the capacity of fish farms established in Kastamonu province was quite limited with 167.5 tons/year between 1992-2014, there has been a rapid increase in the licensed capacity of the farms after 2015. This increase was realized with the issuance of aquaculture licenses in the dams located within the provincial borders and the capacity reached 1376.5 tons/year. Today, many entrepreneurs are waiting and applying to the Provincial Directorate of Agriculture and Forestry to obtain aquaculture licenses and make investments. Therefore, the capacity is expected to increase further in the coming years.

Aquaculture facilities established in Kastamonu province were observed in concrete ponds on land or cage systems in inland water resources. However, Kastamonu province, which has a 166 km coastline, has the potential to grow seafood in the Black Sea. This production potential appears as both sea fish and mussel farming potential. Especially the fact that mussels are fed by filtration from the environment without the need for feed input will lead the way in promoting them as an economic production model. Licensing of mussel production facilities with the survey studies to be carried out will ensure that the relevant sector in Kastamonu will become more vibrant and the food supply security of aquaculture products will be secured by increasing the amount of production.

## 4. CONCLUSION

It was difficult to obtain reliable information during the interviews with the producers. While some producers declared that their enterprises were producing above their current capacity, some producers stated that their aquaculture was below their license capacity due to various problems (feed quality, disease, negative water quality changes, fish escaping due to tearing of nets). It is important for the provincial organisation of the Ministry of Agriculture and Forestry to closely monitor aquaculture production in the field and update its records.

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## ORAL PRESENTATION

### New Potential Methods in Aquaculture Against Fish Diseases

**Soner BİLEN**<sup>✉</sup>

*Kastamonu University, Ihsangazi Vocational Collage, Department of Veterinary, Kastamonu, Türkiye*

<sup>✉</sup>**Correspondence:** sbilen@kastamonu.edu.tr

**Abstract:** One of the most important limiting factors in aquaculture is fish diseases. Antibiotics, chemotherapeutic agents, chemicals and some synthetic substances are used in the treatment of fish diseases. However, the best way to protect against diseases is to protect fish from diseases. Today, there are many applications such as vaccines, immunostimulants and probiotics to protect fish from diseases. With recent developments in vaccine applications, more successful results have been obtained against viral diseases. In this review, it is focused on possible vaccine-immunostimulant combination applications in aquaculture industry.

**Keywords:** Fish Diseases, Vaccines, Immunostimulants, Vaccine-Immunostimulant Combination.



## ORAL PRESENTATION

### Determination of Cefazolin Genotoxicity in Human Lymphocytes by Micronucleus Test

**Ahmet Ali BERBER<sup>1</sup>, Şefika Nur DEMİR<sup>2</sup>, Nihan AKINCI KENANOĞLU<sup>3</sup>✉, İbrahim UYSAL<sup>1</sup>**

<sup>1</sup>Çanakkale Onsekiz Mart University, Çanakkale Vocational School of Health Services, Department of Medical Services and Techniques, Çanakkale, Türkiye

<sup>2</sup>Çanakkale Onsekiz Mart University, School of Graduate Studies, Department of Biology, Çanakkale, Türkiye

<sup>3</sup>Çanakkale Onsekiz Mart University, Faculty of Sciences, Department of Biology, Çanakkale, Türkiye

✉Correspondence: nakinci@comu.edu.tr

**Abstract:** Cefazolin is a semi-synthetic antibiotic of the first generation cephalosporin group. While it is highly active against gram-positive bacteria, it has limited activity against gram-negative bacteria. Due to its wide spectrum of activity, it is used in the treatment of various serious infections such as pharyngitis, skin infections and endocarditis, and even as a prophylactic treatment before surgery. In this study, the genotoxicity of cefazolin, which is used in increasing amounts today, was evaluated by micronucleus test and nuclear division index in human lymphocytes *in vitro*. For this purpose, peripheral blood, taken from a healthy woman and a man aged 20-25, who do not smoke or consume alcohol, was cultured and then exposed to 3.52, 7.04, 14.08 and 28.16 µg/ml concentrations of cefazolin for 48 hours. According to the data obtained, a concentration-dependent and statistically significant increase was detected in all concentrations except the lowest concentration 3.52 µg/ml of cefazolin. On the other hand, no statistically significant change was detected in the nuclear division index at any concentration of cefazolin compared to the control. When all the results are evaluated together, it should be taken into consideration that cefazolin may be clastogenic/aneugenic and therefore genotoxic, and it is recommended to use it with caution.

**Keywords:** Cefazolin, Genotoxicity, Antibiotics, MN Test.

## ORAL PRESENTATION

### Determination of the Relationship between Total Length and Body Width of Two Shrimp Species for Use in Selective Shrimp Grids in Trawl Fishing in İskenderun Bay

Aydın DEMİRCİ<sup>✉</sup>, Sevil DEMİRCİ, Emrah ŞİMŞEK

İskenderun Technical University, Faculty of Marine Sciences and Technology, Hatay, Türkiye

<sup>✉</sup>Correspondence: aydin.demirci@iste.edu.tr

**Abstract:** This study was conducted in the İskenderun Bay using trawl fishing methods, aimed to measure the carapace length and body width of the shrimp species, *Penaeus semisulcatus* and *Metapenaeus stebbingi*. Data were collected in 2013, utilizing 101 specimens of *P. semisulcatus* and 112 specimens of *M. stebbingi*. The results obtained provide insights into the optimal grid aperture size in shrimp selection grids to allow these species to escape. The measured total lengths ranged between 14-26 cm, with body widths varying from 1.5-4.5 cm for *P. semisulcatus*. For *M. stebbingi*, the body length ranged from 7-13 cm and the body width between 0.8-1.8 cm. The relationships between total length and body width are described by the linear equations:  $Width = 0.2048 \times Length - 10.871$  for *P. semisulcatus* and  $Width = 0.1321 \times Length - 1.0741$  for *M. stebbingi*. Based on these results, it is suggested that these size ranges should be considered when designing shrimp selection grids for trawl fishing in the region.

**Keywords:** Shrimp, Trawl, Grid selectivity, İskenderun Bay.

## 1. INTRODUCTION

İskenderun Bay has a great fishing activities implemented in Türkiye's Mediterranean coast (Demirhan et al., 2020; Akar et al., 2022). In the fishing area shrimp trawl fisheries is intense because that area has the high population of shrimp of coastal which has very high economic value (Can et al., 2004). Several local and migrating (Indian and Atlantic) shrimp species with rather high commercial value inhabit the Bay (Öztürk, 2021). In the area nine species including *Farfantepenaeus aztecus*, *Fenneropenaeus merguensis*, *Marsupenaeus japonicus*, *Melicerus hathor*, *Melicerus kerathurus*, *Metapenaeus monoceros*, *Metapenaeus stebbingi*, *Parapenaeus longirostris*, and *Penaeus semisulcatus* (Kumlu et al., 1999). The İskenderun Bay's shrimp species stocks have economic importance for the region fishery as well as, has built its reputation, especially the green tiger shrimp (*P. semisulcatus*) (Avşar et al., 2016). The choice of the very rich cuisine, the "Jumbo (large) shrimp" term is deeply integrated with İskenderun Bay. The green tiger shrimp is one of the world's most important caught penaeids, and the main target for the İskenderun trawl fishery (Demirci 2006; Demirci et al., 2008). Demersal fishing area of İskenderun Bay has important for shrimp stocks, but because of the rich species diversity discard and non-target catch rates was very high. In the fishing area, it has reported for the total catch the shrimp trawl fisheries as discard ratio 40 % and non-target catch ratio 30 % (Demirci, 2006).

In general, shrimp trawl fishery has characterized non-selective fishing gear because of high numbers of fish species and other marine organism (Labropoulou and Papaconstantinou, 2004; Demirci et al., 2012; Şimşek, 2012; 2018; Demirci and Şimşek, 2018). In the non-selective fishing gear, non-target catch reduction devices (BRD), one of the most effective, have used worldwide. (Broadhurst and Kennelly, 1996; Broadhurst et al., 2002; 2012; Scandol et al., 2006; Boopendranath et al., 2008; Lopez and Gisbert, 2009). This BRD functions by allowing organisms smaller than the spaces between the bars of an inclined grid in the trawl extension to pass through and into the codend, while directing larger individuals up through an escape exit.

Some similar multispecies shrimp trawl fisheries have implemented selective devices for trawl fleets, referred to as by-catch reduction devices. Based on the behavioral differences between fish and crustacean species when encountering a grid device (Isaksen et al., 1992; Fonseca et al., 2005), these selective devices have proven successful at reducing

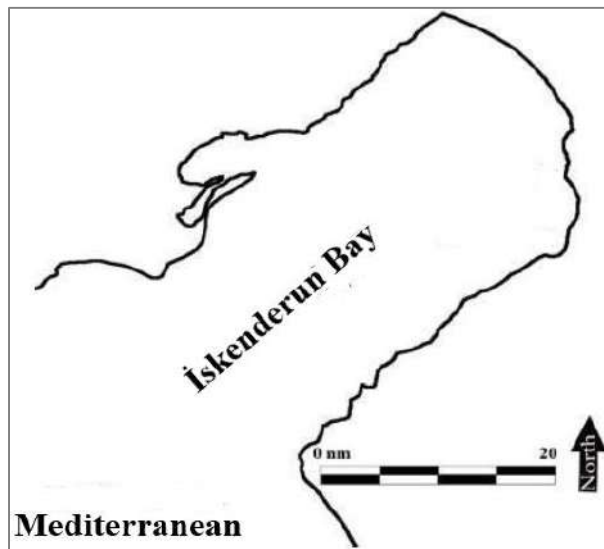
unwanted by-catch without excessive loss of target species (Isaksen 1984, Isaksen et al. 1992, Broadhurst 2000; Broadhurst et al., 2009).

While the above results are positive, they are unlikely to represent the full potential of the Nordmøre-grid for improving selectivity for shrimp trawl fishery in the area (Demirci et al., 2018). Türkiye's initiative in reducing off-target catch of trawlers, Aydın et al. (2011) assessed the NORDMØRE-grid applications.

## 2. MATERIALS AND METHODS

In this study, we have attempted to establish the relationship between the total length and body width of two dominant fish species caught in the Trawl fishery of the Iskenderun Bay namely *Metapenaeus stebbingi* and *Penaeus semisulcatus*. This relationship was modeled linearly using linear regression, to identify fish sizes that correspond to suitable dam openings.

This study was conducted in the İskenderun Bay, shrimp trawl fisheries is intense. A totally of 213 samples (101 specimens of *Penaeus semisulcatus* and 112 specimens of *Metapenaeus stebbingi*) were collected in 2013 (Figure 1). To analyze data, linear regression was used as the methodology in this study.



**Figure 1.** Study area.

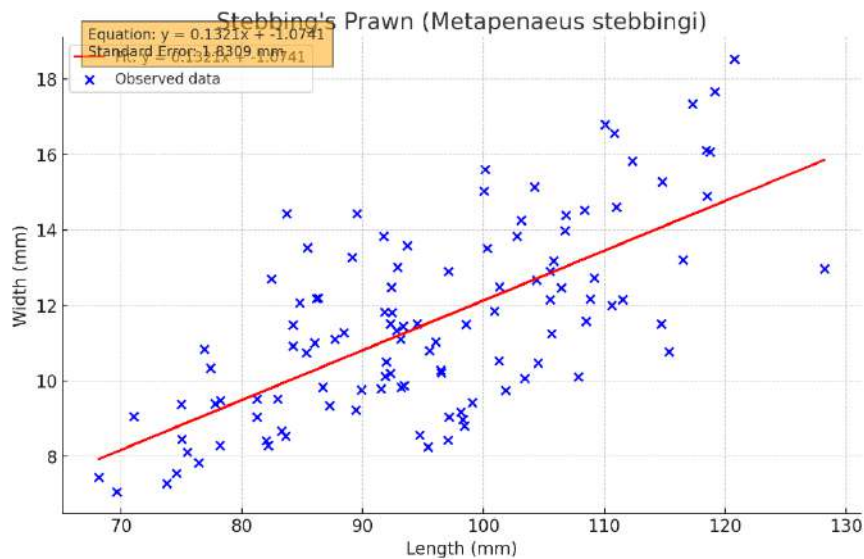
## 3. RESULTS AND DISCUSSION

In the study, the results obtained for both shrimp species are presented in Table 1, while graphs related to *M. stebbingi* are shown in Figure 2. The results for *P. semilucatus* are provided in Figure 3. The body length distribution of *M. stebbingi* shrimp varies from 7 to 13 centimeters, with body widths ranging from 0 to 1.8 centimeters. For *P. semilucatus* shrimp, body lengths range from 14 to 24 centimeters, and body widths vary from 1.5 to 4 centimeters. The relationships between total length and body width are described by the linear equations:  $Width = 0.2048 \times Length - 10.871$  for *P. semisulcatus* and  $Width = 0.1321 \times Length - 1.0741$  for *M. stebbingi*.

**Table 1.** Measurements of samples.

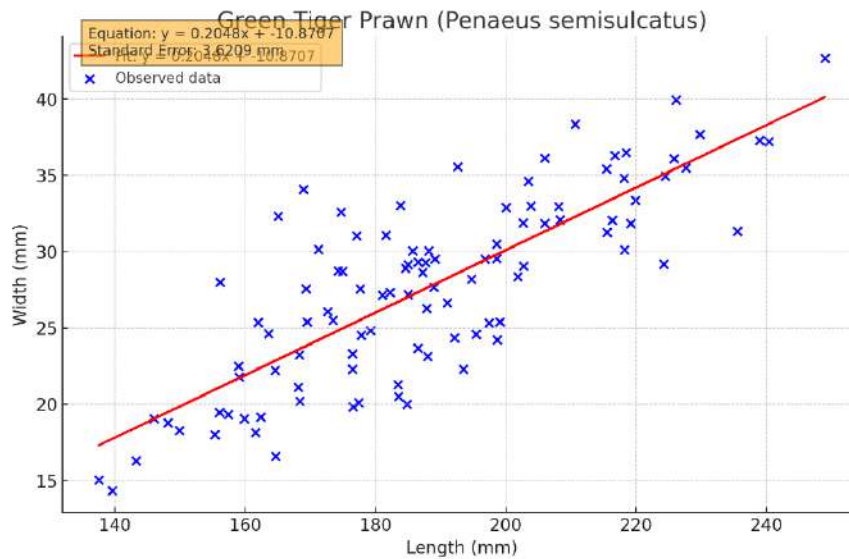
	<i>M. stebbingi</i>		<i>P. semisulcatus</i>	
Measurement	Length (mm)	Width (mm)	Length (mm)	Width (mm)
Min	68.16	7.06	137.53	14.32
Max	128.21	18.53	249.00	42.67
Mean	95.51	11.54	188.00	27.64
Std. Dev.	12.97	2.51	24.21	6.15

This table shows the minimum, maximum, mean, and standard deviation values for both "Length (mm)" and "Width (mm)" measurements in the *M. stebbingi* and *P. semisulcatus* datasets.



**Figure 2.** The relationships between total length and body width of *M. stebbingi*.

In the trawl fisheries of the İskenderun Bay, the selection grid spacing is a critical component that determines the bycatch and the sustainability of the shrimp population. The analysis presented in Figure 2 and Figure 3 illustrates the relationship between the length and width of the two most commonly captured shrimp species in this region: *Metapenaeus stebbingi* (Stebbing's Prawn) and *Penaeus semisulcatus* (Green Tiger Prawn). The linear regression models underscore the size variation and the potential grid sizes that could optimize the selectivity for each species.



**Figure 3.** The relationships between total length and body width of *P. semisulcatus*.

For *Metapenaeus stebbingi*, with a mean width of approximately 11.54 mm, and *Penaeus semisulcatus*, with a mean width of 27.64 mm, the selection grids should be designed to facilitate the escape of smaller, non-target species while retaining the commercially valuable shrimps. The calculated body width indices serve as a benchmark for configuring the bar spacing, which should exceed the mean width of the target species to reduce juvenile catch and enhance the sustainability of the shrimp stocks.

The standard deviation values, indicating the variability within the species sizes, further inform the grid design to accommodate the size range. A grid spacing that accounts for the mean plus one standard deviation could allow the majority of adult shrimps to be retained while excluding most juveniles, thus promoting a more sustainable fishing practice.

#### 4. CONCLUSION

In conclusion, the body width indices derived from these analyses are instrumental in informing the selection grid design in the İskenderun Gulf's trawl fisheries. By tailoring the grid spacing to the morphological data of *Metapenaeus stebbingi* and *Penaeus semisulcatus*, fisheries managers can enhance species- and size-selectivity, thereby supporting both conservation efforts and the economic viability of the fisheries. Implementing a grid system to simultaneously separate these species from other catch compositions does not appear straightforward, as *M. stebbingi* shrimp can pass through a lower bar range due to their small size, while *P. semilucatus* individuals require a bar range of at least 4 centimeters. Considering the region's fusiform and laterally compressed fish species, many fish types have the potential to end up in the same net as the shrimp. Therefore, in this region, it is not easy to selectively separate shrimp and other marine life solely based on the bar spacing of grid selection.

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## ORAL PRESENTATION

### **An Evaluation of Türkiye's Aegean and Mediterranean Island Claims in Light of the United Nations Convention on the Law of the Sea Provisions on Territorial Waters and the Continental Shelf: Comparative Analysis with Other Regional Case Studies**

**Özkan AKAR<sup>1</sup>✉, Aydın DEMİRCİ<sup>2</sup>**

<sup>1</sup>*İskenderun Technical University, Maritime Vocational School, Hatay, Türkiye*

<sup>2</sup>*İskenderun Technical University, Faculty of Marine Sciences and Technology, Hatay, Türkiye*

✉**Correspondence:** ozkan.akar@iste.edu.tr

**Abstract:** This study evaluates Türkiye's positions on the Islands issue in the Mediterranean and Aegean Seas. The Mediterranean and Aegean Seas are of significant geopolitical and economic importance for Türkiye. In these waters, there exist maritime jurisdictional disputes between Türkiye and the Turkish Republic of Cyprus on one side, and Greece, the Greek Cyprus, Egypt, and Israel on the other. Especially in recent years, disagreements related to the islands and the continental shelf with Greece have come to the forefront. Although Türkiye is not a signatory to the United Nations Convention on the Law of the Sea (UNCLOS), it advocates certain positions based on the general principles of international law. Article 76 of UNCLOS allows for the continental shelf of coastal states to extend up to 200 nautical miles from the outer boundary of their territorial sea. Article 121 of UNCLOS stipulates, "Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf." Citing these provisions, especially Article 121, Türkiye argues that considering the distance from the coast, size, and population of certain islands in the Aegean Sea (such as Megisti, Rho, and Fener Islands) under Greece's control, these islands are essentially rocks and should not have a continental shelf or an exclusive economic zone. Even if Türkiye isn't a party to UNCLOS, it respects and acts in accordance with the general principles of international law, striving to adhere to the stipulations of UNCLOS when dealing with island disputes. Türkiye seeks to resolve these disputes in line with the UNCLOS framework, referencing regional examples from other parts of the world where similar disputes have been addressed. When compared with other regional cases, the consistency in Türkiye's positions regarding the Mediterranean and Aegean Seas is evident. Therefore, unjustly siding with Greece can be perceived as a preference for ongoing discord rather than resolution. A consensus rooted in the general principles of international law and regional precedents can equitably uphold the rights of all involved communities.

**Keywords:** Island Dispute, Law of the Sea, Continental Shelf, Territorial Waters.

## **1. INTRODUCTION**

The seas, covering over two-thirds of the world's surface, play a crucial role not only in connecting lands but also as a habitat for diverse living organisms and a repository for non-living resources (Russel and Yonge, 1960). These resources are fundamental for meeting the basic needs of humanity. Beyond serving basic human needs, the seas are vital for transportation, tourism, military, and research activities (Can et al., 2020; Demirci et al., 2020; Kaya and Can, 2022). Maritime transportation, in particular, holds a significant position in the global economy (Akar et al., 2021). In recent years, due to the decreasing availability and quantity of terrestrial non-living resources, marine areas have come to the forefront. The process of creating marine areas, especially in the 20<sup>th</sup> century, has been driven by the search for alternative resources to meet the increasing energy demands as terrestrial reserves start to dwindle. However, the process of searching for, extracting, and bringing these marine resources into service is both technologically demanding and time-consuming. Only a limited number of countries globally possess the technology for such operations.

Maritime zones stretch from the coast into the deep sea and consist of different regions with distinctive characteristics. These are defined as 'Territorial Waters', within the sovereignty of a state; 'Exclusive Economic Zones (EEZ)', where a state has special exploration and use rights; 'Continental Shelf', considered as the natural extension of a state's land territory under the sea; and 'High Seas', which are open for use by all states beyond any national jurisdiction.

The classification and limitations of these maritime areas aim to regulate the rights of coastal states over sovereignty, usage, and benefits derived from these zones. Efforts have been made to determine the rights and responsibilities concerning the use of the seabed, subsoil, and airspace.

Key legal frameworks such as the 1927 Lausanne Treaty, the 1945 Truman Proclamation, the 1958 Geneva Conventions on the Law of the Sea, and the 1982 United Nations Convention on the Law of the Sea (UNCLOS) have shaped these maritime jurisdictions. These documents define the maritime areas and set out how coastal states should act within these zones, and what rights and authorities they have, along with providing mechanisms for resolving any arising disputes.

Despite the establishment of various regulations regarding the use of maritime zones, discrepancies in their implementation are evident in international disputes. Most disputes reviewed in international courts concern territorial waters and continental shelves among neighboring coastal countries. To resolve these issues, international legal norms, as well as customary international law, have been utilized.

In this context, Türkiye's position in the Mediterranean Sea is of particular interest. Türkiye faces several territorial disputes in both the Mediterranean and the Aegean Sea concerning territorial waters and continental shelf claims (Yüksel, 2022). At the heart of these disputes lies the status of islands in maritime law and the rights they confer to coastal states. Specifically, the sovereignty of numerous small islands and islets in the Aegean Sea has been a longstanding issue between Türkiye and Greece.

The objective of this study is to examine and assess Türkiye's claims in these strategic waterways and natural resource basins in light of the provisions of UNCLOS. By comparing Türkiye's maritime legal perspective in the Mediterranean with similar disputes in other regions, this study aims to provide a comprehensive understanding of regional and international maritime law practices. Such an assessment will shed light on the legal and political challenges faced by both Türkiye and other regional countries, potentially guiding the resolution of these disputes.

## **2. EASTERN MEDITERRANEAN AND AEGEAN SEA BORDERS AND DISPUTES: GLOBAL EXAMPLES**

The maritime boundaries in the Eastern Mediterranean and the Aegean Sea encompass a web of disputes involving a range of countries including Türkiye, Greece, and Cyprus. These disputes often involve issues related to territorial claims, maritime jurisdictional rights, access to natural resources, and interpretations of international law, particularly the United Nations Convention on the Law of the Sea (UNCLOS) (Korman, 2010; Wakefield 2016; Winrow, 2016; Prontera, 2017). Examining global examples can provide context and parallels to these complex issues. Here are some notable international cases:

### **2.1. North Sea Continental Shelf Cases (1969)**

The cases involving Germany, Denmark, and the Netherlands addressed the principles for delineating the continental shelf between states when there is no natural prolongation of their land territory. The key dispute was the method to be used for this delimitation. Germany argued for a principle of equitable distribution, while Denmark and the Netherlands advocated for the equidistance principle. The International Court of Justice (ICJ) ruled against a rigid application of equidistance, stating that delimitation should be done on a case-by-case basis using equitable principles, considering the unique geographical and circumstantial factors (Marston, 1969).

### **2.2. English Channel Continental Shelf Case (1975)**

This arbitration concerned the delimitation of the continental shelf between the United Kingdom and France in the English Channel. While both parties agreed in principle that the equidistance method could provide a logical basis for delimitation,

they disagreed on where the equidistance line should be drawn. The arbitral tribunal took into account factors such as the configuration of the coastlines, the presence of islands, and historic rights, among others (Gray, 1993).

### **2.3. Tunisia-Libya Continental Shelf Case (1981)**

The ICJ was asked to determine the boundary of the continental shelf between Tunisia and Libya in the Mediterranean Sea. The court incorporated principles of equity and relevant geological and geomorphological characteristics of the continental shelf to reach its decision. The ruling highlighted the importance of considering the natural prolongation of the respective territories of each state (Feldman, 1983).

### **2.4. Gulf of Maine Case (1984)**

The dispute between Canada and the United States regarding the delineation of the maritime boundary in the Gulf of Maine area was brought before the ICJ. The court reiterated that the continental shelf and the exclusive economic zone (EEZ) are subject to different legal regimes and may therefore require different delimitation methodologies. The decision emphasized that the equidistance principle could not be applied universally and automatically (McRae, 1993).

### **2.5. Libya-Malta Continental Shelf Case (1985)**

In the case concerning the determination of the continental shelf boundaries between Libya and Malta, the International Court of Justice (ICJ) rendered a decision on June 3, 1985, which set a precedent in the Mediterranean for the application of the principle of equity in delineating maritime boundaries between these two countries (McGinley, 1985). The ICJ considered the following factors in its decision:

- The length and shape of the coastlines
- The structure and depth of the seabed
- Ocean currents and winds
- Economic interests

These factors formed the basis for a fair boundary determination process.

### **2.6. Saint Pierre and Miquelon Islands Case (1992)**

In determining the continental shelf boundaries around the Saint Pierre and Miquelon Islands between France and Canada, an arbitration tribunal in 1992 applied the principle of equity instead of the equidistant principle (Politakis, 1993). The tribunal took the following elements into account to reach a fair solution:

- The size and shape of the islands' coastlines
- The depth of the coastlines
- The structure of the seabed
- Ocean currents and winds
- Economic interests

As a result, the tribunal established a corridor ensuring the islands' access to the open sea.

### **2.7. Jan Mayen Case (Denmark vs. Norway)**

The Jan Mayen Case between Denmark and Norway concerned the determination of the continental shelf boundaries between Greenland and the island of Jan Mayen. Denmark advocated for the extensive area and lengthy coastline of Greenland, while Norway put forth the rights of Jan Mayen. The ICJ, considering geological conditions and the balance between the two islands, drew a median line. This case serves as a significant example of how principles of justice and equity can be applied in maritime delimitation between islands (Churchill, 1994).

## **2.8. Eritrea-Yemen Arbitration (1996-1998)**

The maritime dispute between Eritrea and Yemen over the sovereignty of the Red Sea islands and the delimitation of maritime boundaries was initiated in 1996 and concluded in 1998 through an arbitration process (Kwiatkowska, 2001). The Arbitral Tribunal, in its decision-making process, primarily applied the principle of geographical proximity, which dictates that sovereignty over a territory or an island generally belongs to the country that is geographically closest to it.

During the first phase, the Tribunal determined the sovereignty over the disputed islands, and the majority were awarded to Yemen based on their proximity to Yemeni coasts. In the second phase, the Tribunal delineated the maritime boundaries, including territorial waters, continental shelf, and exclusive economic zones (EEZ). While adhering to the principle of equidistance for the delimitation of these maritime zones, the Tribunal also considered special circumstances, such as the presence of the islands, international navigation routes, and interests of third states. These decisions are regarded as significant precedents in international law for maritime boundary delimitation.

## **2.9. Qatar v. Bahrain (2001-2008)**

The dispute between Qatar and Bahrain concerned maritime boundary delimitation in the Persian Gulf and began in 2001, concluding in 2008. The International Court of Justice (ICJ) addressed this dispute in two phases. Initially, the ICJ determined the sovereignty over disputed territories and islands, applying the principle of geographical proximity to ascertain to which nation these belonged.

For the delimitation of maritime boundaries, the ICJ adopted the principle of equidistance, but it also emphasized that special circumstances must be taken into account. These included the presence of islands, international sea lanes, and the interests of third states. The ICJ's rulings in this case have been highlighted as a critical milestone in the field of international law, underscoring the importance of principles such as geographical proximity, special circumstances, and equity in the determination of maritime boundaries (Kwiatkowska, 2010).

## **2.10. Cameroon v. Nigeria (1994-2002)**

The legal proceedings between Cameroon and Nigeria over their land and maritime boundaries started in 1994 and were resolved by 2002. The ICJ, in determining the land boundary, employed the principle of equidistance. When it came to maritime delimitation in the Gulf of Guinea, the Court considered not only the equidistance principle but also special circumstances such as the concavity of the coast, the relative lengths of the coastlines, and the presence of islands.

In both the determination of land and sea boundaries, the Court also took into consideration historical treaties and colonial-era documents that were pertinent to the case. The ICJ's judgments settled the significant territorial dispute between Cameroon and Nigeria and also awarded sovereignty over the resource-rich Bakassi Peninsula to Cameroon. This case is particularly noted for its contribution to the jurisprudence on the role of historical agreements and equitable principles in international boundary disputes (Oduntan, 2007).

## **3. AEGEAN SEA CONTINENTAL SHELF DISPUTES**

The Aegean Sea continental shelf dispute is a longstanding disagreement between Türkiye and Greece over how to determine maritime boundaries and continental shelves in the Aegean Sea. This dispute arises from the differing interpretations of the two countries regarding the rights to maritime boundaries and continental shelf areas associated with the islands in the Aegean Sea (Koymen, 1978). While Greece asserts that the islands have full continental shelf rights, Türkiye contends that the continental shelf associated with these islands belongs to it and that the islands should be treated specially under maritime law. This difference has created a point of contention between the two countries, leading to an impasse on how to delineate maritime borders in the Aegean Sea.

### **3.1. Turkish Legislation on Territorial Waters**

In Turkish legislation, the breadth of territorial waters has been a subject of strategic importance, especially considering the unique geographical situation of the Aegean Sea. On May 15, 1964, Türkiye enacted Law No. 476, "The Law on

Territorial Waters," which set the breadth of its territorial waters at six nautical miles. Any breadth beyond six nautical miles was contingent upon the principle of "effective reciprocity."

Following this law, Türkiye applied a six nautical mile breadth to its territorial waters in the Aegean Sea, resulting in the current balance where 48.85% of the Aegean consists of high seas, 43.68% is Greek territorial waters, and 7.47% is Turkish territorial waters.

Law No. 476 allowed for a wider breadth of territorial waters under the principle of reciprocity and preserved the right to use normal baseline or straight baseline methods for measuring the breadth of territorial waters as deemed appropriate by International Law. In places where the opposite coasts are less than six miles apart, the median line rule has been used, which, in practice, has constituted the boundary of territorial waters between Türkiye and Greece (Kibaroglu et al., 2005).

However, due to the disadvantages arising from the principle of "effective reciprocity," which leaves the initiative to expand territorial waters to other states, Law No. 476 was repealed by the Law No. 2674, enacted on May 26, 1982. One of the purposes of enacting the new law was to clarify Türkiye's stance on the breadth of its territorial waters post-United Nations Convention on the Law of the Sea (UNCLOS, 1982).

As in the previous Law No. 476, the new law acknowledges the territorial waters' breadth as six nautical miles. It grants the Council of Ministers the authority to determine a breadth greater than six nautical miles under certain conditions, considering all the characteristics and circumstances of specific seas and adhering to the principle of equity. Based on this authority, the Council of Ministers has decided to maintain the status quo in the Black Sea and the Mediterranean Sea, which existed before the law came into force.

Today, Türkiye's territorial waters are six nautical miles in the Aegean Sea and twelve nautical miles in the Black Sea and the Mediterranean. Law No. 2674 does not contain the "Principle of Reciprocity," explicitly abolishing the relevant article of Law No. 476. This amendment was aimed, among other reasons, at eliminating the dangers that could arise from leaving the initiative to expand territorial waters to other states (Yıldız, 2020).

Article 2 of Law No. 2674 stipulates that territorial waters between Türkiye and states with adjacent or opposite coasts are delimited by agreement, taking into consideration all relevant characteristics and circumstances in accordance with the principle of equity.

With Law No. 2674, Türkiye has clarified the meaning of the reciprocity principle from its perspective and aligned its internal law with its stance at the Third United Nations Conference on the Law of the Sea. The new law's Article 2 clearly defines Türkiye's attitude concerning the delimitation of territorial waters.

The law emphasizes the principle of equity, both in its first and second articles. The Council of Ministers, in deciding according to the principle of equity, will also consider the principle of reciprocity.

### **3.2. Greek Legislation on Territorial Waters**

Greece, upon ratifying the 1982 United Nations Convention on the Law of the Sea in 1995, obtained the right to extend its territorial waters to twelve nautical miles. However, Greece aims to apply this right in the Aegean Sea, disregarding Articles 15 and 300 of the Convention (Roucounas, 1997).

According to the law adopted by the Greek Parliament on May 31, 1995, Greece reserves the right to extend its territorial waters to twelve nautical miles at any time.

If Greece were to exercise this right, over 70% of the Aegean Sea would become Greek territorial waters, less than 9% would be Turkish territorial waters, and approximately 19% would remain as high seas. This would severely restrict Türkiye's freedom of movement in the Aegean Sea and relinquish its rights over the continental shelf.

Greece argues that the third article of the Convention has become part of customary international law. However, this cannot form customary law, and even if it could, it would not be applicable against Türkiye, given Türkiye's consistent objections from the formation stage of this rule.



In many parts of the Aegean Sea, the distance between Turkish and Greek islands is less than two to three nautical miles. Even if the maritime boundary were drawn based on the median line principle considering the proximity of the islands to the Anatolian coast, it would not comply with the principle of equity in international law (Yorucu and Mehmet, 2022).

If Greece were to insist on a twelve nautical mile territorial sea, a serious imbalance would emerge in the Aegean Sea, adversely affecting relations between the two countries.

Türkiye and Greece have been in negotiations for years to resolve the territorial waters issue in the Aegean Sea, with both parties adhering to their national legislation and perspectives. While Türkiye bases its claims on the principle of equity, Greece relies on its interpretation of international law. The Law No. 2674 enacted by Türkiye is the legislation that defines the breadth of Turkish territorial waters and outlines the principles by which Türkiye is guided in determining its maritime boundaries with neighboring states. The legislation allows for a possible increase in the breadth of territorial waters but has maintained the status quo due to geopolitical and strategic considerations in the Aegean Sea.

#### 4. CONCLUSION

When Türkiye's theses in the Mediterranean and the Aegean Sea are compared with other regional examples, it is evident that they are consistent. Therefore, the Greek the settlement of disputes with Türkiye will be possible by reaching a compromise based on the general principles of international law and regional precedents.

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## ORAL PRESENTATION

### Prospects for the Application of Adsorbent Substances and Growth Stimulants in the Creation of Phytomeliorative Plantings on the Drained Bottom of Aral Sea

**Dani SARSEKOVA<sup>1✉</sup>, Abayeva KURMANKUL<sup>1</sup>, Dosmanbetov DANIYAR<sup>2</sup>, Ruslan AKHMETOV<sup>2</sup>, Ibrayeva ALIYA<sup>1</sup>**

<sup>1</sup>Kazakh National Agrarian Research University, Almaty, Kazakhstan

<sup>2</sup>Almaty branch of LLP "A.N. Bukeikhan Kazakh Scientific Research Institute of Forestry and Agroforestry", Kazakhstan

✉Correspondence: dani999@mail.ru

**Abstract:** This article examines the prospects for using adsorbent substances and growth stimulants to create phytomeliorative plantings on the dried bottom of the Aral Sea. The Aral Sea is suffering from an environmental crisis caused by its extensive exploitation, which has led to dehydration and soil degradation. The use of adsorbent materials can reduce soil contamination with sand, salt and toxic substances, improve its structure and fertility. Growth stimulants, in turn, contribute to the active development of plants, increasing their resistance to stressful conditions and accelerating phytomelioration processes. The article analyzes various adsorbent substances and growth stimulants, examines their effectiveness and possible methods of use in the conditions of the Aral Sea. The work can serve as the basis for further research and development of specific methods for restoring the Aral Sea and its biological diversity.

**Keywords:** Aral Sea, Adsorbing Substances, Growth Stimulants, Phytomeliorative Plantings, Salinity of Soils.

#### 1. THE ARAL SEA AND ITS CURRENT STATE

The Aral Sea, located in Central Asia, was once considered the fourth largest inland body of water in the world. However, since the 1960s, the Aral Sea has faced one of the most serious environmental disasters in history. The main cause of this disaster was the drying up of the Amudarya and Syrdarya, the two main rivers that fed the sea, for irrigation of agricultural land in the Central Asian republics [1].

As a result of this desiccation, the water level in the Aral Sea has significantly decreased, and its area has decreased by more than four times. This led to the division of the sea into two parts - the Northern and Southern Aral Sea. The Northern Aral Sea experienced a slight recovery after Kazakhstan started pumping water from the Syrdarya River, but the southern part remains a highly concentrated salt lake [2].

Problems of salt tolerance of plants in the region:

Salinity of soils and waters in the Aral Sea region has become one of the most serious environmental problems. High concentrations of salts, especially sodium salts, make soils and water incompatible for many plant species. This complicates the cultivation of cultivated plants and leads to a decrease in biodiversity in the region. Plants grown in such conditions must be salt-resistant, excluding many conventional crops [1].

#### 2. ECOSYSTEM DISTURBANCE AND THE EFFECT OF SALT ON THE SOIL

Changing the ecosystem of the Aral Sea has far-reaching consequences. The imbalance of aquatic and terrestrial ecosystems has led to a reduction in the number of fish species and other aquatic organisms. A large volume of water was lost, which caused the almost complete disappearance of many bird species that previously depended on the sea as a nesting site and a place of resettlement [3].

In addition, salt marshes and saline soils, which appeared as a result of the drying of the Aral Sea, turned out to be very salty. This salinity makes it difficult to grow plants and threatens agriculture in the region.

In general, the Aral Sea and its environment have become a symbol of environmental challenges and show the importance of research and efforts to restore this unique region [4].

### 3. PHYTOMELIORATION AND ITS SIGNIFICANCE

Phytomelioration is the process of using plants to improve soil quality and restore damaged ecosystems. This method is widely used in regions with degraded or polluted soils, such as salt marshes around the Aral Sea. Phytomelioration has a number of advantages, including reducing soil erosion, improving its structure and restoring biodiversity [5].

Plants for phytomelioration in the Aral Sea region:

In the Aral Sea region, phytomelioration has become a key tool for soil restoration and biodiversity. Since the 80s of the last century and up to the present, planting and sowing of black saxaul have been carried out on the drained bottom of the Aral Sea. Domestic scientists have conducted various studies of black saxaul plantings [6,7,8,9]. The results were used to carry out phytomeliorative work on the drained bottom of the Aral Sea. The soils of the drained bottom are diverse. Since there used to be a sea in these lands, the practical soils there are saline, and it is recommended to create salt-resistant plants in these saline soils.

For this purpose, salt-resistant plants are used, which are able to survive and grow in conditions of high salinity and harsh climatic conditions [4]. Some of the most effective plants for phytomelioration in this region include:

1. Salt herbs: Such as salt marsh, cherry plum, Artemisia and salt marsh borage. These plants are well adapted to the salinity of the soil and can help in their purification.
2. Saltpetre grouse: This species is used to restore saline soils and restore biodiversity.
3. Lesser Sandstone: A plant capable of withstanding high concentrations of salts in the soil and having a positive effect on reducing salt marshes.
4. Saltpeter shrub: This species is an important element of the restoration of salt marshes and water basins [10].

The choice of specific plants for phytomelioration depends on the type of soil, climatic conditions and restoration goals in the area.

Phytomelioration is an effective tool for restoring the Aral Sea region and combating problems associated with soil salinity. This method contributes to the restoration of the ecosystem and biodiversity in the region and its development is an important aspect in the field of environmental research [11].

### 4. ADSORBENTS AND THEIR ROLE IN PHYTOMELIORATION

Adsorbents are materials that are able to attract and retain harmful substances, including salts, from the environment. In the context of phytomelioration of saline soils in the Aral Sea region, adsorbents can be used to reduce the concentration of salts in the soil. This makes it possible to create more favorable conditions for the growth of salt-resistant plants [12].

Some types of adsorbents that may be useful in this context include:

1. Clays: Especially montmorillonite, which can adsorb and retain salts and heavy metals.
2. Coal: Coal, including activated carbon, can be used to remove salts and contaminants from the soil.
3. Hydrogel materials: These polymer materials are able to retain moisture and help increase the availability of water for plants in salty soils [13].

Growth stimulants and their role:

Growth stimulants are chemicals that promote the growth and development of plants. In salty and degraded soils, which are found in the Aral Sea region, growth stimulators can be used to increase the yield and salt resistance of plants [14].

Some growth stimulants that may be useful include:

1. Humates: Humates are organic substances that contribute to the improvement of the soil and enhance the absorption of nutrients by plants.
2. Cytokinins: These growth hormones can stimulate cell division and increase overall plant growth.
3. Amino Acids: Amino acids can be used to increase the ability of plants to tolerate stress, including soil salinity [15].

The use of adsorbents and growth stimulants:

To use adsorbents, they can be introduced into the soil so that they adsorb excess salts and heavy metals. Growth stimulants can be applied in the form of solutions that are watered by plants or introduced into the soil. This helps plants better absorb nutrients and cope with stressful conditions.

The use of adsorbents and growth stimulants in combination with salt-resistant plants and phytomelioration can significantly improve the conditions for the restoration of salt marsh soils in the Aral Sea region and contribute to the restoration of biodiversity [16].

Prospects for research in the field of phytomelioration at the bottom of the Aral Sea:

Research in the field of phytomelioration at the bottom of the Aral Sea is of great importance for the restoration of this unique region and mitigation of the environmental consequences of sea degradation [17]. In the future, research may focus on the following aspects:

1. Improvement of phytomelioration technology: Development of more effective methods of phytomelioration, including the use of more effective adsorbents and growth stimulants to improve the results of soil and ecosystem restoration.
2. Study of biodiversity: Research on the restoration and conservation of biodiversity in the Aral Sea region can be key to restore the ecosystem and prevent the extinction of rare species.
3. Selection of salt-resistant plants: Continuation of research aimed at the selection and breeding of new varieties of salt-resistant plants capable of growing in saline soils.
4. Water resources management systems: Research on water resources management to provide the necessary amount of water for plants and ecosystems of the Aral Sea [13].

Potential benefits from the use of adsorbents and growth stimulants:

The use of adsorbents and growth stimulants can bring several significant benefits:

1. Increasing yields: Using these methods, it is possible to increase the yield of salt-resistant crops, which may be important for the nutrition of the local population.
2. Reducing soil and water pollution: Adsorbents can reduce the concentration of salts and heavy metals in soil and water, improving the quality of the environment.
3. Ecosystem restoration: The application of these methods contributes to the restoration of biodiversity and natural ecosystems in the region, which has a beneficial impact on the environment.
4. Mitigating the effects of salt on the soil: Adsorbents can help reduce the harmful effects of salt on the soil, which contributes to sustainable agriculture [18].

Research and practical application of adsorbents and growth stimulants can make a huge contribution to the restoration of the Aral Sea and its environment, as well as contribute to the economic development of the region and improve the quality of life of its inhabitants [16].



## 5. CONCLUSION

Research and application of phytomelioration methods, including the use of adsorbents and growth stimulants, represent critical steps in the restoration of the region around the Aral Sea. The ecological catastrophe associated with the degradation of the sea and salt marshes has created serious challenges for the ecosystem, agriculture and public health.

Our research has shown that phytomelioration with the use of salt-resistant plants, adsorbents and growth stimulants can contribute to soil restoration, increase yields, reduce soil and water pollution, as well as restore biodiversity. However, there is still a lot of work to be done.

Further research should be directed to the development of more effective methods of phytomelioration, selection of new salt-resistant plants and water resources management in the region. These efforts can help restore the Aral Sea ecosystem and mitigate the environmental consequences of degradation.

It is also important to emphasize the importance of cooperation between scientists, governments, and local societies to ensure a sustainable future for the Aral Sea region. Through joint efforts, we can create an environmentally sustainable and prosperous future for this unique region.

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## ORAL PRESENTATION

### Forest Reproduction on the Fires of the Past Years by Types of Forest Growing Conditions in the Ribbon Forests of the Irtysh Region

*Aygerim BEYSEKEYEVA<sup>1</sup>, Dani SARSEKOVA<sup>2✉</sup>, Kurmangul ABAYEVA<sup>2</sup>*

<sup>1</sup>NJSC Toraygyrov University, Pavlodar, Kazakhstan

<sup>2</sup>Kazakh National Agrarian Research University, Almaty, Kazakhstan

✉Correspondence: dani999@mail.ru

**Abstract:** By the Law of the Republic of Kazakhstan dated July 15, 1997 No. 160-1 with amendments and additions dated December 24, 1998, May 11, 1999 No. 381-1, November 29, 1999 No. 488-1, June 4, 2001 No. 205-11, December 24, 2001 No. 276-11, August 9, 2002 No. 346-11 "On Environmental Protection" defines the legal, economic and social foundations of environmental protection, environmental safety, prevention of harmful effects of economic and other activities on natural ecological systems, conservation of biological diversity and organization of rational nature management. The reproduction of hares meets one of the basic principles of the Law "On Environmental Protection" – ensuring environmental safety and restoration of disturbed natural ecological systems in areas with unfavorable conditions. Advanced technologies have been applied in the reforestation of sandy belt hog hares to restore the forest with the least negative impact on the environment and minimal disturbance of the soil cover – planting seedlings along furrows with simultaneous soil treatment and the use of planting material with a closed root system, which significantly reduces the repeated use of tillage equipment that violates the surface of sandy soils and leads to their deflation. Chemicals that pollute the environment (herbicides, mineral fertilizers) are not provided for by the project.

**Keywords:** Dry Steppe, Large-Scale Burning, Renewal of Pine, Reforestation, Reproduction of Hares, Fumes, Survival of Forest Crops.

#### 1. CHARACTERISTICS OF THE FOREST FUND BEFORE THE FIRE

The forests of this region belong to the ribbon forests of the Irtysh region and represent a ribbon-island type, historically formed on the territory of the Republic of Kazakhstan in harsh soil and climatic conditions among treeless steppe spaces and performing important climate-regulating, soil protection and water protection functions.

The main forest-forming species are pine, birch, aspen, poplar and willow tree, of which the predominant is common pine.

In the surveyed area, the weighted average composition of plantings is characterized by the following formula: 9Pine tree 1Birch tree, Aspen+ Poplar, Willow, Maple units, etc. The average percentage of forest cover is 97.5% (Table 3). The predominant completeness of plantings is 0.4-0.7. The average stock per 1 ha was 120-160 m<sup>3</sup>.

#### 2. CURRENT STATE OF THE SURVEYED TERRITORY

In accordance with the statement of the set of areas to be surveyed, during the field period, survey work was carried out on the 1997 fires in the Shaldai forestry with an area of 487.6 hectares (in blocks 65, 66, 67, 68) and in the Sadakashchinsky forestry (blocks 102, 103, 118, 119, 133, 134, 135) with an area of 512.6 hectares on the total area of the State Institution of 1000.2 hectares.

At the time of the survey, large trees damaged by fire were cut down, business sortings were removed and the area is not fully developed cutting areas, cluttered with felling residues, half-rotted deadwood, thin-grained deadwood of individual trees and wings of burned forest crops of previous years.

**Table 1.** Shows the distribution of the surveyed area by employment.

No.	Current state, land categories	Area, ha	%
1	Fumes on forested lands, including:	975,7	97,5
	a) plantings with a completely dead stand with a single renewal (up to 500 pcs/ha)	901,1	90,1
	b) plantings with a completely dead stand with renewal up to 1000 pcs/ha	34,6	3,4
	c) plantings with a completely dead stand with renewal up to 1200 pcs/ha	32,4	3,2
	d) areas of burning on the backstage forest crops of the past years with a completely dead stand	7,6	0,8
2	Fumes on non-forested lands, including:	24,5	2,5
	a) glades and wastelands	24,5	2,5
	Total	1000,2	100

Most of the surveyed territory (97.5%) is occupied by burning with a completely dead stand with insufficient renewal from 500 to 1200 pcs/ha. The predominant type of forest of burnt plantings was 2DP – dry pine forests of low-bumpy hills on sod-boron sands. The burnt-down stand was distinguished by one–two-tiers, different ages (from 30-120 years) and average completeness - 0.4-0.6. Natural renewal in this type of forest is usually extremely slow. Only isolated instances of pine shoots and undergrowth are noted on the burning, which cannot provide natural renewal of the forest.

The grassy cover of the surveyed territory is characterized by a rather poor species composition. The most widespread are grass-grain, cereal-mixed grass, mixed grass with a predominance of small - leaved Canadian association. At the same time, only the grass-grain association is characteristic of pine forests. Of the cereals, fescue is the most common, less often feather grass, reed grass, etc. Various grasses are represented by sedge, kachim, horsetail, moss, linseed, wormwood, etc. on the sands of the pine forests. On sod-boron and meadow soils, bedstraw, licorice, sweet clover, astragal, etc. are added to the listed herbs. Quite significant areas in the surveyed territory are occupied by small-leaved Canadian with minor participation of various grasses (fescue, horsetail, sedge). The rapid spread of this weed began after the fire. An analysis of the areas occupied by the small-leaved Canadian showed that it spreads over areas that had an initial (before the fire) low percentage of coverage (up to 20%) with herbaceous vegetation (dead-cover, high-canopy forests).

The nature and density of the herbage depends on the terrain. On rough surfaces, the percentage of coverage does not exceed 30-40%. On flat sands, the coverage also ranges from 30% to 40% under grass-grass vegetation, and under grass-grass vegetation it can increase up to 50%. On meadow and sod-boron soils, the thickest grass cover (grass-grass vegetation), the projective cover reaches 70-90%.

The number of relatively large stumps (in diameter from 26 to 36-40 cm) ranges from 20 to 220 pieces per 1 ha and on average exceeds 100 pieces per 1 ha.

Burning on the plots of forest crops of previous years (7.6 ha – 0.8%) in the surveyed territory, are represented by plots of 3-row backstage pine crops (the width of the wings is 5-9m with an interstage gap of the same magnitude). At the age of 20-30 years, the average height of trees is 6-7m, the average diameter is 6-8cm, the fullness is 0.7. The wings of crops are almost completely burned out, the burned trees have not been removed, some of them are subject to windfall and infected with pests. The backstage spaces have an average blackening and are cluttered with felling residues from logging in neighboring territories, as well as trees that have fallen on them from the wings. There are no stumps, undergrowth and shoots of pine in the intercool spaces.

The surveyed area included 16 clearings and wastelands (from 0.2 to 8.5 hectares) located among burnt plantings. The blackening of the surface is medium or strong. Clutter and resumption are not marked.

**Table 2.** The presence of dead wood, dead wood and the degree of clutter in the surveyed.

The presence of dry-hardy trees with a trunk diameter of 16-32cm			The presence of dead trees with a trunk diameter of 12-32cm			The area of clutter of the harem			
Dec. m <sup>3</sup>	Trunks, pieces	thousand	Dec. m <sup>3</sup>	Trunks, pieces	thousand	Total area, ha	Including the degree of clutter		
							Strong >50m <sup>3</sup>	Middle 10-5m <sup>3</sup>	Weak <10m <sup>3</sup>
710,0	31,34		6985,9	390,51		1000,2	697,5	260,2	42,5

### 3. ANALYSIS OF THE EXPERIENCE OF FOREST CULTURE WORKS AND RECOMMENDATIONS FOR REFORESTATION OF RIBBON FORESTS

The beginning of forestry work in the belt forests of Kazakhstan dates back to 1907. From 1907 to 1947, forest crops were planted on small plots by planting seedlings and pine seedlings manually under Kolesov's sword. The total area of forest crops preserved since that time is only 170 hectares. Massive reforestation of harems and afforestation on non-forested areas in ribbon forests began in 1948 after the release of the decree of the Council of Ministers of the USSR in 1947. "On the restoration of ribbon hogs in the Altai Territory and the Kazakh SSR". Forest crops in the period from 1948 to the 70s of the last century on areas not covered with forest were created mainly by the backstage type. The width of the wings from 6-9 rows is 9-15m; the width of the strips of untreated soil between the wings is from 4-6 m to 15m. The main types of forest crops during this period were: a) pure pine; b) mixed with the main species of pine and accompanying ash-leaved maple and yellow acacia; c) pine-shelyugovy with alternating four-row wings of pine with three-row of shelyuga.

According to the observations of Smirnov V.E. (1963), in wide plowed strips (wings), when creating forest crops, conditions are created for the development of the deflation process, which causes a high drop in crops and even their complete death. On the other hand, narrow edges in the wings lead to desiccation of the soil by herbaceous vegetation in the extreme rows, which leads to thinning and loss of crops. At the same time, numerous areas of continuous pine crops are characterized, as a rule, by a good condition of plantings.

In the 70-80 years of the last century, mainly 3 types of pure pine forest crops were used in reforestation and afforestation:

- 1 – Solid forest crops;
- 2 – Forest crops by furrows;
- 3 – Forest crops by stripes.

A study of these crops according to Balyasniy V.I. and others (1993) on a total area of 77.6 thousand hectares showed that forest crops created by strips and plow furrows have higher preservation, and the vast majority of crops for continuous soil treatment have died. So in the Dolon forestry, plots of 7-year-old crops on an area of 1.54 thousand hectares created by plow furrows were transferred to forested lands. Pine crops created by plough furrows in dry types of forest growing conditions at the age of 7 reach a height of 166-180cm, at the age of 10 - 274-310cm, annual growth in height reaches 37-43cm.

The results of a field study of forest crops laid down by burning 1988-2002 in ribbon forests, conducted by the RSE "Kazakh State Design and Survey Institute of Forestry" in 2002 showed that in the areas of forest crops created by winter tillage of soils (plowed strips), erosion (deflation) and mass drying of pine seedlings are observed, and most of the crops created by plow furrows have a satisfactory condition and high survival rate (Table 3). It should be noted the poor-quality preparation of a significant part of the plow furrows, cut using a homemade device from harrow discs, in which no furrow is formed in places, but only the mineralization of a narrow strip is carried out. In areas with strong blackening, seedlings planted in this strip suffer from the competition of herbaceous vegetation. Most of the seedlings planted manually under the sword of Kolesov died (dried up), which is due to the rapid drying of the upper layers of the soil in the spring and summer, as a result of which the seedlings do not have time to take root.

The explanation for the high survival rate of seedlings planted in the bottom of the furrow in a very arid climate, light mechanical composition of soils (sands) and intense wind conditions is the creation of favorable microclimatic conditions for seedlings in the furrow, as a result of the shading of the root neck and better humidification conditions compared to the soil surface.

**Table 3.** Results of the survey of forest crops in ribbon forests.

Name of the state institution, forestry	Block No	Area, ha	Season and year of planting	Method of soil treatment planting	Landing of planting places, route Quantity per 1 ha, thousand pieces	Average height of forest crops	Survival rate in %, (completeness)	Note
1	2	3	4	5	6	7	8	9
2. Pavlodar region								
Beskaragayskoye SI Severoborskoye forestry	22	26,0	Spring 2002	Furrows along the alignment. places between clutters. Mech. of furrows manually under the sword of Kolesov on an inconvenient site.	$\frac{0,75 \times 2,5}{5,3}$	0,1	68,2	The condition is satisfactory. Poor-quality preparation of furrows, most of the seedlings planted manually under Kolesov's sword dried up.
Beskaragayskoye SI Severoborskoye forestry	$\frac{36}{5}$	13,1	Spring 2000	Furrows-crevices Mech.	$\frac{0,5 \times 1,5}{13,2}$	0,3	42,7	The condition is good. In the relief depressions there is blackening and low survival rate
Chalday SI Chaldayskoye forestry	20	30,0	Spring 1998	Furrows-cracks of poor quality. Mech.	$\frac{0,5 \times 2,5}{8,0}$	0,6	31,0	The condition is satisfactory. Low survival rate is associated with poor quality of soil preparation

In order to improve the technology of restoration of pine forests by forest-cultural methods, in the period from 1982 to 1988, the laboratory of forest crops of KazSRIFA in the Dolon forestry enterprise laid experimental crops on an area of 30 hectares. 7 variants of tillage have been tested in field experiments:

- Strips according to the system of winter plowing (DT-75, BDN-3, Pn-4-35);
- Plow furrows ch.25-30cm (DT-75, PCL-70);
- Plow furrows with loosening of the bottom of the furrow to a depth of 50 cm (DT-75, PCL-70, and PH-60);
- Rotary loosening strips (K-700, RKS-2);
- Trenches up to 60 cm deep (DT-75, scraper);
- Narrow strips (DT-75, PH-60);
- Planting with simultaneous tillage of the improved in KazSRIFA forest planting machine MDR-1 on DT-75.

In addition, the use of planting material with a closed root system was tested. As a result of the comprehensive research carried out, the most effective new technology for creating pine forest crops in ribbon forests was developed. ((Balyasniy V.I. et al., 1993).

In the clearings of very dry, dry and fresh types of forest growing conditions with sod-boron, sod-steppe, dark chestnut sandy and sandy loam soils, a method for creating pine forest crops without pre-tillage is recommended using the MDR-1 forest planting machine improved in KazSRIFA and carrying out care with a cultivator KLP- 2,5.

The improved MDR-1 forest planting machine, equipped with a more powerful loosening knife in the lower part of the coulter, turf plates and elongated grab levers of the planting apparatus, is aggregated with tractors of class 3t. During operation, the machine removes the sod, rolling it off on both sides of the coulter along the unit and loosens the soil to a depth of 40-50cm, with the equipment of a mineralized strip with a width of 160-180cm and with a micro-dip (furrow) in the middle with a depth of 20-30 cm and a width of 80-90cm along the top. Simultaneously with the tillage, seedlings are planted along the bottom of the furrows, immediately after thawing the soil in the early spring. The delay in planting leads to a significant decrease in the survival rate of forest crops due to the rapid drying of the upper soil horizons.

The key to successful reforestation is the use of high-quality planting material - standard pine seedlings grown in nearby local nurseries from seeds of local reproduction. High rates of crop survival were obtained by using planting material (pine seedlings) with a closed root system (PMPC), even in the case of late spring and autumn planting. Pine crops planted by PMPC are characterized by high growth energy; by the age of 5 they reached a height of 112-113cm. The density of plantings on non-wooded areas is recommended up to 8 thousand pieces per 1 ha.

Special attention should be paid to timely and high-quality maintenance of forest crops in the first 2-3 years after planting. In the first year, according to observations, crops are poorly overgrown with weeds, so it is permissible to carry out 2-3 mechanized care in mineralized strips and rows of crops for the 2nd and 3rd years.

In accordance with the "Temporary recommendations on artificial reforestation of harems of ribbon hogs of the Irtysh region" KazSRIFA, Shchuchinsk, 2002, reforestation of harems is primarily recommended on the areas of forbidden zones along the banks of rivers, on easily fluttering sands, on the territory of green areas of cities, along the edges of forests and borders with steppe treeless spaces. Artificial reforestation of gorelnik is recommended after the development of gorelnik by loggers and cleaning them from felling residues and dead wood with the help of bulldozers, a picker of small wood residues PV-1.5 on a tractor DT-75, a universal mounted kopnovoz KUN-10, etc. Clearing can be continuous, corridors, lanes, platforms, depending on the volume and placement of clutter and the risk of erosion, carried out in autumn and winter. When the snow cover is up to 20 cm high and the soil freezes to a depth of at least 20 cm, which ensures maximum preservation of the topsoil. The shafts and piles formed after clearing are burned at the same time, which reduces the fire hazard of the sites and improves their sanitary condition. On burning areas with light sandy soils, clearing of places for forest crops is carried out partially with the abandonment of the wings of burnt trees, which will serve as coolers in the afternoon hours, to restrain soil deflation. Tillage in dry conditions of the growing area is



recommended by furrows cut with a plow PLN-135 on a tractor T-100, T-130 with deepening of the bottom of the furrow with a ripper type PH-60 or cultivator (DLKN-6/8). The use of the upgraded PKL-70 plow gives good results. A loosening paw from PH-60 is attached to it. And behind it (behind the dumps and the loosening paw), a disk battery is welded from the cultivator KLB-1.7, which loosens the bottom of the furrow. The creation of forest crops on burning is recommended mainly by planting standard pine seedlings in the early spring period in the shortest possible time in a mechanized way. The density of planting, depending on the presence of natural regeneration, stumps, clutter and soil treatment schemes – from 2.5 to 9.5 thousand pieces per 1 hectare. The effectiveness of forestry work can be significantly increased by using planting material with a closed root system.

#### 4. CONCLUSION

-The analysis of natural and climatic conditions, the current state of the surveyed territory, the experience of forest-cultural work and recommendations for reforestation of harems allows us to draw the following conclusions:

-Due to the practical absence of natural regeneration and testes, the main measure for the restoration of ribbon forests passed by fire should be artificial forest cultivation – the creation of forest crops – pine trees.

-Active overgrowth of soils with herbaceous vegetation and the presence of blackening in most of the territory, require mandatory soil preparation (cutting furrows) and subsequent care of the created forest crops.

-The most acceptable way to create forest crops in these conditions, ensuring reliable and rapid restoration of the forest at the lowest cost of labor and money, is the mechanized planting of pine seedlings along furrows prepared by the PKL-70 plow or planting seedlings with simultaneous tillage of the soil by the MDR-1 forest planting machine improved in KazSRIFA.

-Harsh, highly arid climatic conditions with a light mechanical composition of soils (sands), contribute to the rapid drying of the upper soil layer and the creation of unfavorable conditions for the survival of forest crops, which determines a very short time for planting – within no more than 12-15 days, immediately after the snow cover, in early spring. In such conditions, planting material with a closed root system (PMPC) gives good results.

-The main direction of the furrows, taking into account the main danger to the survival of seedlings – the opal of the root neck and the drying of the roots, should be from north to south, which will ensure the shading of seedlings in the furrow, and also preferably perpendicular to the prevailing wind direction, in order to avoid spotting young seedlings.

-At the moment, the existing nursery is not able to provide its planting material for the planned forest-cultural work. The condition of the nursery is satisfactory.

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## ORAL PRESENTATION

### **Normation of Annual Stems on Raspberry Fruit Productivity in the Biennial Variety, “Przehyba”, Cultivated in Open and Protected Field**

***Dodica DMITRI***✉

*The Technical University of Moldova*

✉**Correspondence:** dcberrygroup@gmail.com

**Abstract:** The research has been carried out in the central fruit-growing area of the Republic of Moldova, namely at the *Nasu Vasile* Farm founded in 2012. The influence of the sprout rationalization on the development of lateral branches, inflorescences, the size and weight of fruit and the productivity of the plants has been analyzed. The object of the research have been the raspberry plants of *Przehyba* variety, in the 1st and 2nd year of fruiting, cultivated in the field and the greenhouse. The plants had 2.5m to 0.45 cm of space between them in both cultivation systems. The following groups have been studied: V1 – 8 suckers per linear meter, in the greenhouse, V2 – 10 suckers per linear meter, in the greenhouse, V3 – 8 suckers per linear meter, in the field, and V4 – 10 suckers per linear meter, in the field. In the 2023 growing year, the raspberry plants in V1 yielded the highest quality harvests both in the greenhouse and in the field.

**Keywords:** Raspberry, Sucker, Sucker Rationalization.

## ORAL PRESENTATION

### Formation, Cutting and Fruiting of the Cherry Tree

**Stanislav RUSSU**✉

*Technical University of Moldova, Chisinau, Moldova*

✉ **Correspondence:** stanislav.russu@doctorat.utm.md

**Abstract:** Sweet cherry trees constantly bear fruit, are adapted to environmental conditions, produce high-quality fruit that are in demand on the market, and are easy to care using modern technologies. In modern fruit growing, it is recommended to use intensive systems for growing sweet cherry trees grafted on rootstocks of medium vigor (Maxima 14, Gisela 6) at a planting distance of 4-5x2-3 m or on dwarf rootstocks (Gisela 5) at a planting distance of 3.5-4x1.5-2 m, using tree support means such as trellises and wire or individual wooden rods installed at the time of tree planting. Between the years 2022 and 2023, in the north of the Republic of Moldova, the impact of the cultivation system of sweet cherry trees (*Prunusavium L.*) of the Kordia, Regina, Summit, Valina, Stefanny, Sharetta and Marissa varieties, grafted on Gisela 6, which were planted in 2018 at a distance of 4x1 m was evaluated. The trees had super spindle shaped crowns. The shaping and pruning of the trees, the yield and the distribution of the fruit according to their diameter were studied. The purpose of the pruning was to create favorable air drainage in the crown. The trees that have super spindle shaped crowns, which is a variant of the thin spindle shaped crowns, require posts and wires to support them, and an irrigation and fertilization system. At planting, the unbranched trees, grafted on Gisela 6, were shortened 30-40 cm from the ground in order to form a well-developed shoot, which would become the axis and develop branches that develop from lateral buds. In trees with lateral branches, the branches were shortened to 2-3 vegetative buds. The crown was composed of a well-developed axis, which had short branches and fruiting branches. The crown shaping was done in order to keep the branches near the axis in a physiologically active state for fruiting. It was performed by shortening the shoots to 1/3 of their length when the flower buds had differentiated and allowed the remaining buds to mature. During the period of vegetative rest, the excess of fruiting branches was cut. During the fruiting period, the fruit yield was 15-20 t/ha. In recently planted orchards, it is necessary to apply pruning that overlap with the fruit harvesting or its completion, which reduce the crown shaping time and favor the early fruiting of the trees. During the fruiting period of the trees, the branches are not shortened but thinned; during the period of full fruiting, the pruning stimulates the growth and regulate the fruiting.

**Keywords:** Sweet Cherry Tree, Crown Shaping, Sweet Cherry Tree Pruning.

## ORAL PRESENTATION

### New Cherry Varieties Grown in the Northern Part of the Republic of Moldova

**Stanislav RUSSU**✉

*Technical University of Moldova, Chisinau Moldova*

✉ **Correspondence:** stanislav.russu@doctorat.utm.md

#### Abstract:

**Abstract:** The variety is a factor of renewal and progress in horticulture, and is becoming increasingly important along with the production technologies and the ways of fruit utilization. Currently, at the international level, under the pressure of constantly growing market demands the requirements for the sweet cherry fruit varieties are as follows: their must be highly productive, be larger than 26 mm, with a dense pulp texture, a visually attractive red-yellow color, a thick stalk of medium length, sweet taste and intense specific aroma. In 2018, the *Sermopharm* Company planted 10 hectares of sweet cherry trees of the Kordia, Regina, Summit, Sweet Valina, Sweet Stefani, Sweet Sharetta and Sweet Marissa varieties, grafted on Gisela 6, at a distance of 4x1 m. The trees had super spindle-shaped crowns. The biological characteristics of the new varieties imported from Italy were studied. Kordia is a self-sterile variety resistant to diseases specific to sweet cherry trees. The burgundy skinned fruit are medium-sized, cordiform and elongated. The flesh is crunchy, juicy, sweet, non-adherent to the seed, and has a pleasant taste. Regina is a self-sterile variety susceptible to bacterial canker and leaf curl. The fruit are large, elongated, cordiform, with red shiny skin. The pulp is very consistent, slightly juicy, and sweet which posses optimal taste qualities. The fruit are resistant to handling, transportation and cracking caused by rain. Summit is a self-sterile variety susceptible to moniliosis. The fruit are cordiform, with red shiny skin and a very attractive appearance. The flesh is red, adjacent to the seed, medium hard, crispy, juicy, sweet and very tasty. Sweet Valina is a self-sterile variety resistant to fungal diseases. The pulp is fleshy, juicy, very aromatic, sweet with a good level of acidity. The fruit are large (diameter 32-34 mm), in the shape of a bright red heart. Sweet Stefanny is a self-fertile variety resistant to fungal diseases. It has an excellent pulp consistency: fleshy, juicy, very aromatic, sweet and with a good level of acidity. The heart-shaped red colored fruit are large (diameter 30-32 mm). The purpose of the study was to study the technological properties of sweet cherry varieties taken from the world assortment and grown for the first time in the Republic of Moldova. During the fruiting period, the yield of the studied varieties was 15-20 t/ha.

**Keywords:** Sweet Cherry Tree, Sweet Cherry Variety, Sweet Cherry Tree Growing.

## ORAL PRESENTATION

### Methods for Determining the Leaf Surface of Cherry Trees

**Valerian BALAN<sup>✉</sup>, Vasile ȘARBAN, Stanislav RUSSU, Cornel BUZA, Dmitri DODICA,  
Dumitru TALPALARU**

*Technical University of Moldova, Chisinau, Moldova*

<sup>✉</sup>**Correspondence:** valerian.balan@h.utm.md

**Abstract:** The photosynthetic potential of an orchard and the leaf area index play an important role in the use of light, water and nutrients which influence the growth and productivity of trees. Non-destructive methods for determining the leaf area are a useful tool for physiological and agronomic researches. This study describes a model for calculating the photosynthetic potential of an orchard and the leaf index, which is based on the average number of leaves per 1 linear meter of crown volume and the average leaf surface of the sweet cherry trees of Regina variety, grafted on Maxma 14, which are planted at a distance of 5x3 m. The method is an effective and easy way of assessing the area of leaves without destroying them. The proposed method is used to calculate the leaf area of sweet cherry trees, but it can be applied to other types of fruit trees.

**Keywords:** Sweet Cherry Tree (*Prunus avium L.*), Leaf Area.

## 1. INTRODUCTION

The study of the vital processes of plant organisms involves measuring a large number of indicators to assess the assimilative system of plants, which involves numerous methods for calculating these indicators. (Овсяников, 1985; Sala et al., 2015). The leaf being the main assimilatory element of the plant, serves as a structural and energetic material for the whole plant. Therefore, the area of the leaf serves to assess the photosynthetic potential and the intensity of its activity.

The plant parameters such as the leaf area or the leaf area index play an important role in interpreting the photosynthesis, light interception, water and nutrient utilization, and plant growth. The methods used to estimate the leaf area and the leaf index in fruit trees are laborious, inefficient and have low accuracy. In 1911, G. Montgomery quoted by Томилини and Лукьянов В. М. (1972) proposed to calculate the area of leaves using their linear dimensions.

Currently, much experience has been accumulated in estimating the leaf area of different plant species by calculation methods, based on the conversion factor, or by regression equations that relate the area of the leaf to its linear dimensions (length and width) (Montero, 2000; Demirsoy et al., 2003, 2004; Serdar et al., 2006; Rouphael, 2007; V. Cristofori et al., 2007; Киселева, 2017; Singh et al., 2018).

A large number of methods for determining, with varying degrees of precision, the leaf area have been developed, namely, the gravimetric method, the planimetric method, calculation methods based on the measurement of the leaf linear parameters, using the conversion factor and regression equations that relate the surface of the leaf to its linear dimensions (length and width). The most used methods for determining the area of a plant's leaf or of calculating the area of the leaf apparatus are the gravimetric and the planimetric methods (Ничипорович, 1969; Моисейченко et al., 1996; V. Balan, 2009).

The goal of this work was to perform a comparative analysis of the methods for determining the leaf surface in fruit plants and to develop a model for determining the leaf area in the sweet cherry species employing linear measurements of the height and width of the crown, and the density of the leaves, which would help to determine the photosynthetic potential and leaf index of the orchard throughout the entire growing season without leaf destruction.



## 2. MATERIALS AND METHODS

The researches into the determination of the leaf surface of the sweet cherry tree species were carried out in the central and northern areas of the Republic of Moldova. The Regina sweet cherry variety, grafted on the Maxma 14 rootstock, planted in 2011 at a distance of 5x3 m, was studied.

The rows of trees were located from north to south, and the trees with naturally improved crowns of reduced volume merged in the direction of the row. The leaf area was determined using the gravimetric method. To determine the limb surface, leaves from the upper part of the shoot, located in the 5th and 6th positions, and normally developed leaves from rosettes were collected. Only fresh, unwilted or dry leaves were tested in the laboratory. The surface of the limbs on shoots and rosettes was determined separately with the help of the planimeter, using 100 leaves for each category or using the gravimetric method (Balan, 2009).

To measure the limb area using the gravimetric method, the green weight of the leaf (WL) was determined. After that, a sample of the rounds (N) from the limb of the leaves was taken with the help of the tubular drill with a diameter of 0.8-1.2 cm, then they were weighed (W). The rounds were taken from the leaf blade with central veins. The weight of the limb, the number, area and the weight of the rounds were used to determine the surface of the limb according to the formula:

$$SL = WL * N * SR / W \quad (1)$$

where SL is the surface of the leaf, cm<sup>2</sup>; WL – the weight of the leaf, g; W – the weight of the rounds, g; N – the number of rounds, pcs; SR – the surface of the round. The disadvantage of the method is the relatively low level of accuracy, since the weight of the rounds taken from different places of the limb is unequal due to the different thicknesses of the leaf at its base and tip. However, the method is quite simple and accurate when the round sample is taken from limbs with central nerves.

The use of the planimeter consists in determining the surface of the leaf in accordance with the instructions attached to the planimeter. Modern electronic photoplanimeters have a numeric keyboard and the functions of a programmable calculator, may have means of communication with a computer, be equipped with a mini-printer, and perform the functions of a digitizer. They can be used in the field to measure the surface area of leaves directly attached to plant. The planimetric method is efficient and quite accurate, but the equipment needed to make the measurements is not always available.

It should be mentioned that in most mathematical models, the determination of the leaf surface is based on the conversion factor or using regression equations, which relate the leaf area to its linear dimensions (length and width). Such models have been developed for some fruit tree species such as *Pirus communis* L. and *Pirus serotina* Rehd. (Киселева, 2017, 2017), *Prunus avium* L. (Demirsoy et al., 2003), *Prunus persica* L. (Demirsoy et al., 2004), *Castanea sativa* Mill. (Serdar et al., 2006), *Corylus avellana* L. (Cristofori et al., 2007), *Malus domestica* Borch. (Hall et al., 2015).

This method is based on the correlation between the leaf shape and the geometric shape which matches the leaf configuration (elliptic, lanceolate, oval, rounded, cordate) well enough. The variety of leaf blade shapes implies great variation in the choice of linear dimensions.

In most cases, two indicators are used, namely the length and width. After determining the shape of the figure that fits the leaf, the proportionality coefficient between the real area of the leaf, measured using one of the direct methods (gravimetric or planimetric), and the area of the figure is calculated (Третьяков, 1990, 1990; Balan, 2009). If the leaf blade falls within a rectangle, the coefficient is determined as the ratio between the real surface of the leaf and the area of the rectangle with sides x and y:

$$K = S / L_1 * L_2 \quad (2)$$

where K is the coefficient, L<sub>1</sub> – the limb length (cm), L<sub>2</sub> – the limb width (cm), S – the leaf surface (cm<sup>2</sup>) determined using the direct method (Balan, 2009; Киселева, 2017; Singh et al., 2018). The coefficient K is obtained measuring many

leaves repeatedly during the growing season. This method is productive, allows for long-term observations of leaf growth, has lower accuracy, and the value of the coefficients varies from 0.6 to 0.9.

### 3. RESULTS AND DISCUSSION

#### 3.1. Results

The submitted methods refer to the determination of the area of the selected leaf separately or by establishing the conversion factors. The determination of the leaf area and the leaf index (LI) (the ratio between the total leaf area and the orchard area) is usually more rarely done, although it is very important for perennial orchards. The methods used to estimate the leaf area in orchards require effort and a lot of work. They are inefficient, because it is necessary to separate the leaves from the plant, which does not allow further monitoring of their growth. Therefore, the development of simple, available and efficient methods for estimating the photosynthetic potential of an orchard (PPO) and the leaf index (LI) will solve the problems faced by farmers, and will provide practical recommendations related to cultivation technology.

Currently, fruit growing uses a method based on the number of leaves found during separate counting on shoots and rosettes. The photosynthetic and growth potential of trees are determined measuring the total length of the annual branches as well as the number of rosettes. During the period of vegetative rest, the short fruiting branches 2-5 cm long with a vegetative apical bud are counted, and all the annual branches longer than 4-5 cm are measured. The nodes on the annual branches are counted and their density is determined. The number of leaf rosettes on the tree is determined by summing the short fruiting branches 2-5 cm long with a vegetative apical bud and the growing fruit formations 0.5-2.5 cm long, with apical vegetative buds. The described method demonstrates that not the size of the shoots is the basic criterion for assessing the leaf surface, but the total value of the annual branches.

To determine the leaf surface in the rosettes, it is necessary to know the number of leaf rosettes, the average number of leaves in a rosette and the leaf area in a rosette (Balan, 2009). As for the methods for determining the photosynthetic potential in orchards, it should be noted that these methods are still imperfect, especially when it comes to the correlation between production potential, height, thickness, crown shape and technological elements (Balan, 2009; Sala et al., 2015).

The complexity of this method gives the opportunity to make some biometry attempts to determine the leaf surface of sweet cherry trees. The proposed method makes it possible to determine the leaf area and the leaf area index using simpler and non-destructive techniques. The method consists in the evaluation of the leaf surface using the density of the leaves found on 1 linear m, in the volume of the crown on the tree row. In the field, we need a one-meter-long wooden ruler. On a section of a row of trees one-meter-long, a ruler is placed at different angles relative to the vertical and the leaves are counted along the length of the ruler each time. The ruler is placed in the crown of the tree so that it covers the entire space of the crown over a length of 1 m. The number of ruler placements can vary up to 18-20 depending on the uniformity of the crown and leaves. In this study, the algorithm and regression equations have been developed to estimate the PPO and LI according to the following scheme:

1. The determination of the average leaf surface in a volume unit, which includes 1 linear m of the volume of a tree row. The method provides for the placement of a one-meter-long ruler several times in the volume of the crown at different angles relative to the vertical, and the average leaf surface per volume unit is determined using the number of leaves found per linear meter when counting (N), and the average area of a leaf (SF) calculated using the gravimetric method.
2. The real volume of the crown is determined depending on the height of the crown (H), the width in the central part of the crown (B), as well as the distance between the tree rows (L).
3. The leaf surface per 1 m<sup>2</sup> of the crown projection on the ground (PPO) and per 1 m<sup>2</sup> of the orchard surface (IF) is calculated according to the following formulas:

$$PPO = SF * N^3 * H, m^2 / m^2 \quad (3)$$

$$IF = PPO * B / L, m^2 / m^2 \quad (4)$$

where Sf is the average surface of a leaf, m<sup>2</sup>;

N – the number of leaves per 1 linear meter of the crown volume, pcs;

H – the average height of the canopy, m;

B – the average width of the canopy, m;

L – the distance between rows, m.

PPO – the leaf surface related to the surface of the crown projection,  $m^2/m^2$

IF – the ratio between the total surface of the leaves and the surface of the orchard,  $m^2/m^2$

**Table 1.** The method for determining the leaf surface of sweet cherry trees (Maxma 14 rootstock, planting distance – 5x3 m, reduced volume naturally improved crown, tree age – 12, 2022).

Nr.	Specification	Measurement unit	Regina variety
1	Crown height (H)	cm	390
2	Average crown width (B)	cm	249
3	The surface of the limbus	$cm^2$	93,06
4	The number of leaves per 1 linear m	pcs	25,33
5	Leaf area related to the crown projection area, (PPO)	$m^2/m^2$	5,89
6	Ratio of total leaf area to orchard area, (IF)	$m^2/m^2$	2,93
7	Leaf surface	$m^2/ha$	29332

The search for the optimal ruler placement model in order to determine the number of leaves per linear meter was made by placing the ruler 20 times at different angles about the vertical, starting with the tree's axis. The ruler was placed in the crown of the tree so that it covered the entire crown space at a length of 1 m. The tests showed that, for the Regina sweet cherry variety, the utilization of the ruler in the crown volume provided a fairly accurate calculation of the number of leaves per linear meter – 25, 26, 24, 24, 25, 27, 26, 23, 25, 26, 28, 25, 25, 26, 26, 25, 24, 26, 26, 25 (25.33 pcs on average). The method is simple and can be used to assess the leaf area, and to study the relationship between the leaf area and the tree growth.

The surface of a leaf can be calculated using the gravimetric method with the help of a planimeter, or by constructing a regression model using the length and width of the leaf. The leaf surface related to the surface of the crown projection ( $5.89 m^2/m^2$ ), the ratio between the total leaf surface and the orchard surface ( $2.93 m^2/m^2$ ) and the leaf surface ( $29332 m^2/ha$ ) were calculated using the obtained data.

### 3.2. Discussion

It is worth mentioning that the photosynthetic potential of the orchard (PPO), the leaf index (LI) and the leaf surface are of maximum theoretical and practical importance. First of all, the leaf surface must be calculated throughout the vegetation period, and differentiated from one species to another. At the same time, the density of trees must be correlated with environmental conditions and the real possibilities of crown formation and management in order to avoid crown shading. The vegetative ensemble of the canopy in some orchards optimally adapts to climatic conditions (Balan, 1996; 2010; 2015).

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## ORAL PRESENTATION

### Development of Fruit Growing in the Republic of Moldova

**Valerian BALAN<sup>✉</sup>**

*Technical University of Moldova, Chisinau, Moldova*

<sup>✉</sup>**Correspondence:** valerian.balan@h.utm.md

**Abstract:** The development of the fruit growing in the Republic of Moldova has always been based on advanced researches. Scientific studies have been carried out which have led to the development of physiological and technological foundations for the intensification of fruit crop cultivation. The objectives of this study are focused on the development of principles and methods for optimizing the parameters of the orchard structure, which depend on the growth vigour of the variety and rootstock, the fertility and moisture of the soil, the system of tree formation and pruning, as the main productivity factors, as well as the development and implementation of modern fruit production technologies in intensive and super-intensive cultivation systems.

**Keywords:** Fruit Growing, Orchard Management, Orchard Productivity.

#### 1. INTRODUCTION

The training of specialists with higher education in the field of fruit growing began in 1933 when the Faculty of Agricultural Sciences was founded in Chisinau on the basis of Iasi University. Later, the Chisinau Agricultural Institute was organized on the basis of the faculty. In 1991, the institute was transformed into the State Agricultural University of Moldova, and in 2022 it joined the Technical University of Moldova.

Fruit growing is a priority sector of agriculture and strategically important for the economy of Moldova. This activity is possible due to natural conditions favourable for fruit trees growing, and to rich national traditions.

#### 2. MATERIALS AND METHODS

The researches have been carried out in the field. Physiological, biochemical and biometric analyses have also been performed. The methods of analysis, synthesis, tabulation, comparison and graphics have been used to interpret the scientific results. The results illustrating all scientific and technical aspects related to the fruit tree growth and fruiting have been published in scientific, methodical and didactic works, including patents, books, manuals and monographs.

#### 3. RESULTS AND DISCUSSION

##### 3.1. Results

The stages of fruit growing in the Republic of Moldova are as follows: until the 1950s – non-systematic orchards of many varieties of local origin; until the 1970s – classic orchards of valuable varieties of average productivity; starting with the 1970s – intensive and super-intensive orchards of high quality and high productivity varieties. The transition from one stage to another has been carried out on the basis of scientific research and advanced practice. A considerable contribution to the organization, performance and application of modern production technologies has been made by the members of the Fruit Growing Department led by the heads of this department, namely the university professors P. Dorofeev, Gh. Cablucico, Gh. Rudi, V. Babuc, I. Caimacan, V. Popov, M. Barbaros, S. Popa, V. Manziuc etc. The study of the fruit tree species and the agrotechnics used to grow them in various pedoclimatic conditions has led to the fruit tree zoning of the territory of the Republic of Moldova.

In Moldova, apples and sweet cherries are the main fruit species, accounting for about 70% of the fruit production with a considerable export share. Among the fruit crops, the sweet cherry tree has experienced the highest evolution in the last



20 years thanks to the new assortment of high-quality self-fertile varieties, and the variety of vegetative semi dwarfing and moderate vigour rootstocks.

Over the course of more than 40 years, extensive research in the field of fruit growing intensification, especially apple and sweet cherry trees, has been carried out under the guidance of such university professors as V. Tanasiev, V. Babuc, Gh. Cimpoeies, A. Pesteanu, V. Manziuc, S. Popa, I. Ribintev, and with the assistance of such doctoral candidates as S. Vamasescu, I. Bilici, I. Ivanov, V. Sarban. As a result, the physiological and technological foundations for intensifying the cultivation of apple, sweet cherry and other fruit trees in the Republic of Moldova have been developed. In the applied aspect, advanced domestic technologies have been developed and introduced into production, focused on the effective use of the environmental, biological, technological and economic potential inherent in each land sector and orchard, the creation and operation of intensive apple, cherry and other kinds of orchards, the planning of the quantity and quality of fruit, and on the improvement of competitiveness of fruit on the domestic and foreign markets.

The implementation of advanced technologies in production has been carried out, first of all, through manuals and articles, authorized by the Ministry of Agriculture and Food Industry, such as the textbooks *Fruit cultivation* (Balan et al., 2001; Babuc 2012.) and *Fruit bushes and strawberry cultivation* (Balan et al., 2017) and the guide *Good practices for growing fruit, grapes and apple trees in the context of climate change* (Balan et al., 2021) which are a synthesis of previous publications of great didactic and scientific value, and which are used to train agronomy specialists and to carry out scientific research in fruit growing domain. The concept of modernization of cultivation methods and the technological tools through which this modernization is carried out, using the soil as the main production resource, has been founded and developed. Other factors that contribute to the realization of the biological production potential of the variety are related to the fruiting earliness and type, the methods of tree formation and pruning, the resistance of fruit trees to diseases and pests, the tree planting density and the rootstocks used.

The scientific research programmes have been focused on fundamental practical studies into the complex solution of the problems related to the modernization of the fruit tree growing technology, the establishment and exploitation of intensive and super-intensive apple, sweet cherry and other kinds of orchards as follows ( Babuc, 2012; Cimpoeies, 2018; Balan et al., 2021, 2022).

*3.1.1. The argumentation of the need to optimize the optimum parameters of the orchard structure, including the actual distance between trees in the orchard depending on the size of the crowns determined by the growth strength of the variety and rootstock, soil fertility and moisture, and the system of tree formation and pruning*

*The main elements:* A comprehensive study of the fruit growing system has been carried out. Along with the parameters of biological, environmental and technological resources, which determine productivity, the orchard system, to the extent possible, satisfies several expected goals. Without questioning, the scientific value of these goals, their decisive nature when choosing a cultivation system has to be mentioned. Thus, before selecting the biological material, planting distance or crown shape, the first and most important step is to accurately determine the intended goals.

The degree of effective use of natural resources, such as soil, light, slope, terrain characteristics, etc. has been determined. So, it is appropriate to identify the biotic and abiotic factors that define the cultivation system, which corresponds to the biological production potential of an orchard and to the economic interests. Obviously, the design of the orchard system will be based on the following principles: geographical conditions and the degree of natural soil fertility, the relative vigour of the variety-rootstock association, planting density, early and large crops, simple crowns easily adaptable to partial mechanization.

In response to these demands, sustainable, integrated cropping systems have been successfully used. The central idea of sustainable technologies is to place the crop where the dynamics of natural factors (climate, soil, biocenosis) best corresponds to its requirements, so as to achieve high economic efficiency under conditions of reduced consumption of conventional energy. Based on experimental data, it has been determined that tree formation and pruning systems in modern orchards should be simple, make full use of the planting area, use the cultivation factors efficiently, allow the increase of labour productivity and the mechanization of technological processes, favour the early economic fruiting and produce economically efficient fruit.



Valuable scientific works, such as monographs and press articles, have been developed and published, and scientific debates have been organized at congresses, symposia and conferences (Balan, 2009; Balan et al., 2018, 2022).

*3.1.2. Methodology for determining tree planting distances depending on the area of the orchard, the growing system, the environmental, biological and economic factors which are successfully used by orchard design bureaus*

*The main elements:* A complex study has been carried out regarding the determination of planting distances in orchards that contribute to the intensification of the use of natural resources, especially the climatic and pedological ones, which are in an intense process of change, in terms of environmental protection and the use of sustainable technologies.

For each variety-rootstock association, the key factors should be known and applied to obtain large crops of qualitative fruit. These factors, which depend on natural resources, are also the most vulnerable to climate change. Agroclimatic and soil risks (drought, cold, heavy rains, etc.) determine the needs of a biotope to achieve biological productivity per surface unit. Cultivation systems and the productivity potential of the orchards have been determined, and practical procedures have been proposed in order to exploit the ecological, biological and technological potential characteristic of each land sector and cultivation system. Thus, the foundations have been laid for a new practical methodology for the sweet cherry production, useful in studying and estimating the impact of climate change and cultivation technology.

The methodology for determining tree planting distances according to the biological particularities of the variety-rootstock combination, the economic interests pursued and determined by the technology applied in different geographical conditions has been scientifically argued and implemented by the author. This methodology is based on a wealth of research into optimizing orchard structure and economic efficiencies obtained from the employment of different cultivation systems, as well as reducing the risks caused by increased climate variability caused by climate change (Balan, 1996, 2001).

*3.1.3. The development and implementation of modern apple production technologies in the intensive cultivation system*

*The main elements:* the assessment of the ecological and technological productivity potential of the land and its preparation for planting; the selection of variety-rootstock associations the productivity potential of which corresponds to the cultivation conditions; the designing of the optimal productive parameters of the orchard architecture with the row crowns in a vertical plane; the optimization of the internal structure using planting distances of 4-4.5 x 2.5-3.5 m, depending on the growth vigour of the variety-rootstock associations, and the soil fertility and moisture provision; the formation of the tree crowns in the shape of a freely flattened palmette; the determination of the fruit number of the trees with flower buds and the performance of the fruiting pruning according to the planned harvest with the 3-4 year cycle of the renovation of subbranches; the maintenance of the soil and the fertilization system according to the planned harvest; the application of irrigation and other technological processes oriented towards the effective realization of the performance potential (Balan, 2009; Balan et al., 2015).

*3.1.4. The implementation of modern technologies for the establishment and maintenance of apple orchards in the super-intensive cultivation system*

*The main elements:* the assessment of the ecological and technological potential of the land and its preparation for the establishment of the orchard; the selection of a variety-rootstock association with an environmental and technological performance potential; the optimization of the architectural parameters of the orchard with the row crowns in a vertical plane via tree planting distances of 3.5-4 x 0.8-1.5 m, depending on the growth strength of the trees, the variety-rootstock associations used and the fertility of the variety; the pruning and shaping of trees using an improved spindle shape of their crowns; the regulation of the number of fruit on trees, the use of fertilizers, irrigation and other technological procedures depending on the planned harvest. Harvesting fruit at the optimal time; sorting, storing and selling them.

It ensures the efficient use of the ecological, biological, technological and economic potential characteristic of each land sector and orchard unit, in order to plan the fruit quantity and quality, and to increase the competitiveness of apple production on the domestic and foreign markets (Balan, 2015).

### 3.1.5. Contributions to sweet cherry cultivation technology in intensive cultivation system

*The main elements:* the assessment of ecological and technological potential, and the preparation of land for planting trees; the selection of cultivar-rootstock associations with a performance potential which suits the growing conditions; the designing of the optimal productive parameters of the orchard with the row crowns in a vertical plane; the optimization of the internal structure through planting distances of 5-6 x 4-5 m, depending on the growth vigour of the variety-rootstock associations, soil fertility and moisture provision; the shaping of trees using a naturally improved pyramid shape of their crowns; the determination of the number of fruit on trees with flower buds and the fructification pruning with a 4-6-year cycle of the subbranches renewal; the fertility preservation, the use of a fertilizer system depending on the planned harvest; the use of irrigation and other technological techniques aimed at more efficient implementation of the existing performance potential.

A comprehensive study of the process of formation, pruning and care of relatively loose, low-volume, centrally axed, cup-shaped crowns has been carried out. The small volume of spindle-shaped crowns and short planting distances ensure efficient use of solar energy used in the formation of large yields of high-quality fruit, as well as the productivity of manual tree pruning and fruit harvesting, and a high degree of mechanization of technological work. Narrow crowns with a thickness of no more than 3 m thick have led to the establishment of modern sweet cherry orchards of high productivity.

The concept of fructification pruning done by reduction cuts in 3- to 5-year-old branches during the vegetative period, and the maintenance and fruiting pruning, which ensures the growth of vigorous fruiting branches of medium length, has been developed. The pruning is done during or after harvesting.

Numerous scientific works in this area have been published, namely monographs, manuals, recommendations, domestic and international scientific articles. (Balan et al., 2021; 2022).

### 3.1.6. The development and implementation of innovative technologies in sweet cherry tree cultivation in a super-intensive cultivation system

*The main elements:* the assessment of the ecological and technological potential of the land and its preparation for an orchard establishment; the selection of variety-rootstock associations which possess corresponding environmental and technological performance potential; the optimization of the architectural parameters of an orchard with the row crowns in a vertical plane via the tree planting distance of 3.5-4 x 0.8-1.5 m, depending on the vigour of tree growth, the variety-rootstock association used and the fertility of the variety; the pruning and shaping of trees using an improved spindle shape of their crowns; the regulation of the number of fruit on trees, the application of fertilizers, the utilization of irrigation and other technological procedures provided for by the planned harvest. Harvesting fruit at the optimal time; sorting, storing and selling them.

## 3.2. Discussion

It ensures the efficient use of the ecological, biological, technological and economic potential characteristic of each land plot and orchard unit, in order to plan the fruit quantity and quality, and to increase the competitiveness of sweet cherry production on the domestic and foreign markets. A complex study has been carried out regarding the multiple existing cultivar-rootstock associations, numerous planting distances, as well as the diversity of biological material and tree formation systems. The results obtained have led to the introduction of high-density orchard systems, which, subject to the intensification of technological processes, allows to obtain desired yields from a biological and technical point of view.

The researches into the assortment of semi dwarfing and moderate vigour rootstocks have made it possible to create sweet cherry orchards of high density, in which the trees are spindle-shaped, with high yields per hectare and low production costs.

The different vigour of varieties and rootstocks, as well as of the variety-rootstock associations, allows good control of the vegetation in the orchard and has a particularly significant role in vegetative growth, tree productivity and fruit quality. Therefore, the rootstocks used for growing sweet cherry trees directly determine the cultivation system, the methods of

tree formation and pruning, the orchard maintenance and the work carried out in it.

Valuable scientific works, such as monographs and press articles, have been developed and published, and scientific debates have been organized at congresses, symposia and conferences (V. Balan et al, 2017; 2021; 2022).

#### 4. CONCLUSION

The development of fruit growing in various soil and climatic conditions of the country on the basis of advanced scientific and practical achievements is as follows: the establishment of orchards in the most favourable environmental, economic and production organization conditions; the establishment of high-yield short-cycle orchards of virus-free varieties suitable for intensive and super-intensive cultivation systems; the implementation of sustainable, integrated cultivation systems where the dynamics of natural factors (climate, soil, biocenosis) is best identified with their requirements; the utilization of advanced methods of fruit growing; the improvement of the fruit quality and their competitiveness on the market in order to achieve their high economic efficiency in the context of reducing the consumption of traditional energy resources.

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## ORAL PRESENTATION

### Paclobutrazol, a Growth Regulator in Cherry Orchards

**Corneliu BUZĂ**✉

*Technical University of Moldova, Chisinau, Moldova*

✉ **Correspondence:** buza\_cornel@mail.ru

**Abstract:** Around the globe, sweet cherries (*Prunus avium L.*) orchards occupy more than 440 thousand hectares and produce almost 2,3 million tons per year. In the Republic of Moldova, sweet cherry orchards occupy 4100 hectares and produce more than 10 thousand tons per year. Sweet cherry trees are of great economic importance due to the nutritional, technological and commercial value of their fruit. The sweet cherry is a healthy food product. Its regular consumption reduces the risk of arthritis, gout and headaches. The health benefits of sweet cherries are attributed to their chemical composition. The researches have been carried out in the central fruit growing zone of the Republic of Moldova, in Ustiya Star Agro Groop LLC in the district of Criuleni. The orchard was planted with the Kordia, Regina, Stella, Ferrovia and Skeena varieties, grafted on Maxma 14 rootstocks. The trees were planted in the autumn of 2012 at a distance of 5 x 3 m, using trees with naturally improved reduced volume crowns. The effect of the growth regulator Paclobutrazol applied to the soil around tree trunks was assessed. The amount of 1, 2 and 3 ml was mixed with 500 ml of water and poured onto the soil around trunks in a circular strip to a depth of 3-5 cm. The experiments included 4 groups of 3 trees each. The Paclobutrazol (PP333), a plant growth retardant called *antigibberellin*, is widely used to retard growth and to improve flowering in fruit plants. As a result, a shoot with the same number of leaves and internodes is of a shorter length. The period and rate of the Paclobutrazol application influenced the time and intensity of flowering and fruit harvest. The rate of a growth regulator utilization affects the yield per tree and per unit area. The yield of the Cordia, Regina, Stella, Ferrovia and Skina varieties, grafted on Maxma 14 rootstocks, was high in this case. The positive effect was manifested by reducing the growth of annual branches and increasing the number of fruits with a diameter of 28 mm or larger, without affecting the overall yield. The work was part of a strategic priority relating to sustainable agriculture, food security and food safety, namely the development and implementation of modern technologies which are a way to increase the productivity of cherry orchards by maintaining a balance between growth and fruiting. The growth regulator Pacloburazol reduces the vegetative growth of trees.

**Keywords:** Sweet Cherry, Sweet Cherry Variety, Sweet Cherry Rootstock, Growth Regulator.

## ORAL PRESENTATION

### New Varieties of Cherry Cultivated in the Center of the Republic of Moldova

**Corneliu BUZĂ**✉

*Technical University of Moldova, Chisinau, Moldova*

✉ **Correspondence:** buza\_cornel@mail.ru

**Abstract:** In the Republic of Moldova, the sweet cherry tree (*C. avium*) is one of the priority species the fruit of which are in demand on the domestic and foreign markets. In 2022, 37 varieties and 10 promising varieties were registered in the Plant Varieties Catalog. The approved range has made it possible to use intensive systems for establishing and maintaining new sweet cherry orchards at optimal density and with large and cost-effective yields. The most productive sweet cherry cultivars and rootstock varieties used in modern cherry fruit production were studied. The vegetative rootstocks are uniform. They reduce tree growth rates, induce precocity, and allow fruit growers to harvest superior quality fruit in modern, high-density orchards. In the cultivation of sweet cherry trees, vegetative semi dwarfing (Gizela 5), semi-vigorous (Gizela 6, P HL-S, Krymsk 6), moderate vigorous (Krymsk 5, Maksma 14, Piku 1, Gisela 12) and vigorous (Colt, Maxma 60) rootstocks are used, which has recently received special attention in our country. The Ferrovia, Early Star (self-fertile) and Black Star (self-fertile) varieties are of moderate vigor with spreading crowns. They begin to bear fruit in the 5-6th year after planting, mainly on fruiting and middle-sized branches; they have medium and high unstable productivity. The Royal Helen, Stella (self-fertile), Skeena (self-fertile), Summit and Sweet Heart (self-fertile) varieties are of medium-high growth vigour with a well-rounded spherical crown, which bear fruit mainly on fruiting branches, and have high and constant productivity. The Folfer and Ferdous are of moderate to high vigor, have high branching capacity, high productivity and moderate crack resistance. Horticulturists prefer the Kordia and Regina (varieties. Moderate vigorous trees (Cordia) and vigorous trees (Regina) with spherical crowns bear fruit on fruiting and medium-sized branches and have high, unstable productivity. Their fruit ripen in the last ten days of June and early July. In modern fruit growing, the cherry growing system provides for the introduction of self-fertile varieties and vegetative rootstocks with a simple crown shape, which allow for full use of the nutrient space provided to the trees, early fruiting, high-quality and efficient harvesting, the mechanization of technological processes and the increased labor productivity during care and harvesting.

**Keywords:** Sweet Cherry Tree Growth, Sweet Cherry Variety, Sweet Cherry Rootstock.



## ORAL PRESENTATION

### **The Influence of the Pruning Period of Cherry Trees, Grafted on Maxma 14, on Growth and Fruiting**

**Vasile SARBAN**✉

*Ministry of Agriculture and Food Industry, Chisinau, Moldova*

✉ **Correspondence:** sarbanvasile@gmail.com

**Abstract:** The pruning of trees in early autumn is very important, as the main branches and sub branches that thicken the crown are clearly visible, and favorable conditions are created for the differentiation of fruit buds. In spring, new well-developed shoots appear on the pruned branches, which, in turn, produce fruiting branches. That is why, the research has aimed at evaluating the maintenance and the fruiting pruning of sweet cherry trees (*Prunus avium* L.) of the Stella and Skeena varieties, grafted on the MaxMa 14 rootstock, both during the rest period and the vegetation period. Between the years 2019 and 2021, in the central area of the Republic of Moldova, the impact of the pruning period of the sweet cherry trees (*Prunus avium* L.) of the Stella and Skeena varieties, grafted on MaxMa 14, which were planted in 2012 at a distance of 5x3 m was evaluated. The trees had naturally improved reduced volume crowns. The pruning during the rest period and the vegetation period was studied, namely: the pruning during the rest period (the control group); the pruning during the blossoming period; the pruning after harvest (in July); the pruning in early autumn (the first decade of September). Blossoming and fruit ripening time, trunk cross-sectional area (TCSA), and the yield and distribution of fruit according to their diameter were also studied. The time of the tree pruning did not have any impact either on the blossoming time or the harvest time. The pruning period influenced the yield per tree and per unit area, and the yield of sweet cherries of the Stella and Skeena varieties, grafted on MaxMa 14, was high. The pruning done in early autumn contributed positively to the harvest volume, fruit diameter and diameter distribution, while reducing the number of fruit per tree. The positive impact was manifested by an increase in the number of fruit (15.8-34.2%) with a diameter of 28 mm or more, as well as a decrease in the proportion (4.4-4.5%) of fruit with a diameter of 24 mm and smaller, without affecting the overall yield. The results showed that the pruning period had a significant impact on fruit quality and yield increase. The pruning done in early autumn reduced the number of small fruit and increased the number of fruits over 28 mm in diameter. Further research is needed to assess the effect of pruning time on yield and, in particular, on the diameter, weight and distribution of marketable fruit.

**Keywords:** Sweet Cherry, Sweet Cherry Tree, Pruning, Fruit Diameter.

## ORAL PRESENTATION

### **Peculiarities of Cesium 137 Accumulation in the Components of Pine Trees Phytomass in Various Hygrotopes on Sites of Chernobyl Far Field Fallout**

**Anton POTAPENKO<sup>✉</sup>, Natalia TOLKACHEVA, Alexander KOZLOV**

*Institute of Forest of the National Academy of Sciences of Belarus, Belarus*

<sup>✉</sup>**Correspondence:** formelior@tut.by

**Abstract:** The purpose of the study was to investigate cesium-137 accumulation in the components of pine trees phytomass in various hygrotopes on sites of Chernobyl far field fallout. Phytomass samples were collected at 4 sites during 2022-2023 from the following parts of pine trees: bark, wood, 1-year-old and 2-year-old needles, 1-year-old and 2-year-old shoots. Model trees at each site were selected in the amount of 18, the total sample volume of each component was 2.0 dm<sup>3</sup>. Measurement of <sup>137</sup>Cs activity was carried out by the radiometric method using a beta-gamma spectrometer "MKC-AT1315", the lower measurement limit of which is 2.0 Bq/kg with a permissible basic relative measurement error of  $\pm 20\%$ . The studies were carried out at radiological permanent plots in semi-mature and mature pine forests growing in bracken (B2), blueberry (B3), long-moss (A4), wild rosemary (A5) forest types with a <sup>137</sup>Cs contamination density range from 88.5 kBq/m<sup>2</sup> (2.4 Ci/km<sup>2</sup>) up to 551.2 kBq/m<sup>2</sup> (14.9 Ci/km<sup>2</sup>). Current climatic conditions change has significantly affected the groundwater level in forest ecosystems. Which in turn has led to a change in the mobility of radionuclides in the soil and their availability to plants. In connection with this, the problem of radioactive contamination level variation in forest components on areas with different levels of average soil moisture content remains relevant to date. The results of the analysis showed that wood has the lowest values of specific activity of <sup>137</sup>Cs (from 38 to 2171 Bq/kg). The most contaminated components are those formed during the current growing season (1-year-old shoots and needles). The levels of <sup>137</sup>Cs accumulation in which reached 25760 Bq/kg and 19466 Bq/kg respectively. The ratio between of <sup>137</sup>Cs accumulation in wood and different components of pine trees phytomass varies within the following ranges. They are for two-year-old needles 2.1÷5.3; for bark 2.6÷6.0; for two-year-old shoots 4.5÷10.5; for annual needles 5.2÷15.0; for annual shoots 6.0÷20.0. According to these results average proportions of <sup>137</sup>Cs activity in these components characterized as 1:3.8:4.1:6.4:9.5:13.5 respectively. The data obtained confirm earlier studies (1999-2014), which also noted the highest levels of <sup>137</sup>Cs accumulation in physiologically active annual shoots and needles. It has been established that the growth of pine in more humid conditions provides an increased level of <sup>137</sup>Cs accumulation in the components of its phytomass. It was revealed that the degree of average soil moisture moderately correlates ( $r_s=0.61$ ;  $p=0.047$ ) with the level of radionuclide accumulation in phytomass components, for example, bark. A comparison of the coefficients of transition of <sup>137</sup>Cs into other components (except the bark) with the degree of average soil moisture (hygrotope) showed the presence of a strong correlation between them ( $r_s=0.75\div 0.91$ ;  $p\leq 0.007$ ). The results obtained confirm the conclusions of previous studies that the type of soil and its hydrological regime largely determine the accumulation of radionuclide in the forest stand. Currently, the components of pine phytomass based on <sup>137</sup>Cs content are ranked in the following order: wood < 2-year-old needles < bark < 2-year-old shoots < 1-year-old needles < 1-year-old shoots. It has been established that more significant accumulation of <sup>137</sup>Cs in the above-ground phytomass of pine trees is associated with hygrotopes with higher degree of average soil moisture. Thus, with the same density of radioactive pollution in damp and wet growing conditions, the <sup>137</sup>Cs content in the components of pine phytomass is 2-3 times higher compared to wet and fresh conditions. As a consequence, the reference level of <sup>137</sup>Cs content in wood – 740 Bq/kg (or 1480 Bq/kg) limits its use in forest areas with a pollution density of 5 (or 10 Ci/km<sup>2</sup>) or more Ci/km<sup>2</sup> in more humid growing conditions.

**Keywords:** *Pinus sylvestris*, Radioactive Contamination, <sup>137</sup>Cs, Phytomass, Hygrotope.



## ORAL PRESENTATION

### **Industrial Process of Polyols Productions from Polysaccharides Obtaining Biochemical Treatment of Agricultural Heap**

***Evghenii STEFOGLO***✉

*Comrat State University, Agro-Technological Faculty, Moldova*

✉**Correspondence:** steftheodore@yahoo.ca

**Abstract:** It was developed industrial process for obtaining polyols by catalytic hydrogenolysis of polysaccharides from biochemicals treatment of agricultural heap. A kinetic model of the hydrogenolysis reaction of polysaccharide - glucose was constructed: a scheme of reaction routes was identified and numerical values of rate constants along the routes were determined. As a result of analyzing the influence of mass transfer processes on the rate of polysaccharide hydrogenolysis reactions, the process conditions were determined that ensure maximum selectivity of the main product glycerol: catalyst grain size and optimal pressure. An analysis of the effect of long-term stirring of the suspension on the yield of sorbitol hydrogenolysis reaction products was carried out. It was found that the optimal process, ensuring the maximum yield of glycerol, corresponds to the ideal displacement mode, which can be implemented for this process in a reactor with a special packing. A technological calculation and comparative assessment of two types of plug-flow reactors and a cascade of ideal mixing reactors was carried out. It has been shown that when the number of reactors in a cascade is equal to four, the composition of the products of the hydrogenolysis process is close to optimal.

**Keywords:** Industrial Process, Polysaccharides, Hydrogenolysis.

## ORAL PRESENTATION

### The Effect of Priming Applications on the Germination Capacity of Anatolian Black Pine (*Pinus nigra* Arnold subsp. *pallasiana* (Lamb.) Holmboe) Seeds

Şeyma Selin AKIN<sup>1✉</sup>, Esra Nurten YER ÇELİK<sup>2</sup>, Sezgin AYAN<sup>2</sup>

<sup>1</sup>Kastamonu University, Institute of Science, Sustainable Forestry Program, Kastamonu, Türkiye

<sup>2</sup>Kastamonu University, Forest Faculty, Kastamonu, Türkiye

✉Correspondence: selinalptekin02@gmail.com

**Abstract:** In this study, the effect of different priming applications on germination in Anatolian Black Pine (*Pinus nigra* Arnold subsp. *pallasiana* (Lamb.) Holmboe) seeds, which have decreased germination capacity, was investigated. Within the framework of a sustainable forestry approach with the efficient use of resources, particularly reproductive materials, the improving of seeds with reduced germination power through different priming applications instead of destroying them is among the aims of the study. For this purpose, In the study, Anatolian black pine seeds, which are one of the most widely used species in afforestation studies in Türkiye, were chosen as research material. The seeds were harvested in 2006 and 2018. After harvest, the seeds were storage at 4 °C until used them. In addition, the seeds were primed with chitosan, seaweed, and humic acid. As an independent factor, seaweed has an effect on reducing the average germination time while, especially, chitosan priming application was more effective on germination rate and percentage in aged seeds. It has been found that medium and high doses of chitosan in aged seeds improve seed germination capacity by about 70-84% compared to the control treatment.

**Keywords:** Aged Seed, Germination, Pinus, Priming.

## ORAL PRESENTATION

### Blood Serum Osmolarity in Bony Fish

**Ahmet SEPİL<sup>1</sup>✉, Fazıl ŞEN<sup>1</sup>, Ahmet Regaib OĞUZ<sup>2</sup>**

<sup>1</sup>Van Yüzüncü Yıl University Faculty of Fisheries, Van, Türkiye

<sup>2</sup>Van Yüzüncü Yıl University, Faculty of Science, Department of Biology, Van, Türkiye

✉Correspondence: ahmetsepil@yyu.edu.tr

**Abstract:** Fish body fluids contain dissolved salts, ions and various organic compounds, and the density of these substances is expressed as osmotic density. The osmoregulatory mechanism in fishes balances osmotic density changes occurring in the external environment. The transitions fish make between waters with different ion densities bring about some physiological responses created by organs that are also effective in excretion, such as kidneys, gills, intestines and skin in bony fish. The osmoregulatory capacities of fish vary depending on the salinity values in the aquatic biotopes where they naturally spread. Although this capacity varies according to the species, it is significantly higher in diadromous and brackish fish species. The determination of salinity adaptation and osmoregulatory capacity in fish is evaluated by the effect of salinity increase on behaviours (such as feed intake, unusual movements and spawning). However, behavioural differences alone are not sufficient, and the most basic physiological signals of salinity stress are seen in blood serum osmolarity and chloride cells. The critical factor in salinity tolerance studies is determining the maximum salinity level and the time to terminate the experiment. Usually, cessation of feed intake is a sufficient observational response to complete the trial. Because this behaviour shows that osmoregulation cannot occur healthily and the fish will die in the coming days, on the other hand, the death of approximately 40-50% of the number of individuals in the experiment after reaching the high salinity levels is sufficient to terminate the experiment. Studies on the salinity tolerance of fish reveal essential data regarding adapting species to natural waters with different salinity levels, evaluating new biotopes that can be used in aquaculture activities and incorporating alternative species with known production protocols into existing marine aquarium species. In osmoregulation capacity studies, it can be supported by studies such as Na<sup>+</sup>/K<sup>+</sup>ATPase analyses and histological marking of chloride cells, which increase depending on salinity.

**Keywords:** Fish Osmoregulation, Fish Physiology, Salinity Tolerance, Serum Osmolarity.

## 1. INTRODUCTION

Fish kidneys and gills are often responsible for the functions of the excretion and osmoregulation systems, which are closely connected. All living cells need an environment to carry out metabolic activities. This environment contains certain substances, including ions, dissolved in water with specific densities. The amounts of these substances determine the osmotic density of body fluids (Demir, 2006). Osmoregulation is the term used to describe the control of osmotic density. Osmoregulation varies from species to species, however in diadromous fish species, it is substantially higher. When fish migrate between waters with varying ion densities, they undergo certain physiological adjustments. In aquatic species, salinity variation triggers a variety of physiological adaptation reactions, including imbalances in electrolyte levels, activation of energy metabolism, and elevated levels of stress-related hormones in plasma (Liu et al., 2007).

Adapting freshwater and especially brackish water species to saltwater enables these species to be used in marine aquariums. Although aquarism is generally regarded as a hobby, it has turned into an agricultural sector that attracts millions of people worldwide and has a very high economic return in aquaculture (Hekimoğlu, 2006). Therefore, the ornamental fisheries sector must ensure efficient production of marine and freshwater ornamental fish species. The interest in marine reef aquariums in our country and the world has increased recently. The aquaculture industry provides fish for about 90% of the freshwater ornamental fish species, with the remaining 10% coming from hunting in the wild. However, the situation is different in marine aquariums, where over 95% of the food is obtained from hunting and only a small portion is through aquaculture (Gopakumar and Ignatius, 2006). The ability of freshwater, brackish water, and

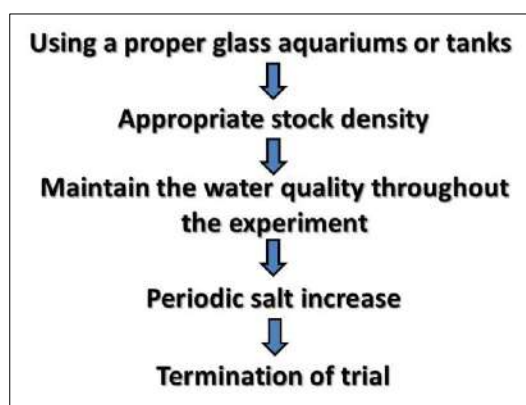
saltwater fish that live in natural waters to adapt to natural settings with varying salinity level is crucial for research on fish introduction.

## 2. OSMOREGULATORY CAPACITY

Living cells need an environment containing certain substances, including ions, dissolved in water with specific densities. The amounts of these substances determine the osmotic density of body fluids. Osmoregulation capacity varies according to the species, and it is significantly higher in diadromous fish species. The transitions fish make between waters with different ion densities bring about some physiological responses created by organs that are also effective in excretion, such as kidneys, gills, intestines and skin in bony fish. Salinity change causes various physiological adaptive responses in aquatic organisms, such as disruption of electrolyte balance, energy metabolism stimulation, and increased stress-related hormones in plasma. It is crucial for fish introduction operations that freshwater, brackish water and saltwater fishes living in natural waters can be adapted to natural environments with different salinity levels.

## 3. TRIAL PROCESS STEPS

Salinity tolerance studies are generally carried out by increasing daily salt up to specified salinity levels, taking blood from fish, separating blood serum and measuring osmolality. These process steps in determining species-specific osmolality values are shown schematically in Figure 1.



**Figure 1.** Process steps in determining osmoregulatory capacity in fish.

When creating the experiment layout, the volumes of the tanks to be used in different salinity groups are related to the sizes of the species. However, it is essential to stock sufficient individuals to obtain statistically significant results. When the literature on the subject is examined, it is seen that the studies were conducted in 3 replicates, and the number of individuals in each aquarium was between 7-12 (Nordlie et al., 1992; Haney, 1999; Sepil, 2020). Throughout the study, feeding at 2-4% of body weight, depending on the fish species, caused water quality to deteriorate as high salinity levels increased. Since different salinity groups are determined, semi-closed or closed-circuit sump systems cannot be used in such studies. Internal filters, such as sponge filters, can be used as filter equipment but provide limited filtration. Therefore, it is so vital to change the water at regular intervals during the experiment and to monitor the nitrogen and phosphorus derivatives in the water.

### 3.1. Daily Salinity Increase

One of the most essential points of the experiment is the daily increase in the amount of salt in salinity acclimation studies. Salt should be added in amounts and daily periods that will not cause excessive stress in the fish for a healthy adaptation. When previous studies on this subject were examined, using *Cyprinodon milleri*, the weekly salinity increase was given as 18‰ in a study (Naiman et al., 1976). Perschbacher et al. (2011), investigating the salinity tolerance of the *Fundulus grandis*, a type of killifish, reached a salinity level 80‰ in 20 days. Oğuz et al. (2023) reported the daily salt increase as



2‰ in *Poecilia velifera*. According to the data, the ideal daily salinity increase is 2-4‰. However, after certain salinity levels (10-15‰) are reached, it is more appropriate to reduce the daily increase to 1‰ to reduce the stress due to the increase in salinity (Capps et al., 2011).

### 3.2. Termination of Trial

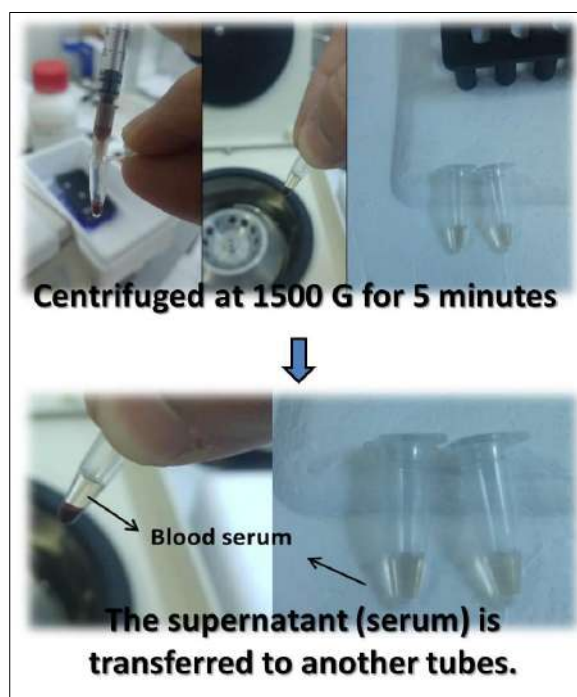
Two factors are considered when terminating the trial by determining the maximum tolerance level. These monitoring behaviours (behavioural symptoms such as feed intake, unusual movements, spawning) and death of individuals (Biological symptoms). Terminating the trial without observing these effects prevents the accurate maximum tolerance level from being determined. Usually, cessation of feed intake is a sufficient observational response to terminate the trial. So, osmotic balance cannot occur healthily, and the fish will die in the coming days. Experiment termination is usually accomplished by observing many deaths at the highest salinity level. The death of approximately 40% of the individuals after reaching the determined salinity level (Nordlie et al., 1992) is sufficient to stop the experiment. The trial is terminated when one of the behavioural or biological symptoms is observed.

### 3.3. Osmolarity Measurement

How many days after the experiment is terminated is imperative that blood should be taken from the fish. The common consensus in many past studies is that fish should be kept at maximum salinity level for 5-7 days to accurately determine the physiological effect (Haney, 1999).

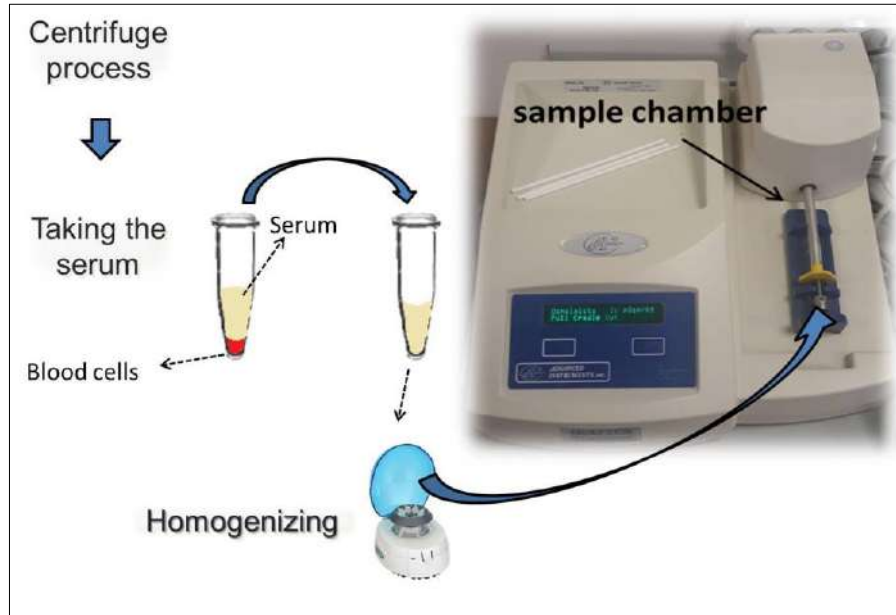
Fish samples should be anaesthetized with 0.2 mL/L Phenoxyethanol before the injection applications. It is more appropriate to use a caudal vein for blood collection, especially in small fish samples (Dernekbası, 2012).

Physiological anticoagulant should be taken into the syringe so this practice will prevent the blood taken into the syringe from coagulating. After sufficient blood is collected for analysis, centrifugation is performed to separate the blood serum. This transaction protocol is summarized in Figure 2 regarding Nordlie (1987) and Haney (1999). After the blood serum is separated, it is homogenized using a mini spin shaker for a few minutes and osmolarity values are read on the appropriate osmometer device (Figure 3). To minimize possible differences between the data, scanning the same serum samples several times and calculating the deviations is vital.



**Figure 2.** Centrifuge and serum separation procedure.

Serum osmolarity values are expressed in mOsm/kg or mOsmol/L. Two interrelated definitions emerge on this subject. One of them is osmolarity (blood serum) and the other is osmolality (aquarium or tank water) in the liquid phase. By comparing these two parameters, the osmotic balance mechanism in fish is interpreted. As the amount of salt in water increases, serum osmolarity is observed up to a particular peak. After a certain salinity level, the osmolarity value of water increases while the serum osmolarity value stabilizes. This point, where it remains constant, actually represents the maximum salinity tolerance of the species, in other words, its osmoregulatory capacity.



**Figure 3.** Preliminary preparation of blood serum samples and measurement in the osmometer device.

#### 4. CONCLUSION

Some previous acclimation studies in fish use the osmoregulation system and salinity tolerance. It constitutes a critical data set for determining the salinity tolerance of fish species, introduction some species into natural waters with different salinity levels, increasing aquaculture areas, incorporating unused wetlands into aquaculture activities and diversifying both food species and ornamental fish. From this perspective, it is crucial to determine the osmoregulatory capacities of brackish water species, especially those that can be considered transitional between salinity levels.

The data obtained on this subject will also enable fresh-salt water bathing procedures, frequently applied in treating various types of external parasites seen in fish, to be carried out simultaneously in a species-appropriate and effective manner.

Studies on salinity adaptation can be supported by using methods such as  $\text{Na}^+\text{-K}^+$ -ATPase enzyme activity and chloride cell counting.

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## ORAL PRESENTATION

### Main Problems and Solution Suggestions for the Quit Forest Work Tendency of Tahtacı Turkmens Working in Traditional Wood Production in Türkiye

**Mustafa Fehmi TÜRKER<sup>✉</sup>, Emine Nur YEŞİLYURT**

*Karadeniz Technical University, Faculty of Forestry, Trabzon, Türkiye*

<sup>✉</sup>**Correspondence:** mft@ktu.edu.tr

**Abstract:** Different interest groups, especially local people, women's communities, forest villagers and forest workers, have a significant impact on the sustainable management process of forest resources and the production of wood raw materials, which is one of the forestry activities that directly affects this process. Tahtacı Turkmens, who are among these communities that are especially effective in sustainable forest management in Türkiye and offer qualified workforce in wood-based product-oriented production workmanship, are important in this context. As a matter of fact, in Türkiye, wood raw material production in state forests, in accordance with Article 40 of the Forestry Law, can be made primarily carried out by cooperatives for the development of forest villages, by villagers in the workplace or by villagers working in forestry around the workplace, and by workers brought from outside if there is not enough labor force or if they are not qualified, workers. However, for the majority of forest villagers working in wood production throughout Türkiye, there is a problem of skilled labor in forestry works as well as inadequacies in terms of technical knowledge, work quality and work efficiency. Especially in cases where the workforce is not sufficient or not qualified for the wood production process, production work in forest enterprises is disrupted and business managers are in a difficult situation in all forest management functions, from production to marketing. At this point, Tahtacı Turkmens appear as the most important segment that provides qualified labor for wood raw material production activities in the process of sustainable forest management in Türkiye. Tahtacı Turkmens are the Alevi Turkmen community who have been engaged in forestry since their ancestors and have made this profession in a tradition. In recent years, it has been stated by the administrative and technical personnel of the forestry sector that the Tahtacı Turkmen population working in traditional wood production has started to decrease gradually. This study aims to determine the reasons why Tahtacı Turkmens working in traditional wood production tend to quit forestry work and to develop solution suggestions by taking into account the opinions of those who directly experience the problem. At the point of reaching the aim of the study, interviews will be held with both Tahtacı Turkmens and administrative and technical personnel working in the forestry sector. Primary data obtained through interviews will be used as the material of this study. In order to achieve the purpose of this study, the interview records mentioned will be obtained within the Mediterranean Region of Türkiye, where Tahtacı Turkmens live intensively.

**Keywords:** Türkiye Forestry Sector, Traditional Wood-Based Product Production Labor, Tahtacı Turkmens.

#### Acknowledgement

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## ORAL PRESENTATION

### Job Satisfaction and Perception of Tahtacı Turkmens in Ensuring the Continuity of Traditional Wood Production in Türkiye

**Mustafa Fehmi TÜRKER, Emine Nur YEŞİLYURT<sup>✉</sup>**

*Karadeniz Technical University, Faculty of Forestry, Trabzon, Türkiye*

<sup>✉</sup>**Correspondence:** eminenurkoyuncu@ktu.edu.tr

**Abstract:** The land characteristics of Türkiye's forest areas necessitate the use of labor-intensive technologies in forestry activities carried out in most of these lands. In forestry activities, where labor-intensive labor prevails, the low loss of life and property is directly belongs to the presence of qualified workforce. Tahtacı Turkmen group, which has been engaged in this profession since ancient times, constitutes the qualified workforce in the forestry sector. This group, which has survived by doing woodworking in various parts of Türkiye's geography, has continued this profession until today, thinking that they have inherited forestry from their ancestors, and has made forestrymanship a tradition. When the studies and expert opinions are evaluated, it is seen that the tendency of this group to do forestry work has decreased recently. In parallel with the decrease in qualified workforce in the forestry sector, it is likely that the sector will experience problems in all enterprise activities from production to marketing in the near future. In addition, the fact that this group tends to quit forestry work also shows that the Tahtacı culture is in danger of disappearing. With this study, it is aimed to create a measurement tool to measure the job satisfaction of Tahtacı Turkmens in ensuring their continuity in traditional wood production work and the perceptions of forestry sector administrative and technical personnel on Tahtacı Turkmens. At the point of achieving the purpose of the study; The focus will be on the scale development process for "job satisfaction", which is expressed as the satisfaction or dissatisfaction of employees with their jobs, and "perception", which is defined as the person's interpretation of stimuli as something meaningful for himself based on his previous experiences. At the point of preparing the specified scales, the factors that may cause job satisfaction and dissatisfaction in this group will be evaluated by observing Tahtacı Turkmens in the field and by conducting interviews with administrative and technical personnel working in the forestry sector. The scope of this paper, whose purpose, material and method are introduced in concise terms will constitute Tahtacı Turkmen forest workers living and working in the Mediterranean Region of Türkiye and the central and provincial organization managers and decision makers of the General Directorate of Forestry, which forms the mainbody of forestry sector of Türkiye.

**Keywords:** Türkiye Forestry Sector, Traditional Wood-Based Product Production Labor, Tahtacı Turkmens, Job Satisfaction and Perception.

#### Acknowledgement

This study is supported by the Scientific and Technological Research Council of Türkiye (TÜBİTAK), Project No: TOVAG-122O937.



## ORAL PRESENTATION

### Analysis of Data Collected during Activities at a Fishmeal and Fish Oil Factory in Sinop for the 2023-2024 Fishing Season

**Barış BAYRAKLI**✉

*Sinop University, Vocational School, Department of Fisheries, Sinop, Türkiye*

✉Correspondence: barisbayrakli@gmail.com

**Abstract:** This study presents a detailed analysis of data collected during the 2023-2024 fishing season at a fishmeal and fish oil factory operating in Sinop. The gathered data encompasses various aspects of the factory's operations, categorized into main sections. Initially, the quantity of processed raw materials (Anchovy, *Engraulis encrasicolus*), was considered, providing crucial insights into the daily production capacity of the factory. Subsequently, the amounts of fishmeal and fish oil obtained based on the processed raw materials were determined, shedding light on the efficiency and diversity of the production process. Furthermore, analyses were conducted on samples of fishmeal taken for daily assessments, determining the quantities of crude protein, crude fat, moisture, and crude ash. These analyses play a critical role in controlling the production process by providing detailed insights into product quality and composition. Finally, energy values calculated from the specified component ratios were examined, offering essential information about the nutritional value and industrial potential of the products. The analysis of this data serves as a valuable resource to comprehend, improve, and determine future strategies for the production process at the fishmeal and fish oil factory in Sinop. This study aims to make significant contributions to productivity, quality control, and product diversity within the fish processing industry.

**Keywords:** Fishmeal, Fishoil, Nutritional Composition, Energy Values.

## 1. INTRODUCTION

Oceans and seas, with their vast expanses and rich biodiversity, have always played a crucial role in meeting the nutritional needs of the global population (Castello et al., 2020; Bayrakli and Duyar, 2019). Turkey, situated on a peninsula surrounded by three different seas, boasts an impressive coastline of 8,333 kilometers and an extensive river network spanning 177,714 kilometers. The fact that the total area of water resources in Turkey exceeds a massive 25 million hectares, equivalent to the total agricultural land in the country, underscores the critical importance of effective utilization in fisheries (Ertör and Cerdà, 2018; Bayrakli et al, 2019)

The consumption of seafood, an integral part of a healthy diet, is steadily increasing worldwide. Recognizing the potential depletion of wild fisheries due to overfishing and environmental pollution, aquaculture has emerged as a significant contributor to global fish production (Zhao et al., 2021). According to the Food and Agriculture Organization (FAO, 2022), the aquaculture sector grew from 21.8 million tons in the 1990s to 87.5 million tons in 2020, making it the fastest-growing sector among global food production industries. The share of aquaculture in global seafood production increased from 19.69% in the 1990s to 49.21% today, surpassing traditional fisheries. The long-term potential of aquaculture is expected to exceed traditional fishing.

Turkey has become a notable example of the global trend, experiencing a substantial increase in aquaculture. In 2010, 25.59% of the country's total seafood production came from aquaculture, reaching 60.58% in 2022, totaling 514,805 tons and surpassing the values obtained from fishing (TUIK, 2023). Particularly, fish farming, known as "aquaculture," has positioned Turkey among the fastest-growing countries in this sector (Yeşilsu et al., 2019).

The aquaculture industry focuses on essential inputs such as fishmeal and fish oil, playing a crucial role in formulating nutritious and balanced feeds for cultivated fish (Boyd et al., 2022). The fishmeal and fish oil industry, initially developed

around the processing of anchovies caught in the Black Sea, is concentrated in strategically located regions like Sinop and Samsun for easy transportation (Bayrakli and Duyar, 2021b).

However, challenges exist regarding the sustainability and cost-effectiveness of fishmeal and fish oil production. As the aquaculture sector continues to expand, the global demand for these essential inputs is expected to rise, potentially leading to price increases (Kesselring et al., 2020). Additionally, Turkey's dependence on imported fishmeal creates economic vulnerabilities that require the implementation of appropriate policies.

In this context, this study examines the activities of a fishmeal and fish oil factory in Sinop during the 2023-2024 fishing season. The analysis covers various aspects, including the quantity of processed raw materials, the efficiency of the production process, and detailed examinations of fishmeal samples for quality control. The information obtained not only contributes to understanding and improving the current production process but also has the potential to shape future strategies in the fish processing industry. The study aligns with the broader global narrative, promoting sustainable aquaculture practices and addressing the challenges posed by the dynamic seafood consumption environment.

## **2. MATERIALS AND METHODS**

### **2.1. Data Collection**

The data for this study were collected from a fishmeal and fish oil factory operating in Sinop during the fishing season from October 10, 2023, to November 14, 2023. The data collection process was carried out during the daily operations of the factory in the product acceptance and storage units.

### **2.2. Processed Raw Materials**

The initial stage of data collection focused on measuring the quantities of processed raw material, specifically anchovy fish, used in the production process. Daily measurements of the incoming raw materials were recorded, providing comprehensive information about the factory's daily production capacity. The weights of the incoming materials transported to the factory by trucks were documented.

### **2.3. Fishmeal and Fish Oil Production**

Subsequently, the quantities of fishmeal and fish oil produced at the end of the production activities were meticulously recorded. In this step, the analysis aimed to evaluate the efficiency and diversity of the production process by analyzing the data obtained from processed raw materials.

### **2.4. Sample Analyses**

After the production stage, samples were systematically collected to contribute to the overall quality control of the factory's output. These samples were analyzed in the factory laboratory.

### **2.5. Fishmeal Composition Analysis**

Comprehensive composition analyses of fishmeal samples were conducted, with samples collected from each batch at different times. Nutrient composition analyses (moisture, crude protein, crude fat, and crude ash) were performed using a Bruker type MPA brand spectrophotometer (Bayraklı vd., 2022). The total carbohydrate content was calculated by subtracting the sum of crude protein, crude fat, moisture, and crude ash from 100. The energy content of fishmeal samples was expressed in kilocalories per gram (kcal/g) and calculated from the percentages of crude protein, total carbohydrates, and crude fat. Conversion factors used were 4.0 kcal/g for protein and carbohydrates and 9.0 kcal/g for total fat. Total Energy = (Crude Protein \* 4) + (Carbohydrates \* 4) + (Crude Fat \* 9) (Bayrakli and Duyar, 2019). These analyses played a critical role in assessing the nutritional content and quality of fishmeal, providing detailed information for process control.

## 2.6. Statistical Analysis

Statistical evaluation was performed using one-way analysis of variance (ANOVA) with SPSS version 22 software (SPSS, Chicago, Illinois, USA) to assess the close composition of fish feeds. Duncan's multiple range test at  $P < 0.05$  was used to evaluate differences among fish feeds' compositions.

## 3. RESULTS AND DISCUSSION

This study analyzed and evaluated the quantities of raw materials, fishmeal, and fish oil obtained during the processing of Black Sea anchovy, providing insights into the efficiency of the production process. The findings include variations in processed raw material quantities, changes in fishmeal and oil production, and the percentage efficiency of these processes. Furthermore, analyses were conducted to understand the reasons behind the lowest and highest values. The lowest processed raw material quantity was 30.9 tons (Batch 6), while the highest was 773.72 tons (Batch 20). The lowest fishmeal quantity was 5.03 tons, and the highest fishmeal quantity was 151.51 tons. The lowest fish oil quantity was 4.13 tons, and the highest fish oil quantity was 108.03 tons (Table 1).

The percentage efficiency in fishmeal production ranged from the lowest of 14.83% (Batch 10) to the highest of 20.66% (Batch 21). In fish oil production, the lowest percentage efficiency was 10.33%, and the highest was 14.52%. The contribution of remaining fish oil in fishmeal on a batch basis to the total oil content ranged from the lowest of 1.58% (Batch 14) to the highest of 2.21% (Batch 1). The lowest overall efficiency value was 25.71%, while the highest overall efficiency, observed in Batch 20, where the highest raw material was processed, was 33.54%. The lowest efficiency values may be associated with low raw material use and potential process disruptions. The highest efficiency values are thought to be linked to high raw material use and more effective production processes.

The success rate of oil separation was observed to be the lowest in Batch 22 (84.42%). This indicates that certain factors, especially during the oil separation stage, reduce efficiency. This low success rate may suggest that the oil is not effectively separated or is lost under specific conditions. On the other hand, Batch 9, with the highest oil separation success rate (90.75%), indicates a more effective processing and efficient oil separation. This batch suggests that specific processing conditions or techniques are more effective than in other batches. Therefore, reviewing and improving processing processes may present an opportunity to increase oil separation efficiency.

**Table 1.** Batch Analysis Data for Raw Materials Anchovy (Tons), Fishmeal (Tons), Fish Oil (Tons), and Nutritional Composition (% and kcal/g).

Batches	Raw Materials Anchovy (Tons)	Fishmeal (Tons)	Fish Oil (Tons)	Fishmeal (%)	Fish Oil (%)	Total (%)	Fat Content in Fishmeal (%)	Efficiency (%)	Crude Protein (%)	Crude Fat (%)	Moisture (%)	Crude Ash (%)	Carbohydrate (%)	Energy (kcal/g)
1	466.08	86.78	60.59	18.62	12.90	31.52	2.21	85.48	71.44±1.89 <sup>ab</sup>	11.65±1.18 <sup>c</sup>	5.63±1.02 <sup>a</sup>	7.81±0.58 <sup>ab</sup>	3.47±1.24 <sup>cde</sup>	404.50
2	289.70	53.22	38.63	18.37	11.33	29.70	1.98	87.05	74.14±1.42 <sup>abc</sup>	10.61±0.82 <sup>bc</sup>	5.66±0.93 <sup>a</sup>	7.85±0.53 <sup>ab</sup>	1.74±0.64 <sup>abcde</sup>	399.02
3	442.02	77.07	57.92	17.44	11.14	28.57	1.90	87.31	74.26±1.17 <sup>abc</sup>	10.73±0.61 <sup>bc</sup>	5.22±0.83 <sup>a</sup>	8.17±0.78 <sup>ab</sup>	1.62±0.74 <sup>abcde</sup>	400.08
4	403.08	67.76	50.73	16.81	10.70	27.51	1.86	87.10	71.32±2.09 <sup>ab</sup>	10.89±0.61 <sup>bc</sup>	6.43±1.71 <sup>a</sup>	9.31±0.57 <sup>abc</sup>	2.04±0.74 <sup>abcde</sup>	391.51
5	118.00	19.83	15.74	16.81	11.34	28.15	1.82	88.02	73.56±1.39 <sup>abc</sup>	10.61±0.29 <sup>bc</sup>	4.39±0.75 <sup>a</sup>	10.12±1.29 <sup>c</sup>	1.60±1.21 <sup>abcd</sup>	395.02
6	30.88	5.03	4.13	16.30	11.36	27.66	1.69	88.79	72.71±1.39 <sup>abc</sup>	10.17±0.21 <sup>abc</sup>	5.90±1.39 <sup>a</sup>	8.60±0.63 <sup>abc</sup>	2.63±0.42 <sup>abcde</sup>	392.88
7	79.00	12.15	9.60	15.38	10.33	25.71	1.67	87.91	72.84±1.01 <sup>abc</sup>	10.68±0.06 <sup>a</sup>	5.01±1.62 <sup>a</sup>	7.79±0.25 <sup>ab</sup>	3.68±0.89 <sup>de</sup>	402.16
8	126.60	20.11	16.33	15.88	10.96	26.85	1.67	88.55	71.69±3.53 <sup>ab</sup>	10.32±0.87 <sup>ab</sup>	6.19±2.52 <sup>a</sup>	8.48±1.54 <sup>abc</sup>	3.32±1.23 <sup>bcde</sup>	392.89
9	166.18	29.05	26.00	17.48	13.30	30.78	1.60	90.75	74.23±0.89 <sup>abc</sup>	8.97±0.09 <sup>abc</sup>	5.21±1.18 <sup>a</sup>	9.51±0.74 <sup>bc</sup>	2.09±0.93 <sup>abcde</sup>	385.97
10	99.16	14.71	13.85	14.83	11.87	26.70	1.47	90.49	72.80±0.97 <sup>abc</sup>	9.73±0.14 <sup>ab</sup>	6.83±0.49 <sup>a</sup>	7.66±1.11 <sup>ab</sup>	2.98±1.46 <sup>abcde</sup>	390.67
11	99.92	16.44	14.34	16.45	12.20	28.65	1.74	89.19	71.62±1.03 <sup>ab</sup>	10.38±0.20 <sup>abc</sup>	7.07±0.69 <sup>a</sup>	8.06±0.29 <sup>ab</sup>	2.86±0.15 <sup>abcde</sup>	391.39
12	55.22	9.61	8.72	17.40	13.42	30.82	1.77	89.94	72.61±0.83 <sup>abc</sup>	9.97±0.49 <sup>ab</sup>	6.53±0.21 <sup>a</sup>	8.11±0.49 <sup>ab</sup>	2.78±0.63 <sup>abcde</sup>	391.30
13	102.60	16.02	13.49	15.62	11.17	26.79	1.62	89.00	71.26±1.01 <sup>a</sup>	10.22±0.34 <sup>abc</sup>	6.98±1.00 <sup>a</sup>	7.76±1.00 <sup>ab</sup>	3.78±0.69 <sup>e</sup>	392.14
14	150.26	24.38	19.98	16.23	11.30	27.53	1.58	89.36	71.55±2.07 <sup>ab</sup>	9.58±0.23 <sup>ab</sup>	7.12±1.86 <sup>a</sup>	8.55±0.47 <sup>abc</sup>	3.20±0.34 <sup>abcde</sup>	385.21
15	216.78	37.18	35.34	17.15	13.86	31.01	1.72	90.45	73.83±1.47 <sup>abc</sup>	9.86±0.33 <sup>ab</sup>	4.97±1.89 <sup>a</sup>	8.61±0.88 <sup>abc</sup>	2.73±0.74 <sup>abcde</sup>	395.01
16	145.78	26.00	24.91	17.84	14.52	32.36	1.80	90.49	73.46±1.42 <sup>abc</sup>	9.79±0.39 <sup>ab</sup>	7.07±0.76 <sup>a</sup>	8.75±1.15 <sup>abc</sup>	1.44±1.06 <sup>abc</sup>	385.67
17	447.80	80.46	72.49	17.97	13.76	31.73	1.73	90.33	75.79±0.50 <sup>c</sup>	9.47±0.30 <sup>ab</sup>	4.92±1.07 <sup>a</sup>	8.70±0.58 <sup>abc</sup>	1.11±0.68 <sup>a</sup>	392.85
18	284.38	49.28	36.97	17.33	12.90	30.23	1.86	87.84	72.85±1.10 <sup>abc</sup>	10.56±0.50 <sup>abc</sup>	6.96±1.05 <sup>a</sup>	8.06±0.69 <sup>ab</sup>	1.57±0.42 <sup>abcd</sup>	392.75
19	376.16	69.04	48.90	18.35	13.02	31.37	1.77	88.34	75.15±1.28 <sup>bc</sup>	9.46±0.26 <sup>ab</sup>	5.63±1.11 <sup>a</sup>	8.81±0.88 <sup>abc</sup>	1.27±0.78 <sup>ab</sup>	389.53
20	773.72	151.51	108.03	19.58	13.96	33.54	2.04	87.26	73.57±1.76 <sup>abc</sup>	10.23±0.51 <sup>abc</sup>	6.42±2.02 <sup>a</sup>	8.08±0.68 <sup>ab</sup>	1.70±0.92 <sup>abcde</sup>	393.15
21	421.36	87.06	53.06	20.66	12.59	33.25	2.13	85.53	73.62±1.17 <sup>abc</sup>	10.13±0.67 <sup>abc</sup>	6.84±1.56 <sup>a</sup>	7.97±0.99 <sup>ab</sup>	1.44±0.96 <sup>abcd</sup>	391.41
22	236.7	43.4	25.6	18.35	10.80	29.16	1.99	84.42	72.16±1.06 <sup>abc</sup>	10.67±0.43 <sup>bc</sup>	6.98±1.62 <sup>a</sup>	7.45±0.49 <sup>a</sup>	2.73±0.30 <sup>abcde</sup>	395.64

The study examined the protein content of fishmeal, which is a crucial protein source in animal husbandry, especially in fish feeds (Karimi et al., 2019). The protein content in fishmeal ranged from  $71.26 \pm 1.01\%$  to  $75.79 \pm 0.50\%$ . Statistically significant differences were found between batch groups with the lowest and highest values ( $p < 0.05$ ). The obtained values are within the reported range of protein content in anchovy meal, suggesting that the protein quality and quantity in fishmeal vary depending on the type of fish used, freshness of the raw material, and the analysis method.

The study also determined the fat content in fishmeal, which ranged from  $8.97 \pm 0.09\%$  to  $11.65 \pm 1.18\%$ . Statistically significant differences were found between batch groups with the lowest and highest values ( $p < 0.05$ ). The obtained fat content values are in line with those reported by other researchers, indicating similarities in the chemical composition of fishmeal.

The moisture content in fishmeal was found to range from  $4.39 \pm 0.75\%$  to  $7.12 \pm 1.86\%$ , with no statistically significant differences between batch groups ( $p > 0.05$ ). The variations in moisture content after the drying process were observed to be influenced by the functionality of the cooling process applied after drying.

**Table 2.** Fishmeal nutrient composition: Literature review findings.

References	Crude Protein	Crude Fat	Moisture	Crude Ash	Carbohydrate	Energy
Duyar and Bayraklı (2005)	66.50 - 76.00					
Bayraklı and Duyar (2019)	$72.56 \pm 0.386$	$8.12 \pm 0.360$	$7.78 \pm 0.810$	$10.75 \pm 0.625$	$0.80 \pm 0.085$	366.47
Bayraklı and Duyar (2021)	68.02 - 76.63	7,52 - 12,44	3.54 – 7.52	10.73 – 11.48		
Bayraklı vd. (2022)	73.02 - 76.41	10.03 - 13.10	2.34 – 3.93	9.60 – 11.71		
This Study	71.26 - 75.79	8.97 - 11.65	$4.39 \pm 0.75$	$10.12 \pm 1.29$	$1.60 \pm 1.21$	395.02

The study analyzed the ash content in fishmeal, which ranged from  $7.45 \pm 0.49\%$  to  $10.12 \pm 1.29\%$ . Statistically significant differences were found between batch groups with the lowest and highest values ( $p < 0.05$ ). The obtained ash content values align with those reported by other researchers (Table 2), indicating that the ash content in fishmeal can vary based on the type of fish, freshness of the raw material, and processing methods.

## 4. CONCLUSION

In light of the findings of this study, the following recommendations are proposed to enhance and sustain the operations of the fishmeal and fish oil factory in Sinop:

To manage the raw materials used in fishmeal and fish oil production in a balanced manner, more effective supply strategies should be developed. To better understand and manage fluctuations in processed raw material quantities, a more detailed monitoring system should be established.

Reviewing the fishmeal and fish oil production processes to reduce the differences between the lowest and highest efficiency values is essential. Processing procedures should be optimized to increase oil separation success rates, and the reasons behind batches with the lowest success rates should be analyzed.

To ensure regular sample analyses, a more stringent quality control process should be implemented. Fishmeal composition analyses should be conducted with more sensitive methods to improve product quality and meet standards.

Strategies based on local fishing resources should be developed to minimize economic vulnerabilities in raw material dependency. Focus on continuous research and innovation efforts to update the technology and equipment used in fishmeal and fish oil production, supporting research on more sustainable and cost-effective production methods.

Regulations and incentives should be developed at the local and national levels to support the aquaculture and fishing industry. Investments in scientific studies are crucial to assess population dynamics, reducing fishing pressure, and preserving aquatic resources.

To increase local participation in fishmeal and fish oil production and reduce environmental impacts, awareness programs should be organized at the community level. Communication strategies should be developed to better introduce the factory's sustainability efforts and operations to the local community.

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## ORAL PRESENTATION

### Effects of Microplastics on Fish and Possible Risk to Human Health

Adem Yavuz SÖNMEZ<sup>1✉</sup>, Yiğit TAŞTAN<sup>2,3</sup>

<sup>1</sup>Kastamonu University, İnebolu Vocational School, Department of Transport Services, Kastamonu, Türkiye

<sup>2</sup>Kastamonu University, Faculty of Engineering and Architecture, Department of Environmental Engineering, Kastamonu, Türkiye

<sup>3</sup>Kastamonu University, Institute of Science, Department of Aquaculture, Kastamonu, Türkiye

✉Correspondence: aysonmez@kastamonu.edu.tr

**Abstract:** Plastic is among the most precious materials humans have access to. It has the benefits of being light, cheap, processable, durable, flexible, etc. For this reason, it has wide use and hundreds of millions of tons of plastic are produced each year. Therefore, millions of tons of plastic also become waste and especially improperly disposed plastics pollute the environment, eventually mixing into water sources. Microplastics, either produced directly in micro sizes or broken down into micro sizes from macroplastics, threaten aquatic life. These can interfere with the biological processes of fish living in a polluted habitat. Moreover, they can be transported to humans through the food chain. Thus, they can also jeopardise human health. Therefore, it is essential to know their effects on fish and humans. Hence, this review study aimed to provide information on the effects of microplastics on fish and human health. The discussed literature in this paper suggests that microplastics are of great concern, especially when combined with other pollutants. It was concluded that more studies are required, particularly on humans, to draw more generalised conclusions.

**Keywords:** Pollution, Plastic, Health, Risk.

## 1. INTRODUCTION

Plastics are organic polymer compounds and various compounds, including oxygen, hydrogen, sulfur, nitrogen, and carbon. It is stated that it is a synthetic material formed by the combination of elements (American Chemistry, 2005). Plastics are widely preferred today because they are easy to use, cheap, lightweight, durable and reusable (Laist, 1987; Andrady & Neal, 2009).

Today, the primary use of plastic materials dates back to the 1800s with the development of rubber technology. The adventure that started with the discovery of the vulcanisation of natural rubber by Charles Goodyear continued day by day with the development of the plastic industry (Stevenson et al., 2008). Later, many forms were obtained to provide extra features such as durability, flexibility, lightness, low cost and ease of use. Some of the most widely used plastics by many different sectors today are Polystyrene (PS), Polypropylene (PP), Low-Density Polyethylene (LDPE), Polyvinyl Chloride (PVC), High-Density Polyethylene (HDPE), Polyethylene Terephthalate (PETE or PET), and various others (i.e., nylon, glass fibre, styrene, acrylonitrile butadiene, acrylic, polylactide, and polycarbonate).

The term microplastic is generally used for particles with the longest diameter of less than 5 mm (Lambert & Wagner, 2018). For the sake of a more precise definition, it has been suggested that microplastics should only be defined as those with a micrometre size of less than 1 mm (Andrady, 2011; Browne et al., 2011). Subsequently, it was suggested that particles between 1 mm and 2500 mm would be appropriate to be called mesoblastic (GESAMP, 2015). In another definition, those larger than 5 mm are classified as macroplastics, those between 1-5 mm are classified as mesoplastics, those between 0.1-1 mm are classified as microplastics and those smaller than 0.1 mm are classified as nanoplastics (Lambert et al., 2014).

However, 5 mm is generally accepted as the upper limit because this size may contain particles digestible by organisms (GESAMP, 2015).

## 2. MICROPLASTIC SOURCES

Two hundred fifty million tons of plastic are produced annually worldwide. For this reason, it is now a known fact that plastic use is a problem that is difficult to deal with (Plastics Europe, 2015). Therefore, contamination of microplastics into the environment can occur from a variety of sources.

Terrestrial littering activities have become a major environmental and public problem today (Njeru, 2006; Seco Pon & Becherucci, 2012). Accordingly, waste management remains a severe issue despite the increasing world population. Waste management practices also vary in various regions of the world (Lambert et al., 2014). Microplastics can enter into the environment via passage through wastewater treatment plants, from the use of microplastics in personal care products, fibres released from textiles into surface waters during washing of clothes, application of biosolids from Wastewater Treatment Plants to agricultural lands, stormwater overflow events, or incidental release (e.g., tire wear) (Nizzetto et al., 2016). It can be mixed from many different sources, such as release from atmospheric deposition of fibers and industrial products or processes (Dris et al., 2017).

Plastic films used in crop production are considered a substantial agricultural emission, and their use is thought to be among the most important sources for plastic contamination in agriculture soils (Xu et al., 2006; Kyrikou & Briassoulis, 2007; Brodhagen et al., 2015).

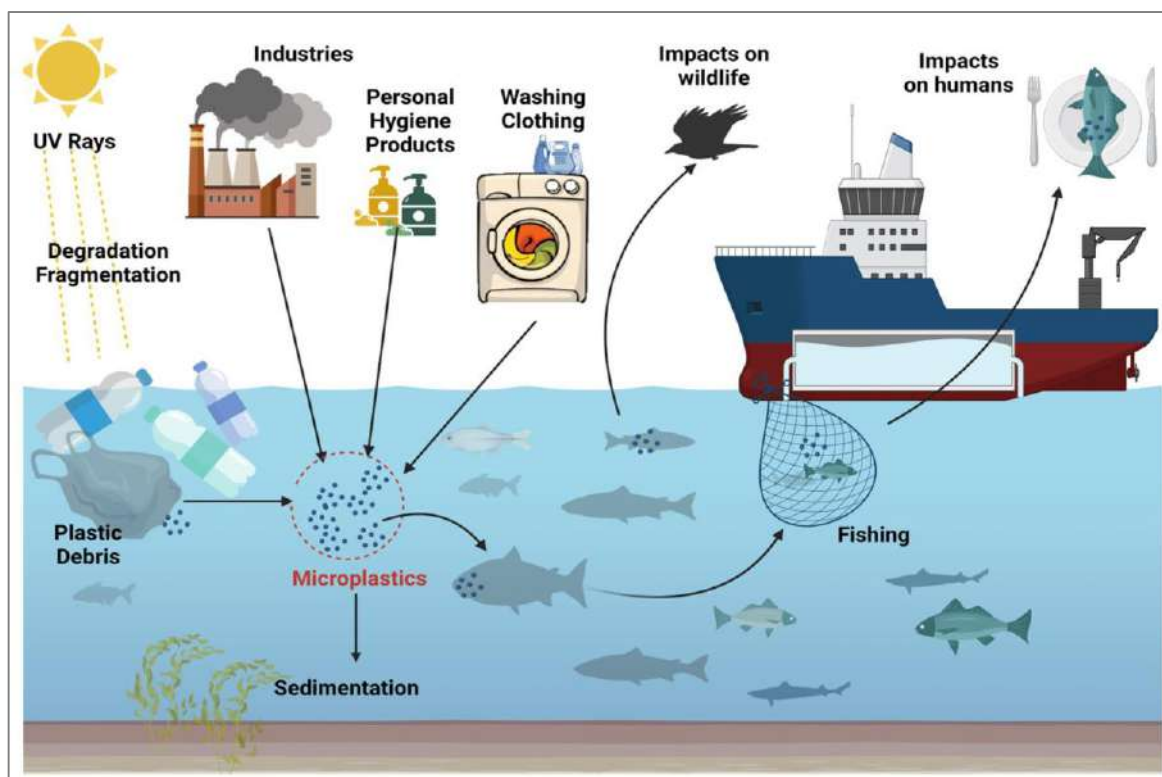
In addition to these, many secondary factors also affect the spread of plastics into the environment.

## 3. CYCLE OF MICROPLASTICS IN THE AQUATIC ECOSYSTEM

Plastics or microplastics entering the environment do not remain stable. Undoubtedly, these microplastics are taken into the environment, circulated within the environmental system, and transported to water resources through various means.

Many plastic materials entering the environment are transported between different environmental divisions (for example, from land to freshwater, then from here to marine environments) with various residence times in each division. Of course, conditions such as weather conditions, distance to the water environment, and land structure are also effective in this transition process (Lambert et al., 2014). In addition, microplastics' transportation and degradation processes differ from those of macroplastics (Harrison et al., 2014).

Plastics are transported to the aquatic environment through various means and begin circulating in the aquatic ecosystem after a series of degradation processes (Figure 1).



**Figure 1.** Circulation of microplastics in the aquatic environment (Ziani et al., 2023).

This degradation occurs due to biological degradation (with the help of microorganisms), chemical decomposition (with the help of UV rays), or physical factors (with the help of wave action, wind, abrasive sand, or sediment) (Barnes et al., 2009; Hidalgo-Ruz et al., 2012; Browne, 2015).

The degradation processes of microplastics have been explained in five different ways. These are;

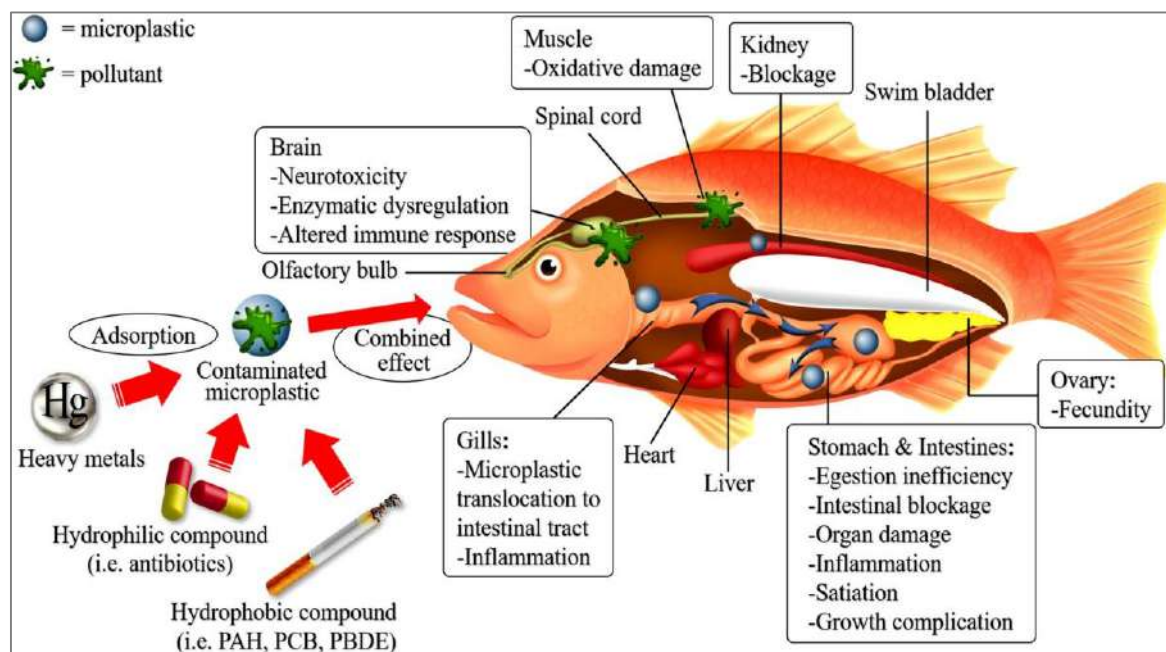
- 1-Photodegradation (by the effect of light or photons such as UV light).
- 2-Thermal decomposition (with high temperature).
- 3-Thermo-oxidative degradation (slow oxidative degradation or molecular degradation occurring at moderate temperatures).
- 4-Hydrolysis (as a result of reaction with water).
- 5-Biological degradation (decomposition of organic materials by microorganisms).

This degradation is tied to many different factors, such as polymer type and polymer age, as well as environmental conditions, including oxygen content, thermal cycles, pollutants, pH, irradiation, humidity, rain, temperature, and sunlight (Veerasingam et al., 2020).

The processes by which microplastics, which are broken down through various processes, are taken into their bodies by aquatic creatures can take different forms.

Various organisms can take microplastics from the aquatic environment and sediment. This can occur directly through ingestion or via gills, i.e., dermal intake. There are studies showing that microplastics of certain sizes can be absorbed by planktonic organisms. These planktonic organisms, which constitute a food source for fish in the aquatic food chain, thus play the role of microplastic carriers. Apart from the microplastics that enter the fish body in this way, there are also those that come directly from feed or from the aquatic environment.

Regardless of the way they are taken into the body, these microplastics cause various physiological effects in fish consumed as human food.



**Figure 2.** A demonstration of the individual and combined effects of microplastic and pollutants to marine life (Amelia et al., 2021).

Figure 2 shows the combined effects of various pollutants on fish. On the other hand, microplastics alone have been shown to have similar effects on fish.

Plastic polymers can exhibit varying toxicity degrees. Therefore, the adverse effects of microplastics are also influenced by the absorption of chemical pollutants with plastic affinity and the chemical composition and type of plastic (Zhu et al., 2019).

However, its general effects on fish include causing hormonal disorders, stress in the immune system, toxicity in the liver, bioaccumulation, damage to smell sense, blockage in the gills, cardiotoxicity, low absorption in the intestines, and inadequate growth (Kayhan, 2019).

#### 4. EFFECTS OF MICROPLASTICS ON HUMAN HEALTH

It is an undisputed fact that aquatic creatures, and especially fish, are frequently consumed by humans, the final consumers in the food chain. This situation poses a significant risk in terms of microplastics that can be transferred from fish to humans. For this reason, studies have begun to be carried out frequently in recent years on the possible effects of these microplastics taken through food on human health.

There are many studies on the direct effects of microplastics on human health. However, it is inaccurate to make definitive judgments about the mechanisms of action. Because factors such as the absorption level of microplastic, the amount taken into the body, the duration and nature of exposure are effective.

It has been reported that plastic particles of 150  $\mu\text{m}$  or larger are generally not absorbed by the intestinal tract. It is assumed that MPs found in edible muscle tissue and different organs are  $<20 \mu\text{m}$  MPs taken into the stomach (EFSA, 2016; Lusher et al., 2017; Tunçelli & Erkan, 2020). In the range of 0.1–10  $\mu\text{m}$ , it has been determined that MPs can penetrate organs, cell membranes, blood-brain barriers, and placenta (Browne et al., 2008; EFSA, 2016; Lusher et al., 2017).

It is thought that more than 90% of micro and nanoplastics ingested by humans are excreted through the human body's excretory system (Smith et al., 2018). According to the results of *in vitro* studies conducted on human cell lines, the potential cytotoxic effects of MP (10 µm) and NPs (40-250 nm) on human cells have been demonstrated (Schirizzi et al., 2017). However, micro and nanoplastics also pose a danger to human health due to pathogenic and non-pathogenic bacteria, chemicals and additives in their structures (Dehaut et al., 2016; Smith et al., 2018). There is an opinion that when exposed to more than one MP source for a long time, the cumulative effect on the body can cause health problems (Karami et al., 2018). It has been stated that the substances found in plastics may cause chronic and acute diseases in humans (ATSDR, 2010).

Studies have partially explained the effect mechanisms of microplastics on human health. It is more focused on the effects that occur as a result of contamination with other pollutants. As a result, it is necessary to conduct studies focusing on the direct effects of microplastics on human health.

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## ORAL PRESENTATION

### How Much Pesticide Enters into Freshwater Bodies?

Yiğit TAŞTAN<sup>1,2✉</sup>, Adem Yavuz SÖNMEZ<sup>3</sup>

<sup>1</sup>Kastamonu University, Faculty of Engineering and Architecture, Department of Environmental Engineering, Kastamonu, Türkiye

<sup>2</sup>Kastamonu University, Institute of Science, Department of Aquaculture, Kastamonu, Türkiye

<sup>3</sup>Kastamonu University, İnebolu Vocational School, Department of Transport Services, Kastamonu, Türkiye

✉Correspondence: yigittastan@gmail.com

**Abstract:** Pesticides are mostly chemical substances used primarily in agricultural production to enhance yield and profitability. They are great tools which helped humanity increase their production especially in the last decades. Currently, they seem irreplaceable when considering their benefits. However, one of the main problems of pesticides is that through various means they contaminate natural resources, eventually ending up in water bodies. Some pesticides are persistent in water and they can exert toxic effects on biota or can reach humans through food chain or via drinking water. Therefore, monitoring environmentally relevant pesticide concentrations is required. Furthermore, knowing these concentrations could also help toxicology studies to assess environmental risks of pesticides. With this purpose, this paper aimed to present an overview on the environmental pesticide concentrations in freshwater bodies. A literature review was conducted to reveal the present situation of pesticide pollution. The examined literature data showed that pesticide concentrations in some studies exceed the drinking water limit set by the European Commission, suggesting that pesticide pollution is extremely high. It was concluded that it is essential to seek better alternatives while trying to minimize the current pesticide pollution at the same time.

**Keywords:** Pesticide, Toxicology, Pollution, Concentration, Lake, River.

## 1. INTRODUCTION

Pesticide is a common name for a wide group of chemicals used in boosting agricultural production (Ccanccapa et al., 2016). Pesticides are used in agriculture against fungi, bacteria, insects, weeds, etc. (Kapsi et al., 2019). Besides agriculture, they are also applied to greeneries such as private gardens or public places (Mojiri et al., 2020). As a result of widespread use, around 3.54 million ton pesticide has been used in 2021 for agriculture alone (Statista, 2023). Pesticides are currently unequivocally indispensable tools for achieving high production quantities. However, there are growing concerns about whether this trend should last or not because each day we accumulate more data about pesticides' toxic effects, leading prohibitions of pesticides. Several pesticides are banned each year. For instance, Department of Plant Protection Products (a unit under Turkish Ministry of Agriculture and Forestry) has terminated the use of 5 different pesticides (Chloridazon, desmedipham, dimethoate, ethoprophos, and linuron) as of 2023 along with many others banned in previous years (BKU, 2023).

One of the substantial problems with the pesticides is their persistency in the environment. Depending on their solubility and degradability, they can last long times in natural zones. They can enter into water sources through surface run-off, winds (spray drift), rainfall, irresponsible use, etc. (Palma et al., 2004; Demircan & Yılmaz, 2005; Altıkat et al., 2009; Glinski et al., 2018; Mojiri et al., 2020). This is a significant problem because some pesticides, even in low concentrations, can be highly toxic to many organisms. Since pesticides are tools mostly designed to kill, they can also cause great harm to non-target organisms (Katip, 2019). Moreover, breakdown of some pesticides in the nature could lead the formation of transformation products that are more persistent or toxic than the source pesticide (Ccanccapa et al., 2016).

Current literature suggests that there are numerous pesticides which are toxic to many different non-target organisms (Stanley et al., 2016). However, one of the most important things to note here is that how well the toxic concentrations determined in empirical studies reflect environmentally relevant pesticide concentrations. For example, if a substance is

toxic to common carp at 0.5 mg/L and it is found at 0.01 mg/L in freshwater, it will be inferred that natural carp populations are not in jeopardy. In contrast, if the substance is found at 0.75 mg/L, then the authorities should be alarmed immediately. This underlines the importance of environmental monitoring studies with regards to toxicity trials and does not imply that empirical toxicity studies which do not measure environmentally relevant pesticide concentrations are incomplete.

Environmental monitoring is among the first steps to understand toxic substances' pathways and behavior. Therefore, this paper aimed to present an overview about the pesticide concentrations in freshwater sources worldwide.

## 2. PESTICIDE DEFINITION, CLASSIFICATION, AND USE

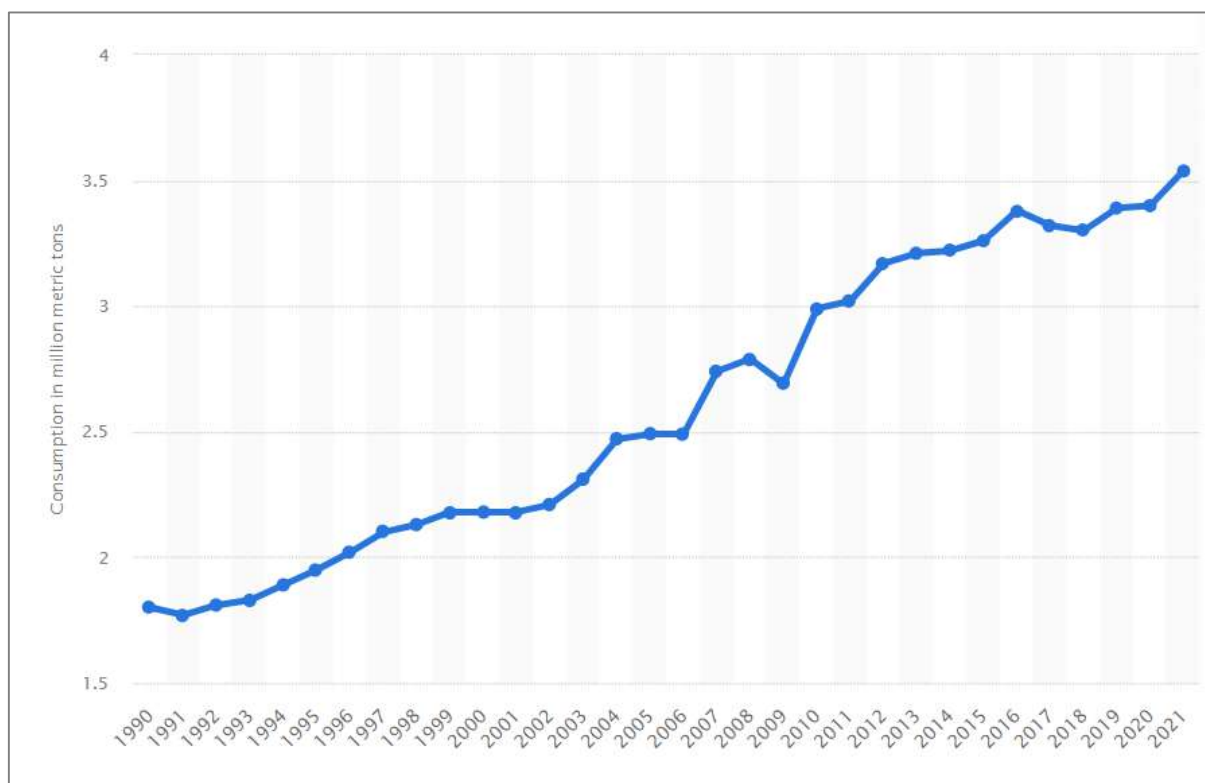
Environmental Protection Agency, based on the US laws, defines pesticide as “Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest” (EPA, 2023a). This definition implies that pesticides could be biological or organic origin. However, in most of environmental studies, pesticides are referred as the chemical agents. Likewise, this paper mainly features chemical pesticides. However, pesticides could be classified into a wide range of different categories (Table 1).

**Table 1.** Pesticide classification (EPA, 2023b).

Pesticide	Action	Target
Algicides	Kill	Algae
Antifoulants	Kill or repel	Organisms that attach to underwater surfaces, such as barnacles that cling to boat bottoms
Antimicrobials	Kill	Microorganisms such as bacteria and viruses
Attractants	Lure to a trap	Pests such as rodent or insect
Biocides	Kill	Microorganisms
Defoliants	Cause leaves or foliage to drop from a plant	Plants
Desiccants	Promote dying of living tissues	Plants
Disinfectants and sanitizers	Kill or inactivate	Microorganisms
Fungicides	Kill	Fungi
Fumigants	Produce gas or vapor intended to destroy	Pests
Herbicides	Kill	Weeds and plants
Insect growth regulators	Disrupt the molting, maturing from pupal stage to adult, or other life processes	Insects
Insecticides	Kill	Insects and other arthropods
Miticides (Acaricides)	Kill	Mites
Nematicides	Kill	Nematodes
Ovicides	Kill	Eggs of insects and mites
Pheromones	Disrupt mating behavior	Insects
Plant growth regulators	Alter the expected growth, flowering or reproduction rate	Plants
Repellents	Repel	Pests, including insects (such as mosquitoes) and birds
Rodenticides	Control	Mice and other rodents

As can be seen from the table, pesticides are mostly utilized to kill. However, most pesticides are not species-specific. This leads non-target organisms, especially the ones belong to the same group of organisms that pesticide targets, to be affected by the nearby pesticide application. Therefore, a growing concern emerges regarding the pesticide use.

Nonetheless, pesticides are currently irreplaceable (Doğan & Karpuzcu, 2019) due to lack of a better alternative This is evidenced by the rapidly increasing consumption worldwide (Figure 1 and Table 2).



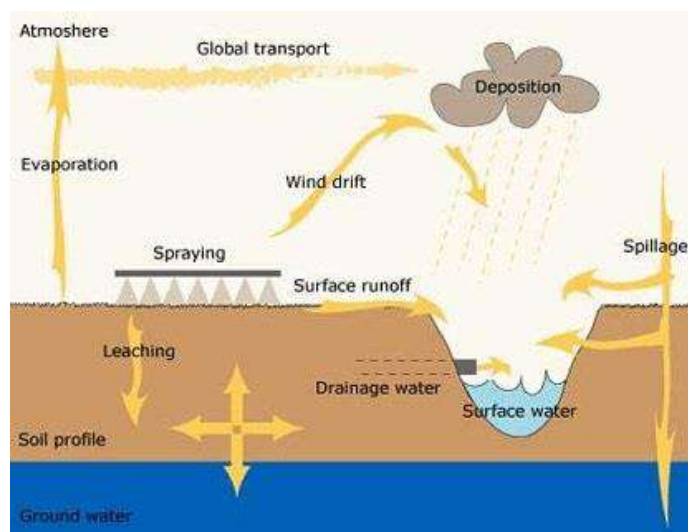
**Figure 1.** Worldwide agricultural pesticide consumption (Statista, 2023).

**Table 2.** Worldwide use of most common pesticide groups (FAO, 2023).

Years	2017		2018		2019		2020		2021	
Pesticide Group	Amount	Share	Amount	Share	Amount	Share	Amount	Share	Amount	Share
Insecticide	721	23.36	701	22.85	737	23.34	695	21.79	758	22.93
Herbicide	1631	52.85	1606	52.36	1657	52.49	1729	54.20	1732	52.39
Fungicide+Bactericide	734	23.78	760	24.78	763	24.17	766	24.01	816	24.68
Total	3086		3067		3157		3190		3306	

Unit of amount: Thousand tonnes, Unit of share: Percent.

As with many other pollutants, pesticides eventually end up in water bodies. This happens through various ways, such as wind drift, surface run-off, spillage, etc. (Figure 2). After ending up in water sources, pesticides pose risks for wildlife, including algae, crustaceans, fishes, birds, etc. (Luttik et al., 2011; Sánchez-Bayo, 2012; Stanley et al., 2016).



**Figure 2.** Transportation pathways of pesticides in the environment (Swedish University of Agricultural Sciences, 2020; Illustration by Lennart Torstensson).

### 3. PESTICIDE CONCENTRATIONS IN FRESHWATER BODIES

Despite great efforts put into environmental monitoring of pesticides, it is challenging to interpret how much pesticides are released into the environment. This has various reasons, such as persistency and degradability of different pesticides, variations in detection methods, difference in environmental routes of different pesticides, challenges in controlling pesticide waste management, etc. Meta-analysis studies in the literature suggest that pesticide pollution exerts significant risks to human and wildlife health (Wolfram et al., 2018; Vasseghian et al., 2021). Table 3 presents pesticide concentrations detected in freshwater bodies by some pesticide monitoring studies conducted worldwide. Moreover, Table 4 shows some dangerously high pesticide concentrations detected in surface waters.

**Table 3.** Worldwide pesticide concentrations in freshwater bodies.

Pesticide	Concentration range, when detected (ppb)	Location	Reference
34 Different pesticides (herbicides, insecticides, and fungicides)	0.05 - 0.610	Louros River (Greece)	Kapsi et al. (2019)
Simazine, hexazinone, 2,4-D, picloram, and carbendazim	0.2 – 9.7	Traiguén river basin (Chile)	Palma et al. (2004)
AMPA, boscalid, diflufenican, fenpropimorph, glyphosate, imidacloprid, metazachlor, quinmerac, tebuconazole	0.0007 – 0.21	Water catchment tributaries near an agriculture site in Germany	Tauchnitz et al. (2020)
Acetochlor	0.002 – 0.678	Seven major watersheds (China)	Xu et al. (2019)
Cyprodinil	0 – 0.38	A wetland near Tifton, Georgia (USA)	Glinkski et al. (2018)
Terbutryn	0.0009 – 0.03	Ebro River basin (Spain)	Ccancappa et al. (2016)
174 Different pesticides	0.0034 – 12.0250	Ergene River basin (Türkiye)	Tokatlı (2020)
26 Different pesticides	0.022 – 2.006	Guayas River basin (Ecuador)	Deknock et al. (2019)

**Table 4.** Some examples of high pesticide concentrations detected in freshwater bodies.

Pesticides	Maximum detected concentration (ppb)	Location	Reference
Metolachlor	10.5	A wetland near Tifton, Georgia (USA)	Glinski et al. (2018)
Diuron	22.8	Tempisque river basin (Costa Rica)	Carazo-Rojas et al. (2018)
Diazinon	24.46	A general analysis in California (USA)	Zhang et al. (2012)
<b>Maximum allowed concentration in drinking water (ppb)</b>			
Any pesticide	0.1		European Commission (2020)
Total pesticide	0.5		

Once in the aquatic environment, the pesticides' effects depend on their solubility and persistency in the environment. Pesticides in water not only pose risk to aquatic life, but also can be carried to humans through drinking water or by biomagnifying in the food chain (Mojiri et al., 2020). As can be inferred from the Tables 3 and 4, concentrations of pesticides in water are alarmingly high in some regions. This indicates that alternative or safer products are required. For instance, as displayed in Table 4, the diuron concentration reported by Carazo-Rojas et al. (2018) is 228 times more than the drinking water limit set by European Commission (2020). Similarly, the Diazinon value reported by Zhang et al. (2012) is nearly 245 times more than this limit. As evident from Table 3, even numbers in some studies, which were considered to report relatively low concentrations of pesticides, exceed the limit. Of course, drinking water systems have filters and apply chemical processes to eliminate these compounds but it is ambiguous whether these systems are efficient all around the globe. Furthermore, even drinking water intended for human consumption is processed properly, aquatic life in polluted waters is still exposed to pesticides, which can jeopardize fish health and eventually reach humans through food chain.

## 4. CONCLUSION

This paper presented an overview on the environmentally relevant pesticide concentrations in freshwater sources. It is evident from the discussed data that it is inevitable to seek for better alternatives to pesticides. Meanwhile, we could apply some measures to minimize their risks. These measures could include:

- Implementation of integrated pest management (IPM) programs (Elliott et al., 1995) which consists of methods like late planting, quarantine measures, and summer ploughing,
- Producing pest resistant or tolerant crop (or plant) species using traditional crossbreeding methods or molecular techniques such as marker-assisted selection (MAS),
- Replacing chemical pesticides with biological control methods
- Training farmers for efficient use of pesticides (by preventing overuse) and proper disposal.

Moreover, aquatic toxicology studies investigating toxic effects of pesticides could also monitor environmentally relevant pesticide concentrations in water sources to better understand their potential risks. Furthermore, these environmental monitoring studies should be conducted on a regular basis to evaluate the trend and speed of the pollution.

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## ORAL PRESENTATION

### Effect of Steroid Nature Growth Regulators on Productivity and Grain Quality of Winter Barley

**Silvia SECRIERU<sup>1✉</sup>, Antonina DERENDOVSKAIA<sup>2</sup>**

<sup>1</sup>*Technical University of Moldova, Chisinau, Moldova*

<sup>2</sup>*Comrat State University, Agro-Technological Faculty, Comrat, Moldova*

✉*Correspondence:* silvia.secieru@am.utm.md

**Abstract:** Research was carried out on winter barley varieties of intensive (Buran) and plastic (Osnova) types, in a field crop rotation saturated with legumes. Predecessors are peas (early harvested) and soybeans (late harvested). Winter barley plants were sprayed with solutions of steroid glycosides Moldstim (MS) and Ecostim (ES) at a dose of 25 mg/l once during the tillering phase - the beginning of their emergence into the tube. It was also established an increase in fresh and dry biomass quantity the increase in the parameters of elements of plants productivity and crop under the treatment of growth regulators. The quality of barley kernels was improved through accumulation of proteins, starch, lipids and diminishing the content of cellulose and ashes. The efficiency of administrated growth regulators increases upon their application in the phases of tillering – beginning of booting stage and depends on variety peculiarities and precursor used.

**Keywords:** Moldstim, Winter Barley, Precursor, Growth Regulators, Steroid Glycosides, Ecostim.

## ORAL PRESENTATION

### Feed Additives Used in Rainbow Trout (*Oncorhynchus mykiss*) Feeds

**Keriman YÜRÜTEN ÖZDEMİR<sup>1✉</sup>, Enraida IMBUK<sup>2</sup>**

<sup>1</sup>Kastamonu University, Faculty of Engineering and Architecture, Kastamonu, Türkiye

<sup>2</sup>Kastamonu University, Institute of Science, Aquaculture Department, Kastamonu, Türkiye

✉Correspondence: kozdemir@kastamonu.edu.tr

**Abstract:** Rainbow trout cultivation was achieved in 77 countries in the world in 2020 and approximately 1.02 million tons. Iran ranks first with 197,370 tons and Turkey ranks second with 144,283 tons. Looking at the 10-year change in Turkey, the amount of cultivation increased from 212,410 tons in 2012 to 471,686 tons in 2021. This species constitutes 35% of the total 471,686 tons of aquaculture in Turkey in 2021. Rainbow trout farming is carried out in 68 provinces in Turkey. In aquaculture production, the main objective is to obtain maximum yield with minimum cost. In recent years, feed additives are widely used in order to increase fish production. While additives added to fish diets increase digestibility, but they reduce anti-nutritional effects of the fish diets. In addition, the feed additives play roles for fish gaining resistance against diseases. Probiotics to be used as feed additives should not be in pathogenic nature and they should not produce toxic substances. Moreover, they should maintain viability during their storage and their high nutritional interaction with fish feed is more desirable. Some studies demonstrated that the use of enzymes and plant extracts in diets increased live fish weight and voluntary feed intake. In this study reviewed the specific literature investigating probiotics, enzymes and plant feed additives in rainbow trout diets.

**Keywords:** Feed Additives, Rainbow Trout, Aquaculture, Feeds.

## ORAL PRESENTATION

### Commercial Micropropagation of Aquarium Plants *Hemianthus callitrichoides* and *Riccia fluitans*

Esra ÖZCAN, Hasan Hüseyin ATAR✉

Ankara University, Faculty of Agriculture, Department of Fisheries and Aquaculture, Ankara, Türkiye

✉Correspondence: atar@agri.ankara.edu.tr

**Abstract:** Aquatic plants used in aquariums are intertwined with fish and maintain the biological balance of the environment as an integral part of the aquarium. They provide oxygen to the environment by taking in carbon dioxide in the water and the residues left by the fish with their roots. For these reasons, aquarium plants are not only considered as an aesthetically pleasing appearance, but also have a very important role in the storage, feeding and improvement of water quality. In this study, it was aimed for the rapid in vitro micropropagation of *Hemianthus callitrichoides* and *Riccia fluitans* species, which are among the most important ground plants in aquariums, at the lowest cost. According to the results obtained, it was observed that the both species were propagated very well in half strength basic nutrient medium containing 20 g/L sucrose. It was also found that plant growth regulators, which are among the most expensive compounds of nutrient media, are not needed for in vitro propagation of these species. In both species, high rates of in vitro micropropagation was achieved in a short period of 4 weeks. In vitro propagated plants were acclimated to aquariums at a 100% rate. Micropropagation methods we developed for *Hemianthus callitrichoides* and *Riccia fluitans* can be widely used for commercial production with an extremely low-cost.

**Keywords:** Nutrient Medium, Sugar Source, in vitro, Plant Regeneration, Aquatic Plants.

## 1. INTRODUCTION

Aquatic plants consist of single or multi-celled organisms containing chlorophyll (Cirik et al. 2001). They use light energy and carbon dioxide in the water and enrich the water with organic matter and oxygen as a result of photosynthesis. These plants, which are the main producers of the aquatic environment, maintain the water balance and also produce plant protein sources. Therefore, aquatic plants form the first link of the food chain in the aquatic environment and are converted into animal protein. Since these plants alkalize the environment, they can also play an important role in removing harmful bacteria from the environment. They also provide habitat and shelter for fish and different aquatic creatures to protect their eggs and larvae from other creatures. In addition to their important functions in the aquatic environment, some aquatic plants have a great potential in terms of the mineral substances they contain as food and feed (Aasim et al. 2018, Doğan 2020a). In addition, many aquatic plants, especially watercress, *Riccia fluitans* and *Bacopa monnieri*, are rich in phenolic and flavonoids and are an important source of antioxidants (Tosun et al. 2013, Sharma et al. 2015).

*Hemianthus callitrichoides* Griseb, also known as dwarf baby tears or Cuba is a semi-aquatic, small, delicate and important ornamental plant belonging to the Scrophulariaceae family. It originates from the Bahamas, Cuba, Jamaica and Puerto Rico islands, and is known as water-star grass in the Bahamas (Acevedo-Rodriguez and Strong 2012). The plant grows in clusters and develops slowly and in a carpet form as a ground plant in the aquarium. (Barpete et al. 2015). The flowers of the plant are small and white in color, and appropriate light, nutrients, CO<sub>2</sub> and pH are required for flowering in water. *Riccia fluitans* L., generally known as crystal grass, belongs to the Ricciaceae family (Edward 2012). This species is very popular as aquarium ground plants and provide shelter for young fish. It can be found floating in ponds and often forms thick mats above and below the water surface. It can also multiply quickly from one branch if it finds suitable conditions (Türkoğlu and Parlak 2014). In this study, it was aimed to micropropagate *H. callitrichoides* and *R. fluitans* species, which are the most preferred aquarium ground plants, in a rapid in vitro technique with a lowest cost. For this purpose, different nutrient media, plant growth regulators and sugar sources were tested.

## 2. MATERIALS AND METHODS

A small group (approximately 10 shoots) was taken with forceps from the *H. callitrichoides* and *R. fluitans* shoot clumps grown in vitro culture vessels and cultured on the nutrient medium in Duchafe Sterivent containers. While full and half strength (1/2) MS medium (Murashige ve Skoog 1962) was used for *H. callitrichoides*, full and ½ SH nutrient medium (Schenk ve Hildebrandt 1972) containing MS vitamins was used for *R. fluitans*. To these nutrient media different concentrations of 6-benzylaminopurine (BAP) and  $\alpha$ -naphthaleneacetic acid NAA, 20 g/L each of sucrose, glucose and fructose were added. Double-distilled water was used in the preparation of nutrient media. All nutrient media were solidified with 3 g/L agar. After adjusting the pH of all media to 5.6, they were sterilized in an autoclave at 121 °C under 1.4 kg/cm<sup>2</sup> pressure for 20 min. Four shoot clumps were placed in each culture vessel that were incubated in growth cabinets under white fluorescent light (35  $\mu$ mol photons m<sup>-2</sup> s<sup>-1</sup>) at 24 °C with a 16-hour photoperiod. All measurements and observations were made 4 weeks after the beginning of culture. The data obtained were subjected to analysis of variance (ANOVA) and the differences between the means were determined with the Tukey or t tests.

Plants grown under in vitro conditions were removed from the culture containers and the agar was completely washed and cleaned. Then, the shoot clumps were transferred to aquariums with a temperature of 24 $\pm$ 1 °C, pH value of 6.5-7.2 and water hardness of 120-140 g/L. White light at a height of 20 cm from the aquarium was used as the light source. Aquarium sand mixture was placed on the aquarium floor. A 1/3 water change was made in the aquariums twice a week.

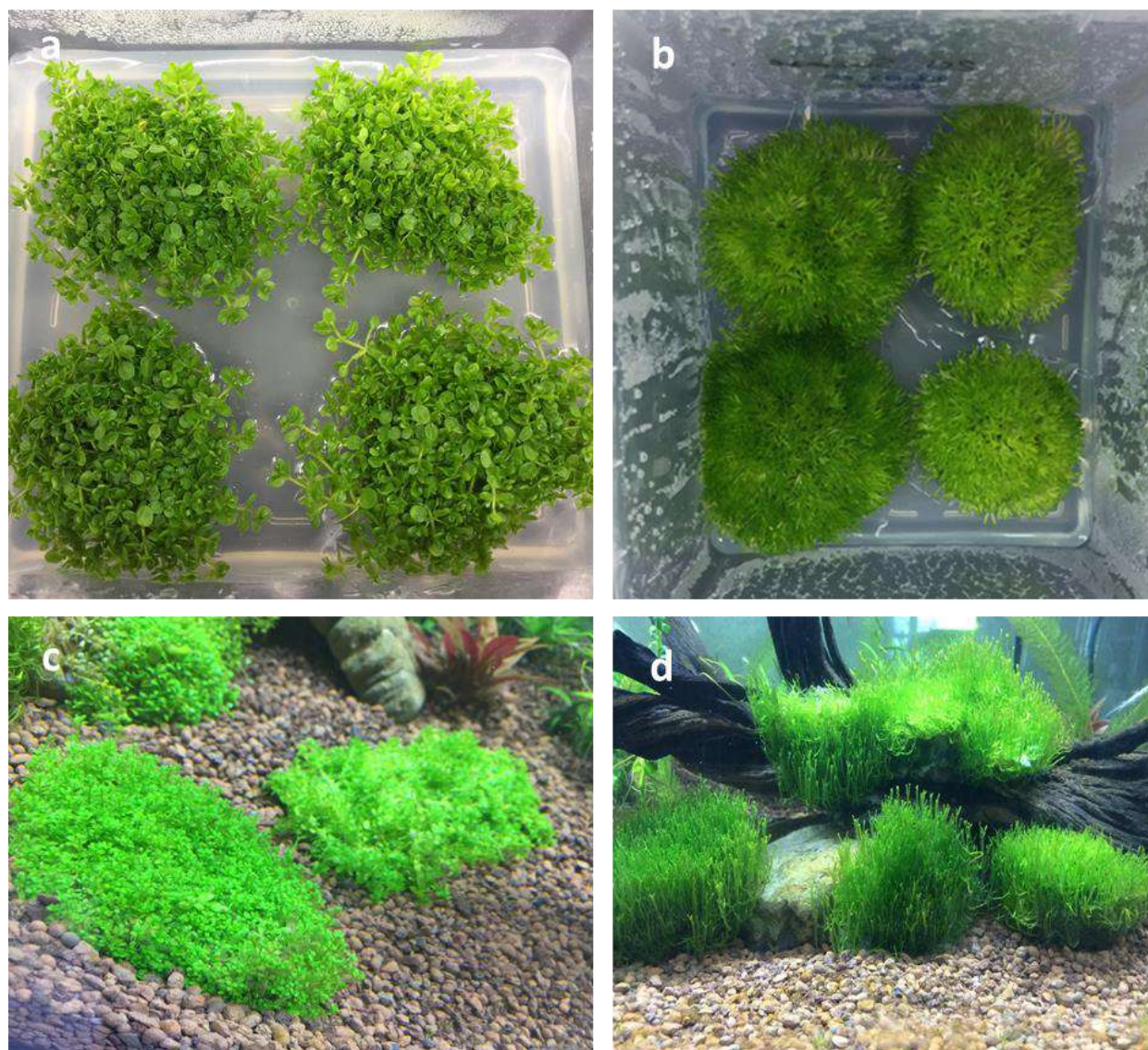
## 3. RESULTS AND DISCUSSION

In our previous study, 12 different nutrient media were tested for rapid in vitro propagation of *H. callitrichoides* and *R. fluitans*, and it was determined that the best medium for *H. callitrichoides* was MS and for *R. fluitans* was SH+Ms vitamins (Özcan vd., 2023). Therefore, in the present study the effect of full and half strength MS and SH nutrient media was investigated for a more economical micropropagation of these species. Sugar sources are mostly used at a rate of 30 g/L in tissue culture studies. In the present work, the effect of 20 g/L sucrose, glucose and fructose was examined to reduce the cost, taking into account the results obtained from previous studies (Özcan et al. 2021, Özcan et al. 2023). At the same time, different ratios of BAP and NAA were tested in this study, but in all applications tried, the application of growth regulator had a negative effect on in vitro micropropagation (therefore data is not given), as in the previous study (Özcan et al. 2023). While 7-8 g/L agar is generally used in tissue culture studies, 3 g/L agar was used in the present study for low-cost production.

### 3.1. Effect of Nutrient Media

The effects of full and half strength nutrient media on in vitro micropropagation of *H. callitrichoides* are given in Figure 1 and Table 1. As can be seen from the Table, although clump diameter and rooting rate were higher in full-strength MS medium than ½ MS, they were found to be statistically insignificant. In *R. fluitans*, shoot clump diameter was higher in ½ SH+MSvit medium, however the difference between it and full-strength SH+MSvit nutrient medium was insignificant (Table 2). On the other hand, the rooting rate was statistically higher in ½ SH+MSvit than full-strength SH+MSvit.





**Figure 1.** Micropropagation of *H. callitrichoides* and *R. fluitans* and their adaptation to the aquarium. (a) Growth of *H. callitrichoides* 4 weeks after the start of culture in 1/2 MS medium containing 20 g/L sucrose. (b) Growth of *R. fluitans* 4 weeks after the start of culture in 1/2 SH+MSvit medium containing 20 g/L sucrose. Adaptation of (c) *H. callitrichoides* and (d) *R. fluitans* to aquarium conditions.

**Table 1.** Effect of full-strength and 1/2MS medium on in vitro micropropagation of *H. callitrichoides* after 4 weeks of culture initiation.

Nutrient medium	Shoot clump diameter (cm)	Root formation (%)
MS	5.70 <sup>ns</sup>	95.06 <sup>ns</sup>
1/2 MS	5.12	93.38

ns = the difference between the means is not significant according to the t-test. Nutrient media were added with 20 g/L sucrose.

**Table 2.** Effect of full-strength and ½ SH+MSvit medium on in vitro micropropagation of *R. fluitans* after 4 weeks of culture initiation.

Nutrient medium	Shoot clump diameter (cm)	Root formation (%)
SH+MSvit	3.02 <sup>ns</sup>	43.82 a
½ SH+MSvit	3.92	38.88 b

The difference between the means shown with different letters in the same Column is significant at the 0.05 level according to the t-test. ns = not significant. Nutrient media were added with 20 g/L sucrose

The basic nutrient media used in tissue culture studies contain all the macro, microelements and vitamins necessary for plant growth. Changing these nutrients, depending on the genotype, can significantly affect in vitro plant development (Malik et al. 2004). In the majority of studies conducted with aquatic plants, full strength nutrient media were used (Koul et al. 2014, Barpete et al. 2015, Özcan et al. 2021, Özcan et al. 2023). On the other hand, Doğan et al. (2022) used different concentrations of MS medium for *Staurogyne repens* and achieved the highest rate of in vitro plant regeneration with full strength MS nutrient medium. However, in our study, *H. callitrichoides* and *R. fluitans* gave the same results in half-strength MS and SH nutrient media, respectively, as in full-strength nutrient media. This difference can be due to genotype (Malik et al. 2004). The use of ½ MS and ½ SH+MSvit nutrient media in *H. callitrichoides* and *R. fluitans* will be more advantageous for economic production.

### 3.2. Effect of Different Sugar Sources

The effects of 20 g/L sucrose, glucose and fructose on clump diameter and rooting in *H. callitrichoides* are given in Table 3. As can be seen from the Table, the highest clump diameter was obtained from glucose, however the difference between the application of sucrose was statistically insignificant. While the highest rooting rate was obtained from the application of sucrose, the difference between the use of glucose was statistically insignificant. In *R. fluitans*, the highest clump diameter was obtained from sucrose application (Table 4). On the other hand, the effect of different sugar sources on rooting was insignificant in this species.

**Table 3.** Effect of different sugar sources on in vitro micropropagation of *H. callitrichoides* after 4 weeks of culture initiation.

Sugar sources (20 g/L)	Shoot clump diameter (cm)	Root formation (%)
Sucrose	5.233 a	41.06 a
Glucose	6.077 a	37.81 a
Fructose	2.243 b	0.000 b

The difference between the means shown with different letters in the same column is significant at the 0.01 level according to the Tukey test. MS medium was used.

**Table 4.** Effect of different sugar sources on in vitro micropropagation of *R. fluitans* after 4 weeks of culture initiation.

Sugar sources (20 g/L)	Shoot clump diameter (cm)	Root formation (%)
Sucrose	4.168 a	44.462 <sup>ns</sup>
Glucose	2.747 b	46.017
Fructose	3.060 b	46.280

The difference between the means shown with different letters in the same Column is significant at the 0.01 level according to the Tukey test. ns = not significant. SH+MSvit was used.

Since shoots and plantlets developing in tissue cultures cannot perform full photosynthesis, sugar must be added to the nutrient medium as a carbohydrate source. The most commonly used sugar source is sucrose. In the present study, the effects of glucose and fructose along with sucrose on in vitro micropropagation of *H. callitrichoides* and *R. fluitans* were investigated. In terms of shoot clump diameter size, sucrose gave higher results than glucose and fructose, as in the previous study on *H. callitrichoides* (Özcan et al. 2021). When the effects of sugar sources on micropropagation of both

species were examined together, it was concluded that the use of sucrose, which is a much cheaper carbohydrate source, would be much more appropriate.

### 3.3. Adaptation of in vitro Propagated Plants to the Aquarium

Four weeks after the beginning of culture, shoot clumps developing in vitro culture vessels were removed and the agar at the base of clumps was completely washed away with tap water. The clumps were then transferred to aquariums where temperature, light and pH were controlled. Ten days after they were transferred to the aquariums, the plants started to grow and a 100% adaptation rate was achieved (Figure 1). These results were consistent with previous acclimatization studies on *H. callitrichoides* and *R. fluitans* (Barpete et al. 2015, Özcan et al. 2021, Özcan et al. 2023).

## 4. CONCLUSION

In the present study, an attempt was made to develop a fast and economical in vitro micropropagation method for *H. callitrichoides* and *R. fluitans*, which are indispensable ground plants in aquariums. It was sufficient to use half strength nutrient medium, which is less costly, instead of full strength basic nutrient medium. Additionally, it was shown that *H. callitrichoides* and *R. fluitans* species can grow in vitro without the need for growth regulators. Moreover, the highest rate of development was achieved in the nutrient medium containing 20 g/L sucrose as a sugar source. Shoot clumps developed in vitro was successfully transferred to aquariums.

## ACKNOWLEDGEMENT

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## ORAL PRESENTATION

### The Use of New M® Rootstocks in Response to Climate Change

**Nicola MORITTU**✉

*Vivai Cooperativi Rauscedo, Agricultural Cooperative, Via Udine, 39, 33095 Rauscedo PN, Italy*

✉ **Correspondence:** vcr@vivairauscedo.com

**Abstract:** In 1895, at the Government Nursery of American Vines in Palermo (Sicily), Frederick Paulsen created the 1103P rootstock. More than 120 years later, 1103Paulsen rootstock mother plantings (RMPs) account for 30 percent of the total viticulture world area. This percentage reaches almost 90% if SO4 (created in the year 1904), K5BB and 140Ruggeri (1896), 110Richter (1902), and 420A (1887) are included. From that era to the present day, the activity of genetic improvement of rootstocks has offered few alternatives. Undoubtedly the efficiency of those early rootstocks played a key role in the longevity of their use, in fact they provide protection from phylloxera and some of them tolerate well the calcareous soils that characterize vast areas of cultivation in Italy and abroad. The success of those rootstocks has crystallized their use for more than a century by winegrowers, mindful of the escaped danger from phylloxera, grateful to them for saving viticulture and therefore also willing to tolerate their limitations. When one then considers that a genetic improvement program to create a new rootstock can take 20 to 25 years, resulting in considerable economic and material effort, it is easy to see the resistance to undertake improvement projects. However, over the course of more than a century, many things have changed, and new challenges and issues plague the viticultural world. First and foremost is the ongoing climate change that is resulting in strong variations in rainfall distribution and an increase in average temperatures, making extreme water deficit conditions increasingly common, with all that this entails in terms of grape production and quality. In the presence of such conditions, soils characterized by high salinity, or the presence of limestone are even more limiting for the adequate development of the vine, due to the difficulty in absorbing the nutrients that the plant needs; to all this is added the demand for an increasingly sustainable viticulture, capable of reducing energy inputs to the benefit of the environment and profitability. Last but not least, the phytosanitary aspect remains extremely topical, because while phylloxera has been contained thanks to the introduction of the first rootstocks, on the contrary, viruses, bacteria, nematodes and fungi that affect the root system remain an element that can severely affect production and quality. Modern viticulture cannot afford to remain anchored in a conservative model. For these reasons, starting from the 1980s at the Department of Agricultural and Environmental Sciences (DISAA) of the University of Milan, a program of genetic improvement of rootstocks was undertaken to offer a solution to the mentioned above problems. From the initial 8,000 seedlings, we arrived, after a long selection process, at the 4 M-series rootstocks registered in 2014 at the National Registry and already available to all winegrowers thanks to "Winegraft S.r.l." and Vivai Cooperativi Rauscedo, which multiplies and markets them on a worldwide exclusive basis. Breeders have made new genotypes that can respond more efficiently to limiting factors such as water shortage, ferric chlorosis and salinity, improve potassium and magnesium uptake, and induce lower vigor in favor of grape quality. Through numerous field trials carried out it was seen that M1 rootstock can offer the best quality performance for red berry varieties and can effectively tolerate high levels of active limestone. M2 induces high production levels and resists drought and salinity well. The M3 genotype ensures highest quality in fertile soils with low limestone concentration, inducing lower vigor and increasing polyphenol accumulation in grapes. Finally, rootstock M4 is an excellent substitute for 110R due to its high resistance to water stress and ability to induce higher vigor. On the oenological side, Vivai Cooperativi Rauscedo, in collaboration with the Wine Research Team, collected some preliminary data on the effect of M rootstocks compared to traditional rootstocks. This early evidence showed higher acidity levels in grapes of varieties grafted on the M series, and a lower average sugar content. These characteristics are certainly interesting in that they are well suited to counteract the effects of climate change and current consumer tastes.

**Keywords:** Wine, Grape, Viticulture, Variety, Climate Change.

## ORAL PRESENTATION

### Antimicrobial Activities of Extracts of Fungi Isolated from *Hyssopus officinalis*

**F. B. ESHBOEV<sup>1,2</sup>, K. M. MARDIEVA<sup>1</sup>, Sh. X. UBAYDULLAEVA<sup>1</sup>, M. D. MURODOVA<sup>2</sup>, D. R. EGAMERDIEVA<sup>1✉</sup>, Sh. S. AZIMOVA<sup>2</sup>**

<sup>1</sup>S. Yu. Yunusov Institute of the Chemistry of Plant Substances, Academy of Sciences of the Republic of Uzbekistan, 100170, Tashkent, Mirzo Ulugbek str. 77, Tashkent 100000, Uzbekistan

<sup>2</sup>Institute of Fundamental and Applied Research "TIAME" National Research University, 39 Kori Niyoziy Str., Tashkent 100000, Uzbekistan

✉Correspondence: [dilfuza.egamberdieva@zalf.de](mailto:dilfuza.egamberdieva@zalf.de)

**Abstract:** The escalating threat of antibiotic resistance has evolved into a pressing global concern, necessitating immediate and concerted efforts to confront this formidable challenge. At the forefront of the quest for innovative solutions to combat microbial infections remains the exploration of natural sources as a promising avenue. Notably, plant-associated fungi have emerged as a valuable wellspring for the discovery of new antibiotics and other bioactive compounds. These fungi, forming symbiotic relationships with plants, wield a diverse array of secondary metabolites that often function as robust defense mechanisms against microbial pathogens. This study delves into the realm of antimicrobial activities, specifically focusing on the extracts derived from fungi isolated from *Hyssopus officinalis*. These extracts, hailing from the fungal isolates, underwent comprehensive evaluation for their antimicrobial efficacy against a spectrum of microorganisms, encompassing not only bacterial strains such as *Staphylococcus aureus*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, and *Escherichia coli* but also the fungal pathogen *Candida albicans*. To assess the antimicrobial potential of these extracts obtained from endophytic fungal isolates, the widely recognized agar disk-diffusion method was employed. The results of this investigative endeavor have unveiled compelling evidence of substantial antimicrobial properties inherent within these fungal extracts, offering valuable insights into the intricate mechanisms underlying their activity. In light of these findings, there is a growing recognition of the untapped reservoir of natural compounds, signifying their pivotal role in confronting the global menace of antimicrobial resistance.

**Keywords:** Antimicrobial, Fungus, *Hyssopus officinalis*, Antibacterial, Extract.



## ORAL PRESENTATION

### Antimicrobial Activities of Penicillic Acid Isolated from *Chaetomium elatum*

**Farkhod ESHBOEV<sup>1,2</sup>, Akhror ABDURASHIDOV<sup>1</sup>, Murodova MUFAZZALKHON<sup>1</sup>, Dilfuza EGAMBERDIEVA<sup>2</sup>✉, Shakhnoz AZIMOVA<sup>1</sup>**

<sup>1</sup>S.Yu. Yunusov Institute of the Chemistry of Plant Substances, Academy of Sciences of the Republic of Uzbekistan, 77 Mirzo Ulugbek Str., Tashkent 100170, Uzbekistan

<sup>2</sup>Institute of Fundamental and Applied Research "TIAME" National Research University, 39 Kori Niyoziy Str., Tashkent 100000, Uzbekistan

✉Correspondence: [dilfuza.egamberdieva@zalf.de](mailto:dilfuza.egamberdieva@zalf.de)

**Abstract:** The search for novel antibiotics has assumed an unprecedented level of urgency in recent years, driven by the alarming rise of antibiotic-resistant bacteria, often referred to as “superbugs”. This predicament calls for a concerted effort to discover and develop new antibiotics that can effectively combat the evolving landscape of infectious diseases. The urgency of this endeavor is underscored by the fact that we are in a race against time; while antibiotic resistance escalates, the pace of antibiotic discovery has significantly slowed. The quest for novel antimicrobial agents to combat the growing threat of antibiotic resistance has spurred interest in unearthing natural compounds from diverse sources [1]. This study investigates the antimicrobial potential of penicillic acid, an organic secondary metabolite isolated from the fungus *Chaetomium elatum* derived from medicinal plant *Hyssopus officinalis*. The research encompassed a comprehensive evaluation of penicillic acid's inhibitory effects against a spectrum of pathogenic microorganisms, including bacteria (Gram-positive bacteria *B. subtilis* and *S. aureus*, Gram-negative bacteria *E. coli* and *P. aeruginosa*) and yeast (*C. albicans*). The findings revealed that penicillic acid exerts significant antimicrobial activity, with notable inhibitory effects against both Gram-positive and Gram-negative bacteria. The results highlight the potential of penicillic acid as a valuable natural compound for further development in the field of antimicrobial therapeutics and its role in combating antibiotic-resistant pathogens.

**Keywords:** Antibiotic, Antimicrobial, Activity, *Hyssopus officinalis*, Alternative.

## ORAL PRESENTATION

### From Printer to Table: Transforming Seafood Production with 3D Printing Technology

**Hasan Hüseyin ATAR<sup>1</sup>✉, Zayde AYVAZ<sup>2</sup>**

<sup>1</sup>Ankara University, Faculty of Agriculture, Department of Fisheries and Aquaculture, Ankara, Türkiye

<sup>2</sup>Çanakkale Onsekiz Mart University, Department of Fisheries Industry Engineering, Çanakkale, Türkiye

✉Correspondence: atar@agri.ankara.edu.tr

**Abstract:** This paper reviews the innovative application of three-dimensional (3D) printing technology in the seafood industry, exploring its potential to enhance sustainable production practices and personalized nutrition. The food industry, notably the seafood sector, faces significant challenges, including high greenhouse gas emissions and considerable food waste, with an estimated two-thirds of fish discarded as waste. 3D printing emerges as a transformative solution, historically used in various sectors, and now adopted in food technology for its precision and customization capabilities. The versatility of 3D printing is highlighted by its use of diverse materials, from traditional food items like meats and vegetables to more avant-garde sources like algae and insects. Recent advances have seen surimi being used as a filament, along with studies exploring the modification of seafood product properties for enhanced printability and quality. Investigations have focused on improving the rheological properties of surimi and other seafood derivatives, utilizing additives like starches and hydrocolloids and methods such as the pH-shift technique and transglutaminase cross-linking. The findings demonstrate that 3D printing can significantly contribute to producing sophisticated food products, with notable implications for health, especially for children, seniors, or patients with swallowing difficulties. Future directions suggest developing health standards and food safety regulations to guide this technology. Increased research into 3D printing in seafood can mitigate sustainability concerns and improve waste management practices. The paper concludes that 3D printing holds immense potential in transforming food production, aligning technological advancements with ecological sustainability and human health.

**Keywords:** 3D Food Printing, Sustainable Seafood Production, Nutritional Customization, Additive Manufacturing in Aquaculture.

## 1. INTRODUCTION

The food industry is accountable for 26% of greenhouse gas emissions, consuming significant energy during production (Ritchie et al., 2022). Furthermore, the food industry is grappling with significant inefficiencies, where issues in storage and limited food processing infrastructure contribute to a staggering one-third of total food production being wasted or lost. This loss is not merely a matter of resource mismanagement; it has profound implications for global nutrition, especially in regions battling hunger. A striking example lies within the seafood industry, a vital source of quality protein, where it is estimated that as much as two-thirds of the total fish quantity is discarded as waste. Such a high protein waste represents a lost opportunity to address nutritional deficiencies and poses a major environmental issue. Therefore, recycling and sustainable disposal of this waste are critical challenges that need urgent attention. (Coppola et al., 2021). In response to these challenges, there is an ongoing search for new methodologies within the food sector to promote sustainability and, particularly, to develop personalized nutrition programs. These initiatives aim to reduce environmental impacts while meeting the diverse dietary needs of individuals.

In pursuing sustainable and efficient food production, the advent of 3D (three-dimensional) printing technology emerges as a transformative force, particularly in seafood, a sector grappling with environmental challenges. Historically, 3D printing technology is employed across various sectors, notably in the automotive and aerospace industries, and has recently been adopted in the food industry to manufacture intricate components. This technology enables the creation of physical models without the need for molds, utilizing computer-aided 3D modeling techniques (Mantihal et al., 2020).

3D printers, which utilize filaments, have become accessible for domestic use, allowing the production of customized parts. A variant of these printers, known as 3D food printers, diverges from traditional filament usage by employing edible materials for manufacturing. Among the edible materials employed in 3D food printing, key components include food substances such as sugar, gelatin-based chocolate, and others. These ingredients are layered successively to create intricately designed shapes (Topuz et al., 2018).

While these options are remarkable for their versatility in 3D printing, the scope of materials extends beyond these to encompass two distinct groups. The first group consists of traditional food items like meats, fish, and vegetables, which are foundational in conventional diets yet innovative in their application in 3D printing technologies. The second group emerges from more avant-garde sources, encompassing algae, seaweeds, and insects, representing a frontier in sustainable and alternative food sources (Bhat et al., 2021). In recent years, surimi has also been used as a filament for 3D food printing, demonstrating the technology's adaptability to various food types (Dong et al., 2020; Gudjónsdóttir et al., 2019; L. Wang et al., 2018). Moreover, producing seafood-like products in 3D printers has become a popular challenge, highlighting the growing interest in replicating complex food textures, rheology, fluid behavior, yield stress, viscosity, and flavors (Tay et al., 2023). Furthermore, directly using seafood in 3D printers necessitates overcoming significant challenges, particularly in achieving the desired consistency and texture (Yatmaz, 2023).

The primary aim of this review is to delve into the innovative application of 3D printing technology in the seafood industry. We aim to provide a comprehensive analysis of current methodologies, assess the potential benefits and challenges, and offer forward-looking recommendations for the future development of this technology in sustainable seafood production.

## 2. CURRENT STATE OF 3D PRINTING IN SEAFOOD PRODUCTION

The role of information/digital technologies can potentially revolutionize the industry, making it more profitable and sustainable (Yue & Shen, 2022). In Asia, it is a common practice to utilize waste from seafood production to create surimi paste, which can be molded into various forms and marketed as a standalone product (Bernhard et al., 2023). Additionally, some researchers have experimented with using surimi paste as an edible ink for 3D printers (Dong et al., 2020; Gudjónsdóttir et al., 2019; L. Wang et al., 2018).

However, printing traditional surimi directly in a 3D printer is not feasible due to certain rheological constraints and requires stabilization. According to Chen et al. (2021), there are four distinct groups of surimi gels based on rheological characteristics: those with complex extrusion, those with good extrusion and self-supporting capabilities, those with suitable extrusion but poor self-supporting properties, and those with complex formation. Building on this classification, another investigation (Dong et al., 2019) into using sweet potato starch as a structural enhancer for surimi in 3D printing found that an 8% concentration of sweet potato starch significantly improved the physical properties of surimi gels. Notably, it reduced the viscosity, thus facilitating smoother extrusion from the 3D printer nozzle. In another study (Li et al., 2022), the impact of adding rice starch in the 3D printing process on the physical properties and the level of plasticity it provides was investigated. In this context, it was determined that surimi with a moisture content of 78% achieved the highest gel strength compared to others. In a different investigation focused on physical properties, researchers producing surimi using a carrageenan-based protein substitute (PS) determined that the optimal proportion of PS for 3D printing is 50% (Kim et al., 2022). The quality improvement for 3D printing using  $\kappa$ -carrageenan has been examined in surimi containing sea cucumber. It was found that the best gel strength, at 1236.04 g mm, was achieved in samples with 1.5% (w/w)  $\kappa$ -carrageenan addition (W. Yu et al., 2022). Pan et al. (2021) studied the effects of adding starch to shrimp surimi on its water-holding capacity and binding properties in 3D printing, as well as the ideal ratios for easy extrusion through the nozzle. The research findings revealed that adding 6% cross-linked starch enhanced the material properties of shrimp surimi, making it more suitable for 3D printing applications. In a novel study (Kim et al., 2021) introducing an innovation in the production of surimi-based imitation crab meat, a coaxial extrusion 3D food printing method was used, where surimi was coated with a potato starch solution to form a filament structure. The study found that using a 12% potato starch solution, surimi-based imitation crab meat demonstrated optimal printing properties, water-holding capacity, and cooking loss.

Another study investigating rheology and protein structure examined the 3D printability of surimi derived from golden pompano fish. It was indicated that the surimi from chopping with salt samples was identified as the most suitable for 3D printing applications (Liu, Sun, Wei, Xia, Pan, Ji, et al., 2022). In an alternative investigation, surimi was derived from golden pompano fish, and it was determined that low-field nuclear magnetic resonance (LF-NMR) is the most efficient technique for swiftly and precisely estimating the appropriate starch-surimi proportions for 3D printing compatibility (Liu, Sun, Wei, Xia, Pan, Liu, et al., 2022).

The adaptation of surimi for use in 3D printers has been expanded beyond starch-based products. Research has also explored the impact of adding calcium chloride ( $\text{CaCl}_2$ ) to low-salt surimi gel on the quality of 3D printing. Rheological and 3D printing results indicated that surimi gel with the addition of 1.5 g/100 g  $\text{CaCl}_2$  was suitable for 3D printing applications (Wang et al., 2023). In a separate study (Gudjónsdóttir et al., 2019), the usability of surimi derived from codfish by-products in 3D printing was examined, comparing the pH-shift method with conventional washing. This study found that working with surimi produced via the pH-shift method was more feasible for ready-to-print raw surimi products.

In a study (Dong et al., 2020) investigating the use of surimi obtained from *Scomberomorus niphonius* as 'food ink' for 3D printing, the addition of microbial transglutaminase (MTGase) was examined for its impact on the shaping capability, physical properties, and structural quality of the surimi and the 3D printed products. It was found that surimi samples containing 0.2% and 0.3% (by weight) MTGase offered the best printing quality. In another study, the suitability of surimi paste for 3D printing was analyzed using the finite element method (Oyinloye & Yoon, 2022). This analysis determined that surimi samples with a moisture content of 82% were rheologically most appropriate for 3D printing applications. A study (Zhu et al., 2023) was conducted using surimi derived from *Scomberomorus niphonius*, employing dry spray transglutaminase (TG) for surface cross-linking to enhance the structure of surimi. This research aimed to assess the potential use of enhanced surimi in assisting individuals with swallowing difficulties in transitioning to solid foods. It was discovered that dry spray TG-based surface cross-linking not only improved the printed shape and structure of the surimi but also supported the production of functional food products. Another study (Yu et al., 2023) posited that products emerging from 3D printers could be more appealing and flavorful and may also meet the specific needs of patients with swallowing difficulties. To investigate this, the study examined using hydrophilic colloids (konjac gum/xanthan gum) in 3D printing to produce transition foods from fish paste. The results indicated that the use of konjac gum/xanthan gum not only provided excellent viscoelasticity, making them suitable raw materials for 3D printing, but also that these products aligned with the International Dysphagia Diet Standardization Initiative (IDDSI) as potential transitional foods.

The application of seafood products in 3D printing technology is not limited exclusively to surimi. In a study conducted by Jin et al. (2023), the effects of modifying the color of mackerel (*Scomber scombrus*) mince prepared using 3D printing technology were evaluated by adding purple potato powder and citric acid. This research also assessed the printability and quality of the 3D-printed product. The findings indicated that increasing the concentration of purple potato and adding citric acid effectively reduced the mince's fluidity and water loss. A different study (Yatmaz, 2023) investigated the influence of various factors on the printing of shrimp flour. This study examined the ratio of shrimp flour to wheat/corn flour, water temperature, oil content, product height, and fill factor as independent variables. The results highlighted the significant impact of the proportion of shrimp flour and water temperature on the dough's hardness, consistency, and internal stickiness. Moreover, these variables were also found to affect the total error rate of the printed products significantly.

### 3. FUTURE DIRECTIONS AND CONCLUSION

The studies demonstrate that 3D printing technology can significantly contribute to producing sophisticated products, offering guidance and innovation in this field. From a health perspective, the diets of children, seniors, or patients with swallowing difficulties can be tailored for specific needs, either in homemade personalization or under commercial conditions. Notably, 3D printers have the potential to revolutionize personalized nutrition programs. By producing nutritious and visually appealing foods, these technologies could introduce high-value foods into our lives in novel ways.

Developing health standards and food safety regulations will be instrumental in guiding this new technology. Increased research into 3D printing, particularly in the context of seafood, can alleviate sustainability concerns associated with traditional fishing practices. The interest in laboratory-produced seafood products or plant-based seafood alternatives is growing. Additionally, waste management in the seafood industry is likely to see significant improvements with the effective use of 3D printing in food production.

In conclusion, 3D printing technology is a promising frontier in the seafood industry, offering innovative solutions for sustainable production, waste management, and personalized nutrition. Its potential to transform traditional practices and contribute to a more sustainable future in food production is immense. As this technology continues to evolve, it will undoubtedly play a crucial role in shaping the future of food production and consumption, aligning technological advancements with ecological sustainability and human health needs.

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## ORAL PRESENTATION

### Let's Look at the War of Climate Change from NASA's Perspective

**Merve KALAYCI KADAK**✉

*Kastamonu University, Faculty of Engineering and Architecture, Kastamonu, Türkiye*

✉ **Correspondence:** mkalayci@kastamonu.edu.tr

**Abstract:** Climate change, the greatest event of the last century, negatively affects all living things. Ecological life cycles are disrupted due to changing climatic conditions. Therefore, there is a struggle for survival among all living things, especially humans. In addition, power wars erupt between states for reasons such as food security, access to clean water, and carbon emission controls. Also, climate change causes alteration of nature in different locations around the globe. Unpredictable disasters occur due to the destruction of ecosystems. As a consequence of changing climatic conditions, changes in forest land cover and loss of agricultural land and wetlands emerge. Forest-covered areas and wetlands are among the areas of the ecosystem that should be protected with the highest priority. However, the unavoidable adverse effects of climate change prevent this situation. In recent years, scientists have used satellite images to make these determinations and predictions. It is possible to determine all these events by using satellite images before and after they occur. Many scientific studies are carried out using satellite images, which can be obtained from various sources. In this context, the destructive effects of climate change can be clearly observed when satellite images, provided without charge by the US National Aeronautics and Space Administration (NASA) on its official website, are examined. In this study, examples of lost forest areas, agricultural areas, wetlands, and some of the disasters caused by climate change all over the world were analyzed through satellite images presented by NASA. As a result, the findings regarding the impacts of climate change, which are causing power struggles, were revealed with some examples, and some of the precautions and suggestions that need to be considered were discussed.

**Keywords:** Climate Change, Satellite Image, NASA, Land Cover.

## ORAL PRESENTATION

### Characterisation of Some Biofertilizer Bacterial Strains from Different Legume Plants in Erzurum

**Esin DADASOGLU**✉

*Atatürk University, Faculty of Agriculture, Department of Field Crops, Erzurum, Türkiye*

✉**Correspondence:** edadasoglu@atauni.edu.tr

**Abstract:** In this study; It is aimed to obtain bacterial isolates that may have biofertilizer potential samples taken from the root parts of different legume plants grown in Erzurum province and to determine some plant growth promoting properties of these isolates. As a result of the isolations made for this purpose; A total of 10 bacterial isolates were obtained. Growth on YEMA medium, nitrogen fixation and phosphate solubility properties of the obtained isolates were determined, and stock cultures of isolates that could be potential biofertilizers were made. According to the results obtained; The growth of all bacteria obtained in YEMA medium was determined to be strongly positive. Likewise, the growth of all bacteria in nitrogen-free medium was observed to be positive. It was determined that the phosphate solubility of 6 bacteria was negative and 4 bacterial strains were positive. As a result of the sequence analysis of both phosphate-solubilizing and nitrogen-fixing bacteria, all 4 effective bacteria were identified as *Rhizobium* sp.

**Keywords:** Biofertilizer, PGPR, Legume Plants.

## ORAL PRESENTATION

### Productivity of Strawberry Depending on Planting Time and Varieties in the Conditions of the Republic of Moldova

**Valerii MANZIUC<sup>✉</sup>, Vladislav BARANYUC**

*Technical University of Moldova, Chisinau, Moldova*

<sup>✉</sup>*Correspondence:* manziucvalerii@gmail.com

**Abstract:** The purpose of this study was to establish the optimal timing of planting strawberries using “frigo” seedlings, as well as to assess the productivity of CIV Italy varieties under the conditions of the Republic of Moldova. The strawberry varieties Marmolada, Aprica, Sibilla, Arosa, and Laetitia and three planting dates were taken as the object of research - mid-June, mid-July, and mid-August. The plantation was established in the summer of 2021, research was carried out during 2022-2023. Research has shown that early planting periods contributed to good tillering and the formation of 3.5 to 4.4 fruiting shoots per bush, as well as a well-developed leaf surface, not significantly different from the second year of the growing season while planting in mid-August led to a reduction in the number of leaves by 2.3 – 2.9 times. The most productive among the studied varieties was the Laetitia variety, which in total for 2 years of fruiting amounted to 55.69 t/ha. The varieties Aprica and Sibilla have the fastest ripening of berries. The most optimal time for planting “frigo” seedlings for the conditions of Moldova is the first ten days of July, which contributes to obtaining the first harvest more than 2 times higher compared to the recommended planting in mid-August.

**Keywords:** Strawberries, Planting Dates, Variety, Productivity.

## 1. INTRODUCTION

Strawberries are the leading berry crop both in the world and in the Republic of Moldova. Over the last decade, due to the increased demand for berries, the area under strawberries in our country has almost doubled, reaching 2000 ha in 2023, and the annual production exceeded 12 thousand tons. The efficiency of strawberry production, as well as the variety and technology of its cultivation, are determined by several factors: soil-climatic, technological, organizational, market, and macroeconomic of a particular country or region where it grows. Currently, in the Republic of Moldova, there is no scientifically based data on the optimal timing of planting using “frigo” type seedlings, and such elements of technology as the application of fertilizers with irrigation water and the use of growth regulators have not been developed. The problem of regionalized strawberry assortment is also relevant, which in Moldova includes 3 obsolete varieties that are practically not propagated anywhere in the world. The purpose of this research is to develop scientifically based planting terms for strawberry plantations with garden seedlings of the “frigo” type, for the conditions of the northern regions of Moldova, and to obtain the maximum yield of high-quality berries in the first year of operation, as well as to offer production the most productive, attractive and manipulation-resistant varieties of strawberries.

## 2. MATERIALS AND METHODS

To realize the set objectives, in the summer of 2021 in GT “Fedorciucova Zoia” Kunicha village, Floresti district, a strawberry plantation was planted in an area of 2.2 ha. The farm purchased “frigo” type seedlings of the A+ category from Mazzoni vivai and Salvi vivai nurseries (Ferrara) in Italy. The Marmolada variety recommended in Moldova for production trials was taken as a control. For the research, seedlings of Aprica, Sibilla, Arosa, and Laetitia varieties were also purchased. To establish optimal planting dates, the varieties Marmolada, Aprica, and Arosa were planted on June 15, July 15, and August 16, the main array of strawberries was planted in the period from July 15 to 19. The seedlings were planted on beds 25-30 cm high, covered with black polyethylene film, and a drip irrigation system laid underneath it. The planting scheme was 140+(60x25) cm.

The placement of variants was carried out in blocks, with 3 repetitions in each variant. Each iteration consists of 10 plants.

### 3. RESULTS AND DISCUSSION

The reserve for increasing the efficiency of strawberry cultivation is the establishment of plantations in the best agronomic terms, which contribute to good plant establishment, promising varieties with different maturity.

The strawberry varieties we took as an object of research belong to different ripening periods and have different growth vigor.

**Table 1.** Features of formation of the above-ground part of the strawberry bush depending on the variety and terms of planting seedlings

Variety name	Plant height, cm	Number of leaves, pc	Leaf area, cm <sup>2</sup>	Leaf wet weight, g	Number of stolons, pc/bush
1. Marmolada	27	29	3156	66.5	12
2. Aprica	33	25	3398	85.2	9
3. Sibilla	28	32	3208	81.1	13
4. Arosa	25	34	3361	67.8	10
5. Laetitia	26	30	2967	61.4	11

Aprica variety belongs to the early group, Marmolada and Sibilla to the middle group, and Arosa and Laetitia to the late group. The obtained results showed that among the studied varieties the most powerful bush development was characterized by the variety Aprica (Table 1). Thus, the next year after planting, the plant height of this variety was 33 cm and was the highest in the experiment. Further, according to this indicator, the studied varieties were arranged in descending order - Sibilla 28 cm and Marmolada 27 cm. Regarding the number of leaves per bush, the highest value was achieved in the Arosa variety, which at the end of the growing season had an average of 34 leaves per bush. The varieties Sibilla and Aprica had a lower number of leaves per bush, which amounted to 23 and 25 leaves per bush. The highest value of leaf surface area was observed in the variety Aprica, which averaged 3398 cm<sup>2</sup>/bush. Despite the small number of leaves, this variety developed the largest leaf plate. The raw weight of leaves was also the highest in the variety Aprica and corresponded to the value of 85.2 g/bush, a little less this indicator was in the variety Sibilla and the lowest value of this indicator - 61.4 g/bush was noted in the variety Laetitia. Along with plant height and number of leaves, the formation of a third type of shoots in strawberries, called stolons, is an indicator characterizing the varietal features of bush development. Stolons appear towards the end of fruiting. In our experience, the beginning of stolon formation was noted by the end of June and depended on the maturity of the variety. Removal of stolons in industrial strawberry plantations is an important and labor-intensive agronomic technique. The less the variety forms creeping shoots, the lower the cost of its care. In our experience, the largest number of stolons, on average, was noted in the Sibilla variety, which amounted to 13 stolons/bush, followed by Marmolada - 12 stolons/bush and Arosa – 10. The most technologically advanced variety was Aprica, which formed only 9 pieces of stolons per bush.

Thus, the study of the main indicators of strawberry bush growth: plant height, number, and area of leaves, showed that the most powerful above-ground part among the studied varieties was developed by the Aprica variety. The vegetative organs of the Arosa and Sibilla varieties were slightly smaller and the lowest indicators of the above-ground part were in the Laetitia variety.

The above-ground strawberry system consists of three types of shoots, which differ in their biological functions. Shoots have an apical (terminal) bud, a rosette of three or five leaves, lateral axillary buds in the leaf axils, and adventitious roots (Chukhlyaev I., 1982, Shamanskaya L., 1991). Under favorable conditions, young plants form 4 shoots, two-year-olds up to 8, and three-year-olds up to 17 or more, and since varieties of the standard type have the potential for a shoot to have one peduncle, then by the number of shoots one can judge its productivity (Burmistrov V., 1985). Note that an intensive increase in the number of shoots occurs throughout the entire period of plant growth and development, then slows down due to plant aging.

**Table 2.** The influence of planting terms on the formation of shoots and leaves by the end of the first year of vegetation, Kunicha village as of November 12, 2021.

Variety name	June 15		July 15		August 16	
	Total shoots, pc/bush	Total leaves, pc/bush	Total shoots, pc/bush	Total leaves, pc/bush	Total shoots, pc/bush	Total leaves, pc/bush
1. Marmolada	4,8	33	4,2	29	1,8	11
2. Aprica	4,2	29	3,9	25	1,8	9
3. Arosa	4,0	36	3,8	34	1,9	12

Our experiments have shown that young plants, under favorable conditions, can form from 2 to 6 shoots in the year of planting (Table 2). An important condition affecting plant growth and strawberry yield is the optimal planting time, which is determined by the climatic conditions of the area and soil type, as well as the availability of planting material. To determine the best planting terms, 3 planting dates were studied in the experiment: June 15, July 15 and August 16. In the first two terms, seedlings of the “frigo” type were planted, and purchased from the company “Salvi vivai”. For planting in the third period, seedlings grown in cups directly on the farm were used.

For the conditions of the Republic of Moldova, the recommended time for planting strawberries is the second decade of August. However, it was noted that the harvest for the next year was not very high due to insufficient development of bushes. The main indicator of the productivity of strawberry plants is the formation of shoots, from the terminal bud of which a peduncle is subsequently formed and fruiting occurs. Thus, the data obtained in our experiment showed that the timing of planting strawberry seedlings had a significant impact on both the development of bushes in general and the formation of shoots. Thus, for the Marmolada variety, the maximum number of shoots - 4.8 pcs/bush - were formed in the first year of planting at the earliest date - June 15. This indicator was also quite high when planting on July 15, amounting to 4.2 pcs/bush. Late planting dates, recommended in Moldova for planting the classic form of current seedlings, led to the formation of only 1.8 shoots per bush. Strawberry plants planted in the second half of August have time to root well in the presence of sufficient moisture, but the shortfall period allows the formation of no more than two shoots per bush. The timing of planting also had a significant impact on the formation of leaves. Thus, when planted on June 15, the most powerful variety Aprica produced 29 leaves by the end of the growing season, which was only 12 fewer than the plants in the second year of planting. When planting on July 10, the number of leaves for the studied varieties decreased by 2 - 4 pieces. Visually, the power of development of the leaf surface of plants planted on June 15 and July 15 did not differ from each other. When planting on August 16, the number of leaves per bush decreased by 3 - 3.2 times and, according to the studied varieties, amounted to only 9 - 12 pieces per bush.

Thus, the early planting of strawberries contributed to good tillering and the formation of an average of 4.0 to 4.8 shoots per bush for the studied varieties, while when planting on August 16, no more than two shoots per bush were formed. Strawberry plants also form a well-developed leaf surface, 25 - 36 leaves per bush, slightly different from the number of leaves formed in the second year of the growing season. Planting on August 16 led to a 3-3.2 times decrease in the number of leaves per bush.

Yield is the most important economic and biological trait and depends on the following factors: the number of leaves, the number of peduncles, the number of berries in the peduncle, and the average weight of berries. The reserve for increasing strawberry yields is the establishment of plantations in the best agronomic terms, which contributed to good plant establishment and selection of promising varieties with different ripening dates.

**Table 3.** Strawberry productivity depending on planting dates and variety in the first year of fruiting, Kunicha village 2022.

Variety name	Number of inflorescence per plant, <i>pc/plant</i>	Number of fruits, <i>pc/inflorescence</i>	Average berry weight, <i>g</i>	Productivity, <i>g/bush</i>	Yield, <i>t/ha</i>
<b>planting June 15</b>					
1. Aprica	4,2	5,4	23,8	540	23,2
2. Marmolada	4,4	6,7	22,9	675	29,0
3. Arosa	4,0	6,3	21,7	547	23,5
<b>planting July 15</b>					
1. Aprica	3,9	5,1	22,9	455	19,6
2. Marmolada	4,2	6,5	21,3	581	25,0
3. Arosa	3,8	6,2	23,8	667	28,7
<b>planting August 16</b>					
1. Aprica	1,8	4,3	28,3	219	9,4
2. Marmolada	1,8	4,6	26,8	221	9,5
3. Arosa	1,9	4,0	25,1	191	8,2

Analyzing the number of flower stalks per plant (Table 3), it should be noted that their formation was greatly influenced by the timing of planting seedlings. When planted late on August 16, the number of peduncles varied from 1.8 in the Aprica and Marmolada varieties to 1.9 in the Arosa varieties. Earlier planting dates led to an increase in this indicator, so when planting on July 15, the number of peduncles ranged from 3.8 for the Arosa variety to 4.2 for the Marmolada variety. This indicator reached even greater values when planting on June 15, for example, the Marmolada variety formed 4.4 peduncles, which was 2.4 times more than when planting on August 16.

Analyzing the fruit formation per peduncle indicator, we see that early planting dates contributed to an increase in this indicator. The largest number of fruits was formed in the Marmolada variety when planted on June 10 and amounted to 6.7 pieces per peduncle. It should be noted that no significant differences in the formation of fruits per one peduncle were observed between the planting dates of June 15 and July 15. With late planting, the number of fruits decreased in the studied varieties by 33-37% and ranged from 4.0 pieces in the Arosa variety to 4.6 pieces for the Marmolada variety.

An important indicator of strawberry productivity is the average weight of the berry. Analyzing the data obtained, it should be noted that both planting dates and varietal characteristics significantly influenced the size of the berries. Among the studied varieties, the highest average berry weight was noted for the Aprica variety and varied from 23.8 to 28.3 g. Next comes the Marmolada variety with indicators of 22.9 – 26.8 g and the smallest fruits were from the Arosa variety, amounting to 21.7 – 25.1 g. It should be noted that the studied varieties in terms of average berry weight exceeded the established standards for strawberries, equal to 15 g (O.A. Gorelikova, 2017). The larger size of the berries when planted on August 16 is primarily due to the smaller number of fruits formed on 1 peduncle. With earlier plantings, the yield per bush was significantly higher, which mainly affected the decrease in the average berry weight.

Analyzing the productivity indicator per bush, it should be noted that it reached its highest values for the Marmolada variety when planted on June 15 and amounted to 675 g/bush. Among the studied varieties, Marmolada was distinguished by the highest productivity, regardless of planting time, exceeding the Arosa variety by 128 g, and the Aprica variety by 135 g/bush.

The integral indicator of productivity is the yield per hectare. The highest yield in the experiment was in the variety Marmolada at planting on June 15 and amounted to 29.0 t/ha. When planted on July 15, the yield was slightly lower, amounting to 28.7 t/ha for the Arosa variety. Late planting date of August 16 led to a decrease in yield more than 3 times and amounted to 8.2 to 9.5 t/ha for the varieties studied. Thus, early planting dates contributed to the increase in the number of peduncles per plant by 2.2 - 2.7 times, as well as to the increase in fruits per peduncle. This indicator reached



the highest values in the Marmolada variety. Among the studied varieties, the Aprica variety has the highest average berry weight, regardless of planting time. The most productive among the studied varieties is the Marmolada variety, the productivity of which in the first year of fruiting was the highest when planted on June 15 and amounted to 29.0 t/ha. The late planting date of August 16 also led to a 3-fold decrease in the yield of the plantings.

**Table 4.** The effect of variety on strawberry plantation yield in two years of fruiting.

Variety name	2022	2023		Total yield over 2 years, t/ha	
	Average berry weight, g	Yield, t/ha	Average berry weight, g	Yield, t/ha	
1. Marmolada	21,3	25,0	17,3	26,7	51,7
2. Aprica	22,9	19,6	20,4	22,6	42,2
3. Sibilla	23,4	27,6	18,1	24,5	52,2
4. Arosa	26,7	28,7	17,8	26,2	54,9
5. Laetitia	27,3	27,5	19,5	28,2	55,7

Analyzing the yield of the varieties studied in the experiment (Table 4), it should be noted that all of them have high potential productivity and there was no significant difference in this indicator between them. The average berry weight of all varieties was higher in the first year of fruiting and ranged from 21.3 g in Marmolada to 27.6 g in Laetitia. In the second year of fruiting the berry size it decreased significantly, especially in varieties with higher yields. Thus, in the variety Laetitia, this indicator decreased by 30% and amounted to only 19.5 g. The yield of all studied varieties during 2 years of fruiting remained stably high and fluctuated within 19.6 -28.2 t/ha. It was slightly lower in the early maturing variety Aprica, amounting to a total of 42.2 t/ha for 2 years, but this does not reduce the value of this variety because it is characterized by excellent marketability, flavor qualities, and higher selling price. In total for two years of fruiting the highest yield was obtained by the variety Laetitia, amounting to 55.7 t/ha.

#### 4. CONCLUSION

The conducted studies have shown that the most optimal time for planting strawberry plants with “frigo” type seedlings for the conditions of the Northern zone of the Republic of Moldova is the first half of July. Until the end of vegetation plants have time to develop a strong vegetative mass, to form an average of 4 fruit-bearing shoots, which provides the second year of berry yield in the range of 25 -28 t/ha. Earlier planting leads to the formation of a large number of stolons that need to be removed, damaged by powdery mildew, and provokes premature fruiting in some varieties.

All varieties studied in the experiment have high potential productivity, deserve to be included in the State Register, and are recommended for planting new strawberry plantations.

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## ORAL PRESENTATION

### Effect of Different Boron Dosage and Application Methods on Yield Parameters and Mineral Content of Wheat (*Triticum aestivum*) Plant

**Elif YAĞANOĞLU<sup>✉</sup>, Adil AYDIN**

*Atatürk University, Faculty of Agriculture, Department of Soil Science and Plant Nutrition, Erzurum, Türkiye*

<sup>✉</sup>**Correspondence:** elifyaganoglu@atauni.edu.tr

**Abstract:** This study was conducted to investigate the effects of boron applied in different doses and in different ways to the soil of Erzurum region on plant growth, dry matter amount and mineral content. The experiment was applied to two soils (Daphan plain and Atatürk University farm), two varieties (Kırık and Bezostaya), three application methods (soil, leaf and seed contamination), five boron doses (0, 1.0, 2.0, 4.0 and 8.0 ppm) under greenhouse conditions. It was established in three replicates ( $2 \times 2 \times 3 \times 5 \times 3 = 180$  pots). According to the results obtained from the experiment, 1.0 and 2.0 ppm boron application increased plant height and therefore the amount of plant dry matter compared to the control, while 4.0 and 8.0 ppm boron application decreased plant height and dry matter amount. The effects of boron dose, boron application method, soil and wheat type on plant height and dry matter amount were found to be statistically significant. The mineral (element) content of the trial plants showed an unstable change depending on the dose, application method, soil and variety. For optimum plant development in wheat cultivation, the available boron content of the soil should be higher than 0.5 ppm and lower than 2.5 ppm.

**Keywords:** Boron, Wheat, Yield Parameters.

## POSTER PRESENTATION

### **Antimicrobial Activity of White mustard (*Sinapis alba*) Essential oil Against *Escherichia coli* and *Staphylococcus aureus***

**Mohamed Omar Abdalla SALEM<sup>✉</sup>**

*Bani Waleed University, Faculty of Education, Department of Biology, Bani Waleed, Libya*

<sup>✉</sup>**Correspondence:** mhomar1988@gmail.com

**Abstract:** In this present study, the white mustard (*Sinapis alba*) oil was extracted by using a screw press (MP-001 Cold Press, Turkey), Various concentrations (0.5, 1, and 2%) of white mustard oil were tested in vitro for their antibacterial activities against *Escherichia coli* and *Staphylococcus aureus*, by using Agar Diffusion Method. The diameter of the inhibition zone in *E.coli* was determined to be between 11.00-13.90mm at 0.5%, while in *S. aureus* was determined to be between 7.00-10mm in all plant seed oil concentrations. Cotton oil served as a negative control and showed no antibacterial effects on *E. coli* and *S. aureus* (7.00 mm zone diameter). Erythromycin (15g/ml) and Florfenicol (30g/ml) were chosen as antibiotics in this study to examine the antibacterial activity of white mustard oil at different doses. Both antibiotics had an antibacterial impact on both microorganisms in the disk diffusion assays. In this study, white mustard seed oils showed weak antibacterial activity against both pathogenic bacteria and were found to be concentration-dependent.

**Keywords:** Disc Diffusion Test, White Mustard Oil, *Escherichia coli*, *Staphylococcus aureus*.



## POSTER PRESENTATION

### Features of Establishing Vineyards on Slopes

**Irina ISHCENKO<sup>✉</sup>, Denis BALZHI**

*Odesa State Agrarian University, Department of Horticulture, Viticulture, Biology, and Chemistry,  
Odesa, Ukraine*

<sup>✉</sup>**Correspondence:** ishchenko2406@gmail.com

**Abstract:** This research topic focuses on analyzing the specific requirements and characteristics associated with establishing and developing vineyard plantations on slopes. It addresses the challenges and solutions related to improving conditions for grape cultivation on terrain less suitable for agriculture. The study incorporates the use of sorbent materials that contribute to increasing the profitability and resilience of vineyard crops on slopes. The application of these materials helps preserve the soil and enhance conditions for healthy grape growth and yield while reducing the impact of erosion and other adverse factors in such areas. Important aspects are considered to ensure the stability and high productivity of vineyards on slopes while mitigating the negative effects of erosion and other factors on these agricultural crops. The results of this research can be valuable for farmers and agricultural enterprises seeking to optimize conditions for grape cultivation on challenging terrains.

**Keywords:** Vineyard Plantations, Slope Cultivation, Soil Preparation, Soil Erosion, Vineyard Productivity.

## POSTER PRESENTATION

### Consequences of Global and Regional Climate Changes

**Anna KRYVENKO<sup>✉</sup>, Ylia KONONENKO, Veronika VOZNIUK**

*Odesa State Agrarian University, Odesa, Ukraine*

<sup>✉</sup>**Correspondence:** kryvenko35@ukr.net

**Abstract:** Global climate change, which has been observed over the past decades, indicates a deviation of the system's functioning from the norm at the biosphere level. The climate crisis, along with the loss of biodiversity, is the greatest challenge facing our world. The main causes of climate imbalance are presented. The impact of climate change on Ukrainian agriculture is described. The main problem for agricultural producers is currently the preservation of winter crops. We have extreme temperature changes, provided there is no snow cover. An abnormally warm winter favors the survival of a significant number of insects and crop pests. There is a need to apply more plant protection products, herbicides, to use other varieties that are more resistant to pests and diseases, which affects the cost price. Therefore, man cannot stop the natural processes of climate change. But he is simply obliged to influence the development of the negative aspects of her business. In this aspect, first of all, it is worth talking about reducing the number of harmful emissions into the atmosphere, using energy-saving technologies, diversifying agricultural production and adjusting the technological processes of growing crops. But there is also an optimistic scenario: the Earth's temperature will rise to a critical 1.5 degrees, after which the planet will begin to cool. However, to realize such a scenario, people must stop burning fossil fuels and stop cutting down forests by 2030. As we understand it, this scenario is unlikely.

**Keywords:** Climate Change, Agriculture, Climate Crisis.





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## POSTER PRESENTATION

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### **Improvement of Oil and Fat Production Technology from Various Domestic Almond Varieties**

***Svetlana PETRENKO<sup>✉</sup>, Natalya MARTIENKO***

*Odesa State Agrarian University, Department of Horticulture, Viticulture, Biology, and Chemistry, Odesa, Ukraine*

<sup>✉</sup>**Correspondence:** petrenko\_s\_a\_@ukr.net

**Abstract:** This scientific article presents detailed research results aimed at studying the impact of agro-biological characteristics of different varieties of Ukrainian almond on their growth, development, and productivity in the conditions of perennial plantings. The main goal of the research was to improve the technology of obtaining oil and fat products from almonds. The paper extensively analyzes the properties of various almond varieties in the context of their adaptation to Ukrainian climate and soil conditions. Parameters of growth, development, and yield of these varieties were studied, as well as the quality of the obtained oil and fat products. The results indicate the potential of certain almond varieties for stable and high-quality cultivation in Ukraine, which can contribute to the further development of this branch of the agricultural industry. The research also reveals opportunities for optimizing agricultural techniques to increase almond yields and ensure stable production of oil and fat products. The obtained data can be valuable for agricultural enterprises and scientific research aimed at enhancing the efficiency of almond cultivation in Ukraine.

**Keywords:** Almond, Oil, Orchard Yield, Variety Testing.



## POSTER PRESENTATION

### **Cultivation of *Actinidia arguta* in the Climatic Conditions of the Southwestern Black Sea Region of Ukraine**

**Yuriy SAVCHUK<sup>✉</sup>, Artem TKACHOV**

*Odesa State Agrarian University, Department of Horticulture, Viticulture, Biology, and Chemistry, Odesa, Ukraine*

<sup>✉</sup>**Correspondence:** yur.savchuck@ukr.net

**Abstract:** This article explores the prospects and opportunities for cultivating the plant *Actinidia arguta*, also known as Japanese raspberry or hardy kiwi, in the climate of the Southwestern Black Sea Region of Ukraine. The research aims to determine the potential of this plant for the agroclimatic conditions of this region and to identify possibilities for its cultivation and use for agricultural purposes. The article discusses agronomic, botanical, and ecological aspects that influence the growth and development of *Actinidia arguta* in Ukrainian conditions, as well as the advantages and potential challenges of its cultivation. The results of this work will shed light on creating new opportunities for agriculture and the development of valuable agricultural crops in the Southwestern Black Sea Region. The obtained findings may be beneficial for agricultural enterprises and research projects aimed at expanding the agricultural potential of the region and increasing the production of valuable agricultural products.

**Keywords:** *Actinidia arguta*, Southwestern Black Sea Region, Cultivation Prospects, Agronomic Aspects.

## POSTER PRESENTATION

### Evaluation of New Varieties of Leaf Lettuce When Grown by the Flow Hydroponics Method

**Liudmyla POPOVA<sup>✉</sup>, Oleksandr FILONENKO**

*Odesa State Agrarian University, Odesa, Ukraine*

<sup>✉</sup>*Correspondence:* lnyu@ukr.net

**Abstract:** In this study experimentally determined the size and productivity of the leaf surface, determined the potential yield, product quality and profitability of the production of leaf lettuce varieties when grown by the flow hydroponics method in the conditions of the Southern Steppe of Ukraine. Determining the area and productivity of the leaf surface of plants showed a significant advantage in these indicators of Rouxay, Dragone and Kurly varieties. At the same time, Rouxay and Dragone varieties form commercial rosettes of the largest mass – 223,2 and 204,4 g and provide the highest commercial yield, which on average is 6.82 and 6.67 kg/m<sup>2</sup>, respectively. It has been established that the economic efficiency of the production of leafy lettuce by the flow hydroponics method is determined by the following indicators: the marketable appearance of the rosette: the shape of the leaf, the dissection of the leaf plate, the color of the rosette; at the sale price, which directly depends on the variety and output of the number of commercial sockets per unit of area. In order to obtain a high-quality harvest and increase the level of profitability of the production of lettuce products when grown by the flow hydroponics method, preference should be given to Rouxay and Dragone varieties. In order to expand the range of products, it is advisable to grow the Kurly variety.

**Keywords:** Lettuce, Seedlings, Flow Hydroponics, Productivity, Conveyor Cultivation.

## 1. INTRODUCTION

The advantage of the southern regions of the country in the cultivation of vegetable products is the possibility of maximum expansion of the product supply period due to the cultivation of super-early products in the open ground in spring and obtaining a high-quality harvest in late autumn. This advantage is especially noticeable in the technologies for growing green crops, in particular lettuce (*Lactuca sativa* L.). At the same time, a skillful combination of crop production in open and closed ground against the background of selection of different varieties and cultivation methods makes it possible to completely eliminate the seasonality of the harvest and provide a wide range of salad products throughout the year.

Today, more and more lettuce producers in Ukraine are growing it hydroponically. The advantages of this method are the possibility of growing crops all year round, and increasing harvests, as well as higher quality products. Lettuce grown on hydroponics is juicier and lower in comparison with products from open ground, the latter plant is constantly in contact with water [1].

At the same time, as evidenced by the experience of producers, when growing lettuce using the hydroponic method, the right selected assortment is important [3]. In such conditions, it is important to combine varieties of different groups of precociousness with high productivity, friendliness of crop formation, as well as high marketable properties, in particular, different leaf plate designs. Therefore, the goal of our work was the study and selection of highly productive varieties of leaf lettuce for conveyor cultivation using the flow hydroponics method..

## 2. MATERIALS AND METHODS

The research was conducted during 2022-2023 on the basis of "Green Planet" from Myrne, Odesa region according to the Methodology of experimental work in vegetable growing and melon growing [4]. The subject of the study were varieties of leaf lettuce: Levistro (control), Kurly, Dragone, Rouxay, Kirinia.

Lettuce was grown by the seedling method in a film greenhouse by the flow hydroponics method. The size of the accounting plot is 10 m<sup>2</sup>. The repetition of the experiment is three times, the placement of options and repetitions in the experiment is systematic.

During the research, observations of plant growth and development rates, biometric measurements of plants, harvest accounting and quality indicators of products were carried out [5]. Mathematical and statistical processing of basic data was carried out using the package of standard programs "Microsoft Excel 2010".

### 3. RESULTS AND DISCUSSION

One of the main directions of lettuce selection is the creation of varieties of different groups of ripeness, which will contribute to the organization of conveyor cultivation of the culture. The study of the rates of growth and development of the varieties we studied showed that Levistro (control) and Kirinia varieties with a growing season of 44-47 days belong to the group of medium-early ones, and Kurly, Dragone and Rouxay varieties, the length of the growing season of which was 51 on average over the years of research - 55 days - to the group of medium-ripening varieties [2].

The data analysis showed that all studied varieties form small commercial rosettes in the conditions of flow hydroponics. Their diameter in the widest part was between 17.6 and 24.3 cm. At the same time, the varieties differed significantly among themselves in the number of leaves. So, rosettes with the largest number of leaves - 38.8 and 31.6 pieces of leaves are formed by plants of the Rouxay and Kirinia varieties, and with the smallest - 21.7 pieces - by the control variety Levistro.

**Table 1.** Results of biometric measurements of plants of foreign varieties of leaf lettuce, 2022 – 2023.

Variety	Plant height, cm	The number of leaves, piece		The number of leaves, piece	Leaf surface area		
		in a row	in the inter-row		plants, cm <sup>2</sup>	1 m <sup>2</sup> of plantings, m <sup>2</sup>	m <sup>2</sup> /kg
<b>Levistro (st)</b>	20,6	17,6	18,5	21,7	3154	10,50	2,1
<b>Kurly</b>	19,0	23,3	22,5	22,4	3633	12,09	1,9
<b>Dragone</b>	20,1	21,4	20,7	24,6	4011	13,36	2,0
<b>Rouxay</b>	21,1	24,3	23,8	38,8	4261	14,18	1,9
<b>Kirinia</b>	20,2	23,2	23,1	31,6	3201	10,66	2,1

Determining the area and productivity of the leaf surface of plants showed a significant advantage in these indicators of Rouxay, Dragone and Kurly varieties. With this, the largest leaf surface area of both one plant - 4261 cm<sup>2</sup>, and 1m<sup>2</sup> of planting - 14.18 m<sup>2</sup>, which is 35% more than the control characterized by plants of the Rouxay variety. The leaf surface area of one plant of the Dragone and Kurly varieties was on average 4011 and 3633 cm<sup>2</sup>, and 1 m<sup>2</sup> of plantations was 13.36 and 12.09 m<sup>2</sup>, respectively, which is 27 - 15% more than the control. The highest productivity with an index of 1.89 is characterized by the leaf surface of the Kurly and Rouxay varieties.

The main indicator of the characteristics of the variety is its productivity, in particular the weight of the marketable rosette and the yield of the plants. The analysis of the data indicates a significant advantage among the experimental variants in terms of these parameters of the Rouxay and Dragone varieties. On average, over the years of research, the weight of commercial rosettes of the Rouxay variety was 223.2 g, and of the Dragone variety - 204.4 g, which is 71.3 and 52.5 g more than the control Levistro variety, respectively.

The Kurly variety also exceeded the control for this indicator. On average, in 2022-23, the mass of its marketable rosette was 189.9 g, which is 38.0 g more than the control. At the same time, Rouxay and Dragone varieties provided the highest marketable yield, which amounted to 6.82 and 6, respectively, on average. 67 kg/m<sup>2</sup>, which is 2.99 and 2.84 kg/m<sup>2</sup> more than the control. Mathematical data processing shows the significance of the specified difference.

The analysis of the data showed that the economic efficiency of the production of leafy lettuce by the flow hydroponics method increases with the following indicators: the commercial appearance of the rosette: the shape of the leaf, the dissection of the leaf plate, the color of the rosette; at the sale price, which directly depends on the type and output of commercial sockets per unit of area. It was established that the preservation of the largest profit and the highest level of profitability of production - 197% ensures the cultivation of the Rouxay variety.

#### 4. CONCLUSION

Simultaneous cultivation of all studied varieties makes it possible to extend the period of receipt of products within 7-10 days. At the same time, in order to obtain a high-quality harvest and expand the assortment of lettuce products when growing by the flow hydroponics method, it is advisable to grow Rouxay, Dragone and Kurly varieties.

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## POSTER PRESENTATION

### **Amaranth - As an Element of Soil Reconstruction and a Source of Healthy Nutrition**

***Yevgen YURKEVYCH<sup>1✉</sup>, Dmytro DELERGIEV<sup>1</sup>, Natalia VALENTIUK<sup>2</sup>***

*<sup>1</sup>Odesa State Agrarian University, Odesa, Ukraine*

*<sup>2</sup>Institute of Climate Smart Agriculture of the National Academy of Agrarian Sciences of Ukraine, Ukraine*

**✉Correspondence:** naval100@ukr.net

**Abstract:** The priorities of the Ukraine agricultural sector development in recent years have been the creation of healthy, ecologically clean products to maintain the health of the nation, and for possibility of supplying them to world food markets. The prerequisite for this is our fertile soil is one of the most natural treasures of Ukraine. However, the Russian invasion dealt a significant blow to the agricultural sector of Ukraine, and according to the calculations of analysts of the KSE Agrocenter and the Ministry of Agrarian Policy, direct and indirect losses in agriculture today have exceeded \$40 billion in total. According to the Ukrainian nature protection group since the beginning of the Russian aggression against Ukraine, about 34% of its territory has suffered systematic disturbance of the surface layer of soils or pollution. These soils require long-term reclamation, but something can be done now. This process is gaining special attention under the conditions of climate change, which is accelerated by the hostilities taking place on the territory of Ukraine. One of the ways to solve this problem is the introduction into production of new competitive economically profitable crops that have a sufficiently high level of adaptive potential. Such crops include the amaranth plant, which is not common in our country. Amaranth, in addition to its high nutritional value, also has great agrotechnical importance in restoring and preserving soil fertility. Low demand for the level of soil fertility, the possibility of growing amaranth on almost all types of soil, except strongly acidic, saline and with a high level of groundwater, its ability to replenish the reserves of nitrogen compounds and organic matter in the soil due to a large amount of post-harvest residues, the ability to create a large biomass with a small amount of applied fertilizers and unique drought resistance make it a strategic crop in overcoming the consequences of global climate change and Russian military aggression.

**Keywords:** Recultivation, Soils, Amaranth, Products of Functional Importance.

## **1. INTRODUCTION**

One of the most important directions of Ukraine's development is the production of ecologically clean food products, the quality of which is able to ensure competitiveness on the world food market. Our country has all the necessary prerequisites for this. This especially applies to soils, which are the most expensive natural treasure. However, according to the calculations of well-known analysts (KSE Agrocenter and the Ministry of Agrarian Policy), the damage caused to agriculture by Russian aggression (about 34% of soils were systematically disturbed and polluted) has already exceeded the amount of \$40 billion. The consequences of the influence of military actions on the fertility of the soil are taking on catastrophic proportions. Restoring the fertility of these soils requires long-term recultivation.

In addition, climate changes, which have been accelerating in recent decades, require the introduction of new, competitive, economically profitable crops, which have a sufficiently high level of adaptive potential, into production. Such crops include the amaranth plant, which is not common in our country (Goptsiy TI etc. 2018; Gudkovskaya NB, Goptsiy TI 2016; Valentiuk N., Kohut I., Stankevich G. 2020; Valentiuk N.O., Yurkevych Ye.O., Kohut I.M. 2021).

Amaranth, known since ancient times, today arouses special interest among the scientific community, agrarians and processors of plant products. This is explained by the unique features of the chemical composition of both the grain and the leaf-stem mass of the plant. Amaranth grain differs from grains traditionally grown in Ukraine by the presence of protein balanced in terms of amino acid composition, increased content of valuable oil, rich in unsaturated fatty acids and



a substance such as squalene, lack of gluten, which opens up a fairly wide range of use of the culture in various spheres of economic activity (D'Amico S., Schoenlechner R. 2017).

Amaranth oil is a naturally balanced complex of biologically active substances. According to studies conducted by various scientists, the substances included in amaranth oil can improve the work of the hormonal and immune systems, as well as normalize metabolic processes in the human and animal bodies. These features of amaranth oil allow it to be used as part of medicinal products and used in traditional medicine, in cosmetology - as part of various cosmetics and in the production of functional food products (D'Amico S., Schoenlechner R. 2017; Valentiuk N., Stankevych G. 2020).

The study of the pharmacological properties of amaranth oil made it possible to open wide opportunities for its use in the treatment of many diseases: therapeutic dentistry for exudative-hyperemic and erosive-ulcerative forms of lichen planus, chronic recurrent adenotic stomatitis, desquamative glossitis, glocalgia and prosthetic stomatitis. Long-term studies indicate the proven effectiveness of amaranth oil in the treatment of cancer.

The by-product of amaranth oil production (meal) can be successfully used as an ingredient in compound feed for fish and farm animals.

Young amaranth plants are happily eaten by pigs and sheep. So R.M. Saunders, R. Becker, conducting research on the effectiveness of feeding amaranth green mass to sheep, proved that amaranth is better digested and contains more protein than oats. Also, according to their conclusions, in terms of protein composition, amaranth can be compared to high-grade alfalfa.

In the food industry, the green mass of amaranth attracts manufacturers as a source of easily digestible protein, perfectly balanced in terms of amino acid composition, vitamins of group B, E, trace elements, as well as the ability to remove radionuclides and salts of heavy metals from the body.

As evidenced by the research data of domestic and foreign scientists, amaranth, unlike many traditional grain crops, also has great agrotechnical importance in restoring and preserving soil fertility. Amaranth has a fairly low demand for soil fertility, which allows it to be grown on almost all types of soil, except for strongly acidic, saline soils and those with a high level of groundwater.

The ability of this culture to replenish nitrogen compounds and organic matter in the soil due to a large amount of post-harvest residues has also been proven. Amaranth is characterized by the ability to create large biomass with a small amount of applied fertilizers and unique drought resistance, which makes it a strategic crop in overcoming the consequences of global climate change and Russian military aggression.

A rather weighty fact in favor of growing amaranth can be considered its plasticity, which will contribute to its effective cultivation regardless of the climatic conditions of the zone. Amaranth does not cause soil fatigue and promotes the development of microorganisms, the activity of which is one of the main factors that ensure soil fertility. This, in turn, allows us to draw a preliminary conclusion about the feasibility of using organic preparations when growing amaranth, among which biological preparations based on the suspension culture of microalgae *Chlorella vulgaris* have recently gained popularity among manufacturers.

The algae biomass is perceived as an organic fertilizer, and it differs favorably from traditional species, as it contains neither pathogenic microflora, nor weed residues, nor pests. Microalgae are successfully used to increase soil fertility, to replenish reserves of organic matter, which contributes to increasing the yield of agricultural crops (Paula Alvarenga etc. 2023).

Representatives of the genus *Chlorella vulgaris* are able to bind up to 60 kg/ha of nitrogen per season, and are also a valuable source of organic matter that improves soil fertility. At the same time, microalgae are a renewable resource, unlike the nitrogen fertilizers industrial production.

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## POSTER PRESENTATION

### **The Influence of Meteorological Conditions on the Development of Fusarium Head Blight and the Formation of the Species Composition of Winter Wheat in the Conditions of Polissia of Ukraine**

***Maïia DHZAM<sup>1</sup>, Viktor ZORUNKO<sup>1✉</sup>, Volodymyr OREKHIVSKYI<sup>2</sup>, Volodymyr VAKULENKO<sup>1</sup>***

*<sup>1</sup>Odesa State Agrarian University, Odesa, Ukraine*

*<sup>2</sup>Institute of plant physiology and genetics, National academy of science of Ukraine, Ukraine*

*✉Correspondence: zorunko1@gmail.com*

**Abstract:** An important factor in the development of Fusarium ear of cereal spikelet's is the amount of precipitation during the flowering period. This increases the moisture content in the grass, which leads to the initial defeat of the disease and the gradual accumulation of infection. The further development of the pathogenesis depends on the amount of precipitation during crop maturation. Conditions favorable for the development of epiphytism's can occur when at least 40 mm of precipitation falls during the flowering period, and at least 140 mm in the following period. Plants are affected by Fusarium head blight from the flowering phase until harvest, so we analyzed this period. In the Polissya zone of Ukraine, the average flowering phase of winter wheat in Kyiv region is June 5, in Zhytomyr region - June 7, and in Chernihiv region - June 9.

**Keywords:** Fusarium Ear, Infection, Flowering Phase.



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## POSTER PRESENTATION

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### **Increasing the Resilience of Farming Systems in the Context of Global Climate Change and Demographics**

***Tetyana MARCHENKO, Oleg KRAINOV<sup>✉</sup>, Serhii ZHERENDIUK***

*Odesa State Agrarian University, Odesa, Ukraine*

<sup>✉</sup>**Correspondence:** oleg.odau@gmail.com

**Abstract:** Climate change creates significant challenges and threats for the agricultural sector. Recently, the agriculture of the countries of the world has suffered significantly from natural disasters - droughts, extreme temperatures, floods, storms, epiphytobia and other stress factors. Today, the creation of highly adaptive varieties and hybrids of agro-ecological orientation with a high degree of genetic protection of the crop from biotic and abiotic factors of the environment, the development of the scientific basis for the creation of genetically programmed varieties and hybrids of a given biological and economic orientation is an important direction of scientific support in the field of crop production. Therefore, in the field of increasing the productivity of grain crops (the main source of food), three main directions are possible: creation and improvement of agricultural technologies adapted to climate changes, genetic and breeding developments; optimization of logistics and specialization of production. The climate changes that have already occurred and are expected in the coming decades definitely affect and will affect agriculture throughout the world. Therefore, it is already necessary to develop measures aimed at reducing the risk of sensitivity of the agricultural sector to the consequences of climate change. The implementation of modern scientific developments that contribute to the minimization of the harmful effects of climate change is possible through the formation of a galaxy of modern, highly educated specialists with knowledge of modern methods of creating new genotypes, plant protection systems against harmful organisms, and information provision of prognostic changes in climate and society. Therefore, at the current level, scientific research on the improvement of climate-oriented modern agriculture is the key to stabilizing agricultural production in the world and solving the food problem of mankind.

**Keywords:** Climate Change, Climate-Oriented Modern Agriculture.



## POSTER PRESENTATION

### Possibilities of Increasing CO<sub>2</sub> Sequestration in the Soil When Replacing Spring Peas with Wintering Peas

**Viktor SHCHERBAKOV<sup>✉</sup>, Aleksandr BUTENKO**

*Odesa State Agrarian University, Odesa, Ukraine*

<sup>✉</sup>**Correspondence:** viktor19422@i.ua

**Abstract:** The issues of the impact of crop production on greenhouse gas emissions and global warming processes are considered. The possibilities of accumulation of atmospheric carbon dioxide in soil organic matter are evaluated. On the basis of the method of empirical calculations, the advantages of wintering peas in comparison with spring forms using classical and Strieep-till technology have been determined. Wintering peas, which are an alternative to spring forms, are preferable as a crop that takes the field 3 times longer than spring peas. Analyses have shown that the introduction of wintering pea varieties into the crop is an effective measure to improve the carbon balance. The total annual gas emission from spring peas was 32.7 t/ha of CO<sub>2</sub>-eq. When replacing the spring variety with a wintering one, this figure was 27 t/ha, which is 20% less. This allows us to believe that wintering peas, due to most of the occupation of the field area, increases the sequestration (conservation) of CO<sub>2</sub> in the soil and thus improves the carbon balance.

**Keywords:** Greenhouse Gases, Global Warming, Peas, Cultivation Technology.

## POSTER PRESENTATION

### *Mordellistena parvula* Gyll. - A New Sunflower Pest in Southern Ukraine

**Yurii KLECHKOVSKIY, Katerina SHMATKOVSKAYA**✉

Quarantine station of grape and fruit cultures of plant protection institute NAAS of Ukraine, Odessa, Ukraine

✉Correspondence: oskvpk@te.net.ua

**Abstract:** Sunflower is an important technical crop for Ukraine, which is confirmed by the trend of increasing the cultivated area, which has been maintained in Ukraine for a long time. Thus, according to the State Statistics Service, the area under this culture has increased by more than 30% over the last decade. This year, a record 6.5 million hectares were set aside for sunflower, compared to 4.417 million hectares in 2010. Oversaturation of field crop rotations with this crop can lead to a change in the timing of its return to the previous place of cultivation, which will subsequently lead to a change in crop rotation, the spread of pathogens and pests, field weediness, deterioration of the ecological situation due to the expansion of the use of pesticides and a decrease in yield by 10-80%. *Mordellistena parvula* Gyll. was first described as a species in 1930 in Ukraine. Since 2004, there have been mass reports of damage to sunflowers in the southern and eastern regions by an unknown pest. In 2006, the pest was identified as *Mordellistena parvula* Gyll. The appearance and dynamic reflecting the number of the pest on sunflower crops in 2022 depended on meteorological conditions. The optimal conditions for the development of the harmful object came in the 3rd decade of May, just then the exit of the imago from the places of winter. The results of monitoring obtained with the help of yellow glue traps made it possible to determine the beginning of the flight, which was recorded in the 3rd decade of May (SET 138.6°C). The mass summer began in the 1st decade of June and was short-lived. Individual specimens were recorded in traps until the 3rd decade of July. The summer of the imago is extended and duration was 61 days. The average number of adults is 1-3 pieces/trap per day. Adults on plants average 1-2 pieces per 15 plants. Bugs on plants were observed 1.5 months. The emergence of the first larvae was recorded in the second decade of July (SET 170°C). Sunflower stalks were cut in areas without pesticide protection and the number of the pest inside was counted in the phase of BBCH 67-71, 83-87, 89. Thus, in the 1st decade of September (phase of BBCH 89), during the last pre-harvest accounting, the average number of damaged plants was 19.25 out of 20 inspected. The average density of larvae was 2.75 - 3.35 pieces per 1 stem. When counting the harvest on the plots of the 'Osman' cultivar, not treated with pesticides and damaged by *Mordellistena parvula* Gyll, the yield was on average 1.6 t/ha, when using treatments – 2.2 t/ha. In 2021, the biophenology of *Mordellistena parvula* Gyll was studied for the first time in the Odesa region in the fields of sunflowers. The development of one full generation of the pest per year has been established. A decrease in yield by 36% was determined in areas not treated with pesticides due to damage at a density level of 12 larvae/m<sup>2</sup>.

**Keywords:** Sunflower, *Mordellistena parvula* Gyll., Monitoring, Harvest.



## POSTER PRESENTATION

### Grapevine Adaptation to Climate Change Through Agrotechnical Approaches

**Andrii SHTIRBU**✉

*National Scientific Centre «V.Ye. Tairov Institute of Viticulture and Winemaking» 40 rokiv Peremohy str., 27, Tairove,  
Odesa region, 65496, Ukraine*

✉ **Correspondence:** stirbu.a@gmail.com

**Abstract:** Most of the scientific community has confirmed climate change. Although this process is long, it has accelerated rapidly in recent decades. As a result, grapes in traditional cultivation regions are gradually being created with new environmental conditions. New research directions are suggested by this problem to help adapt the grape culture and increase its efficiency and stability. Grape cultivation is exposed to risks due to an increase in environmental temperature and a deficiency of soil moisture. New environmental conditions in the future could lead to a decrease in crop yields and berry quality for terroir wine production. According to the literature, the strategy of adapting grapes to changing climate conditions can be based on: a) irrigation of plantations; b) the transfer of culture to regions with more suitable environments; c) the use of clone varieties, cultivars of new breeding, drought-resistant rootstocks. Our research has focused on the possibility of optimizing a grape culture system in a semi-arid climate to maintain stable grape production, even with the possibility of water regime deterioration. Grape adaptation involves developing agricultural technologies that optimize the structural organization of the vineyard for non-irrigated crop cultivation in drought environments. The study was carried out on a non-irrigated vineyard in a cold semi-arid climate, where the aridity index varies from 0.2 to 0.5 (2016-2020). Plantations are represented by wine cultivars 'Zahrei' and 'Aromatnyi' (*Vitis vinifera* L.). The cultivars obtained as a result of generative selection, are characterized by high ecological plasticity. The field experiment was applied to study the effect of two planting density variants (3×1.5 m; 3×1 m) and four vine training systems (when the horizontal cordon is located at the height of 0.4 m, 0.8 m, 1.2 m, 1.6 m) on the yield. The positive effect of compacting plantations at 3×1 m on crop yield was determined without irrigation in semiarid environments for low-vigor cultivar 'Zahrei'. At the same time, for the vigorous cultivar 'Aromatnyi', variant of planting density of 3×1.5 m is more effective. Under dry conditions, at optimal planting density the most efficient system is the training system with the formation of the horizontal cordon at the height of 1.2 m and free-growing shoots. On average, for the investigated 5 years, the maximal level of the yield for 'Zahrei' plantations was determined at the level of 14.1 t/ha, for 'Aromatnyi' – of 11.5 t/ha. Under free growth, the yield of the plantations of 'Zahrei' cultivar increases by 4.3–12.3 % on average as compared to the vertical shoot positioning and by 21.3 % – under their downward positioning. On plantations of the 'Aromatnyi' cultivar, a decrease or increase in the height of the cordon of vines reduce the yield by 13.0-39.9%. The management of spatial shoot location, canopy architecture, and leaf area parameters is ensured through the use of planting and training systems for grapevines. By optimizing, the negative impact of water deficit can be mitigated and plants can be adapted for non-irrigated crops in semiarid climates.

**Keywords:** Grapes, Planting Density, Training System, Productivity, Yield.

## POSTER PRESENTATION

### Growing Grapes in a Greenhouse in the Ukrainian Polissya

**Andrii SHTIRBU<sup>✉</sup>, Oleksandr SALIVON**

*National Scientific Centre «V.Ye. Tairov Institute of Viticulture and Winemaking» 40 rokiv Peremohy str., 27, Tairove,  
Odesa region, 65496, Ukraine*

<sup>✉</sup>**Correspondence:** stirbu.a@gmail.com

**Abstract:** The vineyard was founded on the territory of the natural and agricultural zone of Polissya (Zhytomyr region of Ukraine). Previously, Polissya regions were considered to be unsuitable for a grape crop due to their frost susceptibility, and mostly due to insufficient thermal resources. The climate of the farm location region is characterized as continental with warm, humid and mild winters. The average annual temperature is +7,7 °C, the coldest months are January and February and the warmest ones are July and August. The absolute minimum temperature reaches –33 °C, and the average of absolute minimums is –14 °C. The biological characteristics of grapes require the creation of environmental conditions in protected ground similar to open ground crop conditions in the southern region. It is known that grape cultivation in unheated greenhouses can be introduced in regions where about 1000 °C of heat is not enough for the vegetation period in total. The varietal composition of grapes on the farm is following: the main cultivars and forms of 'Arcadiya' and 'Liviya' table grapes, in smaller volumes – 'Kishmish Luchistii', 'Veles', others. Vineyards in protected ground are laid out in small plots of 360, 450 m<sup>2</sup>. Arched greenhouses are used of the following dimensions: width – 10 m, length – 36 or 45 m. The area under plantings is 6300 m<sup>2</sup>. Grape planting scheme is following: row spacing – 3 m, distance in rows between grape plants – 2,2 m. There are four rows in each greenhouse. Annual lignified grafted seedlings were planted with a stem length of 40 cm, well-developed intact root system and well-ripened growth. The farm adopted a fan-shaped stemless form of grape plants on a vertical trellis. Pruning grapes is carried out on the fruit link. Pruning length is 8-10 buds. The final load rate of the grape plants is set when the green shoots are cut. In comparison to open ground, in unheated greenhouses the average monthly temperature of the coldest month (January) increases from –2,5 °C to –1,8 °C, and of the warmest one (July) – from +23,5 °C to +30 °C. The sum of average daily temperatures above 10 °C in protected ground reached 2889 °C which is 433 °C more than in open ground. This effective heat sum is sufficient for groups of grape varieties from early to mid-ripening berries. Berries ripening in protected ground conditions occurs in the third decade of August (Liviya) and in the first decade of September (Arkadiya). The yield of grapes in an unheated greenhouse is 2,5-3 kg/m<sup>2</sup>. The quality of berries is not inferior to the yield grown in open ground in southern regions which are traditional for the crop. The main grape cultivation agricultural technology in protected ground in Polissya is set out. It is established that in unheated greenhouses, agro-climatic indicators change to levels sufficient for normal growth, development and fruiting of table grapes. In the future, the grape crop in greenhouses conditions of the natural and agricultural zone of Polissya may have social and economic importance, its development will create jobs, provide the local people with table grapes.

**Keywords:** Grapes, Greenhouse, Polissya, Table Cultivar, Yield.

## POSTER PRESENTATION

### Evaluation of the Response of Lettuce Seed Lots to Organic Priming Under Salt Stress

**Burcu Begüm KENANOĞLU<sup>✉</sup>, Cem KAYA**

*Uşak University, Agriculture Faculty, Uşak, Türkiye*

<sup>✉</sup>**Correspondence:** burcu.kenanoglu@usak.edu.tr

**Abstract:** The study was carried out in the Seed Physiology laboratories of Uşak University, Faculty of Agriculture, Department of Horticulture during the 2022-2023. Lettuce seeds of 4 different commercially important varieties (Yedikule (Y), Altın Kıvrıcık (AK), Paris Island (PI), and Great Lakes (GL)) were used in the study. In this study, the effect of organic and bioprimering treatments against salt stress induced in the growth media of lettuce plants irrigated with different salt concentrations (4 dS/m and 8 dS/m) was investigated. Brewed tea prepared from dried leaves of the moringa (M) plant prepared at different doses (2%-4%) and times (12 and 36 hours) was used as organic priming material. Moisture content (at 103 °C, 17 h), germination (3x25 replicates/seed, 14 days at 24 °C), emergence (3x25 replicates/seed, 30 days in greenhouse), controlled deterioration (CD) (at 18% and 24% humidity, 24 h at 45 °C) tests were established. As a result of the tests; total germination and emergence rate (%), mean germination time (MGT), early emergence percentage (first 3 days, %), wet and dry weight (g), root and stem length (cm), chlorophyll values (CCI) were determined. The results of the control germination test of the harvest groups were 41% (Y), 94% (AK), 97% (PI), and 100% (GL), and the earliest emergence (3.5 days) was Y variety. Viability after the CD test was maintained only in PI and GL cultivars (18% humidity). The emergence rates were recorded as 24% (Y), 90% (AK), 68% (PI) and 81% (GL). Especially under 8 dS/m salt stress, these values decreased by 10-25% on average. As a result of 2% M treatment for 12 and 36 hours, an average of 15% increase in emergence rates was determined only in the PI variety. The emergence performance of PI and GL cultivars increased by 10 to 4% with 2% M application for 12 hours under 8 dS/m salt stress. Under the same conditions, the 4% M treatment had a positive effect on the Y and GL varieties. 36 h 2% M treatment increased the emergence rate in all varieties except the Y variety. M treatment had a positive effect on PI variety in terms of wet weight values. In terms of root length and chlorophyll values, salt stress induced a stimulatory effect. The reverse effect of M treatment was observed. The stem lengths of Y and AK cultivars were stimulated by 2 and 4% M treatment for 12 h under 4 dS/m salt stress. In the lack of salt stress, only 2% M treatment for 36 h increased stem length in all cultivars. As a result, it can be said that M treatment, which is organic priming, can have a positive effect in salt-stress environments depending on the varieties.

**Keywords:** Lettuce, Priming, Moringa Leaf Extract, Salt Stress, Seedling Quality.

## POSTER PRESENTATION

### Antagonistic Effect of *Bacillus* Species Against *Macrophomina phaseolina* Under *in vitro* Conditions

**Havva DİNLER<sup>1</sup>✉, Derya MARAL GÜL<sup>2</sup>, Rengin ELTEM<sup>3</sup>**

<sup>1</sup>Uşak University, Faculty of Agriculture, Uşak, Türkiye

<sup>2</sup>Ege University, Institute of Science, Department of Bioengineering, İzmir, Türkiye

<sup>3</sup>Ege University, Engineering Faculty, Department of Bioengineering, İzmir, Türkiye

✉Correspondence: havva.dinler@usak.edu.tr

**Abstract:** With the use of the same cultivation areas in strawberry production for years, some soil-borne disease agents have increased and threaten production. One of the most important pathogens that limit strawberry production and cause yield losses worldwide is *Macrophomina phaseolina*, which causes root and crown rot in strawberries. This pathogen can infect the roots, stems, leaves and bark of different plant species, affecting more than 500 economic crops. Different practices such as fumigation, resistant varieties, solarization, crop rotation, synthetic fungicides and cultural practices are used in the control of soil-borne diseases in strawberry production areas. Soilborne pathogens have become a problem in strawberry production as a result of the phase-out of most soil disinfectants as chemical fumigants, especially methyl bromide (MB) according to the Montreal Protocol. The use of synthetic chemicals for decades to control diseases, their harm to human and environmental health and the development of resistance, as well as the residue problems of chemicals cause serious problems in marketing. Due to all these negative effects, new alternative methods have become very necessary in recent years in order to reduce the use of chemicals in disease control. Therefore, biological control is one of the first methods that come to mind as a sustainable, environmentally friendly and long-term effective method of combating plant diseases. Biological control is considered as an alternative control method that provides these requirements in plant disease control and is widely used in agriculture. In this study, dual culture test was performed to evaluate the antagonistic activity of 25 isolates including *Bacillus velezensis*, *B. amyloliquefaciens*, *B. subtilis* and *Bacillus* spp. against *M. phaseolina* under *in vitro* conditions. In dual culture tests, *Bacillus velezensis*, *B. amyloliquefaciens*, *B. amyloliquefaciens*, *B. subtilis* and *Bacillus* spp. isolates showed antagonistic activity against the pathogen by inhibiting mycelial growth of *M. phaseolina* at an average rate of 52,59%-67,20%, 54,65%-68,87%, 48,77%-64,41% and 51,45%-67,08%, respectively, on the 3rd and 5th days after incubation. Potential biological control agents identified as a result of the study should be tested against the pathogen both individually and in mixtures under *in vivo* conditions.

**Keywords:** *Macrophomina phaseolina*, *Bacillus velezensis*, *B. amyloliquefaciens*, *B. subtilis* Antagonism, Strawberry.

## POSTER PRESENTATION

### Effects of Melatonin on Inflammatory Mediators iNOS, COX-2, and PGE2 in Testicular Toxicity Induced by Acrylamide in Rats

**Emin ŞENGÜL<sup>✉</sup>, Merve BOLAT, Samet TEKİN**

*Atatürk University, Faculty of Veterinary Medicine, Department of Physiology, Erzurum, Türkiye*

<sup>✉</sup>**Correspondence:** emin.sengul@atauni.edu.tr

**Abstract:** Acrylamide (ACR) is a chemical that can pose a serious carcinogenic risk and is formed during thermal processes, such as the high-temperature cooking or frying of starchy foods. Exposure to products created through these means causes damage to individuals. ACR exposure cause to damage in various tissues and organs. Additionally, the observed gonadotoxic effects in experimental animals emphasize the potential harms of this substance. Melatonin (MEL) is a versatile compound secreted by the pineal gland in vertebrates, with various effects and functions. It has been found to play a significant role in regulating steroid hormone secretion in the male reproductive process. Therefore, this study investigated the effect of MEL on ACR-induced testicular toxicity in rats. Rats were randomly divided into five groups: The Control, ACR, MEL10+ACR, MEL20+ACR, and MEL20 group. In the ACR groups, ACR was administered at a dose of 50 mg/kg, while in the MEL groups, MEL was administered at doses of 10 mg/kg and 20 mg/kg. The experiment continued for 14 days, and it was concluded on the 15th day. At the end of the experiment, testicular tissues obtained from the rats were placed in -80°C freezer. Testicular tissues removed from the freezer on the day of the experiment were subjected to homogenization. The resulting supernatants were analyzed according to the ELISA protocol. It was observed that exposure to ACR increased COX-2, iNOS, and PGE2 levels in the supernatants prepared from the tissues of rats exposed to ACR. ACR exposure was found to cause testicular tissue damage in rats. The application of MEL along with ACR significantly reduced the testicular toxicity induced by ACR. Melatonin exhibited anti-inflammatory effects by reducing COX-2, iNOS, and PGE2 levels. However, we believe that conducting more detailed research at this level would be appropriate.

**Keywords:** Acrylamide, Gonadotoxic, Inflammation, Testis, Rat.

## 1. INTRODUCTION

Acrylamide (ACR) is an extremely toxic chemical used to impart durability to textile products and facilitate particle separation<sup>1-3</sup>. Additionally, it is a compound commonly employed in scientific research for the separation and analysis of DNA, RNA, proteins, and other biomolecules<sup>4</sup>. The discovery of ACR formation during thermal processes, such as the high-temperature (>120°C) cooking of starchy foods, has raised significant concerns regarding human health<sup>5,6</sup>. Studies indicate that this compound is rapidly and fully absorbed through the digestive system in rats, while the absorption through the skin is incomplete. This chemical has the ability to pass into breast milk and can traverse the placental barrier, potentially leading to anomalies in the developing fetus. Toxicokinetic studies on ACR have shown a terminal elimination half-life of 2-7 hours<sup>7-9</sup>. A portion of ACR undergoes metabolic conversion in the liver to its glycidamide form. This transformation is facilitated by the Cytochrome P450 2E1 (CYP2E1) enzyme. Glycidamide derived from ACR forms conjugates when it combines with glutathione (GSH). These compounds are subsequently eliminated through urine as by-products in the form of mercapturic acid. It is believed that glycidamide, thought to have higher reactivity than ACR, can potentially cause harmful effects in multiple organs as a result of its interaction with hemoglobin, essential enzymes, and DNA molecules<sup>10-12</sup>.

The potential harmful effects of ACR on the general population are assessed based on a daily average intake of 4 mg/kg of body weight. Studies indicate that a daily intake of 200 mg/kg of body weight of ACR can lead to severe nerve toxicity in humans, and an intake of 300 mg/kg of body weight can increase the risk of cancer<sup>13,14</sup>. In addition to its potential carcinogenic effects, ACR has been observed to exhibit reproductive toxicity in rats<sup>15</sup>. Previous studies have aimed to

investigate the effects of orally administered ACR on testicular functions. The observed effects include severe damage to the testes, reduced mating, fertility, and pregnancy rates<sup>16</sup>.

N-Acetyl-5-methoxytryptamine, commonly known as melatonin (MEL), is a versatile compound secreted by the pineal gland in vertebrates, and it has various effects. MEL is not only known for its anti-aging, anti-inflammatory, and anti-apoptotic properties, but it also exhibits immune-enhancing and cancer-fighting effects. Furthermore, it has been determined that MEL plays a significant role in regulating steroid hormone secretion in the male reproductive process. Its ability to pass through both the blood-testis barrier and the testicular cell membrane, thanks to its lipophilic and hydrophilic properties, allows it to distribute within intracellular organelles<sup>17-19</sup>.

This study was designed to investigate the effects of MEL on cyclooxygenase-2 (COX-2), inducible nitric oxide synthase (iNOS), and prostaglandin E2 (PGE2) levels in ACR-induced testicular toxicity in rats.

## 2. MATERIALS AND METHODS

### 2.1. Chemicals

ACR ( $\geq 99\%$ ) (Cas No: 79-06-1) and MEL ( $\geq 99\%$ ) (Cas No: 73-31-4) were supplied by Sigma-Aldrich Co. (St. Louis, MO, USA). ELISA kits were obtained from BT Lab.

### 2.2. Animals

Sprague Dawley rats used in this study were obtained from the Atatürk University Medical Experimental Research and Application Center (ATADEM). A total of 50 male rats, with an average weight ranging between 200-250 g, were included. The rats were housed in an environment with a temperature of 25°C, a relative humidity of 60%  $\pm$  10%, and a 12-hour light/dark cycle. Both water and pelleted food were provided ad libitum.

### 2.3. Experimental Design

Prior to commencing the experiment, all rats were weighed and divided into 5 groups. The control group received 1 ml of physiological saline via oral gavage for 14 days. The ACR group received ACR at a dose of 50 mg/kg<sup>19</sup> via oral gavage for 14 days. The MEL10+ACR and MEL20+ACR groups were administered 10 and 20 mg/kg<sup>20</sup> of MEL, respectively, via oral gavage for 14 days, and ACR (50 mg/kg, oral gavage) was administered 1 hour after the MEL treatment. The MEL20 group received 20 mg/kg of MEL via oral gavage for 14 days. On the 15th day, the rats were weighed again and euthanized with cervical dislocation under mild sevoflurane anesthesia. Subsequently, testicular tissues were removed, and their weights were recorded. Subsequently, testicular tissues were removed. After rinsing with physiological saline, the testicular tissues were frozen in nitrogen and stored at -80°C until the day of analysis.

### 2.4. Homogenization of Testicular Tissue

Equal amounts of testicular tissue were sampled and transferred to screw-capped tubes. Tissue homogenization was carried out using the Magna Lyser homogenizer device by adding 1500  $\mu$ l of phosphate-buffered saline (PBS) solution. Subsequently, centrifugation was performed at approximately 5000 rpm for about 10 minutes. The resulting supernatants were carefully transferred to clean Eppendorf tubes.

### 2.5. Analysis of Inflammatory Mediators in Testicular Tissue

Measurements of COX-2, iNOS, and PGE2 levels in the supernatants, were carried out following the instructions provided in the protocols of ELISA kits.

### 2.6. Statistical Analysis

Following the completion of the studies, the statistical analysis of more than two independent groups was conducted using one-way ANOVA within the SPSS 20.00 statistical data software. Subsequently, the Tukey test was utilized for obtaining and assessing numerical values. The resulting values were presented as mean  $\pm$  standard error of the mean ( $\pm$  SEM), and statistical significance was defined as  $p < 0.05$ .



### 3. RESULTS

#### 3.1. Effects of ACR and MEL Administration on the Initial, Final Weights, and Testicular Weights of Rats

At the beginning of the experiment, it was determined that there were no significant differences in the body weights of the rats among the experimental groups. The body weights of the rats were recorded at the end of the experiment. It was found that there was a decrease in body weight in the toxicity and treatment groups. Particularly, the body weights of the rats in the control group were significantly higher than those in the groups where ACR was administered. Although testicular weights in the ACR, MEL10+ACR, and MEL20+ACR groups were lower than those in the control group, this difference was not statistically significant (Table 1).

**Table 1.** The Effects of ACR and MEL on the initial, final, and testicular weights of rats.

Parameters	Groups				
	Control	ACR	MEL10+ACR	MEL20+ ACR	MEL20
Initial body weights (g)	241.53±25.56 <sup>a</sup>	235.41±16.32 <sup>a</sup>	232.86±16.18 <sup>a</sup>	226.86±14.17 <sup>a</sup>	223.29±12.03 <sup>a</sup>
Final body weights (g)	264.57±15.24 <sup>a</sup>	206.57±24.9 <sup>b</sup>	218.86±12.3 <sup>b</sup>	232.86±18.32 <sup>ab</sup>	236.14±13.71 <sup>ab</sup>
Testis weights (mg)	1.70 ± 0.14 <sup>a</sup>	1.24 ± 0.11 <sup>b</sup>	1.51 ± 0.03 <sup>c</sup>	1.53 ± 0.14 <sup>ac</sup>	1.57 ± 0.10 <sup>ac</sup>

No statistical significance was found between the values in the same line. Note: a-b:  $p < .001$ ; a-c, b-c, b-ac:  $p < .05$ . Values were expressed as mean ± SEM.

#### 3.2. Effects of ACR and MEL Administration on iNOS, COX-2, and PGE2 levels in Testicular Tissue

As observed in Table 2, the inflammatory mediators iNOS, COX-2, and PGE2 levels in the ACR group, and PGE2 significantly increased ( $p$  compared to the control, MEL20+ACR, and MEL20 groups). It was observed that these mediators decreased in a dose-dependent manner with MEL treatment, and this reduction was more pronounced in the high-dose MEL group.

**Table 2.** iNOS, COX-2, and PGE2 levels synthesis in testicular tissues.

Parameters	Groups				
	Control	ACR	MEL10+ACR	MEL20+ ACR	MEL20
iNOS (ng/ml)	51.69±10.04 <sup>a</sup>	110.71±18.51 <sup>b</sup>	67.53±11.11 <sup>a</sup>	61.71±13.76 <sup>a</sup>	58.76±6.12 <sup>a</sup>
COX-2 (ng/ml)	6.59±2.34 <sup>a</sup>	10.93±1.43 <sup>b</sup>	7.28±2.41 <sup>ab</sup>	6.27±1.97 <sup>a</sup>	6.23±1.99 <sup>a</sup>
PGE2 (ng/ml)	53.50 ± 9.92 <sup>a</sup>	98.88 ± 15.06 <sup>b</sup>	74.73 ± 11.19 <sup>bc</sup>	60.77 ± 11.57 <sup>ac</sup>	55.90 ± 9.58 <sup>ac</sup>

No statistical significance was found between the values in the same line. Note: a-b:  $p < .001$ ; a-bc:  $p < .05$ . Values were expressed as mean ± SEM.

### 4. DISCUSSION

In this study, the administration of ACR to rats resulted in the disruption of testicular tissue structure and oxidative and inflammatory reactions accompanied by an increase in ROS in the tissue. Several approaches were proposed to explain how ACR generates such toxic effects in the male rat reproductive system.

Exposure to ACR has been reported to cause serious health problems. ACR disrupts the balance in redox biology, leading to the production of reactive oxygen species (ROS)<sup>21</sup>. Furthermore, it has been proven that ACR damages the male reproductive system by disrupting the hypothalamo-pituitary-testis axis and spermatogenesis<sup>22</sup>. The high content of unsaturated fatty acids in testicular tissue increases its susceptibility to ROS<sup>23</sup>. Previous studies have found that ACR induces lipid peroxidation by suppressing the endogenous antioxidant mechanism. This disruption in the balance between oxidants and antioxidants has been observed to create inflammation in testicular tissue<sup>24</sup>. Inflammation is a biological response of the body to infections or other injuries; this response triggers a series of immune reactions initiated through cellular signals, cytokines, and various molecules. Inducible nitric oxide synthase (iNOS) is induced in various cells in

response to inflammatory stimuli such as cytokines and lipopolysaccharides. Activated iNOS synthesizes large amounts of nitric oxide (NO). NO is a significant factor in inducing testicular toxicity. It was observed that iNOS activity, which is responsible for NO synthesis, significantly increased in rats exposed to ACR<sup>25</sup>. Inducible nitric oxide synthase (iNOS) and cyclooxygenase-2 (COX-2) are molecules that play a role in the inflammatory process. There is an interaction between these enzymes, and their activities increase as a result of damage. It has been documented that COX-2 is overproduced in kidney damage induced by ACR<sup>26</sup>. Nitric oxide (NO) produced by iNOS and prostaglandins (PG) synthesized by COX-2 can modulate each other's activities. This affects the complexity and regulation of the inflammatory process. PGE2, a type of PG that plays a role in the inflammatory process, is synthesized from arachidonic acid through the COX-2 enzyme<sup>27</sup>. It has a significant role in inflammatory processes in testicular tissue. In a study, it was observed that PGE2 levels increased in rats exposed to ACR<sup>28</sup>.

In our study, we observed that ACR induces inflammation and increases COX-2, iNOS and PGE2 levels, in parallel with other studies. Also, it was determined that MEL, with its anti-inflammatory activity, significantly prevented the ACR-induced increase in testicular COX-2, iNOS and PGE2 levels.

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## POSTER PRESENTATION

### Allelopathic Effects of Some Plant Material on Seed Germination of Dodder (*Cuscuta* spp.)

**Derya ÖĞÜT YAVUZ**✉

Uşak University, Agriculture Faculty, Uşak, Türkiye

✉Correspondence: derya.ogutyavuz@usak.edu.tr

**Abstract:** Artificial components brought into agriculture have become a sector that disturbs the natural environment and produces environmental concerns in order to fulfill the food demands of the world's fast rising population and to gain more product from the same area of land. With increased environmental awareness, the protection of human health, the environment, and biodiversity have come to the emphasize of all research. Plant protection activities are of particular importance in preventing yield losses in agricultural production. The study was carried out under screen house conditions to evaluate the effectiveness of different plant materials in the control of parasitic *Cuscuta* spp. that cause plant health and yield losses by exploiting the host plants. In order to prevent the germination of *Cuscuta* spp. seeds, lavender-added maize silage (lavender flower-lavender flower + stem), fresh lavender (flower + stem), maize stem, wheat stem, and *Sorghum halepense* (flower + stem) plants were evaluated. They were added to the pots at different rate and their effects on the germination of *Cuscuta* spp. seeds were evaluated. The study was carried out with 5 replications in 16,5 cm diameter pots with a mixture of 1/3 peat, 1/3 soil, and 1/3 sand and repeated twice. In the study, all materials, one of which was untreated control, were handled in two different doses and applied to the pots before planting. Then, *Cuscuta* spp. seeds were sown with 25 plants in each pot. After sowing, the germination rate of *Cuscuta* spp. seeds was evaluated and the effectiveness of the treatments on the germination rate was determined. According to the results obtained, it was determined that *Cuscuta* spp. seeds showed different germination rates in the treatments. It is thought that different ratios and combinations of the materials used in the studies to be carried out for the control of the said species should also be evaluated.

**Keywords:** Allelopathy, *Cuscuta* spp., Seed Germination, Weed Control.

## POSTER PRESENTATION

### Effect of Trichoderma Fungi on the Composting Time of Chicken Manure and the Physico-Chemical Fertility of the Composts Produced

**Nguerabe Yamtitina MAHAMAT<sup>✉</sup>**

*Comrat State University, Faculty of Agriculture, Comrat, Moldova*

<sup>✉</sup>**Correspondence:** mhtnguerabe@mail.ru

**Abstract:** With the introduction of new technologies in the field of poultry farming, the capacity of keeping and raising birds has increased many times, so one poultry farm of average capacity can contain about 400 thousand laying hens or 6 million broiler chickens. With so many birds, one poultry farm can accumulate up to 40 thousand tons of bird droppings per year. Many poultry farms are not capable of recycling such amounts of organic matter; as a result, bird droppings accumulate near them, lose their valuable qualities and pose a serious environmental hazard to the environment. To process manure and obtain valuable substances from it, thereby solving environmental problems, farmers resort to various methods of composting. The purpose of the study is to assess the influence of the time of composting chicken manure using fungi of the genus *Trichoderma* (trichoderma) on the physico-chemical fertility of the produced composts. The study was carried out at the Comrat State University and at the SRL "PILICCIK-GRUP" poultry farm in the Gagauzia region in the south of the Republic of Moldova. Twelve (12) piles of chicken manure were formed at a rate of 3 piles per treatment, corresponding to different composting durations (T14, T21, T28, T35 days). Four treatments using a solution of live *Trichoderma* fungi, labeled T14, T21, T28 and T35, corresponding to manure composting durations of 14, 21, 28 and 35 days, respectively, were compared with the control treatment T0 (non-composted chicken manure). The study showed that already after 14 days, chicken manure was completely composted. After laboratory tests, there was a significant improvement in the content of most physical and chemical indicators of the resulting composts. The introduction of such compost into the soil will have a positive effect on its chemical fertility. *Trichoderma* mushrooms not only speed up the composting process, but also improve the quality of the compost.

**Keywords:** Composting, Chicken Manure, *Trichoderma*, Chemical Fertility.



## POSTER PRESENTATION

### Concept of Developing of Yogurt Fortified with Natural Honey Bee

*Anatoli CARTASEV<sup>✉</sup>, Iulia NEICOVCENA, Yamtitina MAHANAT, Anastasia CHILAFLI*

*Comrat State University, Comrat, Moldova*

<sup>✉</sup>*Correspondence:* anaticartasev@gmail.com

**Abstract:** With the growing interest in health and wellness, there is an opportunity to establish a business by offering antioxidant products. Antioxidants play a role in safeguarding the body against stress and the harm caused by free radicals. The aim of this research is to develop a concept for dairy products with antioxidant activity. Dairy products can be a source of antioxidants, though they are not typically as well-known for their antioxidant content as fruits, vegetables, and some other foods. However, there are some dairy products that contain antioxidants, and it's important to note that the antioxidant content can vary depending on factors like the type of dairy product, the diet of the animals, and processing methods. It's worth noting that not all dairy products with antioxidants are the same, and the effectiveness of these products can vary. The quality of the ingredients, processing methods, and overall nutritional profile can differ significantly between products. Therefore, consumers should pay attention to the specific antioxidants included in a product and their concentrations, as well as the overall nutritional content and ingredient quality when making choices for their diets. Honey is a natural sweetener and food product that has been associated with several potential health benefits, including antioxidant effects. When honey is incorporated into dairy products, it can provide not only sweetness but also contribute to the antioxidant properties of the final product. Here's how honey can have an antioxidant effect in dairy products: Honey contains various antioxidant compounds, including flavonoids, polyphenols, and ascorbic acid (vitamin C). These antioxidants help to combat oxidative stress in the body by neutralizing free radicals. Combining honey with dairy products may result in a synergistic effect on antioxidant activity. The antioxidants in honey can work in concert with any existing antioxidants in the dairy product, potentially enhancing the overall antioxidant capacity. The antioxidants in honey can help prevent the oxidation of fats in dairy products, particularly in those with a higher fat content. Oxidation can lead to off-flavors and a decrease in the nutritional quality of dairy products. The presence of antioxidants in honey may help mitigate these issues. Antioxidants in honey can assist in protecting the body from the damaging effects of free radicals. This protection is beneficial for overall health and well-being. Besides its potential antioxidant effects, honey can enhance the flavor of dairy products, making them more appealing to consumers. This can encourage greater consumption of these products, which can be a part of a healthy and balanced diet. It's important to note that the specific antioxidant content of honey can vary based on factors such as the type of honey (e.g., acacia, clover, manuka), the geographical location where it's produced, and the processing methods. Honey labeled as raw or unprocessed is generally considered to retain more of its natural antioxidant compounds.

**Keywords:** Dairy Products, Honey, Antioxidants, Probiotic.

## POSTER PRESENTATION

### Effect of Biopriming and Organic Priming on Tomato Seed Quality

**Burcu Begüm KENANOĞLU<sup>1</sup>✉, Havva DİNLER<sup>1</sup>, Derya MARAL GÜL<sup>2</sup>, Rengin ELTEM<sup>3</sup>**

<sup>1</sup>Uşak University, Agriculture Faculty, Uşak, Türkiye

<sup>2</sup>Ege University, Institute of Science Department of Bioengineering, İzmir, Türkiye

<sup>3</sup>Ege University, Engineering Faculty, Department of Bioengineering, İzmir, Türkiye

✉Correspondence: burcu.kenanoglu@usak.edu.tr

**Abstract:** In this study, it was aimed to determine the effects of different priming methods applied to seed lots of two different commercial tomato varieties on seed viability and seedling quality. For this purpose, *Bacillus velezensis* isolate was used for biopriming and Moringa (*Tagetes sp.*) extract prepared at two different doses (1% and 2%) was used for organic priming. The experiments were carried out in the Seed Physiology laboratory of Uşak University, Faculty of Agriculture. In the biopriming treatment, seeds were shaken in a 10<sup>8</sup> cfu/ml suspension of the bacterial isolate for 30 minutes at 27°C on a shaker. Moisture contents (130 °C, 1 h) of the seed lots were 7% for RioGrande (RG) and 5% for SC2121 (SC). Abnormal and total germination rate (%), average germination and emergence times (days), root length (cm), hypocotyl length (cm), seedling wet and dry weight (g) and chlorophyll content (CCI) were determined to compare the effects of both priming treatments on seed germination (4x25 replicates/seed, 24 °C, 14 days) and emergence (4x25 replicates/seed, 25 °C, 21 days) performances. In addition, controlled deterioration test (4x25 replicates/seed, 45 °C, 18% humidity) was applied to control and primed seed lots to determine seed vigor. When the study's results were analyzed germination rates in control groups were 86% (SC)-88% (RG), emergence rates were 55% (SC)-75% (RG), germination rates as a result of controlled deterioration test were 70% (SC)-78% (RG), and seedling emergence rates were 66% (SC, RG). As a result of organic priming (1% and 2%) treatment, germination rates were around 87%, while seedling emergence rate was determined between 67.5-69.5%. Germination rates were 100% (SC)-87.5% (RG) after biopriming with *B. velezensis* isolate, and emergence rates were 62% (SC)-73% (RG). So, the priming treatments showed different effects depending on the variety compared to the control values.

**Keywords:** Tomato, Biopriming, Organic Priming, Seed Vigor, *Bacillus velezensis*.

## POSTER PRESENTATION

### Determination of the Gas and Contact Effects of Lavender (*Lavandula x intermedia* Emeric ex Loisel) Essential Oil Against Some Soil-Borne Pathogens of Strawberry Under *in vitro* Conditions

Havva DİNLER<sup>1✉</sup>, Ercüment Osman SARIHAN<sup>2</sup> Mehmet Uğur YILDIRIM<sup>2</sup>

<sup>1</sup>Uşak University, Faculty of Agriculture, Department of Plant Protection, Uşak, Türkiye

<sup>2</sup>Uşak University, Faculty of Agriculture, Department of Field Crops, Uşak, Türkiye

✉Correspondence: havva.dinler@usak.edu.tr

**Abstract:** Strawberry production has been threatened by some soil-borne disease agents due to the use of the same cultivation areas for years. Different practices such as fungicides, antagonist organisms and crop rotation are widely used in the control of plant diseases. In addition, natural fungicides derived from allelopathic and medicinal plants have become widespread all over the world as they are environmentally friendly and economical alternatives to other control methods. Therefore, studies on effective natural products that can replace synthetic pesticides to control diseases are being carried out nowadays. This study was carried out to determine the effect of contact and gas application of different doses of Lavender (*Lavandula x intermedia* Emeric ex Loisel) essential oil against *Fusarium proliferatum*, *F. oxysporum*, *F. arthrosporidae*, *F. oxysporum* f.sp. *fragariae* and *Macrophomina phaseolina*, which are pathogens in strawberry production areas, on mycelial development of pathogens under *in vitro* conditions. For this purpose, 7-day cultures of pathogen isolates grown in Potato Dextrose Agar (PDA) medium at 25°C were used. Antibiofilm disk method was used to determine the gas effect of essential oil. Mycelium discs of 5 mm diameter obtained from 7-day-old cultures of pathogens were inoculated into sterile petri dishes (70 mm diameter) containing PDA (10 ml/petri dish). The antibiofilm disks placed on the lids of the inoculated petri dishes were injected with 1, 2.5, 5 and 10 mg/L doses of essential oil using a micropipette. The antibiofilm disks without essential oil were used as control. In the determination of the contact effect, 2.5, 5, 10 and 20 mg/L doses of essential oil were applied directly to the medium, homogeneous mixing was ensured and pathogens were inoculated similarly. Petri dishes in which essential oil was not added to the medium were used as control. Petri dishes prepared with both methods were covered with parafilm and incubated at 25 °C for 7 days. At the end of the experiment, mycelial growth (mm) of pathogens was measured on days 3, 5, 7, 9 and 11 and the % inhibition rates of plant essential oils were calculated compared to the controls. The experiment was established and conducted according to the split split plots design with 4 replicates. Since the gas and contact effect doses of essential oil were different in the experiment, they were evaluated statistically separately. In the experiment, pathogens were placed in the main plots, application doses in the sub-plots, and development times in the lowest plots. The compound analysis of lavender essential oil used in the experiment was determined by GC-MS device. In the analysis, it was found that it consisted of 40 different compounds and the main components were 41.31% linalool, 11.63% camphor and 11.69% 3-cyclohexen-1-ol terpinene-4-ol. According to the results obtained, as a result of the analysis of the variance of all mean values in the three-factor study, it was determined that the differences between the double and triple interaction values of all measured characters and the mean values of the factors were significant at 0.01 level. Accordingly, when the gas effect of essential oil was evaluated in terms of the mycelial development of the plant pathogens, it showed the highest inhibition effect at the highest dose (10 mg/L) on the 3rd and 5th days after incubation. Accordingly, the mycelial growth of *F. proliferatum* (70.53%-49.48%), *F. oxysporum* (67.68%-47.25%), *F. oxysporum* f.sp. *fragariae* (64.84%-48.69%), *F. arthrosporidae* (48.86%-30.6%) were inhibited the most, while the mycelial growth of *M. phaseolina* was inhibited by 25.3% only on day 3 after incubation. Similarly, the contact effect of essential oil showed the highest inhibition effect at the highest dose (20 mg/L) on days 3 and 5 after incubation. Mycelial growth of *F. arthrosporidae* (89.57%-64.02%), *F. proliferatum* (88.43%-64.54%), *F. oxysporum* f.sp. *fragariae* (87.67%-72.23%), *F. oxysporum* (81.17%-64.03%) were inhibited the most, respectively. Mycelial growth of *M. phaseolina* was inhibited by 74.51%-8.3%. The effect of essential oil decreased at 7, 9 and 11 days after incubation at all doses in both treatments. In conclusion, the effects of gas and contact applications of lavender essential oil against pathogens were at different ratios. The contact effect of the essential oil against all pathogens inhibited mycelial development more at increasing doses, but the effect decreased with increasing incubation days (after day 3). The effect on the mycelial growth of *M. phaseolina* was very low.

**Keywords:** *Macrophomina phaseolina*, *Fusarium oxysporum* f.sp. *fragariae*, *F. oxysporum*, *F. arthrosporidae*, Essential Oil, Strawberry.

## POSTER PRESENTATION

### Determination of the Efficacy of Some Herbicides in the Control of *Chondrilla juncea* L. in Wheat

**Ali Osman LÖKÇÜ<sup>1</sup>, Derya ÖĞÜT YAVUZ<sup>2</sup>✉**

<sup>1</sup>Uşak University, Graduate Education Institute, Uşak, Türkiye

<sup>2</sup>Uşak University, Faculty of Agriculture, Uşak, Türkiye

✉Correspondence: derya.ogutyavuz@usak.edu.tr

**Abstract:** Cereals are one of the most important crops that meet the food needs of the world population. It can be grown almost anywhere in the world because it is grown in all kinds of climatic and soil conditions, resistant to various stress conditions, and has a large number of varieties. In wheat production, diseases, pests, and weeds are among the factors limiting production and weeds are among the most important of these factors. If the factors that cause low yield and quality in wheat are not controlled, significant crop losses are experienced, while this loss due to weeds can reach up to 24%. Competition between wheat and weeds is greatly reduced as a result of appropriate herbicide selection. However, the success of the herbicide application varies depending on the weed species, the timeliness and completeness of the application, the conditions before, during, and after the application, the herbicide doses, and the product management after the application. In this context; herbicides were used in order to evaluate the effectiveness of herbicides with different active substances against *Chondrilla juncea* in three different phenological periods of wheat according to the BBCH scale: the beginning of tillering (21-22), the middle of tillering (24-25) and the end of tillering (29-30). It was conducted according to the Randomized Blocks Trial Design with 4 replications. The % coverage values were found to be significant in the effectiveness of herbicides applied at different phenological periods in the control of *C. juncea* in wheat. Herbicides were found to be significant in % cover reduction compared to the control, but not different from each other. Although there were differences among herbicides, effective control levels (90%) were achieved with tribenuron methyl+thifensulfuron methyl, aminopyralid+florasulam and dicamba+triasulfuron.

**Keywords:** Wheat, *Chondrilla juncea*, Herbicide, Weed Control.

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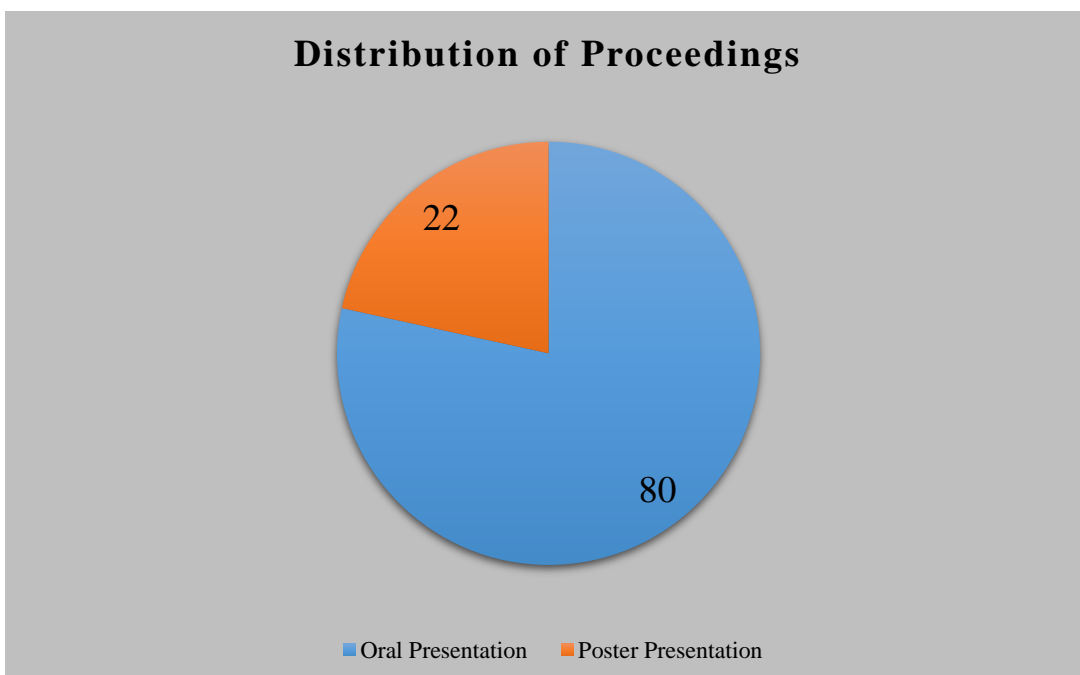
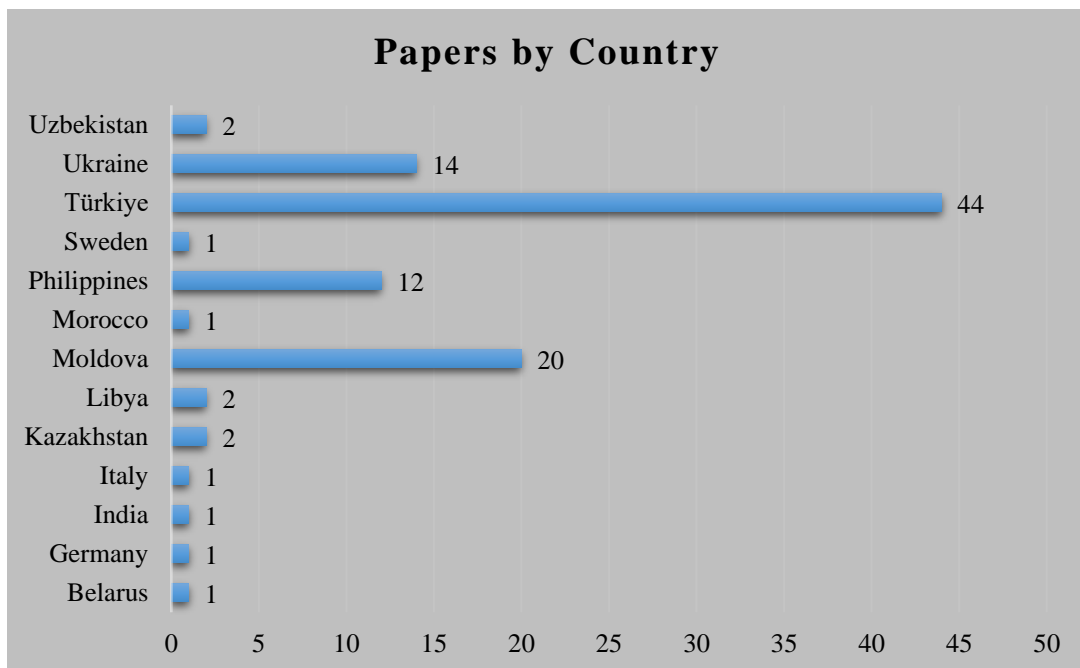


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