SEPTEMBER 7-8

EGE UNIVERSITY
FACULTY OF FISHERIES

INTERNATIONAL SYMPOSIUM ON FISHERIES AND AQUATIC SCIENCES

ONLINE

14th

FABA

FISHERIES AND AQUATIC SCIENCES BALIKÇILIK ve AKUATİK BİLİMLER

PROCEEDING BOOK

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14TH FABA2021 7-8 SEPTEMBER İZMİR

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Proceeding Book

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September 2021
İzmir-Turkey

FOREWORD

On behalf of the Organizing Committee, I am pleased to welcome you to the FABA 2021 Conference. This year's symposium is being hosted by Ege University Faculty of Fisheries in Izmir, Turkey. FABA 2021, International Symposium on Fisheries and Aquatic Sciences taking place in webinar platform on 7 - 8 September 2021. As you know FABA symposium is being organized since 2003 and it brings together colleagues from all around the world working on aquatic sciences. The general aim of the symposium is to gather a selected group of scholars and practitioners to share research and new technologies for a dialogue and discussion covering a wide spectrum of topics in aquatic sciences.

Unfortunately, the symposium, which was planned to be held as FABA 2020 in 2020, was postponed to 2021 due to the fact that the whole world entered the Covid-19 pandemic. This decision was based on critical elements such as the complete ban by the Turkish Authorities on events of limits in size, on top of travel limitations from and to most countries, based on the Pandemic declaration and recommendations made by Turkish Ministry of Health.

Covid-19 Pandemic also affected all scientific research activities, and the lab works so this period resulted in the postponement of the symposium for the first time. The Covid 19 situation continues as a major threat all over the world. Although scientific studies and transportation opportunities are open, the risk is still a reality. In this direction, the FABA 2021 Symposium Organizing Committee decided to hold the postponed FABA symposium in a webinar platform and announced it to the scientific community.

We are so glad about the contribution of valuable participants, 75 scientific presentations and 3 valuable key note speeches were selected among the applications, and a great contribution was made to science and the scientific quality of the symposium. It is my greatest wish that all these difficulties will end in the coming years and that the FABA Symposium series will be realized with face-to-face organizations

I would like to close my words with a round of thanks for everyone who has made FABA 2021 possible. I would like to start by thanking my fellow members of the Organizing Committee, in particularly our colleagues who work to solve in all technical difficulties with digital solutions. Thanks to all scientific committee member for their all supports with using their scientific back grounds in peer-review process and selection of the presentations. The committee has organized a vibrant scientific program and is working hard to present highly respected and internationally notorious speakers to lead it. I would like to thank our invited speakers for agreeing to take time out of their busy schedules to give us their perspectives on a broad-ranging set of topics. And the volunteer who have directly and indirectly supported the success of this organization.

Once again, welcome to FABA 2021 Symposium

Chair of FABA 2021

Prof. Dr. Uğur SUNLU
Ege University, Faculty of Fisheries

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SYMPOSIUM PROGRAM

07/09/2021	★ **Opening Session of FABA 2021 (Common Session)**
09:00	*Prof.Dr. Sedat V. YERLİ* Honorary Chair of the FABA Symposiums
09:05	*Prof.Dr. Uğur SUNLU* Chair of the FABA 2021 Symposium
09:15	*Genel Müdür Yrd. Turgay TÜRKYILMAZ* Deputy Director General - General Directory of Fisheries And Aquaculture, Ministry of Agriculture And Forestry, Republic of Turkey
10:00	*Prof.Dr. Necdet BUDAK* Rector of Ege University
	☆ Key note Speechs
10:30	*Prof. Ad Honorem A. Javier Borderias* Institute of Food Science and Technology and Nutrition (ICTAN-CSIC), Spain "Past, present and possible future of the Seafood Technology"
11:00	*Graham Mair* UN Food and Agriculture Organisation "Managing genetic resources in aquaculture - the opportunity to do it better"
11:30	*Prof.Dr. Masashi Maita* Tokyo University of Marine Science and Technology Department of Marine Biosciences, (TUMSAT) Japan "Current status and issues for sustainable marine aquaculture in Japan"
12:00	Break
Parallel sessions (1st day)	● **Session 1 – Aquatic Biodiversity**
	► ***Chair : Prof.Dr. Alper DOĞAN***
13:00	T1. Fish Biomass Estimation by Underwater Visual Census Method in the Foça Special Environmental Protection Area *Bülent Cihangir, E. Mümtaz Tıraşın, Harun Güçlüsoy, Gökhan Kaboğlu*

13:15	T2. Age and Growth of the Hollowsnout grenadier, *Coelorinchus caelorhincus* (Risso, 1810), in Antalya Bay (Eastern Mediterranean) *Merve Karakuş, E. Mümtaz Tıraşın*
13:30	T3. Biannual Benthic Zone Imaging of the Middle And inner parts of İzmir Bay Between Fall 2014 and Spring 2016 *Alper DOĞAN, Ertan DAĞLI*
13:45	T4. Effects of Benzylparaben on Sea Urchin *Arbacia lixula* by Embryotoxicity Test *Beyza Nalbantlar, Muhammet Ali Karaaslan*
14:00	T5. Determination of Benthic Macro-invertebrate Fauna of Bakırçay River With Some Physico-Chemical Parameters *Cem AYGEN, Murat ÖZBEK, Seray YILDIZ, Esat Tarık TOPKARA, Ayşe TAŞDEMİR*
14:15	T6. Evaluating the Effects of Perfluorooctane Sulfonyl Fluoride on Freshwater Algae Populations by Algal Growth Inhibition Test *Gizem Gülsever, Meltem Boyacıoğlu*
14:30	T7. Disruption of the Endocrine System in Crustaceans Due To Pollutant *A. Kerem Bakır, Muhammet Ali Karaaslan*
14:45	T8. Lateral Line and Caudal Fin Anomalies in Common Sole (*Solea solea* Linnaeus, 1758) from Southern Aegean Sea *Hasan Cerim, Sercan Yapıcı, Özgen Yılmaz*

► ***Chair: Bahar BAYHAN***

15:00	T09. Fish Fauna Of The Yeniçağa Lake *Sercan Böyükalan, Fatih Mangıt, Uğur Sü, Mustafa Korkmaz, Sedat V. Yerli*
15:15	T10. Mass Deaths due to Marine Mucilage in the Sea of Marmara *Uğur Karadurmuş, Mustafa Sarı*
15:30	T12. Monthly Variations of Trammel Net Catch Composition in Beymelek Lagoon, Turkey *Aydın Ünlüoğlu, Coşkun Menderes Aydın, Erdinç Veske, Sencer Akalın, Gökhan Ballıkaya*
15:45	T13. Short-Term Effects of Different Fixatives and Storage Techniques on Morphological Parameters of Fish Species *Elif Bengül Yazıcı, Daniela Giannetto*
16:00	T14. Concentration and Potential Health Risk of Trace Metals in Non-Migratory Anchovy (*Engraulis encrasicolus*) Fished from the Sinop Coasts of Black Sea, Turkey *Barış BAYRAKLI*

16:15	T15. System Analysis of Lake Prespa (Greece) with PClake *Damla Coşkun, Jeroen de Klein, Valentini Maliaka*
16:30	T16. Investigation of Trace Metal Accumulation on Sediments of Tuna Farm Operating in Gerence Bay, Aegean Sea *Mehmet Aksu, Aslı Başaran*
16:45	T17. Assessment of Heavy Metal Pollution and Ecological Risk of Surface Sediments from Homa Lagoon (İzmir Bay) *Elif Çağrı Taş, Uğur Sunlu, Meral Özsüer*
Parallel sessions (1st day)	• **Session 2 – Sustainable Aquaculture and healthy production-1**
	► ***Chair : Prof.Dr. Haşmet ÇAĞIRGAN***
13:00	A1. Fish Meal Replacement by Mealworm (*Tenebrio molitor*) Larvae Meal in Diets for Rainbow Trout, Oncorhynchus mykiss *Ali Atilla USLU, Osman TOLGA ÖZEL, Burcu ÇELİK, Ekrem Cem ÇANKIRILIGİL, İsa COŞKUN*
13:15	A2. Effects of Probiotic Supplementation on Growth Performance in Juveniles of Meagre (*Argyrosomus regius*) *Güneş YAMAN YOLDAŞ, Cüneyt SUZER, İbrahim KÖSE, Onurkan ANTEPLİ, Deniz ÇOBAN, Kürşat FIRAT, Şahin SAKA*
13:30	A3. The Effects of Different Salinity on Survival and Growth of Juvenile Platy (*Xiphophorus maculatus*) *Dilek ŞAHİN*
13:45	A4. Studying of Triacylglycerol Amounts in Chlorella vulgaris Niva-Chl19 Using Fourier Transform Infrared Spectroscopy (FTIR) Method *Pınar Akdoğan ŞİRİN, Serpil SERDAR*
14:00	A5. The First Commercial Scaled Growth Performance Comparison of Rainbow Trout (*Oncorhynchus mykiss*) Culture in Concrete and Earthen Ponds *Özgür ALTAN*
14:15	A6. Potential Impacts of Covid-19 on Turkey's Aquaculture Sector and Coping Strategies *Hülya SAYĞI, Oğulcan Kemal SAGUN, Burcu TAYLAN, Hatice TEKOĞUL*
14:30	A7. Soft-Shell Crab Farming *Berk SUCUKÇU, Halil ŞEN*

	► ***Chair: Prof.Dr. Cüneyt SÜZER***
15:00	A9.Vaccination Injuries *Haşmet ÇAĞIRGAN, Yusuf Yaşar YILDIRIM, Mahmut Hüdai ÇAĞIRGAN, Uğur DEĞİRMENCİ, Egemen NEMLİ, Hülya SAYĞI*
15:15	A10. Trends and Opportunities in Seaweed Aquaculture in Turkey and Introduction of International Coorporation Projects between Ege (Turkey) and Furg (Brazil) Universities and EU H2020 Cost Action "Ca20106" *Gamze TURAN*
15:30	A11. Up-To-Date Seaweed Aquculture Study Results at Ege University Fisheries Faculty Aquaculture Department *Gamze TURAN*
15:45	A12. Sequence-Related Amplified Polymorphism (Srap) Marker System: An Applicable Method for Studies on Invasion Genetics of Freshwater Fish *Sevan AĞDAMAR*
16:00	A13. Bacterial Diseases and Use of Antibiotics in Shrimp Cultivation in the Philippines *Albaris B. Tahiluddin, Ertugrul Terzi*
16:15	A14. Investigation of *Hysterothylacium* Species in Various Fish Species Caught from the Aegean and the Mediterranean Sea Coasts of Turkey *Neslihan SURSAL, Emrah ŞİMŞEK*
16:30	A15. Effects of the Differences of Dietary Protein Concentrates on the Growth of Nile Tilapia Fry (*Oreochromis niloticus*) *EL-NOUMAN, B.A., EGBAL, O.A, SANA, Y.A., AHMED, E.A., OSMAN, A.A.*
16:45	A16. Determination of Anesthetic Effect of Clove Oil and Phenoxyethanol in Jewel Cichlid *(Hemichromis guttatus)* Fish *Müge Aliye Hekimoğlu, Fulay Zağralı, Fatih Güleç*
08/09/2021 (2nd day) Parallel sessions	• **Session 3- Fisheries Technology and Sustainable Management**
	► ***Chair : Prof.Dr. Vahdet ÜNAL***
9:00	F1. Artificial Reef Applications for Diving Tourism in Turkey *Aytaç Özgül, Altan Lök*
9:15	F2. Changes of Socio-Economic and Catch Characteristics of the Trawl Fishery over the Years: Case of Foça, Central Aegean, Turkey *Vahdet Ünal, Fikret Öndes*

9:30	F3. Survey of the Contribution of Sea Cage Farms to Biodiversity *Ali ULAŞ, Serpil SERDAR, Şükrü YILDIRIM, Gamze TURAN*
9:45	F4. Save the Bay: A Case Study of Fisheries Co-Management in Gökova Bay, Turkey *Utku Kuran*
10:00	F5. The Photonic Sensor Application as an in-Situ Sensor System for Sea Cucumber Tanks *Adnan TOKAÇ, Enis N. KOSTAK, Mustafa Tolga TOLON, Christoph STREHSE, Sascha KOSLECK*
10:15	F6. Investigation of Fishing Gears Used to Removal of the Invasive *Pterois miles* from Turkish Seas *Seren EMİRMUSTAFAOĞLU, Zafer TOSUNOĞLU, Ali ULAŞ, M. Hakan KAYKAÇ*
10:30	F7. What If One of the Actors Doesn't Play Its Role in Fisheries Management Process? A Case of Small-Scale Fishery in Gökova Bay, Turkey *Vahdet ÜNAL*
10:45	F8. Artisanal Fisheries in the Foça Special Environmental Protection Area *E. Mümtaz Tıraşın, Bülent Cihangir, Ezgi Saydam, Betül Bardakçı Şener, Harun Güçlüsoy, Gökhan Kaboğlu*
11:00	F9. Perception of Employability in Fishery Cooperatives Among Undergraduate Students of Faculty of Fisheries *Huriye Göncüoğlu BODUR*
11:15	F10. Highlights of the Occupational Safety in Turkish Fisheries *Ozan SOYKAN*
11:30	F11. Morphometry of Striped Venus Clam (*Chamelea gallina* L., 1753) in Western Black Sea *Nil Pembe Özer, Merve Kaplan*
11:45	Break
08/09/2021 (2nd day) Parallel sessions	• **Session 4 – Sustainable Aquaculture and healthy production-2**
	► ***Chair : Prof.Dr. Aysun KOP***
9:00	A17. Effects of Probiotic Supplementation on Growth Performance in Juveniles of Gilthead Sea Bream (*Sparus aurata*) *İbrahim KÖSE, Cüneyt SUZER, Onurkan ANTEPLİ, Umut TURUPLU, Kürşat FIRAT, Şahin SAKA*
9:15	A18. Effect of Different Protein Sources on Protease Activity of Doctor Fish, *Garra rufa* (Heckel, 1843) *Birsen Turunç MEŞE, İsmail ERBATUR, Kaya GÖKÇEK*

9:30	A19. The Importance of Sea Cucumber in Integrated Multitrophic Aquaculture (IMTA) and Its Worldwide Applications *Bengi BAYOĞULLARI, Mustafa Tolga TOLON*
9:45	A20. Precision Agriculture Based Modular Automation System for Monitoring and Management of Microalgal Culture *Doğukan PARLAK, Nilsun DEMİR, Abdullah BEYAZ, Tolga COŞKUN*
10:00	A21. Some Parasites of Chub *Squalius cephalus* (L., 1758) Collected from a Stream System in Kocaeli *Sevilay OKKAY, Ahmet ÖZER*
10:15	A22. The Culture Possibilities of Bearded Horse Mussel *Modiolus barbatus* in the Erdek Bay-Marmara Sea, Turkey *Serpil Serdar, Şükrü Yıldırım, Ali Ulaş*
10:30	A23. Turkey's Foreign Trade of Fisheries Commodities: Past, Present and Future *Deniz Günay, Dilek Emiroğlu*
10:45	A24. The Effects of Oxidized Fish Oil on Growth Performance and Feed Converison of Nile Tilapia (*Oreochromis niloticus*) Fingerlings *Sana YAGOUB ABDALLAH TAHİR, Aysun KOP, Kutsal GAMSIZ, Ali Yıldırım KORKUT, Melike PERVİN*
11:00	A25. Use of Alternative Protein Sources in Aquaculture Feeds *Rahimeh TOYNEGHLI, Ali Yıldırım KORKUT, Kutsal GAMSIZ, Aysun KOP*
11:15	A26. Effects of Glycyrrhizic Acid Supplementation on Growth Performance in Juveniles of Meagre (*Argyrosomus regius*) *Onurkan ANTEPLİ, Cüneyt SUZER, İbrahim KÖSE, Müge HEKİMOĞLU, Şahin SAKA, Kürşat FIRAT, Osman ÖZDEN*
11:30	A27. Evaluation of Spat Settlement of Black Mussel (*Mytilus galloprovincialis) in Summer Season Using by Kriging Method in Arcgis Spatial Analyst* *Erdem ÖZSOY, Serpil SERDAR*
11:45	A28. Occupational Health, Safety and Current Legislations and Regulations in Aquaculture *Fatih PERÇİN*
12:00	A29. Identificiation Of Two Novel Single Nucleotide Polymorphisms (SNPs) Of Myostatin (*MSTN*) Gene In European Sea Bass (*Dicentrarchus labrax*, L.) *Emel Özcan Gökçek, Raziye Işık, Bilge Karahan, Kutsal Gamsız*

12:15	A30. Determination of Antibody Levels in Polyvalent Vaccine Application for Rainbow Trout, (*Oncorhynchus mykiss* W,1792) *Pınar YILDIRIM, Ayşegül KUBİLAY*
08/09/2021 (2nd day) Parallel sessions	• **Session 5- Advanced processing technologies and impact on the quality of seafood products**
	► ***Chair : Prof.Dr. Şükran ÇAKLI***
13:00	P1. Microstructural and Biochemical Changes on *Holothuria tubulosa* Collagens After Hydrolyzation Process *İbrahim Ender KÜNİLİ*
13:15	P2. Quality of Pasta Fortified with Shrimp By-Products Flour *Aslı Cadun YÜNLÜ, Ömer Alper ERDEM, Evren Burcu ŞEN YILMAZ*
13:30	P3. Marination of the Rainbow Trout Fillets (*Oncorhynchus mykiss*) with Kefir *Berna KILINÇ, Bülent KAFA, Fevziye Nihan BULAT*
13:45	P4. Determination of Quality Parameters of Pastry with Anchovies *Ayşe KARA, Emine GÜNEŞ, Elif SARI, Orhan KOBYA, Barış KARSLI, Emre ÇAĞLAK, Özen Yusuf ÖĞRETMEN, Fatma DELİHASAN SONAY*
14:00	P5. Traditional Fish Processing Techniques Applied in the Philippines and Turkey *Albaris B. TAHILUDDIN, Ali Eslem KADAK*
14:15	P6. Effect of Seasons on Biochemical Composition and Collagen Level of *Holothuria (Roweothuria) poli* *İbrahim Ender KÜNİLİ*
14:30	P7. Determination of Physical Quality Characteristics of Turkish Ravioli with Anchovy *Orhan KOBYA , Elif SARI, Ayşe KARA, Emine GÜNEŞ, Fatma DELİHASAN SONAY,Barış KARSLI, Emre ÇAĞLAK, Özen Yusuf ÖĞRETMEN*
14:45	P8. Detection of the Presence of *Listeria monocytes* in Fish Retail Sales Areas *E. Burcu Şen Yılmaz*
15:00	P9. Effects of Modified Athmosphere Packaging on the Storage Period of Stuffed Mussels *Ömer Alper ERDEM, Evren Burcu ŞEN YILMAZ, Mehmet Tolga DİNÇER*
15:15	P10. The Effects of Mucilage on the Human Health and Fishery Products *Berna KILINÇ, Ecem ÖZER, Nihan BULAT*
15:30	P11.Investigation of in vitro antimicrobial activity of garlic extract against two important food-borne pathogen bacteria. *Hatice YAZGAN, Esmeray KULEY, Yeşim ÖZOĞUL, Yilmaz UÇAR, Mustafa DURMUŞ*

08/09/2021 (2nd day) Parallel sessions	● **Session-6 Aquatic Biodiversity - 2**
	► ***Chair: Prof.Dr. Murat ÖZBEK***
13:00	T18. Discrimination of Three Similar Scorpaenid Fishes with Multivariate Morphometric Analysis in the Aegean Sea *Salim Can AKÇINAR, Oğulcan HERAL, Bahar BAYHAN*
13:15	T19. A Preliminary Study on the Food Preferences of False Scad (*Caranx rhonchus* Geoffroy Saint-Hilaire, 1817) in İzmir Bay (Aegean Sea) *Burak ALTAY, Dilek İLHAN, Tuncay Murat SEVER, Sencer AKALIN*
13:30	T20. Investigation of Micro Plastic Uptake in Some Pelagic Fish Species in the İzmir Bay *Seda KIRKAN, Aslı BAŞARAN*
13:45	T21. Reproductive Biology of Warty Crab from the Kapıdağ Peninsula *Uğur KARADURMUŞ*
14:00	T22. Evaluating Oxidative Stress Biomarkers in Thicklip Grey Mullet (*Chelon labrosus*) at İzmir Bay *Mustafa BİLGİN, Esin ULUTURHAN, Enis DARILMAZ*
14:15	T23. The Increasing Risks of the Venoms of the Marine Organisms for Human Health Depending on the Global Sea Warming *Berna KILINÇ, Ecem ÖZER*
14:30	T24. Are the new Bisphenol analogues safe to use? A new findings with old method *Duygu TURAN, Özlem ÇAKALASLAN*
16:00	★ **Closing Session of the FABA 2021 - Common Session**

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FABA2021 SEPTEMBER 7-8

INTERNATIONAL SYMPOSIUM ON FISHERIES AND AQUATIC SCIENCES

EGE UNIVERSITY FACULTY OF FISHERIES, İZMİR

Keynote Speeches

PAST, PRESENT AND POSSIBLE FUTURE OF THE SEAFOOD TECHNOLOGY

Javier BORDERIAS[1]

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ANCIENT TIMES

From a very early stage, fish bones were found in the cave dwellers in the Dordogne, in the south west of France dating from 40,000 B.C.

In Mesopotamia and Indus valley (about 4,000 B.C.) fish was consume. Alongside improved methods of catching fish were developed techniques for preserving them by salting and drying. Salt fish and quern-ground barley porridge were the main foods. Fresh, salted and dried fish were important commodities also in rural areas of ancient Egypt.

CLASSICAL TIMES

In classical times, Herodotus mentions salt fish ("Tarichos") as an item in the diet of the Athenian army in the fifth century B.C. when it was usually eaten without cooking. Later, the ancient Romans, developed about first century B.C. a sophisticated water aquaculture complex, integrating it with fish processing, packaging, and shipment of final products to many places in the Mediterranean basin. Tuna seems to have been the most important sea fish all over the classical world. In tuna after removing the throat and belly, as delicacies, all the rest is preserved in salt; the cheapest parts are the ones next to the tail because they lack fat. Also pike is used to be salted. Vinegar was used to shorter-term preservation. Romans learned for Greeks a method of preserving tuna and mackerel by firs frying in oil, treating with leaves, salt and spices and them pouring boiling vinegar over it. "Garum" mentioned as early as Aeschylus (525-456B.C) was a thick sauce which was originally made from the salted blood and entrails of a fish called "garos" by the Greeks. In the Middle Ages and for long after, fresh fish was mostly of fresh water origin. In England pike and tench were transported alive by road to London but it was exceptional

MIDDLE AGE

In Middle age, fish consumption has been affected positively and negatively by religions, taboos. Fish consumption during the Middle Ages in Europe was promoted by the Catholic Church which ordered 166 days of fasting a year in which meat was forbidden. In other latitudes, Marco Polo (1300 DC) gave accounts of salting tuna on the Arabian Sea and Persian Gulf and the drying of salted sturgeon and preparation of caviar from its roes non the Caspian Sea. During Middle Age all types of fish were preserved by salting but drying was confined mainly to the leaner species Herring and salmon were prone to oxidation and could not be preserved for very long time by simple drying. They kept much better if the access of atmospheric oxygen was impeded by covering with strong salt brine in a tight vessel such as a wooden barrel. Rancidity could also be retarded by the antioxidant effect of wood-smoking. In twelfth and thirteenth century, Danish packed fish in barrels with salt after they were eviscerated. In England about 1349 was developed a characteristic hard-salted, smoked and dried ungutted product called red herring, and was called black herring.

MODERN AGE

In modern age, very relevant is the discovery of Newfounland in 1497 by Cabot on an expedition financed by Bristol merchants. It was reported on his return “that the sea there is swarming white fish, mainly cod”. French, Portuguese and mainly Spanish were soon fishing on the new banks. Usually the fish was salted and preserver during several months until landed, then was exposed to the dry wind in land and stored.

CONTEMPORARY AGE

In contemporary age, by the early nineteenth century, new methods, as canning, were needed to extend the shelf-life of fish and fishery products.

In the present times, in Europe and North America two-thirds of fish production used for human consumption is used in frozen and prepared and preserved forms. In developed countries, the share of frozen fish for human consumption rose from 27 percent in the 1960s, to 43 percent in the 1980s, to a record high of 58 percent in 2018.

In China and some Southeast Asian countries, live fish continue to be based on tradition and are not formally regulated. Commercialization of live fish has continued to grow in recent years thanks to improved logistics and technological developments.

PRESENT TIMES

In developed countries the share of cured forms (dried, salted, fermented, smoked, etc.) declined from 25 percent in the 1960s to 12 percent in 2018. In developing countries, fish preserved by cured form – particularly customary in Africa and Asia – declined from 29 percent in the 1960s to 10 percent of all fish destined for human consumption in 2018. In more developed economies, fish processing has diversified particularly into high-value- added products, such as ready-to-eat meals. The seafood technologies used now are:

- ✓ Heat processing (Sterilization): Rotation shaking, Radiofrequency heating, Microwaving, Ultrasounds
- ✓ Heat processing (Pasteurization): Veri common the Sous-vide processing.
- ✓ Salting: Hard salting, light salting, mainly in white fishes.

Smoking: Cold smoking and hot smoking. For cold smoking the processing is mainly smoldering but also by dipping the muscle in a liquid smoking extract. Also is used the electrostatic smoking.

Drying in developed countries the method of drying is using medium-hot air circulation driers. In developing countries, sun drying is the most convenient means of preserving fish products, particularly in places with high levels of solar radiation. Also is used freeze-drying and osmotic dehydration.

Chilling is the method that produces the least obvious changes. Traditionally, fresh fish has been preserved either alive or in ice. Ice is the most widespread method of keeping fish fresh, but there are other traditional methods, for instance, placing the fish in containers with chilled water. One advanced chilling method is ice slurry.

For **freezing** there are four traditional freezing methods for seafood: (a) blast freezing, in which a flux of cold air (−40°C) is circulated at high speed over the seafood in a room or over or under a conveyor belt; (b) contact freezing, in which the fish is in direct contact with a cold metal surface; (c) cryogenic freezing, where the seafood is sprayed with liquid nitrogen; and (d) immersion freezing, in which the seafood product is immersed in super-cooled aqueous solutions. For thawing, traditional thawing methods include running water, still or ambient air, and forced air. Further new developments, used also at the present, in tempering and thawing equipment include different forms of thawing such as steam vacuum, ohmic thawing, dielectric heating, and microwaves.

For **packaging**, modified atmosphere packaging (MAP) is a “classic” technique that prolongs shelf life by providing an atmosphere that retards microbiological growth and attendant deteriorative and chemical processes. Active food packaging has been defined as a system in which the food product, the package, and the environment interact in a positive way to extent shelf life. The action mechanism includes removal of some gases and emission of desired gases (carbon dioxide, ethanol) and release of active compounds. Intelligent packaging is defined as a package containing a sensor that warns consumers that the product is impaired and may begin to undergo harmful changes.

Seafood proteins technology: Fish meal, surimi, hydrolysates and peptides.

By-product utilization: Historically, fish by-products were often: thrown away as waste; used directly as feed for aquaculture, livestock, pets or animals reared for fur production; or used in silage and fertilizers. However, other uses of fish by-products have been gaining attention. Heads, frames, fillet cut-offs and skin can be used directly as food or processed into fish sausages, pâté, cakes, snacks, gelatine, soups, sauces and other products for human consumption. Small fish bones, with a minimum amount of meat, are consumed as snacks in some countries. By-products are also used in the production of feed (not only in the form of fishmeal and fish oil), biofuel and biogas, dietetic products (chitosan), pharmaceuticals (omega-3 oils), natural pigments, cosmetics, etc. Also crustaceans and bivalves also offer numerous applications for their by-products, as chitin, a polysaccharide extracted from crustacean shell waste, calcium carbonate or calcium oxide. Other marine organisms are the subject of extensive research because of their potential for the discovery of powerful new molecules. Anti-cancer drugs, in particular, have been developed from marine sponges, cyanobacteria and tunicates. Other applications include Ziconotide, a powerful painkiller

derived from the venom of cone snails. Vidarabine is an antiviral drug that was isolated from a marine sponge.

FUTURE

Heat processing: Radiofrequency heating has been also used because it has greater penetrating power.

Freezing methods: Pressure Shift Freezing, in this method, the water–ice transition is depressed under high isostatic pressure. Impingement Freezing consists of directing a jet or jets of fluid at the seafood surface at very high the seafood products. Magnetic freezing acts directly on water by orientating, vibrating, and/or spinning molecules to prevent them from clustering during cooling and thus promote supercooling. Hydrofluidization Freezing is a combination of immersion freezing and forced liquid fluidization. In this method, an aqueous solution at low temperature is used as a liquid refrigerant.

Thawing: New methods include High-Power Ultrasound Method, Low-Frequency Acoustic Thawing and Pressure-Assisted Thawing.

Quality assessment: New methods include Image analysis, Nuclear magnetic resonance (NMR), High resolution NMR, Low field NMR and MRI. New methodology on microbial examination are Electrical methods, Respiratory activity, Immuno-Based Technics and Molecular methods.

AQUATIC DIVERSITY IN AQUACULTURE – A WORLD OF OPPORTUNITY

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INTRODUCTION

It is a given that humankind, our future livelihoods and food security depend on our effective management of biodiversity. With aquatic food accounting for approximately 17 percent of animal protein consumed and with per capita consumption having increased from 9.0 kg in 1961 to 20.3 kg in 2017, the role of aquatic diversity should undoubtedly be part of this discussion, but is often left out of it. This presentation explores our understanding of the current status of aquatic diversity, in the context of its role in present day food systems, particularly in aquaculture, and identifies key opportunities to enhance its contribution to meeting the UN's Sustainable Development Goals. FAO focuses its work on a key component of aquatic biodiversity, namely aquatic genetic resources for food and agriculture (AqGR), which are identified as farmed aquatic species and their wild relatives within national jurisdiction. This work is led by the Fisheries and Aquaculture Division in close cooperation with the FAO Commission on Genetic Resources for Food and Agriculture (the Commission). The work on aquatic diversity follows on from the work that the Commission has done with terrestrial agriculture sectors and this facilitates some useful comparisons with the status and paths being followed in the nascent aquaculture sector relative to the more mature terrestrial food production sectors. In this presentation we highlight some properties of AqGR that differ from those of genetic resources used in crop and livestock production.

THE STATE OF THE WORLD'S AQUATIC GENETIC RESOURCES FOR FOOD AND AGRICULTURE: A SNAPSHOT OF THE CURRENT STATUS OF AQUATIC GENETIC RESOURCES

Until recently aquatic diversity used for food and agriculture was very much an unexplored resource. In 2019, FAO published the first ever global assessment of AqGR in The State of the World's Aquatic Genetic Resources for Food and Agriculture (the SoW-AqGR – FAO, 2019a) which was based primarily on country reports from 92 countries collectively representing 96 percent of aquaculture production. The SoW-AqGR represented a snapshot of the status of species used in aquaculture (and their wild relatives), for the first time including information below the level of the species (e.g. strains and varieties). Countries reported culturing nearly 700 different species including some not previously reported as used in aquaculture. The number of species used in aquaculture is steadily increasing, having risen by 27 percent in the decade from 2006 to 2016 (FAO, 2018). However, there is also a concentration of

production around a small number of species with the top ten species accounting for 50 percent of global production volume. The SoW-AqGR is broad in nature covering the status of resource use, drivers and trends of use, conservation (in situ and ex situ), stakeholders, governance, capacity building and collaboration and cooperation. The SoW-AqGR identifies over 40 specific needs and challenges that need to be addressed to enhance our understanding and management of AqGR. One major initial finding of note was the need for a standardized terminology and nomenclature to classify and describe AqGR, especially below the level of the species. The SoW-AqGR attempts to address this need to some extent through introducing the concept of "farmed types" (such as strains of animals, varieties of plants and products of other genetic interventions) as descriptors of farmed AqGR below the level of species (Mair and Lucente, 2020). Notwithstanding the problem of standardized descriptions, the SoW-AqGR also identifies the paucity of information on AqGR as a fundamental constraint to an informed and responsible management of these resources.

A PROTOTYPE GLOBAL INFORMATION SYSTEM ON AQGR

To address this knowledge deficit FAO is developing a resource for its Members, in the form of a global information system on species and farmed types of AqGR. Using this system countries and stakeholders can report a range of information on the status of management of their cultured genetic resources, including information on distinctive characteristics of each farmed type (for example production performance, phenotypic characteristics and molecular-diagnostic characteristics), their estimated contribution to national production and the main reasons for their production. This information will be made publicly available and will contribute to fill the identified knowledge gap that is critical to inform decision-making on management of national and regional aquatic diversity. A prototype of the system will be released in late 2021 and, pending receipt of further funding, this will be upgraded to a fully-fledged global information system in 2022.

SUSTAINABLE USE AND CONSERVATION

In the SoW-AqGR, countries identified many on-going conservation programs both in situ and ex situ. In situ conservation is achieved primarily through aquatic protected areas but also through well-managed fisheries and even in some aquaculture settings. Ex situ in vivo gene banks (i.e. live collections) existed for nearly 300 species, mainly finfish, whilst ex situ in vitro gene banks (primarily cryopreserved sperm banks) covered around 130 species. The SoW-AqGR identified that all cultured species still exist in the wild. This contrasts with terrestrial agriculture where the progenitors of some modern farmed species have gone extinct, such as the auroch (*Bos primigenius*), the ancestor of modern-day cattle (Park et al., 2015). Many other livestock species are threatened with extinction including the African wild ass (*Equus africanus*), the wild Bactrian camel (*Camelus ferus*), and the wild water buffalo (Bubalus arnee) (FAO, 2019b).

The SoW-AqGR did not identify the priority species for conservation nor provide information on the overall conservation or at risk status of cultured species. The authors carried out a subsequent analysis (Lucente et al, 2021) of cultured species listed in the IUCN red list (https://www.iucnredlist.org/). This analysis of a total of over 440 farmed species showed that 13.5 percent of those species that had been evaluated are listed as under threat or near threatened in the wild. This includes some important aquaculture species such as silver carp (*Hypophthalmichthys molitrix*), the striped catfish (*Pangasianodon hypophthalmus*) and even the common carp (*Cyprinus carpio*), one of the top ten globally cultured species. This

highlights the need to be aware of the overall conservation status of important cultured species, even those cultured in large volumes.

The majority of aquaculture species have been domesticated in the last 3-4 decades (Duarte et al, 2007) which again is in contrast to the major plant and animal species used in terrestrial agriculture which have been domesticated for up to 10,000 years. Due to this relatively recent domestication, levels of genetic diversity in most aquaculture species are very high, similar to those in wild relatives. This is in contrast to many long-domesticated species used in terrestrial agriculture where levels of genetic diversity are significantly reduced compared to their wild ancestors. This is most likely due to multiple genetic bottlenecks for example caused by selection processes by early farmers and by founder effects. Also in crops, breeding for maximum monoculture yield has significantly reduced crop genetic diversity (Chacón-Labella et al., 2019).

However, there are numerous studies that have identified loss of genetic variation (allelic diversity and in some cases also levels of heterozygosity) in domesticated farmed types of aquaculture species, even over just a few generations of captive breeding (Evans et al, 2004, Li et al 2004 and 2007, and Lundrigan et al, 2005). This loss of variation is due to founder effects, such as small base population size and poor genetic management, such as maintenance of low effective population sizes caused by the use of small numbers of broodstock and/or unbalanced sex ratios. There are large sectors of aquaculture, particularly in the developing world, and including some of the major aquaculture species, where management of genetic diversity within important seed supply systems is sub-optimal or completely absent. In these systems the focus in generally on supply of the quantity of seed with scant attention to the long-term genetic quality of that seed. Retaining high levels of genetic diversity in domesticated aquaculture species is fundamental to the future resilience and adaptability of aquaculture farmed types (for example to future aquaculture systems and to the challenges posed by climate change) and to optimizing the potential for future genetic improvement. These high levels of genetic variation in aquaculture species are a major factor in the high potential for genetic gain in selective breeding of aquatic species with gains for quantitative traits, such as harvest weight, of well over 12 percent per generation being realized (Gjedrem and Rye, 2018). This is in contrast to the less diverse livestock species where selective breeding based on phenotypes typically yields gains of less than 5% per generation in quantitative traits, although these rates of gains may be increased through integration of genomic selection into breeding programmes (Georges et al., 2019; Houston et al., 2020). Typical genetic gain in crop species are even lower, at less than two percent per generation (Cobb et al, 2019, Jighly et al, 2019 and Xu et al, 2017).

With aquaculture still being a relatively young sector of food production and domestication of most cultured species having started only recently, we have a window of opportunity to put in place genetic management systems that will retain genetic diversity through seed supply systems and particularly in major breeding centres. However, this needs to be happen quickly, preferably within the next one to two decades, if we are to avoid irreversible loss of diversity. At present, it is usually possible to reintroduce genetic diversity into cultured farmed types by recovering diversity from the wild (assuming genetically diverse wild relative stocks remain extant). However, as farmed types are developed and become better adapted to our culture environments through domestication selection and targeted selective breeding, introducing wild diversity will be less feasible as it will result in a degree of reversal of genetic progress. It is thus important to raise awareness among key stakeholders of the issues around genetic management within seed supply systems and the negative consequences of poor management. To generate real action, monitoring systems must be implemented and supported by tools such as DNA testing to assess levels of genetic variation through the seed supply chain, to identify weak links in seed supply and introduce targeted implementation of good genetic management practices.

GENETIC IMPROVEMENT

It has previously been estimated that less than 10 percent of global aquaculture production is based on farmed types derived from well-managed selection programmes (Gjedrem et al. 2012). The SoW-AqGR further identified that 45percent of farmed types reported by countries were essentially wild types and that only around 26 percent of species across all countries were subject to selective breeding. Furthermore, 45 percent of countries reported that selective breeding did not contribute to any significant extent to their national aquaculture production. There is ample evidence for the benefits of selective breeding and that well managed breeding programmes can deliver strong returns on investment. Such breeding programmes are having a major impact on global production of some species such as salmonids and shrimp. However, the uptake of selective breeding for the development of improved farmed types in global aquaculture is low and advancing slowly, especially for low value species and in developing countries. In this regard aquaculture lags far behind terrestrial agriculture where improved varieties and breeds are ubiquitous. The reasons for this slow uptake are manifold and include: lack of appreciation of the scale of benefits that can arise from genetic improvement; lack of engagement of the private sector and private investment; absence of long-term public support; perceptions that breeding programmes must be large scale and resource-intensive; challenges in protecting the intellectual property arising from breeding programmes; perceptions of negative impacts of selectively bred fish (including confusing them with GMOs); and lack of human resource and infrastructure capacity to implement breeding programmes. Selective breeding is considered as a traditional approach to genetic improvement but generally it should be considered as the core technology forming the basis for the long-term development of farmed types for aquaculture. There have been major advances in modern molecular approaches to genetic improvement including marker-assisted selection and genomic selection. However, these should not be considered as alternatives to well managed selective breeding programmes, given that such programmes take an essential long term approach to managing pedigrees and controlling genetic variation. New generation molecular techniques should be considered primarily as mechanisms to add value to selection programmes and to improve their efficiency, especially for traits that are difficult to measure.

Widespread adoption of selective breeding across major aquaculture sectors could have a dramatic impact on production efficiency and make a major contribution to the sustainable growth of aquaculture production. It is thus of critical importance to address the constraints to implementation and delivery of benefits from selective breeding.

A GLOBAL PLAN OF ACTION

Based on the key findings of the SoW-AqGR, the Commission requested FAO, in consultation with its members and the Commission on Fisheries, to prepare a Global Plan of Action (GPA) to address the principal needs and challenges identified in the SoW-AqGR. Following a series of five regional workshops and input from a range of bodies, FAO has prepared a draft GPA. This GPA will be considered by the 18th Session of the Commission in late September and, if endorsed, may be adopted by the FAO Conference towards the end of 2021. The GPA will be a voluntary and non-binding instrument to promote and focus attention and resources on the conservation, sustainable use and development of AqGR, at national, regional and global levels. It will be a rolling document that can be updated in line with any follow up that the Commission considers necessary. Its initial time horizon is ten years (concordant with the expected implementation of global assessments). The GPA identifies four priority areas of action on AqGR:

1. Characterization, inventory and monitoring

2. Conservation and sustainable use

3. Development of AqGR for aquaculture

4. Policies, institutions, capacity building and cooperation

Strategic priorities and specific actions are identified under each of these priority areas. Once adopted, a monitoring system will be developed including the identification of key indicators of progress against the GPA. The abovementioned global information system will be fundamental to the effective implementation and monitoring of the GPA. This presentation will identify some of the strategic priorities and actions included in the GPA to address the key issues outlined above with regard to the conservation, sustainable use and development of aquatic diversity used in aquaculture.

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CURRENT STATUS AND ISSUES FOR SUSTAINABLE MARINE AQUACULTURE IN JAPAN

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INTRODUCTION

Aquaculture production has been growing worldwide. As a whole, the capture-based fishery amount of production reaches the limit after the latter half of 1980s. Growing of aquaculture industry has been providing the deficit of the supply against increased demand. However, concerns have emerged regarding possible negative impacts on the environment, communities and consumers by growing of aquaculture industry. In 1995, “Code of conduct for responsible fisheries” (FAO) was adopted. Since then, the importance of utilizing fisheries and aquaculture resources responsibly is now widely recognized and prioritized (FAO, 2020). In addition, Sustainable Development Goal (SDG) 14 and other goals relevant to fisheries and aquaculture. Stakeholders related to aquaculture industry become aware of importance to promote sustainable and responsible aquaculture production.

STATISTICS OF AQUACULTURE PRODUCTION IN JAPAN

The amount of fisheries production including capture-based, marine aquaculture and inland aquaculture in Japan have been stable for past 5 years (2016-2020). In 2020, the catch was 3 million 157 thousand tons, the amount of harvested farmed marine products was 967 thousand tons, and 51 thousand tons of farmed freshwater fish was produced. Mariculture accounts for 23 percent of total amount of production. The mariculture production consists of fishes, shellfish (abalone, oyster) and seaweeds (kelp, Wakame, laver). Marine fish farming production was around 250 thousand tons, it was accounts for 25 percent of the marine aquaculture production. 35% of production was shellfish and 40% was seaweeds. This constitution of production has been stable for the past decade. On the other hand, the amount of marine fish farming is about 2 hundred billion JPY. The amount of marine fish farming accounts for 50 percent. Therefore, marine fish farming is classified as an important industry. In fact, the production of mariculture has not been growing both on quantity and the amount basis in Japan.

Fish species farmed in Japan consists of Seriola fish, such as yellowtail *Seriola quinqueradiata* and greater amberjack *Seriola dumerili*, account for 58% and red sea bream accounts for 27% of total farmed marine fish production, respectively. Therefore, the staple products of marine fish farming in Japan are yellowtail, greater amberjack and red sea bream. Recently, production of farmed blue fin tuna has been increasing. 18.5 thousand tons of blue fin tuna

were produced in 2020. Other fish species, such as coho salmon, tiger puffer, Japanese flounder, striped horse mackerel, grouper, and so on.

Thus, characteristics of marine fish farming in Japan is that a variety of species are farmed by many small-scale farmers.

WHY IS IT NECESSARY TO PROMOTE SUSTAINABLE AQUACULTURE?

Based on the benefit of fish eating for human health, fish eating has been spreading on a world-wide level. This results in increase of demands for fisheries resources. If the excessive fishing is done to supply fisheries products match to the demand, decrease of fisheries resources might be occurred.

Aquaculture is feasible for stable supply, quality control and guarantee product's safety in comparison with wild fish. Especially, fish farmers can supply farmed fish that is poor in natural resources and year-round. Edible fish can be produced without influence on natural resources if artificial seed are used. Sustainable aquaculture would become more important as supplier of animal protein sources for human consumption in the future. On the other hand, concerns have emerged regarding possible negative impacts on the environment, communities and consumers by growing of aquaculture industry. Therefore, it is necessary to do various activities that can solve those concerns for growing aquaculture industry.

On performing aquaculture activities, we should aim for achievement of sustainable and responsible aquaculture production by confirming such important aspects as protection of natural stocks, conservation of the environment, and improvement of consumer trust.

CRITICAL FACTORS FOR ACHIEVEMENT OF SUSTAINABLE AQUACULTURE PRODUCTION

"Code of conduct for responsible fisheries" and the accompanying documents (technical guidelines for responsible fisheries) issued by FAO provide guidance to achieve sustainable and responsible aquaculture. Japanese fish farmers have been put in a difficult situation to fully cope with the guidance. The difficulties depend on the problems of characteristics of aquaculture and managing situation in Japan, and we must develop various technologies arriving at the solution of problems disturbing promotion of aquaculture. It is considered that the critical factors for achievement of sustainable aquaculture production in Japan are following;

1) Good quality seed
2) Increase of competitiveness
   - Decline of production cost
     - ✓ Aqua-feed and fish health management
3) Aquaculture environment and ground
4) Product quality and safety

PROBLEMS ON SEED

In order to produce edible fish without influence on natural resources, it is necessary to use artificial seed in aquaculture. A full complement of seeds have been provided by artificial seeds in red sea bream, coho salmon, tiger puffer, Japanese flounder and grouper and so on. However, captured wild juvenile fish have still used as seed in blue fin tuna, yellowtail, and

greater amberjack. It is necessary to develop the technology to produce artificial seeds and supply enough in these species. Further scientific studies on prevention of initial mortality and malformation, improvement of feed organism production system, breeding and development of suitable diet for brood stock are needed.

PROBLEMS ON AQUACULTURE FEED

The cost of feed accounts for around 52 % of production cost in mariculture. Recently, demand for fishmeal has been increasing as the aquaculture production is increasing. On the other hand, fishmeal supply has been decreasing due to decrease of catch of material fish. As a reason, price of aquaculture feed has been increasing. It is considered that the recovery of resources for fish meal material cannot be forthcoming. Therefore, fish farmers are recommended to use manufactured feed (dry pellet) that contains decreased fishmeal. It has been studying on the development of low or non-fish meal diet in yellowtail and red sea bream in Japan, however, with limited success. In those studies, plant proteins, such as soybean meal, corn gluten meal were used as protein sources. Plant proteins are containing various anti-nutritional factors such as trypsin inhibitor, phytic acid, lectin and so on. These anti-nutritional factors can be removed by heating, extraction by water or alcohol. It has tried to use trash fish and/or waste from processing factory as aquaculture feed. But these materials have not yet put into practical use. In addition, Japanese farmers of bluefin tuna, seliola fish, red sea bream feel strong resistance to use low fishmeal diet due to concerns on growth performance, matching to the consumer's demand of product quality.

PROBLEMS ON HEALTH MANAGEMENT

Infectious diseases occurred in intensive aquaculture is a serious problem for achievement of sustainable aquaculture. Outbreaks of infectious diseases affects to the production cost and is worried about spreading the diseases to wild fish, impact of drug use on environment or food safety. Act on Securing Quality, Efficacy and Safety of Pharmaceuticals, Medical Devices, Regenerative and Cellular Therapy Products, Gene Therapy Products, and Cosmetics (Act No. 145 of 1960) has been enforced and fish farmers must strictly obey. Enforcement of this low ensure product safety and prevention of occurrence of drug resistance bacteria. Fish farmers are recommended to use vaccine to prevent infectious disease, however, approved vaccines for fish diseases are limited. Therefore, systematic health management should be implemented to prevent disease outbreaks.

ENVIRONMENTAL CONSERVATION OF FARM SITE

In 1999, Sustainable Aquaculture Production Assurance Act (Act No.51 of 1999) has been enforced. By the low, aquafarmers are required submitting the aquaculture farm improvement plan described farming species, rearing density, monitoring plan of farm site environment, and counter measures when the results of monitoring don't satisfy the standards to local government, and obtaining approval from local governor. Aquafarmers obey this low and reduce environmental deterioration by mariculture.

PROBLEMS ON PRODUCTION SCALE

Aquaculture industry in Japan has been placed in a very awkward position. More than 90% of fish farms are small-scale and the management bases of those farmers are weak.

Therefore, it is difficult to invest their money in equipment and new technology led to increase of production cost. I think that size of business should be expand in order to strengthen their

management bases and then attempt to increase competitiveness and apply a strategic marketing.

This will lead to sustainably aquaculture production. Some technologies require a large amount of initial cost. It is difficult to apply those technology to small scale fish farm.

Many problems are remained to implement sustainable aquaculture, however, I consider that structural reform and development of new technologies lead to contribution of sustainable aquaculture in Japan.

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INTERNATIONAL SYMPOSIUM ON FISHERIES AND AQUATIC SCIENCES

EGE UNIVERSITY FACULTY OF FISHERIES, İZMİR

Sustainable Aquaculture and Healthy Production

FISH MEAL REPLACEMENT BY MEALWORM (Tenebrio molitor) LARVAE MEAL IN DIETS FOR RAINBOW TROUT, ONCORHYNCHUS MYKISS

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ABSTRACT

The study was aimed to determine effect on the growth performance and intestinal histomorphology of the Rainbow trout (*Oncorhynchus mykiss*) fed diets with mealworm (*Tenebrio molitor*) larvae meal at different levels such as 10%, 20% and 30%. In this study, total of 360 rainbow trout individuals (34.26±0.99 g) for 4 treatments as three triplicates (30 for each) were used. Treatments performed in 12 trial tanks (112x112 cm square with depths 40 cm). The fish fed by hand 2.5% of body weight three times a day for 90 days. At the end of study, growth performance and intestinal histomorphology were significantly affected by dietary *Tenebrio molitor*. In feeding with diet containing 20% and 30% *Tenebrio molitor* meal, the growth performance decreased but intestinal villi length increased. We can say that *Tenebrio molitor* meal at level of 10% can be used instead of fishmeal without adversely affecting growth performance. However, future studies should be expanded by being use partially defatted *Tenebrio molitor* larvae meal.

Keywords: Trout, insect meal, growth, intestinal histomorphology

EFFECTS OF PROBIOTIC SUPPLEMENTATION ON GROWTH PERFORMANCE IN JUVENILES OF MEAGRE (Argyrosomus regius)

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ABSTRACT

During the past two decades, using of probiotics has been widely increasing in aquaculture due to the increase in important parameters such as feed efficiency, feed conversion ratio, growth, survival rate, and digestive enzyme activities as well as its beneficial effects on the anti-nutritional factors contained in the ingredients and strengthening immunity. The aim of this study was to investigate the effects of administration of probiotics (Lactobacillus casei, L. plantarum, Rhodopseudomonas palustri and Saccharomyces cerevisiae) in juveniles of meagre (Argyrosomus regius) growth performance. In this study, meagre juveniles of were fed with 2 different diets which supplemented with probiotic (15 ml.kg-1), however, no probiotic was performed to the control group. Each diet was fed to triplicate group of fish (9,76±0,55 cm; 9,25±0,95 g). After 50 days feeding period, growth performance, survival rate, feed conversion ratio (FCR), specific growth rate (SGR) and total protease activity were investigated. At the end of feeding trials, significant differences were recorded in growth performance and FCR ($p<0.05$), whilst there were no significant differences on survival rate and SGR between experimental groups ($p<0.05$). In similar with, specific activities total protease was found significantly higher ($p<0.05$) in probiotic supplemented group compared to the control. It is concluded that supplementation of probiotic significantly affected and positive developments in not only growth parameters but also protease activity in meagre juveniles.

Keywords: Probiotic, Growth performance, total protease, meagre, *Argyrosomus regius*

THE EFFECTS OF DIFFERENT SALINITY ON SURVIVAL AND GROWTH OF JUVENILE PLATY (Xiphophorus maculatus)

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ABSTRACT

Growth and survival of juvenile platy (Xiphophorus maculatus) were determined at salinities 0, 6, 12 and 18 ppt in 3 months duration. Juvenile platy were able to survive and grow at salinities ranging from fresh water (0 ppt) to salty water (18 ppt). Fish reared at 18 ppt in experiment had a specific growth rate of 6.02±0.03 %/day and there were significant differences between all groups of specific growth rate (SGR) and weight gain (WG) ($p<0.05$). In the end of the experiment, weight gain was determined 0.160±0.002 g, 0.182±0.001 g, 0.195±0.005 g and 0.224±0.003 g reared at 0, 6, 12 and 18 ppt, respectively. There were no significant differences between all groups of survival rate and feed conversion ratio ($p>0.05$). Variable results at different salinities ranging from 0 to 18 ppt were not influence survival.

Keywords: Platy, *Xiphophorus maculatus*, salinity tolerance, growth, survival

INTRODUCTION

The platy *Xiphophorus maculatus* (Günther, 1866), native to fresh and brackish waters of Mexico, Belize Guatemala and Honduras, is one of the famous tropical ornamental fish in the world. *X. maculatus* is ovoviviparous (i.e. livebearing), with insemination occurring by the males' gonopodium. The species has many colour varieties – red, black, blue, yellow, wagtail, tuxedo, neon and many more. The size of adult specimens of *X. maculatus* differ from 4-6 cm (Davoodi and Raisi, 2019; Maulana et al., 2020).

For fishes, salinity is one of the abiotic factor that can exert a strong selective force effecting habitat quality, growth, survival and reproduction (Layman et al., 2000). Livebearers as molly, guppy show physiological adaptations that enable them to tolerate and survive extreme salinity levels and fluctuations (Timmerman and Chapman, 2003).

The aim of this study was to assess to response of the growth and survival of juvenile platy at salinities ranging from fresh water (0 ppt) to salty water (18 ppt).

MATERIALS AND METHODS

Experimental System. Four-week-old 180 specimens *Xiphophorus maculatus* fry with a weight range of 0.016±001 g were reared in the Sinop University Fisheries Faculty Laboratory, Turkey. Low salinities were obtained by diluting seawater with fresh water. The twelve plastic aquariums of 11.5 l capacity were operated at salinities of 0, 6, 12 and 18‰.

Growth Trials. The preadapted fry, stocked at 15 fish per plastic aquarium, three replicates per treatment, were fed twice a day (09:00, 15:00) for 2 months with four diets till satiation. At the end of the experiment, the mean weight gain and survival of each salinity treatment were determined. Analyzed parameters included:

Weight increase (g) = Final live weight (g) – Initial live weight (g) (Eq.1)

Spesific Growth Rate (%) = $\{(\ln Wf\ (g) - \ln Wi\ (g))/\ t - t_i\} \times 100$ (Eq.2)

In the equation; Wf is the final weight (g), Wi is the initial weight (g) and (t-ti) is the length of the experiment (day).

Feed Conversion Ratio = Total feed intake (g)/Total weight gain (g) (Eq.3)

Survival Rate (%) = (Final number of fish/İnitial number of fish) × 100 (Eq.4)

Statistical Analysis. Statistical analyses were carried out using "Minitab Release 17 for Windows" software at 0.05 level of significance. The data shown as mean ± standard error were subjected to one-way variance analysis (ANOVA). When ANOVA indicated significant difference between the treatments for a given parameter, then the means were compared with Tukey test.

RESULTS

Fish Behavior: The fish successfully acclimatized to the respective salinities. Swimming and feeding behavior were normally in all salinities. Fish kept in salt water ingested more food than those in fresh water and better coloration.

Growth and Survival of juvenile Xiphophorus maculatus. The difference in initial live weights determined for different groups was not significantly different ($p>0.05$). The experiments lasted for 3 months (90 days) and the growth parameters were determined at the end of the experiments. Mean individual live weight gains, specific growth rates, feed conversion rates and survival rates of the experimental groups determined at the end of the experiment were given in Table 1. When the weight gain and SGR values were examined, it was determined that the difference between 6 ppt and 12 ppt was insignificant ($p>0.05$), but there was difference between 0 ppt and 18 ppt ($p<0.05$). When the survival rate and FCR data were examined, it was determined that the difference between all treatment groups was insignificant ($p>0.05$) (Table 1).

Table 1. Growth parameters, feed conversation ratio (FCR) and survival rate of platy (*Xiphophorus maculatus*) fed in different salinities for 90 days (n= 45) (mean± standard error).

	Treatment Groups			
	0 ppt	**6 ppt**	**12 ppt**	**18 ppt**
Initial weight (g)	0.016±0.00	0.016±0.00	0.016±0.00	0.016±0.00
Final weight (g)	0.176±0.01^{a}	0.198±0.01^{b}	0.211±0.01^{b}	0.240±0.01^{c}
Weight gain (g)	0.160±0.01^{a}	0.182±0.01^{b}	0.195±0.01^{b}	0.224±0.01^{c}
Spesific growth rate (%)	5.33±0.02^{a}	5.59±0.01^{b}	5.73±0.04^{c}	6.02±0.03^{d}
Feed conversation ratio	0.905±0.17^{a}	1.29±0.25	1.88±0.59	1.72±0.32
Survival rate (%)	100.00±0.00	100.00±0.00	100.00±0.00	100.00±0.00

Values (mean ± standard error of means for triplicate) with different superscripts in a row are significantly different.

DISCUSSION

A number of studies on the effect of salinity on growth and survival of a variety of fish species exists (Morgan and Iwama, 1991).

In general, Xiphophorus maculatus was capable of surviving and growing in salinities ranging from fresh water to seawater. In spite of the wide range of salinities tolerated by juvenile Xiphophorus maculatus, the best growth rate was obtained at the 18 ppt. Similarly, Poecilia latipinna juveniles performed best at 10-15 ppt (Kumaraguru Vasagam et al., 2005). In Tilapia rendalli, Kang'ombe and Brown (2010) observed that fish in the 10‰ treatment significantly larger grow ($p< 0.05$) than those in 5‰, 15‰, and freshwater. In the current study food conversion efficiency had the highest values at salinity 18 ppt. Similarly, Kumaraguru Vasagam et al. (2005) suggested that highest FCR was observed at 10-30 ppt and Nahar et al. (2016) determined the highest FCR was observed at 15 ppt. In conclusion, in all treatments were suggested that juvenile Xiphophorus maculatus could survive and growth at wide salinity values (0, 6, 12 and 18 ppt).

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STUDYING OF TRIACYLGLYCEROL AMOUNTS IN CHLORELLA VULGARIS NIVA-CHL19 USING FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR) METHOD

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ABSTRACT

Microalgae can change their biochemical composition by increasing their lipid and carbohydrate accumulation under stress conditions. Many microalgae species accumulate neutral lipid (triacylglycerol, TAG) which is an important product for biodiesel production in response to changes in environmental stresses.

In this study, it was aimed to determine the changes in the amounts of TAG in the Chlorella vulgaris NIVA-CHL19 under different nitrogen concentrations by using Fourier Transform Infrared Spectroscopy (FTIR) method. *Chlorella vulgaris* NIVA-CHL19 was obtained from The Norwegian Culture Collection of Algae (NORCCA). Stock culture of C. vulgaris was cultivated in BG-11 medium and all experiments were carried out BG-11 culture mediums which contained different nitrogen concentrations (100%, 50%, 25% and 0%). Flasks were mixed and continuously illuminated. Each experiment was performed in triplicate. The optical density of microalgae cells was measured by a UV-vis spectrophotometer at 680 nm. Amounts of the cell, dry weights and chlorophyll contents of the experimental groups were determined. Microalgae biomass was centrifuged 10 min. at 10000 rpm for FTIR analysis and dried in a lyophilizer. FTIR spectra ratio of triacylglycerol (1744 cm-1) to amide I (1652 cm-1) was used for the calculation of TAG levels. Besides dried microalgae were used to determined oligosaccharide (1145/1652) and polysaccharide (1045/1652) levels in all groups. *C. vulgaris*, which is cultured under nitrogen deprivation conditions, accumulated more TAG, oligosaccharide and polysaccharide than the control group. TAG can be easily converted to biodiesel using transesterification. Increasing the amount and efficiency of TAG contained in microalgae is high importance for economic production. It was supported by this study that nitrogen stress applied to C. vulgaris increased TAG accumulation and provided an advantage in biodiesel production.

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Keywords: Chlorella vulgaris NIVA-CHL19, nitrogen stress, triacylglycerol, FTIR

THE FIRST COMMERCIAL SCALED GROWTH PERFORMANCE COMPARISON OF RAINBOW TROUT (Oncorhynchus mykiss) CULTURE IN CONCRETE AND EARTHEN PONDS

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ABSTRACT

Earthen ponds have been used by trout farmers for almost more than five years to reduce investment costs and the live food opportunity to support the commercial feed during the production period. This study was compared the growth performance of rainbow trout (*Oncorhynchus mykiss*) which is the most popular freshwater species for Turkey in concrete ponds that may be mentioned as a traditional method and in the earthen ponds that may be called a partly new system for fish farmers. After the hatchery period, 300.000 rainbow trout whose average live weight was 1.65±0.11 g were transferred into the concrete ponds and fed with commercial trout feeds *ad libitum* and five times a day until the fish reached 10 g. Then the fish were randomly spared into two experimental groups with two replicates as the first group was the concrete pond (CP) and the second one is the earthen pond (EP) and were continued to be fed *ad libitum* but three times a day until the end of the study. During the study the average temperature was measured 14.46 ± 2.37 °C , average dissolved oxygen was measure 6.74 ± 0.39 mg/L and pH was measured 7.73 ± 0.37. After 8 months of trial, while the fish in CP reached an average of 228.61±6.85 g, the fish in EP reached 200.76±4.95 g. The feed conversion rate (FCR) and specific growth rate (SGR) were calculated for CP as 1.13±0.27 and 1.81±0.48 and as 0.82±0.34 and 1.90±0.58 for EP respectively. The results showed that the fish that was produced in CP can reach better growth performance than the fish in EP ($p<0,05$); but on the other hand, EP culture can help to reduce feeding costs in commercial productions.

Keywords: Rainbow trout, *Oncorhynchus mykiss*, growth performance, earthen ponds, concrete ponds

POTENTIAL IMPACTS OF COVID-19 ON TURKEY'S AQUACULTURE SECTOR AND COPING STRATEGIES

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ABSTRACT

Chub 2020 has been started with a worldwide pandemic. Corona Virus (COVID-19) has been spread in many countries in months. Most of countries has been locked down due to COVID-19's incubation period and high infectiousness and social distance has become a new life order in many societies. Fishery sectors' operations is continued thanks to be given lockdown exception for our sector by government and persistence of incentives. Meanwhile, producers are encouraged to supply first quality seafood with best prices in domestic market with incentives such as 2 TL/KG for direct sales to Retail Sector. Also, "healthy food" perception has contributed for supplying first quality goods to domestic market. On the other hand, when the Turkish Seafood sector are examined, the market has export-focused growth. Also, Turkish Seafood Market has made an annual turnover more than 1 billion USD and the market have had the same success in 2020. In 2020, export quantities of Turkish Salmon Trout farmed specially in Black Sea region has been increased 50%. In addition, Turkey as world's top producer of Sea bream and Sea bass has protected its exports despite to all logistics and organizational problems. Nowadays, Turkey as a leading country for hygiene and quality standard fights against COVID-19 thanks to its aquaculture farms, factories, hatcheries, and facilities. In this study, potential effects of COVID-19 on Turkish Seafood Sector and Turkish Government Policies against COVID-19 are highlighted and the policies' potential effects are discussed. Also, suggestions for ensuring the continuity and growth of the aquaculture sector have been made.

Keywords: Covid-19, Turkey, Turkish seafood market, Turkish seafood sector

SOFT-SHELL CRAB FARMING

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ABSTRACT

Crabs are creatures that has highly meat quality loved in the world market and consumed as a luxury food. Crabs are mostly marketed as soft-shelled due to their high value and demand in the market. Soft-shelled crabs that have just left their shells to grow and are caught and marketed. The fact that it can be consumed completely, can be harvested earlier than hard-shelled crabs, and has higher demand and market value has recently increased the interest to soft-shelled crab farming. Only a few of the crab species are reared as soft shells. Most of them are Scylla serrata, Portunus pelagicus, Callinectes sapidus species and are grown continuously and regularly. Soft shell crabs are produced in three types of growing systems as open, semi-closed and closed systems. Crabs are kept in these systems until they shed their shells, harvested and sold to various countries or nearby restaurants. It will be profitable to reared crabs, which have economic value in Turkish seas, as "soft-shell", which already has a place in the world market, in order to add a new species to aquaculture and the country's economy, and to create employment by creating a new business line.

Keywords: Crab, culture, farming, rearing, soft-shell

VACCINATION INJURIES

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ABSTRACT

Aquaculture is developing sector in Turkey. Total production of fish reached to 293.000 metric tons in 2020. For prevention of the diseases in Sea bass (*D. labrax*) oily adjuvanted or without adjuvanted injection vaccines used against classical vibriosis. Oily adjuvanted monovalent formalin inactivated *L. garvieae* vaccine or *L. garvieae*, *Y. ruckeri* and *L. anguillarum* antigens containing three valant oily adjuvanted or without adjuvanted injection vaccines are used in rainbow trout culture in Turkey.

Accidentally self-injection of the fish vaccines to hands or fingers may be observed. This may cause pain, reddening/discoloration and swelling at injection site extending to the arm may occur. However, some anaphylactic and allergic reactions, nausea, listlessness and fewer may develop. Injection of oily adjuvanted vaccines to inside of joint capsule of fingers may cause to necrosis and lead to amputation.

A device that fitted to repeater injector and protective glove must be used to prevent self-injection. If accidentally injected fish vaccine should go to surgery immediately with label of the fish vaccine. Adrenaline, antihistaminic and cortisone ampules may life saver and should be kept in the farm.

Keywords: Fish vaccine, self-injection

TRENDS AND OPPORTUNITIES IN SEAWEED AQUACULTURE IN TURKEY AND INTRODUCTION OF INTERNATIONAL COORPORATION PROJECTS BETWEEN EGE (TURKEY) AND FURG (BRAZIL) UNIVERSITIES AND EU H2020 COST ACTION "CA20106"

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ABSTRACT

Seaweeds (or macroalgae, sea vegetables) are amazing aquatic plants that have been widely used for wide range of industries. Today, Seaweed Industry uses approximatelly 32.1 million tonnes of wet macroalgae annually with annual value of 12.6 billion USD. The Industry uses approximatelly 220 seaweed species and most commonly culture genera are also found in Turkey. In this presentation, Potential of Seaweed Aquaculture in Turkey with International coorporation projects related with seaweed aquaculture and its benefits for food security and environmental health to share the trends and the opportunities in the area will be introduced. The potential of seaweed aquaculture in Turkey was determined from the data of extrapolated ecosystem services table found in World Bank Group Report and from the data developed by Turan and Neori. Turkey has a total of 462,000 square km area called exclusive economic zone (EEZ) is a sea zone that maybe expended more in the view of the Turkish claim. Turkish EZZ has a high potential for seaweed aquaculture with 462,000 tons dry seaweed annually. This amount of seaweed can supply 46,200 tons of protein for human and animals, 9,200 tons of nitrogen and 924 tones of phosporus can be removed, 124,740 tons of carbon can be assimilated, with 1,155,000 MWH bio-energy, 924 square km land sparing and 0.462 cubic km freshwater sparing. Or, when we calculate from the costline formulation, it was found that Turkey has the potential to produce 920,000 dry seaweed annually and this result makes double all the benefits calculated above. Turkey is still highly dependent on imports of macroalgae and their products. However, its potential on seaweed aquaculture is enormous due to the natural resources necesarry for intensive seaweed aquaculture for food security, income generation and environmental health.

Keywords: Seaweeds, macroalgae, aquaculture, food security, environmental health

UP-TO-DATE SEAWEED AQUCULTURE STUDY RESULTS AT EGE UNIVERSITY FISHERIES FACULTY AQUACULTURE DEPARTMENT

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ABSTRACT

Seaweeds (or macroalgae, sea vegetables) are amazing aquatic plants that have been widely used for human food, animal feed, including aquafeeds, medicine, pharmacueticals, nutraceuticals, cosmetics, agrochemicals, etc. Today, Seaweed Industry uses approximatelly 32.1 million tonnes of wet seaweed annually with annual value of 12.6 billion USD (FAO, 2020). The Industry uses approximatelly 220 seaweed species and most commonly culture genera are: Laminaria, Undaria, Macrocystis, Sargassum, Porphyra, Euchema, Kappaphycus, Gracilaria, Monostroma, Ulva which are or similar species of the genus also found in Turkey. In this presentation, the results of the studies were performed between 2000 and 2021 at Ege University, Fisheries Faculty Aquaculture Department will be presented. Important seaweed species including Petalonia (or Juvenil Laminaria), Sargassum, Porphyra, Gracilaria, Ulva and many more were isolated from Izmir and on the coast line of the country. Begining from 2000, vegetative or sporofit cultivation studies were started. Mono- and co-cultivation studies of seaweeds were conducted at land-based and sea-based, such as IMTA (Multi-Trophic Aquaculture Systems). From the studies, it was found that seaweed species, including Ulva and Gracilaria species can be cultivated at different aquaculture systems. Seaweeds are also efficient biofilters to treat aquaculture effluent by especially removing nitrogen and phosporus. Plus, They are nutritionally rich organisms that can be used as human and animal feed resources, including aquafeeds with high crude protein levels that can be evalated by changing environmental conditions. Since Turkey highly dependent on imports of seaweeds and their products, seaweed aquaculture should be established at industrial levels because the country has very rich in natural resources necesarry for intensive seaweed aquaculture, such as, sunlight, water, under-exploited coastlines and diversity of seaweeds that are abundant.

Keywords: Seaweeds, macroalgae, aquaculture, IMTA, biotechnology

SEQUENCE-RELATED AMPLIFIED POLYMORPHISM (SRAP) MARKER SYSTEM: AN APPLICABLE METHOD FOR STUDIES ON INVASION GENETICS OF FRESHWATER FISH

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ABSTRACT

Molecular tools can effectively be used in diagnosis, identification, management, and most especially detection of invasion pathways and originations of introduced species. It would provide helpful information for a better conception of the events essential for a successful colonization by comparing genetic differentiation of a species among its native and invasive habitats. PCR-based marker techniques, such as AFLP, RAPD and SSR have been used for studying genetic diversity, taxonomy and phylogeny of the species, but they are generally used for estimating more limited levels of genetic variation. Although the potential for these molecular markers to generate helpful data, researchers have been suspicious to use them resulting from some technical deliminations. Sequence-related amplified polymorphism (SRAP) is a newer genetic marker technique as compared to the other markers which was first used in Brassica oleracea, and since then there have been several studies in different taxa. Sequence-related amplified polymorphism can also be used for assessing invasion genetics of freshwater fish, as it is an easy, reliable, middle-yield, high-dominant total, and iterative way on genetic variation of different species. Depends on the rapidly growing body of the literature, the SRAPs could, and should, be applied to the subjects of population genetics of invasive fish species. The aim of this study was to reveal the potential of SRAP markers in invasion genetics of freshwater fish species. Results from SRAP products may prove to be significant for discovery of genetic polymorphism and variation on researchs in population genetics of non-native freshwater fish species.

Keywords: Genetic variation, molecular markers, non-native species, population genetics

BACTERIAL DISEASES AND USE OF ANTIBIOTICS IN SHRIMP CULTIVATION IN THE PHILIPPINES

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ABSTRACT

Cultivation of shrimp is among the most practiced aquaculture activities globally to meet the demand for aquatic animal food in domestic and international markets. In 2018, the Philippines ranked 10th as a major shrimp-producing country worldwide. Around 2% of the total aquaculture production of the Philippines in 2018 was contributed by shrimp, which is an important export species of the country. Shrimp is cultivated throughout the country, primarily in brackish water ponds using semi-intensive and intensive systems. The intensification of shrimp farming has resulted in the proliferation of diseases. In this study, we reviewed available articles on bacterial diseases and antibiotics used in shrimp cultivation in the Philippines. Luminous bacterial disease, red disease syndrome, filamentous bacterial disease, and acute hepatopancreatic necrosis disease (AHPND/EMS) were identified bacterial diseases in shrimp culture. Oxolinic acid**,** oxytetracycline, and chloramphenicol were among the most predominantly used antibiotics in shrimp cultivation to prevent or treat disease outbreaks.

Keywords: Antibiotics, bacterial diseases, Philippines, shrimp

INVESTIGATION OF HYSTEROTHYLACIUM SPECIES IN VARIOUS FISH SPECIES CAUGHT FROM THE AEGEAN AND THE MEDITERRANEAN SEA COASTS OF TURKEY

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ABSTRACT

Hysterothylacium species belonging to the Raphidascarididae family are the most widespread and diverse groups of marine ascaridoids. To date, 103 *Hysterothylacium* species have been reported from various fish species worldwide. However, there are few studies on the morphological identification and molecular characterization of *Hysterothylacium* species in marine fish from Turkish waters. Here, we aimed to investigate *Hysterothylacium* nematodes in various marine fish species caught from the Aegean and the Mediterranean Sea coasts of Turkey, to determine their prevalence, and to identify the *Hysterothylacium* species using combined the morphological and molecular techniques. For this purpose, a total of 555 fish specimens belonging to 18 different fish species were freshly sampled from fish markets between November 2020 to March 2021 and individually examined for the presence of *Hysterothylacium* nematodes. Among the sampled fish, only two fish species [*Scorpaena scrofa* (Aegean Sea) and *Pagellus erythrinus* (Mediterranean Sea)] were found to be infected with nematodes. All collected nematodes were washed with physiological saline and then individually cut into three parts. Anterior and posterior ends of the nematode were cleared using lactophenol solution for morphological examination. A total of 11 and 5 nematodes found in *S. scrofa* (15% 6/40) and *P. erythrinus* (12.5% 5/40), respectively were morphologically identified as *Hysterothylacium* spp. The overall prevalence of *Hysterothylacium* spp. was 1.98% (11/555). Genomic DNA from mid-body of each nematode was extracted and the ITS1-5.8-ITS2 (ITS) gene regions were amplified by PCR. All purified PCR amplicons were bi-directionally subjected to sequence analyses. Based on high-quality ITS sequence results, *Hysterothylacium* spp. specimens from *S. scrofa* and *P. erythrinus* were identified as *H. fabri* and *H. reliquens,* respectively. In conclusion, with this study supported by the Erciyes University Research Fund (grant number, TSA-2021-10891), *H. fabri* was morphologically and molecularly identified for the first time in *S. scrofa* caught from the Mediterranean Sea coast of Turkey. Moreover, *P. erythrinus* is the second host record for *H. reliquens* Turkish waters.

Keywords: *Hysterothylacium* spp., *Scorpaena scrofa, Pagellus erythrinus,* Molecular identification, Aegean and Mediterranean Sea coasts of Turkey

EFFECTS OF THE DIFFERENCES OF DIETARY PROTEIN CONCENTRATES ON THE GROWTH OF NILE TILAPIA FRY (Oreochromis niloticus)

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ABSTRACT

Decreased feed cost is exceptionally much craved in aquaculture and as a rule this can be done by lessening the level or substituting costly feed ingredients with cheaper ones without negative impacts on the growth. Four feeding experiments were conducted to investigate the effect and possibility of utilizing more than one protein source on the performance growth of Nile tilapia fry (*Oreochromis niloticus*) average weight of 2.3±1.02g for six weeks. Fifteen fry fish were stocked in glass aquaria (75X35X30 cm). Diets were formulated from diverse sources of plant proteins peanut meal (PM), sesame meal (SM), cottonseed meal (CSM) together with wheat bran (WB) and sorghum (S) as energy source feeds. . Diet 1 contained (PM) as the only protein concentrate source. Diet 2 contained equal amounts of (PM) and (SM), diet 3 contained equal amounts of (PM) and (CSM), whereas diet 4 contained equal amounts of all the three protein source concentrates in a proportion of 1:1:1. Fish in one aquarium were cleared out without food as a control treatment though each of the other four bunches of fish gotten one of the four experimental diets, formulated with distinctive combinations of plant protein concentrates but having the same protein level of 35%. Fish were fed at 5% of their weight per day (3 doses). Fish weight increased in all the treatments means the experimental diets were well accepted by the fish. At the end of the experiment results showed no significances different ($p \geq 0.05$) were observed between the diets. But diet 3 resulted in the highest weight gain (108.2±0.96%) and Food Conversion Ratio (2.27±0.39). Considering both diet cost and FCR, diet (3) was the best diet having the lowest feed cost per kilogram fish produced (284 SP/kg fish).

Keywords: Plant protein sources, *Oreochromis niloticus*, growth performance, diet cost

DETERMINATION OF ANESTHETIC EFFECT OF CLOVE OIL AND PHENOXYETHANOL IN JEWEL CICHLID (Hemichromis guttatus) FISH

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ABSTRACT

Jewel Cichlid (*Hemichromis guttatus*) is commercially important in the aquarium industry. Therefore, reducing stress during manipulations in production is an important issue. For this purpose, in this study, the reactions of these species belonging to cichlid family to two different anesthetic agents, clove oil and phenoxyethanol, were investigated. Different doses (0.5-1-1.5-2 ml) for both anesthetics have been studied in order to determine the most appropriate dose which can be applied to the fishes in a short period of time. The response of the fish to the anesthetics added to the test vessel filled with clean water was observed. The fainting and sobering behaviors of the fish were recorded on camera and a chronometer was kept for each phase in minutes-seconds. In this study, the average weight of 0.65 gr jewel cichlid were used. The study was three repetitions. As a result, 2 ml/l clove oil provided for fainting and sobering in 5 minutes ($p \leq 0.05$), and 1 m/l phenoxyethanol anesthesia provided for fainting and sobering in 4 minutes ($p \leq 0.05$).

Keywords: Jewel cichlid, *Hemichromis guttatus*, anesthetic, clove oil, phenoxyethanol

EFFECTS OF PROBIOTIC SUPPLEMENTATION ON GROWTH PERFORMANCE IN JUVENILES OF GILTHEAD SEA BREAM (Sparus aurata)

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ABSTRACT

The beneficial effects of probiotics include faster growth, higher survival rate, increased feed efficiency and feed conversion rate, and pre-digestion of the anti-nutritional factors contained in the ingredients. The aim of this study was to investigate the effects of probiotics (*Lactobacillus casei, L. plantarum, Rhodopseudomonas palustri* and *Saccharomyces cerevisiae*) in juveniles of gilthead sea bream (*Sparus aurata*) growth performance. In this study, juveniles of sea bream were used and fishes were fed with 2 different diets which supplemented with probiotic (15 ml.kg^{-1}). However, no probiotic application was applied to the control group. Each diet was fed to triplicate group of fish (5,75±0,5 cm; 2,39±0,5 g). After 60 days feeding period, growth performance, survival rate, feed conversion ratio (FCR), specific growth rate (SGR) and total protease activity were investigated. At the end of feeding trial, results showed significant differences in growth performance and FCR ($p<0.05$) between two groups. However, survival rate and SGR showed no significant differences ($p<0.05$). Similarly, in probiotic treatments the specific activities total protease significantly higher ($p<0.05$) in juveniles to which control group. In conclusion, it was determined that probiotic application affected significant increases and positive developments in growth parameters and total protease activity in juveniles of sea bream.

Keywords: Probiotic, growth performance, total protease, gilthead sea bream, *Sparus aurata.*

EFFECT OF DIFFERENT PROTEIN SOURCES on PROTEASE ACTIVITY OF DOCTOR FISH, Garra rufa (Heckel, 1843)

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ABSTRACT

Doctor fish, *Garra rufa*, is a detrivor highly valuable candidate species for ichthyotherapy usage and fish SPA centers. Recently, due to high demands in tourism and health sector, the studies focused on the artificial production technics of this species. In this study, captive-bred fish were fed with commercial flakes (43% CP) for two weeks. To determine the inhibitory effects of different protein sources (anchovy meal, chicken meal, krill meal, shrimp meal, soybean meal, soybean protein concentrate, corn gluten and wheat gluten) on proteases, fish were sampled and stored in -20° until *in vitro* assays. A modified *in vitro* method of Garcia-Carreno (1996) was used to determine inhibition effects of different protein sources. To get enzyme extracts, digestive tracts were separated and centrifuged in 16000 g, 30 mins, 4°C. Different feed ingredients and protease enzyme extracts were pre-incubated and the residual activity was measured. The extracts (20 µL) were incubated with protein solutions (20 µL) in HCl Tris buffer (500 µL) for 60 min at 25°C (pH 9.0). In the control group, same amount of distilled water was used instead of protein solutions in the mixture. Afterwards, 100 µL casein was added and the mixture was incubated for 120 minutes at room temperature. Finally, 500 µL TCA (120 gL^{-1}) was added to stop reaction and after centrifugation (12000 g, 5 min, 4°C) the absorbance was recorded at 280 nm (Alarcon et al., 1999). In the present study, the maximum inhibitory effect obtained from anchovy meal which has the highest animal crude protein (55% CP) ratio in among all tested ingredients. To get a detailed knowledge about the effect of different feed ingredients on enzymatic activity, the determination of the degree of hydrolysis and sequential analysis of protein hydrolysis products should be examined in the future.

Keywords: *Garra rufa*, protease activity, protein sources, inhibition ratio

THE IMPORTANCE OF SEA CUCUMBER IN INTEGRATED MULTITROPHIC AQUACULTURE (IMTA) AND ITS WORLDWIDE APPLICATIONS

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ABSTRACT

Integrated Multi-Trophic Aquaculture (IMTA) are aquaculture systems based on the use of waste from aquaculture production as food for another extractive species, and the production of the second or third species with economic value in the same production area. While diversifying the production of commercial fishery products in the IMTA system, it is aimed to minimize the effects of aquaculture production on the environment. In this modern and economical aquaculture system, which has become widespread in many countries in the world, common production of species such as fish-mussels, fish-sea cucumbers, fish-seaweeds, fish-sea sponges are observed. Sea cucumbers, which have the ability to consume particulate organic wastes of primary and secondary species cultivated, are among the prominent extractive species in IMTA applications. In addition to its superior success in consuming benthic organic matter load, its high commercial value makes it a sought-after species for IMTA applications. In this study, world practices and research on the use of sea cucumber in integrated multi-trophic aquaculture systems were examined, and its applicability was evaluated in Turkey, which is the leading European and Mediterranean country in aquaculture and produces approximately 293,175 tons sea fish per year.

Keywords: Sea cucumber, IMTA, aquaculture, extractive species

INTRODUCTION

In aquaculture areas, some undesirable environmental problems can be seen, as can occur during the process of other intensive production animal husbandry activities. Phosphorus, nitrogen concentration, organic matter load and suspended particles in water with varying proportions are the main causes of environmental pollution originating from the places where aquaculture is made (Yıldırım and Korkut, 2004). The most prominent of the cause of negative impact is environmental pollution due to the increase in inorganic nutrients caused by accumulating faeces, metabolic wastes and uneaten feed near fish cages and fish farms. (Morata et al., 2013). The increase in nutrients concentrated in the benthic zone occurs under the influence of many factors such as the species of cultured fish, the nutrient composition of the feed, amount and frequency of feeding, stock density in the cages, the depth of the water column, and chemical properties of the sediment in the seabed. In intensive marine fish farms, all the nutrients required by the fish are given through commercial feeds. However, while fish consume as much feed as they need, excess feed remains and accumulates in the environment as organic waste. Residual feed and faecal matter accumulated under and in the vicinity of the cages cause negative changes in the quality of the aquatic environment, in the physical and chemical structure of the sediment, and adverse ecological and economic consequences following the deterioration of the benthic zone. (Brooks et al., 2003) On average, 60% of the phosphorus (Sugiura, 2018) and 70%-80% of the nitrogen content of the fish feed, depending on the type of fish grown, remain in the environment without being consumed in fish farms. These nutrients cause accumulation of organic matter, which is called eutrophication, especially at the points where there is low water circulation (David et al., 2009). For extractive species such as molluscs, seaweeds and echinoderms, mesotrophic or eutrophic waters are natural environments for their normal life, feeding and growth (Lamprianidou et al., 2015).

While various solutions have been developed to minimize the environmental problems caused by aquaculture, Integrated Multi-Trophic Aquaculture (IMTA) has gained popularity as an alternative application in the fight against nutrient increase that causes eutrophication recently (Granada et al., 2015; Troell et al., 2009). In the production systems of IMTA, it is aimed to create a sustainable nutrient cycle within the system that two or more species representing different trophic levels. In this system, dissolved or particulate waste excreted by the first species form the nutrient material of other extractive species (Lamprianidou et al., 2015). Ensuring the conversion of excess feed and other metabolic waste that cannot be consumed in the system after feeding in the biological process keeps the nitrogen, carbon, nitrogen and phosphorus ratios of the environment stable and contributes to environmental sustainability by preventing plankton explosions (Figure 1).

It is desirable in terms of economic profitability to culture two or more species that are ecologically compatible and can live in similar environmental conditions without competing in an aquaculture system. Integrated Multi-Trophic Aquaculture (IMTA) is defined as a new generation of aquaculture that allows the highest profit yield and diversification of commercial production by enabling the cultivation of two or more species at different trophic levels together with its environmentally compatible system (Chopin et al., 2012; Neori et al., 2004). While this integrative approach offers a natural way to support nutrient recycling in aquaculture farms with maximum benefit, it supports the increase in economic profitability by enabling the commercial production of low trophic level and high market value extractive species within this cycle (Chary et al., 2020).

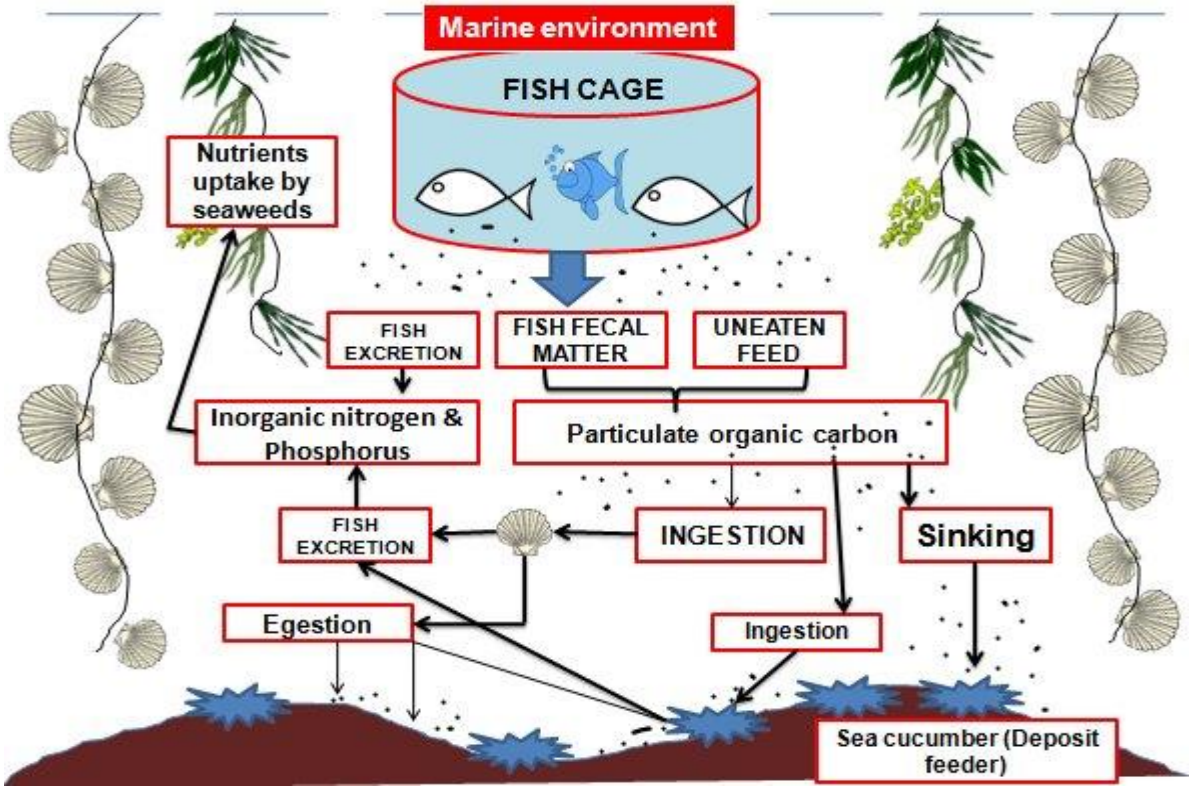

Figure 1. Schematic nutrient cycle in integrated multi-trophic aquaculture system (Jena et al., 2017).

IMTA SYSTEMS WITH SEA CUCUMBER

Sea cucumber species are one of the promising candidates for IMTA systems, considering that they consume sediment, detritus and organic matter in the benthic region to a significant extent with their feeding behavior and have high economic value throughout the world (Tolon et al., 2017). Benthic echinoderm sea cucumbers, which can consume high content of organic waste, excrement and waste feed produced by fish and crustacean species produced in aquaculture farms (Tolon et. al., 2017), have become an indispensable component of IMTA systems (Cranford et al., 2013).

The breeding of bivalves is developing rapidly, especially in China, and their dense populations produce excrement and bioaccumulation in quantities that can have adverse effects on the benthic environment. In the IMTA model, which consists of sea cucumbers grown in suspended cages under bivalves or directly on the sea floor and fed with the excrement of bivalves, it is reported that sea cucumbers show good growth and low mortality rates (Paltzat et al., 2008; Zhouet al., 2006). While the regions where bivalves are grown provide a living space in suitable conditions for sea cucumbers, the system in which bivalve-sea cucumber coexists provide a sustainable and profitable aquaculture model without additional feed input. Another study on an integrated multi-trophic farming system including sea urchins Paracentrotus lividus as the primary species and sea cucumber Holothuria tubulosa as the extraction species revealed that survival rates of P. lividus and H. tubulosa species are high and these species can give successful results in IMTA systems. (Grosso et al., 2020).

In an IMTA system examining the consumption of particulate waste of sea bream (Sparus aurata) among different extractive species, it was observed that candidate extractive species, sea cucumber (A. bannwarthi), had the highest organic matter consumption rate among

others (Israel et al., 2019). Similarly, IMTA trials with European sea bass (Dicentrarchus labrax) revealed that sea cucumber Holothuria forskali is highly efficient in consuming organic waste from sea bass (MacDonald et al., 2013). In the same study, the survival rate of sea cucumbers was determined to be 100%, while the total carbon and total nitrogen levels in the tanks filled with sea cucumbers were significantly lower than the control tanks, revealing that the use of sea cucumber in IMTA systems also provides significant environmental benefits. Tolon et al. (2017) reported high specific growth for sea cucumbers (H. tubulosa) that cultured under finfish cages in Turkey. Similarly, in another study in the South China Sea, in which the sea cucumber S. japonicus was examined for its ability to grow under the fish farm and consume particulate organic matter deposited in situ, sea cucumbers grew well under the fish farm and achieved higher growth rates in the farm area. (Yu et al., 2014).

CONCLUSION

Many IMTA studies emphasize the importance of sea cucumbers in bio-converting organic waste materials excreted from fish farms, however, it is also important to design suitable aquaculture systems for the integrated cultivation of different trophic species. The inclusion of the proper culture systems that can fully meet the biological needs of each species in the production model is a key factor in the success of IMTA system. In this concept, studies specific to local implementation and feasibility of integrated production systems are essential for the spread wide usage of IMTA systems.

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PRECISION AGRICULTURE BASED MODULAR AUTOMATION SYSTEM FOR MONITORING AND MANAGEMENT OF MICROALGAL CULTURE

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ABSTRACT

Microalgae are now used by the food and chemical industries with new applications in many service areas from food and feed to biomaterials. Microalgae production as an agricultural product has great importance and diversity in the sector. Large-scale microalgal cultures are grown in open or closed systems. It is critical that inputs and outputs must be considered sufficiently in open culture systems. Variable parameters provided by climatic conditions in microalgae production in open systems cause negative effects on yield, quality, and costs. Changing climatic conditions affect the production potential more and more each year. Today, precision agriculture technologies are integrated with open systems built on large areas. With the automation system, the existing workforce reduced, and real-time monitoring of the microalgae transferred to the channel provided with sensors in the process until the harvest time. In the modular automation system, instantaneous intervention is performed gradually according to the variable data coming from the sensors. In this way, it provides a microcontroller-based real-time control alongside existing monitoring systems, keeping the parameters under control as much as possible. In addition, with the developing 3D printer technology, modular system parts can be produced as environmentally friendly, inexpensive plant-based raw materials. For this reason, a precision agriculture system has been developed that supports production by controlling the changing inputs in model channel systems, which can be applied to almost all open channel systems with its modularity and saves new investment costs. Integration of precision agriculture into aquaculture, high efficiency in every aspect, lower costs, variable input control, maximum income expectation, and environmental protection are targeted. In this research, the management of a precision agriculture-based modular automation system which is placed on a canal-type system was used for green algae (Scenedesmus spp.) cultivation. It also represents an example of future modular systems for traditional aquaculture.

Acknowledgment: The project was supported by TUBITAK (Project No: 1919B012005731) and carried out in Ankara University Department of Fisheries and Aquaculture Engineering, Live Food Production Unit.

Keywords: Microalgae production, modular automation, real-time monitoring, precision agriculture, microcontroller

SOME PARASITES OF CHUB Squalius cephalus (L., 1758) COLLECTED FROM A STREAM SYSTEM IN KOCAELI

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ABSTRACT

Chub *Squalius cephalus* (L., 1758) is one of the target freshwater fish species in Turkey and is preferred as human food source due to its delicious meat. In this study, we aimed to determine its parasitic fauna in Yalakdere - Kaytazdere stream system flowing into the Marmara Sea for the first time. Samples of chub *Squalius cephalus* were collected by angling and scattering net in Yalakdere-Kaytazdere stream system in Turkey in the period between May 2020 and June 2021. Skin, fins, gills, eyes, brain, liver, gall bladder, stomach and intestines, kidney, urinary bladder and gonads of the fish were examined for parasites. All examinations and biometric measurements were made under a light microscope attached with a digital photography system. Infection indices were determined for each parasite species according to fish length and sex. A total of 147 fish specimens were examined and identified parasites were belong to higher taxon Nematoda *Rhabdochona denudate,* Trematoda *Clinostomum complanatum, Tylodelphys clavata, Posthodiplostomum sp.,* Monogenea *Dactylogyrus sp.* and Cnidaria *Myxobolus sp.* Prevalence (%) of infection of each parasite species revealed that *Myxobolus sp.* was the dominant species, followed by C*linostomum complanatum, Dactylogyrus* sp., *Rhabdochona denudata, Tylodelphys clavata*, and *Posthodiplostomum* sp. This study is the first parasitological investigation conducted in on the parasitic fauna of chub collected from Yalakdere - Kaytazdere stream system located in Kocaeli, Turkey.

Keywords: *Squalius cephalus*, Nematoda, Myxozoa, Trematoda, Monogenea, Kocaeli

THE CULTURE POSSIBILITIES OF BEARDED HORSE MUSSEL Modiolus barbatus IN THE ERDEK BAY – MARMARA SEA, TURKEY

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ABSTRACT

Bearded horse mussel, *Modiolus barbatus* (Linnaeus, 1758), is an important edible bivalve that is distributed in the Eastern Atlantic Ocean and the Mediterranean Sea. It is, therefore important not only to assess the sustainability of natural stocks, but also to facilitate aquaculture efforts of this species. This study investigated the growth and survival rate of *M. barbatus* in farming site for one year from March 2018 to March 2019 in the Erdek Bay - Marmara Sea, Turkey. Temperature, salinity, chlorophyll-a, total particulate matter, particulate inorganic matter and particulate organic matter were measured monthly interval throughout the study. The initial average shell length and total weight of bearded horse mussel were measured as 8.09 ± 0.50 mm and 0.09 ± 0.02 g, respectively. Seawater temperature was measured between 7.6 and 25.2 °C, while salinity was changed from 23.7 and 25.9 ‰ during the study. The highest chlorophyll was assayed as 9.74 µg/l in April 2018 and the maximum total particulate matter was measured as 10.65 mg/l in March 2019 in study area. At the end of the study, bearded horse mussel reached to approximately fourfold shell length than the initial size. In addition to this, survival rate was determined over than 95 %. In conclusion, bearded horse mussel has been identified as a promising candidate species for commercial-scale production.

Keywords: Bearded horse mussel, *Modiolus barbatus*, aquaculture, Marmara Sea

TURKEY'S FOREIGN TRADE OF FISHERIES COMMODITIES: PAST, PRESENT AND FUTURE

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ABSTRACT

Turkey ranks 31st among world countries, 15th among Asian countries, and 6th among European countries in total fisheries production (including aquatic plants and aquatic mammals). In 2020, 54% of 785811 tons of total fisheries production was obtained by aquaculture and 46% by capture in Turkey. Since the beginning of the 2000s, there has been a rapid increase in the fisheries exports due to the increase in aquaculture. Turkey fisheries export amount, which was approximately 14000 tons in 1995, increased 2.5 times between 1995-2005 and 3.5 times between 2005-2015. Fisheries exports, which were approximately 120000 tons in 2015, reached approximately 20000 tons in 2019, with a revenue of over 1 billion dollars. Turkey's fisheries imports followed a fluctuating course. The import amount, which was approximately 45000 tons in 2000, doubled in 2019 and reached a value of 190 million dollars. In the study, the development of Turkey's fisheries trade from past to present has been examined, foreign trade balance, foreign trade volume, export-import coverage ratios have been calculated. Trend analysis was carried out using the least squares method, using the data of 1994-2019 in the forecasts for the future. For trend analysis, polynomial trend line, equation and coefficient of determination were obtained. In the calculations, it was seen that the foreign trade surplus of fisheries, which was approximately 10 million dollars in 2000, reached approximately 840 million dollars in 2019. It was found that the import coverage ratio of aquaculture exports was 540% (Fish meal, fish oil and aquatic products are not included). In 2019, approximately 11000 tons of fish meal were exported (approx. 16.4 million dollars), and approximately 180000 tons were imported (approx. 216 million dollars). Assuming that there will be sufficient total fisheries production in 2030, it is predicted that Turkey's fisheries exports will be approximately 400000 (R^2= 0.9848) and imports will be approximately 160000 (R^2= 0.8361) tons.

Keywords: Fisheries trade, export, import, Turkey

THE EFFECTS OF OXIDIZED FISH OIL ON GROWTH PERFORMANCE AND FEED CONVERSION OF NILE TILAPIA (Oreochromis niloticus) FINGERLINGS

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ABSTRACT

The oxidized oil has many negative effects on farmed fish. Therefore, this study conducted to evaluate the effect of the oxidized anchovy fish oil on the growth performance and feed converison of Nile tilapia (Oreochromis niloticus) reared in fiberglass tanks. Fingerlings in initial average body weight of (15.07±0.58 g) were stocked in three groups in triplicates at a density of 50 fish/tank and fed with three test diets containing either fresh anchovy fish oil (fresh diet, peroxide value POV= 4.9±0.42 meq/kg-1) or anchovy fish oil oxidized to two degrees (oxidised diets, POV=50.1±0.71 meq/kg-1 and 100.80±1.69 meq/kg-1). Fish were fed twice a day at a feeding rate of 3% of their body weight per day for 12 weeks. To evaluate the growth performance, biometry has done every 21 days during the experiment period, and the the muscle samples were taken for biochemical analysis. Average values of water quality parameters including (temperature, pH, dissolved oxygen, salinity and amoia) have measured once a week, were 25.16.0±0.55 □c, 6.64±0.52, 5.01±0.97 mg/L, 0.26±0.46‰ and 0.06±0.23 mg/L respectively. Results showed no significant differences (P > .05) between treatments in weight gain, final body weight, survival rate, specific growth rate, feed conversion ratio, viscerosomatic index and hepatosomatic index. But the fish group fed with fresh oil obtained higher growth performance and lower viscerosomatic and hepatosomatic indexes compared to the fish groups fed oxidized fish oil. The present study demonstrates the oxidized fish oil may have negative effect on the growth performance of Nile tilapia during long rearing period.

Keywords: Anchovy oil, oxidation, growth performance, Nile tilapia

DIFFERENT ALTERNATIVE PROTEIN SOURCES USED AS A SUBSTITUTE FOR FISH MEAL IN AQUACULTURE FEEDS

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ABSTRACT

The aquatic industry is known as one of the most important sectors of food production. Due to the increasing population of the world and because of the need for food production, aquaculture has been targeted as one of the sources of food supply. This sector of the food production has grown rapidly compared to other sectors, from 20 million tons in 1994 to 80 million tons in 2018. Food is one of the most important determinants in increasing the success of aquaculture and accounts for a large part of the total operating costs of fish farms. Among the nutrient groups required by fish, proteins are considered as the most important and expensive part of the diet. Imbalance of diet components while reducing growth and physiological and health deficiencies for aquatic, will lead to many environmental problems. Therefore, due to the high cost of feeding fish, the aquaculture industry needs to use cheap, high-quantity food components to produce a low-cost ration, so the purpose of the ration in aquaculture is to provide a suitable ration. Which can meet aquatic food needs at the lowest cost. Reducing fish stocks at sea to produce fish meal as an alternative to fish meal for the sustainability of the aquaculture industry has also become inevitable. Alternatives can be divided into three parts: plant, animal and microbial. In this article, we will look at suitable alternatives as well as their features. In addition we will refer to the research done in this regard.

Keywords: Aquaculture, fish feed, fishmeal replacement, alternative proteins source, fish nutrition

EFFECTS OF GLYCYRRHIZIC ACID SUPPLEMENTATION ON GROWTH PERFORMANCE IN JUVENILES OF MEAGRE (Argyrosomus regius)

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ABSTRACT

It is commonly known that glycyrrhizic acid (GA), an active component of licorice root, Glycyrrhiza glabra, roots have many properties such as anti-inflammation, antioxidation, antiviral activities and antimicrobial activities that especially growth promoter in both terrestrial and aquatic organisms. The main goal of this study was to determine the effects of glycyrrhizic acid (GA) as a growth promoter in juveniles of meagre (Argyrosomus regius) growth performance and total protease activity. For this purpose, meagre (10.20±0.14 cm; 11.53±0.21 g) juveniles were fed with 2 different diets which supplemented with GA (control, 4 ml.kg-1). Each diet was fed to triplicate group of fish. After 60 days feeding period, growth performance, survival rate, feed conversion ratio (FCR), specific growth rate (SGR) and total protease enzyme activity were investigated. At the end of feeding trial, results presented that significant differences were found in growth performance and FCR ($p<0.05$) in GA supplemented group. However, survival rate and specific growth rate showed no significant differences ($p >0.05$). Similarly, there was a significant different between control and experimental group ($p<0.05$) in total protease activity. As a result, it was determined that GA application at 4 ml.kg-1 affected significant increases and positive developments in growth parameters and total protease activity in juveniles of meagre under culture conditions. In conclusion, supplementation of glycyrrhizic acid affected significant increases and positive developments in growth parameters and total protease activity in juveniles of meagre.

Keywords: Glycyrrhizic acid, growth performance, total protease, meagre, *Argyrosomus regius*

EVALUATION OF SPAT SETTLEMENT OF BLACK MUSSEL (Mytilus galloprovincialis) IN SUMMER SEASON USING BY KRIGING METHOD IN ARCGIS SPATIAL ANALYST

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ABSTRACT

ArcGIS technology is a scalable integrated Geographic Information System (GIS) software developed by Environmental Systems Research Institute - ESRI. Kriging modelling in ArcGIS is a geostatistics method that estimates the value in a given geographic area from a set of measurements. This study was carried out in the Balıklıova, İzmir Bay, during the summer period in 2020. The aim of this study was to investigate the spat settlement of black mussels (*Mytilus galloprovincialis*) on suspended ropes using by Kriging method and estimated spat availability for this area. Rope collectors were prepared from 20 mm diameter polypropylene material and three meters long. Sampling from the collectors was started three months after hanging on the sea. Mussel spats amount were counted and measured in all ropes. After that, it was prepared general distribution map of spat by using the kriging method. When this method was applied in the study area (Balıklıova region in İzmir Bay), it was recorded that mussel spats spread mainly in the range from North-West (NW) to South-Waste axis on the map. Additionally, more abundance of the settlement was determined in the north, south, west and east part of the farm, respectively. In conclusion, sustainable mussel production can be realized by both providing the production period more understandable and by the modelling study and estimating the total spat level in the facility.

Acknowledgement: This study was supported by Scientific Research Project Coordination of the Ege University. Project Number: FDK-2020-21932

Keywords: Geographic Information System (GIS), ArcGIS, kriging method, *Mytilus galloprovincialis,* spat

OCCUPATIONAL HEALTH, SAFETY AND CURRENT LEGISLATIONS AND REGULATIONS IN AQUACULTURE

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ABSTRACT

In the recent years; aquaculture sector has become one of the most important business areas in the world and in our country. However, the decrease in natural resources, the pollution of the seas and wetlands have gradually reduced the supply of natural fishery products. On the other hand, the increase in the world population, increasing food and nutritional needs require an increase in the amount of aquatic production. Increasing aquaculture and their production have led to the expansion of working areas, an increase in the number of employees, and the development of industry and technology. This situation brings dangers, risks and accidents in working areas. In our country, the Fisheries Law No. 1380 is in force. Apart from this, the Occupational Health and Safety Law No. 6331 is applied in all working areas for employees. In addition, Occupational Safety and Health Administration (OSHA) in the USA and EU-OSHA in Europe work in this field. Except this, there are regulations on fishing vessels, working conditions at sea, and divers in Turkey. However, no specific regulations are legislated for aquaculture and its facilities. In this study, information about the regulations applied in fisheries and occupational health will be given and legal requirements need to prepare a regulation in the field of aquaculture will be emphasized.

Keywords: Occupation, health, safety, legislation, aquaculture

IDENTIFICIATION OF TWO NOVEL SINGLE NUCLEOTIDE POLYMORPHISMS (SNPS) OF MYOSTATIN (MSTN) GENE IN EUROPEAN SEA BASS (Dicentrarchus labrax, L.)

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ABSTRACT

The myostatin (*MSTN*) gene, also known as growth differentiation factor-8 (GDF-8) is a member of the transforming growth factor-β (TGF-β) superfamily and plays a specific inhibitory role in the critical phases of development and regulation of skeletal muscle mass in vertebrates. This study was conducted to investigate the *MSTN* gene polymorphisms in European sea bass reared in the İzmir region of Turkey. The 37- 2412 bp long region of the *MSTN* gene were amplified and PCR products were analyzed via the DNA sequencing method. Two novel SNPs as g.15768 C>T and g.16079 C>A in the intron and exon 2 regions of the *MSTN* gene in the European sea bass were detected as preliminary results of this study. The C→A transversion (g.16079 C>A) in the exon 2 region caused amino acid change from Arginine (R) to Serine (S). This gene region was firstly identified in sea bass and the partial DNA sequence of *MSTN* gene was reported for the first time in this study and these sequences were deposited to NCBI GenBank database with the Accession numbers: MN207216-MN207222. Consequently, SNPs which is identified in this study could be useful for European sea bass breeding and marker-assisted selection (MAS).

Acknowledgement: The funding of the current study was supported by Scientific Research Projects Coordination Unit of Ege University (Project No: FKP-2020-21912).

Keywords: MSTN gene, European sea bass, DNA sequencing, SNP

DETERMINATION OF ANTIBODY LEVELS IN POLYVALENT VACCINE APPLICATION FOR RAINBOW TROUT, (Oncorhynchus mykiss W,1792)

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ABSTRACT

A study was carried out in rainbow trout (*Oncorhynchus mykiss*), antibody production and detection following immunization with *Lactococcus garvieae*, *Vibrio anguillarum* and *Yersinia ruckeri* polyvalent vaccine using by slide agglutination and microagglutination from serological techniques. The level of humoral immunity in rainbow trout following immunization by intraperitonal (ip) injection polyvalent vaccine in Freund's Complete Adjuvant, FCA and glucan was studied a period of 270 days. Groups of 50 fish were used for the experimental and the control groups. The experimental vaccine was obtained by formalin inactivation of the bacteria and 0,1 ml intraperitoneal injection and immersion (im.) were applied to the fish. Control fish were injected with 0.1 ml of phosphate-buffered saline (PBS). The non-adjuvant polyvalent immersion and intraperitoneal vaccination groups were boosted after 30 days.

Serum dilution giving the highest agglutination as agglutination titer is recorded. In the slide agglutination test, agglutination was observed in all blood serum. The highest antibody titrer in microagglutination test in injections groups were found polyvalent+booster and polyvalent+glucan groups againts all tested bacteria. In immersion vaccine groups, the highest antibody titer were observed in *V. anguillarum*, while the lowest antibody titer were observed in *Y. ruckeri*.

In conclusion, non-adjuvant and adjuvant polyvalent vaccines administered by intraperitoneal injection and immersion routes (except *Y. ruckeri)* were showed good protection for polyvalent vaccine..

Keywords: *Aquaculture, polyvalent vaccine, adjuvant, agglutination, antibody titer*

INTRODUCTION

Preventive measures in farms have become more and more important in aquaculture. Vaccination can be one of the most sustainable ways to prevent losses due to diseases in aquaculture development. *Lactococcus garvieae, Vibrio anguillarum* and *Yersinia ruckeri* are the bacterial pathogens affecting rainbow trout (*Oncorhynchus mykiss*) and cause of heavy losses, especially in culture have been considered major economic problem in Turkey (Öztürk and Altınok, 2014). Disease control by vaccination is widely used in salmonid aquaculture in Turkey against vibriosis (*Vibrio anguillarum*), yersiniosis or enteric redmouth disease (*Yersinia ruckeri*) and lactococcosis (*Lactococcus garvieae)*. Commercial vaccine products for fish have more often consisted of mixtures of multiple products including two, three, four and five vaccines. There is growing evidence that antigenic as well as non-antigenic components of vaccines can interact synergistically or antagonistically and that they can stimulate, cross-react with, inhibit or even suppress the immune response to specific antigens. Appropriate selection of antigens to be used together in a polyvalent vaccine is very important to determine its full potential and optimum desired immunity (Busch,1997). The vaccination method strategie have been important for the high level of immunity and the extending duration of protection acquired after vaccination. A best vaccine usually has had both a good long-term protection and a strong protection.

The aim of this study was determined of antibody levels of the prepared vaccines; adjuvanted (Freund's Complete Adjuvant 'FCA' and glucan) polyvalent vaccines (formalin-killed bacteria) against to *L. garvieae, V. anguillarum* and *Y. ruckeri*.

MATERIAL AND METHOD

Rainbow trout (average weight of 3g and 20g) without a previous history of diseases were obtained from a commercial farm. Fish were fed with commercial diet during experiments. Water parameters were monitored daily as follows: dissolved oxygen (7,4 mg/l), temperature (12,5° C) and pH (7.4).

For the preparation of vaccines by using *L. garvieae, V. anguillarum* and *Y. ruckeri* which were produced in large scale by Vetal Animal Health Company in Adıyaman-Turkey. The vaccine contained formalin-killed bacteria. In adjuvant vaccines, FCA was mixed at a ratio of 1:1 and glucan was added at a rate of 100 µg/ml. Sterility and toxicity tests of vaccines were made and no toxic effects were found. Fish were anesthetized using phenoxyethanol (1/20,000) prior. The prepared vaccine was administered to 20g fish as 0.1 mL by intraperitoneal (ip.) injection and to 3g fish as 1:10 dilution for 1 minute. Control fish received only phosphate buffered saline-PBS. The group which was applied non-adjuvanted polyvalent vaccine were got a booster injection at 21st day post-vaccination. The groups were challenged with three bacteria to test the protection against the prepared polyvalent vaccine at day 30, 90, 120 or 270 post-vaccination (Table 1). After challenge, the relative percent survival (RPS) was calculated.

Blood samples were taken at 30, 90, 120 and 270 days after vaccination. Five fish from each group were briefly anesthetized and bled by caudal ven puncture to collect serum for determination of antibody titer.

Table 1. Experimental design

Experimental group	Vaccination method and doses	Fish count	Challenge days
Non vacination-Control	Ip., 0.1 ml (PBS)	50(25x2)	30, 90, 120, 270. day
Y. ruckeri, V. anguillarum, L. garvieae (Polyvalent)	Ip., 0.1ml, booster 21 days post vaccination	50(25x2)	30, 90, 120, 270. day
Polyvalent+Glucan (P-Glucan)	Ip., 0.1 ml	50(25x2)	30, 90, 120, 270. day
Polyvalent+FCA (P-FCA)	Ip., 0.1 ml	50(25x2)	30, 90, 120, 270. day
Y. ruckeri, V. anguillarum, L. garvieae (Immersion)	1 minute immersion diluted 1:10	50(25x2)	90, 120, 270. day

Blood samples were centrifuged at 3000 rpm for 10 min. The serum was collected and aliquots of the serum were kept at -20°C until required for assay. In slide agglutination test, serum and bacterin was taken on a clean glass slide and examined without cover glass. The formation of agglutination reaction clusters was observed. For the microagglutination test serial two-fold dilutions of the serum samples in PBS were added to round-bottom polyester, 96-well, microplates. A bacterial antigen suspension (by inactivated with formalin; optical density 1.0 at 600 nm) prepared in PBS was agglutinated by 50 ul of twofold serum dilutions in microplates. The microplates were shaken and incubated at room temperature for 2 h and left overnight at 4°C. The appearance of a button with fuzzy edges at the bottom of the well was considered a positive reaction, the formation of a round precipitate with sharp contours was considered a negative reaction (Eldar et al., 1997; Barnes et al., 2002).

The formula of calculating the RPS (relative percent survivals) index is as below: 1- (% vaccinated mortality/% non-vaccinated mortality) x 100. Differences between groups were tested for significance by oneway analysis of variance ANOVA for significance levels ($p<0.05$) (Hayran and Özdamar, 1995).

RESULTS

RPS Results: The high level of protection against bacterial pathogens were achieved in the fish group which were received non-adjuvanted polyvalent vaccine, FCA and glucan polyvalent vaccine fish up to 9 months against the three pathogens. RPS were determined the highest in the non adjuvanted vaccine group. *Y.ruckeri* 96,77%, *V.anguillarum* 100%; *L.garvieae* 96,66% , glucan: *Y.ruckeri* 93,54%; *V.anguillarum* 96,77%, *L.garvieae* 93,33%, FCA :*Y.ruckeri* 100%, *V.anguillarum* 87,09 %, *L.garvieae* 93,33% at 270 days (Figure 1). For RPS values to immersion vaccinatation groups, polyvalent+im booster vaccinated groups were determined as 100% for *L.garvieae* at 270th day. Im vaccinated group was observed protection until the 90th days againts *V. anguillarum*. However, im vaccination did not confer protection againts *Y. ruckeri*.

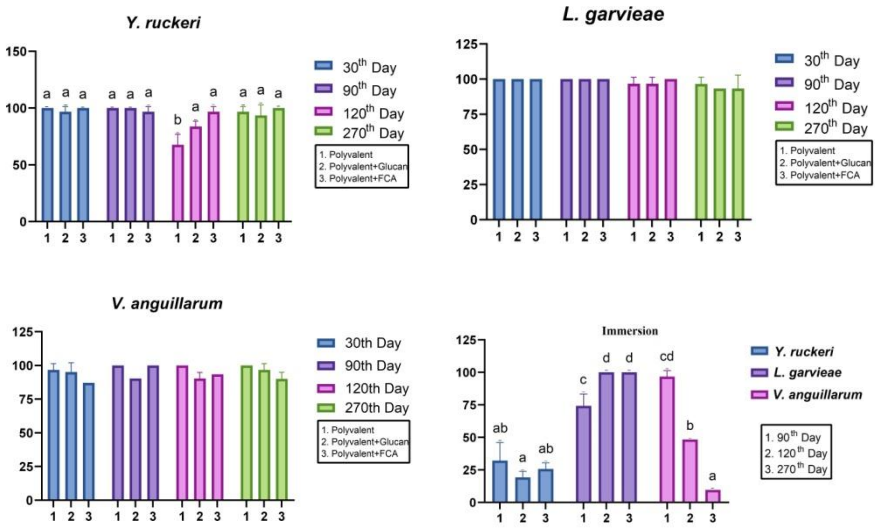

Figure 1. Differences between the vaccinated groups (significance levels, $p<0.05$). Different letters indicate significant differences between vaccinated groups. Non-letters not indicate significant differences.

Slide Agglutination Test Results

When agglutination antigen and immune test sera were mixed on the slide, agglutination was observed in all vaccinated groups (Figure 2). When the slides where agglutinin occurred were examined under a light microscope, clusters formed by bacteria and antibodies were observed (Figure 2).

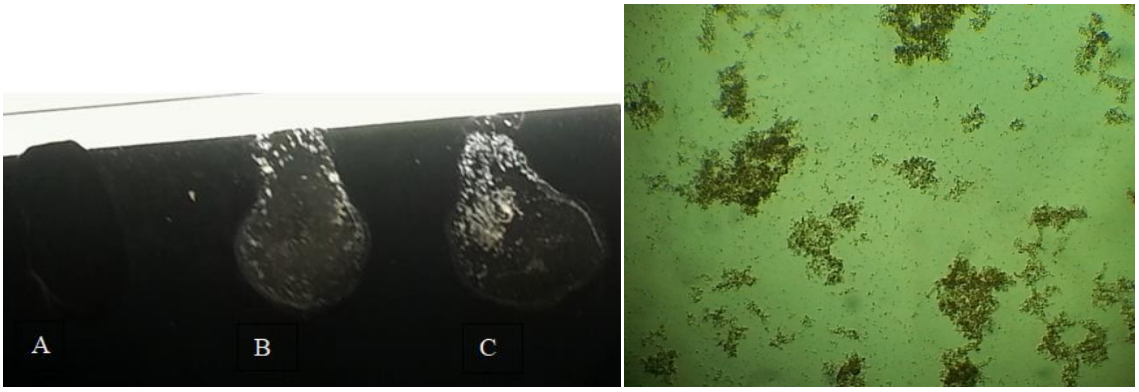

Figure 2. *Left*: Slide Agglutination Test A) negative control B) positive control C) test serum *Right*: Under a light microscope, clusters formed by bacteria and antibodies x40

Microagglutination Test Results

Visible agglutination precipitates were formed as a result of mixing test sera containing agglutination antibody with antigen in micro-well plates. (Figure 3).

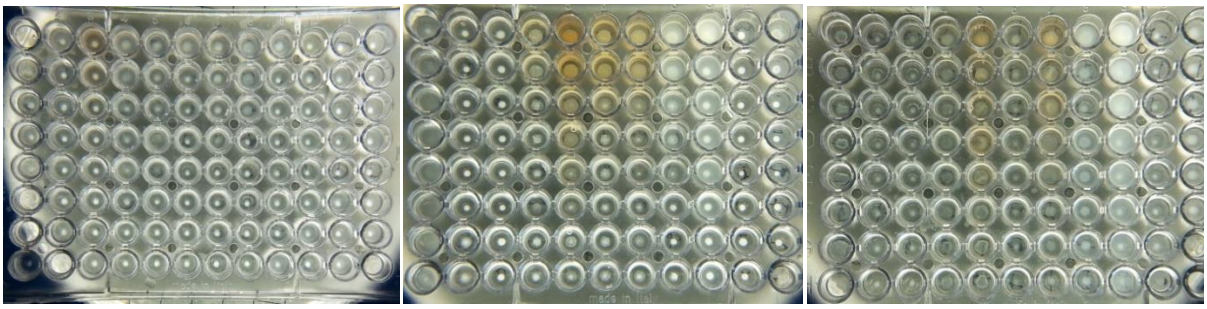

Figure 3. Microplate agglutination plate wells containing immune test sera *left to right*: *Y. Ruckeri, L. garvieae* and *V. Anguillarum*

Antibody titers and agglutinin titers (Log2) according to microagglutination test against to pathogens of the fish immunized on days after immunization are as described with graphs and figures (Figure 4,5 and 6).

Y.ruckeri	P+Booster		P - Glucan		P - FCA		immersion	
Days	Dilution	Log 2	Dilution	Log 2	Dilution	Log 2	Dilution	Log 2
30	1/64	6	1/32	5	1/128	7	0	0
90	1/256	8	1/128	7	1/32	5	0	0
120	1/256	8	1/256	8	1/64	6	0	0
270	1/64	6	1/128	7	1/2	1	0	0

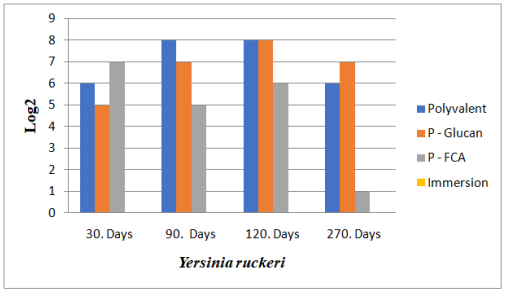

Figure 4. Against to *Y. ruckeri* antibody titers and agglutinin titers (Log_2)

L. garvieae	P+Booster		P - Glucan		P - FCA		immersion	
Days	Dilution	Log 2	Dilution	Log 2	Dilution	Log 2	Dilution	Log 2
30	1/4	2	0	0	1/4	2	1/32	5
90	1/128	7	1/256	8	1/64	6	1/4	2
120	1/16	4	1/16	4	1/64	6	0	0
270	1/256	8	1/8	3	1/8	3	1/2	1

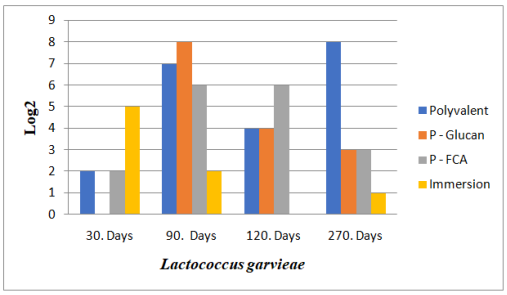

Figure 5. Against to *L. garvieae* antibody titers and agglutinin titers (Log_2)

V.anguillarum	P+Booster		P - Glucan		P - FCA		immersion	
Days	Dilution	Log 2	Dilution	Log 2	Dilution	Log 2	Dilution	Log 2
30	1/16	4	1/32	5	1/64	6	1/16	4
90	1/256	8	1/256	8	1/128	7	1/64	6
120	1/256	8	1/256	8	1/32	5	1/8	3
270	1/128	7	1/128	7	1/2	1	0	0

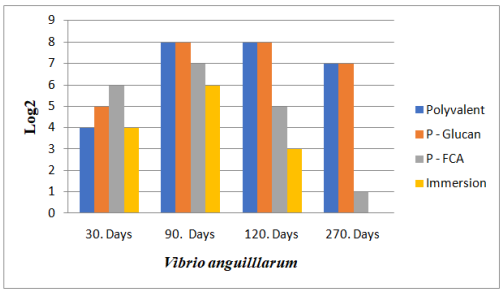

Figure 6. Against to *V. Anguillarum* antibody titers and agglutinin titers (Log_2)

DISCUSSION

Today, important protection is provided by vaccination against infectious bacterial diseases in aquaculture (Schnick et al., 1997). Commercial vaccines against most bacterial diseases, which are important for aquaculture, are successfully used as a preventative in fish farms. However, research continues for existing vaccines to provide long-term and more effective protection (Sommerset et al., 2005).

A polyvalent vaccine protects simultaneously against the majority of the diseases to which a particular fish species is susceptible (Muktar et al., 2016). There is evidence that antigenic, as well as non-antigenic components of polyvalent vaccines, can interact both synergistically as well as antagonistically. Therefore the proper selection of antigens to be used together in the polyvalent vaccine is very important to utilize its full potential and optimum desired immunity (Nikoskelainen et al., 2007).

Several studies developed polyvalent vaccine, Toranzo et al., 1997; Mikkelsen et al., 2004; Shoemaker et al., 2012; Anderson, 1997; Sun et al., 2011 (Hamed et al, 2021). The efficacy of the prepared vaccine in protecting the fish under experimental conditions are validated along with the serological data including agglutination titers which indicate that the vaccine could elicit a protective immune response (Jang et al., 2014).

In conclusion, in the slide agglutination test, agglutination was observed in all blood serum. The highest antibody titrer in microagglutination test in injections groups werefound polyvalent + booster and polyvalent + glucan groups againts all tested bacteria. In immersion vaccine groups, the highest antibody titer were observed in *V. anguillarum*, while the lowest antibody titer were observed in *Y. ruckeri*. The results showed that long-lasting protection by the inactivated polyvalent vaccines can be obtained when adjuvants are adjuncts to elevate the immunological strength of the vaccine formulation.

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INTERNATIONAL SYMPOSIUM ON FISHERIES AND AQUATIC SCIENCES

EGE UNIVERSITY FACULTY OF FISHERIES, İZMİR

Fisheries Technology and Sustainable Management

ARTIFICIAL REEF APPLICATIONS FOR DIVING TOURISM IN TURKEY

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ABSTRACT

Diving tourism, one of the alternative tourism options, has been very popular in the world and in Turkey in recent years. Marine biodiversity, natural reefs, wrecks, corals and other sea creatures attract the attention of divers. Visibility of seawater, temperature, depth, current, distance from the diving point to the shore and accommodation facilities in the region also affect the sustainability of diving tourism. In many regions in Turkey, which has many underwater riches both ecologically and archaeologically; scuba diving is prohibited for reasons such as archaeological sites, military zones, special environmental protection areas and fishing. Therefore, in recent years, alternative diving points have been created for diving tourism by using artificial reefs. The artificial reef phenomenon, which started in the 1980s in Turkey, has developed rapidly. More than 80 artificial reef projects have been carried out on our shores to date. Within the scope of these projects, more than 15000 concrete blocks, 3000 amphorae, 22 ships, 10 trolleybuses, 9 planes, 1 tank and 8 scientific floating artificial reefs were released into the sea. In 35 of these projects, it is aimed to create alternative areas for diving tourism. While artificial shipwrecks like ships and planes were used in the first years, underwater parks with different themes have been created in recent years. In this study, the projects for diving tourism in Turkey were examined and the materials used, the permit process and the interest of the divers to these points were evaluated. In addition, mistakes made in material and location selection and conflicts between sectors are discussed.

Keywords: Artificial reefs, diving tourism, fisheries, management, Turkey

CHANGES OF SOCIO-ECONOMIC AND CATCH CHARACTERISTICS OF THE TRAWL FISHERY OVER THE YEARS: CASE OF FOÇA, CENTRAL AEGEAN, TURKEY

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ABSTRACT

This study aimed to provide information on both the current status and historical changes of the trawl fleet in the Foça, Aegean Sea. For this aim, we used the questionnaire form which was used in 1999 by Ünal (2004) and collected data in 2019 by face-to-face interviews with trawlers. The questionnaire consists of characteristics of vessels and fishing activity, socio-demographic characteristics of fishers, their income and fishing expenses, annual landings of species and management issues. The results showed the total annual landing of vessels significantly decreased for the last two decades. Fishers noticed the landings of some species such as Mustelus mustelus, Lophius piscatorius, and Triglia lucerna showed a marked decrease for this period. Furthermore, a decrease was reported in the mean length of some caught species such as Merluccius merluccius, Lophius piscatorius and Zeus faber for the same period. On the other hand, the volume of fuel tanks of vessels and tow duration showed significant increases from 1999 to 2019. Due to decreased stocks and income, the trawl fleet of Foça decreased by ~75% from 1999 to 2019 and 55% of the current fishers reported that they may leave the fishery sector within the next 10 years. This also changed the tradition of sharing system in the trawl fishery; the number of crews is paid as share rather than salary significantly decreased. Additionally, as the young people no longer prefer to work in their family-owned fishing vessels, the number of crews from vessel owners' households has significantly decreased for the last twenty years. We discussed the aforementioned changes together with the current management measures and regulations related to the trawl fishery and provided some recommendations for the upcoming Fishery Communique.

Keywords: Fisheries economy, fisheries management, trawl fishery, Aegean Sea, Turkey

SURVEY OF THE CONTRIBUTION OF SEA CAGE FARMS TO BIODIVERSITY

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ABSTRACT

The main goal of this study is monitoring of diversification of some algae and macro invertebrates attached to marine sea cage farms (floating tubes, net, ropes) and also carried out from January 2015 to February 2020 at in the Gülbahçe-Izmir Bay. Sampling of macro invertebrates and algae were performed by scuba divers and recorded underwater camera (Gopro black edition). As a result, totaly 15 macro invertebrata species were determined. 10 species belongs to bivalvia, 3 species belongs to crustacea and 2 species belongs to Echinodermata and dominated by some economical Mytilus galloprovincialis, and Balanus sp. Additionally, it was determined that Ostrea edulis, Pinctata radiata Paracentrotus lividus, and Modiolus barbatus has economical value among these species. Totaly 5 algae species were determined, Ceramium sp belons to Rhodophyta, Ulathrix sp belongs to Ochrophyta, Enteromorpha comprezza, Ulva rigida and Ulva lactuca belongs to Chlorophyta. It is concluded that marine sea cage units are artificial habitats in the marine ecosystem for providing of habitat and enhancement of natural stock for fish/other aquatic organisms.

Keywords: Fish cage unit, macro invertebrate, Algae, İzmir Bay

SAVE THE BAY: A CASE STUDY OF FISHERIES CO-MANAGEMENT IN GÖKOVA BAY, TURKEY

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ABSTRACT

Overfishing is one of the most serious problems threatening the health of the seas and local coastal communities. Marine Protected Areas with No Fishing Zones are valuable biodiversity conservation tools to ensure the sustainable use of diminishing fish stocks. Nevertheless, to be successful for long-term conservation these areas have to be monitored and rules must be enforced. Using semi-structured interviews and participant observation I analyze collective action efforts for marine conservation in Turkey, Gökova Bay. Guided by Elinor Ostrom's social-ecological systems framework and design principles I analyze the challenges and advantages of co-management in a social setting, and its role to scale-up marine conservation. Interviews showed that traditional forms of management are not applicable in Gökova Bay and the co-management governance approach offers collaboration between small-scale fisheries, government agencies, and NGOs. However there is an urgent need for top-down steering and assistance especially regarding sanctioning and rule enforcement by the state.

Keywords: Small-scale fisheries, common-pool resources, socio-ecological systems, co-management, sustainability science

THE PHOTONIC SENSOR APPLICATION AS AN IN-SITU SENSOR SYSTEM FOR SEA CUCUMBER TANKS

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ABSTRACT

Marine monitoring and sensors that can be used to analyze this activity, are becoming important actors in the world. Therewithal providing low-cost in-situ sensors like in this study generates notable milestones due to that case. To prove the effectiveness of this photonic sensor in turbidity measurement, we have conducted series of laboratory and field experiments. Calibration measurements carried out along with pilot study in sea cucumbers tanks that are famous with their water filtering specialties. Both experiments gave us promising results with proving IR/Turbidity relation and detecting some vial activities of the sea cucumbers via water turbidity. Further field experiments and developments will be carried out with the light of this experiment.

Keywords: Photonic sensor, turbidity, sea cucumber, marine monitoring

INTRODUCTION

The performance of sensors and sensor systems has increased significantly in recent years, it is desirable to expand the use of optical sensors and sensor systems in monitoring the marine environment. This sensors around ocean structures and infrastructures often requires the use of very expensive instruments and equipment. When this issue combines with open-source systems and their service requirements, monitoring activity becomes challenging in various ways (Schima et al., 2019).

Following that idea in-situ photonic sensors crafted by integrating the developed photonic sensors on various platforms. In this context, monitoring with photonic sensors will help increase the performance of existing monitoring systems, as well as increase data quality, security and continuity.

"OpenAquaSense" (https://gitlab.com/christoph.strehse/openaquasense) photonic sensor is an example as an open-source platform for tailor made marine sensing. The designed sensor can be used to make measurements in the UV, IR and RGB spectral range, with LED brightness, integration time and gain settings of detectors. Turbidity, temperature and pressure measured with the help of this sensor.

MATERIAL AND METHOD

The developed system is made to perform transmission measurements. Thus, the sensor probe consist of an emitter and a detector unit. The light is emitted into a medium and reaches the detector at the end of the optical path. As the optical path length stays constant at 10 mm, the concentration of the absorbing medium can be calculated according to the Beer-Lambert- Law using the intensity ratio of transmitted and emitted light (Strehse et al., 2019)

The sensor consists of two main parts; top (control) unit and sensor unit. Top unit contains various main and auxiliary parts like Arduino microcontroller, Bluetooth, GPS and MicroSD card modules. Sensor probe contains IR, UV, RGB LED emitter and detector modules along with pressure and temperature sensor. Sensor probe casing has a 3D printed, PET-G material.

IR light has been shown to be negatively correlated with turbidity in water (Postolache et al., 2002). To prove that and see the IR/NTU correlation, sensor calibration was carried out in laboratory and photon counting red by sensor, compared with Nephelometric Turbidity Units (NTU). WTW Turb 355 IR/T model turbidity meter used in calibration tests. As the turbidity was increased, 10 measurements were made with the turbidimeter and 20 measurements with the photonic sensor, and a calibration curve was created for comparison by using the average of these measurements. Quadratic fitting model was used and similarities correlated with R2 method.

Afterwards, a pilot study conducted in Ege University Urla sea cucumber breeding facilities. A glass tank with a volume of 200 x 50 x 60 cm (~600 liters) was used as the experimental setup. Water circulation was ensured by filtering the water taken from the marine environment continuously. First, natural sand (sediment) taken from the sea was added to the tank that containing sea water. Empty (without sea cucumbers) tank planned for sensor measurement. Following that experiment, full (with sea cucumbers) tank experiment planned for weekly measurement.

RESULTS

Calibration curve can be seen in Figure 1. That calibration curve shows us that correlation between IR(counts) and NTU values obtained from same water sample under room temperature (25Co). In this graph, fractions at some points caused by increased turbidity agent (milk).

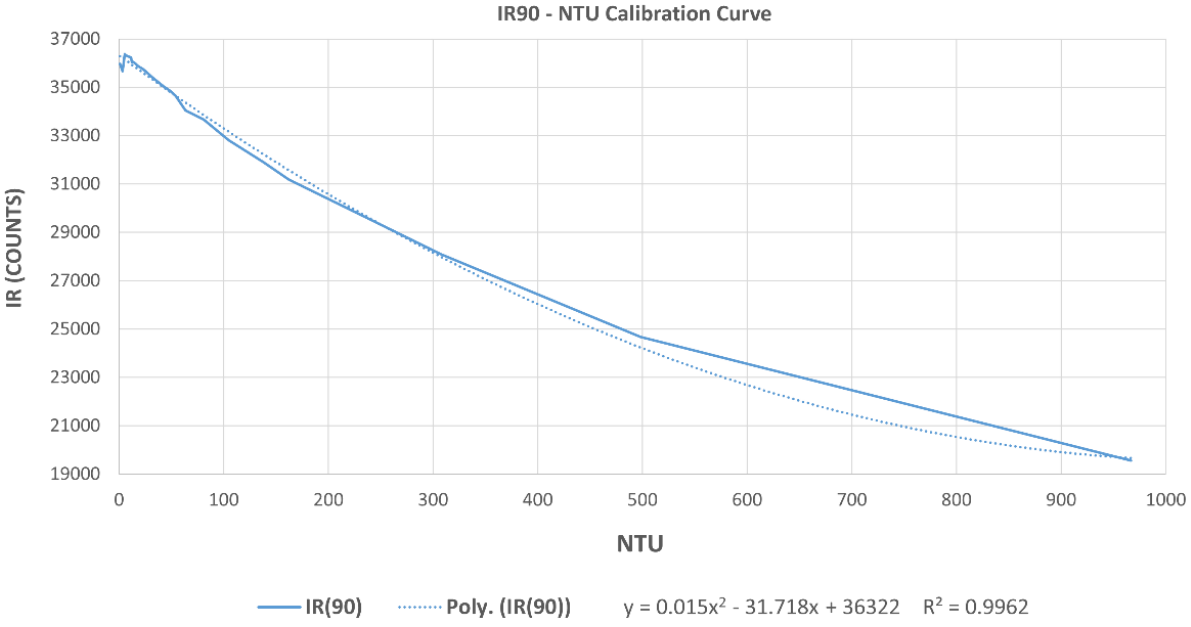

Figure 1 – IR/NTU calibration curve

The first measurement took place shortly after sediment was added into the experiment tank. Due to this sand addition process, a high amount of turbidity was observed in the tank. Over time, the water became clearer as the sediment settled to the bottom. The measurement took exactly 1 week and during this period, the tank was provided with zero ambient light (C=0) and no intervention took place. This measurement routine was repeated every 15 minutes. The measured temperature was measured as the highest 25.46°C, the lowest 23.21°C, and the average 24°C. It was estimated that this temperature change would not make a significant difference in sensor measurements according to temperature dependency experiments. In the week following this study, approximately 30 sea cucumbers (Holothuria tubulosa) were added to the same tank and 4 days later, the sensor setup was placed in the tank. The experiment was continued from the same water source and with the same filtration/circulation. However, in this study, artificial light was given to the environment at 12-hour intervals, like the amount of light in natural environment, so that the species in the tanks could exhibit their natural metabolic activities without being stressed. The experiment in this tank lasted for 1 week like the previous one. As a result of these measurements, a comparison chart was created with the previous empty tank study (Figure 2).

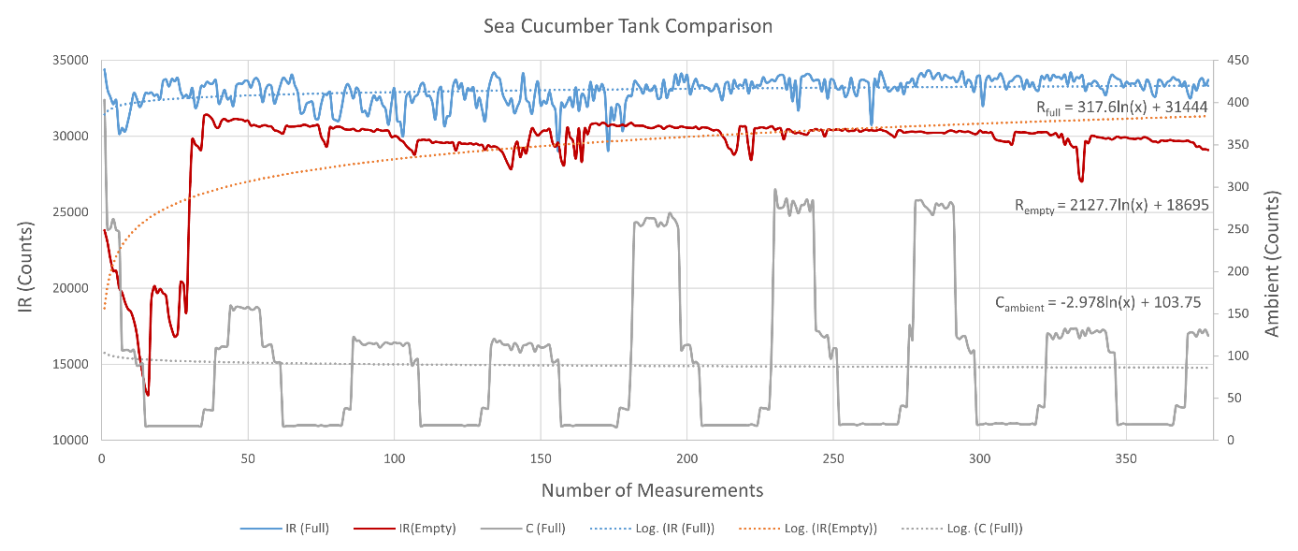

Figure 2 – Sea cucumber tank experiment comparison graphic

As can be seen in the comparison of IR values, there is a significant difference between the IR values in the measurements made in empty and full tanks. While the average photon count in the empty tank was 30014.71, the photon count average in the full tank was 33529.47. It is thought that this difference between the IR values may be due to the water filtering feature of the sea cucumber. In addition, there is a noticeable fluctuation between the two experimental data. While the empty tank follows a linear line, the full tank draws values much above and below this average direction. For this reason, it can be interpreted that the biological vital activity caused by sea cucumbers is detected by the sensor.

DISCUSSION

The data obtained in studies using photonic sensors in sea cucumber tanks gave promising results in terms of more comprehensive studies that can be done in the future. On the other hand, this sensor design can be used in harbor, stream, offshore aquaculture farm environments and large-scale scientific research can be carried out in these fields. Within the scope of this study, it has been seen that the tailor-made optical sensors like this infrared-based turbidimeter have the potential to be used actively in larger fisheries industries.

ACKNOWLEDGEMENTS

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INVESTIGATION OF FISHING GEARS USED TO REMOVAL OF THE INVASIVE Pterois miles FROM TURKISH SEAS

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ABSTRACT

Devil firefish *Pterois miles* that entered the Turkish seas in 2014 is continuing to spread rapidly from east to west and north of the Aegean Sea. Mitigating negative impacts of the invasive lionfish is a top priority for marine resource managers with fishery removals. For this reason, fishing gears that can remove lionfish were examined in detail by the literature, *in situ* observations and fishers interviews. Lionfish also show fearless behaviour towards other fish to divers, making them an easy target for spearfishing. Therefore, spearfishing is currently the primary approach for removing lionfish to mitigate their impacts in coastal areas by tournaments, derbies and festivals. Since lionfish species are caught sporadically on large-scale fishing gears such as bottom trawlers and purse seines, these fishing gears do not effective for removal of lionfish. In field observations, thick net (a kind of trammel net and targets groupers, red porgy etc.) was determined the most effective fishing gear catching of lionfish as by-catch especially in the summer months between Kaş and Göcek. However, traps are the most suitable removal gears that can be effective in stony-rocky deeper areas where nets cannot be set. A non-containment curtain trap (shortly purse trap), developed in US waters, targets only lionfish, has a very low rate by-catch and discard by remaining open during deployment and closing during retrieval. Because unlike other traps, only *Fish Attractive Devices* are used, bait is not used in the trap. It is considered that thick net and purse trap were the most effective fishing gear that removal of the lionfish population. However, the removal efficiency and potential environmental impacts of both fishing gears should be scientifically investigated and improved with field studies. Consequently, we expect the results from the evaluations will help guide management decisions for the potential use of the fishing gears that remove of lionfish in Turkish seas.

Keywords: *Pterois miles*, invasion, removal, trammel net, purse trap

WHAT IF ONE OF THE ACTORS DOESN'T PLAY ITS ROLE IN FISHERIES MANAGEMENT PROCESS? A CASE OF SMALL-SCALE FISHERY IN GÖKOVA BAY, TURKEY

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ABSTRACT

Fisheries management is an integrated process that includes data collection, data analysis, resource allocation, decision making, planning, enforcement, and often stakeholder engagement. Fishery cooperatives, scientists, NGOs, relevant governing authorities, recreational fishing associations, and some other interested users based on where you manage fishery are considered important stakeholders in fisheries management. Representatives of all these fisheries stakeholders came together many times within an FAO-supported project to prepare and implement an Ecosystem Approach to Fisheries Management Plan for the small-scale fishery in Gökova Bay, Turkey. This study aims to show the results that will be encountered if one of the stakeholders does not play its role in the fisheries management process. Within the scope of the FAO project, the relevant FAO template was followed. This included preparation of a baseline report, organizing stakeholder workshops to decide major issues, management systems, preparation and acceptance of the plan. All stakeholders attended these workshops and fulfilled their duties. A management plan based on the Ecosystem Approach to Fisheries which is considered as an appropriate framework for fisheries management was prepared after two-year intensive works of stakeholders. The plan was unanimously accepted and eventually was submitted to the Directorate General of Fisheries and Aquaculture to put it into practice. This initiative was awarded "Best Practice for Co-management of Small-Scale Fisheries" by the FAO-GFCM-EU-WWF. However, after 3 years, the implementation of the plan has still not been acted on. In conclusion, our experience has shown us that even if all stakeholders played their roles in the best possible way, you cannot manage fisheries if the official management authority is not willing to do so. This situation also explains why co-management efforts are sluggish in Turkey. Most likely, official institutions do not want to share their powers and responsibilities with the resource users. Future studies should be planned to question the reasons for this reluctance.

Keywords: Ecosystem approach to fisheries, co-management, fisheries management

ARTISANAL FISHERIES IN THE FOÇA SPECIAL ENVIRONMENTAL PROTECTION AREA

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ABSTRACT

Successful ecosystem-based fishery management is dependent on information gathered on a fishery community's socioeconomics, fishing practices and its interaction with the marine environment. To understand the perspectives and attitudes of the fishery community is crucial to achieve a sustainable fishery and reach conservation goals in marine protected areas. Therefore, this study aims to describe the characteristics of the artisanal fishery community in the Foça Special Environmental Protection Area (SEPA) and provide conservation proposals for the project entitled "Mapping of marine key habitats and assessing their vulnerability to fishing activities in Foça Special Environmental Protection Area, Turkey" within the MedKeyHabitats II project of the Regional Activity Centre for Specially Protected Areas (SPA/RAC). A fisheries questionnaire was prepared and used to interview representatives and members of the Foça fishery cooperative from 21.09.2019 to 16.11.2019. 24 of 97 (25%) registered artisanal fishers were interviewed and a Geographic Information System (GIS) database was created for the fisheries spatial analysis in a grid system of 1x1 km. Fishing grounds, effort, interaction with habitats and species and illegal fishing practices were mapped using this grid system and its related database. The study revealed that the fisher community was mainly comprised of experienced fishers (79% had fishing experience exceeding 20 years), and the fleet composition was of a median vessel age of 23. The gears could be broadly classified into four major categories: lines, longlines, gillnets and shore operated stationary lift nets. The fishing effort was spatially concentrated around the archipelago for 81-122 days per fisher per year. 31 target species were named, and a high interaction with the Mediterranean monk seal and cetaceans was noted. As suspected, illegal fishing practices were widespread and considered seriously detrimental to achieving an ecosystem-based fishery management in the area.

Keywords: Questionnaire survey, socioeconomics, fishing operations, interaction, GIS

PERCEPTION OF EMPLOYABILITY IN FISHERY COOPERATIVES AMONG UNDERGRADUATE STUDENTS OF FACULTY OF FISHERIES

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ABSTRACT

Qualified human resource is crucial for the fisheries sector to continue its activities. The endeavors to solve employment issues in the sector through fishery cooperatives is on current agenda. The purpose of this study is to assess the perceptions of undergraduate students of Ege University Faculty of Fisheries on fishery cooperatives. The study also examines the students' views on the employment potential of fishery cooperatives as human-driven businesses. Towards this aim, 168 undergraduate students, actively continuing education during 2020-2021 spring semester were assessed through online survey. The number of students was calculated according to stratified random sampling. Whether there is a meaningful difference in the willingness of the students to work in fishery cooperatives was calculated with Pearson Chi-square test, while impacting factors thereof were evaluated with logistic regression analysis. Of the students, 89% were willing to work at a fishery cooperative and 99% were willing to be educated on the subject. The students conveyed that through such education, fishery cooperatives would improve the stature (71%) and fairness (68%) of the occupation. 91% ($x2 = 29,113$; $p<0,05$) of the students who were willing to work in the fishery sector and 90% ($x2 = 5,320$; $p<0,05$) of the students who didn't come from a fisher family were observed to be willing to work at a fishery cooperative. The willingness of the student to pay for a seminar/course on fishery cooperatives was observed to depend on the year they are in (Chi-square(7)=45,566;(p=0,001). The foremost subject that the undergraduate students wanted to learn about fishery cooperatives is cooperative management. The results of the study is expected to guide university managements and related decision-makers in eliminating the negative impressions and improving the positive image of fishery cooperatives on students.

Keywords: *Education demands, fishery cooperatives, employment, fishery, cooperative education*

INTRODUCTION

Cooperatives can deliver services required locally, create employment and localize monetary circulation (Bayaner, 2002). ILO reported in 2016 that cooperatives create jobs, investments and contribute to the social and economic development of the entire society (ILO, 2016). The European Union acknowledged cooperatives as an important type of management in terms of creating jobs and employment and issued a declaration titled "On the promotion of co-operative societies in Europe" (EU, 2004). Cooperatives both create and maintain employment. It is known that cooperatives provide jobs to 100 million people and create 20% more employment than multinational companies (Çıkın, 2013).

The "Report on Employment of Fisheries Engineers and Fisheries Technology Engineers in Fisheries Cooperatives" of the Central Associations of Fishery Cooperatives emphasizes that fishery cooperatives are a significant tool in realizing the development of sustainable fisheries (CAFC, 2020) and a major option for addressing employment issues. Previous researches (Ünal et al., 2015; Alkan, 2016; Çımat and Duran, 2018) have also underlined that employing qualified personnel capable of practicing cooperative management is essential for the active involvement of fishery cooperatives in sustainable fisheries.

The purpose of this study is to assess the perceptions of undergraduate students of Ege University Faculty of Fisheries on fishery cooperatives, as well as examine the students' views on the employment potential of fishery cooperatives as human-driven businesses. The study is expected to help fisheries engineers in realizing the employment potential of fishery cooperatives and guide government authorities in determining the necessary steps to take pertinent action.

MATERIALS AND METHODS

The material of the study comprises of the data collected in an online database from surveys conducted with Ege University Fisheries Faculty students in March 2021, under the circumstances of the COVID-19 pandemic during 2020-2021 spring semester. The number of students surveyed was calculated using stratified random sampling (Newbold, 1995; Karagölge and Peker, 2002). Sample space consists of 420 students (total of 1st, 2nd, 3rd and 4th year students) of the Facutly of Fisheries of Ege University. With 95% confidence interval and 5,86% error margin, the sample size calculated was 168. Therefore, from each year, 40% of the students were surveyed. Survey data were evaluated on SPSS 21 software. Frequency distribution, simple average and proportional distribution were calculated in statistical analyses. Pearson Chi-square test and logistic regression (Şenel and Alatlı, 2014) were utilized in order to examine some variable correlations.

RESULTS AND DISCUSSION

43% of the studends were female and %57% were male. At the time of the survey, 94% of the studends were single while 6% were married. Average time of education in the school was calculated to be 2,52±0,13 (min.1-max.10) years. %70 of the students stated that they planned to work in the fisheries sector while 25% didn't have an idea yet. 92% of the students didn't have a fisher family. 55% admitted that they didn't know the exact definition of a cooperative. At least one family member of 5% of the students is a cooperative member. %89 of the students wanted to work in a fishery cooperative. 83% of the students have never visited

a fishery cooperative and 99% have not received any education on fishery cooperative management.

When asked about their thoughts about fishery cooperatives (Table 1), 61% of the students stated that they are not aware of the fishery cooperatives in the area.

Table 1. Student's thoughts about fishery cooperatives

	Yes (%)	No (%)	No idea (%)
I am aware of the fishery cooperatives in my area.	20,2	60,7	19,0
I have knowledge about the fishery cooperatives in my area.	14,3	39,3	46,4
I can give examples of fishery cooperatives in Turkey.	19,0	36,9	44,0
I am aware of the fishery cooperatives in developed countries.	6,5	45,8	47,6
I follow developments about fishery cooperatives.	10,1	45,2	44,6
I know the services offered by fishery cooperatives.	21,4	33,9	44,6
I would like to have education on fishery cooperative management.	54,8	6,5	38,7
Fishery cooperatives have impact on employment.	33,9	4,2	61,9
A fishery cooperative is a suitable establishment to achieve my goals.	24,4	17,9	57,7
I think that fishery cooperatives are democratic establishments.	18,5	7,1	74,4

It's observed that students' willingess to work at a fishery cooperative differs meaningfully from the willingness to work in the fisheries industry (x2 = 29,113; p<0,05). Accordingly, of the students willing to work in the fisheries sector, 91% were also willing to work at a fishery cooperative, whereas among those not willing to work in the fisheries sector, 67% didn't want to work at a fishery cooperative either (Table 2).

Table 2. Relation between the willingness of students to work in the fisheries sector and their willlingess to work at a fishery cooperative.

Willing to work at a fishery cooperative		Willing to work in the fisheries sector			TOTAL
		Yes	*No*	*No idea*	
Yes	Frequency	107	3	39	149
	Percentage (%)	91,5	33,3	92,9	88,7
No	Frequency	10	6	3	19
	Percentage (%)	8,5	66,7	7,1	11,3
TOTAL		117	9	42	168
x^2 = 29,113			s.d = 2, p =0,000		

It was also observed that students' willingness to work at a fishery cooperative differs meaningfully according to whether or not they were coming from a fisher family (x2 = 5,320; p<0,05). 90% of the students who didn't come from a fisher family were willing to work at a fishery cooperative (Table 3).

Table 3. Relationship between coming from a fisher family and willingness to work at a fishery cooperative

Willing to work at a fishery cooperative		Have a fisher family		**TOTAL**
		Yes	*No*	
Yes	Frequency	9	140	149
	Percentage (%)	69,2	90,3	88,7
No	Frequency	4	15	19
	Percentage (%)	30,8	9,7	11,3
TOTAL		13	155	168
x^2 = 5,320			s.d = 1, p =0,021	

Among the topics students were most interested to learn, cooperative management comes first (Table 4).

Table 4. Foremost topics students want to learn about fishery cooperatives

Topics	Not at all interested'	Not very interested	Neutral	Somewhat interested	Very interested	Score	Rating
	1	*2*	*3*	*4*	*5*		
Fishery cooperative management	*10,1*	*3,0*	*6,5*	*54,2*	*26,2*	*383,4*	*1*
Marketing in a fishery cooperative	*9,5*	*5,4*	*6,5*	*50,6*	*28,0*	*382,2*	*2*
Fishery cooperative system in Turkey	*10,7*	*2,4*	*8,3*	*52,4*	*26,2*	*381,0*	*3*
What is a fishery cooperative and what is its function?	*11,3*	*3,6*	*6,5*	*50,0*	*28,6*	*381,0*	*4*
Examples of fishery cooperatives abroad	*11,9*	*3,0*	*7,7*	*49,4*	*28,0*	*378,6*	*5*
Examples of successful fishery cooperatives	*10,1*	*4,2*	*6,5*	*55,4*	*23,8*	*378,6*	*6*
Project opportunities in fishery cooperatives	*10,1*	*5,4*	*6,0*	*54,2*	*24,4*	*377,7*	*7*
Auditing Fishery cooperatives	*10,1*	*3,6*	*8,3*	*56,5*	*21,4*	*375,2*	*8*
Principles of fishery cooperatives	*10,7*	*3,6*	*11,3*	*50,0*	*24,4*	*373,8*	*9*
History of fishery cooperatives	*13,1*	*6,5*	*13,7*	*48,8*	*17,9*	*351,9*	*10*

Results convey that 93% of the students would like to take “fishery cooperatives” as an undergraduate class. 61% of the students were willing to pay for a course/certificate program on cooperatives. Table 5 shows the willingness of students to pay for a course/certificate program on cooperatives according to years of education. 1st, 2nd and 3rd year students were observed to have more willingness to pay for a course/certificate program on cooperatives whereas 69% of the 4th grade students are not willing to pay for such education.

Table 5. Logistic regression analysis on willingness to pay for a course/certificate program on cooperatives depending on years of education

Variable	β	Std. Error	p-score	inclination
Constant	-3,226	1,653	0,050**	0,040
Sex	-0,422	0,386	0,274	0,656
1st year students			0,000***	
2nd year students	-2,444	0,46	0,000***	0,087
3rd year students	-1,881	0,563	0,001***	0,152
4th year students	-0,691	0,547	0,206	0,501
Willingness to work in fisheries sector	-0,117	0,226	0,605	0,890
Fisher family	-0,157	0,667	0,813	0,854
Willingness to take education on fishery cooperatives	0,313	0,803	0,697	1,368
Willingness to work at a fishery cooperative	0,961	0,603	0,111	2,615

Likelihood ratio test:Chi-square(7)=45,566;(p=0,001) ***%1,**%5, *%10 level significance respectively.

DISCUSSION AND CONCLUSION

As an attempt to assess the views of undergraduate students of Ege University Fisheries Faculty on the functions and employment opportunities of fishery cooperatives, the results of this study has revealed that students are willing to work at fishery cooperatives and have education on this subject. It's observed that students (99%) don't receive education on fishery cooperatives in their undergraduate years. There is no fishery cooperative course/education/curriculum program in 17 fishery faculty undergraduate programs (The Council of Higher Education Atlas, 2021). Similar studies conducted with fishers (Ünal et al. 2015; Çımat and Duran, 2018) showed that cooperative members, employees and managers do not have enough formal education on cooperatives either. Findings of the study conforms with Alkan (2016)'s study that cooperatives can provide emloyment for qualified personnel who can serve members and such employment ensures complete and timely service of the cooperative. Fisheries engineers working as qualified personnel in fishery coopeartives (Yelişayer et al, 2016) shall benefit both the cooperative and the recently graduated engineer mutally in terms of employment. Therefore, it is substantial for courses on fishery cooperatives to be included in the fishery faculty curriculum. Moreover, similar to the employment of agricultural advisors (Oğuz, 2010) in agricultural cooperatives as an initiative of the Ministry of Agriculture and Forestry, government bodies such as the General Directorate of Fisheries and Aquaculture and Department of Training And Publication should work together to commence programs to employ fishery engineers in fishery cooperatives.

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MORPHOMETRY OF STRIPED VENUS CLAM (Chamelea gallina L., 1753) IN WESTERN BLACK SEA

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ABSTRACT

In this study, about 10.000 striped venus clams (*Chamelea gallina*) were collected in winter and spring, in the production fields, parallel to Black Sea coastline of the county Kandıra, Kocaeli through six months. Consisting of September 2019-February 2020; 600 of these C. gallina were analyzed from the aspects of length, weight, length-weight relationship and condition factor. After all measurements, mean length and weight were 17,9±0,20 mm and 2,06±0,73 g respectively. Maximum length was measured 24,7 mm in September and minimum length was 13,0 mm in November, maximum weight was 5,18 g in September and minimum weight was measured 0,70 g in November. Total weight dispersion was between 1,6-1,8 g (%43), total length dispersion was centered between 17,0-18,0 mm (%23). When the regretion balance of length-weight relationship was analyzed for six months, the maximum regretion constancy (b) was identified 2,9502 in November and the minimum regretion constancy was identified 2,5466 in October. In the light of these surveys, it has been identified that C.gallina samples have a negative allometric growth in length-weight relationship.

Monthly, condition factor (K) was estimated 35,8±3,1 in September, 33,2±3,1 in October, 34,1±3,7 in November, 34,4±2,8 in December, 34,1±2,7 in January and 35,7±3,6 in February.

For the measurement of all 10,037 samples, total weight is 20.798 kg, total shell weight is 13.774 kg and total weight of raw meat is 7.024 kg. The efficiency in meat is measured %33,8.

Keywords: *Chamelea gallina*, condition factor, length-weight relationship, meat-efficiency, striped venus

INTRODUCTION

Chamelea gallina is a bivalve in the family Veneridae (Demircan, 2007) and the shell is spandrel oval named as 'cik cik' in public (Deval, 1995). In our country, some prohibitions and limitations were taken in 1986 to protect the stock status of C. gallina in Sea of Marmara by Ministry of Agriculture and Forestry (Ölmez et al., 2003). Fishing of C. gallina is forbidden in all the fields between April 15th and September 30th, and the minimum landing size is 17 mm. Economically-important C. gallina provides foreign currency inflow in the exportation of fisheries (Demircan, 2007). Our country gets the demand of C. gallina for many European countries and especially for Italy.

In this study, length, weight, length-weight relationship, condition factor and meat-efficiency have been investigated on the samples gathered from production fields of C. gallina, in the Black Sea coast (Kandıra, Kocaeli).

MATERIAL AND METHOD

This study includes totally 10.037 samples of *Chamelea gallina* L., 1753 collected from the production fields, parallel to Black Sea coastal line in the county of Kandıra, Kocaeli.

600 samples, collected in September, October, November, December, January, February of 2019-2020 years were measured monthly and their length, weight, length-weight relationship and condition factor were investigated. Microbalances of 0,01g (AND GX-600, Japan) and digital caliper of 0,01 mm (Mitutoyo, Japan) were used for both weight and length measurements. Meat-efficiency of all the samples were calculated.

To define length-weight relationship;

$TW = a\,TL^{b}$ equality (Ricker, 1975).

This equality reveals;

TW= weight of clam (g), TL= length of clam (mm), a= intersection, b=slope

To calculate condition factor of C. gallina, $K=\frac{TW}{TL^3}\times 100$ formula was used. (Pauly, 1984).

For percent of meat –efficiency = edible meat (g)/ (live weight) (g) x 100 formula was used (Ölmez et al., 2003).

RESULTS

The pattern of total length in 600 samples was centered between 17,0 and 18,0 mm (%23). Mean length was determined as 17,9±0,20 mm. Mean weight was measured 2,06±0,73 g and pattern of total weight was centered between 1,6 and 1,8 g (%43). Maximum, minimum and mean length and weight in the months this study covers are given in Table 1. Through this study, maximum length 24,7 mm and maximum weight 5,18 g were measured in September. Minimum length 13,0 mm and minimum weight 0,70 g were measured in November. For the condition factor measurements, this value is between 33,2 and 35,8±3,1 (Table 1).

Table 1. Data on maximum, minimum and mean (mm) and weight (g) and condition factor for months

Months	Sample number	Maximum length (mm)	Minimum length (mm)	Mean length (mm)	Maximum weight (g)	Minimum weight (g)	Mean weight (g)	Condition factor
September 2019	100	24,7	15,2	19,6±0,19	5,18	1,32	2,74±0,74	35,8±3,1
October 2019	100	20,2	14,0	17,2±0,13	2,48	0,89	1,71±0,35	33,2±3,1
November 2019	100	23,2	13,0	17,0±0,19	4,95	0,70	1,72±0,63	34,1±3,7
December 2019	100	20,2	14,3	17,0±0,13	2,85	1,03	1,70±0,39	34,4±2,8
January 2020	100	24,1	16,7	20,0±0,16	4,92	1,60	2,76±0,68	34,1±2,7
February 2020	100	21,1	14,6	16,9±0,12	3,24	1,04	1,74±0,39	35,7±3,6
Mean	**600**	**24,7**	**13,0**	**18,0±0,20**	**3,94**	**1,10**	**2,06±0,53**	**34,6±3,2**

The “b” value, which is the regression constant value of the lenght-weight relationship, expresses the allometric or isometric growth of the organism. In allometric growth, if the "b" value is greater than 3, it is positive allometric growth, and if the "b" value is less than 3, it is negative allometric growth; in isometric growth, the “b” value is equal to 3 (Köseoğlu, 2005). When the regression analysis equation of length-weight relationship was investigated, the regression constancy was determined (b) 2,5860 in September, 2,5466 in October, 2,9502 in November, 2,8327 in December, 2,7784 in January and 2,7491 in February (Table 2).

Table 2. Regression analysis of length-weight relationship

Month	$W=aL^b$	r^2	a	b	Growth
September 2019	$W=12\times10^{-4}L^{2,586}$	0,9170	12×10^{-4}	2,586	Negative allometric
October 2019	$W=12\times10^{-4}L^{2,5466}$	0,8267	12×10^{-4}	2,547	Negative allometric
November 2019	$W= 4\times10^{-4}L^{2,9502}$	0,8993	4×10^{-4}	2,950	Negative allometric
December 2019	$W= 5\times10^{-4}L^{2,8327}$	0,8720	0 5×10^{-4}	2,833	Negative allometric
January 2020	$W=7\times10^{-4}L^{2,7784}$	0,8928	8 7×10^{-4}	2,778	Negative allometric
February 2020	$W = 7\times10^{-4}L^{2,7491}$	0,7635	7×10^{-4}	2,749	Negative allometric

Total weight was 20.798 kg, total shell weight was 13.774 kg and total weight of raw meat was 7.024 kg in all 10,037 spicemens. Meat-efficiency of C.gallina was calculated %33,8.

DISCUSSION

Mean length 17,9±0,20 mm and mean weight 2,06±0,73 g were measured in this study. Alpbaz and Önen (1989) measured that the mean length of C. gallina was 27,0–30,0 mm and the mean weight was 10-11 g (Çolakoğlu, 2011). Demircan (2007) stated that 1640 C. gallina samples had maximum 29,0 mm, minimum 11,0 mm length. When studied on total weight, minimum was 0,35 gr, maximum weight was 6,8 gr. Maximum condition factor was estimated in September, minimum was in October. In the study on striped venuses, maximum condition index was in June and September (Dalgıç, 2006).

In this study, meat-efficiency was calculated %33,8. Demircan (2007) determined the rate of meat-efficiency in 1640 C. gallina samples was measured %14,6 - %18,1.

The six-month-old data demonstrates that the length-weight relationship has negative allometric growth. Çolakoğlu (2011), determined C.gallina samples had negative allometric growth (b<3). Köseoğlu (2005) determined 963 C.gallina samples had negative allometric growth (b=2,91).

According the some previous study, the length and weight values of C.gallina decrease gradually. So, it is necessary to overcome with prohibitions, wrong and excessive fishing to protect the stocks of C.gallina. The fishing pressure has to be diminished. The fishing policies based on time and field (prohibitions, limitations vs.) will be protected the stocks of striped venus clams.

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Advanced processing technologies and impact on the quality of seafood products

MICROSTRUCTURAL AND BIOCHEMICAL CHANGES ON Holothuria tubulosa COLLAGENS AFTER HYDROLYZATION PROCESS

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ABSTRACT

Collagen as the most important biochemical constituent in sea cucumbers was investigated to reveal better utilization from the Mediterranean economic species namely *Holothuria tubulosa*. Modified collagen isolation procedures were applied to the body wall of the species and obtained collagen was hydrolyzated using pepsin and a combination of pepsin-trypsin enzymes. The changes in the microstructures of obtained hydrolysates were visualized using scanning electron microscopy (SEM) and Fourier transform infrared spectrophotometry (FTIR), while biochemical changes were revealed by determining amino acid residues, element composition, and total atomic masses from predetermined areas. Collagen was successfully isolated at high purity, and the activities of pepsin and pepsin-trypsin improved the purity while changing the amino acid profile and the surface atomic composition. The effects of both enzymes were especially seen as reducing the mass sizes of fibrils in SEM analysis. Typical Amide-A (3284 cm-1), Amide-B (2971 cm-1), and Amide-I-II-III (1636-1541-1239 cm-1) peaks were observed in FTIR analysis, however, more intense peaks from stretching of primary C=N bonds (between 1020 and 1090 cm-1) were additionally observed in PSC and trypsin hydrolysate. Elemental composition focused especially on toxic metals was significantly reduced by hydrolyzation process. A significant reduction was observed at residues of some amino acids such as threonine, serine, and leucine, while the residues of glycine and hydroxyproline as major constituents of collagen were found at higher levels after trypsin hydrolyzation. Results showed that the potential of *H. tubulosa* species could be improved for better utilization capacities if the necessary fundamental, technological, and scientific approaches were performed.

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Keywords: *Holothuria tubulosa,* collagen, hydrolyzation, microstructure

QUALITY OF PASTA FORTIFIED WITH SHRIMP BY-PRODUCTS FLOUR

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ABSTRACT

Shrimp peeling waste could be a good source for producing high quality food. They are potential sources of calcium. Transforming them into powder and using for fortification of food is highly beneficial for human health. Pasta is one of the world's favorite food all consumed by all ages and all countries. The aim of this study was to develop high nutritional, and sensory acceptable pasta from by-products of shrimp.

The raw materials (shrimp shells) were obtained from processing plant. After cleaning process, they were packed in polyethylene bags and stored at -18˚C for 1 week. They were thawed in the refrigerator overnight and then they were steamed by using autoclave and then dried. The dried samples were then subsequently milled into uniform powder which was used as an ingredient with concentration of 10 and 15% to form determined pasta formula. Pasta were then subjected to further analysis such as chemical composition, calcium content, physicochemical (pH), physical (cook loss, water absorption and color), microbiological (total aerobic plate count, yeast and mold) and sensory profile to determine the effect of adding different concentrations of shrimp by-product flour on pasta.

Keywords: Shrimp, by-products, pasta, quality

MARINATION OF THE RAINBOW TROUT FILLETS (Oncorhynchus mykiss) WITH KEFIR

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ABSTRACT

In this study, rainbow trout (Oncorhynchus mykiss) fillets were marinated with kefir in refrigerated conditions. The determination of the microbial loads of trout fillets during storage at 4°C and the effects of probiotic bacteria in kefir on the microbial ecology of trout fillets were also investigated. Trout fillets were purchased from the market and then they were cut into approximately 10 g of portions. They were divided into groups, which were marinated with kefir and non-marinated groups (control group). After that, trout fillets were marinated at the ratio of (1:1) trout: kefir by using kefir for 30 minutes at 4°C. All of the groups were stored at 4°C. Microbiological (total mesophilic aerobic bacteria, E. coli, psychrophilic bacteria, coliform, yeast-mold, Vibrio spp., Salmonella spp., proteolytic) and sensory (cooked and uncooked) analyses were done on the storage days of 0, 1, 3, 6, 8 and 10. As a result of this study, Vibrio spp. and Salmonella spp. were not determined in any of the examined samples. As a result of the microbiological evaluations, it was determined that the shelf-life of the marinated group with kefir was determined more longer, when compared with the non-marinated group. Trout fillets marinated with kefir were determined as acceptable on the eighth day of storage, whereas the control group was exceeded the limit of consumption on the sixth day. Marination of trout fillets with kefir improved the sensory quality (color, taste, texture and appearance) of trout fillets. According to the sensory analyses, trout fillets marinated with kefir were determined more preferred than the control group according to the panelists.

Keywords: *Oncorhynchus mykiss*, kefir, microbial ecology

DETERMINATION OF QUALITY PARAMETERS OF PASTRY WITH ANCHOVIES

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ABSTRACT

Nutrition is the basis of physiological needs. Protein, fat, carbohydrates, minerals and vitamins are the nutrients that should be taken daily to meet the nutritional needs. Fishery products, on the other hand, have an important place in nutrition by containing these nutrients. Aquaculture is the product group in which microbiological, physical and chemical deterioration occurs the fastest. In order to minimize the deterioration process, seafood-based foods are preserved by methods such as freezing, drying, canning, smoking, salting. In this study, a recipe has been developed for anchovy in the category of seafood, in order to gain consumer appreciation and to present its quality parameters to consumption with the least variable. In the study, pH, water activity (aw), dry matter, moisture content, L (brightness), a (red-green), b (yellow-blue) color values were examined in order to determine the physical quality parameters of pastry with anchovies. TVB-N, TBA analysis was performed to determine the chemical quality. Sensory analysis was carried out to reveal consumer taste. pH, water activity, L, a, minimum and maximum values of pH, water activity, L, a, analysis of pastry with anchovies samples that can be prepared are 5.38 – 5, 0.9185 - 0.9338, 34.4 – 46.1, 4 .3 – 10.0, 13 .7 – 31.2, dry matter value was 68.25% and moisture content was 31.75%. The mean values of TVB-N and TBA were found to be 10.56 mg/100g and 5.05 mgMA/100g, respectively. As a result of the sensory analyzes made, one hundred percent of the participants stated that they could purchase the product within the scope of marketing. According to the data obtained after the study, it has been determined that while developing different recipes for anchovy, which is the most important product of our country in aquaculture, nutritional quality can be preserved, an industrial product contribution can be provided as frozen ready-made food and it will allow to increase the amount of consumption for healthy nutrition.

Keywords: Aquaculture, anchovy, pastry, quality parameters

TRADITIONAL FISH PROCESSING TECHNIQUES APPLIED IN THE PHILIPPINES AND TURKEY

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ABSTRACT

The exploitation of aquatic resources has been a practice for the past decades utilize as food sources. The diverse aquatic resources of a country are economically important in providing food, income, foreign currency, and job opportunities for its population, especially when under sustainable exploitation. The utilization of aquatic resources efficiently through the application of effective processing technology has been said to be one way of reducing shortages between demand and production as well as post-harvest losses and wastage. In this paper, using the available articles, we reviewed and compared the traditional fish processing techniques applied in the Philippines and Turkey. Traditional fish processing techniques such as salting, drying, smoking, and pickling/marinating are common in both countries, which varied in terms of finished products with more innovation in the Philippines since this country is rich in aquatic resources. Fermentation is widespread in the Philippines with unique finished products such as *bagoong* and *patis* but seemed to be lacking in Turkey based on literature.

Keywords: Philippines, traditional fishing processing, Turkey

EFFECT OF SEASONS ON BIOCHEMICAL COMPOSITION AND COLLAGEN LEVEL OF Holothuria (Roweothuria) poli

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ABSTRACT

Holothuria poli is an economic sea cucumber species found in the Mediterranean. This species has been extensively exploited in Turkey seas to meet the international market demand in the last decade. The present study was designed to determine the changes in biochemical compositions and the collagen levels and pepsin soluble collagen yields of the body wall of *H. poli* according to seasons. It was determined that the percent levels of moisture, protein, fat, ash and carbohydrate levels were in the range of 80.8 – 84.0, 7.6 – 10.1, 1.4 – 1.8, 6.2 – 7.1, and 0.2 – 0.8, respectively. The lowest collagen yield in 100 g wet weight of body wall was determined as 5.14 % in winter samples and the highest yield was determined as 6.32 % in summer samples. Slight differences in mean collagen yields were observed according to five predetermined length frequencies. Pepsin soluble collagen yields (PSC) ranged between 1.52 – 2.15 % of the wet weight body wall and the highest PSC yields were observed at 5% enzyme:substrate ratio in the winter samples. This study demonstrated that the biochemical composition, collagen and PSC yield could be varied by seasons in *H. poli*. Further studies could be performed to reveal similar changes and to provide better utilization strategies for this species.

Acknowledgement: This work was supported by Çanakkale Onsekiz Mart University, Scientific Research Coordination Unit with FBA-2019-2977 project number.

Keywords: *Holothuria poli*, collagen, pepsin solubilized collagen, biochemical composition, seasons

DETERMINATION OF PHYSICAL QUALITY CHARACTERISTICS OF TURKISH RAVIOLI WITH ANCHOVY

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ABSTRACT

Today, the importance of a healthy and balanced diet is increasing. With the awareness of consumers, more attention is paid to food selection and the orientation to healthy foods increases even more. Aquaculture is one of the most important foods in terms of human health and balanced nutrition. The balanced nutritional content, especially the fact that it contains essential amino acids and omega-3 fatty acids, makes aquaculture valuable. However, against all these positive characteristics, seafood consumption in our country has lagged behind the world average. The average consumption of fish per capita in the world is 16 kg, in the European Union this number is 22 kg and in Turkey it is 6.1 kg. Some studies are being carried out to increase the fish consumption rate in our country. It is thought that the per capita fish consumption rate in our country can be increased thanks to the new food products produced by preparing the contents of the dishes, which are preferred in consumption or are highly appreciated locally. In this study, a new variety of ravioli, which is one of the most admired dishes in our country, was made with anchovies content. The physical quality characteristics of Turkish ravioli with anchovy were determined. Average pH, water activity (aw), dry matter, L (brightness), a (red-green), b (yellow-blue) values of cooked Turkish ravioli with anchovy were calculated. These values were calculated as 5.61±0.02, 0.9710±0.01, 44.15±0.37, 28.01±3.26, 6.31±1.84, 21.83±2.42, respectively. In the sensory test, it was determined that 93.33% of the participants could buy Turkish ravioli with anchovy.

Keywords: Seafood, anchovy, Turkish ravioli, physical quality

DETECTION OF THE PRESENCE OF Listeria monocytes IN FISH RETAIL SALES AREAS

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ABSTRACT

Listeria monocytogenes is an important food-borne pathogen and is widely found in nature. Many industrialized countries are concerned about the presence of this pathogen in food, especially in ready-to-eat foods. Seafood is also among food sources that can contain *L. monocytogenes*. In this study, the presence of L. monocytogenes was examined by collecting samples from fresh or cooked (ready-to-eat) items in several seafood retail regions. The samples were obtained from four distinct locations (bench, employees' hands, cleaned and cooked seafood) in three different retail areas. Samples were gathered during the fall, winter, spring, and summer seasons. The presence of *L. monocytogenes* was investigated in the samples brought to the microbiology laboratory and, if detected, the species was confirmed. There was no intense *L. monocytogenes* in the samples. In the autumn samples, in two of the three enterprises, samples taken by swap method from the cleaning bench were; 2.1 LogKOB/100cm^2 and 1.2 LogKOB / 100cm^2 *L. monocytogenes* were detected. However, *L. monocytogenes* was not detected in samples taken from cleaned (prepared for cooking / sale) seafood and samples from cooked (ready for consumption) seafood. *L. monocytogenes* could not be detected in winter, spring and summer samples.

Acknowledgement: This project (17-SÜF-020) was supported by Ege University BAP Coordination Unit.

Keywords: *Listeria monocytogenes*, food-borne pathogen ready-to-eat food, seafood retail.

EFFECTS OF MODIFIED ATHMOSPHERE PACKAGING ON THE STORAGE PERIOD OF STUFFED MUSSELS

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ABSTRACT

Stuffed mussel is a ready-to-eat seafood product usually sold by street vendors in Turkey. Stuffed mussels are traditionally cooked with a pot which contains mussel meat, spices, rice and sometimes pine nuts and currants can be added. In this study, to produce stuffed mussels (*Mytilus galloprovincialis*), the "steam cooking" technique was chosen with using *a* steamer. Modified atmosphere packaging technique was preferred for the study. Gas ratios of *the* modified atmosphere were as follows; Group A: 90% nitrogen (N)- 10% carbon dioxide (CO_2), Group B: 70% N- 30% CO_2, Group C: 60% N- 40% CO_2 and Group D: Filled with *an* ambient atmosphere (control group). After production, samples were stored at cold storage temperatures (0, +2 oC), and analyses, microbiological assessments, and sensory evaluations were performed to monitor quality differences between groups. (The Total Volatile Base Nitrogen analysis (TVB-N mg/100gr) revealed that Group B and Group D (control) exceeded the consumption limit on days 31 and 27, respectively) Trimethyl Amin Nitrogen (TMA-N, mg TMA-N/100gr) value of Group A was found to be higher than Group B and C and lower than Group D *on* the last day of cold storage. Furthermore, the shelf life of Groups was evaluated based on chemical quality and sensory analysis, where the microbiological counts for all groups did not reach the consumption limit value for processed seafood (6 log cfu g-1) during the study. However, psychrophilic bacteria counts of rice and mussel meats groups were exceeded 5 log cfu g^{-1} *on days* 29 and 31.

Keywords: *Mytilus galloprovincialis*, Stuffed mussel, modified atmosphere packaging, chemical quality, microbial quality

THE EFFECTS OF MUCILAGE ON THE HUMAN HEALTH AND FISHERY PRODUCTS

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ABSTRACT

Mucilage is known as thick stratification formed on the surface of the sea. It is not completely considered as a pollution and it causes negative effects as a result of activities in the sea. In recent years, it is often observed, especially on the shores of the Marmara Sea in Turkey. This stratification formed by mucilage forms a habitat for different types of bacteria on the sea surface and on the seafloor. As result of the accumulation of inorganic and organic substances in the content of mucilage accumulated on the surface and floor of the sea, it leads to the formation of microbial flora that will negatively affect on human health. In addition, the mucilage layer breaks the contact of the sea and atmosphere, causing a decrease in dissolved oxygen in the water. It threatens not only the lives of all living creatures in the sea with a decrease in oxygen but also marine, fishing and tourism sectors are negatively affected by mucilage. In this study, aspects on the causes of mucilage formation, waste sources, distribution routes of the pollution, the effects on fishery products and human health will be compiled. In addition to this, the pathogenic bacteria in the mucilage and the effects of these pathogenic bacteria on human health will be emphasized. Moreover, information about what should be done to prevent mucilage, what precautions can be taken, ways to solve this problem and their impacts on humans, who cantact with seas containing mucilage, will be given, respectively.

Keywords: Mucilage, human health, fishery products, pathogenic bacteria

INVESTIGATION OF IN VITRO ANTIMICROBIAL ACTIVITY OF GARLIC EXTRACT AGAINST TWO IMPORTANT FOOD-BORNE PATHOGEN BACTERIA

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ABSTRACT

Garlic (*Allium sativum* L.) is one of the most important plants widely used all over the world. It also contains bioactive compounds especially, allicin, other organosulfur, and phenolics, having antimicrobial and antioxidant potential in fish and seafood products. The purpose of the study is to investigate the in vitro inhibitory effect of garlic extract on two important food-borne pathogen bacteria (*Staphylococcus aureus* and *Salmonella* Paratyphi A). Garlic extract was obtained using the maceration method with minor modification. Antimicrobial activity of garlic extract was carried out using the well diffusion method. Garlic extract was extremely effective on *Salmonella* Paratyphi A and *Staphylococcus aureus* with the high inhibition zone diameter of 32.33 and 19.33 mm. These results showed that garlic extract presented a noticeable antimicrobial activity against two important food-borne pathogen bacteria and thus, garlic extract may have the potential to be used as a natural antibacterial agent in fish and seafood products.

Keywords: Garlic extract, antimicrobial activity, seafood safety, food-borne pathogens, well diffusion

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EGE UNIVERSITY FACULTY OF FISHERIES, İZMİR

Aquatic Biodiversity

FISH BIOMASS ESTIMATION BY UNDERWATER VISUAL CENSUS METHOD IN THE FOÇA SPECIAL ENVIRONMENTAL PROTECTION AREA

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ABSTRACT

The state of native fish populations and their habitat is an important concern in coastal/marine protected area (CMPA) management. In addition to several other variables related to fisheries, fish biomass data can be used for assessing the production capacities of both commercial and noncommercial species within a system. This study aims to estimate the fish biomass in the 0-50 m depth interval of the Foça Special Environmental Protection Area (SEPA) in order to provide conservation proposals related to fish and their habitats for the project entitled "Mapping of marine key habitats and assessing their vulnerability to fishing activities in Foça Special Environmental Protection Area, Turkey" within the MedKeyHabitats II project of the Regional Activity Centre for Specially Protected Areas (SPA/RAC). The study was performed in November 2019 with R/V Dokuz Eylül 3 of the Institute of Marine Sciences and Technology of Dokuz Eylül University. The underwater visual census (UVC) method was applied at six stations in three different depth strata (5-10-20 m) with four replicates. The stations were selected to represent hard, soft and meadow habitats. During UVC, the total number of individuals and lengths of fish, depth, slope and characteristics of the bottom structure were recorded. The spatial distributions of hard, soft and meadow habitats were obtained from the geomorphological units defined within the project and their sub areas representing three depth strata was calculated using Geographic Information System (GIS). In this study, 25 fish species from 10 families were observed. Biomass was estimated as approximately 16 tonnes/km2 in the 5-meter depth strata, 12 tonnes/km2 in the 10-meter depth strata and 26 tonnes/km2 in the 20-meter depth strata. The total fish biomass was calculated as 463,677.6 kg in 17.77 km2 of the study area.

Keywords: Fish biomass, UVC, CMPA, GIS

AGE AND GROWTH OF THE HOLLOWSNOUT GRENADIER, Coelorinchus caelorhincus (Risso, 1810), IN ANTALYA BAY (EASTERN MEDITERRANEAN)

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ABSTRACT

This study reports the preliminary findings on the age and growth of the hollowsnout grenadier (*Coelerinchus caelorincus*) sampled during monthly trawl surveys in Antalya Bay (Eastern Mediterranean) between July 2016 and July 2017. A total of 2503 (712 females, 630 males and 1161 undetermined) *C. caelorincus* specimens were collected at depths of 200-500 m. Pre-anal length (PAL) and total weight of the sampled fish ranged between 1.1-7.5 cm and 0.6-73.1 g, respectively. The pre-anal length-weight relationship for the whole sample was $W = 0.2566 PAL^{2.7411}$ ($r^2 = 0.79$) and indicated a negative allometric growth. Age determinations were based on 411 otolith readings and ranged from 1 to 10 years. The von Bertalanffy growth parameters were: L_∞ = 10.87 cm, K = 0. 0943 $year^{-1}$ and t_0 = -0.977 year. Even though slight differences have been observed in the growth parameters results, estimated by other studies in the other authors part of in Mediterranean Sea, the age range, long life span, growth parameters, showed similarities.

Keywords: *Coelorinchus caelorhincus,* hollowsnout grenadier, age, growth , Antalya Bay, Eastern Mediterranean

BIANNUAL BENTHIC ZONE IMAGING OF THE MIDDLE AND INNER PARTS OF IZMIR BAY BETWEEN FALL 2014 AND SPRING 2016

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ABSTRACT

Benthic zone of the inner and middle parts of Izmir Bay was visually observed within the frame of a monitoring project by means of GoPro Hero 3 Black Edition underwater camera and 2 Bigblue VTL2500P underwater video light sources are mounted on the equipment developed for underwater imaging. Four stations were selected and biannually monitored between Fall 2014 and Spring 2016 in the region where the circulation and navigation channels planned to be built in the inner and middle parts of the bay. According to the video images obtained from 4 stations, the Stations 3 and 4 in the middle bay give a much better impression in terms of biodiversity and ecological quality than the Stations 1 and 2 located in the inner bay. Significant seasonal fluctuations were observed especially at the Stations 1 and 2, and an increase in species diversity was detected in April samplings compared to September samplings. Especially, in the images obtained in the April 2016 sampling at the Station 2, it was seen that the macro-zoobenthic diversity increased considerably and the tubes of *Pseudopolydora paucibranchiata* and *Polydora cornuta*, which are foreign polychaete species, covered the ground.

Keywords: Underwater imaging, Aegean Sea, İzmir Bay, benthos, alien species

EFFECTS OF BENZYLPARABEN ON SEA URCHIN Arbacia lixula BY EMBRYOTOXICITY TEST

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ABSTRACT

Chub Parabens started to be used for the first time in the 1920s as a preservative in pharmaceuticals and increased production and use of preservatives in many food and industrial materials, especially in cosmetics. Despite the rapid degradation in aquatic environment, paraben varieties which are more permanent chlorine derivatives which are degradation products can accumulate in sediments and living organisms. Although studies have been conducted in various human cell cultures and experimental animals, studies on their effects on aquatic organisms are scarce. In the current study the effects of parabens derivative Benzylparaben on sea urchin using *Arbacia lixula* species was investigated. The embryotoxic, spermiotoxic and genotoxic effects of benzylparaben has been demonstrated. Millions of eggs increase the reliability of the experiments statistically. Furthermore, sea urchin embryos provide the opportunity to work with a living metazoon. These trials; cheap, short-term, reliable and sensitive are important features. In embryotoxicity experiments, deterioration occurred in sea urchins that passed to larval stage after fertilization and were exposed to paraben variety Benzylparaben. According to our result the EC_{50} value was 0,446 mg/l which makes us think that Benzylparaben could have pressure on marine ecosystems.

Keywords: Bioassay, sea urchin, embryotoxicity, Benzylparaben

DETERMINATION OF BENTHIC MACROINVERTEBRATE FAUNA OF BAKIRÇAY RIVER WITH SOME PHYSICO-CHEMICAL PARAMETERS

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ABSTRACT

Turkey has 25 main hydrological basins and one of them is North Aegean Basin. Bakırçay River is the longest one in the basin and its length is about 129 km. The present work aimed to investigate the benthic macroinvertebrate fauna of Bakırçay River. 15 different sampling stations (4 lentic, 11 lotic) were selected and 4 field works were conducted between October 2017 and July 2018, seasonally. Macrobenthic samples were collected by a 500 µm mesh sized kick-net in lotic biotopes, and an Ekman-Birge bottom sampler in lentic biotopes. During the field studies, physical and chemical parameters about the sampling stations (water temperature, pH, dissolved oxygen, salinity and conductivity) were measured with WTW Multi 3430. As a result of biological studies, a total of 135 benthic macroinvertebrate taxa were identified including 4 Hirudinea, 25 Oligochaeta, 14 Mollusca, 5 Malacostraca, 14 Ephemeroptera, 32 Diptera, 10 Trichoptera, 12 Coleoptera, 6 Hemiptera, 2 Plecoptera and 11 Odonata.

Acknowledgement: This study presented some parts of the project (16/SÜF/038) which was supported by Ege University Scientific Research Projects Coordination (BAP).

Keywords: Bakırçay River, benthic, macroinvertebrate, fauna, biodiversity

EVALUATING THE EFFECTS OF ERFLUOROOCTANE SULFONYL FLUORIDE ON FRESHWATER ALGAE POPULATIONS BY ALGAL GROWTH INHIBITION TEST

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ABSTRACT

Pollution of the aquatic environment caused by persistent organic pollutants such as perfluorinated compounds (PFCs) and their biodegradation products Perfluorooctane sulfonate (PFOS) and Perfluorooctane sulfonyl fluoride (POSF) has attained great importance in recent years due to the toxic effects on living organisms. These chemicals are widely used in paper factories (in paper-pulp compound), textile factories, food packaging, sterilization substances, stain and soil repellents for carpets, agricultural pesticides, water-based paints, kitchenware, furniture, firefighting foam, domestic and industrial cleaning materials, cosmetic products, and in many other similar fields PFCs used against scratches and stains. POSF is transformed to PFOS in water through hydrolysis at ambient temperatures. POSF by products and residuals released to air, water and land during manufacture. Perfluorooctane sulfonate its salts and POSF were added to Annex B of the Stockholm Convention on Persistent Organic Pollutants in May 2009. Aquatic organisms of all trophic levels have been used in ecotoxicological evaluation of pollution in aquatic systems and their sediments. Accordingly, they are the most important parts of the aquatic food chain. Also, they are food resource and provide oxygen and shelter for many aquatic organisms. They have been used to evaluate the toxic potentials of persistent organic compounds by Algal Growth Inhibition test for decades. Cell growth is determined by Spectrophotometer at 670 nm (Biotek) and calculated as indicated in OECD 201 guideline. According to our results POSF is inhibiting the algal growth in low concentrations by 53 % at 0,01 mg/L and 96% at 0,25 mg/L which means that POSF is risky for algae populations in the environment.

Keywords: *Posf, phytotoxicity, ecotoxicity, bioassays*

DESCRIPTION OF THE ENDOCRINE SYSTEM IN CRUSTACEANS DUE TO POLLUTANT

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ABSTRACT

Crustaceans, a major group of animals which serve as food for humans and animals come under phylum Arthropoda. There are about 45,000 crustacean species distributed throughout the World. The crab, marine shrimps, crayfishes, lobsters and freshwater prawns are edible and they belong to crustacea. This group of animals is free-living and the habitat of most of them is freshwater or marine, where few of them are semi terrestrial.

Crustaceans have an important role in the ecosystem as they serve as vital food sources for both marine animals and humans. Small crustaceans can recycle nutrients as filter feeders, and larger crustaceans can act as a food source for large aquatic mammals.

Edible crustaceans have lots of importance because of its role in acting as rich protein food, sustainability in culturing and trading. The acceptance of crustacean food in World has also increased due to its softness, flavor, easy digestion and numerous health benefits due to the presence of protein, minerals and vitamins which are known to prevent a range of diseases. Besides food industry, other major industries that use crustaceans are pharmaceutical and cosmetic industries.

The availability of seed for aquaculture in the nature is limited and tedious to obtain. Also as a new threat, the volume of published literature about endocrine disruption in wild species has increased significantly during the last decade.

However, studies on the specific mechanisms by which the endocrine system can be disrupted are scarce, and this is a critical point to be developed for fully understanding the risk of known endocrine-disrupting compounds (EDCs), as well as for predicting the potential deleterious effects of pollutants whose disrupter effects on endocrine systems are not still evident.The aim of this review is give a fresh look to literatüre and take care for the importance of EDC's on Crustacea as these compounds have used widely and in a big amounts.

Keywords: Crustacea, endocrine disruptor compounds, pollution

LATERAL LINE AND CAUDAL FIN ANOMALIES IN COMMON SOLE (Solea solea LINNAEUS, 1758) FROM SOUTHERN AEGEAN SEA

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ABSTRACT

This study presents two anomalies that was found in two wild common sole specimens. Specimens were captured with 80 mm stretched mesh size trammel net incidentally (in June 2014 and in December 2015) from Güllük Bay, southwest of Turkey where is one of the important common sole fishery areas. Female common sole specimen has lateral line anomaly. According to observations, the lateral line has unordinary shape – labyrinth like, furcate. Other sample, male specimen, has caudal fin anomaly. The specimen has large body size and hence, it was thought that having no caudal fin did not affect its swimming ability besides activities like feeding. The present study contributes to literature about rare anomalies in wild fish stocks.

Keywords: Common sole, trammel net, Güllük Bay, fish malformation

MASS DEATHS DUE TO MARINE MUCILAGE IN THE SEA OF MARMARA

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ABSTRACT

Mucilage is a secretion released by some phytoplankton groups in response to changing environmental conditions such as pollution in the marine environment, seawater temperature, and stagnation in sea conditions. This phenomenon causes trophic disruption, oxygen deficiency and mass mortalities. Marine mucilage started to be seen in small amounts at certain depths in the Marmara Sea in November 2020 and started to aggregate on the surface in April. This paper summarizes our results about the devastating effect of mucilage bloom on marine ecosystems and mass deaths in the Sea of Marmara. This study was conducted in the Kapıdağ Peninsula and surroundings (located part of the southern Sea of Marmara) during the mucilage event in the Sea of Marmara between April 2021 and May 2021. The mass mortalities and benthic changes were monitored regularly with dives. For these purposes, line transects, quadrat and visual count methods were used underwater. Atherina sp. was the most affected taxon, followed by Engraulis encrasicolus, *Spicara sp.*, *Trachurus trachurus* and *Sardina pilchardus*. Most (93%) of the species that died were pelagic. Twenty-five percent of the species that died due to mucilage had an economic value and were caught as a target in fisheries. Our results underline the urgent need to find a solution to the problem. Unless the problems are resolved, we predicted that the mucilage events will continue to adversely affect the marine ecosystem and fisheries in the Sea of Marmara, even the whole Mediterranean.

Keywords: Mucilage phenomenon, Marine ecology, Fishery management, Mediterranean

MONTHLY VARIATIONS OF TRAMMEL NET CATCH COMPOSITION IN BEYMELEK LAGOON, TURKEY

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ABSTRACT

Coastal lagoons are highly productive and dynamic environments of fundamental importance in the ecological processes of the coastal biota. They provide essential habitats for many organisms and serve as feeding, breeding and nursery areas for various commercial fish and shellfish species. Because lagoons are very sensitive to environmental changes, they should be monitored to ensure species diversity and sustainability and establish proper and effective management plans. In this context, the objective of the present study is to provide information on the diversity and abundance of the commercial marine species in Beymelek Lagoon, on the western Mediterranean coast of Turkey. Monthly samplings were performed in the lagoon at four locations using a trammel net and one station close to the lagoon inlet by the passive fishing trap in 2019. A total of 18517 specimens belonging to 34 species were caught throughout the study period. Of these 34 species, 30 were bony fishes, and the remaining were crustaceans. Among all the species caught, seven species were alien for the Mediterranean Sea, including four bony fish and three crustaceans. Minimum species diversity values were observed in January, February and March, while the maximum values were in May and June. *Callinectes sapidus*, *Sparus aurata, Chelon labrosus,* and *Lithognathus mormyrus* were dominant almost in the whole of the samplings, and they were usually composed of 65-75 % of the total catch. Other dominant species were *Dicentrarchus labrax, Chelon auratus*, *Chelon saliens*, *Sardinella maderensis* and *Sardinella aurita.* These species were caught in small quantities during most of the sampling months; however, they were solely or together constituted 10-20 % of the total catch in some months. The remaining species have been caught rarely in low quantities. The catch rates and species diversity were observed more stable at sampling locations inside the lagoon and more variable at the inlet station. In conclusion, it has been observed that the number of species has increased compared to the previous studies in the lagoon, and the amount and diversity of alien species may increase in the coming years.

Keywords: Beymelek Lagoon, trammel net, catch composition, catch rate, diversity

ARE THE NEW BISPHENOL ANALOGUES SAFE TO USE? A NEW FINDINGS WITH OLD METHOD

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ABSTRACT

Bisphenols are important kind of emerging contaminants of the great concern as they have wide usage in industry especially plastics. As they have been studied well Bisphenol – a and bishpenols – s have been limited due to their harmful effects on mammals and aquatic organisms. Analogues of Bisphenol-A have been synthesised and used for decades and thought to be harmless. New findings suggest they are not as innocent as it thought. Although analytical chemical testing methods give information regarding the quality and quantity of pollution, biological testing methods can give a qualitative description of the presence and strength of toxicity. Aquatic organisms of all trophic levels have been used in ecotoxicological evaluation of pollution in aquatic systems and their sediments. Algae and aquatic plants are the most important primary biomass producers in both fresh and salt waters. Algae have been reported as equally or more sensitive than animals and have been widely used in toxicity tests. Phytotoxicity tests can be used to assess the effects of Bisphenol analogues. Three of the bisphenol analogues were assessed with 4 different concentrations. Phyototoxicity test is continued for three days and biomasses are calculated with spectrophotometer by absorbance values. According to our results Bisphenol – S was the most toxic one with EC50 of 2,94 mg/L. Other tested bisphenol analogues showed slightly difference with EC50 varied 5,16 – 5.69 mg/L.

Keywords: Bisphenol analogues, phytotoxicity, ecotoxicity, bioassays

CONCENTRATION AND POTENTIAL HEALTH RISK OF TRACE METALS IN NON-MIGRATORY ANCHOVY (ENGRAULIS ENCRASICOLUS) FISHED FROM THE SINOP COASTS OF BLACK SEA, TURKEY

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ABSTRACT

The drastic increase of human population and industrial wastes mostly affect coastal areas. Trace metals should be monitored in terms of food safety from seafood and potential health risks should be determined for local consumers (adult and child groups). Non-migratory anchovy (Engraulis encrasicolus) samples caught in two stations (Sinop Adabaşı and Sinop İstefhan) in the Black Sea were collected with gill nets on May 2021. The anchovy extracts were analyzed by ICP-MS Optical Emission Spectrophotometer. The trace metals concentrations in anchovy meat were found as Zn>Fe>Al>As≥Mn>Cu>Se>Pb>Hg≥Ni>Cr>Cd. Arsenic (As) density was found higher at Adabaşı station (2.21±0.006 mg kg-1 ww) and mercury (Hg) density was higher at Istefhan station (0.07±0.000 mg kg -1 ww). The Pb value was found to be higher at the Adabaşı station than the values reported by the Turkish Food Codex and the EU Commission, but the other metals were determined below the limits. The target hazard quotient (THQ) was above 1 in terms Hg trace metals in both adult and child groups and both stations. The THQ value for Pb detected in Adabaşı station was found above 1 in adult and child groups. This study showed that non-migratory anchovy was affected by the pollution of coastal areas. According to the health risk results, it is recommended to consume anchovy caught from Adabaşı at most once a month, and anchovy caught from İstefhan at most once a week.

Keywords: *Engraulis encrasicolus*, trace metals, Black Sea, health risk assessment, target hazard quotient

INTRODUCTION

Trace metals accumulate in human body through food consumption and pose potential health problems (Bayrakli, 2021a). In order to estimate the critical level of these elements and establish safe food standards, some internationally valid coefficients such as estimated daily intake (EDI), target hazard quotient (THQ), and cancer risk (CR) have been proposed (US EPA 2000).

In the Black Sea, anchovy migrates to the north in the spring months. Apart from the migration season, anchovy fish are caught with gill nets in the Southern Black Sea Region (Özdemir et al, 2020).

The Black Sea is a closed sea and the pollution level is constantly increasing (Bat et al. 2015). Hence, monitoring of trace metals and the assessment of potential health risks are important for the safety of consumers. The aim of this study was to determine trace metal concentrations of non-migratory anchovy distributed in the Southern Black Sea, and to contribute to the existing data on potential risks of seafood for human health.

MATERIALS AND METHODS

At Adabaşı and Istefhan stations, in May 2021, 27 and 39 anchovy specimens were collected from the gill nets with an average length of 8.83±0.71 and 8.89±0.49 cm, and an average weight of 4.01±0.88 and 4.65±0.82 g, respectively.

Trace metals analysis (As, Al, Cu, Cr, Ni, Fe, Mn, Se, Hg, Cd, Pb, and Zn), health risk assesment (EDI, THQ, CRlim, CR) formulas, weight and portion sizes of adults and children were applied according to Bayrakli (2021a,b). Se/Hg, HBVSe formulas were applied according to Yabanlı et al. (2021). Statistical significance of the data was determined by ANOVA (analysis of variance).

RESULTS AND DISCUSSION

The trace metal concentrations in anchovy meat were found as Zn>Fe>Al>As≥Mn>Cu>Se>Pb>Hg≥Ni>Cr>Cd (Table 1). Arsenic (As) density was found higher at Adabaşı station (2.21±0.006 mg kg-1 ww) and mercury (Hg) density was higher at Istefhan station (0.07±0.000 mg kg -1 ww). The Pb value was found to be higher at the Adabaşı station than the values reported by the Turkish Food Codex and the EU Commission, but other metals were determined below the limits. The results of this study were similar to the amounts of some trace elements reported for anchovy in the Black Sea before, but higher than some elements (As, Hg, Pb, Al, Se) (Varol et al., 2019; Türkmen & Dura, 2016; Pecheva et al., 2019). It is thought that the non-migratory anchovy caught in this study is more affected by the pollution of the prevailing marine ecosystem than the migrating anchovy.

The target hazard quotient (THQ) was above 1 in terms Hg trace metals in both adult and child groups of both stations. The THQ value for Pb detected in Adabaşı station was found above 1 in adult and child groups. This study showed that non-migratory anchovy was affected by the pollution of coastal areas of the Southern Black Sea. According to the health risk results, it is recommended to consume anchovy caught from Adabaşı at most once a month, and anchovy caught from Istefhan at most once a week (Table 2 and 3). In this study, for revealing the risks of Hg exposure in terms of consumer health, Se: Hg molar ratio and Se-HBV results were taken into consideration. If Se:Hg molar ratio is >1 and Se-HBV result is

positive, then Se found in the studied anchovy has a protective effect towards the effects of Hg on human health (Yabanlı & Tay, 2021).

Table 1. Trace metal values of non-migratory anchovy by region (mg kg−1 ww)

Elements	**Adabaşı**	**İstefhan**
Al	4.42±0.104[b]	22.03±0.538[a]
As	2.21±0.006[a]	1.43±0.009[b]
Cd	0.02±0.000[b]	0.03±0.001[a]
Cr	0.02±0.003[b]	0.09±0.005[a]
Cu	1.38±0.007[a]	1.19±0.013[b]
Fe	16.37±0.105[b]	27.62±0.282[a]
Hg	0.07±0.000[b]	0.14±0.003[a]
Mn	1.48±0.025[b]	2.11±0.025[a]
Ni	0.11±0.001[b]	0.09±0.001[a]
Pb	0.59±0.011[a]	0.04±0.001[b]
Se	0.79±0.019[b]	0.88±0.028[a]
Zn	31.06±0.150[a]	29.08±0.222[b]
Se/Hg	28.60±0.595	15.98±0.463
HBVse	22.51±0.928	14.07±0.809

Table 2. EDI per meal size, THQ, CRlim, CR for the studied metals in adults and children based on the consumption of ancfovy meat (RfD in mg kg−1 day−1)

	RfD	**EDI** (mg kg^{-1}ww)				**THQ**				**CR$_{lim}$** (kg)				**CR**			
	mg kg^{-1}	Adabaşı		İstefhan		Adabaşı		İstefhan		Adabaşı		İstefhan		Adabaşı		İstefhan	
	ww	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child
Al	1	0.01	0.03	0.07	0.16	0.01	0.03	0.07	0.16	16.37	3.74	3.25	0.74				
As	3×10^{-4}	2.1×10^{-4}	**4.7×10^{-4}**	1.4×10^{-4}	**3.1×10^{-4}**	0.72	**1.58**	0.47	**1.03**	0.32	**0.07**	0.49	0.11	**3.2×10^{-4}**	**7.1×10^{-4}**	**2.1×10^{-4}**	**4.6×10^{-4}**
Cd	1×10^{-3}	5.4×10^{-5}	1.2×10^{-4}	1.1×10^{-4}	2.5×10^{-4}	0.06	0.12	0.11	0.25	4.28	0.98	2.07	0.47	**3.5×10^{-4}**	**7.6×10^{-4}**	**7.2×10^{-4}**	**1.6×10^{-3}**
Cr		5.9×10^{-5}	1.3×10^{-4}	3.0×10^{-4}	6.6×10^{-4}	0.00	0.00	0.00	0.00	20>	20>	20>	20>	3.4×10^{-5}	7.6×10^{-5}	**1.6×10^{-4}**	**3.5×10^{-4}**
Cu	0.04	4.5×10^{-3}	9.8×10^{-3}	3.9×10^{-3}	8.5×10^{-3}	0.11	0.25	0.10	0.21	2.04	0.47	2.40	0.55				
Fe	0.7	0.05	0.12	0.09	0.20	0.08	0.17	0.13	0.28	3.02	0.69	1.80	0.41				
Hg	1×10^{-4}	**2.2×10^{-4}**	**4.9×10^{-4}**	**4.6×10^{-4}**	**1.0×10^{-3}**	**2.22**	**4.87**	**4.67**	**10.26**	**0.10**	**0.02**	**0.05**	**0.01**				
Mn	0.14	4.8×10^{-3}	1.1×10^{-2}	6.8×10^{-3}	1.5×10^{-2}	0.04	0.08	0.05	0.11	6.75	1.54	4.73	1.08				
Ni		3.7×10^{-4}	8.2×10^{-4}	3.0×10^{-4}	6.6×10^{-4}	0.02	0.04	0.02	0.03	12.27	2.81	15.28	3.49				
Pb	4×10^{-3}	1.9×10^{-3}	**4.2×10^{-3}**	1.2×10^{-4}	2.7×10^{-4}	**6.50**	**14.29**	0.43	0.94	**0.04**	**0.01**	0.58	0.13	1.7×10^{-5}	3.6×10^{-5}	1.1×10^{-6}	2.4×10^{-6}
Se		2.6×10^{-3}	5.6×10^{-3}	2.9×10^{-3}	6.3×10^{-3}	0.52	**1.15**	0.59	**1.29**	0.46	**0.10**	0.42	**0.09**				
Zn	0.3	0.1	0.2	0.09	0.2	0.34	0.77	0.32	0.70	0.68	0.16	0.73	0.17				

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 (Arsenic)				Hg (Mercury)				Pb			
	Adabaşı		Istefhan		Adabaşı		Istefhan		Adabaşı		Istefhan	
	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child
EDI	2.2×**10^{-4}**	4.7×**10^{-4}**	1.4×**10^{-4}**	3.1×**10^{-4}**	2.2×**10^{-4}**	4.9×**10^{-4}**	4.7×**10^{-4}**	1.0×10^{-3}	2.0×10^{-3}	4.3×10^{-3}	1.3×**10^{-4}**	2.8×**10^{-4}**
EWI	3.1×10^{-5}	6.8×10^{-5}	2.0×10^{-5}	4.4×10^{-5}	3.2×10^{-5}	7.0×10^{-5}	6.7×10^{-5}	1.5×**10^{-4}**	2.8×**10^{-4}**	6.1×**10^{-4}**	1.8×10^{-5}	4.0×10^{-5}
EMI	7.2×10^{-6}	1.6×10^{-5}	4.7×10^{-6}	1.0×10^{-5}	7.4×10^{-6}	1.6×10^{-5}	1.6×10^{-5}	3.4×10^{-5}	6.5×10^{-5}	1.4×**10^{-4}**	4.3×10^{-6}	9.4×10^{-6}
THQ_{day}	0.72	1.58	0.47	1.03	2.22	4.87	4.67	10.26	6.50	14.29	0.43	0.94
THQ_{week}	0.10	0.23	0.07	0.15	0.32	0.70	0.67	1.47	0.93	2.04	0.06	0.13
THQ_{month}	0.02	0.05	0.02	0.03	0.07	0.16	0.16	0.34	0.22	0.48	0.01	0.03
CR_{day}	3.2×**10^{-4}**	7.1×**10^{-4}**	2.1×**10^{-4}**	4.6×**10^{-4}**					1.7×10^{-5}	3.6×10^{-5}	1.1×10^{-6}	2.4×10^{-6}
CR_{week}	4.6×10^{-5}	1.0×**10^{-4}**	3.0×10^{-5}	6.6×10^{-5}					2.4×10^{-6}	5.2×10^{-6}	1.6×10^{-7}	3.4×10^{-7}
CR_{month}	1.1×10^{-5}	2.4×10^{-5}	7.0×10^{-6}	1.5×10^{-5}					5.5×10^{-7}	1.2×10^{-6}	3.6×10^{-8}	8.0×10^{-8}
$CR_{lim/day}$	0.32	**0.07**	0.49	**0.11**	**0.10**	**0.02**	**0.05**	**0.01**	**0.04**	**0.01**	0.58	0.13
$CR_{lim/week}$	2.23	0.51	3.44	0.79	0.72	0.16	0.35	**0.08**	0.25	**0.06**	4.03	0.92
$CR_{lim/month}$	9.54	2.18	14.76	3.37	3.08	0.70	1.52	0.35	1.09	0.25	17.28	3.95

In conclusion, we thought that our results made an important contribution to the database on pollutants available for the non-migratory anchovy, and that some metals provide important information about their consumption limits to minimize potential health risks. Due to the metal pollution detected in the meat of non-migratory anchovy captured in the study areas, further studies are needed for the assessment of health risks (EDI, THQ, CR, CRlim) of other marine species in the Black Sea.

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SYSTEM ANALYSIS OF LAKE PRESPA (GREECE) WITH PCLAKE

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ABSTRACT

The Lake Lesser Prespa is a Ramsar Wetland with exceptional endemic biodiversity which is shared between Greece and Albania. Agricultural runoff and breeding avifauna are considered as important nutrient sources of the lake, leading to increase of eutrophication problems. To evaluate the current water quality status of the Lake Lesser Prespa and to determine possible responses of the lake to increased nutrient loading, a model study was setup using the ecosystem model PCLake. In this way, the critical nutrient loading for transition to a turbid, chlorophyll dominated state might be estimated. Different nutrient loading scenarios, including the effect of different inflows and depth of the lake, have been applied in the PCLake ecosystem model. Current nutrient loadings are in the range of 0.5-10 mg/m^2/d for nitrogen (N) and 0.04-20 mg/m^2/d for phosphorus (P). The main nutrient sources of the lake are the breeding waterbirds which most likely enrich the lake with nutrients on a local scale , as well as the surface streams. Groundwater inflows and internal nutrient loading from lake sediments seem to be less significant nutrient sources the model results show that the major N source is the streams inflow, whereas major P sources are both the breeding waterbirds and the streams inflow. There was a limited amount of hydrological data for some variables which lead to uncertainties in the water budget of the lake. Model scenarios of PCLake show that the critical P loading is around 0.45 mg/m^2/day assuming a clay/peat sediment, and depth 1m. Mostly, high chlorophyll was simulated in the highest level of P loading (3 mg/m^2/d). Also, aquatic vegetation was mostly found at a depth of 1 and 2 m at medium (0.3 mg/m2/d) and low (0.03 mg/m^2/d) P loading level. Scenarios in the PCLake model demonstrated an inverse relation between aquatic vegetation and chlorophyll in all situations. The overall conclusion is that the PCLake model can help to predict the future ecological states of the Lesser Prespa Lake.

Keywords: PCLake, eutrophication, water budget, critical nutrient loading

INVESTIGATION OF TRACE ELEMENT ACCUMULATION ON SEDIMENTS OF TUNA FARM OPERATING IN THE GERENCE BAY, IZMIR, AEGEAN SEA

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ABSTRACT

Bluefin tuna fattening in the Mediterranean has been expanding since 1990s. The expansion of tuna fattening has been accompanied by widespread concerns about its impacts on the marine environment and little known about metal contamination resulting from the sector. The aim of the study was to investigate seasonal accumulation of some metals (As, Cr, Cd, Ag, Mn, Ni, Hg, Mo, Co) and phosphorus, carbon and sulfide on sediments of a tuna farm located in the Gerence Bay.

The sampling was carried out on a tuna fattening farm in Gerence Bay. In order to detect the accumulation of metals on sediment environment, 5 stations were selected in the area where the cages were installed. Carbon values were determined according to modified Walkley–Black titration method. Sulphur, phosphorus and trace metal concentrations in the sediment samples were measured by Inductively Coupled Plasma – Mass Spectrometer (ICP-MS) analysis at ACME Analytical Labs, Vancouver, Canada.

The results of this study were compared with other studies performed in the Mediterranean Sea, as well as with the Sediment Quality Guidelines (SQGs, US EPA). Arsenic was found above the EPA values from all stations. Station 2 and station 5 are classified as “moderately polluted” for nickel except for some seasons.

In addition, t-test was used to determine whether there was a difference between the mean of concentrations of metals, S, C and P of the cage and reference stations. As a result of the analysis, the mean concentrations of the cage and reference stations of Mn, Cr, Hg, S, P were found to be significantly different from each other ($p<0.05$).

Keywords: Bluefin Tuna, sediment quality, trace metals, Aegean Sea

ASSESSMENT OF HEAVY METAL POLLUTION AND ECOLOGICAL RISK OF SURFACE SEDIMENTS FROM THE HOMA LAGOON (IZMIR BAY)

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ABSTRACT

Study area, Homa Lagoon is one of the commercially important fishing areas in the Izmir Bay (Aegean Sea, Turkey) which is affected by the heavy metal pollution due to the urbanization, industrial and agricultural activities. The purpose of this study was to determine the levels of heavy metals such as Cd, Cu, Pb, Zn, Cr, As, Ni, Al in sediment. The surface sediment samples were collected using Van-Veen grab from 10 stations from the Homa Lagoon, seasonly between 2013 and 2014. The heavy metal analyses were performed using the 4 acid digestion and ultra trace ICP-MS method by the ACME Analy. Lab. Ltd. (Vancouver, Canada). Reference materials (STD DS9 and STD OREAS45EA) were used as a quality control for analytical methods. The maximum and minimum concentrations in sediment were found as 0,3-0,8 ppm for Cd; 5-34 ppm for Pb; 12-28 ppm for Cu; 12-54 ppm for As; 14-88 ppm for Zn; 18-104 ppm for Ni; 81-108 ppm for Cr and 10800-22100 ppm for Al.According to results, the order of heavy metal concentrations were: Al>Cr>Ni>Zn>As>Cu>Pb>Cd. The enrichment factor was calculated to determine whether the source of the metal concentrations found in the sediment was natural processes or due to anthropogenic effects. Moderately enrichment was found for Ni and Cr, and severe enrichment was found for As. According to the results, sediment samples are contaminated with Cr, As and Ni, and considered as polluted per the SQG. In addition, sediments from the Homa Lagoon were found slightly toxic for Cr due to exceeding the LEL values and heavily toxic for As and Ni due to exceeding both LEL and SEL values.

Keywords: Sediments, heavy metal, enrichment factor, sediment quality guidelines, Homa Lagoon

DISCRIMINATION OF THREE SIMILAR SCORPAENID FISHES WITH MULTIVARIATE MORPHOMETRIC ANALYSIS IN THE AEGEAN SEA

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ABSTRACT

The scorpionfishes in the genus Scorpaena are benthic inhabitants of mostly rocky habitats, distributed in temperate and tropical seas. Their commercial value and ecological niches increase the importance of correct identification of the species for fisheries and habitat management. Traditional identification of the species is carried out by a combination of some morphological features, metric measurements and meristic counts. In this study, 161 specimens of *S. porcus* (n= 40), *S. elongata* (n= 20), *S. scrofa* (n= 101) were obtained from commercial fishermen in the Aegean Sea between 2017 and 2019. Multivariate statistical analysis [Principal component analysis (PCA), Discriminant Function Analysis (DFA)] were conducted on 16 morphometric measurements in order to discriminate the species by minimum variables. Seven measurements taken from the head region (body depth, head length, eye diameter, preorbital length, postorbital length, interorbital length, jaw length) discriminated these three species with 100% success in DFA. The two principal components explained 90.25% of the cumulative variance (PC1: 83.53%, PC2: 6.72%). Based on our findings, we hypothesize that other species in the Scorpaena genus can also be distinguished using these morphometric characters in the head region.

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Keywords: Scorpanea, discrimination, morphometry, discriminant function analysis, principal component analysis

A PRELIMINARY STUDY ON THE FOOD PREFERENCES OF FALSE SCAD (Caranx rhonchus Geoffroy Saint-Hilaire, 1817) IN İZMİR BAY (AEGEAN SEA)

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ABSTRACT

In the study, the food preferences of Caranx rhonchus were studied from the stomach contents of 125 specimens obtained from commercial catches in the İzmir Bay, Aegean Sea. The food composition inside the stomachs was examined under a stereo microscope between 10X and 40X magnification, and the prey species were identified at a possible lowest taxonomic category. The occurrence frequency of each prey category into the stomachs and the number of the categories for each fish were counted and analyzed in terms of numerical methods and food preferences related to seasons, size groups, sexes, and overall fish. The study revealed that the false scad is mainly fed on planktonic crustaceans, which was found in all life stages (~ 50% in terms of number) and observed approximately in 40% of the stomachs. Besides that, bone fishes and their eggs were found as important prey, and they were included in nearly 45% of all the stomachs, but relatively in small numbers (~20%). The other preys belonged to the Cnidaria, Mollusca, Plantae, Annelida and Insecta, which were represented in small numbers in the diet of C. rhonchus found only in ~10% of all stomachs when combined. According to the seasons, the changes of the food preferences were only clear in winter, and the diet of the false scad was based on completely Crustacea in the season. Our results also showed that when the fish size is taken into account, small-sized fish feed on lesser types of marine organisms than bigger ones, but gender type does not affect food preferences.

Keywords: *Caranx rhonchus*, stomach content, numerical methods, pelagic fish, Aegean Sea

INVESTIGATION OF MICROPLASTIC UPTAKE IN SOME PELAGIC FISH SPECIES IN THE IZMIR BAY

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ABSTRACT

The present study focused on microplastic pollution in some pelagic fish species distrubited in the Izmir Bay. Accordingly, *Boops boops* - bogue, Sardina pilchardus (Walbaum, 1792) sardine, *Spicara maena* – blotched picarel, and *Caranx rhoncus* – spotfin scad which are widely consumed fish species in Turkey, were examined. The fish samples were supplied from Urla Fisheries Cooperative and frozen in the laboratory facilities. For the extraction and characterization of microplastics, fish were incised from the anus to the esophagus and their digestive systems were removed and treated with 30 ml of 10% KOH solution for the complete breakdown of organic substances. Microplastics isolated from tissues were examined and photographed under a microscope (x=45). A total of 226 microplastics were extracted from the digestive system of 117 (34.66%) of the 338 fishes examined. To verify that the particles detected are microplastic and determine their polymeric properties, four samples were analyzed by the Fourier Transform InfraRed (FTIR) spectroscopy It was determined that samples were polyethylene and polypropylene. According to results, digestive systems of the pelagic fish distributed in the Izmir Bay included microplastics. Based on species, 34 (23.45%) out of 145 sardines, 56 (43.08%) of 130 bogues, 21 (42.86%) of 49 blotched picarel, and 6 (42.86%) of 14 spotfin scad were found to contain microplastics in the digestive system. This study revealed that the species with the lowest percentage of microplastics was sardine and the species with the highest percentage of microplastics was bogue.

Keywords: Microplastic, pelagic fish species, Izmir Bay, marine pollution

REPRODUCTIVE BIOLOGY OF WARTY CRAB FROM THE KAPIDAĞ PENINSULA

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ABSTRACT

The warty crab, *Eriphia verrucosa* (Forskal, 1775) is abundant in the Black Sea and the Mediterranean Sea. Although the species is highly fecund, it has decreased in numbers since the 1980s and is now listed in the Ukrainian Red Data Book of endangered species. In this study, the reproductive aspects of warty crab in the Sea of Marmara is reported for the first time. A total of 57 ovigerous females were collected by SCUBA dives at depths ranging from 0 to 40 m from August 2020 to July 2021 in the Kapidag Peninsula. Fecundity and egg diameter were evaluated according to three embryonic stages. The number of eggs was estimated based on the gravimetric method, and egg diameter was measured to the nearest 0.0001 cm under a microscope equipped with an image capture system. Ovigerous females were observed only between April 2020 and July 2021. Carapace width ranged from 4.70 to 7.95 cm of ovigerous females with a mean size of 6.15 ± 0.10 cm. Fecundity was not correlated with female size (r= 0.357) and ranged from 6,565 to 167,230 eggs per female (60,993 ± 5236). Female size at the onset of sexual maturity was estimated as 4.70 cm, and the mean egg diameter was measured as 602.43 ± 9.53 µm (402.8 to 765.5 µm). ANOVA results showed that mean egg size was significantly different between embryonic developmental stages (F= 27.496; df= 2; P < 0.05). The anthropogenic effects on the Sea of Marmara and environmental factors probably affected the local warty crab population, as inferred by its low fecundity rates and delayed maturation size.

Keywords: *Eriphia verrucosa*, Brachyura, fecundity, egg diameter, Marmara Sea

EVALUATING OXIDATIVE STRESS BIOMARKERS IN THICKLIP GREY MULLET (Chelon labrosus) AT İZMİR BAY

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ABSTRACT

In this study, we investigated the oxidative stress-related biomarkers (catalase and malondialdehyde) on selected tissues (liver, gills, and muscle) of *Chelon labrosus* in İzmir Bay to evaluate spatial differences between Inner and Outer Bay.

C.labrosus specimens were collected by fishing at both Inner Bay (İnciralti) and Outer Bay (Foça) in December 2019. Liver, gills, and muscle tissues were separated and rapidly placed in the liquid nitrogen tank (-198°C). Catalase (CAT) and malondialdehyde (MDA) levels were determined spectrophotometrically by using a microplate reader.

Mean CAT levels (U/mL) were found in muscles as 0.181 in gills as 0.779 and in livers as 0.622 at the Inner Bay. On the other hand, CAT levels were detected in muscles as 0.265, in gills as 1.093, and in livers as 0.666 at the Outer Bay. Also, mean MDA contents (pmol MDA/mg tissues) were determined in muscle tissues as 0.0191, in gills as 0.0768, in livers as 0.0372 at the Inner Bay. MDA contents were found in muscle tissues as 0.0385, in gills as 0.1045, in livers as 0.0588 at the Outer Bay. Therefore, biomarker levels in Outer Bay results are generally higher than Inner Bay.

According to the ANOVA and Tukey post-hoc tests, significant differences between tissues and locations were observed for MDA. Also, statistical differences were found between only tissues for CAT, however, no significant differences were detected between locations.

It's known that these biomarkers (CAT and MDA) are indicators of pollution status in the marine environment. Inner Bay of İzmir has affected negatively harbor activities and urbanization. Also, biomarker results showed that Outer Bay is under threat of pollution by the Gediz River and other anthropogenic activities. Therefore, biomonitoring researches should be maintained in İzmir Bay for ecological risks and human health.

Keywords: Biomarkers, catalase, malondialdehyde, *Chelon labrosus*, İzmir Bay

THE INCREASING RISKS OF THE VENOMS OF THE MARINE ORGANISMS FOR HUMAN HEALTH DEPENDING ON THE GLOBAL SEA WARMING

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ABSTRACT

A great number of aquatic organisms such as mollusks, crustaceans, echinoderms, cnidarians, seaworms, sponges and fish can be caused the injuries of people, who contact them in the seas. Venomous marine organisms have venoms that these aquatic organisms can be delivered their venoms by stings and bites such as sea snakes, lionfish, stonefish, weeverfish, stingrays, sea urchins, worms, sponges, corals, jellyfish, cone snails and octopuses etc. In recent years, the number of tropical poisonous fish and marine organisms has been increasing in our country's waters as a result of global sea warming. The venoms of these organisms are create problems in terms of human health such as allergic reactions, blurred vision, pain, paresthesias, vomiting, hypotension, fever, chills, paralysis, dysphagia, respiratory distress, fatal envenomation, cardiac failure etc. People are exposed to the venoms of these aquatic creatures when this organisms bite or people can be touched them while swimming in the sea. These venoms cause effects ranging from mild irritation to death. People need to be made the aware of the increasing risks of the venoms of the marine organisms for human health. Therefore; In this review, the venoms of the marine organisms and the problems caused by these venoms in terms of human health will be discussed. In addition to this, the results of the infections it causes and the treatments will be mentioned because of the raising awareness in people.

Keywords: Venoms, marine organisms, human health, global warming

SHORT-TERM EFFECTS OF DIFFERENT FIXATIVES AND STORAGE TECHNIQUES ON MORPHOLOGICAL PARAMETERS OF FISH SPECIES

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ABSTRACT

For ichthyology studies, fish data are often obtained from stored rather than fresh samples. This is because it is not always possible to examine immediately fish caught in the field that are then expected to be used after months or years after being stored. During this storing period, morphological changes may occur in preserved fish creating biases in the analysis. Therefore, the severity of these changes need to be taken into consideration for the choice fixation protocols. In this study, the short-term effects of different fixatives and storage methods on morphological characters of two freshwater fish species (*Gambusia holbrooki* and *Oreochromis niloticus*) were analysed. Fish samples (23 *O. niloticus* and 42 *G. holbrooki*) were kept using different fixatives (ethanol 70%; 10% formaldehyde; 4 days formaldehyde 10% and then ethanol 70%; 37% formaldehyde; 1-day ice and then ethanol 70%). The changes on fish morphometric were evaluated at different days (1, 7, 14, 21, 28, 35, 42, 49 and 60). To underline differences between groups, the results were compared by means of Analysis of Variance (ANOVA), Covariance Analysis (ANCOVA) and Principal Component Analysis (PCA). As a result, for both fish species' samples the biggest shrinkage in size was recorded after keeping the fish in 40% formaldehyde. The smaller variations were observed in samples stored in ice for 1 day and then in 70% ethanol. Based on the obtained results, it is recommended, when possible, to avoid the use of formaldehyde for fish storage and try to choose alternative storage methods that do not affect the size of the samples.

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Keywords: Formaldehyde, alcohol, fixatives, *Gambusia holbrooki* and *Oreochromis niloticus*