Scientific Basis and Optimal Conditions for Developing Sustainable Aquaculture Facing the Climate Change

26th of September 2022

Egypt's Vision for Cop27: The Role of Animal Health in Egypt's National Climate

Organization Committee

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Vet. Yasmeen Hamed Asfour
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(SESSION A)

Prof. Mohamed Moustafa Mohamed

Professor of Aquatic Animal Medicine & Management, Faculty of Veterinary Medicine, Cairo University.

Prof. Mohamed Abdelaziz Ahmed

Professor of Aquatic Animal Medicine & Management, Faculty of Veterinary Medicine, Cairo University.

Prof. Adel Abdel Aleem Shaheen

Professor of Aquatic Animal Medicine, Faculty of Veterinary Medicine, Benha University.

(SESSION B)

Prof. Mohamed Moustafa Mohamed

Professor of Aquatic Animal Medicine & Management, Faculty of Veterinary Medicine, Cairo University.

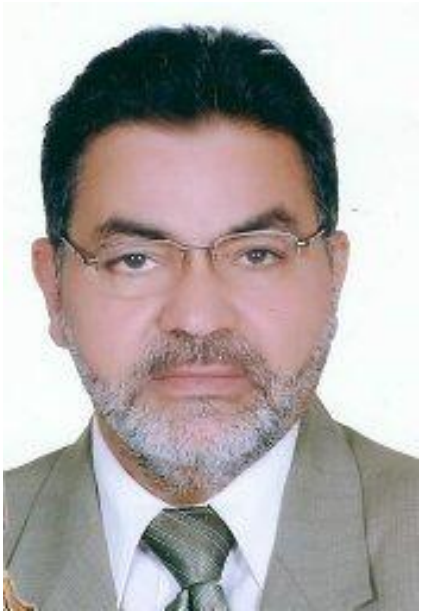
Prof. Alaa Eldin Abdel MoutyEissa

Professor and Head of Aquatic Animal Medicine & Management department, Faculty of Veterinary Medicine, Cairo University.

Dr. Nayrah Abd ElNabi Shaltout

Associate Professor of Marine Laboratory, Marine Environmental Division, National Institute of Oceanography and Fisheries

Prof. Adel AleemShaheen



Dr. Adel is an emeritus Professor, Faculty of Veterinary Medicine, Benha University. Department Aquatic Animal Medicine and expert of high level for the African Union, AU-IBAR and chief of aquaculture working group.

He is experienced ataquatic animal diseases, 2. Aquaculture; reproduction and breeding in different aquaculture systems with different management methods. 3. Marine Pollution.

He was a member of Memorandum of Understanding with World fish - Abbassa, Egypt, 2020, the national committee for fish resources development – Minister of Agriculture and Land Reclamation – Egypt 2018, the national committee for evaluation and improvement of Egyptian Lakes – Minister of Agriculture and Land Reclamation 2017. He was a coordinator of the committee- Fish Resources Development- for the General Syndicate of the Veterinarians (coordinator of the aquaculture working group), 2017.

He Published three consultancies in aquaculture and aquatic animal diseases for the African Union – Interafrican Bureau for Animal Wealth (AU-IBAR). He was attendee as invited speaker and/or Coordinator in national and international Workshops, Symposiums, and Conferences. He was a trainer in workshops for regional and local trainees in the worldfish, Abbassa.

He had many international relationships: VIMS Virginia Institute of Marine Science- USA, Mississippi State University- USA, Mississippi State University, Miyazaki University- Japan, University of Agricultural Sciences and Veterinary Medicine, Iasi, Romania, 30 consulting visits to a number of African countries as expert for Aquaculture and aquatic animal diseases.

He had award of excellence from west African region of the world aquaculture society African chapter 2020. Prizes for scientific excellence in international publication from Benha University 2016, 2017, 2019 and 2020.

Impact of Climate Change on Fisheries and Aquaculture

Abstract

Global warming and ocean acidification are the two main effects of the accumulation of carbon dioxide (CO2) and other greenhouse gases (methane CH4, Chlorofluorocarbons CFCs, Ozone (O3), and Nitrous Oxide (N2O) in the atmosphere as a result of human activity, and these effects will ultimately have an impact on fisheries and aquaculture. Ocean has a vital significant source of wholesome food, income, inspiration, and stability.

Marine ecosystems are threatened by threats such as climate change, overfishing, illegal fishing, sea and ocean warming, rising acidity, oxygen depletion, and pollution. To drive the ocean toward a cleaner future, more creative policies and innovative solutions should be considered.

Biodiversity is extremely susceptible to climate change as with every 1°C increase in the global mean surface temperature the chance of extinction for roughly 10% of species.

Mangrove, salt marshes, seagrasses, tropical forests and boreal forests are of a natural carbon sink ecosystem because they greatly reduce the harmful effects of human carbon emissions by capturing and storing a portion of the excess carbon dioxide, known as sequestered carbon. It is stored and released from coastal ecosystems including mangrove swamps.

One of the key players in the capture and storage of the greenhouse gas carbon are whales. whales facilitate the transfer of nutrients and release fecal plumes near the surface after feeding at depth. When the whale died and descent to the ocean's bottom can trap nearly 33 tons of carbon dioxide Whale carcasses sequester carbon in the deep sea, where they provide habitat and food for phytoplankton and numerous inhabitant invertebrates. 1% improvement in phytoplankton activity due to whales may capture hundreds of millions of tons of additional CO2 a year.

Climate change could have positive or negative effects on aquaculture, depending on how it directly and indirectly affects the farmed aquatic animals and the natural resources that aquaculture needs, particularly water, land, seed, feed, and energy. The productivity and profitability of aquaculture systems will be impacted by the effects of climate change on fisheries because they are an important source of feed and seed for this industry.

Seaweed aquaculture may help slow down climate change by, among other things, producing biofuel or lowering wave energy. Integrated multi-trophic aquaculture (IMTA) may be also more resilient to climate change.

Prof. Mohamed Abdel Aziz Ahmed Abdel Aziz

Dr. Mohamed is a professor and vice Head of the Department of Fish Diseases and management 2011-2017.

He was a fish farming expert in the Arab Organization for Agricultural Development of the League of Arab States since 2012-2013 and Acting Head of Fish Diseases and management Department 2010-2011

- Assistant professor of fish diseases and management 2006- 2011. Department of fish diseases and management. Faculty of veterinary medicine, CairoUniversity.

-Lecturer of fish diseases and management 1999-2006. Department of fish diseases and management. Faculty of veterinary medicine, CairoUniversity.

-Assistant lecturer of fish diseases and management 1996-1999. Department of fish diseases and management. Faculty of veterinary medicine, CairoUniversity.

-Demonstrator of fish diseases and management 1992-1996 present. Department of fish diseases and management. Faculty of veterinary medicine, Cairo University.

The effects of climate changes on aquaculture production and its implications on sustainability & development of this sector

Abstract

Undoubtedly Aquaculture significantly expand its production, making it the fastest-growing food production sector globally reaching 82.1 million ton representing 46% of the global fish production with future expect to grow to 53% in 2030 (FAO 2020).

Consequently as a result of the continued unsustainable harvests from capture fisheries, the aquaculture production is seen as the only solution to meet the rising demand for aquatic products globally.

However, the sustainability & development of the sector is at great risk due to the predicted effects of climate changes that are not only a future but also a present reality.

In this speech, we assess the potential effects of climate changes on aquaculture production and its implications on the sector's sustainability and development.

Climate changes includes various rudiments, such as rising temperatures, sea-level rise, fish &shellfish diseases and harmful algal blooms, changes in rainfall patterns, the uncertainty of external inputs supplies, changes in sea surface salinity, and severe climatic events.

Furthermore, several adaptation options have been presented as well as some gaps in existing knowledge that require further researches & investigations. Overall, climate change effects and implications on aquaculture production sustainability and development are expected to be both negative and positive although, the negative effects overshadow the positive ones.

Scientific basis and optimal conditions should be adapted to the predicted changes in the short-term while taking mitigation measures in the long-term including the appropriate site of performing fish culture facilities, the adaptive fish culture systems that can face different climate changes, ideal fish & shell fish to be cultured, ideal programs for biosecurity measures application in aquaculture could be the only way toward sustaining the sector's production. However, successful adaptation will depend on the successful cooperation among scientific researchers, authorities and producers toward adaptive capacity in different regions of the world.

Asst. Prof. NayrahAbdElNabi Ali Shaltout

Dr. Nayrahis an associate professor of Marine Chemistry Laboratory, Marine Environmental Division, National Institute of Oceanography and Fisheries. Her field of Research is pollution monitoring, treatment and impact of climate change and ocean acidification on Marine chemistry and on biodiversity.

She is a member in Egyptian Society for Mediterranean Conservation (ESMC), International Society for Applied Life Sciences (ISALS), MTS (Marine technology Society), IEEE, Egyptian Society of Natural Toxins, and WESEAS active reviewers.

She is an editorial Board as a reviewer of Applied Ecology and Environmental Sciences, American Journal of Environmental Protection and American Journal of Marine Science, active reviewer of American Journal of Marine Science, and a reviewer for Horizon Research Publishing (HRPUB), for Environment and Ecology Research.

She was listed in "Leading Scientists of The World 2013", Cambridge, England and "Marquis Who's Who in the World 2013" She was PI in Mediterranean Sea Acidification in a changing Climate, in the Framework Program 7 (FP7) start from 1/2/2011 till 31/7/2014, PI of the project "*Supporting a Global Ocean Acidification Observing Network – towards Increased Involvement of Developing States*" (INT7019). Funded by OA-ICC Ocean Acidification International Coordination Center, IAEA The International Atomic Energy Agency, **2016-2019.** Now she isChief Scientific Investigator of the Project 'Evaluating the Impacts of Ocean Acidification on Shrimp, Sea Cucumber and Clams - Egypt' which forms part of the IAEA Coordinated Research Project 'K41018' entitled 'Evaluating the Impact of Ocean Acidification on Seafood – a Global Approach' (CRP), April 2019 to August 2024.

Socioeconomic impact of climate change and ocean acidification on marine biodiversity and blue economy

Abstract

Carbon dioxide (CO2) levels in the atmosphere have increased from 280 ppm to more than 420 ppm as reported in May 2022, an increase that is almost 50% higher than at the beginning of the industrial era. Only half of the CO2 released by human activities has remained in the atmosphere. Between 1800 and 1994, the ocean absorbed about 9.5 billion tons of CO2 per year. This demonstrates that the ocean has been an effective atmospheric CO2 sink; however, this ecosystem service comes at a very steep price. Today's ocean is undergoing a fundamental shift in its chemistry, commonly referred to as "ocean acidification" (OA). These changes are occurring globally and therefore are also observed in regional seas.

Ocean acidification (OA) is a serious consequence of climate change with complex organism-to- ecosystem effects. Hence climate change and ocean acidification can lead to significant direct and indirect socio-economic impacts on the detriment of an important number of ecosystems. The potential socio-economic impacts of climate change and OA can affect different sectors such as fisheries, aquaculture, recreational tourism, jobs, ecosystem services, food security, trades and profits, having thus social and culture impacts on wellbeing, poverty alleviation. It is very likely that in combination ocean warming and ocean acidification will increasingly impact the fisheries sector during the coming decades. Climate model projections show that by 2060 more than 20% of exploited fishes and invertebrates currently found in the Eastern Mediterranean could become locally extinct due to climate change. By 2100, more than half of all endemic marine species in the Mediterranean are expected to make it on the IUCN Red List of Threatened Species. This will partly be brought about by the expected migration of marine species to cooler areas within an otherwise highly restricted Mediterranean basin.

Prof. Ahmed M. Hassan

Dr Ahmed M. Hassan is a professor, Department of Hygiene, College of Veterinary-Medicine, Suez Canal University, Egypt. He was Associate Dean for postgraduate studies and research, College of Veterinary-Medicine, Suez Canal University, Egypt (2012- 2016) and Dean, Fish farming and technology institute, Suez Canal university, Egypt (2016-2017).

In Egypt: Teaching and conducting research related to improving animal performance and mitigation of stress as well as impact of environmental pollution on aquatic life. Also serve as a consultant for the biggest aquaculture project in the middle east area in preventing diseases and treatment in case of disease eruption.

In USA: My teaching at Tuskegee university, Alabama, USA was in the biology department for the pre-medical students. There I taught Cell& Genetics biology and Organsmic biology during the period of 2004- 2006 (Assistant professor). My research was focusing on prostate cancer and prevention of its progression through a model of invitro and in vivo studies on prostate cancer cell lines and using of Cetrorelix and exploring pathways in prevention of prostate cancer progression. Our lab. Discovered involvement of PKA pathway besides PKC pathway discovered before.

Climate Change's Impact on Egypt's Aquaculture (challenges and possible practical solutions)

Abstract

Aquaculture output continues to develop rapidly, making it the world's fastest-growing food production industry. It provided 46% of global fish output in 2020, with that figure predicted to rise to 53% by 2030 (FAO 2020). However, the sector's viability is challenged due to the expected impacts of climate change, which are not just a future but also a present reality.

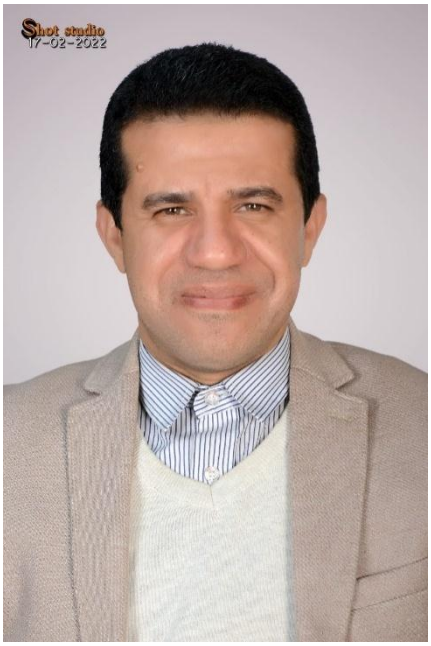
Climate change is currently regarded as one of the most serious challenges facing not only national and regional governments but also global society (Khalil et al. 2022). Climate change is expected to impact aquaculture either directly by influencing the physical and physiology of finfish and shellfish stocks in production systems due to water acidification caused by oceans and seas absorbing CO_2 from the atmosphere, or indirectly by altering primary and secondary productivity, ecosystem structure, input supplies, or by affecting product prices, fishmeal, and fish oil costs, and other agricultural goods and services (Adhikari et al. 2018, De Silva 2013, Freeman and Development 2017, Handisyde et al. 2006). Overall, the consequences and implications of climate change on aquaculture production sustainability are predicted to be both detrimental and beneficial, with the negative effects outweighing the benefits. Adapting to projected changes in the short term while adopting mitigation measures in the long term may be the only option to keep the sector's output going. However, successful adaptation will be determined by the adaptability of producers in various locations of the world (Maulu et al. 2021).

To overcome these challenges, we need to think globally while acting locally. At the level of action, several sectors will be engaged in reducing the consequences of climate change. Different interventions should be implemented in the aquaculture industry; on the one hand, fresh water sources will be in limited supply worldwide, while marine water will be polluted by gas effluents, which are resulting from climate change.

Water quality, fish, fishponds, feed alternatives, and additives are all essential components of aquaculture. To summarize, aquaculture should rely on groundwater near the sea to provide a low contamination level and consistent temperatures to cope with marine water pollution and rising surface water temperatures. To address freshwater scarcity, we must implement intensive aquaculture systems (Bio floc, RAS, In-pond RAS, and using techniques that decrease water exchange such as a promising application of magnetic fields). At the level of fish and fishponds, we need to improve fish performance and immunity while also allowing for water stratification to reduce the effects of rising water temperatures.

Using a novel dietary element for aquafeed, such as algae and probiotics, to improve fish performance and immunity while improving water quality by reducing nitrogenous compounds and, as a result, lowering water exchange. Additionally, as fish require high protein diets, we need to adopt strategies to produce alternative proteins, of which insect protein is an appropriate alternative as it is a feasible product. One example is black soldier fly (BSF) larvae, which contain an elevated level of digestible protein and have a production cycle of only two weeks. BSF production will assist in a variety of ways since it can be grown locally and it feeds on organic wastes (animal manure, human food wastes), converting them from environmental pollutants to fertilizer.

Prof. AlaaEldinEissa



DrAlaaEldinEissa has earned a Ph.D. in Aquatic Animal Medicine from Michigan State University, USA in 2005 and a Masters in Vet Sciences “Fish Diseases” from Cairo University in 1997and a Bachelor of Veterinary Sciences from Cairo University in 1993 (Accredited to D.V.M. in 2004). He is currently working as the Chairperson of Aquatic Animal Medicine and Management Department at Faculty of Veterinary Medicine, Cairo University.Prof. Eissa was also certified as Molecular Laboratory Diagnostician (graduate diploma in Molecular Pathology from Michigan State University, USA). He has over 25 years of experience in fish/ shellfish diseases diagnosis, aquaculture health management, aquatic environment risk assessment and rehabilitation of degraded aquatic wildlife habitats. With this unique mix of expertise, Alaa has excelled in delivering leading-edge aquaculture project development and management know-how to clients in USA, Canada, Egypt and Libya.

For distinction & innovation in aquaculture health management Prof. Eissa was awarded the “National Encouragement Award in Agricultural Sciences” from the Supreme Council of the Egyptian Academy of Science and Technology for the year 2008 and the “Scientific Distinction Award in Interdisciplinary and Multi-specialty Sciences” and Agricultural Sciences from the Supreme Council of Scientific Research of Cairo University for the year 2010 & 2016.

In 2017, he has been selected by the supreme authority of Suez Canal to work as Aquatic Veterinary Consultant to the Suez Canal National Company for Fish Farming and Aquatic Animal Health.

Since 2018 till now, he is holding the Fish Diseases section editor position and member of the editorial board of the highly ranked Turkish journal of fisheries and aquatic sciences. He is also an editorial board member and reviewer for several international journals. During the period from 2012-2015, he has acted as an executive editor / cofounder of the International J of Veterinary Science and Medicine.

In 2019, he has been hired to lead the scientific and technical offices of Makka Feed Company; a promising national fish feeds company.

He is an active supporter for wildlife conservation and degraded aquatic habitat restoration movements in Egypt and across the Mediterranean.

Climatic changes impact on different aquatic environments and its linkages to epidemic

Abstract

Intense episodes of extreme climatic changes caused by gigantic emissions of carbon dioxide and march gases have caused sharp / extraordinary surge of global warming with concurrent melting of Antarctic glaciers. Further, sharp increase in oceans / seas levels with subsequent increase in water acidity to unprecedented degree that caused steady depletion of calcium from shells/scales of shellfish/fish. The powerful decalcification of aquatic creatures will generate a chain of extinctions if the acidity rates continued to elevate. Because of the continuous scarcity of fish stocks in natural fisheries as a result of pollution, climate change and overfishing it has become very logical to devote efforts to developing fish farming technologies continuously to reach maximum productivity. Yet, many negative aspects strongly affected the growth and sustainability of fish farming, most of which were related to the quality of aquaculture water, the quality of food, the sharp changes in climate, environmental pollution. This comes from an unprecedented breakdown of water properties, including low levels of dissolved oxygen (DO), high levels of ammonia and organic matter, and a sharp increase in microbial load, severe suppression of the skin and systemic immune barriers, and the subsequent microbial invasion.

Such microbial invasion will swiftly result in frequent episodes of clinical diseases and mass mortalities that abort all attempts to develop aquaculture procedures and drastically impact the sustainability of the entire aquaculture process. As a result of the catastrophic intense global warming, the concomitant low levels of DO associated with potential disruption of other chemical water properties, several reverse biological processes have arisen. Such reverse dynamic processes have suppressed the immune systems of aquatic species triggering them to microbial invasion. Moreover, these sharp changes have led to the emergence and development of the tiniest /most dangerous organisms, precisely the viruses. The irresistible viral emergence will permanently change the genetic map of many organisms, whether terrestrial or aquatic species with possible cascades of extinction among vulnerable creatures. Ultimately, the steady increase in rates of viral emergences, development and mutations has made them a death tool that threatens the entire aquatic diversity with annihilation. For example, Israel has announced the emergence of Tilapia Lake Virus (TiLv), a novel viral epidemic. Over time, cases of mass kills of tilapias were recorded in different countries across the world such as Ecuador, Thailand, Indonesia, China and finally Lake Victoria, where three countries, Tanzania, Kenya and Uganda, have suffered mass kills in both cultured and wild tilapias. It is not surprising that the epidemic spread of the virus is also linked to waterfowl migration pathways across the world triggered by extreme climatic changes. Viral Nervous Necrosis (VNN) virus, which was known to infect grouper and other marine fish have crossed the barrier of only infecting salty species to also infect Nile tilapia fish in North Africa, Southeast Asia and South America. Also, the emergence of viral threats that were infecting frogs and freshwater amphibians to suddenly infect large-mouthed bass (LMB) such as the Large Mouth Bass Virus (LMBV), which almost could have caused extinction of this fish species through the Lake of Michigan , United States. Furthermore, the emergence and development of dozens of viruses that have moved from crustaceans' vectors living in open water to cultured crustaceans such as shrimp, lobsters and crabs with consequent clinical diseases and acute episodes of mass kills. In this respect, the epidemiological patterns of WSSV spread have signified the drastic impacts of immense global warming on disease spread and geographical relocation.

Prof. Mohamed A. Tony

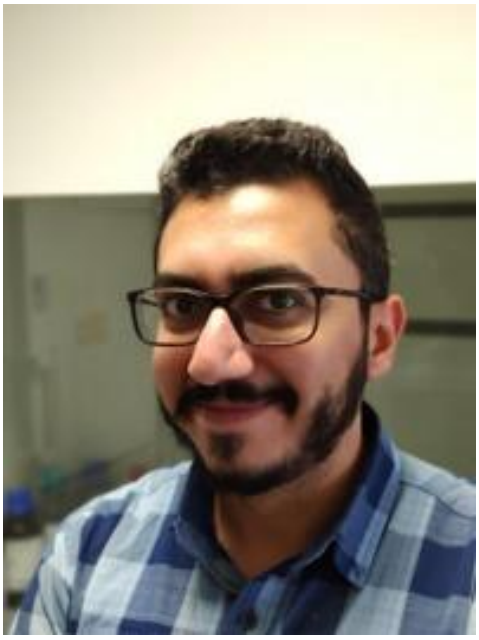
Dr. Mohamed is a professor at department of Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine, Cairo University. His area of experience is the Role of different nutrients in the animal body, Importance of Feed Additives in Poultry andAnimal Nutrition, Feedstuffs Evaluation, Genetically Modified Feed, Poultry and other farm animals nutrition. He is a member of Egyptian Veterinary Nutrition Association (EVNA), World Poultry Science Association (WPSA), Poultry Science Association (PSA), and DAAD scientific committee.

New trends in Aquaculture nutrition under Climate Change

Abstract

Climate change has both direct and indirect impacts on aquaculture production systems in marine and freshwater environments. Global aquaculture production has been increasing drastically in the last five years and trend suggests that it will continue over the future. Attention is now turning to the rapidly growing aquaculture sector and its vulnerability to a changing climate. This growth leads to a higher demand of aquaculture feeds from sustainable resources which currently face several problems like: competition on feed raw materials, decline in resources and dramatic increase in feed prices. Some aquaculture systems depend on natural feed resources as natural biota (Phytoplankton, Zooplankton, etc). This biota has huge socioeconomic value, through food production, recreation, nutrients recycling, gas regulation and natural feed resources for aquacultures. Climate impacts on the natural biota might thus have widespread economic implications. Increase in seawater CO_2 concentration and water temperature will change the activity of individual phytoplankton species and tend to favour some aquatic species over others. All these issues result in expensive feeds. Feeds represent between 50–70% of the total cost of fish production, therefore search for sustainable feed alternatives is needed. The new trends in fish nutritional researchers tend to investigate suitable new alternative resources, which provide least cost and high quality production. For a new resource to be considered as ideal aquaculture feed alternative, this resource must have a low price, similar nutritional qualities to the classic feed resource and should also be free from anti-nutritional factors. Among the new alternative feed resources that showed positive results are microalgae, insect protein and black soldier fly larvae. Maximizing feed utilisation by feed processing, using feed additives and supplements should also be a priority in aquaculture production systems. Moreover, for successful aquaculture production systems a set of adaptive practices has been identified, such as diversified and integrated aquaculture systems, water quality monitoring, species selection, selective breeding, genetic improvement, site selection together with improved cage and pond construction.

Dr. Mohamed Ibrahim Shaalan



Dr. Mohamed Ibrahim Shaalan Currently works as a lecturer of pathology in the faculty of veterinary medicine, Cairo University. Teaching duties include courses of animal and fish pathology for undergraduate and postgraduate students. He obtained his doctoral degree in fish pathology from University of veterinary medicine Vienna, Austria in 2017. Later, Dr. Shaalan had different postdoctoral fellowships in Austria, France and Hungary. He published 40 international publications with more than 600 citations and H-index of 11. He was a visiting lecturer at Complutense University of Madrid. Also, he participated in many international meetings as a presenter and keynote speaker. He is a member of the national committee of oceanography and fisheries.

Nanotechnology for sustainable aquaculture: Novel solutions to cope with climatic change

Abstract

The deterioration of aquatic environment quality and the impact of climatic change has led to a significant upsurge of pathogens and diseases in aquaculture. The introduction of nanotechnology in aquaculture opens a new dimensions and vast applications that attracts attention to the recent trends of global fish production.

Nanotechnologies as an innovative and novel approach had paved the way to for new perspectivea for the biomolecules analysis, targeted drugs and hormones delivery, early diagnosis of infectious diseases, development of nano-vectors for gene therapy, and as a transport vehicle for DNA, disease therapeutics and nutritional supplements. The potential use and applications of nanotechnologies would open the way to increase the quality and quantity of fish production. Moreover, the comparative evaluation of the nanotechnology-developed processes with conventional ones proposes new prospectus in technological developments for an efficient water and wastewater management. Nanomaterials show superior characteristics for drug and vaccine delivery aiming at protection of fish in aquaculture against infectious pathogens. This presentation shows the present applications of nanotechnologies explored by the researchers in order to develop sustainable aquaculture in the times of drastic global climatic changes.