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Inside...

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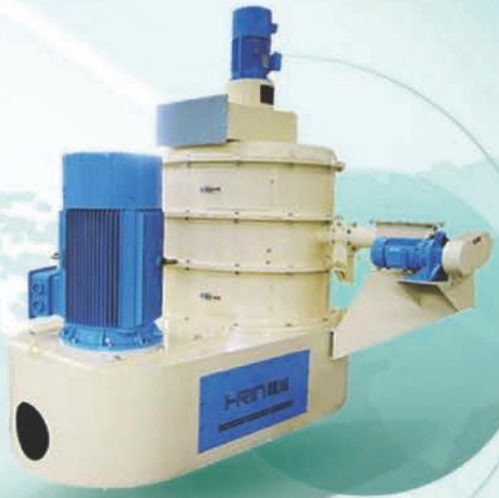

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Do not make untrue claims

India's Aquaculture output may touch a record 7 lakh tonne

Dear Readers,

The April 2019 issue of *Aqua International* is in your hands.

I happened to vist West Bengal Poultry Fair on 25 -27 February 2019, International Poultry Expo in Dhaka, Bangladesh on March 8 -10 and VIV Asia 2019 at Bangkok, Thailand on 13 -15 March 2019 and the events were well organised with reasonable footfall of the stakeholders.

It has become a practice to the organisers of exhibitions on Poultry and other sectors making wrong claims of large footfall / visitors to the exhibition although the actual number of visitors during the expo period is much lower than their claims.

VIV Asia's press release claims than the show receives more than 45,000 visitors during Bangkok three days. During the 3 – day event if 15,000 persons visit the expo repeatedly for 3 days, it becomes 45,000 visits which is in correct count, and it should infact be counted as 15,000 visitors (not 45,000 visits).

Similarly Poultry India 2018 organisers also made wrong & claims of large footfall. This bad practice should go, and should present correct number of visitors during Expo Period.

Even 5,000 professional visitors is a good figure and there is no need of making untrue big claims.

In the News section, you may find news about

Seafood exporters are pinning their hopes on the 2020 Tokyo Olympics driving up consumption in the Japanese market. Japan is one of the world's top seafood markets and the third largest seafood importer. However, it is a market that looks for consistent supply of quality products in all forms.

Scientists from the Central Institute of Brackishwater Aquaculture (CIBA-Chennai) officially announced that samples of wild crab (Scylla Seratta) collected from farms in Krishna district have been found to be infected with 'white-spot virus'.

Presenting the results of their investigation on the wild crab to a group of 150 farmers here, CIBA Principal Scientist Dr M. Poornima on Wednesday declared that the Scylla Seratta was infected with the white-spot virus and investigation was intensified to identify the source of the virus and issues associated with it.

Cooperators connected with fisheries cooperatives across the country are sore with National Fisheries Development Board (NFDB) which has failed to include a single representation from the fisheries cooperatives in the apex body. The recently reconstituted governing board of National Fisheries Development Board (NFDB), Hyderabad is bare of representation from the fishery cooperative sector. It bears recall that there are 21 thousands fishery cooperatives with about 31 lakh members in the country.

The US decision to scrap the concessions to India under the Generalised System of Preferences will not adversely impact the country's seafood export to American market as most of its marine food products, including high-in-demand shrimps, enjoy 'zero tariff' under the current GSP regime, says the Marine Products Export Development Authority.

In the Article section, article titled "Effect of Endocrine Disrupting Substances in Aquaculture" by Gyandeep Gupta, Munish Kumar, Banani Mohanta, Prasanta Jana, Sumit Kumar Verma and Rakhe Kumari discussed about Endocrine disrupters compounds (EDCCs) an exogenous substance or mixture that have capacity to modify function of the endocrine system.

Most of EDCs interface with nuclear receptors family hormones. The mode of action of EDCs is either agonist or antagonistic. EDCs are estrogenic active compounds can be natural like phyto and myco-estrogens or anthropogenic such as certain pharmaceuticals, pesticides and industrial chemicals.

M.A.Nazeer
Editor & Publisher
Aqua International

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Aqua International will strive to be the reliable source of information to aquaculture industry in India.

AI will give its opinion and suggest the industry what is needed in the interest of the stakeholders of the industry.

AI will strive to be The Forum to the Stakeholders of the industry for development and self-regulation.

AI will recognize the efforts and contribution of individuals, institutions and organizations for the development of aquaculture industry in the country through annual Awards presentation.

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Seafood exporters hope to expand Japan Business

Kochi : Seafood exporters are pinning their hopes on the 2020 Tokyo Olympics driving up consumption in the Japanese market. Japan is one of the world's top seafood markets and the third largest seafood importer. However, it is a market that looks for consistent supply of quality products in all forms.

Mr Rajarshe Banerjee, President, Seafood Exporters Association of India, West Bengal region, told that the Japanese market had shrunk to 40 per cent of its size compared to what it was seven years ago. This is because of quality standards in Japan, which are much more stringent than the far more relaxed US markets. Besides, Japanese prefer Black Tiger shrimps, while Indian shrimp exports are mainly dominated by Vannamei.

Black Tiger push sought

To renew Black Tiger shrimp exports from Bengal, he urged the Marine Products Development Authority (Mpeda) to make efforts to promote the traditional Black Tiger aquaculture, which was more than 100 years old. Mr K. S. Srinivas, Chairman, Mpeda, said that the Japanese market is expected to witness a boom in seafood consumption, especially shrimps, with the 2020 Olympics getting nearer.

Globally, production of Black Tiger, the prime shrimp commodity in Japan, is getting eroded due to various disease problems. The traditionally farmed tiger shrimp in India are free from antibiotic residues. Increased supply of traditional Black Tiger shrimp from West Bengal, Kerala and Karnataka would help increase the shrimp trade to Japan.

RGCA, the research wing of Mpeda, has taken up production of high health Black Tiger shrimp seeds from its multi-species aquaculture complex at Kochi, targeting the traditional and extensive farming systems of the South West coast of India and West Bengal. "Foreseeing the overwhelming demand, we are also planning specific brand promotion campaigns for Indian seafood in Japan".

Indian exports to Japan are dominated by frozen shrimp and the country exported 85,651 tonnes of seafood worth $445 million in 2017-18. Of this, frozen shrimp was 33,828 tonnes with a value of $334 million. Other items popular in the Japanese market include squid, cuttlefish, octopus, clams, lobsters, fish fillets etc. According to exporters, Japan has 100 per cent testing requirement for farmed shrimp imports from India. There is a good scope for shrimp and other value added products in Japan markets if India exercises better control on antibiotic contamination in the export value chain and provides third-party certification such as Aquaculture Stewardship Council (ASC), Best Aquaculture Practices (BAP) certification.

With changing market preferences, Indian processors have started offering value added products such as cooked shrimps, sushi shrimp, marinated shrimps etc. However, the percentage of value addition in India is relatively small compared to Thailand, Indonesia, Vietnam or China. Many Japanese importers ship raw material from India to SE Asia or China, add value and ship to Japan.

Expansion and diversification of coastal and inland aquaculture would enhance shrimp production and bring in more varieties, such as Tilapia, Mud Crab, Scampi and Cobia to the export basket.

However, there is a need to foster tie ups with Japanese importers to ship new varieties as value-added products that suit the Japanese palate and to minimise over-dependence on shrimp items.

ICAR Aquaculture training program in Medziphema

Dimapur: A three-day training program on "Diversifying Aquaculture Practices for Enhancing Livelihood" ICAR Nagaland Centre, Medziphema, was conducted recently, at the conference hall of the centre. Thirty farmers from Dimapur, Peren and Longleng districts participated in the training program.

Speaking at the inaugural session, Dr D. J. Rajkhowa, joint director, welcomed all the participants and apprised them about the necessity to diversify aquaculture practices in the context of the changing climate scenario and shrinking resources. Mr Jyotish Barman, scientist (Fisheries) and course coordinator of the training program, in his address highlighted the need to adopt scientific management practices and integrating diverse farming practices to offset high input costs.

Topics on composite fish farming, integrated fish farming, freshwater prawn culture, hatchery management, water quality management, eel culture, magur culture and prevention and control of Epizootic Ulcerative Syndrome were covered during the training program. The training concluded with distribution of certificates to the trainees.

White-spot virus returns to A.P., wild crab highly affected

Andhra Pradesh : Scientists say virus behind high mortality rate of crabs

Scientists from the Central Institute of Brackishwater Aquaculture (CIBA-Chennai) officially announced that samples of wild crab (Scylla Seratta) collected from farms in Krishna district have been found to be infected with 'white-spot virus'.

Presenting the results of their investigation on the wild crab to a group of 150 farmers here, CIBA Principal Scientist Dr M. Poornima on Wednesday declared that the Scylla Seratta was infected with the white-spot virus and investigation was intensified to identify the source of the virus and issues associated with it.

Probe sought

CIBA scientists were asked by the State government to investigate the reasons for the mass mortality rate of the wild crab cultivated across the coastal belt in Krishna district.

Setback to aquaculture

According to Fisheries Department Assistant Director Mr Suresh, the wild crab is being hatched in nearly 5,000 hectares in major locations of Machilipatnam, Krithuvennu, Koduru, and Nagayalanka in Krishna district and Repalle in Guntur district. The duration of the culture ranges between three months and six months based on the size of the seed.

The culture of wild crab became an alternative to shrimp cultivation, which was also hit by the white-spot virus earlier in Andhra Pradesh. Presently, 90% of the crab seed is being collected from the mangroves in Krishna and Guntur districts.

Temporary measures

The alarming rate of mortality of the wild crab in the farms since November 2018 became a major setback in the region's brackishwater aquaculture sector, prompting the State government to swing into action to explore the scientific reasons for the mortality. "The crop holiday of 20-30 days between the two crops and chlorination of inflow water are strongly advised to minimise mortality. However, it's a temporary solution to avoid mass mortality. The white-spot virus has been detected largely in the wild crab samples collected from the ponds in which shrimp was cultivated earlier," Ms Poornima, an expert in fish pathology, told.

Nearly 90% of the production of wild crab from Andhra Pradesh is exported to South-east Asian countries. The Central government has granted an amount of ₹6 crore for setting up wild crab hatcheries at Suryalanka in Guntur district in 2017 but the development of the hatcheries hit a roadblock as the State government was yet to procure the land.

Shrimp exports to US rise 15.6% in 2018, India's aquaculture output may touch a record 7 lakh tonne

India's shrimp exports to the US were 15.6% higher in 2018 to 248,127 tonne and accounted for 36% of the total shrimps imported into the nation, according to the latest data of US agency National Oceanic and Atmospheric Administration. US imported 695,723 tonne of shrimp in 2018, a 4.8 % higher than the previous year. Indonesia comes second with 132,344 tonne and is followed by Ecuador with 75,891 tonne. India is the second-largest fish producer in the world after China and accounts for nearly 6% of the global fish production. In December, India exported 21,913-tonne shrimp to US, against 18,965 tonne in the year-ago period. Indian shrimp export growth is expected to slow down after four years of robust growth due to stiff competition from other suppliers, according to a report by credit rating agency ICRA.

The report says volume growth is likely to be 7-10% CAGR during CY2018-19 as against 17% CAGR between CY2013-17 and adds that stiff competition could result in a demand-supply mismatch and induce volatility in shrimp prices. The impact of implementation of Seafood Import Monitoring Programme (SIMP) for shrimp exports into US is a key factor to be watched in Indian exports of shrimps to US. SIMP mandates stringent data requirements to trace the entire supply

chain of seafood from the point-of-harvest to the point-of-entry into the US.

In 2018, US Department of Commerce had hiked the anti-dumping duty on Indian shrimp imports to 2.34 % from earlier 0.84 % in the preliminary results for the Administrative Review for 2016–2017.

The US government imposed an anti-dumping duty on frozen warm-water Indian shrimps in 2004, saying it was hurting US shrimp farmers. The Coalition of Gulf Shrimp Industries, an association of shrimp farmers, has been fighting aquaculture shrimp imports into US claiming that artificially low-priced imported shrimp from seven countries including India have suppressed and depressed domestic prices.

According to sources, Indian aquaculture output is estimated to touch a record 7 lakh tonne during the current fiscal and reach 1 MT by 2020. Seafood exports for the last fiscal touched $7.08 billion with 13,77,244 tonne exported, against 11,34,948 tonne and $5.77 billion in the year-ago period, according to state-run Marine Products Exports Development Authority data.

CIFA observes International Women's Day with the theme "Think equal, build smart, innovate for change"

Bhubaneswar: The ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar observed International Women's Day. On the occasion, the Institute had organised the Live Telecast of Hon'ble Prime Minister's address and interaction with SHG members. The campaign theme for 2019 International Women's Day is "Balance for better" to think equal, build smart, innovate for change for women. This year theme depicts the innovative ways in which we can advance in gender equality and the empowerment of women especially in the social protection systems, access to public services and sustainable infrastructure.

Dr S. N. Mohanty, Head, Obstetrics & Gynaecology, Apollo Hospital, Bhubaneswar was the Chief Guest of the function. He emphasized on the importance of women health and hygiene. He described in detail the physiological development of women in different phases and need for maintaining a good health for development of a healthy nation. This will lead to an economically developed society as women are the backbone of family.

Dr Subhashree Nanda, Joint Secretary, School & Mass Education Department, Govt. of Odisha, graced the function as the Guest of Honour. She stressed the importance of education in empowerment of women.

Ms Reeta Rani Das, External Member, ICC, ICAR-CIFA gave a presentation on "Right to Information Act". She stressed on the importance of RTI and its use for prevention of atrocities against women at work place.

Dr B. R. Pillai, Director, ICAR-CIFA addressed the gathering and emphasized that the potential of women can be enhanced by providing education to them. Our society can change only when attitude towards women will change and we can certainly provide them a positive working ambience.

Dr K. D. Mahapatra, Principal Scientist and Chairperson of Internal Women Complaint Committee (ICC), ICAR-CIFA, welcomed the gathering and introduced the guests. She expressed her tribute to the women who have immensely contributed to shape the society. She brought to the notice of house the presence of ICC in the Institute for healthy work atmosphere for the working women.

The programme was smoothly conducted and coordinated by all the women staff members and scholars of Institute. The programme was moderated by Ms Snatashree Mohanty, Scientist and ended with the vote of thanks proposed by Ms Priyanka C. Nandanpawar, Scientist, ICAR-CIFA.

Mud Crab Hatchery to be Established in Maharashtra

Hyderabad: Cooperators connected with fisheries cooperatives across the country are sore with National Fisheries Development Board (NFDB) which has failed to include a single representation from the fisheries cooperatives in the apex body. The recently reconstituted governing board of National Fisheries Development Board (NFDB), Hyderabad is bare of representation from the fishery cooperative sector. It bears recall that there are 21 thousands fishery cooperatives with about 31 lakh members in the country.

However, this seems to have not gone down well with those who set great store by the role the fishery cooperative sector can play in realizing the goals of Blue Revolution in the country. Leaders associated with the cooperative fishery sector have also said in no uncertain terms that the govt. would do well to enlist the support of their organizations in accomplishing the revolution by 2020.

"It is a pity that not a single o-operator from fishery cooperatives has been inducted to the 53 member strong governing body. This has meant excluding over 21 thousands

fishery cooperatives with about 31 lakh members from contributing their bit towards achieving the blue revolution, said a o-operator.

A couple of other o-operators have said the same thing demanding representation for the fishery cooperative sector including North, East, West, South, Central and North East Zones. In particular, Central, North and North East Zones have been completely ignored.

Considering the govt. has created a separate department of fisheries it would have been only logical if the govt. had involved the cooperative fisheries sector in its exertions towards the blue revolution, he regretted.

Given, Union Minister of Agriculture and Farmers' Welfare Ms Radha Mohan Singh all the time underlying the fact that blue revolution will help the govt. achieve its goal of doubling the income of farmers by 2022, the exclusion of the fishery cooperative sector from the governing body barely stands to scrutiny.

Withdrawal of GSP benefits by US to India not to affect seafood exports

Most of seafood exports not covered under GSP regime, says MPEDA Chairman

Kochi: The US decision to scrap the concessions to India under the Generalised System of Preferences will not adversely impact the country's seafood export to American market as most of its marine food products, including high-in-demand shrimps, enjoy 'zero tariff' under the current GSP regime, says the Marine Products Export Development Authority (MPEDA).

"There is a widespread apprehension that the US decision will affect the seafood exports from India to America, which is a major importer of our marine products. But such an apprehension is unfounded," said Mr. K S Srinivas, Chairman, Marine Products Export Development Authority (MPEDA).

MPEDA made a detailed analysis and found that there would not be any immediate setbacks anticipated due to withdrawal of GSP benefit in seafood exports, he added.

"The exports of prepared and preserved shrimps and crab to America will not be adversely affected as these enjoy zero tariff at present under the GSP regime," Mr Srinivas pointed out.

India usually exports seafood worth USD 2,300 million to American market with frozen shrimp as the flagship item of exports. However, frozen shrimp currently enjoys zero tariff and is not covered under the GSP regime.

"Moreover, the exports of other items such as frozen fish and frozen cephalopods are also not currently benefitted under the GSP. Hence the withdrawal of GSP will not affect our seafood exports to US," he noted.

In FY 2017-18, India shipped 13,77,244 MT of seafood that earned US$ 7.08 billion (Rs 45,106.89 crore), with frozen shrimp and frozen fish continuing to be the principal export items. USA, the leading destination for Indian seafood in value terms, imported seafood worth USD 2,320.05 million.

The overall export of shrimp during 2017-18 was 5, 65,980 MT worth USD 4,848.19 million, with USA continuing to be the largest market (2, 25,946 MT) for frozen shrimp and accounting for 53% of total Vannamei shrimp exports. Frozen shrimp was the principal item of exports to USA with a share of 95.03% in dollar value.

The GSP scheme, launched in 1974, aims to assist developing countries in increasing their exports by facilitating duty-free entry for thousands of products from designated beneficiary countries.

CMFRI teams up with Korampadam Co-op Bank to promote cage fish farming

New Delhi : In a major effort which is beneficial to hundreds of families in Kadamakkudy panchayat, the Central Marine Fisheries Research Institute (CMFRI) has partnered with the Korampadam Service Co-operative Bank, Kothad, to promote cage fish farming in the backwaters of the panchayat.

In a joint initiative aimed at helping the villagers become small-scale entrepreneurs through cage fish farming, CMFRI and the bank conducted a skill development programme to train them in practicing the less-expensive farming method. As many as 114 villagers attended the training that covered various stages of cage fish farming, such as cage fabrication, site identification, species selection, feed management, harvest and marketing. Visits to cage farming sites and practical training were also included in the three-day programme.

In a further step to promote the cage farming enterprises in the backwaters of the panchayat, CMFRI will offer all the technical guidance to the villagers, while the bank will give them loans as initial capital to carry out cage fish farming.

"CMFRI would extend technical support to the farmers in each phase of the cage farming process to empower them to become entrepreneurs in the field," said Mr A. Gopalakrishnan, the institute's director, adding, "This will act as a source for additional income to the fishermen, and it will help increase the domestic fish production as well."

Species such as cobia, seabass, snappers, mullet and pearl spot will be used for cage farming.

The collaborative programme has been linked with CMFRI's ongoing project, which was launched last year and aims to train 5,000 fishermen across the country in practicing cage fish farming with the financial assistance of the National Fisheries Development Board (NFDB).

"The CMFRI has so far trained 2,500 fishermen all over the country, and about 2,500 cage fish farming units are currently operational across the coastal states under CMFRI's technical guidance," said Dr Imelda Joseph, head, mariculture division, CMFRI.

CMFRI is also part of a joint initiative with NFDB to set up 500 cage fish farming units in Kerala by providing technical as well as financial aids to the fish farmers.

New Fish Biochemistry Laboratory of Mumbai Research Centre of ICAR-CIFT Inaugurated

Ribbon cutting ceremony of new fish biochemistry laboratory by Dr J.K. Jena

Mumbai Research Centre of CIFT has established new additional facility of fish biochemistry laboratory which has two sections, one for instrumental facility and the other one for routine biochemical analysis. Dr J.K. Jena, Deputy Director General (Fisheries Sciences), ICAR, New Delhi inaugurated the new facility by curtain raising and ribbon cutting. The meeting that followed begun with the traditional lamp lighting ceremony by Dr Jena. Dr L.N. Murthy, Scientist Incharge of the Centre delivered welcome address. Delivering the Presidential address, Dr Ravishankar C.N., Director, CIFT opined that with the extension of laboratory can have more consultancies, more HRD programmes and trainings and Scientists can work on species-specific and region-specific interventions related to seafood industry. Dr. Jena in his speech highlighted importance of fisheries in empowerment of fish farmers, fisherfolk and small, medium and large scale entrepreneurs. He also urged for need-based research, especially in harvest and post harvest sector in order to double the farmers income. Felicitation address was given by Mr Rajakumar Naik, Deputy Director, MPEDA and Mr S.R. Kulkarni, seafood exporting industry representative from M/s Hirawati Seafood Exporting Company. Mr Sandeep Dongre, Secretary Seafood Exporters Association, Mumbai Chapter and The Director, M/s. Sanchita Marine Pvt. Ltd also graced the occasion. Engineers of CPWD who were instrumental in construction were invited in the function and they were honored with ponnada and momentoes by respected DDG. The meeting concluded with a vote of thanks by Dr. A. Jeyakumari, Scientist. Later the Honorable DDG visited the new lab facility and interacted with scientists and all the staffs of Mumbai research centre.

Visit of DDG to the new laboratories

The guests with the staff of the Centre

CMFRI expands wings to Lakshadweep

Takes over administrative control of Lakshadweep KVK

Kochi, Mar 08: The Central Marine Fisheries Research Institute (CMFRI) expanded its wings to Lakshadweep islands with the institute taking over administrative control of theKrishiVigyan Kendra (KVK) situated at Kavarathi Island. The CMFRI has drawn an action plan for activation of the KVK, which is aimed at facilitating the islanders efficiently tap its unique agricultural resources on the land and the sea for quality life in the islands. The KVK will focus on scores of objectives such as enhancing the agricultural productivity; increasing farmer's income, generating employment opportunities to locals, especially women; boosting value added products by micro-enterprises; and facilitating market access on the strengths of its credentials, to list a few. An agricultural extension centreunder the Indian Council of Agricultural Research (ICAR) for linking the agricultural research institutions and the farmer, the KVK will involve in various eco-labelling efforts for unique commodities of the Islands. This includes green certification of Lakshadweep coconut and MSC (Marine Stewardship Council) certification of tuna fisheries that will facilitate market advantage for these commodities from the islands.

Consultative Meeting

As a precursor to a full swing operation of the KVK, the CMFRI will convene a high-level consultative meeting on Saturday to formulate a Perspective Plan for the functioning of the Kendra in the coming years. The meeting will be attended by Dr A K Singh, Deputy Director General (Extension) of the ICAR along with scientists of different institutions under the ICAR. Mr Damodhar A.T., I.F.S., Secretary (Agriculture) will lead the delegation of senior functionaries from the Lakshadweep Administration and the lead farmers of the islands. The meeting will identify priority areas for the KVK, considering the unique resource base of the islands and stakeholders' perception. A road map for full realisation of the KVK's potential to meet the set objectives will be made at the meeting. In addition, a three-day training on developing value added products from fish wastes will be held to the micro-enterprisers in the islands.

To boost CMFRI's role in Lakshadweep

Taking over of the KVK would add impetus to the CMFRI's interventions in the islands with the KVK forming the base for the operation of various activities of the institute, said Dr AGopalakrishnan, Director of the CMFRI."Historically, the CMFRI has been studying the fisheries and ecosystem of the islands ever since the institute was incepted, through focussed research projects and has been contributing to the steady development of the sector through science based management guidance", he said.

"The Lakshadweep islands are well known for its unique varieties of coconut and high value oceanic tunas as well as the eco-friendly approach for coconut cultivation and tuna fishing. The institute is running a range of research projects, including on coral reef associated marine biodiversity of the islands and fishery management plans for tuna, aimed at sustaining the ecosystem and the fisheries in Lakshadweep", he added.

Helping fisherwomen in the State tread the self-reliance path

50 participants being trained to prepare 'value-added' fish products.

In pursuit of ambitious plans to tap the enormous potential for value added fish products in the market, a group of 50 fisherwomen from across the State are undergoing hands-on training at the Fisheries Research Station at Palair in Kusumanchi mandal here.

The National Fisheries Development Board (NFDB)-sponsored three-day training programme on 'fish processing and value addition', which began on Tuesday, opened up skill development opportunities for fisherwomen.

The organisers have roped in the services of P. Bhagya Laxmi, a fish products trainer from Kakinada in Andhra Pradesh, for the training, which has been designed to help the participants get hands-on training in preparation of a range of scrumptious fish products such as fish cutlets, fish wafers, fish balls and fish pickles laced with mangoes in hygienic conditions.

The main objective is to impart the requisite skills to the fisherwomen to enable them to start small scale enterprises and sell value added fish products to tread the path of financial self-reliance, said Dr G. Vidyasagar Reddy, senior scientist and head of Fisheries Research Station.

It also helps the participants gain deeper insight into fish processing, packaging, storage and other aspects that are vital to a successful enterprise.

Thanks to rising health consciousness, there is a burgeoning demand for fish and fish-based products known for their nutritional value, said K. Swaroopa, president of Yellandu-based Matsya Mithra Mahila Sangham from Bhadradri-Kothagudem district. "Value addition is imperative for augmenting income for our cooperative societies," she said.

She added that the skill development programme is a key initiative that will motivate the fisherwomen to open outlets to sell value added fish products by availing loans and pursue sustainable livelihood opportunities for economic empowerment.

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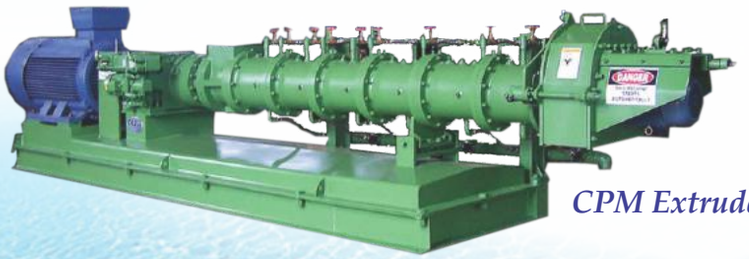

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CIFT recognised as National Reference Laboratory for Fish and Fish Products

ICAR-Central Institute of Fisheries Technology, Cochin has been conferred with a status of "National Reference Laboratory (NRL) for Fish and Fish Products" by Food Safety and Standards Authority of India (FSSAI), Ministry of Health and Family Welfare, Govt. of India under Regulation 3 of Food Safety and Standards (Recognition and Notification of Laboratories) Regulation, 2018 vide Order No. 12013/02/2017-QA. CIFT is the only research Institute under SMD (Fishery), ICAR to be adorned with such a high profile recognition. The Institute had already been notified as National Referral Laboratory vide Government of India Gazette Notification S.O. 97(E) of Ministry of Health and Family Welfare (Food Safety and Standards Authority of India) dated 10th January, 2017. Along with CIFT, eight more laboratories in Government sector and five laboratories in private sector have also been given the status of National Reference Laboratory in specific areas.

With the vision of creating a laboratory system network on par with global food testing laboratories;Food Safety and Standards Authority of India (FSSAI) hasnotified 13 food testing laboratoriesin the country, which are accredited as per appropriate ISO/IEC standards for method development, method validation, proficiency testing and training by National/ International accreditation bodies.

As per FSSAI guidelines, the functions of National Reference Laboratory (NRL) are as follows:

- Be the resource centre for provision of information on certified reference materials
- Develop standards for routine testing procedures and reliable testing methods
- Provide technical support in the area of competence
- Evaluate the performance of other notified laboratories
- Coordinate exchange of information amongst notified laboratories
- Collaborate for data generation among network of notified food laboratories and referral food laboratories and collate the data related to their specific domain
- Carry out such other functions, as may be specified by the Food Authority from time to time in the related areas

Under the NRL notification, CIFT has earmarked with the following research activities on emerging issues pertaining to:

- Risk assessment of dietary exposure of persistent organic pollutants and emerging contaminants such as brominated flame retardants and pharmacologically active substances to Indian population from fish and fisheries products.
- Research on ingression of specific migration of chemicals from plastic packaging materials to fishery products
- Research on incidence of biotoxins in finfish/ shellfish

Rising shrimp exports unshrink aquaculture segment: Report

Chennai: The end of bad days for stocks in aquaculture segment has come, as a report states that India's shrimp exports are gaining momentum.

According to brokerage house Equirus Securities, the positive sign will help Avanti Feeds and Apex Frozen – two prominent names in the segment – as their stocks fell 43 per cent and 47 per cent, respectively.

Equirus has a target of Rs 520 on Avanti Feeds as well as Apex Frozen with an investment horizon of one year. The brokerage expects the earning per share (EPS) of both companies to decline in FY19 and then rise in FY20.

Avanti Feeds slipped from Rs 721 to Rs 408 and Apex Frozen Food plunged from Rs 621 to Rs 324 in the last 12 months.

Equirus expects Avanti Feeds' EPS to tank 35.7 per cent in the current fiscal year and similarly, Apex Frozen's EPS is expected to fall by 17 per cent.

However, the EPS is expected to see a surge in FY20, as the report suggests, Apex Frozen will see a massive 66 per cent year-on-year (YoY) rise and Avanti Feeds will see a jump of 24 per cent in their respective EPS.

"We have highlighted earlier that after strong volume growth of 32 per cent in CY17, Indian shrimp exports decelerated to over eight per cent YoY in CY18. This was mainly due to a weaker second crop that led exports to decline three per cent YoY in H2CY18," the report said.

However, shrimp exports started recovering in December 2018 and the surge continued in January 2019 as well, the report said.

The weakness in EPS for FY19 corresponds to the trend in shrimp export from India. The shrimp export volumes grew seven per cent YoY in January. But, in terms of value, exports declined six per cent YoY in

the month compared to a 12 per cent fall in December.

The US continued to be the preferred destination as two-fifths of all exports went to Washington. China also contributed to the rise in shrimp export from India. Its share rose to 17 per cent in January, compared to three per cent last year.

KVK's drip irrigation kit to help vegetable growers save water

Kochi, Mar 12: The drip irrigation kit—Irrigate Easy— developed by Ernakulam Krishi Vigyan Kendra (KVK) of the Central Marine Fisheries Research Institute (CMFRI) is ready for sale at its salescounter at CMFRI. The KVK introduced the kit to support those struggling to go ahead with the homestead farming owing to scarcity of water during the hot summer season.

The kit would behighly useful in vegetable gardening, for which summer is the ideal season in Kerala's conditions if irrigation is ensured, said Dr Shinoj Subramannian, Senior Scientist and Head of KVK. "Using of the kit can save water usage for farming up to 60 per cent. The kit that can irrigate one cent area or up to 80 grow bags is priced Rs.450", he said. Organic manure, organic pesticides and other products useful in vegetable farming are also available at the counter.

India looks to revive monodon sector

A new line of tiger prawn (Penaeusmonodon) seed is now available to farmers in India.

India's Marine Products Export Development Authority (MPEDA) started supplying high-quality post-larvae from its new Multi-species Aquaculture Complex (MAC) at Vallarpadam.

Monodon were the most widely cultured shrimp species in India, when the country struggled to source sufficient disease-free shrimp stocks, prompting producers to shift to vannamei (whiteleg) shrimp production. However, a recent increase in tiger prawn prices has led MPEDA to develop a monodon breeding programme with the help of its research wing, the Rajiv Gandhi Centre for Aquaculture.

The first customer for the new line was Keralan shrimp producer HormisTharakan.

The 9-acre MAC facility may help revive India's monodon production, while it also supplies Juvenile Tilapia, Barramundi, Cobia, Pomapano and mud crab for on growing.

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Vaccination: A Novel way of Preventing Disease in Aquaculture Industry

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Introduction

A vaccine is a biologically based preparation that improves immunity by stimulating the antibody production against a particular disease or group of diseases. It has been usedfor many years in humans and other animals against a variety of diseases. Vaccines are generally administered to the animals before a disease outbreak. Vaccination is a very effective method to treat, orinsteadto say prevent diseases which have been practiced for a long time.The vaccination was first described in 1798 by Edward Jenner, who was the pioneer of the smallpox vaccine, the world's first vaccine.

Properties of the Ideal Vaccine

(Grisez and Tan 2005).

- is safe for the fish and the consumer;
- protects against a broad strain and gives 100% protection;
- provides long-lasting protection
- cost-effective; and easy for application

Why do we need a vaccine for fish?

Fish and fish products are consumed as food all over the world, and it is a good source of animal protein. Fisheries sector holds about 1.1% in total GDP, and it contributes 5.5% of agriculture GDP in India. The annual export earning is 30,420 crores. Per capita, fish consumption is more than 9 kg p.a. However, we now suffer from overfishing and excess pollution in the ocean. Intensive culture system where single or multiple fish species are reared in high densities, so disease-causing agents easily transmitted to the entire population. The species reared in cages, and open aquatic environments are directly exposed to the pathogens. The inland sector needs to be improved further to deal with them assive need of the food sector, and that is the reason why we need to solve the major problems like disease outbreak in the aquaculture sector.

Different Types of Vaccines

There are many different types of vaccines are currently in use, the most common are described below. (Yanong, 2011)

Bacterins/ bacterial vaccines: This comprised of killed, formerly pathogenic bacteria.

Live, attenuated vaccines: These vaccines are created by reducing the virulence of the live micro-organisms, so they no longer cause disease.

Toxoids: Inactivated toxic compounds are used as a vaccine. E.g., the tetanus toxoid vaccine in humans.

Subunit vaccines: It uses a small portion of a micro-organism that ideally will stimulate an immune response to the entire organism.

DNA vaccine: A DNA vaccine uses a gene from micro-organisms to stimulate the immune system.

Methods of vaccination in fish

I) Oral vaccination

Direct delivery of vaccine via the digestive system of the fish. In this method the vaccine is mixed thoroughly to the feed before feeding hence the stress on the fish is minimal. The oral vaccine is the most preferred method of vaccination; it conveys relatively short immunity such that additional vaccination may be required (Komar et al., 2004).

II) Immersion vaccination

Immune cells located in the fish skin and gills will become directly exposed to the vaccines (antigens). In some cases the antigen is carried internally using immune cells, in such situations more systemic response will be developed in the host. This type of vaccination given by a short dip orbath. In the immersion method, the protection may not last long and second vaccination is needed (Komar et al., 2004).

III) Vaccination through injection

Direct delivery of a small volume of vaccine into the muscle via intramuscular injection or the body cavity using intraperitoneal injection. It directly stimulates the immune cells. This method is effective against many pathogens, and the protection is much longer than other methods of vaccination.

Highlight Points

- **Most of the fish vaccines were developed and commercialized for salmon.**
- **Environmental safety concerns currently hinder the development and use of live virus vaccines in fish.**
- **Most of the vaccines used in fishes are inactivated pathogens. However, recently DNA vaccines (recombinant vaccines) were developed against many pathogens.**
- **DNA vaccine is an entirely new approach in this field, and that can be used to prevent many diseases in the aquaculture industry.**

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- *Bacillus macerans*
- *Bacillus coagulans*
- *Bacillus mesentericus*
- *Bacillus Sp.*
- *Pseudomonas denitrificans*
- *Pseudomonas putida*
- *Pseudomonas Sp.*
- *Rhodococcus erythropolis*
- *Rhodobacter Sp.*
- *Acidithiobacillus ferrooxidans*
- *Thiobacillus thiooxidans*
- *Lactobacillus acidophilus*
- *Lactobacillus brevis*
- *Lactobacillus reuteri*
- *Lactobacillus rhamnosus*
- *Lactobacillus sporogenes*
- *Lactobacillus plantarum*
- *Lactobacillus fermentum*
- *Acetobacter aceti*
- *Citrobacter freundii*
- *Nitrobacter Sp.*
- *Nitrococcus Sp.*
- *Bifidobacterium infantis*
- *Paracoccus pantotrophus*
- *Bifidobacterium longum*
- *Pediococcus acidilactici*
- *Pediococcus pentosaceus*
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Vaccines available to treat fish diseases

The first commercially available bacterial vaccines were inactivated whole cell formulations against enteric redmouth disease (ERM) and vibriosis. These vaccines were introduced in the USA during the late 1970s, and these vaccines can be produced at a low cost (Evelyn, 1997). Most of the vaccines against bacterial infections used are mainly inactivated bacteria. The viral vaccines used commonly are inactivated or recombinant viral vaccines. However, the inactivated viral vaccines are effective only if it is delivered to fishes via injection. However, inactivation of viruses is difficult. The most efficient viral vaccines for fishes like DNA vaccines against salmonid rhabdovirus, VHSV, IHNV and WSSV vaccines still under experimental level. The parasitic infections like white spot disease, whirling disease, amoebic gill disease, and proliferative kidney disease will create a severe problem in fishes. However, to date, there is no parasitic vaccines are commercially available. Some of the commercially available fish vaccines are given in Table no.1. (Sommersetet *al*., 2005).

Table 1. List of commercially available bacterial and viral vaccines

Bacterial vaccines	Viral vaccines
Vibriosis	IPNV, other aquatic birnaviruses
Aeromonas salmonicida	Pancreas disease/PDV
Coldwater vibriosis (*Vibrio salmonicida*)	Infectious hematopoietic necrosis/IHNV
Furunculosis (*Aeromonas salmonicida subsp. salmonicida*)	Grass carp hemorrhage disease/GCHDV
ERM/Yersiniosis (*Yersinia ruckeri*)	Iridoviral disease/RSIV
Columnaris (*Flavobacterium columnare*)	Infectious salmon anemia/ ISAV

DNA vaccine

The traditional vaccines like live attenuated vaccines always a threat to the host organism due to its reversibility. If those vaccines are not prepared with proper accuracy, it can cause the disease to the host. Also, the live attenuated vaccines require a continuous cold chain except which the quality and efficiency of the vaccine will immediately degrade whereas, inactivated vaccines do not require a cold chain, but the immune response created by those vaccines were very week. In contrast to other vaccines, DNA vaccines have many advantages. DNA vaccines can elicit both cell and humoral mediated immunity for a long time (Lorenzen and LaPatra, 2005). These vaccines do not require a cold chain, and it can easily be focused on the antigen of interest. In DNA vaccine there is no possibility of reversion like a live attenuated vaccine.

How are the DNA vaccines made?

DNA vaccines are made from plasmid expression vectors by inserting the gene of pathogenic microorganisms which can produce an antigenic protein using recombinant DNA technology. This recombinant vector is also known as DNA vaccine construct. This construct is then transformed into the bacterial host organism to produce multiple copies of the construct. Then the plasmid is isolated from the bacteria and directly used as a vaccine (Lorenzen and LaPatra, 2005).

DNA vaccines for fishes

The first DNA vaccine commercially used in fish was against Infectious Hematopoietic Necrosis Virus (IHNV) inAtlantic salmon after that further research took place in this field. Many DNA vaccines were developed against various pathogens. Some of those vaccines are in clinical trial. The list of DNA vaccines studied extensively were given in Table 2.

Table 2. List of DNA vaccines available for fishes

DNA vaccine	Species
IHNV (Apex- IHN by Novartis, UK)	Atlantic salmon
IPNV (Mikalsen et al., 2004)	Atlantic salmon
ISAV (Mikalsen et al., 2005)	Atlantic salmon
VHSV (Lorenzen et al., 2002)	Rainbow trout
WSSV (Krishnan et al., 2009)	Black tiger shrimp
AHNV (Sommerset et al., 2003)	Turbot
CCV (Nusbaum et al., 2002)	Channel catfish
SVCV (Kanellos et al., 2006)	Common carp

Strategies in DNA vaccination

The DNA vaccine is injected into the host organism via intramuscular injection. Once the DNA gets inserted, the host recognizes the vaccine as foreign material, and the degradation process begins by lysosome. It is not efficient for all pathogens. Consumer acceptance of the GMOs might influence the acceptance of DNA vaccinated fishes.

Conclusion

Currently, vaccines are available for some of the economically important bacterial and viral diseases. Till now vaccines for the protection against parasitic and fungal diseases have not yet been developed. An optimal vaccine must be able to induce innate mechanisms, a sufficient antibody response, induce a T-cell response(s) and generate specific immune memory in the host fish species. Many Indian Government research centers have already taken up projects for developing, and commercialization DNA vaccines against the fish diseases occur in some economically important aquaculture species, and scientists believe that by some improvements and modifications, this technique can be the most important disease prevention measure in fisheries.

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More Reference can be provided on request.

Effect of Endocrine Disrupting Substances in Aquaculture

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Introduction

Endocrine disrupting substances (EDS) an exogenous agent which have ability to alter the synthesis, release, transport, binding action, metabolism and elimination of natural hormones in the body that is responsible for normal physiology, homeostasis and regulation of development process. According to World Health Organization (WHO) endocrine disrupter is defined as "an exogenous substance or mixture that have capacity to modify function of the endocrine system and consequently causes adverse health effects in an organism which is also reported by Evans et al. (2011). Endocrine disrupting compound (EDC) have direct effect on hypothalamus-pituitary-thyroidal or hypothalamic-pituitary-gonadal axes (Ankley et al., 2009).Major group of endocrine disruption substances are phytoestrogens; pharmaceuticals and synthetic hormone, dioxin and dioxin-like compounds; industrial chemicals; pesticides. Chloro-diphenyl-trichloroethane (DDT)) and herbicides. Among the phytoestrogen, the main classes are isoflavones (genistein, daidzein, glycitein, equol and biochanin A), the coumestanes (coumestrol), the lignans (enterolactone, enterodiol), the flavonoids (quercetin, kaempferol), the triterpenes (e.g. oleanolic acid), the stilbenes (resveratrol) and saponins.

1. Mode of action of EDCs

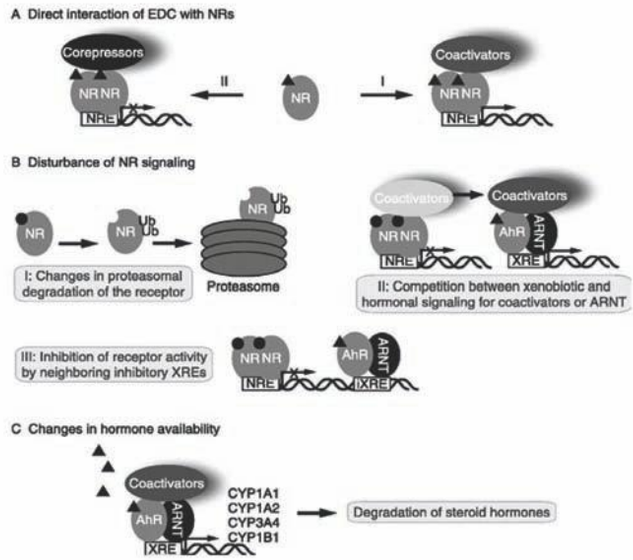
EDCs affects either by directly interfering with signalling or by triggering other signalling pathways. Most of EDCs interface with nuclear receptors family hormones. The hormone of nuclear receptors family including progesterone receptor (PR), steroid hormone receptors ERs, androgen receptor (AR), glucocorticoid receptor, thyroid hormone receptors. Nuclear receptors reside either in the cytoplasm or in the nucleus of the cell in the association of chaperones or co-repressors(Picard, 2006). These binding triggers conformation change of receptors and dissociation of repressors complex and increase the transcriptional factor. If ligand is absent then the co-repressor and receptor found in the complex and thus repress the target gene expression.

1.1 Mimicking the biological activity of a hormone (agonistic effect)

EDC have similar chemical to natural hormone and have ability to bind with a cellular receptor, which could lead to an unnecessary response by initiating the cell's normal response.

1.2 Binding to the receptor but not activate it (antagonist effect)

They may have similar type of structure but not exact same, so after binding with the receptor they block the pathways of natural hormone production.



Mechanism of action of EDSc (Swedenborg et al., 2009)

Highlight Points

- **Endocrine disrupters compounds (EDCCs) an exogenous substance or mixture that have capacity to modify function of the endocrine system.**
- **Most of EDCs interface with nuclear receptors family hormones.**
- **The mode of action of EDCs is either agonist or antagonistic.**
- **EDCs are estrogenic active compounds can be natural like phyto and myco-estrogens or anthropogenic such as certain pharmaceuticals, pesticides and industrial chemicals.**

2. Phytoestrogens

Phytoestrogen are naturally occurring polyphenolic compound in plant like legumes, soybeans, beans, cereals and sesame that may exert estrogenic activity. They binds with estrogenic receptors (ERs) α and β, binding affinity with ERβ is more than ERα and acting as partial agonists, agonists and antagonists.

Due to the presence of phenolic ring in phytoestrogen, their structure is similar to the Estradiol, and bind to the receptors and exhibit the action. (Barlow et al., 2007).Flavonoids and coumestanes are considered as the most common estrogenic compounds in these plants (Mazur, 2000).

Pavlov et al. (2009) reported that anthropogenic factors such as pollutants act as EDC and can alter the gametogenesis leading to a disturbance of normal reproduction like irregular development and morphological distortion of the gonads, delay of sexual maturity, change in the duration of the periods of gonadal development, reabsorption of sex cells in females and males at various stages, increase in the number of fishes omitting spawning, and decreased fecundity. The main classes of phytoestrogens are the flavonoids (quercetin, kaempferol), isoflavones (genistein, daidzein, glycitein, equol and biochanin A), the lignans (enterolactone, enterodiol), the coumestanes (coumestrol), the stilbenes (resveratrol), saponins and the triterpenes (e.g. oleanolic acid and ursolic acid).

2.1 Isoflavones:

Daidzein and Genistein Isoflavones possess a 3-phenylchroman skeleton derived biogenetically from the 2-phenylchroman skeleton of the flavonoids. Isoflavones are found in Leguminosae plants including soybeans. Isoflavones inhibit aromatase enzyme, cell cycle progression, antioxidant properties and also stimulate the synthesis of sex hormone binding globulin (Ososki and Kennelly, 2003). Isoflavones also having some estrogenic and anti estrogenic action. Genistein and daidzein are the major Isoflavones most commonly found in plants as inactive glucosides. Biochanin A and formononetin are the precursors of Genistein and daidzein respectively, which are produced from breakdown of intestinal glucosides. Rainbow trout fed with soybean based diets (having Genistein and daidzein) increased plasma vitellogenin concentration in both male and female (Pelissero et al., 2001). Equaol is metabolite of daidzein and formonetin in the gut micro flora when farmed animal fed with diet having high inclusion level of soybean. Eqauol and genistein can interfere with endocrine and reproductive processes in teleosts (Pelissero et al., 1991). Intraperitoneal injection of equal and genistein induced vitellogenesis in Siberian sturgeon (Acipenser baeri) yearling.

2.2. Coumestans: coumestrol

Alfalfa and clover are the main sources of coumestrol however, alfalfa sprouts considered as the most significant dietary sources of coumestans. Coumestrol has significantly higher binding affinity with estradiol as compare to genistein, and exhibits strong estrogenic activity. Apart from estrogenic activity coumestrol also increases lipogenesis and glycogenolysis in perfused rat liver (Dixon, 2004). Coumestrol are reported most potent phytoestrogen among all, it increases the most vitellogenin secretion at lowest dose (Pelissero et al., 1991).

2.3. Saponins as Phytoestrogens

Saponins are secondary metabolites glycosylated, non-volatile, surface active compounds mostly found in plants. Dietary saponin is also known to reduce fertility (Qun and Xu, 1998). Saponin of Albizia lebbeck bark showed antifertility activity in male rat, it is due to disturbance in testicular somatic cell function (Gupta et al., 2005). The saponins which are steroidal glycoside linked to hydrophobic aglycone (sapogenin) can be an alternative to androgenic hormones used for tilapia sex inversion and sterility. Diet containing saponin 300 mg/kg fed to tilapia showed infertility (Francis et al., 2005). Higher inclusion of saponin (700 mg/kg feed) the diet of tilapia, induce sex inversion to all male tilapia.

2.4. Xenoestrogens

Xenoestrogens are natural compounds or synthetically derived agent like pesticides, drugs and industrial by product. Xenoestrogens adversely affected fish in several area like reproduction, immune function, growth and offspring fitness. Xenoestrogens induce vitellogenesis in male fish. Xenoestrogen have ability to mimic the endogenous action and nongenomic action too. Major Xenoestrogen are present in environment and enters in the human food chain by the process of bio-magnification, such as DDT derivatives, alkyphenols and Polychlorinated biphenyis (PCBs).

The potency of EDCs depends upon number of factors like EDC concentration, life stage of organism, temperature, duration of exposure, presence of other EDCs, environmental stressors like salinity, pH etc. (Mills and Chichester, 2005).

3. Major Problems Due to EDCs

EDCs have the potential to disturb normal endocrine processes regulating cell growth, homeostasis and development. They also interfere with the synthesis, storage, metabolism, transport, elimination and receptor binding of endogenous hormones (Lyssimachou, 2008).

4. Major Problems Due to Phytoestrogens

The most common problems due to EDCs associated in wild fish include;

1) Disrupted or retarded testicular development
2) Egg producing cells in a male testis (testis-ova fish)
3) Elevated levels of a female egg protein (i.e. phospholipo protein vitellogenin) in male fish
4) Masculinization of females
5) Anomalous reproductive behaviour.

5. Conclusion

It has been reported that certain environmental EDCs like phytoestrogen caused epigenetics effects that could across generation which leads to alter physiology of the offspring. There is need in hour to understand how these compound can influence epigenetic patterns and molecular mechanism to alter the physiology.

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****More Reference can be provided on request.***

New Challenges & Scope for Sustainable Vannamei Farming in India

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Shrimp farming by "less investment and high profit" mentality of most of the farmers led to emphasize the horizontal expansion by shifting culture techniques from traditional extensive to improved extensive, semi-intensive and intensive types. But recently low price in export markets and disease prevalence has caused many farms under loss or only break even point. Due to the high price and demand of shrimp in the international market, expansion of shrimp culture, particularly vannamei has been taking place throughout the world. Recent trends of brackishwater shrimp farming tend to increase manifold for its demand in international market due to unique taste and employment opportunity in tropical and sub-tropical regions. The pace of growth of vannamei farming in India has been impressive but for further expansion and sustainability the main issue is the lack of availability of quality seed from Specific Pathogen Free brood stock. By 2015, in Andhra Pradesh the CAA has given permission to 192 L. vannamei hatcheries and the Government of India permitted 17 hatcheries for nauplii rearing in facilities outside the jurisdiction of the CAA. For the last couple of years, L. vannamei farms started to develop their own brood stocks from grow out ponds and began producing seed; these seed are sold in the market as SPF and due to the lack of proper testing facilities is impossible for farmers to known the real quality of the seeds.

Disease outbreaks are another issue that L. vannamei farming is facing nowadays; they have increased the economic risks and slowed the industry's development. Its good that only qualified hatcheries are in action at the moment with strict guidelines from CAA. Rapid development of shrimp farming brings a series of environmental, human health and safety problems, thus causing concern about its sustainability. Self pollution of nearby farms happened generally in many farms as one farm's effluent is the source of other farm's intake. Thus commercial shrimp farming poses a threat to coastal ecosystem by discharging huge amount of organic and nutrient loads beyond its self-cleansing capacity.

White spot disease (WSSV), White Faeces Syndrome (WFS), Loose Shell Syndrome, Black Gill Disease (BGD), Running Mortality Syndrome (RMS) and White Muscle Disease (WMD) are the most common diseases that have affected L. vannamei in all maritime states of India. And most recently, Enterocytozoon hepatopenaei (EHP) which does not cause mass mortalities but has been shown to reduce growth. Globally, the feed prices are gradually increasing as a consequence of the rise of raw materials and fishmeal price hikes and Andhra Pradesh shrimp producers are resenting this situation, reflected in the increment of their operational costs.

Market price fluctuations (International)

Price fluctuations and the lack of information on international prices and demand have generated economic losses for small-scale producers. The uncertainty of market prices has made farmers unable to buy high quality feed, which is very costly. In addition, the quality of more economical feed is often unknown and has to be tested but there is a dearth of technical manpower and laboratories.

Looking forward:

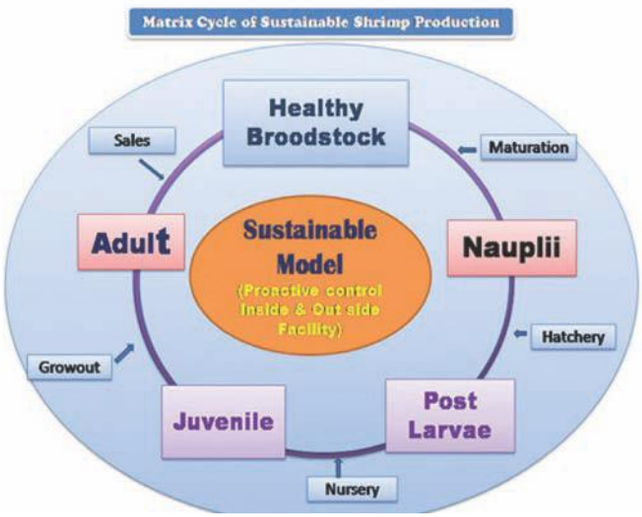
The shrimp farming industry in the region has been consolidated over the years, but to achieve sustainability it is necessary to increase the Aquatic Quarantine Facilities (AQF) and create more SPF brood stock and nauplii rearing centers. At the same time, it is important to prevent the operation of unauthorized hatcheries and nauplii rearing centers. It is also fundamental to generate protocols and guidelines for probiotic use in soil, water and feed; as well as promote the implementation of best management practices and biosecurity in shrimp culture. The installation of reservoir ponds in L. vannamei farms should be a must, as well as effluent treatment. The government should incentivize the

Highlight Points

1. **The coral reefs offer many values to human society and environmet.**
2. **Coral reef highly suseptible for environmental change.**
3. **The countries and communities need to enforce laws against coral destruction.**
4. **Conservation policies should ensure natural carbon sequestration by protecting different ecosystem.**
5. **Controlling coastal development through a strategy can help to protect reefs from long-term stresses.**

rehabilitation of abandoned shrimp farms and expansion of culture areas as well as promote the development of alternate species with culture systems and hatcheries for mud crabs, sea bass and cobia. Techniques for reducing bacterial loads in shrimp culture systems should be addressed, among other topics.

Andhra Pradesh L. vannamei aquaculture sector is characterized by small-scale farms, therefore it is important to organize shrimp producers into Farmer Producer Organizations to provide technical support and training in Best Management Practices and Biosecurity, as well as information about the national and international market. In Gujarat so many corporate farms are available, and West Bengal and Odisha are mixed of small & big farms.



Discussion:

The potential of shrimp culture in Andhra Pradesh is extraordinary; it generates a great number of direct and indirect jobs in the region, represents a great opportunity for rural development and brings a significant economic impact. Thus, it is important for all shrimp farmers to practice responsible aquaculture by only purchasing seed from authorized hatcheries, implementing strict biosecurity protocols and following strict quarantine measures and best management practices in culture systems. This way crop losses will be reduced, as well as the risk of disease outbreaks. Andhra Pradesh has the possibility to become an aquaculture hub in India, that's the reason why the State government has considered incentives and subsidies to foment aquaculture and its sustainability.

Conclusion:

Adopting better aquaculture practices by means of promoting environment friendly culture systems without provoking detrimental impacts on environment, and biosecurity principles to avoid disease outbreak are core points to develop sustainable shrimp culture. Sustainable utilization of available resources and infrastructure can lead to the development of under exploited resources with the potential of generating a large number of employments, and enormous social and economic benefits to the coastal region of the country. Biosecurity is an integrated approach and to be followed in all phases of farming. Sustainable utilization of available resources and infrastructure can lead to the development of under exploited resources with the potential of generating a large number of employments, and enormous social and economic benefits to the coastal region of the country along with stable and profitable business.

- To procure reputed SPF brood stock from 2 sources and cross them up to 3-4 generations
- Ensure good detection level (PCR) by sampling multiple tissues emphasizing brood stock
- Ozone is efficient for water treatment in Broodstock/ hatchery system
- Exclude WSSV through disinfection/treatment/efficient filtration of water/stress reduction
- Stress management/limited water exchange/enough aeration/BAP
- Optimization of Shrimp health monitoring/close track of shrimp activity in all holding units
- Less inputs in ponds to control production costs and sales through society
- Efficient and skilled pond management with use of advanced technology.

Mycotoxins in Food

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Introduction

Mycotoxin is a toxic secondary metabolite produced by fungus and is capable of causing disease and death in both humans and animals. Because of their pharmacological activity, some mycotoxins or mycotoxin are used as antibiotics, growth promoters, and other kinds of drugs.

The diseases caused by the growth of fungi on animal hosts are collectively called as "mycoses". The diseases produced by dietary, respiratory, dermal, and other exposures to toxic fungal metabolites are collectively called "mycotoxicoses". The fungi that cause mycoses are divided into two categories, primary pathogens (e.g., *Coccidioidesimmitis* and *Histoplasmacapsulatum*) and opportunistic pathogens (e.g., *Aspergillusfumigatus* and *Candida albicans*). The ordinary portal of entry is through the pulmonary tract and direct inoculation through skin contact is not uncommon in case of mycosis. The symptoms of a mycotoxicosis depend

on the type of mycotoxin; the amount and duration of the exposure; the age, health, and sex of the exposed individual. The severity of mycotoxin poisoning can be compounded by factors such as vitamin deficiency, caloric deprivation, alcohol abuse, and infectious disease status.

Mycotoxins are produced by three genera of fungi: *Aspergillus, Penicillium* and *Fusarium,* that are found widely in nature and produce toxins under the optimal conditionswhich includes presence of carbohydrate, moisture >14%, relative humidity >70%, temperature 15- 350C and oxygen. Mycotoxins are usually produced in feedstuffs prior to harvest but can develop in finished feeds that are not properly dried or stored.The most important mycotoxins are including aflatoxin, citrinin, ergot akaloids, fumonisin, ochratoxin, patulin, trichothecene, and zearalenone.

1. Aflatoxin

Aflatoxins are a family of toxins produced by certain fungi that are found on agricultural crops such as maize (corn), peanuts, cottonseed, and tree nuts. The main fungi that produce aflatoxins are *Aspergillusflavus* and *Aspergillusparasiticus, Aspergillusbombycis, Aspergillusochraceoroseus, Aspergillusnomius,* and *Aspergilluspseudotamari* are also aflatoxin-producing species, but they are encountered less frequently.These are the ability to grow where a high osmotic pressure exists eg.high concentration of sugar, salt. *Aspergillus* species are highly aerobic and are found in almost all oxygen-rich environments.A. *flavus* has a minimum growth temperature of 12 °C (54 °F) and a maximum growth temperature of 48 °C (118 °F) and the optimum is 37°C.The four major aflatoxins are called B1, B2,G1, and G2, based on their fluorescence under UV light (blue or green) and relative chromatographic mobility during thin-layer chromatography.Aflatoxin M1 and M2are derivatives of aflatoxin B1 and B2 associated with milk and milk products. Aflatoxin Q1 (AFQ1), a major metabolite of AFB1 is found in *invitro* liver preparation of higher vertebrates.

Aflatoxin B1 is the most potent natural carcinogen and produced by toxigenic strains. Half of *Aspergillusflavus* strains produce aflatoxinsin quantities more than 106 µg/kg. Aflatoxin is associated with both toxicity and carcinogenicity in human and animal population. Exposure to aflatoxins is associated with an increased risk of liver cancer. The diseases caused by aflatoxin consumption are loosely called "Aflatoxicoses".

Aflatoxin contamination has been linked to increased mortality in farm animals and lowers the value of grains as an animal feed. Milk products can also serve as an indirect source of aflatoxin. When cows consume aflatoxin-contaminated feeds, they metabolically biotransformaflatoxin B1 into a hydroxylated form known as aflatoxin M1.

The carcinogenic effect of aflatoxin B1 has been found in fishes such as salmonid, rainbow trout, channel catfish, tilapia, guppy and Indian major carps and Penaeusmonodon. Yellowing of the body was indeed a manifestation of aflatoxin in the feed. Yellowing of tilapia was well manifested in feeds containing >29 ppb aflatoxin. Feeds containing aflatoxin levels less than 5 ppb can manifest histological changes in the liver and the higher levels of aflatoxin in the feed can lead fish mortality.

Signs of Feed Contaminated with Aflatoxins is i) Contaminated feed are discoloured ii) Contaminated feed lump together and smell musty. iii) The presence of blue/grey mold on feed, stale feed are often saturated with moisture and appear to 'sweat'. The Signs of Aflatoxicosis in Fish are i) Pale gills ii) Impaired blood clotting iii) Anemia iv) Prolong feeding of concentration of AFBI causes liver tumours which appear as pale yellow lessons and can spread to kidney. v) Poor growth rate and lack of weight gain. vi) Increase in fish mortality vii) Fin and tail rot viii) Aflatoxin contaminated feeds results in eye opacity leading to cataract and Blindness.

Aflatoxin B1 (AFB1) when fed to rainbow trout (Oncorhynchusmykiss) through oral feeding at a dosage of 500ppm for 20 months had caused liver cancer. In other salmonidfed to the diet containing 20ppb of AFB1, only 62% are affected by liver tumour. Channel catfish(Ictaluruspunctatus) are less sensitive to AFB1 than salmon. Symptoms observed in channel catfish was extreme pale gills, liver and other organs. High concentrations of AFB1 caused necrosis and basophilia of heptocytes,enlargement of blood sinusoids in the head kidney, accumulation of iron pigment in intestinal mucosa epithelium, and necrosis of gastric glands in cat fish.

The maximum allowable limits for aflatoxin B1 and M1 in infant foods are 0.10 and 0.025 µg/kg, as per EU regulations. In general commodities, EU regulation permits the maximum total aflatoxin at concentration varying from 4 to 15 µg/kg (ppb). But, the maximum allowable concentration of aflatoxin prescribed by FDA in feedstuffs is 20 µg/kg.The permissible limits for total aflatoxinfor all commodities in India is 30 ppb.

2. Ochratoxin

Ochratoxins are a group of mycotoxins produced by *Aspergillusochraceus*, and *Penicilliumverrucosum* and P. *carbonarius*. Ochratoxin A is the most prevalent fungal toxin of this group. Ochratoxins are found as metabolites of many different species of *Aspergillus*, including *Aspergillusalliaceus*,

Highlight Points

Mycotoxin is a toxic metabolite from fungus which causing disease and death in both humans and animals because of their pharmacological activity. There are seven types of mycotoxins found such as aflatoxin, citrinin, ergot akaloids, fumonisin, ochratoxin, patulin, trichothecene, and zearalenone. Among this, afatoxin is natural carcinogen causes liver cancer which produced by *Aspergillusflavus* and *Aspergillusparasiticus*. Fish feeds affected by this type of toxins. Discoloration, musty smell and blue/grey mold are the symptomson mycotoxin affected feed and cause liver tumours, Poor growth rate, mortality, cataract and Blindness in fishes. They are heat stable and it can be controlled by proper checking.

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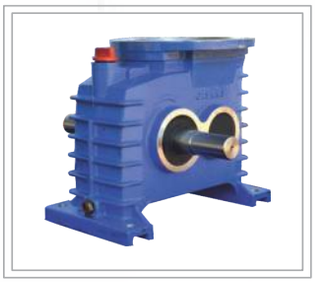

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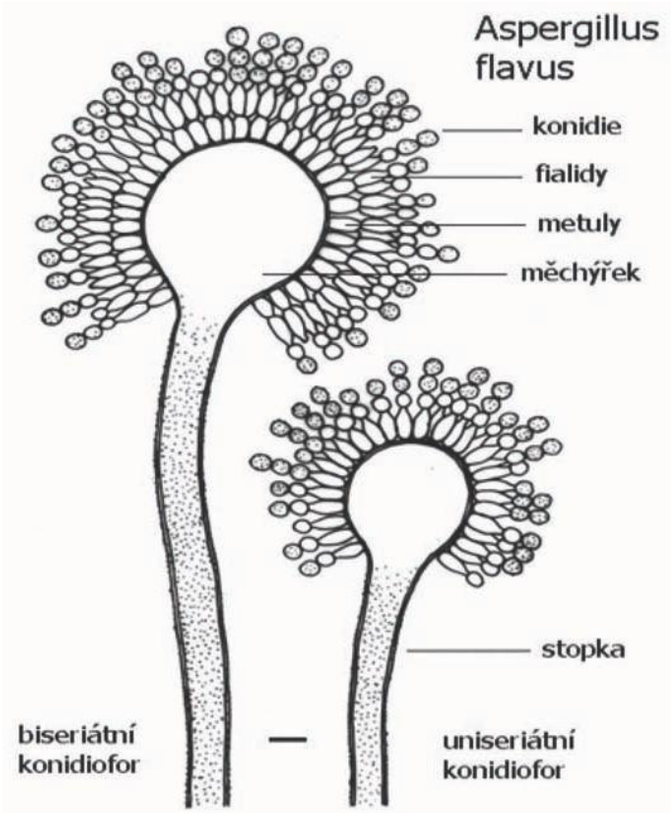

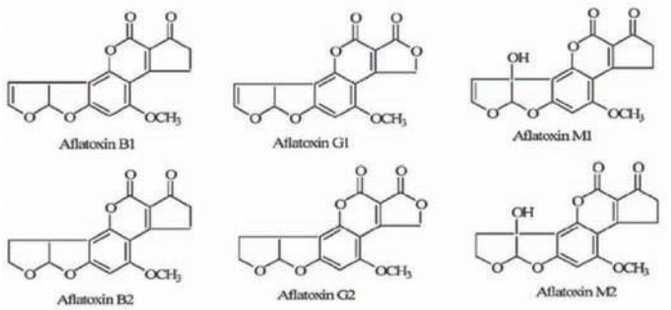

Aspergillusauricomus, Aspergilluscarbonarius, Aspergillusglaucus, Aspergillusmelleus, and *Aspergillusniger.* Ochratoxin A is found in barley, oats, rye, wheat, coffee beans, and other plant products. It is a nephrotoxin to all animal species and is most likely toxic to human. It is also an immune suppressant, a potent teratogen, and a carcinogen. Ochratoxins have been detected in blood and other animal tissues as well as in milk, including human milk. They are involved in a human disease called endemic "Balkan Nephropathy". The limit of ochratoxin A is 0-50 ppb in food and 0-1000ppb in feed as per European Union regulations.

3. Patulin

Patulin is a mycotoxinproduced by a variety of molds, in particular, *Aspergillus* , *Penicillium* and *Byssochlamys. Penicilliumexpansum* is the blue mold that causes soft rot of apples, pears, cherries and hence this toxin is most commonly found in rotting apples. It has antibacterial, antiviral, and antiprotozoal activity. It is toxic to both plants and animals, precluding its clinical use as an antibiotic.The Joint Food and Agriculture Organization-World Health Organization Expert Committee on Food Additives has established a provisional maximum tolerable daily intake for patulin as 0.4 mg/kg (ppm) of body weight per day.

4. Citrinin

Citrinin is a polyketidemycotoxin produced by several fungal strains belonging to the genera *Penicillium, AspergillusandMonascus.* Citrinin has mainly been found in rice, wheat, flour, barley, maize, rye, oats, peanuts and fruit and may co-occur in cereals with ochratoxin A. Citrinin was first isolated from *Penicilliumcitrinum* prior to World War II .It has been associated with "yellow rice disease" in Japan .

The types of toxicity that are studied for citrinin are acute toxicity, nephrotoxicity, genotoxicity and carcinogenicity. According to the European Food Safety Authority, the critical citrinin uptake is 53 µg/kg for children upto 3-9 years old, in grains and grain-based products while it is 19 to 100 µg/kg for adults.

5. Fumonisins

Fumonisins are a group of mycotoxins derived from Fusarium. It has three types, Fumonisin B1, Fumonisin B2 and Fumonisin B3. Fumonisin B1 is the most prevalent member of a family of toxins, known as "fumonisins", produced by *Fusariumverticillioides.* The risks associatedfumonisin B1 have been evaluated by the World Health Organization's International Programme on Chemical Safety (IPCS) and the Scientific Committee on Food (SCF) of the European Commission. They prescribed a tolerable daily intake(TDI) for FB1, FB2, FB3, alone or in combination as 2 µg/kg body weight. In humans, it causes esophageal cancer. It has been isolated at high levels in corn meal and corn grits.The maximum permissible limit for fumonisins iso-1000 µg/kg in food and 5000-50,000 µg/kg in feedstuffs.

6. Trichothecenes

Trichothecenes are a very large family of chemically related mycotoxins produced by various species of *Fusarium, Myrothecium, Trichoderma, Trichothecium, Cephalosporium,* and *Verticimonosporium.* It has a strong impact on the health of animals and human. They are powerful inhibitors of protein synthesis. Type Atrichotheceneis more toxic than the other foodborne trichothecenes The major effects of trichothecenesare reduced feed uptake, vomiting and immuno-suppression.

7. Zearalenone

Zearalenone is a secondary metabolite from *Fusariumgraminearum.*It is heat-stable toxin and is found worldwide in a number of cereal crops, such as maize, barley, oats, wheat, rice. It can permeate through the human skin. There is no regulation limit of this mycotoxin. It is a common contaminant in cereal grain used for animal and human food.

Conclusion

Among all *mycotoxins, afatoxin* is more dangerous compared to others which is produced by *Aspergillusflavus* and *Aspergillusparasiticus.* It is natural carcinogen that can lead to liver cancer. The aflatoxinis also toxic to some fish such as rainbow trout and channel cat fish. Fumonosins are of great concern to catfish because they feed oncorn products. In general,mycotoxins are heat stable so even extrusion processing will not inactivate it and they can be controlled mainly by checking the fish feeds for mycotoxins.

Impact of Algal Bloom in Aquaculture

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Introduction

An algae bloom or algal bloom is a rapid accumulation or increase in the population of algae in aquatic eco-systems, and is recognized by the discoloration of the water by increased density of their pigmented cells. They make the water look like pea soup. Algal blooms can occur in freshwater as well as in marine environments. Sometimes these algal blooms can be harmful too. A harmful algal bloom is a type of bloom that causes adverse impacts to aquatic organisms via production of natural toxins and ultimately causes mechanical damage to aquatic organism. They are generally associated with large-scale mortality of fin fishes and other aquatic organisms and with various types of shellfish poisoning.

Why does algal bloom occur?

1. Excessive load of nutrients

Blue-green algal(BGA) blooms are known to be natural phenomena and it is not exactly clear which factors trigger a bloom, but excess of nutrients such as sewage and fertilizers certainly can stimulate the occurrence of blooms (i.e. greater density of algae).

2. Temperature

One of the most crucial factors that trigger the algal blooms is the improper mixing of the surface and deeper water layers of the aquatic system. In lakes and reservoirs mixing of the water layers is mainly controlled by wind action and temperature. Through the summer season the surface water gets heated up and resulting in a comperatively warmer surface layer and cooler bottom layer which do not get the chance of mixing. In rivers, mixing occurs due to the water flow.

3. Human Activities - such as logging, road construction and other developmental activities can deposit nutrients and organic matter in the water.

Some floating blue-green algae used to float on the surface under these favourable conditions thus having access to light (photic region), optimum temperature and nutrients. This allows the algae to flourish and bloom. Some other motile algae can swim to the photic region where these conditions are available. Natural sources of nutrients such as nitrogen and phosphorus can be supplemented in the water bodies by a number of human activities. For example, in rural areas, agricultural runoff can wash the fertilizers from the field into the water.

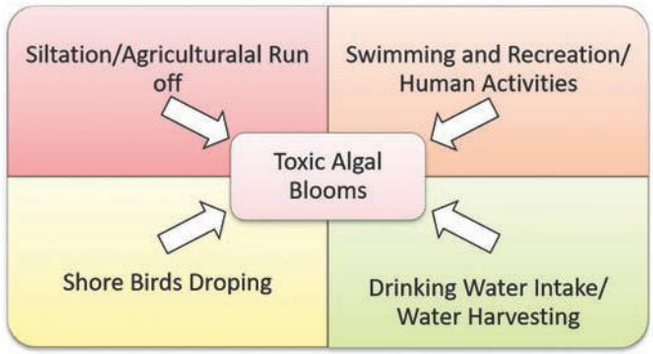

Figure 1: Factor Influencing the formation of toxic algal blooms.

Toxic Bloom

Some algae are capable of producing toxic chemicals which pose a threat to aquatic organisms including fish, other wild and domestic animals, and human beings. When the algae die and decay the algal toxins are released in the water. Blooms of cyanobacteria and other toxic algae can cause illnesses in human such as lung irritations and gastroenteritis (if the toxin is ingested). It can also Cause skin irritation to the people who swim through the water having toxic algal bloom. Toxicity can sometimes lead to severe illness and can cause death to animals.

Diseases caused by Harmful Algal Blooms

- *Neurotoxic shellfish poisoning (NSP):* These are mainly caused by the toxic dinoflagellate Gymnodinium breve and seen along the coasts of Florida, Gulf of Mexico, and sometimes along the southeast Atlantic coast. Brevetoxin is responsible for NSP and it lead to massive fish kill and it is also harmful for aquatic birds and mammals.
- *Paralytic shellfish poisoning (PSP):* Various species of the dinoflagellate genus Alexandrium, Gymnodinium, Pyrodinium are responsible for PSP. They are found along Northern Atlantic and Pacific coasts. The main toxin responsible for PSP is saxitoxin.
- *Amnesic Shellfish Poisoning(ASP):* ASP mainly caused by Pseudo-nitzschia spp. (diatoms) and the toxin responsible is Domoic acid.
- *Diarrhetic Shellfish Poisoning (DSP):* caused by Dinoflagellates spp. Such as Dinophysis acuminata,

Highlight Points

- **All kind of algal blooms are not noxious type.**
- **Toxic algal bloom Causes massive fill kill and lead to economic loss.**
- **Harmful Algal Bloom is a global threat and can cause severe illness in human being.**
- **Regulation of excessive nutrient entering into the water is the best mitigation strategy.**

Dinophysis fortii, Prorocentrum lima and the main toxin for DSP are Okadaic acids and dinophysistoxins.

Detrimental Aspects of Algae

- Blooms of freshwater algae such as microcystis cause fish mortality.Red tides and other marine blooms produce toxins and these toxins accumulated in food chains and causing serious health problems.
- Causing damage to frescoes, cave paintings, and other works of art
- Fouling of ship bottom and other submerged surfaces.
- Causing fouling to the shells of commercially important bivalve species.

Red tide

Fish kill

How Do Blue-green algal Toxins affect other Animals?

- When the aquatic system becomes toxic due to blue-green algal bloom, it may cause death to the aquatic organisms.
- Sometimes , domestic animals such as dogs or cattle may be poisoned if they do not have other source of drinking water.
- Some strains of blue-green algae can produce a number of toxins.
- Neurotoxins produced by the algae can affect the nervous system and cause sudden death, within 30 minutes, due to paralysis and respiratory arrest.
- Hepato-toxins which are produced by the toxic algae can affect the liver and cause slow death, up to 36 hours after drinking the toxic water.

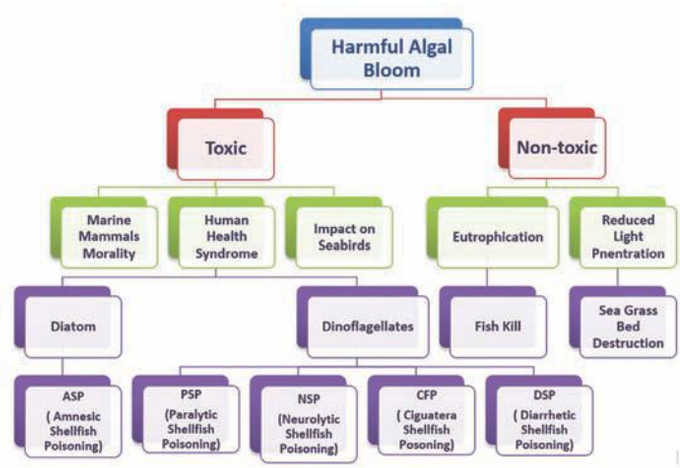

Figure 2: Impact of Harmful Algal Blooms

Precautions

- Treat any intense bloom with suspicion
- Avoid drinking water from bloom-infested lakes and reservoirs
- Do not swim in water containing concentrated algal material
- Provide alternative source of drinking water to the pets and domestic animals

Control

There are several options for controlling algal bloom once it is identified. Since algal growth is stimulated by the availability of nutrients (carbon ,nitrogen and phosphorus) and light penetration, hence the light penetration to the pond bottom has to be restricted. Light penetration to the pond bottom often occurs in the shallow areas. These shallow areas are the places where growth of pond algae and weeds typically starts. Carbon and nitrogen are abundant nutrients in ponds. The lack of phosphorus is the factor that keeps algal blooms at bay. Ponds that receive excessive nutrients, especially phosphorus, generally experience algal blooms. For controlling pond algaal bloom, deepening of the shallow areas of the pond has to be done so that light does not penetrate to the soil of the pond bottom. Water depths of 3 feet or more will help to control the aquatic weed and algae problems in ponds. Recently, triploid grass carp, also called white amur, were used as biological control for pond weed and algae. Apart from these mechanical control of algal bloom can also be adopted.

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Role of Dopamine in Fish Reproduction

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Introduction

Dopamine is a catecholaminergic neurotransmitter that is widely expressed in the fish brain and plays an important role in central functions and behaviours, such as cognition, perception, emotion, motivation, reward, memory and decision making. In the mammalian brain, the central dopaminergic system is comprised of four major pathways: the mesostriatial, mesolimbic, mesocortical and tuberoinfular systems (Missale et al., 1998). The mesostriatal pathway originates in the substantia nigra and projects to the striatum. This pathway is involved in extrapyramidal motor function. The mesolimbic pathway originates from the ventral tegmental area of the midbrain and projects to the nucleus accumbens and amygdala. This pathway is primarily involved in cognitive functions, memory, and emotion. The mesocortical pathway also projects from the ventral tegmental area to cortical structures and involved in motivation and reward. Tuberoinfundibular pathway projects from the hypothalamus to the hypophysis where it is involved in neuroendocrine regulation (Messias et al., 2016).

Peripheral dopamine is involved in diverse functions. In the kidney, dopamine increases the filtration rate and inhibits sodium reabsorption. In the cardiovascular system, dopamine is involved in inhibiting norepinephrine release (Goldberg and Rajfer, 1985). In the adrenal cortex, dopamine found to stimulate and inhibit both epinephrine and norepinephrine release and regulate the secretion of aldosterone (Porter et al., 1992; Vizi et al., 1993; Missale et al., 1998).

Dopaminergic signalling is mediated by five distinct receptors that are organized in two separate clades based on their interaction with the enzyme adenylyl cyclase: D1-like receptors that include the D1 and D5 receptors; D2-like receptors including the D2, D3, and D4 receptors. D1-like receptors activate adenylyl cyclase while the D2-like receptors inhibits it. Moreover, two clades of dopamine receptors exhibit different affinities to the dopamine, with D2-like receptors exhibiting 10- to 100- fold greater affinity than the D1-like receptors. All of the receptors exhibit the typical seven-transmembrane domain α-helical G-protein coupled receptors structure, including an extracellular N-terminus and an intracellular C-terminus (Sibley et al., 1993; Jaber et al., 1996). D1-like receptors couple to stimulatory subsets of G-proteins to activate adenylyl cyclase, which leads to an increase in intracellular levels of cyclic adenosine monophosphate. The D2-like subfamily couples to inhibitory subsets of G-proteins, which inhibits adenylyl cyclase and decreases levels of intracellular cyclic adenosine monophosphate (Albert et al., 1990; Plug et al., 1992). The central dopaminergic system, acting through dopamine-D2-type receptors forms an important inhibitory component of the regulation of reproductive brain-pituitary-gonad axis (Yu and Peter, 1990).

There have been several studies on the neuroanatomical localization of the dopamine system in fish. Majority of dopamine neurons are localized to the diencephalon as opposed to the midbrain regions. Immunocytochemical studies indicate that the zebrafish dopamine neurons send ascending projection pathways to the telencephalon. These ascending pathways represent homologous mammalian mesostriatal, mesolimbic and mesocortical pathways (Rink and Wullimann, 2002). Several studies in teleosts demonstrated that dopamine neurons responsible for the inhibitory control of reproduction originate in a specific nucleus of the preoptic area, and project directly to the region of the pituitary where gonadotrophic cells are localized (Dufour et al., 2010).

Dopamine in fish reproduction

The hypothalamus in fishes exerts its regulation on the release of the gonadotrophins via several neurohormones such as gonadotropin-releasing hormone (GnRH), dopamine, γ aminobutyric acid, kisspeptin, pituitary adenylate cyclase activating peptide, norepinephrine, neuropeptide Y, Insulin-like growth factor I, norepinephrine, leptin and ghrelin (Levavi-Sivan et al., 2010). In addition, gonadal sex steroids and peptides exert their effects on the gonadotropins either directly or via the hypothalamus. GnRH is considered as the major hypothalamic factor controlling pituitary gonadotrophins; however, its stimulatory action opposed by the potent inhibitory actions of dopamine in teleosts. This dual neuroendocrine control of reproduction by GnRH and dopamine has been demonstrated in several teleosts, where dopamine plays an inhibitory role in the neuroendocrine regulation of the last steps of gametogenesis.

Peter et al. (1978) were the first to unravel the existence of a dopaminergic inhibitory neuroendocrine control of

Highlight Points

- **Dopamine is one of the major inhibitory factor in farmed fish reproduction**
- **Dopamine inhibition is especially significant in cyprinid fish**
- **Melatonin modulates the activity of dopamine in teleosts**
- **Dopamine antagonists are included in the gonadotropin and other synthetic hormonal based preparations for captive breeding**

reproduction in the goldfish. Subsequently, several studies indicated that the dopamine inhibits both basal and GnRH-stimulated luteinizing hormone secretion in teleost fish. Both in vivo and in vitro experiments, as validated by molecular and biochemical studies indicate that the dopamine D2-like, but not D1-like, receptors inhibit gonadotropin secretion directly in the pituitary. This led to the development of methods to induce maturation and spawning in aquaculture, using a combined treatment with a GnRH agonist and a dopamine-D2 receptor antagonist such as domperidone. This method called LinPe is widely used in aquaculture as an alternative and reliable strategy to control reproduction in captivity when compared with other hormonal treatments, synthetic human chorionic gonadotropin (hCG) and pituitary extracts (called hypophysation) (Dufour et al., 2010).

Dopaminergic inhibition is especially significant in cyprinid fish. Hence, spawning induction in cyprinid fish in aquaculture requires the use of dopamine D2 receptor antagonists (pimozide, domperidone or metoclopramide) to promote a significant surge of LH, in response to GnRH that will lead to successful ovulation (Peter et al., 1988; Yaron, 1995; Levavi-Sivan et al., 2010). However, the dopaminergic inhibition does not operate in all fish and is lacking in few fish like Atlantic croaker and gilthead seabream (Copeland and Thomas, 1989; Zohar and Mylonas, 2001). Dopaminergic activity varies during the seasonal reproductive and spawning cycle. Sex steroids have been shown to regulate dopaminergic systems in several teleost species, affecting both dopamine synthesis and dopamine receptor expression. In females, sex steroids play a major role in the regulation of dopaminergic activity by increasing the inhibitory tone during vitellogenesis, as demonstarted in silurids, salmonids, and percomorphs (De Leeuw et al., 1986; Senthilkumaran and Joy, 1995; Linard et al., 1995; Saligaut et al., 1999; Yaron et al., 2003; Levavi-Sivan et al., 2005). Dopamine inhibition would be maximal at the end of gametogenesis and would decrease during induction of ovulation or spermiation, under the control of external and internal cues (Dufour et al., 2005). In grey mullet, dopamine inhibition was shown to have a role at two different stages of the reproductive cycle, not only at the stage of final oocyte maturation and ovulation but also at the early stages of vitellogenesis (Aizen et al., 2005). Dopamine is also involved in the inhibition of pubertal onset in fish. In the juvenile spade fish, a decrease in dopaminergic activity was observed in the hypothalamus at the time of puberty (Marcano et al., 1995). In the immature European eel, the pituitary luteinizing content is high, and a combined treatment with GnRH and dopamine antagonist induced luteinizing release and ovarian development (Dufour et al., 1988). In the grey mullet, a dopamine antagonist treatment is highly potent than GnRHa treatment in increasing circulating estradiol-17β levels and enhancing maturation and spawning (Aizen et al., 2005). Few studies have revealed that melatonin modulates the activity of dopamine systems in some teleosts, making the melatonin-dopamine pathway a prominent relay between environmental signals and control of reproductive activity in fish (Dufour et al., 2010).

Conclusion

Various studies revealed that dopamine and GnRH interactions on gonadotrophin release involve multiple cellular mechanisms, such as down-regulation of GnRH receptor, interference with GnRH intracellular pathways and influence of neurotransmitters and neuromodulators (Dufour et al., 2010). Recently, kisspeptin has been found to modulate the activity of reproductive BPG axis through GnRH pathway in some teleosts (Ohga et al., 2017, 2018), suggesting possible interaction of dopaminergic systems in modulating the seasonal reproductive cycle in teleost fish. Also, it was demonstrated that Prussian carp injected with human kisspeptin, in combination with dopamine antagonist elevated circulating LH levels, suggesting possibility of application of synthetic kisspeptin peptide as an inducing agent along with the dopamine antagonist in carps (Gosiewski et al., 2015; Sokolowska-Mikolajczyk et al., 2018).

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