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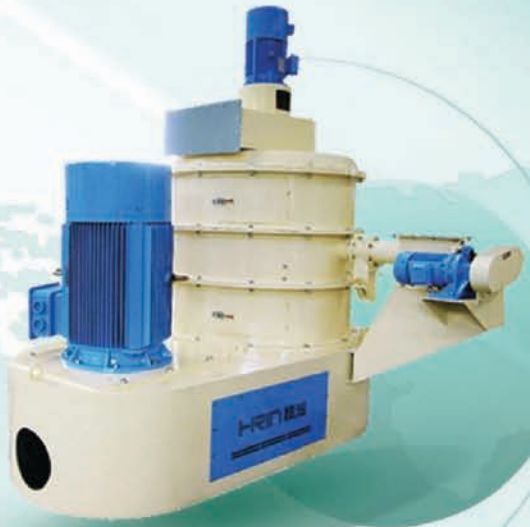

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Aqua International

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NRS Publications,
BG-4, Venkataramana Apartments,
11-4-634, A.C.Guards,
Hyderabad - 500 004, India.
Tel: 040 - 2330 3989, 96666 89554
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Gentle Biosciences Pvt. Ltd. ISO 9001:2015 CERTIFIED COMPANY

Marketing Off:# 59A-15-28, 1st Floor, Pantakaluva Road, Near NTR Circle, Patamata, Vijayawada-520010,AP.
Ph : +91 7680079988
E-mail: gentledirector1@gmail.com

www.gentlebiosciences.com

Its Webinars time now !

Dear Readers,

The October 2020 issue of ***Aqua International*** is in your hands.

The October 2020 issue of Aqua International is in your hands.

In the News section, you may find news about – A Webinar on 'Dengue and its prevention and Probiotics: fact or fiction' was organized by Dept of Zoology, S. Banerjee College, West Bengal on 5 September 2020. In it, Dr Koushik Ghosh, Professor of Zoology and Incharge, Aquaculture Laboratory, Dept of Zoology, Burdwan University, WB spoke on 'Development of Probiotics: Aquaculture Experience' after explaining the historical perspective in detail, beginning of research worldwide and functional characteristics of probiotics in general which is valuable.

The Webinar for 'Understanding and Managing Small Scale Fisheries' was organized by ICAR-Central Inland Fisheries Research Institute, Barrackpore in collaboration with Inland Fisheries Society of India and PFGF on the theme 'Small Scale fisheries (SSF) in inland open waters -- Status and opportunities' on September 9 and 10. In it, Dr J. K. Jena, DDG (Fisheries Science), ICAR, New Delhi in his presidential address emphasized on strategies need to be taken on how best we can manage SSF in India.

Central Institute of Brackishwater Aquaculture inks MoU with young entrepreneurs — Karthik Gowda V.S., Kaushik Alike and Sachin V. Savan — from Kumta.

Even though 23 years have passed since the CIBA succeeded in the captive breeding of Asian Seabass (Koduva), a fish with high commercial value, hatcheries have remained only with government research institutions. The private sector has been more interested in shrimp farming. Now, for the first time in the country, CIBA has signed a memorandum of understanding to set up a Seabass hatchery in the private sector, on start-up mode, in Karnataka. The MoU was signed with Canares Aquaculture, owned by young entrepreneurs Karthik Gowda V.S., Kaushik Alike and Sachin V. Savan from Kumta in Karnataka to ensure the transfer of CIBA's technology.

CIBA signed a Memorandum of Understanding with Salem Microbes Pvt Ltd, Salem, Tamil Nadu on September 18, 2020 for production and marketing of a phage based product developed by the Aquatic Animal Health and Environment Division (AAHED) of CIBA. The phage product is effective for the bio-control of bacterial diseases in shrimp hatchery settings.

Aquaculture in India is an important economic activity and a flourishing sector with varied resources and potentials. India ranks high in fisheries production and second in aquaculture. There is a huge value chain involved globally and the pandemic has affected the trade not just in exports but also internal consumption. A solution can be reached by increasing aquaculture efficiency, introduction of new methods to increase yield. It is important for those involved with the sector to remain constantly abreast of the newest global advancements. Keeping this thought in mind, several industry experts from India and across the world gathered at a one-of-its kind virtual conclave to discuss various topics pertaining to the industry.

The last ten years have seen certain unwavering world shrimp market contestants: First, every time the industry looks set to embark on a new cycle of strong, consistent growth, it gets hit with another setback. Second, maxed out pond area with declining production in China and Thailand was more than offset by double-digit annual growth in Indian and Ecuadorian shrimp output, where high prices drove the expansion into new, untapped frontier areas. Assumptions 2 – and world shrimp output growth are starting to falter.

The webinar held on September 23 and 24 by SAP, had speakers covering the major markets of shrimp consumption and production. George Chamberlain, the President of the Global Aquaculture Alliance, in his keynote address of the event pointed out that global shrimp supply has been on a rising trend for the last few years and prices have been falling during the same time indicating that markets were getting saturated in spite of the emergence of China as a major market in recent years. Citing the case of avocado as an example of what unified marketing efforts by the producers and sellers can achieve, Dr Chamberlain called for a similar effort in which shrimp consumption is promoted. Angel Rubio, the Chief Analyst at Urner Barry, a leading food data services firm, talked about the shrimp demand in the US market and said that retail sales of shrimp rose during the pandemic but could not compensate for the lost sales in the food service segment.

Readers are invited to send their views and comments on the news, features and articles published in the magazine which would be published under "Readers Column". Time to time, we shall try to update you on various aspects of aquaculture sector. Keep reading the magazine regularly and update yourself. Wish you all fruitful results in your efforts.

M.A.Nazeer
Editor & Publisher
Aqua International

Our Mission

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.

AI will strive to maintain quality and standards at all times.

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Webinar talk on Development of Probiotics: Aquaculture Experience

A Webinar on ***'Dengue and its prevention and Probiotics: Fact or Fiction'*** was organized by Dept of Zoology, S. Banerjee College, Dist. Hooghly, West Bengal on 5 September 2020.

Dr Koushik Ghosh, Professor of Zoology and In-charge, Aquaculture Laboratory, Dept of Zoology, Burdwan University, WB spoke on *'Development of Probiotics: Aquaculture Experience'* after explaining the historical perspective in detail, beginning of research worldwide and functional characteristics of probiotics in general. Dr Ghosh discussed about association of bacteria at different regions of gut of freshwater fish *Labeo rohita*; discovered different colonies of bacteria formed in fish gut by scanning electron microscopy and those present in mucous; screening of bacteria (probiont) from *L. rohita* for Anti-Nutritional Factor-degrading enzyme production, antagonism against pathogenic bacteria and others; study on its stability in GI tract, ability to form colony within gut, growth in intestinal mucous; biosafety to host; selection of probiotics and its *in-vivo* validation. He mentioned that gut probiotic bacteria should not contain antibiotic (Ab) resistance factor / virulence resistant genes; otherwise it will be horizontally transmitted to pathogenic microorganisms in gut, which is unwanted.

In studies on *in-vitro* antagonism assay, Dr Ghosh found growth of pathogenic bacteria to be inhibited by probiotic bacteria; most of bacteria isolated from fish gut utilized intestinal mucous; selected ones could tolerate conc^{n} of bile in gut; Gamma-haemolytic bacteria strains and Ab-susceptible ones selected as probiotic organism. He has isolated proper probiotic bacteria from proximal and distal regions of gut of Indian major carps. Out of 1216 strains isolated, 105 were pathogen-inhibitory gut isolates as it found to show antagonistic nature to quite some extent to well known fish pathogens, and, of which, 99 strains belonged to genus Bacillus. He studied gut microbiota in IMC *via* high-throughput sequencing (for culturable and non-culturable ones); significant variations exist in composition of gut microbiota of *L. rohita*, *Catla catla* and *Cirrhinus mrigala* growing in same culture environment, which have been detected and analyzed. He further discussed on purification of anti-microbial products (bacteriosin-like compounds) produced by probiotic bacteria in *L. rohita* gut namely *Bacillus* >>

BMR donates Rs 1 crore to AP CM for "NAADU - NEDU Education Programme"

From left: B. Masthan Rao, Chairman, BMR Group, presenting Rs One crore to Y. S. Jaganmohan Reddy, Chief Minister, Andhra Pradesh. V. Vijayasai Reddy, MP, Rajya Sabha, is also seen. B. Masthan Rao, donated Rs One crore to Andhra Pradesh Chief Minister for "NAADU - NEDU education programme". A land extent of 3.1 acres was purchased and donated to ZPH School for a play ground in his native village - Iskapalli, Nellore district where BMR did his schooling.

>> *methylotrophicus*, *B. amyloliquefaciens*, *B. licheniformis* and *Pseudomonas fluorescens*; their molecular characterization *via* SDS-PAGE.

Dr Ghosh conducted experiment on 60-day feeding trial with probiotic-supplemented formulated diet from '0' day onwards with selected three *Bacillus* sp in different combinations on *L. rohita* fingerlings (50gm) in 350lit FRP tanks. Probiotic-exposed fishes were challenged with *Aeromonas hydrophila* on 60th day and different parameters evaluated on 75th day. Best growth (155.40gm) and digestive enzyme activity; highest survivability rate (about 90% in respect to about 22% in those maintained on diet without probiotics and challenge done); best lysozyme, respiratory burst, serum bactericidal and phagocytic activities; improved haematological parameters; highest serum antibody concentration - all were obtained in *L. rohita* in group 'Basal diet + *B. methylotrophicus* + *B. licheniformis*'. The *L. rohita* group 'Basal diet + *B. licheniformis*' also performed well. It was the first demonstration and assessment regarding *B. methylotrophicus*, *B. amyloliquefaciens* and *B. licheniformis* as a compound probiotic on growth, immune modulation and disease resistance in *L. rohita*. In addition to probiotics, Dr Ghosh in his talk also highlighted characteristics of synbiotics and prebiotics, lactic acid bacteria in finfishes and genus Bacillus as promising probiotics in aquaculture. News communicator Subrato Ghosh participated in this Webinar attentively.

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India Office

Add: No 401 , Dega Towers , Raj Bhavan Road , Somajiguda , Hyderebad , Telangana - 500082
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Contact: Arun Kumar K
E-mail : arunkumar@famsungroup.com
Mob: +91 9901916554

Contact: Shelby
E-mail: lxb@famsungroup.com
Mob: +91 9100436652

DDG (Fisheries Science), ICAR speaks on strategizing how best to manage Small Scale Fisheries

The Webinar for 'Understanding and Managing Small-Scale Fisheries' was organized by ICAR-Central Inland Fisheries Research Institute, Barrackpore in collaboration with Inland Fisheries Society of India and PFGF on the theme 'Small-scale fisheries (SSF) in inland open waters - status and opportunities' during 9th and 10th September 2020. In it, Dr J. K. Jena, DDG (Fisheries Science), ICAR, New Delhi in his Presidential address emphasized on strategies needed to be taken on how best we can manage SSF in India.

Dr Jena mentioned that target set in PMMSY scheme to increase country's annual fish production to 22 million tonnes by year 2025 from present 14 million tonnes and doubling export. Contribution of SSF may be 1 million tonne in 14 million tonnes but the social impact of SSF with respect to nutritional and livelihood security is phenomenal. Much importance should be given to SSF, a dynamic sector and is important for several generations. SS fishers reside near rivers, wetlands, reservoirs; their rich traditional knowledge inherited from ancestors, fishing practices, crafts and gears used, their skill - how best it can be utilized to enrich our knowledge that should be looked into. SSF of different geographical locations like in Brahmaputra, Ganga, hilly areas are very much different and diverse with regards to materials used as crafts and gears, fish landing, market channel, profit, etc. No poverty, no hunger and well-being of people are 3 main aspects of Sustainable Development Goals and SSF have been contributing in it. Almost 100% of inland fisheries in India is the SSF, whether in rivers, canals, lakes and estuaries. SSF, which is traditional and subsistence one, is opposite of commercial fisheries.

Analysis of socio-economic condition of people in diverse SSFs should be made; most people involved in SSF are less than average Indian. Fish productivity reduction and uncertainty are issues in SSF. Policy guidelines formulated on mesh size regulation, sustainable development, prevent fish habitat destruction, etc, policy intervention is there. Estuaries are nursing ground for many finfishes but management measures are not existing; overfishing, pollution, minimum environmental flows have become issues in SS estuarine fisheries. Dr Jena, while discussing on the above-mentioned facts, emphasized on ways to devise how best we keep this SSF resource intact, how best we can have sustainability and responsible SSF management. We need to reduce pressure on Small Indigenous Fishes, sufficient ranching programme to be done and we have more such in PMMSY. SSF resource is often invisible; its quantification and building up of time-series information on abundance and distribution pattern of major fishes in SSF should be done. Dr Jena further emphasized on sharing of knowledge, experience, synergy in our approach, bringing SS fishers into discussion and regular consultation process with inputs of all - these will help, along with policy, in proper implementation of guidelines. Finally Dr Jena emphasized on having greater knowledge base, necessity of better road map and building up important strategies. News communicator Subrato Ghosh participated attentively in this Webinar live on Google Meet.

First private seabass hatchery to be set up in Karnataka

Chennai-based Central Institute of Brackishwater Aquaculture inks MoU with young entrepreneurs — Karthik Gowda V.S., Kaushik Alike and Sachin V. Savan — from Kumta.

Even though 23 years have passed since the Chennai-based Central Institute of Brackishwater Aquaculture (CIBA) succeeded in the captive-breeding of Asian seabass (Koduva), a fish with high commercial value, hatcheries have remained only with government research institutions. The private sector has been more interested in shrimp farming.

Now, for the first time in the country, CIBA has signed a memorandum of understanding (MoU) to set up a seabass hatchery in the private sector, on start-up mode, in Karnataka.

The MoU was signed with Canares Aquaculture, owned by young entrepreneurs Karthik Gowda V.S., Kaushik Alike and Sachin V. Savan, from Kumta in Karnataka, to ensure the transfer of CIBA's technology.

They were students at the Mangalore Fisheries College, and during a visit to CIBA's seabass hatchery at the Muttukadu Experimental Station, their interest was kindled, and the idea of setting up their own aquaculture start up was born.

When they approached CIBA authorities to set up a hatchery, the institute provided them technical guidance and field training in seabass nursery rearing.

The institute also followed up, enabling the start-up to obtain funding support to start the firm.

"It is a significant development in the country's aquaculture sector, as youngsters coming to the field with start-up ventures will pave way for resurgence and growth in brackishwater aquaculture, especially Asian seabass farming in the country," said K.K. Vijayan, director, CIBA. *Contd on Page 18*

CIBA signs MOU with Salem Microbes for Technology Transfer of 'Phage Therapy' for the control of bacterial disease in shrimp hatchery rearing systems

Dr Ramesh Kumarand Dr Vijay Anand, Directors of Salem Microbes and Dr K. K. Vijayan, Director, CIBA during signing of MoU for Technology Transfer of Phage Therapy.

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Reluctance of private sector

He explained that the private sector was largely reluctant to enter marine fish seed production because of the relatively longer production cycle and the need for a unique skill set to rear marine fish larvae.

M. Kailasam, principal scientist of CIBA, said eggs would be collected by inserting a small tube in the genital opening of the fish. "We will then analyse the eggs to ascertain their maturity. If they have reached the perfect stage, we will give the fish hormone injections to facilitate the release of eggs," he said. Hatchlings will be supplied to farmers after 25 days, he added.

Dr Vijayan said in the case of these young fisheries graduates, if they possess technical skills in the area, they were more likely to become successful entrepreneurs in aquaculture. "It is equally important to use indigenous technologies in both hatchery reared seeds and formulated feeds for development of scientific seabass farming in the country," he reiterated.

Contn from Page 16 :

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Indian aquaculture industry to aid in creating *AatmaNirbhar Bharat* and facilitate rehabilitation for reverse migrants

21st September 2020, Kolkata: Aquaculture in India is an important economic activity and a flourishing sector with varied resources and potentials. India ranks third in fisheries production, and second in aquaculture. There is a huge value chain involved globally, and the pandemic has affected the trade not just in exports but also internal consumption. A solution can be reached by increasing aquaculture efficiency, introduction of new methods to increase yield. It is important for those involved with the sector to remain constantly abreast of the newest global advancements. Keeping this thought in mind, several industry experts from India and across the world gathered at a one-of-its kind virtual conclave to discuss various topics pertaining to the industry. The Conclave witnessed a host of distinguished speakers from the industry – **Mr Amit Saraogi, Managing Director, Anmol Feeds, Mr Tim O'Keefe**, President, Aqua-Food Technologies Inc., **Dr Andy Shinn**, Senior Scientist, Benchmark R&D (Thailand), **Mr Umakanth R**, Aquaculture Consultant, Asia Subcontinent, USSEC, **Dr P.E. Vijay Anand**, Senior Lead, Emerging Market Development, USSEC, **Dr Y. Basavaraju**, Former Dean, College of Fisheries, Mangalore, **Mr Ramachandra Raju**, President, Society for Indian Fisheries and Aquaculture (SIFA), **Mr Anton Immik**, CEO, ThinkAqua, **Dr Mohd. Golam Quader Khan**, Professor, Dept. of Fisheries Biology and Genetics, Bangladesh Agricultural University, **Mr Raynalfie Rahardjo,** Business Development Manager, JALA, Indonesia and **Mr Tarun Shridhar**, Former Secretary, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India.

Amit Saraogi, Managing Director, Anmol Feeds Pvt Ltd

Addressing the audience of the conclave, **Mr Amit Saraogi, Managing Director, Anmol Feeds,** stated, "*Fisheries alone has employed 145 million people and contributed to 1.07% of the GDP and generated export earnings of Rs 334.41 billion as per a recent estimate of National Fisheries Development Board. Aquaculture over recent years has not only led to substantial socio-economic benefits such as increased nutritional levels, income, employment and foreign exchange, but has also brought vast un-utilized and under-utilized land and water resources under culture. The measures announced under the* ***Pradhan Mantri Matsya Sampada Yojna*** *for Fisheries and Shrimp sector to boost export and rural employment are encouraging. These measures will boost rural entrepreneurship, enable wealth creation to boost the economy to make India self-reliant as envisioned by our Hon'ble Prime Minister. Aquaculture can become a huge source of generating employment and livelihood as investment in this sector is less compared to the benefits it can give. It can increase protein availability, create generation of rural employment and help achieve the food security goals. Especially with all the reverse migration happening across the country, aquaculture, fisheries and shrimp culture can help in rehabilitation of these migrants and help create a livelihood for them.*"

He further added, "*We have a considerable amount of business in our neighbouring countries of Nepal and Bhutan. However, we are unable to reap the benefits of the Export Promotion Capital Goods Scheme as the earning is in Indian currency. I would like to take this platform to request the authorities to kindly look into this unconscious anomaly and help us to boost the economy of the country.*"

The virtual conclave focused on three main verticals- Health and Biosecurity to Ensure Safe Production, Culture System Improvisation and Advanced Nutrition for Optimum Growth and Better Production. The keynote speakers shared their vast experience on Aquatic Health & Nutrition while the panel discussion dwelled on how various countries and organizations have put the pandemic behind them and are charting the road ahead. This industry has the capacity to accommodate the migrant labour population and can feed many of the economically challenged. It has the potential to help rebuild the nation's economy and support the economic transformation of rural India.

During the course of the session, keynote speaker **Dr Andy Shinn**, Senior Scientist, Benchmark R&D (Thailand) said, "*There are perils of ignorance in aquaculture. Timing of treatments must be carefully implemented. In each farm situation the problems may vary. Juveniles and adults must be monitored and treated separately. Disinfecting all farm equipment thoroughly before treating is important. Seeking proper vet advice is essential without misplaced good intention by middlemen. Prepare emergency plans to maintain bio security. Procrastination and recklessness should be avoided in aquaculture.*"

Dr P.E. Vijay Anand, Senior Lead, Emerging Market Development, USSEC, added, "*A lot has been spoken about in the last few months of COVID regarding immunity and how consumption of protein can boost the immune system. It is a well-known fact that fish protein is one of the healthiest. There is an opportunity for brands for market creation and boost the aquaculture system riding on this element.*"

The panel discussed on the learnings for the aquaculture industry from COVID. The eminent panellists emphasized the need for developing market strategy to boost production, marketing the products, responsible management *Contd on Page 22*

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Probiotics for water treatment

1. WATER QUALITY CONDITIONING

Best choice of *Bacillus* spp. that rapidly decompose uneaten feed, feces and other organic substances in pond water, keeps water quality optimal

2. HIGH ACTIVITY OF SPORES

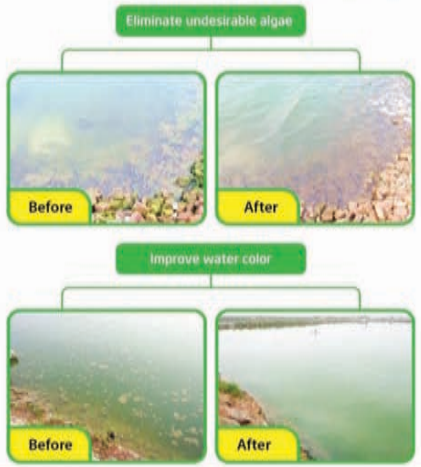
No cultivation is needed. Easily adapt to the changes of surroundings and grow fast in freshwater or seawater culture farming, even under low oxygen environment

3. DECREASE AMMONIA CONTENT

Prevent the accumulation of toxic substances such as NH_3, NO_2, etc.

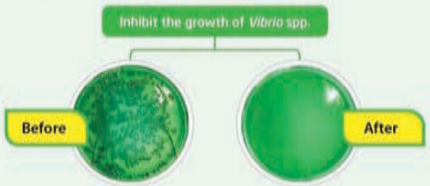
4. IMPROVE WATER COLOR

Improve water color regulate the algae and bacteria balance in water, turning your pond from green to clear



5. ESTABLISH BALANCED POND BACTERIA SYSTEM

Compete nutrition with vibrio and inhibit them to grow. Provide nutrition for probiotics in the pond, to establish a well-balanced farming system.



6. INCREASE AQUACULTURE PRODUCTION

Good quality of water prevents fish/prawn infections, making high profit of production

* COMPOSITION:

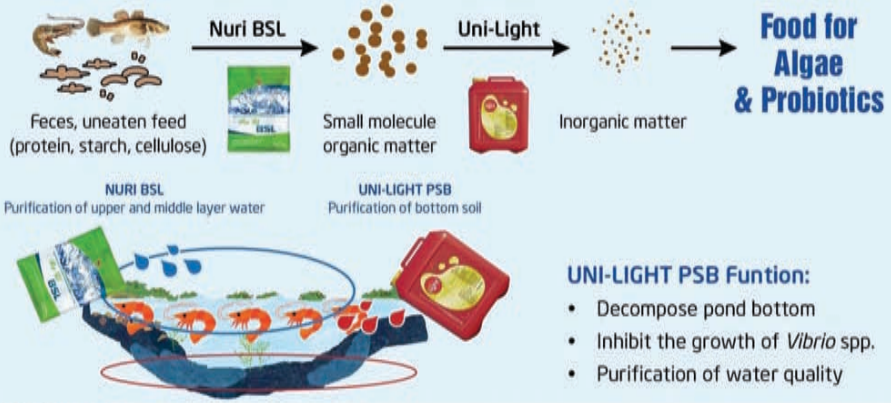
Bacillus spp. > 1x 10^{11} cfu/kg	15%
(Bacillus subtilis, Bacillus amyloliquefaciens, Bacillus licheniformis)	
Carrier (rice bran, corn gluten)	75%
Moisture	10%

* STORAGE:

Keep at dry, well-ventilated condition. Avoid direct sunlight exposure and use as soon as possible once opened for best quality.

* DIRECTION OF USE:

No cultivation is needed. Apply Nuri BSL with water-soluble bag near to the working water wheel or pour into the pond evenly. Recommend apply Uni-Light PSB together with Nuri-BSL on sunny day to achieve a clear pond more efficiently.



UNI-LIGHT PSB Funtion:

- Decompose pond bottom
- Inhibit the growth of *Vibrio* spp.
- Purification of water quality

BSL Dosage:

/10,000 m² Quantity	10 - 30 pl/m² tiger prawn or < 80 pl/m² Vannamei	For >30 pl/m² tiger prawn or > 80 pl/m² Vannamei	For > 150 pl/m² Vannamei
7 days before stocking	800 g - 1,000 g	1,200 - 1,500 g	1,200 - 1,500 g
Day of stocking	300 g - 500 g	800 g - 1,000 g	800 g - 1,000 g
Every 7 - 10 days after stocking	300 g - 500 g	800 g - 1,000 g	3 - 5 days / use 1,000g - 2,000g

****Dosages can be adjusted according to the water conditions and practices.*

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No. 16-18-20, DT 743 Road, Song Than II Ind Zone, Di An Ward, Di An City, Binh Duong Province, Vietnam.

aquafeed@upvn.com.vn
www.uni-president.com.vn

Aquaculture vaccine venture launched

A new aquaculture vaccine development company has been launched by Touchlight Genetics and Stonehaven Incubate.

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The new joint venture aims to develop DNA vaccines for the aquaculture sector

The joint venture company, called Touchlight Aquaculture, will - according to a press release issued today (29-9-2020) - "utilise Touchlight Genetics' innovative DNA-based Doggybone platform to develop new vaccines".

The technology "provides a unique, synthetic DNA vector system in combination with an enzymatic process, allowing for larger scale commercial production, at a significantly lower cost".

DNA vaccines have the potential to enable cost-efficient, safe and more effective immunisation with shorter production timelines, improving availability. DNA vaccines have already been shown to be safe and effective with approvals already granted for veterinary use. However, these have shown some limitations in terms of commercial scalability, which resulted in limited widespread adoption.

Stonehaven Incubate is the only global business incubator focused on identifying cutting edge technologies developed to improve human health and creating stand-alone companies to apply those for animal health.

Touchlight is a biotechnology company which concentrates on the discovery and development of human DNA-based genetic medicines. The company's technology has the potential to revolutionise the production and utilisation of DNA-based assets across multiple therapeutic areas, and this is their first application in the veterinary field.

Dr Mark Heffernan, CEO of Stonehaven Incubate, said: "We are delighted to be working with an established and proven leader in DNA vaccine technologies, and now applying this in a field seeking innovation and advancement. Aquaculture has a critical role in addressing the protein gap created by the rapidly expanding global population, which is expected to reach 9 billion by 2050. With a large percentage of global fish stock lost to infectious disease annually, there is growing awareness of the need for more cost-effective vaccine options."

"Touchlight Aquaculture will be at the forefront in disease prevention in this high growth industry that is strategically very important to us at Stonehaven Incubate," he added.

Jonny Ohlson, CEO of Touchlight, said: "There has never been greater need to deploy effective vaccines at global scale, whether in humans or in animals. DNA vaccines are the future thanks to their potential to enable efficient and safe immunisation on a large scale. We are excited to use our technology to support the aquaculture sector, and with Stonehaven Incubate we have a partner with proven expertise in animal health."

Contn from Page 20 :

Indian aquaculture industry to aid in creating AatmaNirbhar Bharat and facilitate rehabilitation for reverse migrants

practices and accurate knowledge acquisition by farmers to maintain quality and hygiene for internal as well as export markets. India ranks third in fisheries production, and second in aquaculture. India is home to more than 10 percent of the global fish diversity. With diverse resources ranging from deep seas to lakes in the mountains and more than 10% of the global biodiversity in terms of fish and shellfish species since independence, the country has shown continuous and sustained increments in fish production. National Institute of Agricultural Economics and Policy Research reported the projected demand would go 11.80 million metric tonnes by FY21. Fish production rose from 800,000 tons in FY 1950 to 4.1 million tons in the early 1990s. From 1990 through 2010, Indian fish industry accelerated, reaching a total marine and freshwater fish production to about 8 million metric tons.

In their two-decade old journey Anmol Feeds have strived to change the narrative of the feed industry by bringing in modern cutting edge technologies, innovative practices and policies for improved feeding, livestock health care, management and trade. The importance of upskilling of farmers has been one of their core objectives, training them to use modern technology for maximum output which can benefit both the farmer and the country at large. With the reverse migration of labours, it will be important to create livelihood and employment for these fellow countrymen. Animal husbandry especially aquaculture and poultry can become a huge source of generating employment and livelihood as investment in these sectors is less compared to the benefits it can give.

East coast oysters show resilience to ocean acidification

Oysters from Saint-Simon Bay in northern New Brunswick have been shown to be impressive tolerance to ocean acidification, according to a new study in the ICES Journal of Marine Science.

Experimental eastern oyster broodstock at the oyster hatchery in northern New Brunswick

Globally, seawater pH is decreasing as the oceans absorb excess carbon dioxide from the atmosphere.

"The oceans are a massive sink for atmospheric carbon dioxide," says Jeff Clements, lead author of the study. "All of this extra CO_2 is changing the chemistry of the oceans, with potentially deleterious effects for marine shellfish."

While ocean pH is not actually acidic by definition, the change in ocean pH presents a challenge for marine life. A major consequence is that shellfish like oysters have a harder time making shells. Although studies have reported negative effects of ocean acidification on oysters in the eastern United States, how oysters in Atlantic Canada may be affected remains unknown.

To fill this knowledge gap, the researchers studied Eastern oysters (Crassostrea virginica) at the L'Étang Ruisseau Bar oyster hatchery in northern New Brunswick. They found that adult oysters actually increased their reproductive development under low pH. In addition, while juvenile oysters were smaller and had a higher percentage of deformities under low pH, their survival was actually higher.

"To our knowledge, this is the first study showing such positive effects of low pH on this species of oyster, which is quite promising," says Clements.

The researchers attribute the toughness of the oysters in this region to a long history of exposure to low pH conditions.

"The estuarine waters in which these oysters have evolved are very dynamic and show large natural fluctuations in pH due to events like freshwater runoff and daily fluctuations driven by photosynthesis - these waters regularly experience episodes of low pH," says Martin Mallet, co-author of the study and hatchery manager at L'Étang Ruisseau Bar.

Clements and Mallet both admit that there are some caveats to the study that are important to note. For example, the relatively short time periods to which the oysters were exposed to low pH means that longer-term studies are needed to see if there are any effects of chronic exposure.

Overall, however, they think their results provide room for cautious optimism in the region and hope to follow this study with more work in the future.

"This isn't just good news for the oyster industry in Atlantic Canada, but it's also great news for industry and government research in the region," says Clements.

Mallet agrees "We have a great relationship and plan to continue working on research projects together in the future."

Webinar on Perspectives in Fish Taxonomy

The International Webinar on Perspectives in Fish Taxonomy was organized by Dept of Zoology and IQAC, Bajkul Milani Mahavidyalaya, Dist. Purba Medinipur, West Bengal on 20/9/2020. Dr A. Mohapatra, Scientist-E at Estuarine Biology Regional Centre, Zoological Survey of India (ZSI), Odisha and Chief Guest of Webinar spoke on 'Current trends in marine fish species discovery in India'. Invited speakers Dr S. S. Mishra, Scientist-D at Marine Fish Section, ZSI, Kolkata spoke on 'Diversity and distribution of fishes in India' and Dr P. Chakraborty, Professor and Curator of Ichthyology, Louisiana State University, Baton Rouge, USA spoke on 'The future of fish taxonomy'.

Dr Mohapatra stated that 859 freshwater and 2773 marine and estuarine finfishes found in India; 150 marine species described globally in 2000-2009; Indian scientists W. Viswanath, A. G. K. Menon, M. Arunachalam and others described new freshwater fish species; less opportunity to describe new marine species, 8 young Indian scientists did it; freshwater fishes described in India @ 20nos/ year (on av.) but very less number of marine fishes; 'holotype' as 1st specimen from which the species been described; importance of type specimen, verifying from museum while describing new species; morpho-taxonomy/ classical taxonomy as a tool; osteological tools, vertebrae counting and its arrangement by X-rays done for Anguilliformes; mitochondrial Cytochrome c oxidase-I amplification and sequencing as molecular taxonomy; scale, gill raker, finray counting, otolith study, DNA analysis - all required for best approach.

Dr Mohapatra highlighted on Image analysis (Truss Network System) and identifying species; morphometry study through computerized softwares which automatically separates closely-similar species; ZSI discovered new species of Moray Eel recently from Bay of Bengal; new fish records from India. Disappearance of fish species observed, trash fishes discarded by fishing trawlers at sea but there may be new species in trash. He described possible causes of decline in number (amount) of certain marine fishes caught in recent years.

Dr Mishra discussed about origin of fishes; difference between poisonous and venomous fishes; early system of classification of life by Aristotle, Conrad von Gesner, Carolus Linnaeus; 200 fishes of Visakhapatnam identified and described in year 1803 by Patrick Russell, first in Indian subcontinent; first study of freshwater fishes by Francis Hamilton in 1822 and 260 new fishes described in Ganga; Sir Francis Day's work on 1418 fish species as bible of Indian ichthyology; Alfred William Alcock described 169 deep-sea fishes from Bay of Bengal and Arabian Sea. According to Dr Mishra, 3702 fish species known in India, 992 freshwater and 2710 marine and estuarine species.

Developing manpower on taxonomic study of fishes needed; Indian species of magur is *Clarias magur*, not *C. batrachus*; *Channa orientalis* is endemic to Srilanka and Indian species is *C. gachua*; *Pampus argenteus* is now *P. candidus*. He highlighted threats to fishes; declining abundance of many commercially-important fish species; fishermen's complaint of reduction in fish size; saw fishes now in an extinction phase; fish diversity in decline; proper identity, distribution and biology needed for threatened fishes for conservation strategy.

Dr Chakraborty traveled in many natural habitats to conduct natural history research to have comparative material in describing new fish species. He discussed about role of museums in genomics' age; importance of having voucher specimen; new genera described by him and revisions of genera; new species of ponyfishes identified in Sri Lanka; proper naming of fishes; his work on phylogeny of cichlid fishes; gobies from Australia and Madagascar described separately; CT scan of riverine cave angel fish of Thailand showing its pelvic girdle connected to vertebral column, helping to understand anatomical features; MRI scan done to observe *in-situ* fluorescent green light producing organ in ponyfishes and light organ shape used to define their different genera. It is a modern taxonomic technique. Audio file of produced sound of ponyfishes graphed; two surgeon fishes *Prionurus punctatus* and *P. laticlavius* established as same in west coast of USA using genomic work after looking at many genetic markers and comparing their diets and habitat (molecular ecology).

He further explained that fishes have ultraconserved elements in genome (UCE markers), highly variable regions adjacent to these core regions allows for determining relationships. UCEs used to figure out relationships in electric fishes, their electric signalling pattern. 'Exon capture' (protein coding genes) or 'Target capture' used to determine relationship of marine gobies.

Next gen sequencing, RadSEQ, SWEET Synteny (aligning different portions of different size genome) are also modern techniques. Genome size varies widely from giant lungfishes to tiny pufferfish, genome sequencing recently done for ocean sunfish *Mola mola*, the largest teleost that provides insights into its fast growth rate.

Dr Chakraborty mentioned that taxonomic principles of keeping vouchers and comparing specimens are key even in today's modern science and this age of genomics. Many species left to discover, more people (taxonomists) needed to describe fish species on planet before they go extinct.

News communicator Subrato Ghosh listened to all presentations attentively.

The tragedy and hope of modern Shrimp farming

One of CP's new RAS based Thai shrimp growing facilities. From 18 % a year ago. 30% of CP's shrimp are now raised in RAS facilities it hopes to raise all its Thai shrimp in biosecure resource- efficient RAS farms by 2023.

The last ten years have seen certain unwavering world shrimp market contestants : First, every time the industry looks set to embark on a new cycle of strong, consistent growth, it gets hit with another setback.

Second, maxed out pond area with declining production in China and Thailand was more than offset by double-digit annual growth in Indian and Ecuadorian shrimp output, where high prices drove the expansion into new, untapped frontier areas. Assumptions #2 – and world shrimp output growth – are starting to falter.

On one hand, India's once rapid growth is now retreating into stagnation. After exponential shrimp output growth from barely 100,000 tonnes in 2009 to 700,000 tonnes in 2017, mounting problems controlling EMS, WFD and WSSV outbreaks in aging ponds inflated production costs even as shrimp prices slumped. For most of 2018, Indian shrimp's US export price was up to 30% below the 2014-15 average and 20% below its average 2016-17 price.

The year's deflation was the result of China's crackdown on shrimp import smuggling via Vietnam. It shifted a portion of shipments meant for China to a world market already bloated by high US inventory levels, causing prices to languish near depressed mid – 2018 levels.

As this undermined shrimp farming returns, many Indian producers minimized their losses by keeping a large number of ponds fallow. Amid mounting disease outbreaks, older ponds had their stocking densities reduced so as to reduce the frequency of white spot and white feces disease infections, which became a serious issue after 2016. Consequently, 2018 production slumped back 7% to an FAQ estimated 650,000 tonnes.

Despite all these challenges, many Indian shrimp farming executives remained optimistic about achieving a million tonnes of output by 2020 – but 2019 is not allowing that to happen. First prices slumped back to mid – 2018 lows, undermining returns. That caused many farmers to cut back on re-stocking.

This was followed by unusually dry conditions in late Q1 and early Q2, which held back pond quality and shrimp growth. Depending on the region, industry reports stated H1 2019 pond stocking levels were reduced by 20% to 30% from 2018 levels, but it was still hoped prices and output would recover in the second half of the year – which would still have made for a 10% to 15% drop in output from 2018 levels.

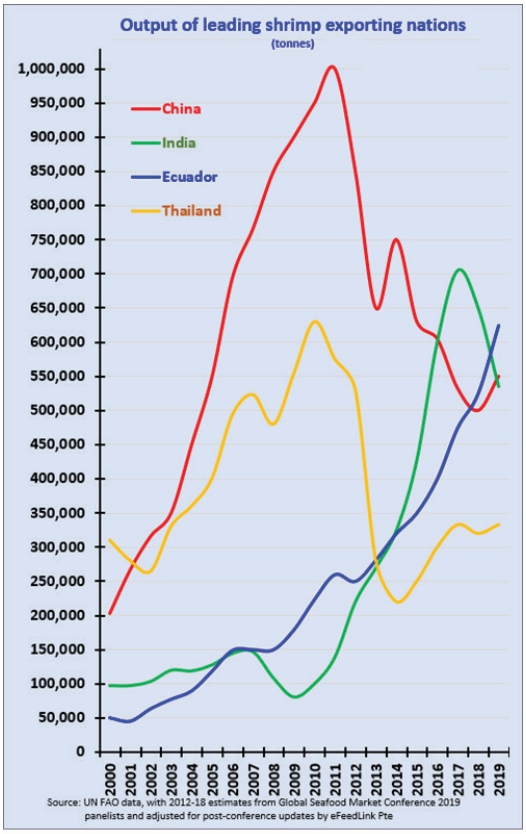
Matters were made worse by early May's Cyclone Fani, whose tidal surge washed away entire shrimp farms along eastern India's Odisha coast. This region's output losses are believed to have contributed at least 45,000 tonnes of exports in 2018.

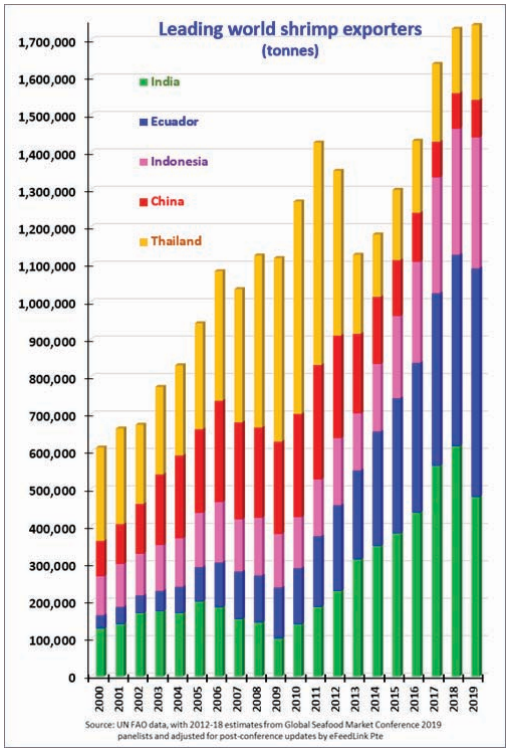
With shrimp prices continuing to languish at low levels, unusually heavy monsoon caused the Godavari river that runs through Andhra Pradesh to experience severe flooding. As this state accounts for 60% to 70% annual production, regional farmers interviewed by Undercurrent News expect this disaster to reduce national shrimp output by another 5%.

On one hand, thanks to a late 2017 / early 2018 production surge, India's 2018 shrimp exports defied last year's lower output volume, growing to an FAO estimated 615,000 tonnes. On the other hand, 18 months of down trending shrimp production means that India's 2019 shrimp exports are poised for a steep decline. While some industry stakeholders project 2019 output of below 500,000 tonnes, even a more optimistic 55,000 tonnes estimate implies 2019 exports of under 500,000 tonnes.

The good news is that Ecuador is still doing well, boosting its export volume from 510,000 tonnes in 2018 to a projected 610,000 tonnes this year. The bad news is that India's projected 130,000 to 170,000-tonne drop in 2019 shrimp exports more than offsets higher Ecuadorian shipments. With the exports of other suppliers rising by barely a collective 100,000 tonnes, we are looking at either negligible or no growth in world shrimp exports.

In sum, low prices, poor returns, voluntary stocking reductions and subsequent bad weather is poised to reduced India's shrimp output for a second





consecutive year and by 15% to 20%, into the 520,000 tonnes to 550,000-tonnes range (though some observers claim output could fall below 500,000 tonnes). – All this is a far cry from the million-tonne output many Indian shrimp farming executives predicted for 2020 just one year ago.

While India grapples with its shrimp farming troubles, shrimp farming's most technologically advanced nation is trying a new approach. Thailand hopes that its decade of misery is nearly at an end. After EMS and EHCP broke out in Thai ponds in 2011, they became chronic, output limiting factors. Since then, Thailand has only managed to produce slightly over 50% of its peak 640,000 tonnes shrimp output of ten years ago without these diseases and die-offs occurring.

Rather that fight battle it can't win, Thailand is moving to a new, ecologically friendlier growth model : In Q4 2018 CP announced its intention to migrate all its shrimp production from traditional outdoor ponds to indoor recirculation aquaculture systems (RAS). An August 1st 2019 article in Shrimp News stated that the proportion of CP's RAS grown Thai Shrimp has jumped from 18% in early 2019 to 30% as of Q3. By 2023 CP expects to grow all its Thai Shrimp in bio secure RAS operations.

According to CP executive vice president of aquaculture business Premsak Wanuchsoontom "We have so far, experienced no disease outbreaks in our RAS systems and use no antibiotics." At the very least, this implies that going forward, Thai shrimp will not be subject to Indian or Vietnamese style export bans, which were imposed due to high antibiotic levels or the presence of banned supplements. RAS's compartmentalized bio secure infrastructure also means that "should problems be encountered, the affected animals can quickly be isolated and the outbreak contained."

Best of all, RAS promises that the peak stocking densities can be exceeded in a sustainable, additive-free manner, Wanuchsoontom stated that whereas well managed outdoor systems yield 20 to 30 tonnes/ hectare, IT- managed RAS control systems can achieve 60 to 70 tonnes / hectare.

Moreover, the doubling of productivity is complemented by a 60% to 70% reduction in water usage. This is important, as RAS-based shrimp cultivation's higher start-up costs can be partly offset by lower operating expenses.

If CP succeeds in a profitable manner, we can expect its rival Thai shrimp integrators to follow in adopting RAS-based shrimp cultivation. If Thailand can thereafter sustainably grow its shrimp output back to its previous 600,000 tonnes + level, China, Malaysia and other disease-constrained nations would probably follow, thereby triggering a new cycle of rapid shrimp farming growth not seen since 2010.

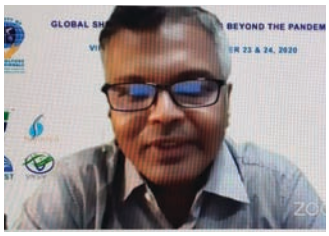
Consequently, 2019's stagnant shrimp output holds two important lessons : On one hand, India's mounting disease woes betray the unsustainability of today's shrimp farming model : Beyond a certain age, a large proportion of outdoor shrimp ponds appear to become unusable; after a few decades of growth, the supply of new, clean ponds runs out.

Thailand pioneered the current, unsustainable paradigm and may just be developing a new, sustainable means of boosting production without exhausting a limited supply of virgin, frontier growing ponds.

- Source: eFeedlink

Global Shrimp Demand and Supply moderately affected by disruptions due to the Pandemic, but response to price falls to redefine market in the future, concludes the *"Global Shrimp Markets: Looking Beyond the Pandemic"* Webinar conducted by the Society of Aquaculture Professionals in September 2020

Haris Muhtadi Indonesia



A.V. Suresh, SAP President

Ramesh, SAP General Secretary

The webinar conducted on September 23rd and 24th had nine speakers covering the major markets of shrimp consumption and production. George Chamberlain, the President of the Global Aquaculture Alliance, in his keynote address of the event pointed out that global shrimp supply has been on a rising trend for the last few years and prices have been falling during the same time indicating that markets were getting saturated in spite of the emergence of China as a major market in recent years. Citing the case of avocado as an example of what unified marketing efforts by the producers and sellers can achieve, Dr Chamberlain called for a similar effort in which shrimp consumption is promoted. Angel Rubio, the Chief Analyst at Urner Barry, a leading food data services firm, talked about the shrimp demand in the US market and said that retail sales of shrimp rose during the pandemic but could not compensate for the lost sales in the food service segment. Price of shrimp fell as a result but retail establishments passed the benefit of low prices to the consumers through promotions. It is likely that the experience of cooking shrimp at home will encourage consumers to increase their purchase of shrimp in retail outlets even after the pandemic is over.

Willem van der Pijl, a seasoned industry analyst of the shrimp sector who recently started Shrimp Insights, a data service specific to global shrimp trading, spoke about the European markets. He said that shrimp consumption in Europe was down by 6% up to June 2020, but the shrimp mostly impacted by this drop was the ocean-caught premium shrimp. The farmed penaeid shrimp were much less affected (only 1%). Due to opening of restaurants, the summer sales of shrimp is believed to have been healthy but the ongoing second wave of Coronavirus outbreak points to the possibility of lockdowns during the winter which would negatively impact consumption. Among the suppliers, Vietnamese and Latin American suppliers have a competitive position in the European markets requiring other Asian suppliers to reassess their competitiveness.

Vincent Lin of Grobest Seafoods presented an analysis of China as a shrimp destination. The country had imported 703,000 tonnes of shrimp in 2019 and was maintaining an increasing trend of imports till July 2020 when fragments of Coronavirus genetic materials were found on the packaging materials of shrimp imported from Ecuador. Consumer confidence was severely impacted and the import volumes and prices tumbled as a result. China's shrimp production has been affected due to the emergence of new diseases, so local production will go down and be directed to the premium live markets. Resumption of imports at or beyond the scale of 2019 will resume only when consumers gain the confidence that frozen food is not a risk factor in the spread of coronavirus.

Pawan Kumar Gunturu of Sprint Foods, India provided a perspective of Indian exporters to the global markets. He mentioned that shrimp processing was affected due to the lockdown which caused difficulties in accessing the process plants and forced migrant workers to move back to their home bases. Cancellation or postponement of purchase orders, decline in prices and cancellation of export incentives by the government have caused further hardships for the exporters. Mr Gunturu emphasized that India needs to build on its strengths and move into more value added products in the near future.

In the subsequent panel discussion moderated by Ravi Kumar Yellanki of Vaisakhi Biomarine, P. Anilkumar of the Marine Products Export Development Authority, indicated that Indian shrimp exports have declined by about 15% but the exports of cooked and breaded forms of products to the US market have registered an increase indicating that

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Saji Chacko

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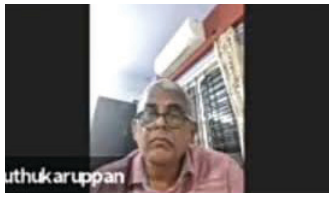

Muthukaruppan

Madhusudhan Reddy

Indian processors have the flexibility to meet the market requirements in a short notice. S. Santhanakrishnan of Maritech, a seafood and aquaculture consulting firm, said that India's ability to supply large size shrimp can be leveraged to serve niche markets globally.

The program on September 24th was on shrimp supply from major markets. Speaking about the Vietnamese market, the CEO of Grobest Feeds, Samson Lee, remarked that supplies from Vietnam have not been severely affected due to the significant domestic market and sustained demand from the export markets. Strict control of the pandemic and sensible lockdown policies minimized the disruptions in supply. However, a contraction of supplies from about 630,000 tonnes in 2019 to 570,000 tonnes in 2020 may occur. For the long term, Mr Lee predicted a strong growth of the Vietnamese supply and higher productivity through intensification including a return to 2019 production levels in 2021 and from thereon a 3% annual growth.

Haris Muhtadi of CJ Feeds, Indonesia said that the country did not follow a strict lockdown. The first half of 2020 saw a slight increase in the production and export of shrimp when compared to the previous year. Indonesia's production in recent years has reached close to 350,000 tonnes and the production in the first six months of 2020 was estimated to be about 200,000 tonnes. The USA remained the largest importer of Indonesian shrimp buying nearly 65% of the production. Mr Muhtadi estimated that there may be some drop in production in the second half of the year due to disease challenges and Indonesia may end up with a decline of about 6-7% in production by the end of the year.

Paresh Kumar Shetty of Avanti Feeds, India said that the sudden and strict early lockdown in the country resulted in many disruptions affecting shrimp production and processing. Lower shrimp prices also dampened farmers' spirits. While lockdown has been relaxed, labor availability continues to be an issue. Also, farmers are facing production challenges in many regions. As a result, Mr Shetty said that India's farmed shrimp production is likely to go down from about 800,000 tonnes in 2019 to about 675,000 tonnes in 2020.

Gabriel Luna, an industry analyst in the shrimp business of Ecuador, spoke about the phenomenal growth of shrimp production and exports in the past ten years. Exports from Ecuador had grown four times in ten years and reached about 630,000 tonnes in 2019. By August 2020, the country had reached about 450,000 tonnes, a 6% year-on-year increase. This increase was despite the difficulties due to lockdown and exports to China, Ecuador's largest market in 2019. Shrimp farmers were unable to harvest their crops in April and May due to the lockdown followed by disruptions in exports to China in July. Shrimp prices collapsed to historic lows as a result. Fortunately, Ecuador was able to quickly increase its sales to the USA and Europe and has presently achieved a good redistribution of its markets. The decline in prices has affected profitability but Mr Luna remarked that Ecuador will seek to improve productivity not by expanding land area or intensification but by focusing on improvements in shrimp growth and survival and to improve profitability by going into niche markets like organic shrimp.

The panel discussion at the end of the second day noted that shrimp supply from the major producing countries has not been seriously impacted by COVID-19. Perhaps, the global supply of farmed shrimp may decline by about 10% in 2020 when compared to 2019. Global trade of shrimp has not been affected to a large extent *Contd on Page 36*

New team elected for SAP

Dr Arul Victor Suresh, the new President for 2020 - 2022

The Elections to the Executive Committee of Society of Aquaculture Professionals (SAP) for the ninth term (April 2020 – March 2022) were held between 18 March and 20 March 2020 wherein the online voting process was followed. There were 25 contestants for 12 elected positions. A total of 265 SAP members had cast their votes. The results were declared by the Election Committee on March 23. The following persons had succeeded in finding a place based on the majority support of the fellow SAP members.

Dr Allada Narayanaswamy

Mr Anil Ghanekar

Dr Arul Victor Suresh

Mr Jaideep Kumar

Mr Konakanti Madusudan Reddy

Mr Mohanty Shrinibas

Dr G. Ramesh

Mr Saji Chacko

Mr Sandip Ahirrao

Mr I. Simon Chelladurai

Mr R. Sriram and

Mr D. Vijayanand

Due to the challenges posed by the Covid 19 situation the meeting of the new EC team was held virtually through Google Meet on May 9 and the team confirmed new office bearers for the term April 2020 to March 2022. During this meeting, taking cognizance of the contributions made by Mr P.K. Senthil Kumar who has played a vital role in the organization of SAP since inception, the new EC

Dr A.V. Suresh, President

members as well as the Past Presidents nominated him to the SAP EC unanimously and the following office bearers assumed charge:

President
Dr Arul Victor Suresh

Vice- President
(Membership)
Mr Saji Chacko

Vice-President (Events)
Mr Konakanti Madusudan Reddy

Vice-President (Education)
Mr Shrinibas Mohanty

General Secretary
Dr G. Ramesh

Joint General Secretary
Mr P.K. Senthil Kumar

Treasurer
Mr D. Vijay Anand

Joint Treasurer

G. Ramesh, General Secretary

Mr I. Simon Chelladurai

Subsequent to assuming office, SAP members who had contributed to SAP activities in the past, and those from previously under-represented regions and sectors were considered and a list of candidates was presented to the EC and the following five persons were elected and nominated to the EC.

1. Mr D. Panchyuthapani (Panchu)
2. Dr Manoj Sharma
3. Mr A. Kumaresan
4. Mr P. Prabakaran
5. Dr Partha Bandyopadhyay

We are already beginning to see various challenges posed to Aquaculture Industry due to the Covid-19 situation and the new EC Members in consultation with the Advisory Committee formed by the Past Presidents as well as eminent dignitaries from Aquaculture Industry and with the support of other Aquaculture Stakeholder Organizations will be coming up charting our plan of action to represent to the policy makers in the Government to gather support to all the stakeholders in the Aquaculture value chain. Please do feel free to reach out to any of us in the EC team if you have any queries and provide us your valuable support, said a note from the General Secretary

Dr G. Ramesh.

Contn from Page 34:

Global Shrimp Demand and Supply moderately affected by disruptions ...

except in the case of China. However, lower shrimp consumption in the US where the increase in retail sales has not compensated for the loss of food service sales, means that unsold inventories would be fairly high. Further declines can be expected in the winter due to anticipated restrictions in restaurant operations. Shrimp prices have been battered due to the disruptions of the lockdown as well as the loss of consumer confidence in China. While the low prices have been used to stimulate some of the consumption, the response in the major producing countries to low prices will drive future decisions on production, types of products, market focus, and farming technologies. Dr Chamberlain reiterated that the pandemic only exacerbated what was already a downward trend in prices and the solution was to invest in a unified market promotion by the stakeholders in the shrimp sector to stimulate more consumption.

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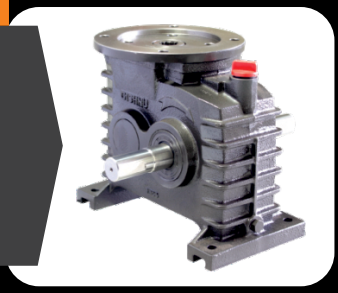

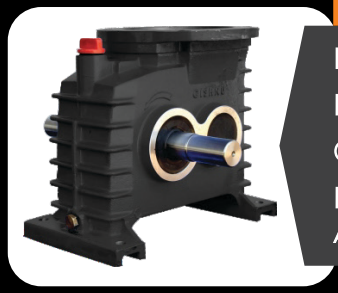

Type : A3 Aero RF (Aluminium)

Range : 1 hp to 3 hp
Pedals : 4, 6 & 8
O/p RPM : 105 & 120
Power savings : 75%
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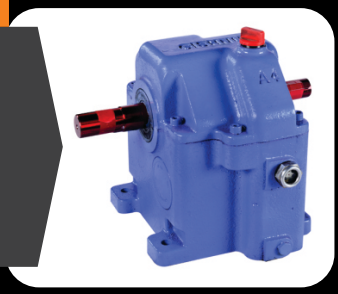

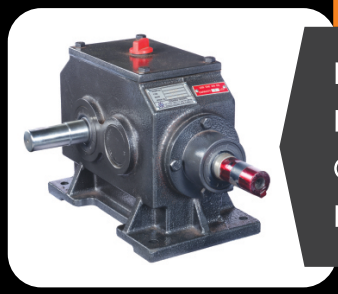

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Bacterial strains such as Bacillus Subtilis, Nitrobactor, Nitrasomonas, rapidly converts ammonia into Nitrates, Nitrites and finally non-toxic Nitrogen. Hydrogen Sulphide converts into Sulphates, Sulphites and finally non-toxic Sulphur, Methane into Non-toxic carbon. This conversion reduces the obnoxious gasses in the pond bottom. Reduction of this gasses improve the D.O. level in the water and bottom.

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Global Climate Change: A nexus for alteration in Behaviour, Distribution and Reproduction of Fishes

Abhilipsa Biswal, Tapas Paul, Arya P. and Husain N.
ICAR-Central Institute of Fisheries Education, Andheri (West), Mumbai 400061

Highlight Points

▶ The Inter-governmental Panel on Climate Change (IPCC) has projected that the global annual seawater temperature would rise by 0.8 to 2.5 ˚C by 2050. ▶ Climate change causes change in the composition of phytoplankton and distribution of economically important pelagic fish Oil sardine (*Sardinellalongiceps*)and Indian mackerel (*R.kanagurta*). ▶ Climate change leads to the alteration of thegonadal maturation and spawning periodicity of threadfin breams, catfish and Indian Major Carps. ▶ Hypercapnia and increased temperature effects physiological response of fish by alteringthe heat shock response, antioxidant enzymes and decreased metabolic rates.

1. Introduction

In the present scenario, global climate change is considered to be one of the main concerns for decrease in species diversification of fisheries and aquaculture. Climate change is defined as alteration in the physical, chemical, and biological properties of aquatic habitats (Hartmann *et al.*, 2013). It includes modification in physical habitat such as increased mean water temperatures and altered hydrologic regimes of lotic and lentic habitats resulting from changes in precipitation. Chemical characteristics of water bodies include dissolved oxygen, salinity, nutrient concentrations which are directly altered by climate change. Recently it is observed that both marine and terrestrial production of costal countries has been declined to 85% affecting the overall economy (Pecl *et al.*, 2017). Further, it is projected that climate change can alter the primary production of oceans up to 6 percent globally and 11 percent tropically by the end of this century. On note, climate change can lead to the declination of global fish catch potential more or less up to 10 percent by the end of the year 2050 and can affect the tropical fishing region to more severe extent (FAO, 2017). Rising in sea level induces the alteration in spawning and migratory pattern of fishes. For example, variation in oceanic temperature and currents led displacement of skipjack tuna and bigeye tuna to further east regions, thus leading to uncertain food security of pacific islands (Kibria *et al.*, 2016). The most potent environmental challenges be faced by the upcoming oceanic environment is excessive warming and oceanic acidification of water body. Further, it has been previsioned that there might be a drop in 0.3-0.4 units in oceanic pH and overall rise in global surface temperature with 1.1-6.4 ˚C by the ending of this century. These changes in oceanic water may as a potential stressor in the aquatic organism driving them to compromise with the new environment. In response to this, fish will try to cope with the stress by altering the physiological response upto a certain limit, but extreme stress may affect the survival and physiological response of fish and other aquatic organisms (Pimentel *et al*., 2015). Keeping the view of all these, the present article aims to highlight the impact of climate change on fish behaviour and physiological response.

2. Impact of climate change on global fisheries resources

2.1 Oceanic temperature rise

For modulation of global climate, oceanic system plays a crucial part. The net heat uptake capacity of sea is nearly about thousand times higher than the atmosphere; thus, oceanic system absorbs a great amount of global heat emission and leads to change in the ocean dynamic system. (Barange and perry, 2010). The Inter-governmental Panel on Climate Change (IPCC) has projected that the global annual seawater temperature would rise by 0.8 to 2.5 ˚C by 2050 (IPCC, 2007). Depending upon the geographical location increase in oceanic temperature can have either positive or negative effect on fisheries. Due to rise in oceanic temperature, the fish species of tropical region will move towards the temperate regions. In temperate areas, growing period of fish will increase in duration due to warming of water in summer and wild fish mortality will decrease in winter contributing to higher growth rate of fishes. Thus, temperate countries will face positive effects and the tropical countries will face the negative effect due to rise of oceanic temperature.

Global climate change leads to the shifting of particular fish species to a different location, movement of fishes to deeper

region resulting in creation of new fishing zone. Thus, it alters the fisheries or fish catch of a particular region. For example, an observation has shown forty-five Australian warm temperate fishes have colonized towards the south polar region due to change in oceanic temperature. Rise in oceanic temperature causes an increase of species richness towards regions of high altitude and polar regions. Further, it is projected that both warm and cold-water species of north America, Asia and Europe may have northward expansion and warm water species of Australia, south America may proliferate towards southwards signifying higher fish diversity in temperate regions. On note, inhabitant African fish species such as black codling, rocling and black eel have been recorded to move towards the galician waters due to change in oceanic temperature (Kibria *et al.,* 2016). Rise in temperature can act as an potential endocrine disrupting factor causing that occurs due to low oxygen solubility in high temperature and further hypoxic condition (<2.8mg/l) can impair fish reproduction, success of fertilisation and hatching.

2.2 Ocean acidification

Antropogenic activity such as industrialisation, deforestation and fossil fuel burning can emit a large amount of carbon dioxide in to the atmosphere. Approximately around 30% carbon dioxide are absorbed in to the sea water (Wittmann and Portner, 2013). The affinity of CO_2 with water is more in comparison to the affinity of oxygen with water. CO_2 dissolves in the ocean water to form the carbonic acid (H_2CO_3) and increased concentration of hydrogen ion results in decrease of the oceanic pH. This phenomenon is regarded as ocean acidification.

Generally, it is reported that egg stage of fish is more vulnerable to CO_2 induced mortality than post hatched larvae. For example, *Menidia beryllina* showed 70% decrement in survival and 18% reduction in length (Baumann *et al*., 2012). Further, by exposing economically important Atlantic cod larvae with different concentration of CO_2, it was observed that with the increase of concentration the degree of tissue damage (pancreas, liver, kidney, eye and gut) increases in the larvae (Frommel *et al*., 2014). CO_2 elevation also reported to cause abruption of the normal behaviour of fishes such as loss of lateralization capacity. This process may lead to increase in vulnerability of larval fishes to predation in ocean of high carbon dioxide concentration. Further, high concentration CO_2 and ocean acidification has no effect on the survival Yellow tail king fish larvae (Munday *et al.,* 2015).

2.3 Sea level rise

Global warming leads to the melting of glaciers, ice caps causing additional water addition in bulk amounts to sea (Kibria *et al.,* 2016). The sea level has already elevated by 10 to 20 cm during the 20th century and it is forecasted that sea level rise can be between 9 cm and 88 cm by the end of 21st century (Church *et al.,* 2001). Due to intrusion of sea water, the mangroves and estuarine habitats of Africa, Australia and Asia are expected to be highly affected (Warren *et al.,* 2011). It is predicted that Sundarbans will reduce from 60 to 30 percent by the rise of sea level up to 88 cm by the end of 2100 and further, with the sea level rise of 1 m, the Sundarbans can be completely lost (World Bank, 2000). It will cause adverse effect on migratory fish, commercial fish, shrimps and crab species of Sundarbans mangrove area impacting the world fisheries (World Bank, 2000). Elevation of sea level may change the salinity of estuarine habitat by inundation. As nursery is the spawning ground for many fishes, the sea level rise phenomenon can be inimical to the reproduction and recruitment of species which depend upon estuarine habitat (Mohammed and Uraguchi, 2013). Although the sea level rise can adversely affect the fresh water fishes, it will create a new direction for expansion of brackish water species culture (Kibria *et al.,* 2016). Further, in Indian scenario sea level rise for Cochin (southwest coast) during the past century is estimated at 2 cm and is expected to rise at the rate of 5 mm per year in decades to come which will accelerate the risk of erosion and flooding (Vivekanandan *et al.,* 2009).

3. Impact of climate change on Indian Fisheries

3.1 Impact on distribution and migration of fish

In last fifty years from 1961-2005, the sea surface temperature shown a rise by 0.2 ˚C along north west, south west and north east coast and by 0.3 ˚C along south east coast. It has been predicted that in the regions of Andaman and Nicobar, Lakshadweep and Gulf of Mannar, the annual average temperature can rise from 28.5 ˚C from 2009 to 2099 and in case of Gulf of Kutch from 27 to 30.5 ˚C. Sometimes rise in sea surface temperature also shows positive effect in fisheries. For example, Indian mackerel and oil sardine fish catch are generally highest along the south west cost. But due to rise in temperature these faunas are establishing their population along the Northwest and east directions (Vivekanandan *et al.,* 2009). Several researchers have reported that global climate change will cause change in the composition of phytoplankton available in Indian waters. Few species of phytoplankton showed higher multiplication rate at increased temperature (29˚C) which decay earlier at the higher temperature. Further, small commercially important pelagic fish species may extend their boundaries due to climate change. For example, Oil sardine (*Sardinella longiceps*) had limited distribution only in Malabar upwelling zone along the southwest coast of India (8˚N and 14˚N latitude and 75˚E and 77˚E longitude) having annual average sea surface temperature (SST) ranges from 27 to 29˚C. It is surprising to observe that catches of oil sardine from latitude 14˚N and 20˚N are increasing over last two decades. On note, SST has a positive correlation with oil sardine fish catch. Since the average SST of Indian seas are warming by 0.04 ˚C per decade, the oil sardine are extending towards northern latitude. Moreover, due to effect of climate change Indian mackerel (*R. kanagurta*) has been descending deeper which was previously found to be in sub-surface water (Vivekanandan, 2011). False Trevally (*Lactarius lactarius*), an economically important fish found along the Rameshwaram coast of south east India reported to migrate along the coast including the east coast of Sri Lanka due to rise in ocean temperature and human disturbance. Another important fish species, yellowfin tuna is reported to found Bay of Bengal and eastern Arabian Sea in the last five years is due to climate driven changes in the migration route of the fish.

3.2 Impact on reproduction and physiology of fish

Climate change leads to the alteration of the spawning and physiology of fishes. The physiological response of fishes varies among different species depending on the factor that whether they are eurythermal or stenothermal (Somero, 2010). The timing of spawning, an annually occurring event, is an important indicator of climate change. In recent times, shifting of spawning seasons of commercially important fish species are now evident in the Indian seas. The threadfin breams *Nemipterus japonicus* and *N. mesoprion* distributed along the entire Indian coastline showed a variation in spawning season over the years. It is found that the spawning season of these species shifted from warmer to relatively cooler months (from April-September to October-March). The spawning of both the species increased with increasing temperature during October-March with optimum SST between 28-29 ˚C. Further, climate change induced variation in rainfall pattern may influence gonadal maturation and breeding period of *C. punctata* in wetland (Karnatak *et al.,* 2018). Since the breeding of spotted snakehead is highly correlated with rainfall, variation in precipitation pattern may alter the breeding periodicity. Further, temperature was also found to have in facilitating gonadal maturation in *C. punctata* at 29-31˚C. The Gonado Somatic Index (GSI) has threshold value of 4.15 units indicating that in presence of suitable environmental cues, female *C. punctata* will spawn successfully. But due to global climate change, temperature and pattern of rainfall may change which will shift the breeding periodicity of this fish. It is reported that fish spawn availability of Indian Major Carps (IMC) has decreased abruptly and the onset of breeding season has advanced by one month in the hatcheries due to effect of increased water temperature and shifting of the rainfall pattern facilitating early maturation and spawning (Das *et al.,* 2012). Such changes in spawning behaviour of fish will result in change in ecosystem structure and function, leaving species to adjust to new prey, predators, parasites, diseases and competitors.

Several researchers have reported that climate change effects physiological response by altering antioxidant and digestive enzymes of fish (Frommel *et al*., 2014; Pimentel *et al.,* 2015). Increased temperature and CO_2 concentration increased the heat shock response and the activity of antioxidant enzymes, namely catalase (CAT) and glutathione S-transferase (GST) in commercially important fish species. Further, hypercapnia causes significantly decreased metabolic rates (up to 27.4 %) of flatfish larvae, *Solea senegalensis*, at both present (18 ˚C) and warmer temperatures (+4 ˚C) (Pimentel *et al.,* 2015). Digestive enzymes such as pancreatic (up to 26.1 % for trypsin and 74.5 % for amylase) and intestinal enzymes (up to 36.1 % for alkaline phosphatase) were found to be reduced due to increased CO_2 concentration.

3.3 Impact on corals

Coral reefs are highly diverse marine habitat supporting about one million species globally. They are sensitive to changes in oceanic temperature, with higher temperature than normal SST causes coral bleaching. Coral reefs are available in Gulf of Mannar, Gulf of Kachchh, Palk Bay, Andaman sea and Lakshadweep sea. It is projected that coral cover of reefs may soon start deteriorating due to increase in sea surface temperature (SST) and bleaching (Vivekanandan *et al*., 2010). Due to bleaching an occurrence of catastrophic events, reef building corals are likely to disappear as dominant organisms on coral reefs between 2020 and 2040. Further, it is believed that if acidification of sea water continues in future, all coral reefs will die within 50 years.

3.4 Future strategies to adapt climate change

Keeping in view of climate change, the main challenge of fisheries sector is to meet food supply, enhance nutritional security, improve livelihoods and economic output and ensure ecosystem safety. These objectives can be met raising the concern of climate change evolving adaptive mechanisms and implementing action involving all the stakeholders' farmers and fishers; regional and national bodies; industry, scientists and academics. The strategies of sustainable utilisation of fisheries resources should be given priority at national level to improve supplies before the threat of climate change assumes greater proportion. By reducing the CO_2 emission from fishing boats, fisheries sector may strive to mitigate climate at global level. Further, department of Fisheries, GoI can initiate new policy for providing incentives for reducing the sector's carbon footprint, following adaption and mitigation strategies.

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Organic Acids: Alternative Prophylactic Agents in Aquaculture

Nahida Rasheed and Ramjanul Haque
ICAR- Central Institute of Fisheries Education, Mumbai-400061

Highlight Points

▶ The use of antibiotics in the feeds of cultured aquatic animals to mitigate infectious diseases or to boost growth performance is commonly practiced. ▶ One of the potential substitute for antibiotic use in aqua feeds is organic acids or their respective salts. ▶ Organic acids inhibits the colonization of harmful microbes in the intestine, lowering gastric pH leading to increase in pepsin activation. In addition they are used as preservatives to prevent the feed from fungal, mold and bacterial attack.

Introduction

The use of antibiotics in the feeds of cultured aquatic animals to mitigate infectious diseases or to boost growth performance is commonly practiced. Large amounts of antibiotics are often used in the aquaculture industry to prevent or control infectious diseases caused by various pathogens.In view of the current restrictions on antibiotic use, there is a critical need to evaluate alternatives. One potential substitute for antibiotic growth promoters in aquafeeds is organic acids or their respective salts.

Organic acid impacts on growth, nutrient utilization, mineral availability, gut microbiota and disease resistance. From the literature several studies have reported that some organic acids can significantly enhance the growth performance and health status of fish.Thisreportsaims to contribute to the sustainability of world aquaculture production by providing a viable alternative to hazardous antibiotics, hence meeting the growing protein demand for antibiotic-free seafood products.The extensive use of antibiotics in aquaculture has the potential to threaten public health due to antibiotic residue bio-accumulation in consumer-ready aquaculture products.

In a recent review, Cabello et al. (2013) indicated that several antibiotic-resistant genetic elements had been reported to be shared between aquatic bacteria, fish pathogens and human pathogens, and might have originated in aquatic bacteria.

Why to ban antibiotics in animal feed formulations

A worldwide effort is to be made to reduce and eventually eliminate the use of antibiotics for growth promoting purposes in the aquaculture and it has been started with the ban on the use of sub-therapeutic antibiotics in the European Union on January 2006 (European Parliament and Council Regulation(EC) No 1831/2003). The European Union banned the use of antibiotics in animal production, Since January 2006, because they lead to the transfer of resistant bacterial species pathogenic for fish and shrimps (Budiati et al., 2013). Thus, a great interest has arisen in seeking alternatives to antibiotic substances that could inhibit pathogens and also act as growth promoters (Lim et al., 2010). In this context, organic acids or their salts have become a promising alternative feed additive for aquatic animal (Ng and Koh, 2011). Organic acids and their salts can also contribute in nutritional ways, because they are components in several metabolic pathways for energy generation, for instance, for ATP generation in the citric acid cycle or carboxylic-acids cycle. Whereas, diet acidification significantly reduces the pH diet, but does not affect the gastrointestinal pH.

Short-chain organic acids (C1–C7) and their salts or mixtures, commonly known as acidifiers, are promising alternatives for antibiotic growth promotants (AGP) and have been receiving growing attention from aquaculture researchers. Organic acids, such as benzoic, formic, lactic and propionic acids, have traditionally been used as storage preservatives in food and feed ingredients for preventing product deterioration caused by fungi and microbes. Some organic acids have been shown to have strong antibacterial effects against important food borne pathogens.

Organic acids

Organic acids are organic compounds with one or morecarboxyl groups. These include saturated straight-chainmonocarboxylic acids (C1–C18) and their respective derivatives, such as unsaturated (cinnamic, sorbic), hydroxylic(citric, lactic), phenolic (benzoic, cinnamic, salicylic)and multicarboxylic (azelaic, citric, succinic) acids (Cherringtonet al. 1991a), with a general molecular structure of R-COOH, where R represents the monovalent functional group. These acids are commonly referred to as short-chainfatty acids, volatile fatty acids or weak carboxylic acids.Organic acids are produced through the microbial fermentationof carbohydrates by various bacterial speciesunder different metabolic pathways and conditions. Organic acids may also form into single or double salts of their acid through combining with potassium (K), sodium(Na), calcium (Ca), etc. Weak lipophilic organic acids and their salts are consideredas **'generally regarded as safe' (GRAS)** substances andhave been used for centuries as preservatives in foods andbeverages (Russell & Gould 2003).

Organic acids will mostly be present in an undissociated form,

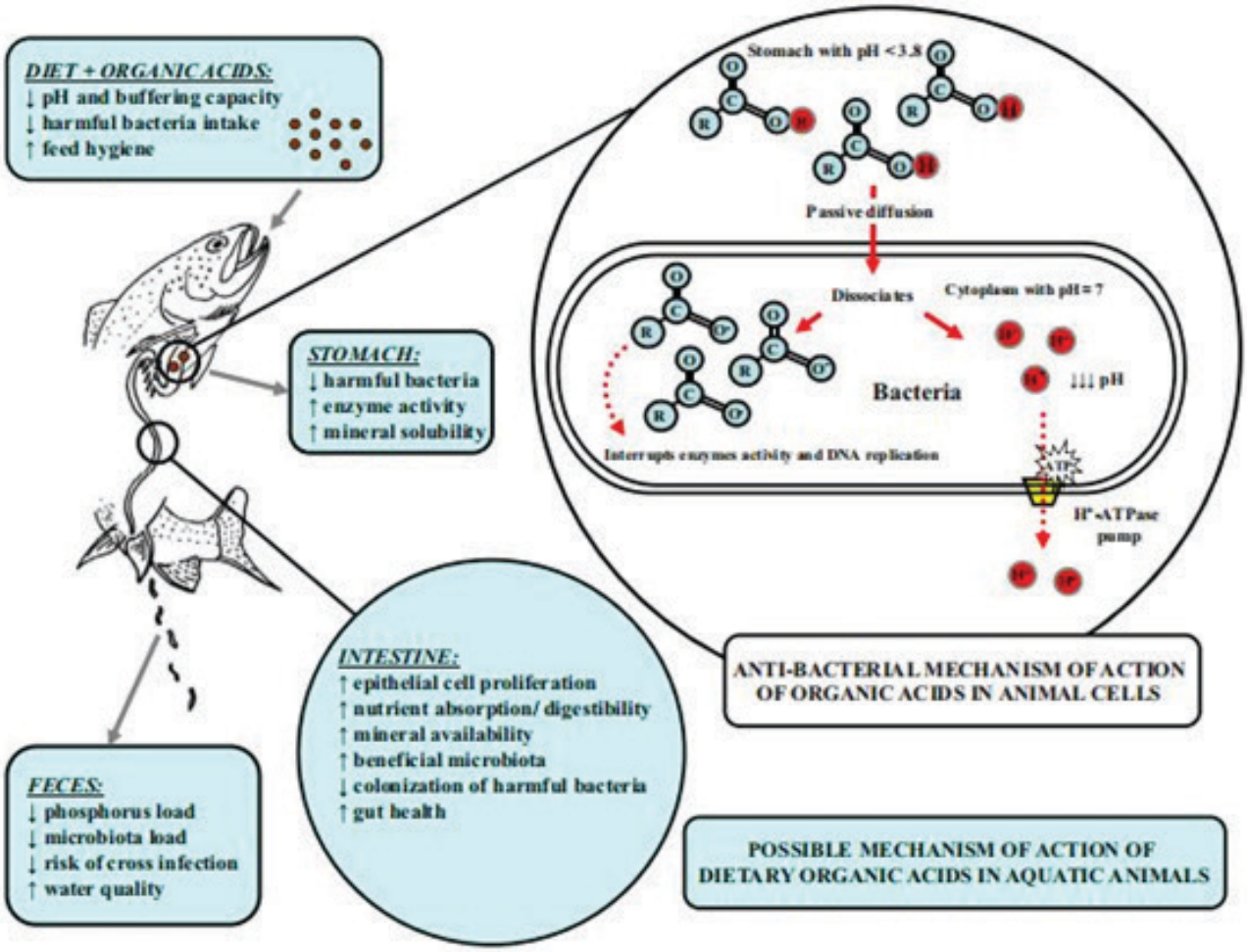
thus increasing the proportion of free acids that can readily enter the bacterial cells by simple diffusion. Lower molecular weight organic acids, for example formic, aceticand lactic acids, are miscible in water, whereas higher molecular weight organic acids such as benzoic acid arei nsoluble in water due to their hydrophobicity.

Mode of action and effects of dietary organic acids

Antimicrobial properties of organic acids

The antimicrobial activity of lipophilic weak acids was traditionally explained by the perturbation of membrane function,which blocks the transport of substrate molecules(amino acids, organic acids, phosphate, etc.) into cells(Freeseet *al.*1973). The most obvious mode of action of these lipid-soluble weak acids is via direct acidificationof the extracellular pH through its ability to dissociate into ions and release hydrogen ions (protons) to the surrounding medium. However, the predominant mode of action of these acidifiers ismainly based on their ability to lower the cytoplasmic pH once they traverse across the cell membranes of microbes. The majority of bacterial species has specific pH requirements for optimal growth and is unable to grow under extreme acidic conditions (pH < 4.5). Organic acids can exert their antimicrobial activity on microbes by directlyl owering the pH of the environment via releasing hydrogenions and thus preventing or impeding the growth and proliferation of acid-sensitive bacteria. Weak organic acids,such as acetic, citric, benzoic, sorbic and lactic acids, are commonly employed to lower the pH of foods or beverages in order to limit microbial growth. All organic acids seem to have a similar mode of action against microorganisms. Organic acids are believed to be more effective at low pH when they are mainly in the undissociated form as showed in figure 1, and are thus the most effective form in killing microorganisms (Lambert & Stratford 1999). This is because the undissociated form of an organic acid is lipophilic and can passively diffuse through a bacterium's cell membrane. Once inside the nearly pH neutral cytoplasm, it dissociates,releasing charged acid anions and protons that are impermeable back across the cell's membrane. Accumulation of excess protons within the cell will lower the cytoplasmic pH, thereby causing an inhibition of bacterial cell metabolism through the suppression of cell enzymes,particularly the pyruvate decarboxylaseenzyme which contributes to energy metabolism(Sava 2011). Cell death may occur when the cytoplasmicpH drops below the physiological optimal range for growth(Smigic et al. 2009). Bacteria that do not tolerate changes in trans-membranous pH gradients such as E. coli, Salmonella and Campylobacter(Dibner & Buttin 2002) will undergo cellular stress and eventually die.

Figure 1- Mode of action of organic acids against microorganisms. The undissociated organic acids traverse across the cell wall of bacteria via passive diffusion and



dissociate inside the cytoplasm, causing the cytoplasmic pH to decrease. Eventually, the cell enzymes and nutrient transport systems are suppressed resulting in irreversible damage to the microbial cell, often causing death.

Effects of organic acids on gastrointestinal microbiota of aquatic animals

Inclusion of organic acids, their salts or mixtures thereof to aquafeedscan influence the bacterial community of the gastrointestinaltract in aquatic animals. The first evidence of appreciable reduction in the cultivable microbiota in the expelled faeces and gut surfaces of fish fed organic acid supplemented diets was reported by Ng et al. (2009). The inclusion of organic acids in fish and shrimp diets has been shown to reduce the population of potentially deleterious bacteria such as Vibrio spp. In the intestinal tract (Chuchird et al. 2015).Organic acids enhance nutrient availability Addition of organic acids in aquafeeds had generally resulted in improved nutrient digestibility. Various hypotheses have been proposed on the mode of action of organic acids in enhancing nutrient utilization interrestrial livestock which includes:

i) lowering gastric pH leading to increase pepsin activation,
ii) lowering diet and intestinal pH, which may increase solubilization of minerals,
iii) acting as chelating agents which binds various cations within the intestine resulting in increased mineral absorption or
iv) inhibiting the colonization of harmful microbes in the intestine which may otherwise utilize nutrients meant for the host animal.
v) In animal nutrition, organic acids and their salts act as a growth promotants primarily through their impact in the feed and gastrointestinal tract of the animal.
vi) Organic acids are commonly used as preservatives tohelp prevent feeds and feed ingredients from deterioration caused by bacteria, moulds and yeasts (prevents the growth of undesired harmful microbes during storage and/or release of toxic metabolites (especially mycotoxins) produced by fungi.).
vii) The addition of organic acids reduces the gastric pH which favours proteolytic enzyme activity, thereby increasing protein digestibility and animal performance(Dibner & Buttin 2002).
viii) Another beneficial effect of lowering gastric acidity is an improvement of phosphorus (P) availability from phytate-P in plant feed ingredients (Dibner&Buttin 2002). Themajority of organic P in plant ingredients exists in the formof phytic acid or phytates **which are not digestible to monogastric animals** due to lack of phytase activity in thedigestive tract.

Strategies to enhance efficacy of organic acids in aquafeeds

The use of organic acids in aquafeeds has three major challenges. Most free organic acids are highly corrosive, some are easily soluble in water, and organic acids become less effective in an alkaline environment (e.g.in distal gut). The corrosiveness and pungent smell of most free organic acids requires special handling, storage and transportation of these compounds. Other than workers' safety, free organic acids can also cause corrosive damage to the aquafeed mill machineries. Leaching of organic acids from the feed pellets into the surrounding culture water will be a major issue for aquatic animals. This is especially challenging for crustaceans since they do not swallow the feed pellets whole but break up and masticate their feed before ingesting. As previously mentioned, organic acids are most effective in their undissociated form which enables them to passively diffuse into bacterial cells. In the stomach,when the pH value is usually lower than the pKa value of most organic acids , organic acids remain bundissociated. However, in the intestinal tract, under more alkaline conditions, some of the organic acids dissociate and therefore lower its antibacterial efficacy.

Conclusion

Research findings augment well for the use of organic acids as a viable alternative to harmful antibiotics in commercial aquaculture. Dietary organic acids can be used as a component of a sustainable fish and shrimp health management programme in the aquaculture industry. Organic acids, as functional feed additives, can impart disease protective properties to farmed aquatic animals via several modes of action. The pH modulating and antimicrobial properties of organic acids can inhibit proliferation of harmful bacteria while encouraging the growth of beneficial bacterial in the gastrointestinal tract of aquatic animals which in turn can affect the overall health of the animal. Dietary organic acids and/or their salts have been shown to have immunostimulation effects on several species of fish and shrimp which ultimately lends itself to imparting greater disease resistance and recovery from infections. Certainorganic acids have been reported to stimulate feed intake and improve nutrient utilization giving rise to wellfed fish and shrimp which are then less prone to stress and pathogen infections. The hepatopancreatic protective properties of dietary organic acids have also been demonstrated in shrimp during bacterial infections. These factors, bothsingly or in combinations thereof, will contribute to ther eduction and ultimately elimination of the current abuse and misuse of antibiotics in aquaculture.

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nahidarashid14@gmail.com

Quarantine: Need of the Hour for Healthy Aquaculture Practices

Md. Idrish Raja Khan
Department of Aquatic Health Environment, College of Fisheries, Central Agricultural University, Tripura

Highlight Points

▶ Diseases have become one of the most significant constraints to aquaculture development and management worldwide. ▶ It is clear that most disease incursions and outbreaks stem from unregulated movement of aquatic animals, with little or no risk assessment and quarantine. ▶The way to reduce the introduction of pathogens and occurrence of disease outbreaks is to apply appropriate international and national norms, recommendations and standards that govern safe trans-boundary movement of aquatic animals and animal products.

Introduction

COVID 19 Pandemic has triggered a public health crises followed by a long lasting lockdown to lead an on-going economic crises due to it the measures were taken by the government to contain the infection. In the current scenario, the top priority is consumer safety and to achieve that, safe production and supply of basic necessities become crucial. The pandemic brings awareness and urge among people and farmers to follow strict guidelines for the common goal of public safety. In this horrific situation the term "Quarantine" brings everyone attention on the table including aqua-farmers and consumers. Quarantine means maintaining a group of aquatic animals in isolation with no direct or indirect contact with other aquatic animals, to undergo observation for a specified length of time and if appropriate testing and treatment, including proper treatment of the effluent waters. The purpose and scope of setting up of quarantine stations are to prevent the ingress of dangerous exotic diseases into the country through imported livestock and livestock products. The increased and faster international trade and travel exposed every country to the danger of infiltration of known and unknown transmissible diseases which have the potential of very serious and rapid spread, adverse socio-economic and human/animal health consequences.

There are many infectious diseases of livestock which are prevalent in other countries but luckily not present in India. It is, therefore, necessary that such exotic diseases do not enter our country through movement of livestock and livestock product from across the borders. The entire procedure of keeping a watch on livestock disease is the responsibility of the Office of International Epizooties (O.I.E.) through its International Zoo Sanitary Code. For this purpose, this organization has classified the prevalent disease as OIE listed diseases. An efficient animal quarantine organization is necessary for conducting checks at the international airports/ seaports and land routes. Because livestock may covertly carry pathogens without showing overt signs of clinical disease, they must be held in quarantine for observation and testing to establish their pathogen-free status before release.

What is Quarantine?

The International Aquatic Animal Health Code of the Office International des Epizootics (OIE, the World Animal Health Organization) defines the term "quarantine" as: "Maintaining a group of aquatic animals in isolation with no direct or indirect contact with other aquatic animals, to undergo observation for a specified length of time and, if appropriate, testing and treatment, including proper treatment of effluent waters." (OIE, 2003).

A similar but slightly different definition was used by the Food and Agriculture Organization of the United Nations (FAO) and the Network of Aquaculture Centers in Asia-Pacific (NACA) "Holding or rearing of aquatic animals under conditions which prevent their escape, and the escape of any pathogens they may be carrying, into the surrounding environment. This usually involves sterilization/disinfection of all effluent and quarantine materials."

Keeping this in view, Government of India initiated a central sector scheme namely "Animal Quarantine & Certification Services" (AQCS) during the Fourth Five Year Plan (1969-74) under which four Animal Quarantine stations were set up at Delhi, Chennai, Kolkata & Mumbai and now two more quarantine stations at Hyderabad and Bangalore in 11th plan. The First quarantine station at Delhi was established in 1969, followed by Chennai in 1974, Kolkata in 1975 and Mumbai in 1981.

This technical requirement for setting up quarantine facilities can be categorized based on the general level of risk (as determined by risk analysis) represented by the specific consignment of aquatic animals being moved:

1. The quarantine of "**high risk**" species (e.g. aquatic animals being moved either internationally through introductions

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and transfers or domestically between regions of different health status that are destined for use in aquaculture)

2. The quarantine of "**lower risk**" species (e.g. aquatic animals destined for the ornamental trade) to improve biosecurity for aquatic animals whose trade is an established practice) and
3. The routine quarantine of aquatic animals at production facilities (e.g. new, domestically produced or locally captured broodstock or juveniles or animals whose movement has been contingent upon additional, more stringent, risk management measures, such as the use of SPF stocks, international health certification, pre-border and/or border quarantine, *etc.*).

Objectives

- To prevent the ingress of any Exotic Livestock Diseases,
- To act as a defence force against ingress of exotic disease,
- To provide an internationally accepted certification service,
- To inspect and register the individual or organization exporting the animal by-products.

Functions

- Implementation of the provisions of the Livestock Importation Act and Central Government orders in force on importation and exportation of livestock and livestock products.
- Detention, segregation, observation and testing of livestock and livestock products meant for import/export.
- Destruction and disposal of imported livestock and livestock products found infected and posing threat to national health security.
- Pre-shipment Quality control to increase national exchequer.
- To have a proper liaison with custom authorities for effective and proper implementation of livestock and livestock product importation Act.
- To be in close association with the state directors of animal husbandry regarding disease position and surveillance.
- To associate with the heads of various recognized laboratories in India for getting an expert opinion and for testing of materials.

The Basic Requirements of Effective Quarantine

- Adequate physical infrastructure appropriate to the level of containment required (secure facilities, secure intake water source, *etc.*
- Established operating protocols (including the chain of custody); and well-trained staff.
- Detailed information on the requirements for setting up and operating quarantine facilities for exotic species and for routine ornamental fish trade

Quarantine Measures for Aquatic Animals and the Risk Assessment

In the past, quarantine was often seen as a separate activity, and as a procedure that should be applied to all imports of living aquatic animals, often with the unrealistic goal of "zero risk" of disease entry to the importing country. Biosecurity is indissociable part quarantine measures, so it becomes to also understand the biosecurity. Biosecurity in general terms is a strategic and integrated approach to analyzing and managing relevant risks to human, animal (including aquatic), plant life and health and associated risks to the environment (FAO, 2007).

Risk Management Strategies in Quarantine

The decision whether to require quarantine or other biosecurity measures should be done on a case-by-case basis and determined by a risk analysis. Risk reduction measures are subdivided into pre-border and post-border measures.

A. Pre-border measures

Pre-border measures are often critically dependent on the inspection, certification and compliance regime of the exporting country and are most effective when undertaken as a cooperative undertaking by the competent authorities (CA) of the importing and exporting countries.

1. Certification of Production Source

The inspection, testing and certification of hatcheries and other aquaculture production facilities as free from specific pathogens is a highly effective method to assure freedom from many serious diseases.

2. Use of Specific Pathogen Free (SPF) Stocks

The development of SPF stocks for some species of penaeid shrimp (SPF *Litopenaeus vannamei*, *L. stylirostris* and *Penaeus monodon* are currently available) is a good initiative to provide shrimp growers and hatcheries with broodstock and postlarvae of known health status with regard to certain pathogens.

3. Zoning

Sourcing stock from production facilities located in disease-free zones is another highly effective method to assure that the aquatic animals being moved are free from certain serious pathogens.

4. Restrictions on Life Cycle Stages

Juvenile stages and especially fertilized eggs generally carry fewer subclinical infections than do adult animals. Restricting importations to surface-disinfected fertilized eggs is often an effective way to prevent the movement of parasites, most bacteria and some viruses.

5. Lists of Approved Species

Allowing importation only of certain preapproved "lower risk" species is an effective means to reduce the likelihood of pathogen introduction. Such lists should be country-specific as determined by risk analysis, taking into consideration the various national factors.

6. Lists of Approved Exporting Countries

Importing countries may wish to establish lists of exporting countries that have met preset risk management conditions and thus can be pre-approved as lower risk sources for certain types of aquatic animals. Such conditions might include, for example:

- Presence of disease surveillance, monitoring and reporting programmes
- Existence of zoning programmes
- Existence of production facility health certification programmes

- Evaluation of the CA
- Existence of standard operating procedures (SOPs) or better management practices (BMPs)
- The existence of contingency plans for serious disease outbreaks.

7. On-site Inspection of Exporting Facilities

For movements of "high risk" species, the officials of the importing country may wish to make on-site visits to the proposed hatchery or other production facilities to verify the biosecurity measures that are in place to support claims of health status.

8. Evaluation of Competent Authorities

In cases where, as part of a risk assessment, the officials of an importing country has uncertainty regarding the zoo sanitary measures used by a potential exporting country, an evaluation may help to relieve any specific concerns.

9. International and other Health Certificates

Requiring international health certificates for specific OIE-listed diseases of concern to the importing country can provide a high level of assurance that consignments are free of the specified diseases.

10. Pre-border Quarantine and Temporary Holding

Risks to the importing country posed by "high risk" species can be reduced by conducting quarantine and disease testing of the stock/consignment or aquatic animals to be imported in the exporting country, or in a third country having appropriate quarantine capacity. Pre-border quarantine holding of "lower risk" aquatic animals in the exporting country can also allow time for any diseases or infections to become evident.

11. Pre-shipment Treatment

In some cases, the use of pre-shipment treatments can reduce the risk of pathogen transfer.

12. Inspection, Certification and Compliance Audits.

Establishing auditing procedures to verify that exporters, importers, officials and private contracting agencies are strictly adhering to specified protocols and requirements should be considered.

B. Post-border measures

1. Restrictions on Initial Use.

Placing restrictions on the initial use of introduced or transferred aquatic animals provides the opportunity to detect any introduced diseases prior to the animal's general release into the natural environment and increases the opportunity for control and eradication.

2. Monitoring Programmes

Inclusion of a disease surveillance component within monitoring programmes for introduced or transferred aquatic animal species can be used to confirm that serious diseases have not been spread to new environments and in the case where serious exotic pathogens have escaped detection in quarantine, will help minimize their impacts by allowing containment or eradication programmes to be initiated at an early stage.

3. Contingency Planning

All proposals for introductions and transfers should include planning for actions to be taken in case escape of animals or pathogens from quarantine occur or a serious pathogen fail to be detected during quarantine and be released into aquaculture facilities or the natural environment.

Standards and Guidelines for Quarantine

The International Council for the Exploration of the SEA (ICES) in its "ICES *Code of Practice on the Introductions and Transfers of Marine Organisms"*provides a recommended protocol for the introduction or transfer of live marine organisms that includes a decision-making process incorporating consideration of risks due to possible ecological (pest), pathogen and genetic impacts of the species being moved to the receiving country. Once a decision has been made to introduce or transfer an aquatic organism, the ICES Code provides a general protocol on how the movement should occur, with long-term quarantine being a fundamental component. Appendix C of the ICES Code provides brief general guidelines for the operation of quarantine facilities for aquatic animals destined for introduction or transfer.

Period of Quarantine

The quarantine period will vary depending on the time required to complete the health screening procedure. In all cases, animals should be kept under observation in the quarantine facility until all tests are completed and each organism's health status is known.

Conclusions

Quarantine is an important risk management measure that can be applied to reduce the risk posed by serious aquatic animal diseases when aquatic animals are moved internationally or domestically between different regions or zones, or when new broodstock or other life cycle stages are introduced into hatcheries and other aquaculture production facilities. For international movements, the decision to require pre-border, border and/or post-border quarantine of live aquatic animals should be made based on risk analysis, and stringency of quarantine to be applied should be commensurate with the estimated risk. The first movement (introduction) of a new species (an exotic)is likely to require use of highly stringent protocols, such as those outlined by ICES (2005).The quarantine of broodstock and other life cycle stages entering aquaculture production facilities can be routinely applied to reduce the likelihood of introducing serious diseases to the facility that will cause morbidity, mortality and associated production and financial losses.

Further reading

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idrish.raja.khan@gmail.com

Management and control of Quality changes in dried fish

S. Sundhar[1], S. Aanand[2], R. Shalini[1], R. Jeya Shakila[1], and G. Jeyasekaran[1]
[1]Department of Fish Quality Assurance and Management, TNJFU, Nagapattinam
[2]Erode Centre for Sustainable Aquaculture, TNJFU, Nagapattinam

Highlight Points

▶ Dry fish contains less cholesterol but a high amount of protein and vitamins hence has good nutritional value they . ▶ Physical, chemical and microbial changes adversely affect the quality of dry fish. ▶ Good manufacturing practices produce good quality dry fish for human consumption.

Introduction

Fish is a highly perishable commodity that spoils rapidly by enzymic decomposition, bacterial action, and oxidation. Hence, it requires proper handling, processing, packaging, before distribution. Drying is a traditional and cheap method of fish preservation since ancient times. There is a huge demand for dry fish in the domestic and foreign markets. The principle involved in fish drying is to reduce the reduction of available water present in the fish muscle to levels, arrests the microbial growth and render most intrinsic enzymes inactive. Lowering water activity influences the enzymatic changes and the microbiological growth is completely arrested when water activity is below 0.6. Generally, the moisture content of dried fish should be 10-15% to prevent the growth of moulds and microorganisms thus providing an extended shelf life to the dried fish. Drying can be done using open-air using sun and wind, salt and smoking. The freeze-drying can also be applied for drying wherein the fish is first frozen and water is removed by sublimation.

Types of Fish drying

Drying is usually achieved in two ways, natural drying and artificial drying. Natural drying is widely used for drying fish, utilizing natural solar energy, humidity, and airflow. Sun drying is the simplest method of drying fish suitable for small and lean fishes and this method heavily depends on the natural weather conditions, with no control over the operations. When this process is better achieved by permitting airflow over and below the product, it is called air drying. Under artificial drying, dehydration is achieved under controlled conditions, employing solar or mechanical dryers. Artificial methods provide better quality dried fish, devoid of sand, dust and uniformly dried product. However, the cost of production of artificial dried fishes makes the process less preferred by most dry fish processors, opting for natural drying.

Quality problems in dried fish

The quality of dried fishes adversely affected by the occurrence of microorganisms like fungus, bacteria other physical and chemical changes such as insect infestation, and fragmentation, rancidity, case hardening.

Spoilage by Fungus: Fungus can grow well on unsalted as well as salted fish if the product contains high moisture content > 15%. This growth results in discolouration and imparts the flavour of fish. Growth of fungus also leads to the breakdown of fat and protein besides the production of mycotoxins. Fungal growth can be prevented by using 20-30% sodium chloride that effectively controls the growth of most of the fungus.

Dun spoilage: Dun spoilage is caused by halophilic mould *Wallimia* sp that can grow at a salt concentration of 5 to 26%. These moulds tend to grow on well dried fish, producing dark patches like brownish black/chocolate or yellow brown spots on the surface of the product. This problem can be controlled by proper maintenance of low temperature and humidity during storage and transportation. Plastic bags which can cause temperature rise and condensation, during transport need to be avoided.

Pink or red discolouration: Red/pink discolouration is caused by halophilic bacteria like *Halobacterium salinaria, H. cutirubum, Sarcina morrhuae, S. Litoralis and Halococcus spp*. These are aerobic, proteolytic and non-pathogenic bacteria are present in most commercial salt. The pink discolouration is primarily caused slimy pink patches of microbial colonies, on the surface of wet or partially salt dried fish. These bacteria cannot grow in brine or fully dried fish. Dip treatment of fish in Sulphur dioxide or sodium metabisulphite followed by maintaining a constant temperature below 10°C helps prevents the growth of bacteria.

Rancidity/Rust: Rancidity is caused by the oxidation of fat and fatty fishes like mackerel. Oxidation of fat imparts characteristic odour and fish turn brown, hence the common name 'rust'. Impurities in salt and traces of copper can accelerate rancidity which reduces nutritive value of the product. Packing in airtight containers, or modified atmospheric packing can control rancidity.

Case hardening: This is caused by rapid drying during the initial stage, leading to faster drying of flesh on the outside while the centre remains moist. The result is dried fish having the chalk-white appearance, hard and brittle. Maintaining constant temperature reduces case hardening.

Insect infestation: It occurs during the initial stage of drying and storage of the dried products. Mainly blowflies belonging

to the family are Calliphoridae and Sarcophagidae infest the fish during the initial stage of drying, primarily being that attracted by the smell of decaying matter from the spoiling fishes. Flies lay their eggs in dried fishes which developed into maggots. They develop during storage, beetles especially *Dermestes spp.* attack dried fish, which consumes the product until the bones only remain. This results in both economic and nutritive loss to the fish processor. Mites are important pests, found infesting dried products. They are very minute and bring about powdering of the product thereby giving it a white appearance. *Lardoglyphus konoi* is a commonly found mite in fish products. Pyrethrins (3 mg/kg) synergized with piperonyl butoxide (20 mg/kg) is recommended by FAO/ WHO.

Fragmentation: Denaturation and excess drying of fish results in breakage of dried fish during handling and transport. Dried fish can become brittle and liable to physical damage when handled roughly. Fragmentation in dried fish can be prevented by using fresh and good quality raw material.

Problems in packaging dried fish

Dried fish are hygroscopic and absorb moisture under high humidity and are susceptible to oxidation when in contact with atmospheric oxygen, also attacked by moulds, bacteria, insects, rats and mice. Dried fishes are easily damaged due to improper handling because of its brittle nature and packaging methods such as jute sacks, wooden boxes and baskets are ineffective to protect the dried fish from that damage. Dried fish in plastic or polythene bags exposed to direct sunlight or hot places causes 'sweating' that wets dried fish making it susceptible to mould attack. Sharp, hardpoints and edges of dried fish puncture and rip the plastic or polythene bags, allowing air moisture, dust, and insects to spoil the dried fish. The use of jute sacks, Plywood boxes, waxed corrugated cartons, wooden or cardboard box fitted with a lid, and laminate films of polyester or polyethylene are mostly used for packaging of dried fish. vacuum packing and gas flushing method can also be used to pack the dried fish.

Production of good quality dried fish

Only fresh fish must be used for preparing dry fish. The raw material must be sorted according to size, type of fish and dried under the appropriate climatic conditions. Fish should be dried as safely as possible to avoid contamination with dirt, sand, and bacteria. Drying racks above the ground level or drying in the solar dryer protects against pests even during unfavourable weather conditions without spoilage, maintaining its nutritional values. Fishes should be sun dried away from sources of contamination such as roads, factories, farms and areas where burning or fires are going on. For drying, use raised racks permits airflow around both sides of the fish and dry it quickly. Drying fish on clean concrete or cement surfaces provides a dirt free and sand free product. Another method used to dry fish on clean fishing nets, placed on the ground, allowing water from fish to drain away. But care must be taken to protect the fish from dust and animals. Permitted preservatives such as calcium propionate, potassium sorbate, sodium benzoate, parabens, sulphur dioxide, sodium nitrite and fungicides at permitted levels can be used to protect from the fungal infestation. 200 mg/kg of Sodium sorbate or Calcium sorbate or Potassium sorbate is the recommended dose of Food Safety and Standards Authority of India (FSSAI). Addition of salt and 0.1 % citric acid before drying improves the quality of sun dried prawns. The dried fish must be stored in a place that is free of insects and rodents. The product is best stored on raised on stilts above the ground, in a well-ventilated, shady spot.

Net Drying of Fish

Beach drying

Solar drying

Machine drying

Quality dry fish in animal/poultry feed

Dried fishes are a common ingredient in poultry and animal feed. Poor quality can lead to increased mortality or other clinical illness to birds and animals. Microbiological infection especially bacteria such as *Salmonella* spp. and *E. coli* is also seen in animal feed due to the addition of fish meal. Protein in dried fish muscle are susceptible to deterioration, creating harmful products (NH_3, histamine, putrescine, cadaverine). The presence of histamine in dried fish used for animal and poultry feed affect the mucous membrane of stomach which can result in black vomit problems in poultry. The poor quality dried fish has a strong off odour that can be transmitted to milk, egg and meat. The optimum salt content in dried fish used for poultry feed should be 2.5 to 7.5 % recommended by CODEX and Bhutan standards and more than 12% by FSSAI. For use in poultry feed, the recommended level of salt in dried fish is 0.2%.

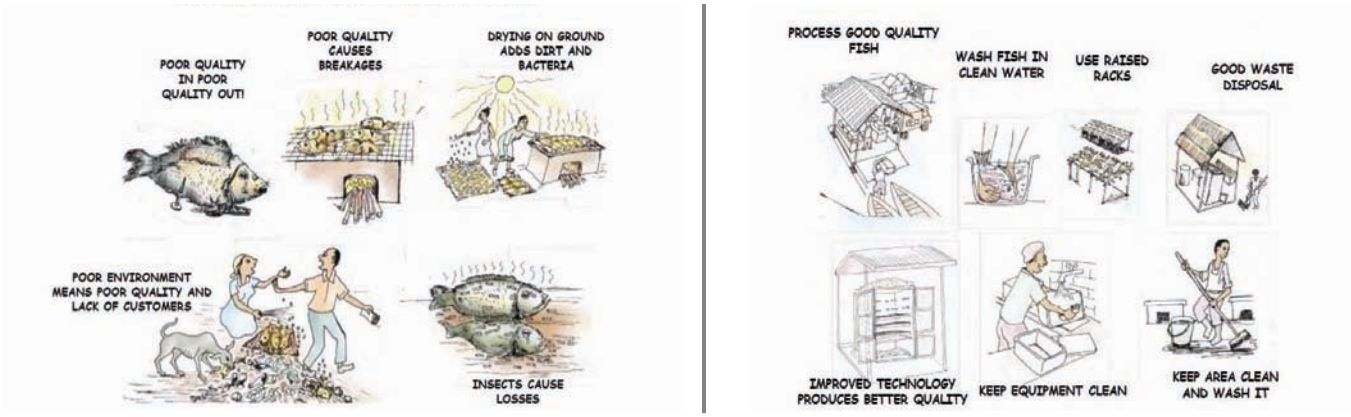

Fig. 1. The poor practices of drying fish and hygienic practices of drying fish

Codex and Bhutan standards for Dry fish

Moisture	Not more than 15.0 percent
Sodium chloride	2.5 to 7.5 per cent
Ash insoluble	1.0 to 1.5 percen

Codex and Bhutan standards for Dried salted fish

Moisture	Not more than 16.0 percent
Sodium chloride	Not less than 10.0 percent
Ash insoluble	not more than 1.0 percent

Codex and Bhutan standards for the microbial requirement of dried

Total coliform count	maximum 100000/gm
E.coli	not more than 20/gm
Staphylococcus aureus	not more than 100/ gm
Salmonella ,Shigella, Vibrio cholarae and *Vibrio parahaemolyticus*	all absent in 25/gm
Yeast and mould Count	absent in 25gm

FSSAI standards for dry fish

Characteristics	Requirements
Water activity (aw) at 25 °C	Less than 0.78
Salt content	Not less than 12 %
Histamine content,	max. 200 mg/Kg
Acid Insoluble Ash on dry basis	Not more than 1 %

FSSAI standards for Microbiological quality of dried fish

Total plate count	Not more than five lakhs / gm
E. Coli	Not more than 20 / gm
Staphylococcus aureus	Not more than 100 / gm
Salmonella & *Shigella*, *Vibro cholera* and *Vibro parahaemolyticus*	Absent in 25 gm

FSSAI standards for Edible Fish Powder

Sl. No	Characteristic	Requirement
1	Moisture % by weight	Max 10
2	Crude protein content	Min 65
3	Total available lysine g/100g of Protein	Min 6
4	Fat content	Max 6
5	Ash	Max 18
6	Acid insoluble	Max 0.5

sundhar.fqm16@gmail.com

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