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India's seafood exports, both in terms of volume and value, achieved an all-time high in 2022-23 with 1.7 million tonnes of shipment worth Rs 63,969 crore

Contribution of microalgae to nature towards oxygen production, maintaining the food web and role in nutrient cycles will be higher, making sustainable nature. Therefore, techniques should be devised to develop cost-effective microalgae production systems in indoor facilities and also conservation of natural grounds should be considered as an important activity in order to sustain aquatic organisms thriving in the wild.

Dear Readers,

The July 2023 issue of Aqua International is in your hands. In the news section, you may find news about ...

India's seafood exports, both in terms of volume and value, achieved an all-time high in 2022-23. It shipped 1.7 million tonnes of seafood worth Rs 63,969.14 crore ($8.09 billion) during the financial year, growing 26.73 per cent in quantity terms and 4.31 per cent in value terms over 2021-22. The US, China and the European Union are key markets for Indian seafood. South East Asia is the fourth largest market.

ICAR-Central Inland Fisheries Research Institute has organized one day awareness program onfish disease surveillance and health management under NSPAAD phase II project funded by Pradhan Mantri Matsya Sampada Yojana (PMMSY). The program was conducted at Balagarh and Tribeni, Hooghly District, West Bengal. In Balagarh, a total of 40 fishers including 36 women and 2 men participated, while in Tribeni 45 fishers including 40 men and 2 women participated in the program. Dr B. K. Das addressed the gathering and motivated the fishers on the fish health and chemotherapeutic management and informed the fishers on negative effect of antibiotics and chemicals indiscriminate use in fishes.

Prof. S. Felix has written to all Deans of Fisheries Colleges in India on the need of quality fisheries graduates. Its a nice opportunity to say a hello to all the Deans of the Fisheries Colleges in India. As the Deans of the Fisheries Colleges, you all have a certain responsibility to enlighten your University authorities and the Govt 's Secretary concerned to improve your Institutions in terms of better facilities and adequate faculty so as to produce the 'quality graduates'. Fisheries Colleges who are under the Agri and Vet Universities have to raise their voices to get facilities and faculty strength so as to produce adequate numbers and quality Fisheries Graduates.

Dr Nitin Pipralia, a native of Rajasthan is an aquaculture consultant in North India covering Rajasthan, Haryana, Punjab as well as Uttar Pradesh. His aqua career began in 2005 when he shifted from Terrestrial biotechnologist to Marine Biotechnologist under DBT sponsored Masters's course in CAS in Marine Biology, Parangipettai, Tamil Nadu. Creating awareness among shrimp farmers in the region by paying visits to their ponds to attend to their real-time queries and providing the best effective solution along with guiding them to follow best aquaculture practices and effective nutrition and health products for a disease-free profitable harvest.

Minister of State, Department of Fisheries, Govt of West Bengal held a meeting with all Fishery Extension Officers of 29 Blocks of District South 24 Parganas, West Bengal on 7June 2023. Roy Chowdhury mentioned that we must take fish farming more seriously and should work collectively, so that noticeable success will be achieved.

Chhattisgarh is a landlocked and heavily forested state located in Central India. The State has a total of forty-two (42) Scheduled Tribes. According to Census, 2011, Chhattisgarh has

Contd on next page

NRS GROUP
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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about 7.5 percent of India's tribal population and tribal people form about 30 percent of the state's population. ICAR-CIFRI has taken initiatives to uplift the socio-economic status of the primitive tribal populace of Chhattisgarh by joining hands with the Department of Fisheries, Chhattisgarh. Pen culture intervention is a tool to raise in situ fish seed in the reservoir which will not only improve the production of the reservoir but also reduce the cost of production, subsequently the livelihood of the fishers will be improved.

ICAR- National Bureau of Fish Genetic Resources, Lucknow conducted a 5-day training-cum-capacity building programme on 'Quality broodstock development using fish milt cryobanking' during 12 to 16 June 2023, for the benefit of the fisheries officers of the Department of Fisheries, Government of Madhya Pradesh. 15 fisheries officers of the Department of Fisheries, Government of Madhya Pradesh participated in the training coordinated by Scientist Dr Santosh Kumar. NBFGR has demonstrated seed production using cryopreserved milt in 38 hatcheries in 11 States in the country.

Fisheries College and Research Institute, Thoothukudi organised Open Day for school students and public on June 19 in commemoration of establishment of Tamil Nadu Dr J. Jayalalithaa Fisheries University, Nagapattinam. The college was established in Thoothukudi by Tamil Nadu Agricultural University (TNAU) in October 1977, making it the second fisheries college in India. Presently, it is functioning as one of the constituent colleges of the fisheries university. The Open Day was inaugurated by Rejini, Chief Educational Officer, Thoothukudi. There were exhibits of marine ornamental fish aquarium, glass aquarium, edible fishes, shrimps, crabs, lobsters, brooder fishes, models of integrated fish farms and fish processing units. As many as 2,000 students from 22 schools visited the exhibition.

Indian industry should get a level-playing field like Ecuador, which has forged ahead in shrimp culture, and Vietnam and Thailand in terms of wild catch, said Seafood Exporters' Association of India (SEAI) president Jagdish V. Fofandi recently. While the cultivation of Pacific white shrimp Vannamei has not taken off in Kerala despite the fact that around 60% of the shrimp processed in the State is accounted for by imports from Andhra Pradesh. The area under aquaculture in Gujarat has dropped considerably. South Gujarat, which dominates the aquaculture scene, has seen production dropping from around 90,000 tonnes to 30,000 tonnes.

USSEC invited to join us for a live webinar in America on July 2 and 3, with USSEC's Chief Executive Officer Jim Sutter and market expert Marty Ruikka, President of The Pro Exporter Network. They will dive into the numbers and share insights and potential implications for the global soy complex as they move further into the marketing year.

In the Articles section – Probiotics in Aquaculture: A Promising Alternative Approach, *authored by* **Raju Ram,** said that antibiotic use in aquaculture**,** on the other hand, may be harmful to the environment and human health by encouraging the development and spread of resistance to other bacteria, including human and fish pathogens. Furthermore, using antibiotics and chemicals to treat diseases is only a partially successful strategy. Probiotics are members of the host's healthy microbiota, so they could be an alternative to using antibiotics in aquaculture (Perez et al., 2010). Probiotics may protect against bacterial diseases through a variety of mechanisms, including the production of inhibitory compounds, competition for essential nutrients and adhesion sites and modulation of immune responses.

Another article titled **– Yeast – Noval Aquafeed Ingredient for Future,** *authored by* **Satheesh M,** described that aquaculture is becoming increasingly popular around the world. In order to produce more fish in a sustainable way, quality feed and seeds are more important. Aqua feeds are formulated with a vast pool of ingredients that are intended to supply their nutritional requirements to perform their normal physiological functions, including maintaining a highly effective natural immune system, growth and reproduction. So, feed ingredients are crucial to nutritional research and feed development for aquaculture.

Article titled – **Microalgae – Promising live food for fish and shrimp larvae,** *authored by* **Halpati Reena Prakashbhai**, discussed that Aquaculture is the fastest-growing sector which is mainly dependent on seed production and larval rearing which eventually provides an input for culture systems and ultimately brings about an output through it. Larval rearing is generally carried out under controlled hatchery conditions and usually requires specific culture techniques, especially husbandry techniques, feeding strategies and microbial control. The main reason is that the developing larvae are usually very delicate, small, extremely fragile and generally not physiologically fully developed. Contribution of microalgae to nature towards oxygen production, maintaining the food web, and role in nutrient cycles will be higher, making sustainable nature.

Another article titled – **Aquamimicry: A novel concept towards sustainable shrimp farming,** *authored by* **Dettu Nebu**, said that aquaculture continues to grow faster than any other major food producing sector in the world with an average annual growth rate of 5.3 % per year during the period 2001-2018 (FAO, 2020). It is contributing to food security, livelihoods, foreign exchange etc. Shrimp is the lucrative crustacean species farmed across the world and accounting for about two-third of the value of fish exports. In India, commercial shrimp culture was introduced in late 1990s and reached a peak in 1994 and thereafter it was suddenly declined due to the series of white spot disease outbreak.The profitability between the conventional aquaculture and aquamimicry system was reported to be 17% and 40% respectively with a high survival rate of 90-95%.

Article titled – **Stress Management in Shrimp Farming,** *authored by* **Mr Roshan Krishnan,** said that Aquaculture India Stress is quite common in all living organisms especially when they are not in their natural habitat. In shrimp farming, stress occurs when the animals are exposed to conditions that require extreme or prolonged adjustments to adapt. One of the major challenges in shrimp farming remains acute and chronic stressful conditions because of improper handling, disease causing pathogens, lack of optimal nutrition, environmental stress, etc. These stress conditions can lead to retarded growth, poor immune response and increased susceptibility to disease, eventually resulting in survival drop and poor ROI.

M.A.Nazeer
Editor & Publisher
Aqua International

ICAR-CIFRI organizes awareness program on fish disease surveillance and health management

Interaction of ICAR-CIFRI officials with stakeholders

Hooghly: ICAR-Central Inland Fisheries Research Institute has organized one day awareness program on fish disease surveillance and health management under NSPAAD phase II project funded by Pradhan Mantri Matsya Sampada Yojana (PMMSY). The program was conducted at Balagarh and Tribeni, Hooghly District, West Bengal on 9 May 2023.

In Balagarh, a total of 40 fishers including 36 women and 2 men participated, while in Tribeni 45 fishers including 40 men and 2 women participated in the program. During the program, Dr B. K. Das, Director ICAR-CIFRI enlighten the gathering on several areas of disease surveillance and health management of fish including aquatic environment vis-à-vis antimicrobial resistance issues, status of fish disease management, sustainable approaches for aquaculture development, etc. Later, Dr B. K. Das addressed the gathering and motivated the fishers on the fish health and chemotherapeutic management and informed the fishers on negative effect of antibiotics and chemicals indiscriminate use in fishes. The pamphlet on both English and Bengali were prepared on disease identification and their possible management measures and distributed among the participants to sensitize the fishers for better management of their fish farm. Dr Vikash Kumar and research scholars of NSPAAD Phase II project Mr Souvik Dhar, Mr Satyanarayan Parida and Mr Kampan Bisai coordinated the program with great efficiency.

Distribution of pamphlet both in English and Bengali on disease identification and their possible management

India's seafood exports touch all-time high in 2022-23

India shipped 1.7mn tonnes of seafood worth Rs 63,969 crore

New Delhi: India's seafood exports, both in terms of volume and value, achieved an all-time high in 2022-23. It shipped 1.7 million tonnes of seafood worth Rs 63,969.14 crore ($8.09 billion) during the financial year, growing 26.73 per cent in quantity terms and 4.31 per cent in value terms over 2021-22.

According to a press statement from the Ministry of Commerce and Industry, Frozen shrimp remained the major export item in terms of both quantity and value while USA and China turned out to be the major importers of India's seafood.

Frozen shrimp, which earned Rs 43,135.58 crore ($5481.63 million), retained its position as the most significant item in the basket of seafood exports, accounting for a share of 40.98 per cent in quantity and 67.72 per cent of the total dollar earnings.

Frozen shrimp remained the major export item in terms of both quantity and value while USA and China turned out to be the major importers of India's seafood.

In rupee terms, shrimp exports during the period increased by 1.01 per cent.

Frozen fish, the second largest exported item, fetched Rs 5,503.18 crore ($687.05 million) accounting for 21.24 per cent in quantity and 8.49 per cent in dollar earnings. This year the export of frozen fish has increased by 62.65 per cent, 58.51 per cent, and 45.73 per cent in quantity, rupee and dollar value terms respectively.

The US, China and the European Union are key markets for Indian seafood. South East Asia is the fourth largest market.

Uni-President

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NET 200 g **BSL**

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

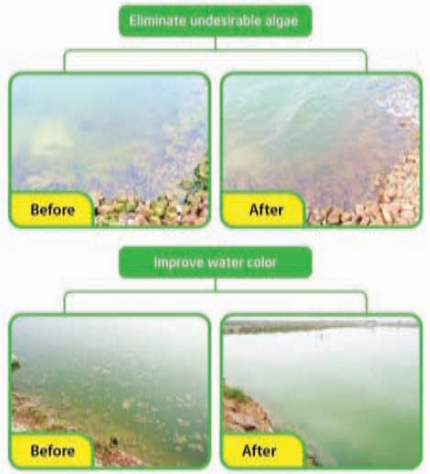
No cultivation is needed. Easily adapt to the changes of surroundings and grow fast in freshwater or seawater culture farming, even under low oxygen environment

3. DECREASE AMMONIA CONTENT

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

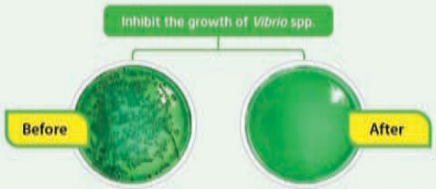
4. IMPROVE WATER COLOR

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:

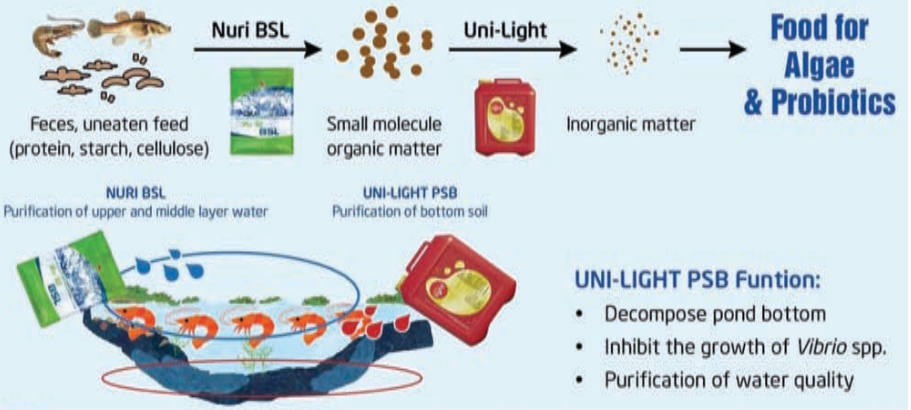
Bacillus spp. > 1x 10^{11} cfu/kg	15%
(Bacillus subtilis, Bacillus amyloliquefaciens, Bacillus licheniformis)	
Carrier (rice bran, corn gluten)	75%
Moisture	10%

* 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 m³ 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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Prof S. Felix writes to all Deans of Fisheries Colleges in India on the need of "quality graduates"

Its a nice opportunity to say a hello to all the Deans of the Fisheries Colleges in India.

As the Deans of the Fisheries Colleges, you all have a certain responsibility to enlighten your University authorities and the Govt 's Secretory concerned to improve your Institutions in terms of better facilities, adequate faculty so as to produce the 'quality graduates'.

Fisheries Colleges who are under the Agri and Vet Universities have to raise their voices to get facilities and faculty strength so as to produce the adequate Nos and the quality Fisheries Graduates.

The graduates need to be produced in a larger Nos in your college and in India?
Change your mindset to run 20 - students colleges. University will tell you that there is no job opportunity! There is no budget with the Govt! Fisheries Science is not the priority! etc. Its not acceptable that colleges of 25 to 45 years old are still admitting only 20 to 40 students per year. Job opportunity doesn't mean it at Universities (APs), Fisheries Depts (ADs) and Fisheries Research Institute (Scientists) alone. You have larger job opportunities in the Pvt sector which is being used by the Zoology, Botany and other graduates! Further, the Start- up scope in our Fisheries and Aquaculture sector is in abundance. SAUs are started in India for this purpose only! Hence its time to increase the strength of all your colleges to a minimum of 60 immediately. The practicals can be conducted in 2 batches. The Fisheries University affiliated colleges and those who are 25 plus years old can start admitting 80 plus students per college. Have a faculty strength of 15 to 20 at least for 60 student colleges (The ICAR recommendation of 39 faculty for a 40 student Fisheries college is not practical and it's impossible too!).

Make your Fisheries colleges a Multidisciplinary Institutes:
We have come a long way since the first Fisheries Colleges were started in the 1970s at Mangalore and at Thoothukudi. But still all the 40 and odd Fisheries Colleges are offering only a B.F.Sc. Course!! Are you not bored of this program?? World has changed a lot!! B.F.Sc. is not that kind of superior course that you can not change the form and flavour of this course and diversified into many job oriented courses!!?? Look at the Courses being offered at KUFOS, Kochi and TNJFU, Tamilnadu. More than 10 UG courses can be offered from the Fisheries Colleges and try to accommodate as many students as possible (eligible interested ones) in your colleges. You can diversify into Engineering (F. Eng), Technology (B.Tech), Business (BBA) and Vocational Degrees (B.Voc), etc. Sky is the limit! Think out of the box! Show the current generation of youth that we can also offer the courses of their choices.

Budget is not the problem and you can have these courses on your own:
Look at the many Agriculture Universities in your respective states and see how they are managing many programs!

Don't hesitate to talk to your Universities! Dean's positions are not simple ones; you have a lot of responsibilities for the development of the college.

Running a 20 to 40 student college is not a big thing at all. Make your colleges 'really big' in terms of students admission, providing quality education, creating job opportunities and to open up opportunities for their Higher studies.

Fisheries Colleges with the admission strength of 20 to 40 and Universities with 200 to 400 strength will disappear/ get merged as per the New Education Policy, 2020!!

Believe you can do it!
Still if you have doubts in mind, call me for a chat!

I will give the required tips to do this magic!

Its time to make your Fisheries Colleges BIG and to create the next few **Fisheries Colleges in your state.**

You have to start not a mere Fisheries College now! But the **Fisheries Institutes of Science, Engineering & Technology !!**

All the Best!
Thank you.
Regards,
S.Felix

Aqua International Editor M.A. Nazeer celebrated the marriage of his son M.A. Nadeem, B.Tech, with Ms Aswad Sulthana, D/o Mr Mohd Ishtiaq-ur-Rahman recently in Hyderabad. Relatives and friends from the industry graced the occasion and blessed the couple. Guests enjoyed the Nizami dinner hosted on the occasion.

Man Swimming in Desert

Dr Nitin Pipralia, a native of Rajasthan is an aquaculture consultant in North India covering Rajasthan, Haryana Punjab as well as Uttar Pradesh. His aqua career began in 2005 when he shifted from Terrestrial biotechnologist to Marine Biotechnologist under DBT sponsored Masters's course in CAS in Marine Biology. Parangipettai, Tamil Nadu. Where became used too of repeatedly facing one question. How come a native of the desert studying Ocean or marine science? for which instead of any reply, he used to smile and skip but made a promise to himself that this must be full proof replied by concrete action not vocal.

With time during his master's, his interest in marine biology and sustainability keep increased. Especially the physiology of marine fishes and crustaceans like shrimp resultant, after finishing the course instead of opting traditional job in the domain, he went to further research in aquaculture, joined as a senior research fellow in a DST project at Delhi University for an environmental assessment project for various aquaculture activities in all

Dr Nitin Pipralia

coastal states of India. His enthusiasm didn't satisfy here and with his keen interest in the same, he earned an international fellowship from GoI to continue his research on the practical aspect of Aquaculture in Europe.

Finally, after a concrete practical exposure to Aquaculture, aquatic physiology, feed regime and their environmental concern he returned to his motherland India and started serving his duties by creating awareness and instructing BAP, from Surat, Gujarat in big established aqua health care companies like Glen Biotech and Tablets India Ltd and few more as Technical manager.

How are you supporting Shrimp culture in North India?

Creating awareness among shrimp farmers in the region by paying visits to their ponds to attend to their real-time queries and providing the best effective solution along with guiding them to follow best aquaculture practices and effective nutrition and health products for a disease-free profitable harvest. My consultancy covers start from Site selection, water profile, seed selection, health care and nutritional input and feed chart considering FCR maintains off course up to harvest.

How does your consultancy benefit aqua farmers?

My consultancy not only assures them of the profitable crop but also guides them for better planning of post-harvest management considering the environmental aspects of their traditional agriculture species.

I do guide farmers in the selection of the best quality SPF seed, which is the most important aspect of a successful crop, comparing various parameters like seed PL, Brooder trait, M/G ratio, organ deformation, HP status and many more major disease screening like WSSV, EHP at the personal level.

The stocking method includes the adaptation of guest PLs for better survival followed by guiding them for feed chart, feed additives and water parameter, especially during the first month as this time only the basic immunity develops and lead to the desired harvest.

I pay planned visits to each of my sites for unbiased technical guidance which is more important. Otherwise like every company representative. Who just visit to promote their products for which they are paid.

I do makes important notes on the basics of Shrimp culture for prospective farmers to get them a real

understanding physiology of shrimp in pond culture in the language they understand easily along with the importance of different crafts and gear during culture concerning sustainability.

Why shrimp farming became popular in this region?
Well, as per the case of Rajasthan a concern, 60% of Rajasthan land is desert and habitation of around 40 % of the population, amongst them few districts are hard dry, in that there were two Sins that maximum population faced here.

First is groundwater saline natured. So, although available in plenty cannot be used for agriculture, making traditional livelihood agriculture on monsoon depended only, since monsoon is a very short season and that too in traces lead huge of land dry and barren. Second sin huge barren land.

But with the idea of shrimp culture, the dry or barren land is being used for a pond and saline groundwater is also a prerequisite for the same. Hence the sins turned into an opportunity, where farmers can earn even many folds money than what they were earning from traditional monsoon based agriculture.

Why shrimp farming is more advanced and fast updating than other aquaculture species?
Yes, you are right of course.

Advancement in shrimp farming is one step ahead of all traditional aquaculture sp.

Proper R&D over this species at the brooder level followed properly maintainable at hatchery levels for the latest commercial strain with better adaptability.

due to high fecundity a new commercial strain can be developed genetically within record time for example in shrimp a 6-month-old brooder can spawn approx.

What is the future of shrimp farming in India?
Shrimp gonna be the new definition of staple food in India shortly, it just needs a small awareness of the benefits of shrimp over other traditional meat options.

Domestic consumption needs to increase which can only be achieved by spreading awareness and availability PAN India or else shrimp was previously available in coastal states before it was not culturing in the north.

Various values added products of shrimp can be developed by many local SHGs, this will lead to their livelihood generation too.

Right now it is being consumed in the form of biryani, gravy. baked products and pickle to add their nutritional value but with the population bombardment to meet the dietary requirement with proper nutritional values. shrimp is the best choice.

What is health management in shrimp farming to achieve sustainability?
Disease, an unhealthy situation of cultured shrimp is always a challenge like in other livestock cultures.

Five years back, max culture was being practised in open systems i.e., ponds, which are denser in coastal regions for tidal water. Where due to the malpractices of water discarding in creeks and same water sources, new catastrophic diseases every 1 to 2 years. so proper management of discarding of water during and post culture needs to manage to make a

profitable cum sustainable culture otherwise issues in controlling bi-security lead to horizontal spread.

Do you have any international Exposure in Aquaculture exhibitions and consultancy?
I am also a member of SEB which presented my finding on aquaculture at their annual meets and international conferences in Spain, Luxembourg, Netherlands, Germany, France, Prague, Czech Republic, Bern, Interlaken in Switzerland and Brighton, UK.

I have also participated in Nellore Aqua International Expo, 2021 as an expert panel in the Farmer interaction session.

Consulting an aquaculture group in China and Madagascar as well, for the last 4-3 years.

What is your message to shrimp farmers?
I would love to congratulate all shrimp farmers to opt for shrimp culture and request them to go for permissible stocking of quality Seed with quality feed and opt for the best Aquaculture practices for better profitability but with special concern for environment for its sustainability always.

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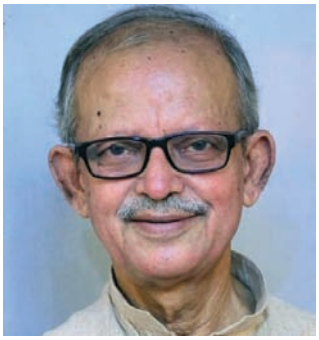
WB Fisheries Minister meets FEOs of South 24 Parganas

Kolkata: Mr B. Roy Chowdhury, Hon'ble Minister of State, Department of Fisheries, Govt of West Bengal, held a Meeting with all Fishery Extension Officers of 29 Blocks of District South 24 Parganas, West Bengal on 7 June 2023. The Secretary, Fisheries Department; Director of Fisheries; Senior Special Secretary; Additional Director of Fisheries and other higher officials were present in the meeting. While discussing about physical progress of implementation of ongoing developmental schemes of Fisheries Department at Block level, Roy Chowdhury opined that it will be good if 10 new Fish Production Groups (FPGs) are formed in each Block and 1 FPG in each Gram Panchayat.

After doing Registration of FPGs, one Government water body may be provided to each FPG and it will be an achievement for us when they will go for fish production. They must be guided so that fish production level of FPGs is increased. Need-based training on scientific and modern methods of pisciculture must be imparted to them, Booklets on fish farming to be given to FPG members-cum-fish farmers; subsequently they must be reminded of different techniques and methods in follow-up programmes, which will be a revision for them. Amount of fish production obtained by FPG in comparison to that of target and expectations, increase in fish production level – all must be looked into.



Fisheries Minister of West Bengal B. Roy Chowdhury

Roy Chowdhury enquired from FEOs about actively-functioning Fishermen Cooperative Societies at Block level, area of water bodies they possess for fish culture. Emphasizing on need of organizing more training programmes for fish farmers, he mentioned that there are many ponds (Government and private water bodies) in different Blocks in West Bengal where pisciculture is not practiced properly. Roy Chowdhury mentioned that we must take fish farming more seriously and we should work collectively, so that noticeable immense success will be achieved. With initiative of Fisheries Department, recently pH papers have been distributed to fish farmers at Block level in West Bengal – we must assess how much they have been benefitted. He mentioned that experienced and elderly fish farmers often speak correctly about growth of stocked fishes in culture ponds by seeing pond colour and the fingerlings of fish species suitable for stocking in such ponds.

Being MLA of Panskura Purba (Kolaghat) AC in Purba Medinipur district, Roy Chowdhury has noticed and experienced lesser number of trucks entering into West Bengal on daily basis from Odisha via National Highway in recent years – that are loaded with ice-preserved big-sized fishes. He opined that we must minimize the import (supply) of such Rohu and Catla in truckloads from Andhra Pradesh as much as possible and take steps to increase production of big-sized fishes sufficiently in water bodies in different districts of West Bengal. We may aim to supply fishes to Odisha and other states. In achieving this, we must elevate our level of thoughts, be more spirited and active in our efforts and update ourselves with newer methods of pisciculture. Youths and middle-aged persons in villages may build up their future by adopting fish farming, they will find a means of strengthening their life and livelihood – practicing fish farming in proper manner will become a continuing source of income for them. Roy Chowdhury encouraged all FEOs and explained all the concepts nicely. He described how the insulated fish boxes supplied by Fisheries Department proved very helpful to fish sellers (fish vendors) in rural West Bengal during COVID-19-induced lockdown period – they could sell fishes at doorsteps in different parts of their locality by loading fish box (containing fishes with ice) behind their bicycle.

Source: *Subrato Ghosh*

Pen culture demonstration cum awareness programme held at Chhattisgarh under Scheduled Tribe Component

Chhattisgarh: 4 June 2023, Chhattisgarh is a landlocked and heavily forested state located in Central India. The State has a total of forty-two (42) Scheduled Tribes. According to Census 2011, Chhattisgarh has about 7.5 percent of India's tribal population and tribal people form about 30 percent of the state's population. ICAR-CIFRI has taken initiatives to uplift the socio-economic status of the primitive tribal populace of Chhattisgarh by joining hands with the Department of Fisheries, Chhattisgarh.

Reservoirs and dams are the major inland open water resources in this state. ICAR-CIFRI has undertaken fish production enhancement programme in small reservoirs in Chhattisgarh through participatory mode by involving the Primary Fishermen Co-operative Societies (PFCS) of the selected reservoirs. The Institute has provided twenty numbers of pen, ten boats with engine, twenty coracles and twenty tonnes of CIFRI Cage Grow feed in ten selected small reservoirs in Chhattisgarh viz. Taurenga, Baherakhar, Sutiapath, Matiamoti, Koserteda, Rabo, Ghunghutta, Gej, Keshvanala.

Pen culture intervention is a tool to raise in situ fish seed in the reservoir which will not only improve the production of the reservoir but also reduce the cost of production, subsequently the livelihood of the fishers will be improved. ICAR-CIFRI organized Penculture demonstration programme in collaboration with DOF, Chhattisgarh in five small reservoirs viz. Baherakhar, Sutiyapath, Rabo, Paralkot and Ghunghutta of the state during 24 May 2023 to 4 June 2023 aiming to raise in situ fingerling in the pen for enhancing the production of the reservoir cost-effectively. Two scientific teams demonstrated CIFRI HDPE installation and stocking in the selected reservoirs. After the demonstration sensitization programme was organized at the reservoir site to aware the beneficiaries about the importance of Pen culture for fish production enhancement in the reservoirs. A total of 340 tribal beneficiaries attended the demonstration cum awareness programme.

The programme was coordinated by Dr A. K. Das, Pr. Scientist; Mr Satish Koushlesh, Scientist; and assisted by Mr Kaushik Mandal, TA, Mr S. Debnath, Mr Suraj Chouhan and Mr Snigdho Deb Barma of ICAR-CIFRI under the guidance of Dr B.K Das, Director, CIFRI.

Source: *www.cifri.res.in*

ICAR-NBFGR conducts trainees Officers of the Department of Fisheries, Govt of Madhya Pradesh on "Quality broodstock development using fish-milt cryobanking"

Lucknow: ICAR- National Bureau of Fish Genetic Resources, Lucknow conducted a 5-day training-cum-capacity building programme on 'Quality broodstock development using fish milt cryobanking' during 12 to 16 June 2023, for the benefit of the fisheries Officers of the Department of Fisheries, Government of Madhya Pradesh.

Dr U. K. Sarkar, Director, ICAR-NBFGR emphasized the vital role of cryopreservation techniques in developing quality broodstock and genetically diversified seeds for aquaculture, conservation and research in current climatic challenges.

The key deliberations made during the training were the genetic management of brooders, milt cryopreservation, health management and broodstock development from riverine stocks and maintaining the genetic diversity in farm stocks.

Fifteen fisheries Officers of the Department of Fisheries, Government of Madhya Pradesh participated in the training coordinated by Scientist Dr Santosh Kumar. ICAR-NBFGR has demonstrated seed production using cryopreserved milt in 38 hatcheries in 11 States in the country.

(***Source:*** *ICAR- National Bureau of Fish Genetic Resources,*

Tirunelveli Campus Connect

Thoothukundi: Fisheries College and Research Institute, Thoothukudi organised Open Day for school students and public on June 19 in commemoration of establishment of Tamil Nadu Dr J. Jayalalithaa Fisheries University, Nagapattinam. The college was established in Thoothukudi by Tamil Nadu Agricultural University (TNAU) in October 1977, making it the second fisheries college in India. Presently, it is functioning as one of the constituent colleges of the fisheries university. The Open Day was inaugurated by Rejini, Chief Educational Officer, Thoothukudi. There were exhibits of marine ornamental fish aquarium, glass aquarium, edible fishes, shrimps, crabs, lobsters, brooder fishes, models of integrated fish farms and fish processing units. As many as 2,000 students from 22 schools visited the exhibition.

FCRI conducted a fish farmers' meet recently. Amal Xavier, Joint Director, Department of Fisheries and Fishermen Welfare, Thoothukudi highlighted

School students visiting the Fisheries College and Research Institute on the occasion of Open House in Thoothukudi on 19 June 2023.

the explained the schemes of State Fisheries Department. J. Maria Michael Christopher of Aqua Remedies, Chennai; R. Suresh Raja, Lead Fish Farmer, Himalayan Aqua Farm, Thanjavur; and K. S. Vijay Amirtharaj of FCRI spoke on various topics. Keerthana, Sub Inspector, Department of Fisheries, explained fisher's welfare scheme under PMSSY. A total of 100 fish and shrimp farmers from various parts of Tamil Nadu participated.

A career guidance programme was conducted for first year students of PET Engineering College, Valliyur, on June 5. Principal K. Madhan Kumar presided over the programme. A. Shahul Hameed, Data Architect Consultant, Azure Cloud, US, gave an insight on

Contd on Page 30

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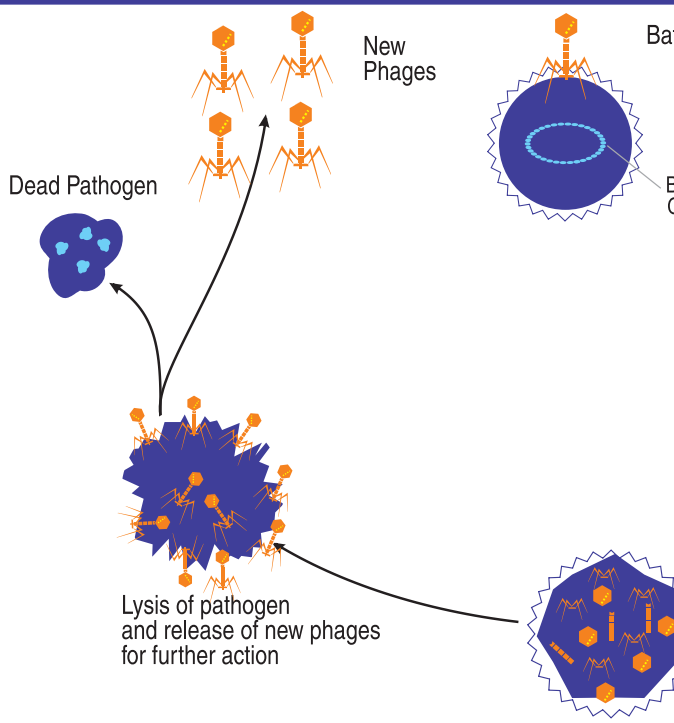

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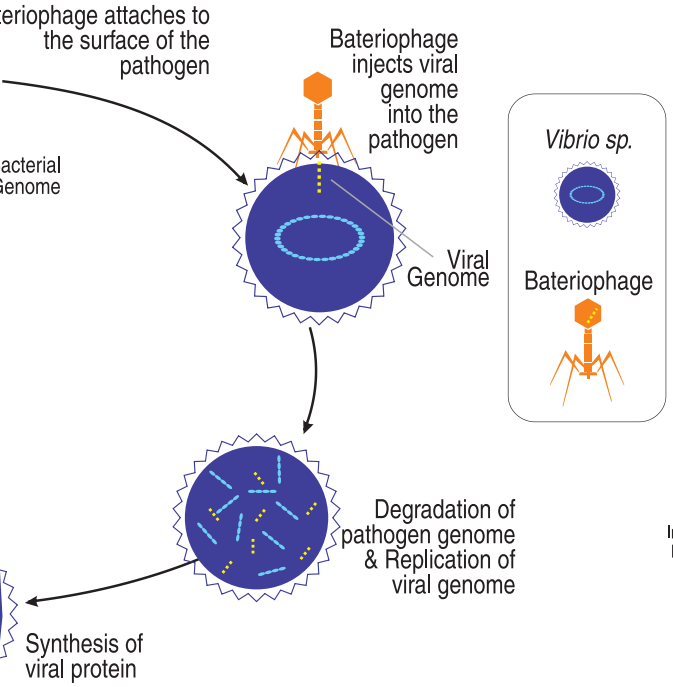

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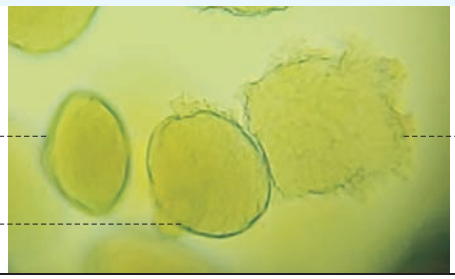
Stages of *Vibrio sp.* colonies infected with Bacteriophages & Progressive Lysis observed on an Agar plate, under Stereo Microscope



Colony 1 in Stage 1: Intact Colony may be infected or yet to get infected.

Colony 2 in Stage 2: Phage infected Colony showing Partial lysis.

Colony 3 in Stage 3: Phage infected Colony Completely lysed, cell contents with multiplied phages spreads out in search of their host.

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Seafood exporters demand expansion of aquaculture area

Indian industry should get a level-playing field like Ecuador, which has forged ahead in shrimp culture, and Vietnam and Thailand in terms of wild catch, says Seafood Exporters' Association of India president Jagdish Fofandi

Seafood Exporters' Association of India president Jagdish Fofandi

The more than $8-billion seafood industry has reiterated its demand to expand the area under aquaculture and to create an ecosystem where aquaculture will flourish in the country. Indian industry should get a level-playing field like Ecuador, which has forged ahead in shrimp culture, and Vietnam and Thailand in terms of wild catch, said Seafood Exporters' Association of India (SEAI) president Jagdish Fofandi recently.

He said Ecuador was well entrenched in the US shrimp market, while Indian wild-caught shrimp had been banned in the country over the past four years. Abraham Tharakan, a seafood industry veteran, said Indian shrimp exports to the US used to be worth around $250 million in the past.

They were speaking on the sidelines of the two-day dialogue on fishery certification for achieving sustainable development goals in India. The programme has the support and cooperation from SEAI, Sustainable Seafood Network of India, NITI Ayog, Marine Stewardship Council, and WWF.

Mr. Fofandi said the Indian seafood industry, despite handicaps including deceleration in the Japanese market, had crossed the $8 billion-mark during 2022-23. He added that the demand for surimi (fish paste) from India in the Japanese market had slumped precipitously. This has had a big impact as Japan accounted for the bulk of surimi exports from India. Japan is no longer a major market for Indian seafood.

The seafood industry representatives also pointed out that a drop in catch had not been reflected in the market so far but called for expansion of area under shrimp aquaculture in the country. Ecuador has done extremely well in the area, they said as they called for the creation of such a conducive ecosystem in India, which would create a level-playing field.

While the cultivation of Pacific white shrimp Vannamei has not taken off in Kerala despite the fact that around 60% of the shrimp processed in the State is accounted for by imports from Andhra Pradesh. The area under aquaculture in Gujarat has dropped considerably. South Gujarat, which dominates the aquaculture scene, has seen production dropping from around 90,000 tonnes to 30,000 tonnes.

Mr. Fofandi said aquaculture required not only fields for cultivation but also an ecosystem that would help business flourish. The availability of quality seeds, feed, and electricity charges play a big role in aquaculture, he added.

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Tirunelveli Campus Connect

opportunities in the software industry. He spoke on new openings. Semi Almouza, Software Consultant, US, advised the students to have an inquisitive mind and have an urge to question as it would lead to indepth learning. The programme was coordinated by Placement Officer S. Mohammed Peer Madharsha.

An achievement by Vel's Vidhyalaya

Vel's Vidhyalaya Senior Secondary Schools in Ambasamudram and Tenkasi have made an achievement by making 19 students of the first-Grade XII batch by cracking NEET UG 2023 and getting qualified for free medical seats on merit basis. The school followed strategies such as exclusive learning materials, extensive teaching, one on one doubt clarifying sessions, periodically conducted assessments facilitated by qualified senior faculties with proven records, thus leading to the astounding success of the programme in the maiden attempt.
l Correspondent M.V.M. Veeravel Murugan, Director K. Rajarajeswari, IIT & NEET head. Nagasrinivasan appreciated the NEET achievers.

On Indian philosophy

V.O.C. College of Education, Thoothukudi organised a discourse on "Indian Philosophy" on account of "Indian Philsopher's Day on June 15. S. Prema Latha, Associate Professor of Education, welcomed the gathering. Principal T. Kanakaraj, presided. The Resource Persons were G. Rajeswari of Alagappa University College of Education, Karaikudi; J. Maria Prema of St. Ignatius College of Education, Palayamkottai; S. Rasul Mohaideen from the host college; and A. Veliappan of Manonmaniam Sundaranar University, Tirunelveli. They explained the values, culture, ethics, aesthetics tradition, metaphysics, epistemology and significance of Indian Philosophy and Indian Philosophers. They emphasised that philosophical values should be transferred to the next generation via prospective teachers. M. Sasikala, Assistant Professor, proposed vote of thanks.

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Bon Ammonia and obnoxious Gasses

Shrimp / Fish performs all their body functions and growth in water. Good quality water and proper D.O. levels determines the success or failure. Good quality water, optimum D.O. level is of prime importance for health and growth of Shrimp / Fish.

Irregular water exchange, excess and leftout feed, dead algae, fecal matter, increases the organic load at the pond bottom. Accumulation of such waste absorbs available oxygen, creating anaerobic condition which leads to pollution of pond bottom. Polluted pond bottom and unhealthy environmental conditions triggers the release of toxic gasses like Ammonia, H_2S, Methane, etc, The toxicity of Ammonia, Hydrogen Sulphide, Methane attributed mainly due to unionized form. As the concentration in water increases, ammonia excretion by aquatic organism diminishes and the level of ammonia in blood and in other tissues increases. Ammonia increases oxygen consumption by tissues, damage gills and reduces the ability of blood to transport oxygen, and increases the disease susceptibility. To eliminate / overcome the above problems 'GASSEN PLUS' Yucca Schidigera, it contains Steroidal"Saponin" which help to reduce ammonia and other noxious gasses such as H_2S, Methane, etc., Microbial enzyme "Urease' Production inhibited by Saponin which leads to an increases D.O. and reduction of BODand COD levels.

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.

COMPOSITION:
YUCCA SCHIDIGERA
ALOEVERA
BACILLUS SUBTILIS
BACILLUS POLYMIXA
BACILLUS LICHENIFORMIS
NITRASOMONAS
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STABILIZERS

DOSAGE : 1 Kg per Acre or consult your Aqua Technician For Specific Usage & Dosage

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U.S. Soy Webinar: Acreage Report & Farmer Perspective

Americas: July 2 | Asia: July 3

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You're invited to join us for a live webinar with USSEC's Chief Executive Officer Jim Sutter and market expert Marty Ruikka, President of The Pro Exporter Network. They will dive into the numbers and share insights and potential implications for the global soy complex as we move further into the marketing year.

Speakers

Jim Sutter
Chief Executive Officer, USSEC

With a rich commercial background in the food and agriculture sector, following leadership roles in Cargill's global grains and oilseeds business, Jim plays a key role in defining and driving USSEC's vision for U.S. Soy as a trusted, sustainable source of nutrition and energy worldwide. Jim leads a global team focused on differentiating, elevating preference, and enabling market access to U.S. Soy for human consumption, aquaculture, and livestock feed in 80+ countries internationally. This is accomplished through active collaboration with USSEC's 100+ members who represent the soy value chain including U.S. Soy farmers, processors, commodity shippers, merchandisers, and food and agriculture organizations.

Marty Ruikka, President, The ProExporter Network

As a principal of The ProExporter Network, Marty manages the firm's Commodity Market Zone Analysis (CMZA) software. CMZA is used to help rationalize many mergers, acquisitions, and divestitures and to establish the strategic origination plans for many grain companies and cooperatives. Marty is also responsible for the firm's ethanol analysis and feasibility studies. He began working with The PRX Network soon after its inception in the late 1980s.

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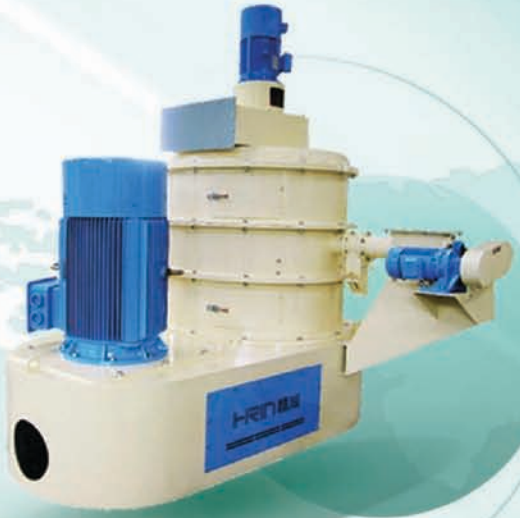

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Probiotics in Aquaculture: *A Promising Alternative Approach*

Email: raju.fbtpa603@cife.edu.in

Raju Ram, Lakan Lal Meena and Chandan Haldar
ICAR – Central Institute of Fisheries Education, Mumbai.

Highlight Points

The expansion of aquaculture as an industry has surged in recent decades, resulting in environmental harm and low crop productivity. The use of probiotics in aquaculture operations has been driven by the need for better disease resistance, aquatic organism development and feed efficiency.

Chemotherapeutic drugs' use has been banned in several nations in recent years due to health and environmental concerns. As a result of this restriction, alternative ways to boost aquaculture output and disease resistance are in high demand.

Probiotics, live microorganisms that provide a health advantage to the host by giving both a nutritional benefit and protection against pathogens, are one of these choices, and their use could eventually replace some of the medicinal chemicals routinely employed in aquaculture.

1.0. Introduction

Many countries have turned to aquaculture as a major source of revenue. The emergence of a large variety of pathogens is thought to be the major limiting factor, despite the fact that this activity has expanded, diversified and intensified. Antibiotics are used to treat as well as prevent bacterial infections (Taylor et al., 2011). Antibiotic use in aquaculture, on the other hand, may be harmful to the environment and human health by encouraging the development and spread of resistance to other bacteria, including human and fish pathogens. Furthermore, using antibiotics and chemicals to treat diseases is only a partially successful strategy. Probiotics are members of the host's healthy microbiota, so they could be an alternative to using antibiotics in aquaculture (Perez et al., 2010). Probiotics may protect against bacterial diseases through a variety of mechanisms, including the production of inhibitory compounds, competition for essential nutrients and adhesion sites and modulation of immune responses. It's worth noting that probiotics in aquaculture can improve the health of the host by controlling pathogens and improving water quality by changing the microbial community composition of the water and sediment.

2.0. Selection of probiotics

When selecting the right probiotic strain for aquaculture, there are various factors to consider. The following qualities should be considered: host origin, strain safety, antimicrobial substance production, ability to control host immune response, or efficient competition with pathogens for intestinal mucosa adhesion sites. In vitro antagonism studies, in which pathogens are exposed to potential probiotics or their extracellular products in liquid and/or solid medium, are one of the most frequent techniques to obtain a source of these microorganisms. However, past research has shown that in vitro testing do not necessarily anticipate a potential in vivo effect, thus these findings should be regarded with caution. *Lactococcus lactis, Leuconostoc mesenteroides* and *Lactobacillus plantarum,* three possible probiotic bacteria, all exhibited the ability to inhibit *Lactococcus garvieae* in vitro. Despite demonstrating antagonism in vitro, only *L. plantarum* protected rainbow trout (*Oncorhynchus mykiss*) from *lactococcosis* (Perez et al. 2011). The choice of probiotics is crucial because the wrong microbe can have negative consequences for the host. Probiotics from autochthonous sources are thought to have a better chance of competing with indigenous microbes (Sun et al. 2013); thus, isolation from the suitable fish species can be an efficient approach of selecting effective probiotics. For example, using *Lactobacillus fructivorans,* a strain isolated from the stomach of adult seabream, Carnevali et al. (2004) found a substantial reduction in larval and fry mortality (*Sparus aurata*). Several in vitro screening procedures are required to select probiotics, including assays for antagonistic chemical synthesis, adhesion to fish intestinal mucus and the generation of additional helpful compounds such as vitamins, fatty acids and digestive enzymes.

3.0. Components of Probiotic

Aquaculture uses a diverse range of microorganisms, including both Gram-positive and Gram-negative bacteria. Non-bacterial alternatives such as bacteriophages, microalgae, and yeasts are frequently investigated as probiotics for aquaculture. Probiotics are made up of a vast variety of Gram-positive bacteria that are used all over the world. Endospore-forming Bacillus genera have a wide range of applications, with Bacillus subtilis being widely utilized in aquaculture.

4.0. Administration methods of probiotics

4.1. Water and feed additives

Probiotics are administered in two ways: directly through the mouth/water or through feed additives. Most probiotics are designed to be mixed with feed and this practice is the most widely employed in aquaculture. Few reports are suggesting that probiotics (*Lactobacillus rhamnosus*) and other feed additives boosted the fertility of zebrafish (*Danio rerio*). Oral treatment produced benefits for prawns of all sizes and such prawns could be treated at any point during the culture period. Probiotics are commonly supplied to culture water directly, as water additives, or soaked in bacterial suspension.

4.2. Single and combination

Probiotics can be used alone or in conjunction. Most probiotic research has utilized single cultures, and whether two or even several combinations of probiotic strains might be advantageous is highly theoretical. Single-strain probiotics are ineffective compared to mixed-strain probiotics. Recent studies have employed a mix of probiotics and prebiotics, immunostimulants, or natural plant compounds. Synbiotics is a combination of probiotics and prebiotics that works by giving a probiont a competitive advantage over rival endogenous populations, then boosting the survival and implantation of the live microbial dietary supplement in the GI tract of the host.

4.3. Live and dead / inactivated probiotics

The usefulness of live and dead probiotics in aquaculture is a contentious topic. Rainbow trout were protected from *Vibrio anguillarum* and *Vibrio ordalii* by Kocuria SM1 live cells (Sharifuzzaman and Austin 2010). The expression of immune genes (TNF, TGF-b, IFN, and Ig) was higher in diets containing viable probiotics (live-spray and freeze-dried) than in diets containing heat-killed probiotics (Panigrahi et al., 2011). Live probiotics provide benefits to the host, while some dead/inactivated cells or probiotic supernatant do as well, but others do not. Unfortunately, there is no evidence that using live or dead probiotics is better.

4.4. Enrichment

Enriching live feed with probiotics in the form of encapsulations is an intriguing concept, as probiotics can remain viable and even proliferate on the live feed. As a result, live feed can efficiently deliver probiotics to the hosts. Probiotic enrichment of live feed such as artemia, rotifer and copepods is thought to be appropriate. In grouper *Epinephelus coioides* larvae, the copepod (*Pseudodiaptomus annandalei*) is suitable as a carrier of probiotic *Bacillus spp* (Sun et al., 2013).

5.0. Mode of action of probiotics

The most likely modes of action are:

- Stimulation of humoral and/or cellular immune responses;
- Alteration of microbial metabolism by increasing or decreasing relevant enzyme levels;
- Competitive exclusion, in which the probiotic antagonizes the potential pathogen by producing inhibitory compounds or by competing for nutrients, space (¼ adhesion sites in the digestive tract) or oxygen.

6.0. Applications of Probiotics in Aquaculture

Research into the use of probiotics on aquatic organisms has been prompted by the need for sustainable aquaculture. The initial focus was on their usage as growth promoters and to improve animal health; however, additional areas of interest have emerged, such as their effect on reproduction or stress tolerance, albeit further research is required.

6.1. Growth Promoter

Probiotics have been employed in aquaculture to boost the growth of cultured species, although it's unclear if these items boost appetite or improve digestibility by their very nature. Some individuals believe it could be a combination of variables; additionally, it would be crucial to investigate whether probiotics taste pleasant to aquaculture species.

6.2. Inhibition of Pathogens

Consumers today seek natural products free of ingredients such as antibiotics and there is a trend toward illness prevention rather than treatment. As a result, probiotics are a potential option for pathogen suppression and disease management in aquaculture species.

4.3. Improvement in Nutrient Digestion

Probiotic strains create extracellular enzymes including proteases, amylases and lipases, as well as growth factors like vitamins, fatty acids and amino acids. As a result, when probiotics are added to the meal, nutrients are absorbed more efficiently.

6.4. Improvement of Water Quality

Water quality was measured in various studies after probiotic bacteria, particularly those of the gram-positive species Bacillus, were added. This is likely due to the fact that this bacterial group is more efficient than gram-negative bacteria at converting organic materials to CO_2. Fish producers may be able to reduce the accumulation of dissolved and particulate organic carbon throughout the growing season by maintaining high levels of probiotics in production ponds.

6.5. Stress Tolerance

Aquaculture operations necessitate intensive production in shorter periods of time, putting crop species under stress. Chronic stress, for example, has been shown to cause an overall decrease in muscle protein synthesis in the zebra fish Danio rerio (Vianello et al., 2003).

6.6. Effect on Reproduction of Aquatic Species

Breeding aquaculture species have high nutritional requirements and reproductive capacity is dependent on proper concentrations of lipids, proteins, fatty acids, vitamins C and E, and carotenoids. Furthermore, the interaction between these components has an impact on reproduction in a variety of processes, including fertilization, birth and larval development.

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Yeast – Noval Aquafeed Ingredient for Future

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Highlight Points

- Microbial protein sources are considered as sources of feed ingredients for aquafeeds to ensure long-term sustainable aquaculture.
- Microorganisms present in culture water will use, recycle and transform excess nutrients from fecal and feed wastage convert into microbial biomass which is consumed by cultured organisms.
- Yeasts able to convert non-food lignocellulosic biomass into microbial protein.
- Yeast-based diet enhances the growth, immunity and gastrointestinal health of fish.
- Dietary supplementation of deficient amino acids will enhance the quality of a yeast-based diet.

Introduction

Aquaculture is becoming increasingly popular around the world. In order to produce more fish in a sustainable way, quality feed and seeds are more important. Aquafeeds are formulated with a vast pool of ingredients that are intended to supply their nutritional requirements to perform their normal physiological functions, including maintaining a highly effective natural immune system, growth and reproduction. So, feed ingredients are crucial to nutritional research and feed development for aquaculture. Among the feed ingredients, protein-based ingredients are having great attention nowadays. The most important protein source for aquatic feed is fishmeal; it is still considered the most desirable protein source in aquaculture diets for carnivorous and omnivorous fish, because of its high protein content and balanced amino acid profiles, high digestibility and palatability and rich essential n-3 polyenoic fatty acid levels. But it is considered limited to a few countries and rather expensive. So as an alternative to fish meal, many animal protein sources like meat and bone meal, blood meal, poultry by-product meal, feather meal, bacterial protein meal and plant protein sources like soybean meal, soy protein concentrate, Distillers Dried Grains with Solubles (DDGS), peameal, chickpea meal, black beans, etc. So far animal proteins including fish meal, squid meal, shrimp head meal, oyster meal and mussel meal are the best sources of proteins due to the amino acid profile. To accomplish long-term aquaculture development, new tactics and alternate protein sources are required. Alternative protein sources such as plant protein sources also have their own limitations in aquafeed.

Microbial Protein

The microbial protein is used as a novel feed ingredient for sustainable aquaculture. Microorganisms such as microalgae, bacteria, filamentous fungus and yeast have been increasingly popular in aquaculture over the last two decades (Nevejan et al., 2016). These microbes could come from a variety of sources, including the beer industries or biofloc technologies (BFT), etc. These are the most effective ways for achieving long-term aquaculture sustainability. Brewer's yeast is a microbial protein source that has been utilized in animal feed as an alternative protein source. The biofloc systems are based on the promotion of microbial growth and proliferation of either autotrophic or heterotrophic microorganisms; these microbes are expected to use, recycle and transform excess nutrients from feces, dead organisms, unconsumed food and a variety of metabolites into biomass, which is then consumed by the cultured organisms. BFT is a result of the construction of constantly mixed and aerated ponds, systems that resemble biotechnological plants and optimize the potential of microbial activities (Avnimelech, 2015).

Yeasts

Yeasts have been considered sustainable components, owing to their ability to convert non-food lignocellulosic biomass into important protein resources. There has previously been substantial research on the impact of yeast cell wall components in influencing fish health responses. Yeasts are the potential sustainable feed ingredients in their ability to convert low-value non-food biomass from

the forestry and agricultural industries into high-value feed with less reliance on arable land, water, and changing climatic conditions (Anwar et al. 2014; Couture et al. 2019; Lape na et al. 2020). Yeast cells contain a significant amount of crude protein (40–55%) and other bioactive components that are beneficial to fish growth and development (Verland et al. 2013; Hansen et al. 2019; Rawling et al. 2019; Vidakovic et al. 2020).

Raw material for the production of yeast

Molasses were being used as a primary raw material in the production of yeast. The first-generation feedstock (primarily food biomass) may be less acceptable as substrates for yeast fermentation due to major environmental concerns such as biodiversity, water, and land use, as well as competition with human meals. Non-food biomass or second-generation feedstock, is gaining popularity as a carbon source for yeast production. Second-generation feedstocks, including as lignocellulosic biomass, are the world's most cost-effective and renewable biofuel resources (Anwar et al. 2014). Lignocellulosic biomass has a complex network of polysaccharides like cellulose, hemicellulose, and lignin that are difficult to hydrolyze using acid, alkaline, or enzyme treatments. The agricultural and forestry sectors are the primary sources of lignocellulosic biomass. Yeast offers a better opportunity to convert extremely non-hydrolyzable lignocellulosic biomass into biofuel with a wide range of industrial applications.

Nutritional value of yeast

Yeast has a lower crude protein concentration (40–55 percent) than fishmeal but is comparable to soya bean meal. Except for methionine, lysine, arginine and phenylalanine, which are typically limiting essential amino acids in Atlantic salmon and rainbow trout, the diverse yeast species have favorable amino acid profiles when compared to fishmeal. According to the findings, *S. cerevisiae* has a higher methionine and cysteine level than other yeast species, but a lower lysine concentration. Similarly, as compared to other yeast species, B. adeninivorans has a reduced arginine concentration. Glutamic acid levels are consistently high in all yeasts. Differences in species and strains, substrate media used, culture conditions, downstream processing and analytical methods used during the manufacturing process all influence diversity in yeast amino acid profiles (verland et al. 2013). Yeasts have low lipid content, high ash content and moderate carbohydrate content (Halasz and Lasztity 1991; Verland et al. 2013). Unsaturated fatty acids content is the majority of the fatty acid composition (Halasz and Lasztity 1991; Brown et al. 1996). Except for trehalose, the carbohydrates are mostly polysaccharides with a small quantity of mono- and oligosaccharides (Halasz and Lasztity 1991). Apart from these macronutrients, yeasts are a good source of other important minor nutrients such as vitamins (mainly B-group vitamins), minerals, and enzymes (Lapena et al. 2020a). The mineral composition of different yeast species varies

Composition of yeast cell wall

In general, the cell wall accounts for 26–32 percent of the cell's total dry weight (Fleet 1985; Nguyen et al. 1998; Klis et al. 2002). The cell wall is mostly composed of polysaccharides (85–90%) and protein (10–15%). (Nguyen et al. 1998; Schiavone et al. 2014). The primary polysaccharides are glucan and mannan, with a little quantity of chitin.

Nucleic acid and its effects on fish growth and health status

Nucleic acids present in yeasts may have protein-sparing effects and In salmonids, they increase immunological responses and epithelial cell development (verland and Skrede 2017). Despite their increased nucleic acid concentration, yeasts have a similar amino acid composition to fishmeal and soy protein, with the exception of sulfur-containing methionine and cysteine, which are typically low in yeast.

Supplementation of yeast on the growth and nutrient utilization

According to Ferreira et al. (2010), S. cerevisiae is the second most valuable by-product of the brewing industry and has promise as a significant raw material for a variety of industrial applications, including fish feed. The majority of aquaculture studies have shown that *S. cerevisiae* can be used to partially replace fishmeal or soy protein in aquatic species such as Atlantic salmon (verland et al. 2013), rainbow trout (Huyben et al. 2017; Vidakovic et al. 2020), Artic charr (Vidakovic et al. 2016), catfish (Essa et al. 2011; Peterson et al., 2012), goldfish (Gumus et al. 2016), lake trout (Rumsey et al. 1990), Nile tilapia (Abass et al. 2018), sea bass (Oliva-Teles & Gonc¸alves 2001), shrimp (Guo et al. 2019) and sea bream (Fronte et al. 2019).

Fermentation media, yeast strain and post-fermentation processing, as well as fish species and diet formulation, may all have an influence on the growth and wellbeing of fish. Higher inclusion levels of *S. cerevisiae* fish feed may result in lower growth and nutrient utilization (verland and Skrede 2017). In fish such as rainbow trout (Huyben et al. 2017) and Beluga sturgeon, dietary supplementation of intact *S. cerevisiae* may be employed to modify intestinal microbiota (Hoseinifar et al. 2011).

Yeast Bioactive compounds on the health status of fish

As a result of the ban on antibiotics in animal feeds, interest in alternative products (including yeast derivatives) to support animal health and growth has grown. In fishes, dietary-glucans enhance immune responses and host survival after a pathogen infection including Atlantic salmon (Robertsen et al. 1990; Bridle et al. 2005), rainbow trout (Siwicki et al. 2004; Guselle et al. 2007) and European seabass (Siwicki et al. 2004; Guselle et al. 2007).

In fish, dietary MOS can be used to improve skin mucous barrier function and regulate gut morphology (Eryalcin et al. 2017; Schmidt et al. 2017). (Micallef et al. 2017). The ability of MOS to bind to enteropathogenic bacteria and prevent host colonization is the most well-known mechanism of action (Torrecillas et al. 2014). The most often utilized yeast species in aquaculture is *Saccharomyces cerevisiae,* which is known for its health-promoting properties in a variety of fish species.

Yeast has been used as an abatement strategy to counteract

distal intestine inflammation in Atlantic salmon (Grammes et al. 2013; Hansen et al. 2019). However, inconsistent responses have been observed on the ability of yeast to alleviate intestinal inflammation in Atlantic salmon. According to Grammes et al. (2013), *C. jadinii* supplemented at 20% dietary inclusion level counteracts soya bean meal-induced enteritis in Atlantic salmon fed 20% soya bean meal-based diets during the seawater phase. Different yeast species can be used as a major protein source in fish feeds. On the other hand, the optimum inclusion levels for different species are still undetermined.

Strategies to improve the Yeast utilization as an aquafeed ingredient

The chemical composition of different yeast species is influenced by the substrates used. For example, some yeast species, such as *S. cerevisiae*, are very efficient at metabolizing hexose carbohydrates, whereas others are very good at fermenting pentose sugars. Nowadays, to utilize the specific type of sugar genetic engineering (Wahlbom et al. 2003; Attfield and Bell 2006) or using yeast that can co-ferment both hexose and pentose sugars (e.g. *C. jadinii and K. marxianus*) (Paraj'o et al. 1995; Yanase et al. 2010) or co-culture of two yeast strains (Azhar et al. 2017) are being followed. Furthermore, the nutritional composition of complete yeast cells is frequently influenced by environmental factors such as temperature, oxygen and pH. (Halasz and Lasztity 1991).

Supplementation of crystalline amino acids

Supplementation of crystalline amino acids in the diet of fish may be a way to compensate for the amino acid imbalance found in yeasts. However, the postprandial availability of these two groups of amino acids (intrinsic amino acids in yeasts and crystalline amino acids) differs; crystalline amino acids are more easily available within the intestinal lumen than intrinsic amino acids (Berge et al. 1994; Yamamoto et al. 1998; Larsen et al. 2012). To increase the dietary utilization of yeasts as a significant protein source in fish feeds, an effective synchronization strategy between the intrinsic and crystalline amino acids will be required in the future through diet optimization.

Exogenous enzyme supplementation

Supplementing fish feed with exogenous dietary enzymes has improved the nutritional content of the feed (Castillo & Gatlin III 2015; Adeoye et al. 2016; Maas et al. 2018). This method could be utilized to improve nutrient digestibility and yeast utilization in fish. Endogenous enzymes produced by aquaculture species have little effect on the complex network of polysaccharides found in yeast cell walls. However, dietary treatment with exogenous enzymes capable of dissolving the yeast cell wall and improving nutrient utilization could alleviate this problem.

Cell wall rupturing technique

When compared to intact cells, cell wall rupture improved protein and energy digestibility of brewers' yeast cells, yeast extract, and yeast protein isolate. Other researchers have found that disrupting yeast cell walls partially or completely improves nutrient digestibility and overall utilization in Atlantic salmon (Hansen et al. 2021), shrimp (Zhao et al. 2017), and Arctic charr (Zhao et al. 2017). (Langeland et al. 2016). Chemical, enzymatic, physical and mechanical approaches for rupturing yeast cell walls have been used to increase the nutrient digestibility of the yeasts (Nasseri et al. 2011; Lape na et al. 2020b).

- Chemical rupturing - can be accomplished by exposing cell walls to acid, alkaline, or a mix of these treatments (Schiavone et al. 2014).
- Enzymatic hydrolysis - Autolysis, with the help of endogenous enzymes enclosed by the yeast cell walls, or exogenous enzymes targeting a specific layer of the cell walls (Schiavone et al. 2014; Hansen et al. 2021).
- Mechanical cell wall rupturing - Crushing, crumbling, grinding, pressure homogenization, or ultrasonication can all be used to disintegrate the cell wall mechanically (Nasseri et al. 2011; Hansen et al. 2021).

Genetic engineering

Genetic engineering has the potential to be used to create high-protein yeast strains. Mutagenesis (Guthrie and Fink 2002), breeding (Walker 1998), and evolutionary engineering have traditionally been used to create new production strains (Francis and Hansche 1972). More recently, many attempts have been made to modify metabolic pathways in yeasts in order to favor the protein secretion process (Tang et al. 2015; Bao et al. 2017).

Conclusion

The use of cost-effective downstream processing with good quality yeast production, as well as genetic modification or enhanced nutrient digestibility by exogenous enzyme supplementation, could be a viable way to improve overall protein quality in yeast. Additional investment in large-scale manufacturing and at accessible pricing for feed makers and fish farmers is required for yeast to compete with fishmeal and soy protein in aquafeeds.

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Microalgae – Promising live food for fish and shrimp larvae

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Highlight Points

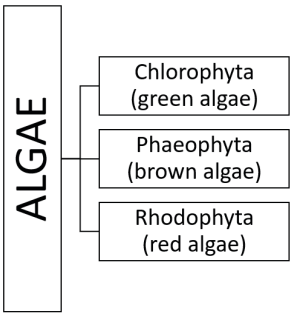
- Aquaculture is the fastest-growing sector, mainly depending on seed production and rearing.
- Fish larvae are very delicate organisms. The transition from endogenous to exogenous feeding is a crucial moment on which the survival of the larvae will depend.
- During this time, livefeed plays a significant role, especially microalgae, because of its size and its ability to synthesize HUFA and PUFA such as docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA) and arachidonic acid (AA) are known to be essential for various larvae.
- Microalgae are a good source of vitamins such as vitamin A, B1, B2, B6, B12, C and E and minerals such as potassium, iron, magnesium, calcium, and iodine.
- Because of its good nutritional value and wide range of applications in all the sectors, including food production, nutraceuticals, pharmaceuticals, cosmetics, wastewater treatments, makes the microalgae more important.
- The contribution of microalgae to nature towards oxygen production, maintaining the food web, role in nutrient cycles will be higher and it makes nature sustainable.

Introduction

Aquaculture is the fastest-growing sector which is mainly dependent on seed production and larval rearing which eventually provides an input for culture systems and ultimately brings about an output through it. Larval rearing is generally carried out under controlled hatchery conditions and usually requires specific culture techniques, especially husbandry techniques, feeding strategies, and microbial control. The main reason is that the developing larvae are usually very delicate, small, extremely fragile and generally not physiologically fully developed. For example, their small size (i.e. small mouth size), the incomplete development or altricial nature of their perception organs (i.e. eyes, chemoreceptors) and digestive system are limiting factors in proper feed selection and use during the early first-feeding or initial-feeding period.

Fish larvae are very delicate in nature and whose survival depends on several factors, the most important one being the appropriate feed supplementation. Yolk serves as the nutritional reserve for the newly hatched larvae for 2-3 days post-hatch. Once the yolk reserves have been exhausted, the larvae have to prey on external food particles and digest them. The transition from endogenous to exogenous feeding is a crucial phase upon which the survival of the larvae is dependent. During this time, live feed plays a significant role, especially microalgae, because it is small in size perfectly fitting the tiny mouth of the larva; moreover, production on a large-scale basis is very much possible in hatcheries.

Microalgae are a primary food source for molluscs and other finfish and shellfish larvae. Also, the biochemical composition of zooplanktons such as rotifer, copepods, Moina is enhanced by the microalgae and the enriched zooplanktons are used as a feed for fry, juvenile stages of fishes. Microalgae are microscopic and invisible to the naked eye. They are present in freshwater and marine systems, living in water columns and sediments. They are unicellular species that exist individually or in chains or groups. Their sizes range from a few micrometres (µm) to a few hundred micrometres depending on the species. Unlike higher plants, microalgae are free-floating having no roots, stems or leaves. They can specially adapt to an environment dominated by viscous forces.



Classification

Based on the nature of photosynthetic pigments, algae are further classified into three divisions as mentioned under:

Chlorophyta (green algae) - Mostly present in freshwater and free-floating types.

Phaeophyta (brown algae) - Mostly present in marine waters, which contain iodine and algin.

Rhodophyta (red algae) - Present in marine waters.

Nutritional value

Nutrient	Micro algae	*Chlorella vulgaris*	*Spirulina sp.*	*Scenedesmus obligus*	Nannochloropsis *sp.*	*Haematococcus sp.*	*Dunaliella salina*
Crude Protein (%)	25 to 50	15 – 58	60 – 71	50 – 56	32	29 – 45	25.69
Lipid (%)	10 to 30	14 – 22	6 – 7	12 – 14	12	20 – 25	18.02
Carbohydrate (%)	5 to 40	12 – 17	13 – 16	10 – 17	26	21 – 23	40.21
Ash (%)	5 to 40	14.3	17.8	14.7	15.1	15.78	15.89
EPA	15 to 20% of total lipid	123.46 mg/g DW	331.07 mg/g	10-15% of total lipid	3.7g/100g DW	<1%	<1%
DHA	4 to 15% of total lipid	36.53 mg/g DW	144.87 mg/g	5-12% of total lipid	13.86 mg/g DW	-	1-2% of Total lipid

Source: (Whyte 1987, Brown and Miller, 1992 Renaud et al. 1999, Knuckey et al.,2002; Raya et al., 2016; Banerjee et al., 2011; Mularczyk et al., 2020; Muhaemin et al., 2010)

The proximate composition can vary substantially between microalgae species, cell size, digestibility, production of toxic compounds, and biochemical composition. PUFAs derived from microalgae, i.e. docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA) and arachidonic acid (AA) is known to be essential for various larvae. Microalgae are excellent sources of vitamins such as vitamin A, B1, B2, B6, B12, C and E and minerals such as iron, potassium, magnesium, calcium and iodine (Brown and Miller, 1992). It also contains a fascinating diversity of pigments, important in nutritional studies as colouring agents for fish flesh and antioxidants.

Advantages of microalgae production

- Mass culture production of unicellular algae such as diatoms (viz. Chaetoceros and Skeletonema) and small phytoplankters (viz. Isochrysis, Tetraselmis and Chlorella) is becoming quite popular for feeding larvae of fishes, prawns, shrimps and molluscs in aqua hatcheries.
- In recent years the use of microalgae as a possible source of protein for human consumption has also been proven to be significant.
- Many new applications of microalgae has been recognized, such as wastewater treatment, nutrient recycling, bio - conservation of solar energy, etc.
- In larval rearing tanks, microalgae stabilize the water quality in static rearing systems (remove metabolic by-products, produce oxygen).
- Polysaccharides present in the algal cell walls serve as an immune-stimulating agent which will stimulate the non-specific immune system in the larvae.
- The nutrient composition of microalgae can be maintained by supplementation of nutrients in the growth media.
- Feeding incidences increased by enhancing visual contrast and light dispersion.
- Other pathogenic microbial control by algal exudates in tank water and/or larval gut.

- Microalgae are available in various size ranges from 5 to 25 microns meeting the feed size requirements ideally well for the early stages of different aquatic animals.
- Microalgae are the primary food source for all stages of filter-feeding organisms such as bivalve molluscs (Clams, oysters, scallops) etc.
- They served as an important food source for live food organisms (rotifers, copepods, cladocerans, brine shrimp etc.) used in aqua hatcheries.
- Microalgae stimulate enzymatic synthesis and onset of feeding in young larvae.
- It also acts as a water conditioner by stripping off nitrogenous substances.
- Microalgae contain various nutritious and bio-active compounds, and they serve as one of the best sources of nutraceuticals.
- Microalgae also have a variety of pigments with antioxidant properties, and some microalgae produce abundant vitamins and immunostimulants in their cells, which can contribute to the health of aquatic species.
- Microalgal pigments, like astaxanthin, could also give the fish attractive colour, increasing their marketability (Posten and Schaub, 2009).
- Certain microalgae are high in omega-3 fatty acids like docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA); these fatty acids are health-beneficial not only to fish but also to humans (Ryckebosch *et al*., 2012).

Constraints on algae production for aquaculture

The primary constraint on microalgae production for aquaculture is the cost. On average, 30–40% (max. 70%) of hatchery costs can be attributed to algal culture. Especially for smaller hatcheries, this cost is likely to be on the higher end.

- The algal species cultured for aquaculture do not grow in highly selective environments as *Dunaliella*, *Spirulina* and *Chlorella*. They do not flourish in highly demanding conditions. They are often grown in closed systems rather than open ponds or raceways.
- Because the climate in which the algae are grown is frequently unsuitable for growth (extreme temperatures or precipitation etc.), the algae must be grown indoors with artificial lighting and temperature control, resulting in higher energy expenses. As the cultures are often light-limited, artificial lighting results in poorer yields.
- Algal culture necessitates knowledge that is often unavailable at the hatchery/farm, and it is frequently viewed as a waste of resources, resulting in serious problems when cultures 'crash.' Costs rise due to the decreased reliability.
- The majority of the algae are produced in batch culture, which increases the amount of labour needed and the facility's capital requirements.
- Carboys, big bags, tower reactors, tanks, and other culture systems are inefficient, resulting in low output and unreliable cultures. Additionally, these systems are not appropriate for computer control or automation, resulting in higher labour expenses.
- The scale of operation significantly impacts the cost of manufacturing algal biomass. When compared to the scale of industrial *Dunaliella*, *Spirulina*, and *Chlorella* culture operations, most hatcheries' algal requirements are minimal, significantly raising the algae's unit cost.

Conclusion

Mass culture of microalgae is a costly and laborious process, but the importance of larval rearing is much more important from aquaculture point of view. Although production cost is more in small scale production but the same will be efficiently reduced in mass culture conditions. Nutritional value and a wide range of applications in all the sectors, including food production, nutraceuticals, pharmaceuticals, cosmetics, and wastewater treatments, make microalgae more important. Contribution of microalgae to nature towards oxygen production, maintaining the food web, and role in nutrient cycles will be higher, making sustainable nature. Therefore, techniques should be devised to develop cost-effective microalgae production systems in indoor facilities and also conservation of natural grounds should be considered as an important activity in order to sustain aquatic organisms thriving in the wild.

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Aquamimicry: *A novel concept towards sustainable shrimp farming*

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Highlight Points

Aquamimicry is an innovative technology which mimic the natural environment of organisms in a confined water conditions. In this system, suitable carbon source along with probiotics are added which helps to create zooplankton (copepod) bloom. Aquamimicry can be considered as an efficient technology as it helps to reduce the feed cost, maintain water quality and health of the organisms.

Introduction

Aquaculture continues to grow faster than any other major food producing sector in the world with an average annual growth rate of 5.3 % per year during the period 2001-2018 (FAO, 2020). It is contributing to food security, livelihoods, foreign exchange etc. Shrimp is the lucrative crustacean species farmed across the world and accounting for about two-third of the value of fish exports. In India, commercial shrimp culture was introduced in late 1990s and reached a peak in 1994 and thereafter it was suddenly declined due to the series of white spot disease outbreak. Shrimp farming be will not be sustainable unless it is scientifically managed and judiciously monitored and it may result in many of the environmental and social issues besides increased outbreak of diseases. India has diverse range of shrimp farming systems ranging from traditional tide fed ponds to super intensive systems. Opting for more intensive practice by deterioration and antimicrobial resistance (AMR) in shrimps. As a result, we need to develop a technology that allows for both sustainable production

and environmental conservation. Aquamimicry is such an eco-friendly alternative for production which do not relies in any harmful chemicals and also economically profitable.

Aquamimicry is a new concept of simulating the estuarine environment in the confined pond condition. It is achieved by creating blooms of zooplankton mainly copepods and microalgae by adding carbon source along with probiotics. These live feeds serve as a good source of nutrition and maintain health of the cultured shrimps. The added probiotics enhance the growth of helpful bacteria and maintain optimum water quality. In aquamimicry, water mimics the appearance and composition of natural estuarine water. In such systems, pH and dissolved oxygen fluctuations are minimized and there is no need for antibiotics or chemicals.

Carbon source and its application

Fermented carbon source such as finely powdered rice or wheat bran with probiotics (like *Bacillus* sp.) is mixed with water at a ratio of 1: 5-10 under aeration for 24 hours and added to the pond. Here the rice bran acts as a prebiotic and along with added probiotics bacteria, a symbiotic effect is created. Within a week of administration of FRB (fermented rice bran), copepod bloom can be observed in the pond. The amount of mixture to be added is dependent on both the system and the turbidity level. As a general guideline, 1 ppm is advised for extensive systems, whereas 2-4 ppm is employed for intense systems. The ideal turbidity should be around 30-40 cm. If higher, less bran should be added and vice versa. This method differs from biofloc technology in the amount of added carbon is reduced and is less dependent on nitrogen input ratios.

Sedimentation and biofilter ponds

In extensive systems, PL can be stocked at a lower stocking density of 10-20 individuals/m^2. During the grow out period the ponds need to routinely seeded with FRB to sustain the copepod bloom and the dosage of the FRB is depended on the turbidity. To adopt aquamimicry concept in intensive systems, water from the grow out pond goes to the sedimentation pond through the central drainage system. Fishes like catfish or milkfish can be cultured in these ponds. As these fishes are bottom feeders they continuously churn up the detritus and it promotes growth of oligochaet worms and invertebrates which can be utilized by these fish. From the sedimentation pond, water overflows to biofilter pond where fishes like tilapia can be cultured. By this wastes in the water is reduced and it can be pumped back to grow out pond. After the shrimp being harvested, the pond is

completely cleaned of black soil and residual accumulated detritus. The sediment ponds should be thoroughly cleaned every three years.

Advantages

- Water quality can be maintained in the optimal level.
- Improvement in the overall nutrition and health of shrimp as they feed on live feeds.
- Reduced disease outbreaks as they raised in stress free condition.
- Low FCR
- Reduced water exchange.
- Reduced production cost.
- Increased growth rate and productivity.

Conclusion

The profitability between the conventional aquaculture and aquamimicry system was reported to be 17% and 40% respectively with a high survival rate of 90-95%. In aquamimicry system the cost of production per kilogram of shrimp is approximately 65% less than the conventional system (Romano and Kumar, 2017). The harvested shrimp is of high quality as it consumes natural foods containing pigment such as astaxanthin, amino acids and fatty acids especially PUFA, which increase their marketing value as organic shrimp.

Stress Management in Shrimp Farming

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Stress is quite common in all living organisms especially when they are not in their natural habitat. In shrimp farming, stress occurs when the animals are exposed to conditions that require extreme or prolonged adjustments to adapt. One of the major challenges in shrimp farming remains acute and chronic stressful conditions because of improper handling, disease causing pathogens, lack of optimal nutrition, environmental stress, etc. These stress conditions can lead to retarded growth, poor immune response, and increased susceptibility to disease, eventually resulting in survival drop and poor ROI.

What causes stress to Shrimps?

1. Biological Factors

   a. Biomass reaching beyond the pond carrying capacity, high density with poor infrastructural facility, over dominance of disease-causing agents and parasites.

   b. Over blooming of toxic planktons

   c. Presence of competitor and weed fishes.

2. Procedural factors

   a. Delay in health check and sampling

   b. Cast netting during sunny weather climate, exposing the animals to hot temperature.

   c. Delay in shifting shrimps from nursery to grow-out or from pond to pond.

   d. Pond bottom disturbance during partial harvesting.

3. Physical and Chemical factors

   a. Quality of the feed used in the farm has got a direct impact on the growth and health of the shrimps as it is the main source of energy. Nutrients and energy provided by the feed are essential to maintain the homeostasis of the animal, along with optimal immune function. Poor quality feed may lead to imbalance in nutrients, vitamins, and minerals to shrimps.

   b. Low dissolved oxygen level because of insufficient aerators and other managerial issues. All the living organisms in the pond ecosystem utilize the dissolved oxygen for respiration and metabolic activities.

   c. Toxic gas formation because of over feeding, poor pond bottom management and water quality management. Once the pond ecosystem is deteriorated, shrimp need more energy to overcome stress resulting in slow growth and poor survival.

   d. High/heavy diurnal fluctuation of water quality parameters like pH, dissolved oxygen, salinity, temperature, etc. also leads to stressful condition to shrimps.

   e. Sudden change in weather condition (unexpected rain, heat wave, cyclone, etc.) or during seasonal change can alter the water quality parameters leading to stress.

   f. Usage of chemicals, sanitizers and molting inducers may alter the water quality parameters or even it can cause damage to cuticle of shrimps leading to stress conditions.

   g. Sudden changes in water quality parameters while adding new water.

General symptoms of stress

With close observation of the shrimps and its behavior, one can easily understand whether the animals are passing through stress condition or not.

In general, when the shrimps are exposed to stress condition, due to melanosis, the body of the shrimp changes to purple in color. Reddish or cut antennae along with purple colored walking legs, swimmerets and uropod can be found in animals exposed to stress.

Sometimes due to poor dissolved level or presence of toxic gases, we can find blisters, swelling, color change or even chocking of the gills.

Partial molting, rough cuticles and rough antennae indicates the stress due to hardness and mineral imbalance in the pond ecosystem.

We can observe surfacing of shrimps and parking of moribund animals in the dike side because of poor water quality parameters and virulence of pathogens.

Shrimps are invertebrates and it doesn't have a developed immune system. So, every time it needs to fight against the stress or pathogens for their survival. We can observe sudden hike in feed consumption in the early stage of stress and if they cannot overcome the stress situation, we can see gradual drop in the feed intake or sudden stop in feed consumption. Once the animals are subjected to stress, majority of the energy will be utilized for recovery purpose. Whereas in normal condition, the excess energy will be utilized for digestion, maintenance, disease resistance and growth.

How to mitigate stress conditions?

Following the BMP (Best Management Practice) is the only option to manage or mitigate stress during shrimp farming. Keeping in mind about all the factors resulting in stress, we need to act from the pond preparation till harvest. We can use biological method, Chemical method, or both combinations to manage stress during shrimp farming.

Biological Method

Basically, targeting to increase the carrying capacity of the pond and restricting or nullifying the entry of pathogen into the system. Which includes,

- Enriching the soil by adding required quantity of minerals and nutrients according to the soil profile during pond preparation.
- Implementing biosecurity protocols to eradicate and restrict the entry of pathogens, carriers, competitors, weed fishes & shrimps, toxic substances into the system.
- Maintaining optimum water quality parameters with less diurnal fluctuations throughout the crop.

Parameters	Optimum range	Diurnal fluctuation limit
Dissolved Oxygen	>5 mg/L	Less than 4 degrees
pH	7.7 to 8.3	Less than 0.5 degree
Salinity	15 to 30 (PPT)	Less than 3 PPT
Temperature	27 to 31 (°C)	Less than 5°C
Transparency	35 to 45 (Cm)	-
Alkalinity	120 to 180	-
Ammonia	< 0.1 mg/L	-

- Maintain optimum primary productivity in the pond during stocking.
- Reducing shrimps' exposure to atmosphere especially during health check and sampling. Complete such activities in the early hours before temperature rise.
- Farming with reduced density during unfavorable conditions (low salinity, High salinity, seepage ponds, rainy season, etc.).

Chemical Method

Discussing about chemical method, it is the nutritional part ingesting to shrimp for its biological and physical activities throughout the crop. Feed and health supplements provide required energy for all activities and growth of the animals.

- Species specific diet with balanced nutrition can make shrimps grow faster and avoid stress conditions (**Gamma** for vannamei & **Kuroline** for Monodon). It also enhances disease resistance capacity of shrimps and helps in fast stress recovery during unfavorable conditions.
- Usage of high-performance feed **(Xpand)** with high inclusion of marine animals as protein source can support farmers to gain faster growth in normal conditions. Added with antioxidants, anti-stress, and immune boosters, it can act as a protective shield against disease causing agents and to overcome stress during unfavorable pond conditions.
- Using feed supplements and health care products to develop the disease resistance capacity and boost immune system can support shrimps during stress condition.

Relaxx is a unique combination of natural ingredients designed to improve the immune system of young and adult animals and help them to overcome stress challenges that may occur during the culture cycle. It is a blend of natural products containing prebiotics, phytogenic, vitamins, organic trace minerals and toxin binders to stimulate immune response and to inhibit pathogenic bacterial actions. It can support in eliminating the adverse effect of ammonia and help in quick wound recovery. It also acts an effective binding agent to adsorbpathogenic microorganisms, enzymes and toxins (including mycotoxins due to ion exchange capacity).

About Skretting

Skretting is a global leader in providing innovative and sustainable nutritional solutions and services for the aquaculture industry working closely with shrimp and fish farmers. Skretting has 30 production facilities in 18 countries on five continents and manufactures and delivers high-quality feeds from hatching to harvest for more than 60 species. The total annual production volume of feed is more than 3 million tonnes. It is headquartered in Stavanger; Norway and it employs 4,000 employees. Its team of more than 140 employees is dedicated to Innovation that works on the core competencies of nutrition, feed production and health for aquaculture. In India, we have head office in Hyderabad and our manufacturing footprint in Surat, Gujarat.

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