

# Aqua International

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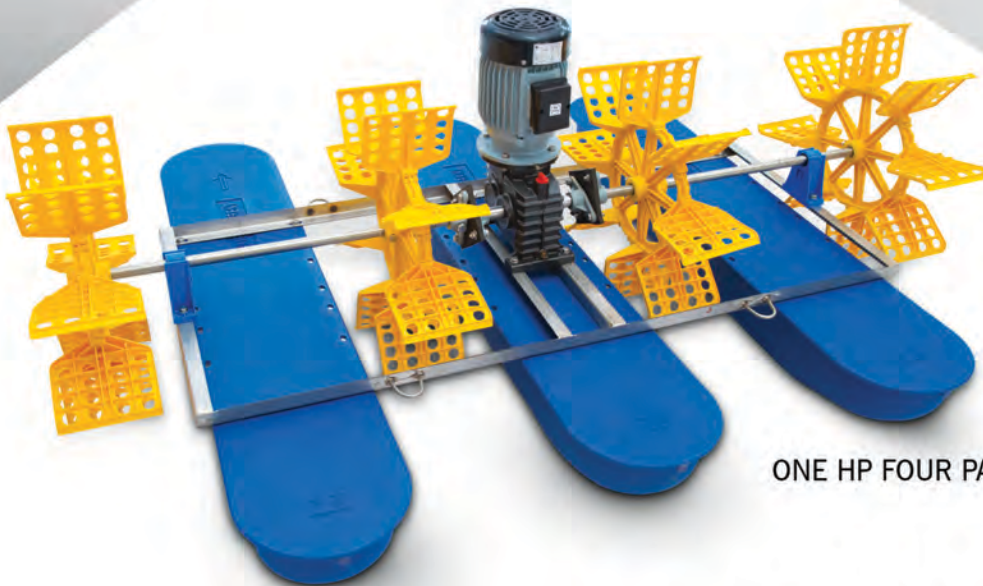
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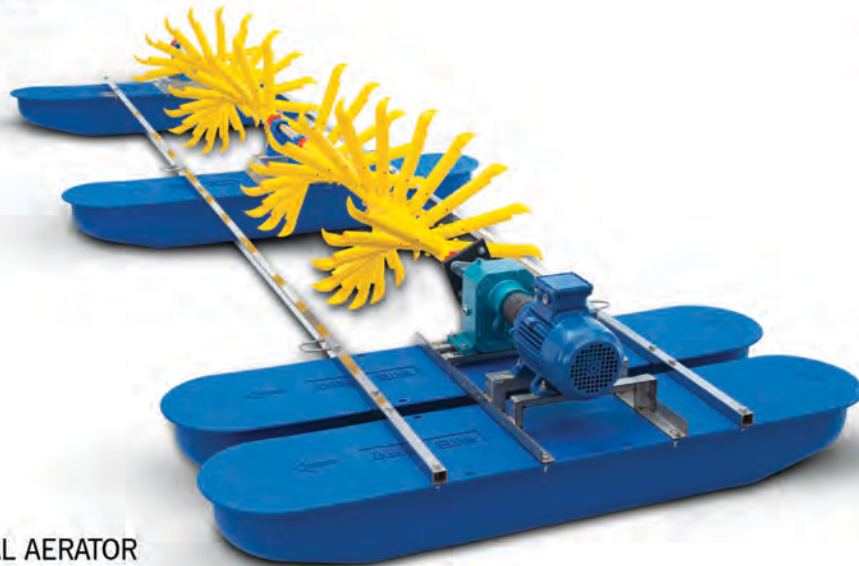
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- Editor



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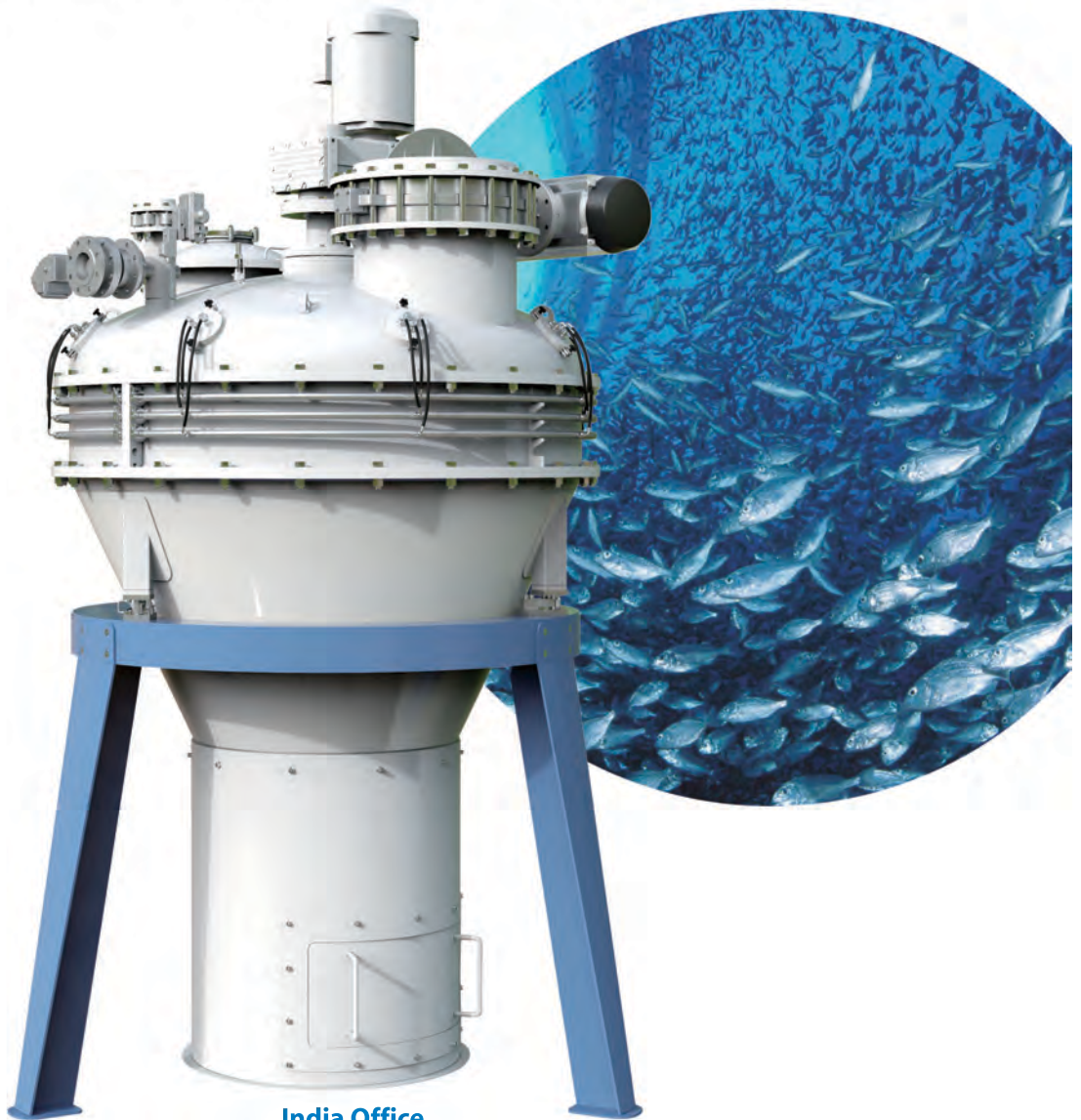
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International Agro Arbitration Centre, the world's first agro focussed dispute settlement body was launched on 13 October 2023 at New Delhi

## India's Seafood sector expresses concern at the proposal by Louisiana Senator Bill Cassidy to constitute India Shrimp Tariff Act to levy duty on shrimp imports from India

*Due to its high protein and free amino acid content and low fat and ash levels, Fish Protein Hydrolysate is used in various commercial fish and shellfish diets. Furthermore, according to several research studies, FPH derived from various fish and shellfish wastes is used as either fish meal alternatives or attractants in many commercial farmed fishes. As a result, FPH is a new fish meal alternative for sustainable aqua feed production.*



Dear Readers,

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

**International Agro Arbitration Centre (IAAC),** the world's

first agro focussed dispute settlement body was launched on 13 October 2023 at New Delhi, promoted by the Indian Chamber of Food and Agriculture. Justice P. Sathasivam, Former Chief Justice of India and Former Governor of Kerala on the occasion said that IAAC is poised to revolutionize dispute resolution mechanism within the agricultural and food sector in India and worldwide. Agriculture is an incredibly diverse sector. Post WTO food and agro trade has significantly grown to over \$2 trillion and a large number of companies have gone global today with trade, technologies and businesses. While USA, Netherlands, Germany and Brazil occupy top positions in agro food exports, India is fast catching up exporting Agri products to more than 150 countries in the world, accounting for more than \$55 billion and importing close to \$25 billion. Such rapid growth in trade gives rise to many issues and trade disputes, which need to be promptly and cost-effectively addressed, said Justice P. Sathasivam. The launch program was joined online by IAAC's global board members Ms Khairul Nessa, Executive Director, World Trade Centre and Vice Chair, WTC Global Agriculture

Committee, Mr Tarun Shridhar, Member, CAT and former Union Secretary, Dr Abusaleh Shariff, Chairman, US-India Policy Institute, Mr Harikshan Rankawat, President, Federation of Indian Industries, UAE and Dr Vikas Chaturvedi, Chairman, Institute of Chartered Accountants of India, Amsterdam.

**The country's seafood** sector has expressed concern at a proposal by Louisiana senator Bill Cassidy to constitute the India Shrimp Tariff Act to levy duty on shrimp imports from India. The proposal made in the last week of September has found support from the Southern Shrimp Alliance, an organisation of shrimp fishermen, shrimp processors and other members of the industry in that country's eight warm water shrimp producing states of Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina and Texas. Frozen shrimp comprises nearly 70 percent of seafood export from India, which reached a record \$8.09 billion in Financial Year 2023. The US is currently the largest market for Indian seafood, mainly shrimp. To address these inequities, the India Shrimp Tariff Act would impose a general rate of duty on Indian shrimp of 10 percent beginning in 2024. One year later, in 2025, the duty rate would be increased to 20 percent. From 2026 forward, the duty rate on Indian shrimp would be 40 percent equivalent to India's rate of duty on shrimp imports into that country, Cassidy said. All India Shrimp Hatcheries Association president Ravi Kumar Yellanki urged the government to respond. The commerce ministry should take it seriously and should make a pre-emptive step to

*Contd on next page*



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

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

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

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

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counter it. Once the Senate passes the bill, it will be difficult for India to fight it, he said, adding that this is not the first time Cassidy has come up with proposals to restrict Indian shrimp imports. The issue has been raised in a foreign country and it is not certain that the bill will be passed, said Seafood Exporters Association of India president Jagdish V Fofandi, adding, "The Indian government has to counter it. For the time being, we are adopting a wait and watch policy."

All India Shrimp Hatcheries Association organised Hatch India 2023 conference on 29 and 30 September 2023 at Visakhapatnam, Andhra Pradesh with the objective of initiating a dialogue between brood stock suppliers and hatcheries. A large number of shrimp brood stock suppliers and hatcheries took part in the event.

Dr D. Ramesh Kumar, CEO, Salem Microbes Pvt Ltd made a presentation on *Microbial Management in Shrimp hatcheries through Alternate approaches* during the session day on *Disease Management* in HATCH INDIA 2023. Dr Ramesh is a Microbiologist with extensive experience in isolation and identification of bacterial pathogens of aquatic species and genomics of pathogens and probiotic strains is currently involved in development of bacteriophages cocktail against bacterial pathogens. He advised Hatcheries to equally care for Preventive and treatment aspect through Good Microbiota Management for a successful Hatchery cycle. During the panel discussion session, he explained the benefit of using Liquid Bacteriophages which is more appropriate and effective in aquaculture applications and that the Liquid bacteriophages are quick acting, does not cause turbidity and solubility problem and can be equally effective as Water and feed supplement.

**Lallemand celebrated** a significant milestone 100 years of yeast production in its production plant on 21 September 2023 on rue Préfontaine, Montreal. Colleagues from all around the world, clients, partners and local politicians joined company executives for the celebration of the important landmark. This is a great opportunity to pay tribute to our supportive business partners, valued customers and our talented employees who have all played a part in our success story, stated Antoine Chagnon, President and CEO of Lallemand. "I raise my glass to those who built this factory, originally dedicated to baker's yeast for the local market and the visionaries who made it a launching platform for the global company that Lallemand has become today" he concluded. Lallemand has now a diverse and global presence in 50 countries over 5 continents, more than 5000 employees and operates 48 production facilities, including 24 yeast and 10 bacteria plants. The company develops, produces and markets yeast, bacteria, fungi and derivatives of these microorganisms for applications in baking, wine, beer, distilled spirits, fuel ethanol, animal and human nutrition, pharmaceutical industry and other food and agricultural industries.

**The occurrence of Tilapia Parvovirus** affecting farm-bred tilapia, a freshwater fish species, and causing a huge mortality rate has been reported for the first time in India at ponds in Walajah in Ranipet district of Tamil Nadu. 'Fish samples were collected from 10 ponds in the farm and fish from eight ponds showed TiPV-positive by PCR. This DNA virus caused mortality ranging from 30 to 50% in the farm and 100% mortality in the laboratory,' said Dr Sahul Hameed, Director, Aquatic Animal Health Laboratory of C. Abdul Hakeem College at Melvisharam. Considered as "a poor-man's fish", Mozambique tilapia was

introduced to Indian fresh water bodies in the 1950s and it is called Jilabi in Tamil.

**In the Articles section – Fish Protein Hydrolysate: An Emerging Dietary Protein Source in Aqua Diets**, authored by **Govindharaj Sathishkumar**, described that Fish processing industries produce a significant amount of fish waste, which includes skin and scales, bones, swim bladders, intestines, blood and liver, representing almost 50% of the total weight. As a result, recycling such wastes has gained popularity as an alternative use for fish meal. The development of by-products from fish and fishery waste has increased the attention to alternative protein sources in aqua feed production. Due to its high protein and free amino acid content and low fat and ash levels, FPH is used in various commercial fish and shellfish diets. Furthermore, according to several research studies, FPH derived from various fish and shellfish wastes is used as either fish meal alternatives or attractants in many commercial farmed fishes. As a result, FPH is a new fish meal alternative for sustainable aqua feed production.

Another Article titled – **Scarlet Badis, *Dario dario*: A Promising Indigenous Fish Species of India for Nano - Aquarium Industry**, authored by **Banlam J. Marbaniang and G. Biswas**, discussed about Ornamental fish industry is a blooming industry in India having high potential in flourishing well in the export market if breeding technologies of several indigenous fishes can be standardized and disseminated among hobbyists, farmers, breeders and entrepreneurs working in this field. India has an abundant indigenous ornamental fish diversity available from hotspots, such as the Western Ghats, North-Eastern region etc., but currently contributes only a meagre 0.4% to the export market. The only drawback existing so far is the dependency on wild stock which is far from sustainability due to the rise in habitat loss and pollution resulted from developmental and human activities.

Article titled – **Nutritional Programming in Fish**, authored by **Aditi Banik**, said that aquaculture could benefit from nutritional programming as an approach. Early nutrition of fishes from both endogenous (maternally derived) and external sources could have similar developmental and metabolic programming effects. Survival, growth, brain development and nutrition metabolism are all factors that have been studied in fish. Sustainable aquaculture requires depletion in the use of fishery's non-renewable products in feeds and at least partial replacement with more sustainable ingredients. Thus the concept of nutritional programming is a promising strategy for enhancing fish production at a low input cost wise. Some recent research on finfish aquaculture is motivated by the physiological adaptability exhibited by fishes via nutritional programming. This strategy has successfully been applied to several economically important fish species too. Additionally, more work is required to raise the marginal profit projectile so that it can be implicated commercially.

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

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# ICFA launches World's First International Agro Arbitration Centre in New Delhi

*IAAC will fulfil the need of India's and global disputes settlement in food and agriculture sector*



**Launch of Agro Arbitration Centre**

**New Delhi:** IAAC is set to emerge as a trustworthy global institution with an expert panel comprising legal, financial, and agro-trade professionals at its core, Justice P. Sathasivam.

Launching the world's first agro focussed dispute settlement body, International Agro Arbitration Centre (IAAC) on 13 October 2023 at New Delhi, promoted by the Indian Chamber of Food and Agriculture, Justice P. Sathasivam, Former Chief Justice of India and Former Governor of Kerala, said that IAAC is poised to revolutionize dispute resolution mechanism within the agricultural and

food sector in India and worldwide.

Agriculture is an incredibly diverse sector. Post WTO food and agro trade has significantly grown to over \$2 trillion and a large number of companies have gone global today with trade, technologies and businesses. While USA, Netherlands, Germany and Brazil occupy top positions in agro food exports, India is fast catching up, exporting Agri products to more than 150 countries in the world, accounting for more than \$55 billion and importing close to \$25 billion. Such rapid growth in trade gives rise to many issues and trade disputes,

which need to be promptly and cost-effectively addressed, said Justice P. Sathasivam.

Domestic agro sector is also huge and different businesses from inputs to output and services are rapidly expanding with innovation and new products and technologies. While the rising business and trade of agriculture comes with its own benefits, the disputes arising within the agro trade industry can hinder its efficiency in several ways. These disputes may crop up for a variety of reasons; contract disputes, nuisance claims, produce quality, patent and IPR

infringements, payments and debt recovery, among others, said Mr Justice Anil R Dave, former Judge, Supreme Court, while highlighting the vacuum felt for long time of sector specific arbitration centre with domain expertise.

Bearing in mind the gravity of such issues, IAAC, a unique agro sector focused arbitration centre, has been incepted to provide a forum to address the challenges and mitigate the negative effects that disputes can have on productivity, relationships, costs, ultimately promoting a more productive and efficient agro trade and businesses globally, asserted Dr M.J. Khan, Chairman of IAAC and also the chairman of parent body, ICFA.

Recognizing the critical need for dedicated dispute resolution in the fields of agriculture and food, IAAC is set to emerge as a trustworthy global institution with an expert panel comprising legal, financial and agro-trade professionals at its core. The International Agro Arbitration Centre is an India based leading institution that provides alternative dispute resolution services to the agro food industry worldwide, said Dr Ashok Dalwai, Chairman, PM Task Force of Doubling Farmers Income.

The IAAC shall offer arbitration, mediation and expert determination services to resolve disputes that may arise in the agro sector with the country or outside. IAAC promotes the peaceful resolution of disputes in the agro and



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Inhibit the growth of *Vibrio* spp.



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Improve water color



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### \* 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.



### BSL Dosage:

Quantity /10,000 m <sup>3</sup>	10 - 30 pl/m <sup>2</sup> tiger prawn or < 80 pl/m <sup>2</sup> Vannameli	For > 30 pl/m <sup>2</sup> tiger prawn or > 80 pl/m <sup>2</sup> Vannameli	For > 150 pl/m <sup>2</sup> Vannameli
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

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

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► food industry and trade through alternative dispute resolution mechanisms. The Centre seeks to provide cost-effective, efficient and impartial dispute resolution services that enable parties to resolve their disputes quickly and effectively, said Mr Siraj Chowdhary, Board Member, Tata Group and former Chairman, Cargill India Limited.

The Indian policy and judicial system also encourages commercial disputes to be resolved through the mediation process and arbitration, before approaching the Courts. IAAC's commitment extends to providing equal opportunities to parties across the globe, transcending geographical, linguistic and financial boundaries, said Justice Sathasivam in his closing remarks.

The launch program was joined online by IAAC's global board members. Ms Khairul Nessa, Executive Director, World Trade Centre and Vice Chair, WTC Global Agriculture Committee, Mr Tarun Shridhar, Member, CAT and former Union Secretary, Dr Abusaleh Shariff, Chairman, US-India Policy Institute, Mr HariKshan Rankawat, President, Federation of Indian Industries, UAE and Dr Vikas Chaturvedi, Chairman, Institute of Chartered Accountants of India, Amsterdam, according to a note received from Ms Shamshravish Rein, Executive Director, IAAC, Advocate, Supreme Court of India, Email: shamshravish.rein@agroarbitration.com

## Lallemand Celebrates One Century of Yeast Production in Montreal



**Montreal, Canada, 25 September 2023** – 21 September 2023, Lallemand celebrated a significant milestone: 100 years of yeast production in its production plant on rue Préfontaine, Montreal. Colleagues from all around the world, clients, partners and local politicians joined company executives for the celebration of this important landmark.

“A 100 years! This is a great opportunity to pay tribute to our supportive business partners, valued customers and our talented employees who have all played a part in our success story,” stated Antoine Chagnon, President and CEO of Lallemand. “I raise my glass to those who built this factory, originally dedicated to baker's yeast for the local market and the visionaries who made it a launching platform for the global company that Lallemand has become today” he concluded. Mr Chagnon took the helm of the company in 2015, succeeding his father Jean and grand-father Roland before him.

Not with standing its respectable age of 100 years, Lallemand's

Préfontaine plant has a bright and rich future ahead, due to the potential of microbes to help addressing some of the most pressing issues of our times.

“We are all facing new challenges: climate change and feeding the entire planet are on the menu for the coming decades, and innovative microorganisms can play a key role in facing them. Among others, they can help us reduce carbon emissions, lower the use of antibiotics and chemical preservatives, and promote the use of microbial fertilizers or biological crop protection products that reduce the use of fossil products,” said Antoine Chagnon. “We are also working on the next generation of probiotics to promote further health benefits,” he added.

Lallemand has now a diverse and global presence in 50 countries over 5 continents, more than 5000 employees and operates 48 production facilities, including 24 yeast and 10 bacteria plants. The company develops, produces and markets yeast, bacteria, fungi and derivatives of these microorganisms for applications in baking, wine, beer, distilled spirits, fuel ethanol, animal and human nutrition, pharmaceutical industry and other food and agricultural industries.

Lallemand is present in the daily life of hundreds of millions of people around the world, including:

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## On the Death of Renowned Indian Fishery and Aquaculture Scientist Dr S. D. Tripathi

**Kolkata:** Dr S. D. Tripathi died on 23 August 2023 at 88 years of age. At the 6th Indian Fisheries Forum at ICAR-CIFE, Mumbai during 17-20 December 2002, in Souvenir article 'Small-scale farming systems for rural development' I heard his Presentation, where he discussed about certain low-cost but effective technologies for increasing fish production, suited for small-scale fish farmers possessing less resource living in distant and marginal villages.

In the Presentation on 'Reservoir fisheries - an untapped resource' at the 7th IFF at Bangalore during 8-12 November 2005, the article associated with entrepreneurship development project of a Kolkata-based NGO and another article on 'Small-scale farming systems' will be pertinent in West Bengal context, for resource-poor fish farmers in distant villages in South 24 Parganas and other districts. The adoptable technologies he described were also meant for them. It translated in Bengali and published it in a bimonthly Bengali science magazine 'Bigyan Mela'. It came out in December 2005.

Dr S. D. Tripathi came to ICAR-CIFA on 15 March 2007 as resource person in Workshop on Selective breeding of Rohu and visited the Presentation titled 'Whither aquaculture 2025?'. So lucid were his descriptions and explanations, whatever may be the subject matter



**Dr S.D.Tripathi**

and sub-discipline of fisheries and aquaculture. After reading articles on his topics of Presentation, enrich knowledge base with new technologies, facts and figures.

His Presentation on 'Inland Fisheries in India' on 18 December 2003 in Fish for All programme at Kolkata.

I made it possible to have courtesy visit to home at Mumbai in 1st week of March 2015 during his 3-week Training Programme on Molecular Diagnostics in Fisheries and Aquaculture at ICAR-CIFE, Mumbai, and he given to Dr S. D Tripathy a copy of my Booklet on Threatened Fishes of India, published by NRS Publications, in which his name was written in inside page.

I witnessed one important moment: celebration of Dr S. D Tripathy 80<sup>th</sup> Birthday at ICAR-CIFA, Bhubaneswar under the initiative of Director, CIFA and other scientists during the National Seminar on Aquaculture Diversification on 3 December 2016, where he spoke on 'Diversification of freshwater aquaculture in India'. Tripathy received the prestigious Fellowship of IFSI at ICAR-CIFRI, Barrackpore in National Symposium on Fisheries Enhancement in Inland

Waters on 27 April 2002; Tripathy name has been came in Advisory Board in Fishing Chimes magazine. In his 9-page article 'My experiences and memories with CIFRI', published in Reminiscence by ICAR-CIFRI in 2007, Tripathy association with this institute right from his joining as Asst. Fisheries Training Superintendent on 30 May 1960 till his post as Project Coordinator, AICRP at FARTC on 31 March 1985, also his experiences of working with fish farmers as Fishery Scientist in rural sector in different districts of West Bengal.



**Dr Tripathi receiving IFSI Fellowship Award**



**Dr Tripathi speaking on his 80<sup>th</sup> Birthday**

In the National Seminar on Priorities in Fisheries and Aquaculture at Rangeilunda Fisheries College on 12 March 2017, after chairing one Technical Session, Tripathy published articles on 'Human resource development in fisheries sector' (Proceedings of National Seminar on Priorities in Fisheries and Aquaculture), 'Ornamental fishes – breeding, culture and trade' (National Seminar on Ornamental Fish Breeding and Culture; ICAR-CIFE Kolkata Centre; 16 February 2004), 'Options for enhancing fisheries in inland open

waters' (All India Zoology Congress; ICAR-CIFRI; 9-11 June 2017), 'Carp seed production Technology – a review' (Workshop on Carp Seed Production Technology; AFSIB Indian Branch; 2-4 September 1988) - so informative and educative for PG students, researchers, scientists, extension workers, State Government high-rank officials, aqua-entrepreneurs and progressive fish farmers.

Dr S. D. Tripathi, was a great person in way of speaking, listening to someone patiently and giving him some advice, polite and thoughtful in making comments every time. His chairing Technical Sessions in national-level

programmes, summarizing the presentations of young scientists so nicely and inspiring them in the end. Not just an eminent fisheries expert, professional, scientist in India and invitee in several National-level Conferences in ICAR institutes and fishery colleges over the years. He was a great human being. As mentioned in English Edition of Odisha Samachar dated 24 August 2023, Tripathy has made a lasting contribution to research and education in Indian fisheries and aquaculture.

Courtesy: **Subrato Ghosh**



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# Aqua Feed Dealer Arrested by Chandigarh Police



**West Godavari, AP:** An Aqua Feed dealer Mr Kopparthi Panduranga Rao, Proprietor of Aditya Enterprises of Doddanapudi village, Kalla Mandal, West Godavari district has been arrested by Chandigarh Police on 22nd September 2023 in a cheque bounce Case.

The accused had purchased Aqua Feed from Godrej Agrovet Limited and has issued a cheque for payment. The cheque was bounced and the Company filed a cheque bounce case against him. The accused was not appearing before the court and therefore the Court issued a Non – Bailable warrant against him.

On 22nd September the Chandigarh Police arrested the accused from his home and produced him before the Court at Eluru, from there the accused has been taken by the police to Chandigarh to produce him before the court.

CNR No: CHCH030026782021  
CIS No: NACT/2084/2021  
Godrej Agrovet Ltd Vs Aditya Enterprise etc.  
Present: Proxy counsel for the complainant

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# Indian Seafood Industry Worried as US takes Aim at Shrimp Import from India

*Curtailed access to the biggest market for Indian shrimp would add to the woes of a sector that is already facing depressed demand and prices globally*

## United States of America:

The country's seafood sector has expressed concern at a proposal by Louisiana senator Bill Cassidy to constitute the India Shrimp Tariff Act to levy duty on shrimp imports from India.

The proposal made in the last week of September has found support from the Southern Shrimp Alliance (SSA), an organisation of shrimp fishermen, shrimp processors and other members of the industry in that country's eight warm water shrimp producing states of Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina and Texas.

Frozen shrimp comprises nearly 70 percent of seafood export from India, which reached a record \$ 8.09 billion in Financial Year 2023. The US is currently the largest market for Indian seafood, mainly shrimp.

The SSA website says that in the proposed India Shrimp Tariff Act, Cassidy has pointed out that imports of Indian aquaculture shrimp that he alleges is highly subsidised account for 40 percent of the volume of all shrimp imports into the country.

According to him, India's dominance of the US shrimp market has reduced the share of the local



**Frozen shrimp comprises nearly 70 percent of seafood export from India, which reached a record \$ 8.09 billion in Final Year 2023. The US is currently the largest market for Indian seafood, mainly shrimp.**

shrimp industry to less than 10 percent of the shrimp consumed in the country. He noted that while India imposes a customs duty of 30 percent on shrimp imports with an additional 10 percent social welfare surcharge, the US imposes no basic duties on imports of shrimp into the country.

"To address these inequities, the India Shrimp Tariff Act would impose a general rate of duty on Indian shrimp of 10 percent beginning in 2024. One year later, in 2025, the duty rate would be increased to 20 percent. From 2026 forward, the duty rate on Indian shrimp would be 40 percent equivalent to India's rate of duty on shrimp imports into that country," Cassidy said.

SSA executive director John Williams has welcomed the proposal and sought the support of other senators for the

legislation. "Shrimpers cannot work because Indian shrimp unfair trade practices have gone unaddressed for over 10 years. Now, more than ever, fishermen and their families need the support of Congressional representatives," read his statement on the SSA website.

All India Shrimp Hatcheries Association (AISHA) president Ravi Kumar Yellanki has urged the government to respond.

"The commerce ministry should take it seriously and should make a pre-emptive step to counter it. Once the Senate passes the bill, it will be difficult for India to fight it," he said, adding that this is not the first time Cassidy has come up with proposals to restrict Indian shrimp imports.

The issue has been raised in a foreign country and it is not certain that the bill will

be passed, said Seafood Exporters Association of India president Jagdish V Fofandi, adding, "The Indian government has to counter it. For the time being, we are adopting a wait and watch policy."

The seafood industry also argued against the notion of heavy subsidies in aquaculture. D Ramraj, past president of AISHA, said the subsidies available are on a par with other aquaculture shrimp producing countries. "Moreover, aquaculture farmers, who are the primary producers, do not enjoy subsidies on seed and feed which are the basic requirements for a farm. If the bill is passed, it will affect the livelihood of thousands of shrimp farmers," he said.

Cassidy also claimed that while the European Union requires that half of all Indian aquaculture shipments be tested for veterinary drugs, but the US Food and Drug Administration has declined to apply additional scrutiny to Indian farmed shrimp imports and inspects less than 0.1 percent of shrimp shipments for the presence of banned antimicrobials.

The India Shrimp Tariff Act would also have provisions to eliminate the exemption of cooked shrimp from the requirements of the US Department of Agriculture's country-of-origin labelling (COOL) requirements. "Section 5 of the bill eliminates the exclusion of cooked crawfish and cooked shrimp products from COOL disclosure requirements and would

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► provide consumers with the ability to choose US wild-caught cooked shrimp at grocery stores throughout the country,” Cassidy said. If it comes through, this could have an adverse impact on the consumption of value-added Indian shrimps in the US.

He has also raised questions about the environmental and social sustainability of Indian shrimp aquaculture. “This shrimp is produced under weak environmental and worker protection, meaning that Indian shrimp aquaculture is characterised by decimated mangrove forests, rampant use of banned antibiotics and fungicides, and child labour. Indian shrimp is processed under contract labour arrangements that encourage and facilitate forced labour,” the senator said.

He noted that global environmental concerns regarding the impact of deforestation have not extended to mangroves and these ecosystems have been sacrificed to further expand shrimp aquaculture in India. “While US shrimp importers and purchasers have condemned the use of peeling sheds in Thailand, this same production model has proliferated throughout the Indian shrimp industry,” Cassidy added.

The proposal has come even as seafood exports from India faced a downturn in FY23 with poor demand and low prices for shrimp in major importing markets such as the US, China and Europe.

## India's First Tilapia Parvovirus Reported in Tamil Nadu

*This DNA virus caused mortality ranging from 30 to 50% in the farm and 100% mortality in the laboratory, says expert*

**Tamil Nadu:** The occurrence of tilapia parvovirus (TiPV) affecting farm-bred tilapia, a freshwater fish species, and causing a huge mortality rate has been reported for the first time in India at ponds in Walajah in Ranipet district of Tamil Nadu.

“Fish samples were collected from 10 ponds in the farm and fish from eight ponds showed TiPV-positive by PCR. This DNA virus caused mortality ranging from 30 to 50% in the farm and 100% mortality in the laboratory,” said Dr Sahul Hameed, Director, Aquatic Animal Health Laboratory (AAHL) of C. Abdul Hakeem College (CAHC) at Melvisharam.

Considered as “a poor-man’s fish”, Mozambique tilapia was introduced to Indian fresh water bodies in the 1950s and it is called Jilabi in Tamil. Capable of surviving in low-oxygen levels in water, the fish has turned invasive across the country. Nile tilapia introduced in the 1970s is a little bigger and is cultured on a large-scale and available in the market for ₹100 to ₹150 per kg.

“I have already closed three of five processing factories. My annual turnover dropped to around Rs 1,300 crore from Rs 1,800 - 2,000 crore last year. It may fall further this year,” said Tara



*Considered as “a poor-man’s fish”, Mozambique tilapia was introduced to Indian fresh water bodies in the 1950s*

niloticus in 1970 and red hybrids because of their fast growth and market demand.

In India, tilapia farming is being carried out in different parts of Andhra Pradesh and Kerala, and is sold in domestic markets as whole fish. In 2022, the tilapia production was estimated at about 70,000 tonnes, of which 30,000 tonnes come from aquaculture.

The AAHL of C. Abdul Hakeem College has been carrying out screening of tilapia regularly for viral pathogens under the R&D programme, funded by the Department of Biotechnology, Government of India, for developing vaccines against them.

“While screening the fish for viral pathogens in

Ranjan Patnaik, managing director of Falcon Marine Exports, a Bhubaneswar, Odisha-based aquaculture company.

There was a double-digit percentage drop in marine products exports from

the months of February and March 2023, the research team reported the occurrence of Tilapia parvovirus,” explained Dr Sahul Hameed, who led the research team.

The TiPV was first reported in China in 2019 and Thailand in 2021. India is the third country to report the occurrence of TiPV.

“Our research finding has been validated by ICAR-National Bureau of Fish Genetic Resources, Lucknow, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar and Kerala University of Fisheries and Ocean Studies, Cochin,” said Dr Sahul Hameed.

The finding has been communicated to Archives of Virology (Springer Nature Switzerland AG) for publication.

Dr Sahul Hameed said that research should be initiated to develop a vaccine against TiPV to help fish farmers to prevent the loss due to TiPV and action must be taken immediately to prevent its spread to other regions of India.

April to July, said Yellanki. “August is no different though the figures are yet to come. This trend is likely to continue for a few more months. One way to deal with it is to promote the domestic market,” he said.





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## Scientists Test Fukushima Fish After Nuclear Plant Water Release

*More than a million metric tons of water was contaminated from contact with fuel rods at the reactor following the 2011 disaster*



*A member of the team of experts from the International Atomic Energy Agency observes the inshore fish as the sample at Hisanohama Port in Iwaki, northeastern Japan Thursday, 19 October 2023. They are visiting Fukushima for its first marine sampling mission since the Fukushima Daiichi nuclear power plant started releasing the treated radioactive wastewater into the sea.*

**Japan:** A team of international scientists collected fish samples from a port town near Japan's crippled Fukushima nuclear plant on Thursday, seeking to assess the impact of the plant's recent release of treated radioactive water into the sea.

The study by the U.N.'s nuclear watchdog is the first since the water release began in August, a move that drew criticism from local fishermen and prompted China to ban all imports of marine products from Japan over food safety fears.

Scientists from China,

South Korea and Canada observed the collection of fish samples delivered fresh off the boat at Hisanohama port, about 50 kilometres south of the plant which was destroyed in the 2011 earthquake and tsunami.

The samples will be sent to laboratories in each country for independent testing, the International Atomic Energy Agency said.

"The Japanese government has requested that we do this and one of the reasons they want us to do this is to try and strengthen confidence in the data that Japan is producing," said Paul McGinnity, a research scientist with the IAEA overseeing the survey.

More than a million metric tons of water - enough to fill 500 Olympic-sized swimming pools - was contaminated from contact with fuel rods at the reactor following the 2011 disaster.

Before being released, the water is filtered to remove isotopes, leaving only tritium, a radioactive isotope of hydrogen that is hard to separate, plant operator Tepco says. The water is also diluted until tritium levels fall below regulatory limits. >>

## A Field Day with Farmers - Fishermen was Organised



**15 October 2023, Chettuva Estuary:** ICAR- Central Coastal Agricultural Research Institute, Goa and Kerala University of Fisheries and Ocean Studies, Kochi, jointly organised a field day for the farmers and fishermen in Venkitangu Panchayat near Chettuva estuary today as a part of the ongoing post-doctoral research work.

A team visited about 20 different households of fishermen and farmers and interacted with the farmers to identify the major challenges faced by them. The purpose of the visit was to understand the issues faced by the farmers and fishers belonging to the Scheduled Caste community and interventions required for dairy animals and implementing sustainable fish culture activities in an integrated way with ducks/poultry in the panchayat.

This is a novel venture between KUFOS and the Scheduled Caste Sub Plan

programme of ICAR-CCARI, wherein selected beneficiaries would be provided technical and financial support to enhance their livelihood prospects. The team also made an assessment of the issues faced by the fishermen, who indicated that the siltation is the major challenge in the estuary, which reduced the depth of the estuary significantly. As a result, the fish productivity of the estuary is drastically reduced and technological interventions are required for the removal of silt from the estuary.

Animal feed supplements were distributed to the livestock/poultry/goat and duck farmers as a part of the programme. As an offshoot of the programme, it was suggested to form a self-help group of fishermen and farmers to promote integrated farming and value addition in agriculture in the region through different schemes of the agencies.

>> Tritium is considered to be relatively harmless because its radiation is not energetic enough to penetrate human skin; however, when ingested

at levels above those in the released water it can raise cancer risks, a Scientific American article said in 2014.



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- Packaging: 25 kilogram, tied inner polybag with sewn outer woven nylon bag.

- Storage: Store in a cool, dry place.



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Prevents entry of opportunistic pathogens and safeguards health of this high value asset.



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**Zoea & Mysis:**  
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**PROBIOTIC** ✓

**SANITISER** X  
**DISINFECTANT** XX  
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# BACTERIOPHAGE THERAPY TARGETS PATHOGEN

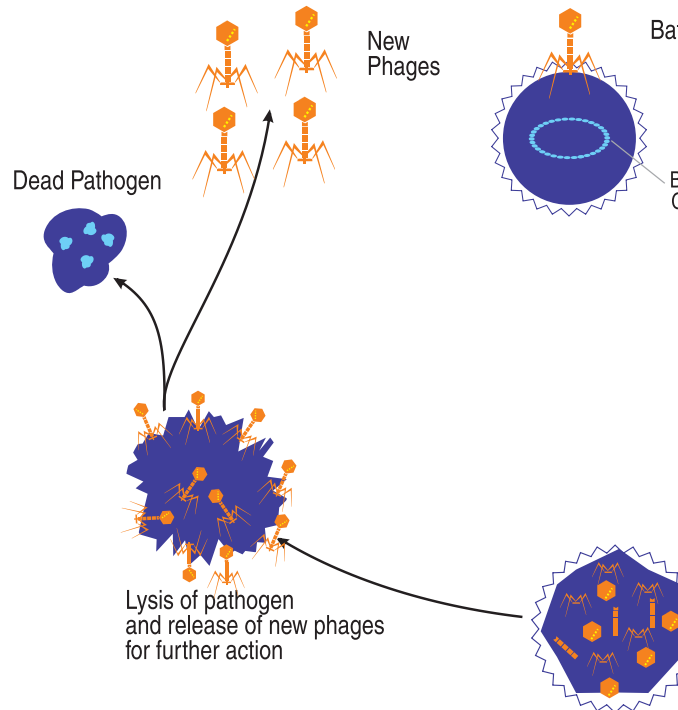
V PHAGES HATCHERY & V PHAGES GROWOUT are a cocktail of phages that are safe on aquatic animals, people and ecosystems. They are resistant to antibiotics and insecticides.

"V PHAGES" cocktail targets against most common pathogens

• *Vibrio parahaemolyticus* • *Vibrio alginolyticus* • *Vibrio cholerae*

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Easy & Safe to use | Dose dependent

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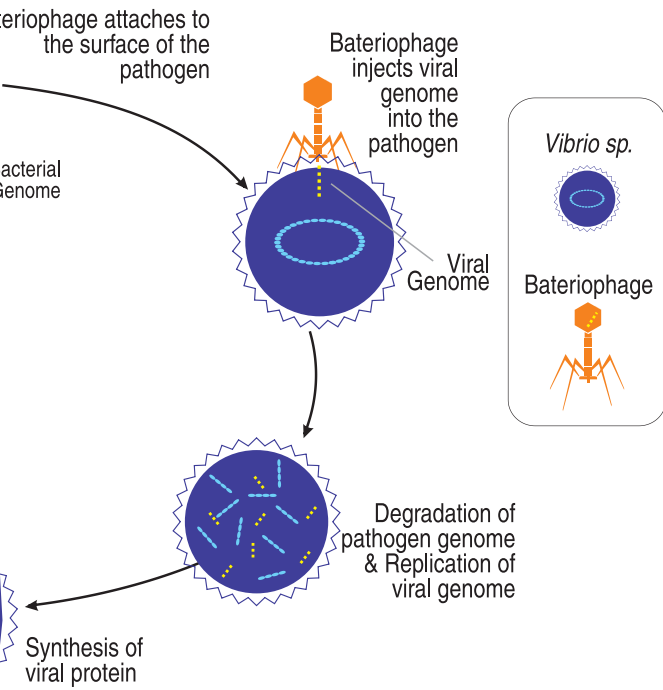
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*parveyi* • *Vibrio campbellii* and other pathogenic *Vibrio sp.*

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## BENEFITS

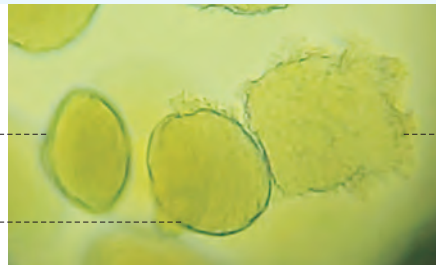
- Effective against Vibriosis, other Bacterial Infections and Running Mortality Syndrome (RMS).
- Effectively prevents Gut Infections and Improves feeding.
- Prevents sudden crop loss and extends Life of Pond during critical profit-making period.
- Enhances Probiotic performance.

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**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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## Tamil Nadu Fishers arrested in Sri Lanka: Protest Staged in Rameswaram Demanding Centre's Intervention

*Fishermen and their families participated in a large protest in Rameswaram, demanding that the Centre intervene to bring back the 27 fishermen arrested by the Sri Lankan Navy last week; they also insisted on the impounded boats being retrieved*



**Rameswaram fishermen staged a protest in front of the Post office, demanding that Centre intervene in the release of 27 fishers arrested by the Sri Lankan Navy last week**

**Rameswaram:** Hundreds of fishers, along with their families including children, participated in a protest seeking the Union government's intervention to bring back 27 jailed fishermen and their five boats, impounded by Sri Lankan Navy personnel on 14 October 2023, while they were fishing along the Palk Bay.

Fishermen from different unions participated in the agitation held in front of the Post Office in Rameswaram on **Wednesday, 18 October 2023**. A fisherman leader, P. Jesu Raja, said that the Union government should

consider the plight of the fishermen. "Our livelihood is at stake. Braving several odds, we have been venturing into the sea for our survival. We strictly adhere to the rules laid out by the governments of India and Sri Lanka. Even so, under some pretext or the other, these fishermen were held," he said.

### **Over 125 boats impounded in five years**

Mr Raja said that while the Union government and the Tamil Nadu government had come to their rescue in the past, one major issue that has remained unresolved was that while the fishermen

## Godrej Agrovet Breaks Ground for Palm Oil Complex in Telangana

**Khammam:** The Godrej Group, which broke ground for a ₹300 Crore integrated palm oil complex in Khammam recently, is considering investing in dairy, pharma, personal care products, furniture, real estate, retails, poultry and aquaculture.

'Telangana is all set to become a new home for the group. The ground-breaking for the palm oil factory in Khammam is the

first of many investments in diverse areas such as dairy, animal feed, retail, real estate, FMCG and more that we are working closely together on,' said Minister K. T. Rama Rao, who along with senior leadership of the group, participated in the function of Godrej Agrovet in the district.

'We are fostering a deep relationship across many sectors,' the Minister said.

were released, their boats were not. "From 2018 to date, over 125 boats including mechanised and country boats which were impounded, have not been released. Each mechanised boat cost ₹30-40 lakh. Without our boats, our livelihood is lost, not to mention debt, since many have invested in their boats by taking loans," he said.

Under these circumstances, the Union government, instead of remaining a mute spectator to the issue, should hold talks at the highest level in Sri Lanka and ensure that the fishermen would not be held under baseless charges. "We are under constant threat, and insecurity haunts each one of us," Mr Raja said.

The fishermen and their families, who participated in the agitation, told media persons that venturing into

the Palk Bay nowadays had become a life or death ordeal. For families of the fishermen, there was immense anxiety, stress and trauma about the hazards they worked under.

One elderly woman Arputhammal, from Mandapam, said she depended on an income from her only son, who has been jailed. "I live under a small thatched roof put up on a piece of poromboke land. There is absolutely no one to take care of me. I have been traumatised from the day my son was jailed. Will he come back," she asked, weeping.

Fishermen leaders said that they have been assured that the jailed fishermen would be brought back soon, but they have urged the governments to retrieve the boats as well.

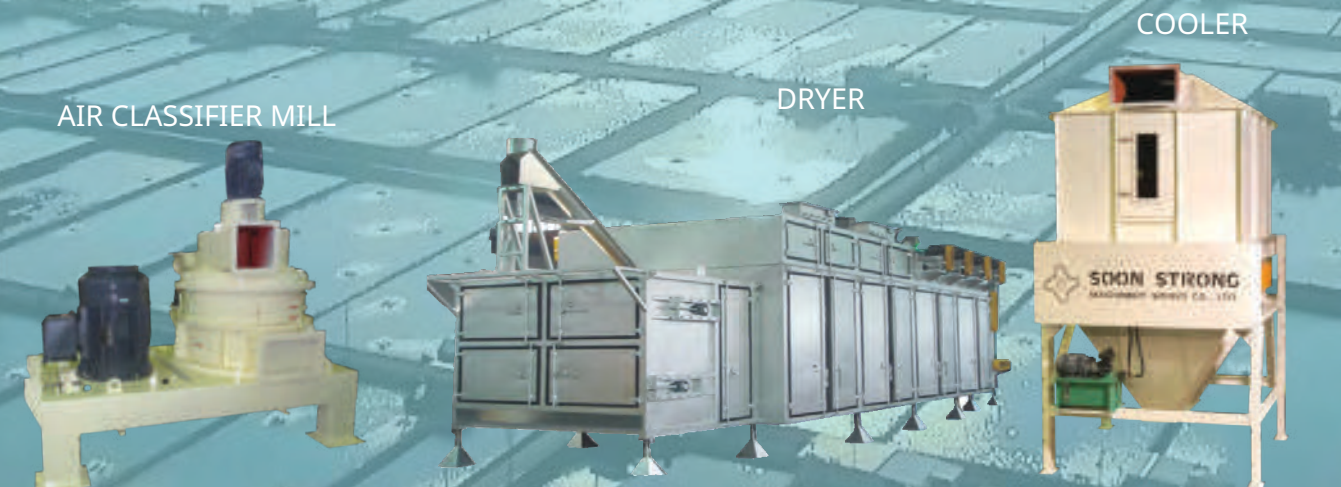
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# Microbial Management in Shrimp Hatcheries through Alternate Approaches

*Dr D. Ramesh Kumar, C.E.O, Salem Microbes Pvt Ltd makes presentation in Hatch India 2023*

**Visakhapatnam:** Dr D. Ramesh Kumar, C.E.O, Salem Microbes Pvt. Ltd. of Salem Microbes made a presentation on “Microbial Management in Shrimp Hatcheries through Alternate approaches” in the 22nd day session on “Disease Management” of HATCH INDIA 2023 held at Visakhapatnam on 29 - 30 September 2023.

Dr Ramesh is a Microbiologist with extensive experience in isolation and identification of bacterial pathogens of aquatic species and genomics of pathogens and probiotic strains is currently involved in development of bacteriophages cocktail against bacterial pathogens. His company, Salem Microbes are pioneers in aquaculture probiotics production in India since 2000 with presence in SE Asian countries directly and through their business associates.

In his presentation, he gave an overview on microbiota of normal and diseased Shrimps in Hatchery conditions.



**Dr D. Ramesh Kumar, CEO, Salem Microbes making the presentation on Microbial Management in Shrimp Hatcheries through Alternate Approaches**

He explained the relationship between infective microbial community on the Shrimp brood-stock and PL produced and the importance of genomic studies to understand this.

He gave 3 Stage treatment strategy when you want to achieve a Disease-free state in a hatchery. His recommendations are (1) Probiotics for Water quality management, (2) Bacteriophages for controlling pathogenic Vibrio's and (3) A New proprietary approach called SIM MICROBIOTA, where he gave more emphasis on the Shrimp intestinal pathogen management (SIM).



**From Left: Dr Ramesh Kumar, Madhusudhan Reddy, Surendran, Beeda Masthan Rao and Sathy Reddy in an informal chat.**

He highlighted the following points,

(1) Dr Ramesh Kumar said that by using a General Probiotics, we still get many problems as Poor conversion, Zoea 2 syndrome leading to less production.

(2) He showed the difference between before and after use of Vibrio killing Bacteriophages in different sections of a Hatchery and how it will positively influence the final production.

(4) He said that the primary cause of incidence of White gut, White fecal, Running mortality which is widely reported in farms since last 2 years has a common origin of the presence of various pathogenic Vibrio species apart from EHP, where Vibriosis can be controlled by this SIM PROGRAM.

He finally advised Hatcheries to equally care for Preventive and treatment aspect through Good Microbiota



**AISHA President Yellanki Ravi Kumar felicitating Dr Ramesh Kumar**

(3) In SIM MICROBIOTA PROGRAM, the emphasis was on the management of Intestinal pathogens of the Brood stock first and then the PLs produced from those broodstock. He explained that, when you continuously maintain a Healthy gut in the Broodstock, it has a remarkable effect on the PLs as lot of pathogenic Bacteria get inside the PLs even though we practice egg washing and other sanitary procedures.

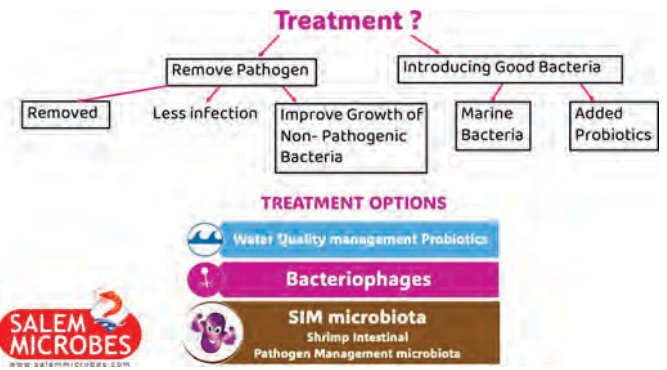
Management for a successful Hatchery cycle.

During the panel discussion session, he explained the benefit of using Liquid Bacteriophages which is more appropriate and effective in aquaculture applications. He also added that the Liquid bacteriophages are quick acting, does not cause turbidity and solubility problem and can be equally effective as Water and feed supplement.



# MICROBIAL MANAGEMENT in SHRIMP HATCHRIES thru' ALTERNATE APPROACHES

Dr.D.Ramesh Kumar  
CEO / Head – R & D



## SUPERIORITY OF BACTERIOPHAGES

- SPECIFICITY
- QUICK ACTION
- NO RESIDUE
- PROMOTION OF PROBIOTIC MICROBES
- BY REDUCING COMPETITION FOR FOOD

### TARGET PATHOGENS IN BACTERIOPHAGE FORMULATION

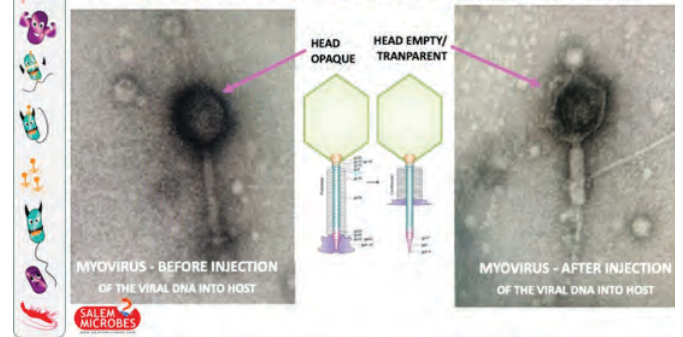
- *Vibrio harveyi*
- *Vibrio campbellii*
- *Vibrio parahaemolyticus*
- *Vibrio alginolyticus*



Demonstration of Bacteriophage activity against Pathogenic isolate

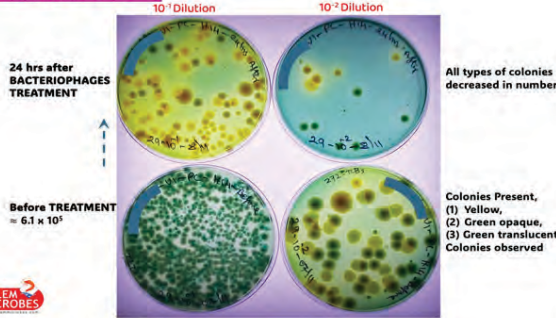


BS2- MYOVIRIDAE FAMILY MEMBER – PART OF PHAGES CONSORTIA – ISOLATE OF SMPL



Electron Microscopy of Phage Isolates in V PHAGES Consortia of Salem Microbes

## Post Larval tanks @ PL5



From left: Vijayanand, Tikku Sathyanarain, Dr D. Ramesh Kumar, Joshi Shankar, Kalraj, P. K. Senthil Kumar and Dr Nageswara Rao



AISHA Tamil Nadu team being felicitated by the National President Yellanki Ravi Kumar. Saradhi Chinnam, Dr Nageswara Rao, Joshi Shankar, Kalraj, Dr Balasubramanian, Sathy Reddy and Muthukaruppan are seen in the picture.



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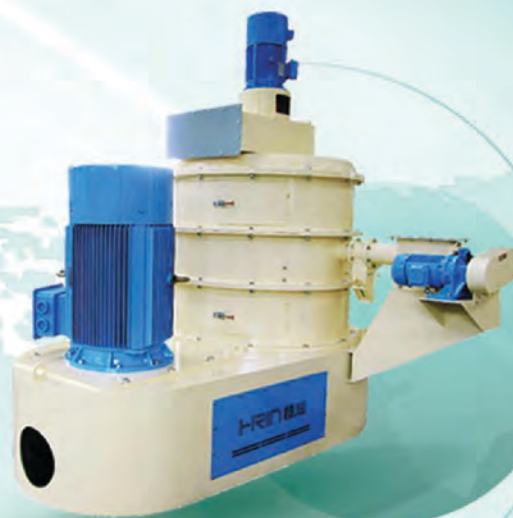
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# Fish Protein Hydrolysate: An Emerging Dietary Protein Source in Aqua Diets

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Assistant Professor, Directorate of Incubation and Vocational Training in Aquaculture, TNJFU, ECR, Muttukadu, Chennai.

**Mr Kalidoss Manikandan, M.F.Sc.,**

SRF-Ph.D. Research Scholar, Directorate of Incubation and Vocational Training in Aquaculture, TNJFU, ECR, Muttukadu, Chennai.

- ▶ FPH is highly nutritious by-product from fish/shellfish processing wastes.
- ▶ FPH is having good source of bioactive peptides.
- ▶ Due to the presence of an excellent source of nutrients, FPH is used as either a feed supplement or an attractant in high plant or low fish meal based fish diets.
- ▶ Supplementation of FPH has improved the growth, nutrient utilization, digestibility and immune responses of commercial farmed fish diets.

## Introduction

Global fish production has been increasing steadily, with all-time high of 178.5 million tonnes produced in 2018 aligned with a record-high per capita fish consumption of 20.5 kg in 2018. Aquaculture is expected to meet the global demand for aquatic animal production due to the reduction in captured fisheries. In fish and shrimp production, feed accounts for over 50–60% of the production cost, which is mainly composed of protein. Traditionally, the most preferred dietary source of protein is fish meal due to the presence of high crude protein digestibility, well-balanced amino acids, source of essential fatty acids, essential minerals and vitamins. Although fish meal is considered as the most nutritious ingredient and most digestible ingredient for aqua-feed, issues with supply, increasing

prices, and environmental concerns are resulting in pressure on the aqua-feed industry to reduce the levels of fish meal inclusion in aqua diets. Therefore, there has increased the investigation of economically viable, environmentally sustainable and locally available alternative protein sources for fish meal in aqua feed production.

Fish processing industries produce a significant amount of fish waste, which includes skin and scales, bones, swim bladders, intestines, blood and liver, representing almost 50% of the total weight. As a result, recycling such wastes has gained popularity as an alternative use for fish meal. The development of by-products from fish and fishery waste has increased the attention to alternative protein sources in aqua feed production. Fish protein hydrolysate (FPH) is a by-product of fish processing waste and it is rich in

free amino acids and low molecular weight peptide compounds. For that reason, FPH has been used as a fish meal replacer, feed supplement, and feed attractant in low fish meal diets in commercial fish and shellfish diets. Previous studies have confirmed that FPH improves the growth and feed utilisation and enhances the digestion, antioxidant and immune status of various fish and shellfish.

# Gassen Plus

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<sub>2</sub>S, 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<sub>2</sub>S, Methane, etc., Microbial enzyme "Urease" Production inhibited by Saponin which leads to an increases D.O. and reduction of BOD and 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  
NITROBACTOR  
STABILIZERS

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

**PRESENTATION:** 500 gms & 1 kg



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ANTIBIOTIC FREE,  
STEROIDAL FREE.

Therefore, this article has developed to discuss the source, production process and the importance of fish protein hydrolysate in aqua diets.

**Fish protein hydrolysate**

FPH is a powdered or inert liquid product obtained from fish processing wastes by the action of enzymatic hydrolysis using proteolytic enzymes. These enzymes hydrolyse or break down the proteins into short-chain peptides and free amino acids depending on the nature of the enzyme. In the hydrolysis process, the hydrophobic groups of polypeptide chains are converted to hydrophilic groups, which provides two end carbonyl and amino groups that increase the charge and polarity with water. These interactions control the physicochemical properties of FPH such as solubility, emulsifying, oil binding capacity and water holding capacity.

**Fish protein hydrolysate sources**

Fish protein hydrolysate is produced from fish and shellfish processing wastes such as

- Dark muscle
- Skin and scales
- Fins
- Head
- Viscera
- Trimmings

- Fish bone and frame

**Production of FPH**

There are several methods used to produce FPH including

- Enzymatic hydrolysis
- Chemical hydrolysis (acid/alkali)
- Autolysis
- Bacterial fermentation

Due to the advantages of enzymatic hydrolysis and chemical hydrolysis, the FPH is mostly produced by these methods. The autolysis process is triggered by the action of endogenous digestive enzymes in the fish. However, these enzyme concentrations significantly fluctuate depending on the species, age and season. The bacterial fermentation process is done by lactic acid bacteria that produce acid and antimicrobial factors that inhibit competing bacteria, but removal of fat by this method is difficult. FPH produced by enzymatic hydrolysis is widely accepted and produces better quality protein hydrolysate in a short time period. Moreover, enzymatic hydrolysis does not produce any residual solvents or toxic chemicals in the end product of hydrolysate.

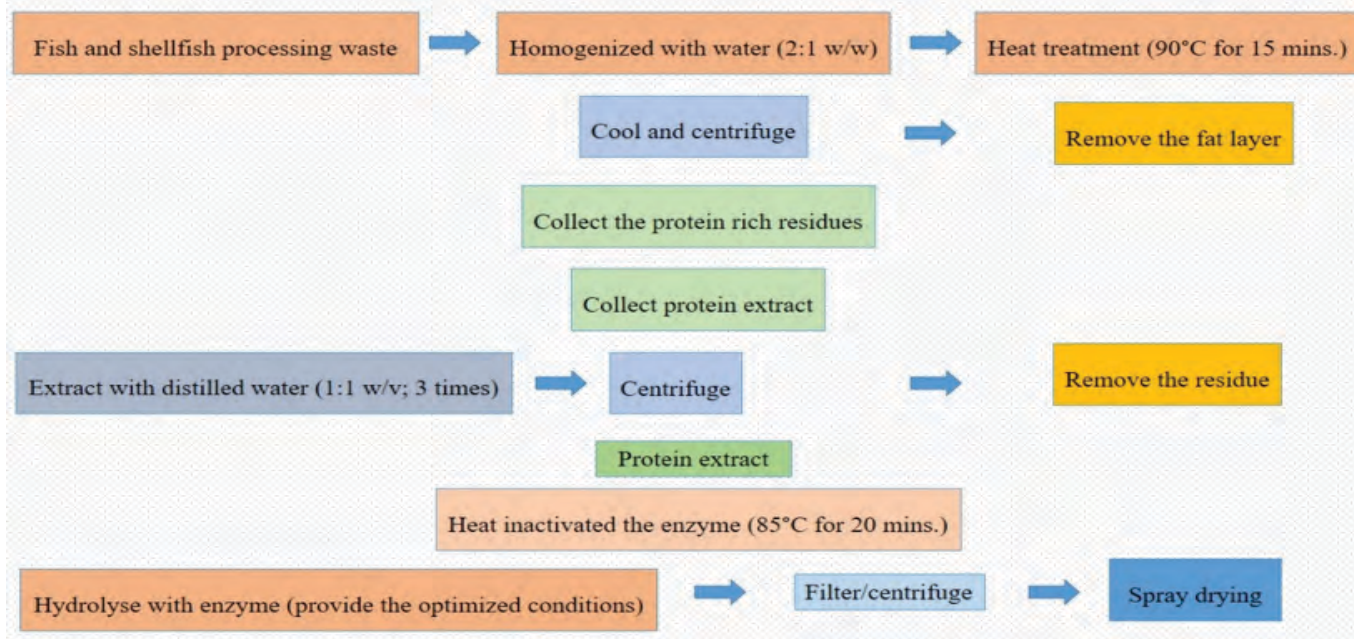
**Enzymatic hydrolysis**

In the enzymatic hydrolysis process, the following proteous enzymes such as alcalase, nutrase, flavourzymes,

protamex, papain, pepsin and trypsin are used to effectively produce FPH. An alkaline enzyme, alcalase, is obtained from *Bacillus licheniformis*, and it is the highly efficient enzyme for FPH production due to its ability to be activated in mild environmental conditions and to produce small peptides in a short time period.

In the enzymatic process, the first step is that fish and shellfish processing wastes are minced and homogenised with water (2:1 w/w). The minced waste raw materials are heated to 90°C for 15 min in a hot water bath to deactivate the endogenous proteous enzymes. After that, the raw material is transferred to a temperature-controlled water bath (60 °C). Then, the minced raw material is continuously stirred with a glass rod. Once the optimum temperature is reached, the pH is adjusted to 8.2 using 1 M NaOH. Then, the hydrolysis is initiated through the addition of 3.33 µl of proteous enzyme (Alcalase) per g of raw waste materials. Throughout the hydrolysis process, the pH is kept constant by using a 1 M NaOH solution. Finally, the hydrolysis is terminated by deactivating the enzyme by increasing the temperature (90 °C for 20–30 min).

**Fig 1. Fish protein hydrolysate production steps from fish and shellfish processing waste**



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Booster in Gel Form

**ALL IN ONE** gel

A UNIQUE COMBINATION OF FAT SOLUBLE VITAMINS, WATER SOLUBLE VITAMINS, AMINO ACIDS, TOXIN BINDERS, HEPATO PANCREATIC STIMULANTS, ANTI STRESSORS, USFA, LDLP, APF, AND MACRO & MICRO ELEMENTS IN GEL FORM

COMPOSITION :

Vitamin-A	-	5000IU
Vitamin-D3	-	1000 IU
Vitamin-E	-	15 mg.
Vitamin-B1	-	1.86 mg.
Vitamin-B2	-	1.25 mg.
Vitamin-B6	-	0.62 mg.
Niacinamide	-	30 mg.
D-Panthenol	-	1.26 mg.
Inositol	-	10 mg.
Folic Acid	-	10 mg.
Biotin	-	15 mcg.
Vitamin-B12	-	6.25 mcg.
L-Lysine	-	175 mg.
DL-Methionine	-	150 mg.
Vitamin-C	-	200 mg.
Toxin Binders	-	200 mg.
Hepato		
Pancreatic stimulants	-	100 mg.
LDLP	-	15mg.
USFA	-	5 mg.
APF	-	30 mg.
Calcium Gluconate	-	20 mg.
Magnesium	-	25 mg.
Manganese	-	15 mg.
Cobalt	-	15 mg.
Zinc	-	25 mg.
Selenium	-	2.5 mcg.
Protein Hydrosylate	-	1000 mg.
Betaine Hydrochloride	-	1000 mg.

BENEFITS :

Improves feed conversion and growth rate. Enhances resistance against diseases. Ensures uniform growth. Neutralizes imbalances of Vitamins, Minerals, Amino Acids and Proteins Detoxify toxic materials and improves health. Improves absorption of the Calcium, Phosphorous and reduce incidence of loose shell.

DOSAGE :

50 ml per kg.  
of feed or consult  
your aqua technician  
for specific usage  
and dosage.

**Presentation: 5 Ltr. & 25 Ltr.**



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**Table. 1: Enzymatic process to produce FPH from different fish and shellfish wastes using different enzymes**

Fish species	Fish parts to produce FPH	Enzyme type	Optimum conditions			
			Conc. of enzyme	pH level	Time (min)	Temperature
<i>Lophius vomerinus</i> (Monk fish)	Heads	Alcalase	3.33 µl	8.2	-	61°C
<i>Oreochromis niloticus</i> (Tilapia)	Head, skin, trimmings, fins, frames and viscera	Pepsin	1%	2.5	185	37°C
<i>Sardinella spp</i> (Sardine)	Muscles free from head, tail and viscera	Protamex	0.01%	-	90	55°C
<i>Theragra chalcogramma</i> (Pollock)	Frames	Alcalase and flavourzyme	-	8.5	180	50-55°C
<i>Catla catla</i> (Catla)	Visceral waste	Alcalase	1.5%	8.5	135	50°C

**Table. 2: Nutritional composition of fish protein hydrolysate from different fish species**

Fish species	Crude protein (%)	Ether extract (%)	Total Ash (%)
Monk fish hydrolysate	76.3	14	1.30
Tilapia hydrolysate	82.0	10.3	9.07
Sardine hydrolysate	72.2	9.2	7.50
Krill hydrolysate	84.1	2.3	10.5
Shrimp hydrolysate	64.9	10.8	10.3
Tilapia hydrolysate	71.2	15.4	4.8

### FPH in Aqua Diets

FPH enhanced the growth, feed utilization, digestibility and immunity of fish and shellfishes. Therefore, FPH is used as either a feed supplement, an attractant, an immune stimulant, or a fish meal replacer in various fish and shellfish diets. In diets of silver pompano, inclusion of tilapia protein hydrolysate has significantly improved innate immunity, antioxidant enzymes, and also enhanced disease resistance of silver pompano against *Vibrio anguillarum*. Similarly, local marine fish protein hydrolysate enhanced the growth and feed conversion of African catfish diets. Dietary inclusion levels up to 10% of sardine protein hydrolysate improved the growth performance and nutritional efficiency in South American Catfish. Moreover, 5% of sardine protein hydrolysate has enhanced the digestive enzyme activity and lactic acid bacterial load in fish intestine.

**Table. 3: Effects of FPH on growth performance and nutrient utilization in commercial aquaculture species**

Fish species	Source of hydrolysate	Inclusion level	Effects
( <i>Trachinotus blochii</i> ) Silver pompano	Tilapia protein hydrolysate (TPH)	9% TPH	Weight gain, specific growth rate, protein efficiency ratio; Feed conversion ratio.
( <i>Clarias gariepinus</i> ) African catfish	Monk fish protein hydrolysate (MPH)	3.8% MPH	Relative weight gain, specific growth rate.
( <i>Rhamdia quelen</i> ) South American catfish	Sardine protein hydrolysate (SPH)	10% SPH	Weight gain and specific growth rate.
( <i>Pangasius hypophthalmus</i> ) striped catfish	Fish hydrolysate (FH) and Shrimp hydrolysate (SH)	2% FH and SH	Weight gain, SGR, hepatosomatic index.
( <i>Pagrus major</i> ) Red Sea bream	Shrimp hydrolysate (SH), Tilapia hydrolysate (TH) and Krill hydrolysate (KH)	3% SH, TH and KH	Weight gain, specific growth rate and hepatosomatic index.
( <i>Scophthalmus maximus</i> ) Turbot	Pollock fish protein hydrolysate (PPH)	3.1% PPH	Specific growth rate, protein efficiency ratio and protein retention



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# Scarlet badis, *Dario dario* (Hamilton, 1822): A promising indigenous fish species of India for nano-aquarium industry

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## Abstract

Ornamental fish industry is a blooming industry in India having high potential in flourishing well in the export market if breeding technologies of several indigenous fishes can be standardized and disseminated among hobbyists, farmers, breeders and entrepreneurs working in this field. India has an abundant indigenous ornamental fish diversity available from hotspots, such as the Western Ghats, North-Eastern region etc., but currently contributes only a meagre 0.4% to the export market. The only drawback existing so far is the dependency on wild stock which is far from sustainability due to the rise in habitat loss and pollution resulted from developmental and human activities. Therefore, this industry is a very less explored area and requires rigorous work and research developments to

achieve the goal of captive breeding of numerous indigenous species and bloom in the export market by becoming a major player. Likewise, in this article we will discuss about an indigenous species, namely, scarlet badis/red badis, *Dario dario*, which can be considered as a species of high value, but currently has no advancements in all aspects.

## Introduction

Ornamental fish industry is an ever-growing industry contributing a hefty output to the global economy. Globally, photography is the most followed hobby, whereas ornamental fish keeping stands out to be in the second position. People are taking up aquarium keeping as a pastime at a faster pace than ever before, especially during the covid-19 pandemic. Around 100 million aquarium hobbyists around the world are dabbling in this industry

by keeping a variety of commercially available and wild-caught fishes. There are about 125 countries gaining a significant economic value through ornamental industry and as per 2020 reports this gigantic industry has a trade value of a staggering US\$ 18-20 billion at the global level. The total number of active species in the import and export markets consist of about 2500 numbers of which 60% belong to the freshwater group and 40% are marine (Ministry of Fisheries, Animal Husbandry and Dairying, 2020).

## Aquarium Industry: Indian Scenario

As far as India is concerned, it is at a growing stage but there are numerous challenges along the way which ultimately makes India contribute a meagre 0.4% to the export market currently and this keeps India standing still at the 34<sup>th</sup> position among the top exporting

countries (Ministry of Fisheries, Animal Husbandry and Dairying, 2020). India is a country with enormous potential in the industry but in terms of global ranking in the export market, it is placed at a lower position as compared to other Asian countries. The main issue of the country is the maximum dependency on wild collection and this pressure is mainly borne by the lakes and rivers of the North-Eastern Region and Southern Regions.

The North Eastern Region harbors around 250 ornamental fishes of which 58 are exported which accounts for 85% of the whole market. *Puntius shalynius* (shalyni barb), *Botia dario* (Bengal loach), *Schistura reticulofasciatus* and *Danio dangila* (mustached danio) are the main indigenous species. There are 155 ornamental fish species occur in the Western Ghats, among which, 117 are endemic. Main groups are catfishes, danios, barbs, catopra, glass fishes, rasboras, hill trouts and killifishes.

India is home to a large number of ornamental fish species. The Indian water biodiversity consist of 374 and 700 indigenous freshwater and marine species respectively and also harbors exotic marine species whose number currently stands at more than 300 species; Indian ornamental fishes are in high demand in the international market. Freshwater species contributes 80% of trade, while brackish and marine water fishes contribute 20%. The domestic ornamental fish trade is estimated to be worth around Rs 500 crores. The export trade in 2017-2018 was worth Rs 8.40 crore, with an annual growth rate of 11.6%.

### Importance of Conserving Indigenous Ornamental Fishes

Maintenance of aquatic ecosystem is greatly enhanced by the presence of indigenous/native fishes, the reason behind this is the biological behavior of the species which has adapted to the aquatic environment for generations of its existence building an important correlation with the environment thereby maintaining

- ▶ *Dario dario*, commonly known as Scarlet badis is an important indigenous ornamental fish having a very high value (\$1-8/piece) in the international market.
- ▶ Being one of the smallest percoid fish species with a maximum size of 1 inch, it is most suitable for nano aquariums.
- ▶ Presently, trade of this species relies exclusively on collection from natural waters of north-eastern states.
- ▶ In order to popularize this species on a larger scale, development of captive breeding technology is extremely required to boost the profitability of ornamental fish breeders.

and sustaining a healthy ecosystem. Native fish conservation is part of a bigger effort to protect the planet's biodiversity. Better ecosystem services result from a greater diversity of species.

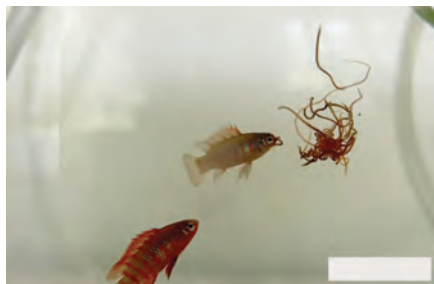
Humans and the ecosystem both benefit from the services provided by fish. They provide food and support economy, while also contributing to the diversity of aquatic ecosystems. Native fishes are crucial members in the ecosystem trophic levels, equally important as other organisms in balancing the food web and holds an important niche in the food chain system.

Even though some native fishes are not commercially valuable, protecting them is still necessary. Many native fishes can only live in one environment, which means that some species can only be found in one location on the planet. Native fish conservation contributes to the creation of a distinct and vibrant environment. (<https://www.nps.gov/subjects/fishing/benefits-of-native-fish.htm>)

### Scarlet badis, *Dario dario*: A potential indigenous species

The scarlet badis (*Dario dario*), also known as the red badis or scarlet gem

badis, is a tropical freshwater fish that is one of the smallest percoid teleost species with bright colouration and full of personality having a lifespan of 3-6 years. It is mainly a zooplankton predator that eats small crustaceans, worms (tubifex), insect larvae and other zooplankton (Barlow *et al.*, 1968). Worms and other tiny crustaceans are favorites of scarlet badis. Traditional fish flakes or pellets are unlikely to be accepted, but if they are, meatier foods should always be supplied. Scarlet badis is among the few small fishes that can thrive in small tanks, and has a water requirement of 10 gallons (37.8 L) wherein a male can be stocked along with 2-3 females. In the aquarium trade, it goes by several names viz., *Badis badis bengalensis*, *B. bengalensis* which was incorrectly mentioned in 1999 in a publication of a fishkeeping magazine. *D. dario* (Hamilton, 1822) is found primarily in tributaries of the Brahmaputra River in Assam and West Bengal, possibly also exists in Bhutan. *D. dario* was found to be most closely related to *Badis badis* (blue perch) based on phylogenetic study (Wanga *et al.*, 2021). Scarlet badis is mainly found along with *Badis blosyrus* and *Badis konabos* during wild collection, but are compatible together in glass tank.



**Figure 1. Scarlet badis feeding on Tubifex worm**



**Figure 3: Male (left) and female (right) scarlet badis (left)**

Scarlet badis, being a small and tiny creature, is a perfect centerpiece for nano-aquarium. It usually inhabits shallow clearwater streams and rivers consisting of sandy or gravel bed as substratum for the fishes coupled with dense population of aquatic vegetation (*Hygrophilia*, *Limnophila*, *Ottelia*, *Rotala* and *Vallisneria*). Being an incredibly shy and timid species, they tend to find hideouts for sheltering themselves, therefore providing a dense thicket of foliage is an ideal refuge. It is quite effective to have a dense moss cushion that is at least 4 inches (10 cm) deep and which does not have any gaps. For the brood, it serves as a safe haven and a first source of food (Kullander and Britz, 2002).



**Figure 2. Aquarium set-up mimicking natural environment by adding sand, gravel bottom, plant (amazon sword, eel grass, Vallisneria) and mud pots for hideouts**

Regarding stocking of tank mates, it is highly advisable to keep same-species combination as they do best with each other but with just one male in the tank, as males tend to fight among each other. It has been recommended to keep *D. dario* in an only-species setup as it is mostly incompatible with other species, but *Danio margaritatus* commonly known as galaxy rasbora/celestial pearl danio are a probable partner that might be compatible with *D. dario*. Light maintenance from low to moderate



**Figure 4. Male scarlet badis (below) chasing female (top) as a sexual behaviour**

is recommended for enhancing plant growth.

This fish is ideal for a nano aquarium because of its small size (male: 0.75-1.0-inch, female: 0.5-0.75 inch). People can simply keep a pair at their apartments or offices in a nano aquarium. Males, measuring 0.75-1.0 inch (2-2.5 cm) in length have 7 vivid red and blue stripes and bright red fins with white-blue borders and fin membranes. The colour intensity, number, and width of the blue stripes, on the other hand, might vary significantly. The distinctive black stripe running through the eye from the upper border of the operculum to the mouth is a distinguishing feature of the scarlet badis. Females are slightly smaller than males measuring 0.5-0.75 inch (1.5-1.8 cm) and having gray-brown colouring with normally colourless fins. Although, the first ray of the ventral fin and the margin of the anal fin may be white-blue, it is not as bright and elongate as in males. On the flanks, individual females may have uneven red patches and small, bluish, iridescent

dots. Fighting males enhance their colours, stretch their fins, and swim slightly head-down toward each other to impress females. Fighting males intensify their colours during spawning season, stretch their fins, and swim slightly head-down toward each other while dancing with other males to impress females (Kullander and Britz, 2002). When the fish are still juveniles, distinguishing a male from a female might be difficult due to their lack of distinct coloration.

Females have a blunter head profile and a notably rounder belly when ready to spawn, whilst males are thinner and more elongate. Males will rapidly start carving out territory, courting females and driving out competitors. The male approaches any female who approaches him and swims after her, frequently butting her in the flanks and steering her toward the spawning substrate. It enjoys temperatures between 18-24°C (Kullander and Britz, 2002) and 23.6-26.7°C (Jennifer Doll, 2021), with a pH range between 6.5-7.5.

### Price comparison of scarlet badis from different sellers

Sl. No.	Price	Unit	Seller	Website/Location
1.	₹75.00/unit	6 no./unit	Best4Pets	best4pets.in
2.	₹99.00/unit	1 no./unit	Fishe Shop Aqua Pvt. Ltd.	fisheshop.com
3.	₹145.00/unit	1 no./unit	Aquarium Fish India	aquariumfishindia.com
4.	\$6.99/unit	1 no./unit	Flip Aquatics	flipaquatics.com
5.	\$7.99/unit	1 no./unit	Live Aquaria	m.liveaquaria.com
6.	\$33.00/unit	6 no./unit	Aqua Huna	aquahuna.com
7.	\$1.50/unit	1 no./unit	Fish Bazaar	fishbazaar.sg
8.	\$0.50-1.00/unit	1 no./unit	Aqua Life India (Exporter)*	Bansdroni, Kolkata

\*Aqua Life Industry is an exporting company based in Kolkata which exports scarlet badis collected from North Bengal to America and other countries.

#### Status of scarlet badis

According to the IUCN, *D. dario* has a status of Data Deficient (DD), which means that there is not enough data collected regarding the population, occurrence, habitat and other related aspects of the species. Therefore, we cannot say that this species is threatened or of least concern; therefore, the need of the hour is to conduct studies and surveys on it. So far, the only source for collection of this fish according to suppliers is from the tributaries of Teesta River which is a part of the Brahmaputra River System in North Bengal. There is an urgent need to standardize breeding technology of this species in order to popularize it in the aquarium fish trade, allow the small-scale ornamental fish breeders to take up this fish and gain a good economic return since this fish has a high demand in the market for nano-aquarium and most importantly to reduce the pressure put onto the natural environment since it is the only source so far. In India, scarlet badis is still not popularized at a level of its potential, and this can be concluded as per surveys done in the largest pet market of India, i.e., the Galiff Street Market, Kolkata wherein no seller sells this species and the reason might be due to its difficulty in procuring or unavailability of specimens. For international hobbyists, *D. dario* has been high on the list of the most popular fishes for small planted aquariums (Strozyk and Sander, 2012).

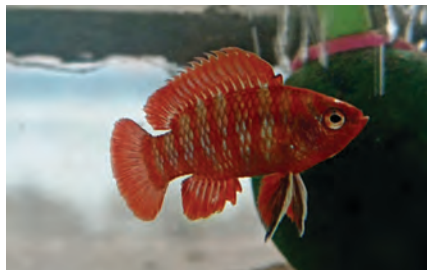


Figure 5. Beautifully coloured and attractive male scarlet badis with bright red bands

Therefore, this species paves way for researches to work on several aspects, mainly captive breeding and to popularize this beautifully coloured indigenous fish of the Brahmaputra basin and meet its demand in the nano-aquarium industry as this fish is really a jewel in a small glass aquarium which will be a centre of attraction in a room and is really a pleasure to watch it beautifully moving across the aquarium and don its sparkling red bands, which is a soothing remedy to the eyes.



Figure 6. Scarlet badis kept in nano aquarium

#### Mitigation for Increasing Population

Humans are a natural component of nature, and the extinctions that result from their dominance and superiority are unavoidable (Huntley and Langton, 1994). According to Philippart (1995), captive breeding and re-introduction/ranching of captive-bred individuals into the natural environment is the most probable way of conserving threatened and endangered fish species. Surprisingly, little study has been done on captive breeding of this species thus far, paving the way for future research into various aspects of this fish's breeding. Captive breeding strategies, according to Pandey and Mandal (2017), prevent overexploitation of reef fish by easing the burden on wild-capture. Small indigenous fish species have suffered a significant decline due to overfishing and habitat degradation (Thilsted et al., 1996). According to Mahapatra et al. (2014), only 15% of native ornamental fishes are captive bred, while majority of the supply is based on wild collection (85%). Therefore, as far as current situation and technology availability are concerned, the key way to sustain the population of this beautiful indigenous fish is to standardize captive breeding protocols and popularize the same among hobbyists, ornamental fish breeders, entrepreneurs etc.

#### Conclusion

The ornamental fish trade is rapidly rising and hence, it is a wonderful tool to enhance the livelihood of small-scale ornamental fish farmers

and breeders and moreover, contributing to the country's economy. Ornamental fishes indigenous to India are gems of a creature that can make aquarium look brighter and more beautiful. India has a very high potential to be a game changer in the market, but as of now, the maximum potential has not been realized yet. Therefore, with the available hotspot of indigenous ornamental species, it is a must for us to standardize breeding techniques in captivity to reduce pressure upon the wild stock particularly on the fish in the subject, whose supply is solely dependent on wild catch. Thereby, more intense work and research advancements are required; thereafter proper dissemination and extension activities need to be carried out for popularization of the technique among breeders and farmers in order to achieve the goal and flourish in this sector in terms of production and supply.

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**Fish Protein Hydrolysate:  
An Emerging Dietary Protein Source in Aqua Diets**

**Conclusion**

Fish protein hydrolysate is a by-product obtained from fish and shellfish processing waste through the above-mentioned hydrolysis process method. However, due to the advantages of processing conditions, enzymatic hydrolysis is the most commonly used processing technique for FPH. Due to its high protein and free amino acid content and low fat and ash levels, FPH is used in various commercial fish and shellfish diets. Furthermore, according to several research studies, FPH derived from various fish and shellfish wastes is used as either fish meal alternatives or attractants in many commercial farmed fishes. As a result, FPH is a new fish meal alternative for sustainable aqua feed production.

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# Nutritional programming in Fish

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## Introduction

From the term Programming, we can get an idea about the process of instructing or learning by means of an instructional program. But this has a broad sense of view if interceded with nutrition. Precisely, Programming is a general phenomenon where exposure to a particular stimulus during a critical window of development leads to long-term changes in structures or functions. The programming agents may be from exogenous or endogenous sources. In a nutshell, programming refers to an inheritably settled circumstance being stirred up by external (antigens, drugs, etc) or internal (release of hormone) stimulation. Among those exogenous stimuli, nutrition is especially important and has a well-established role in programming. To date, nutritional programming has been evaluated in birds (reviewed by Morisson et al. 2017), farm animals (reviewed by Sinclair et al. 2016) and primates (including humans). The greatest effort of programming studies has been done in laboratory experiments on rodents because of clinical and biomedical implementations. Research regarding nutritional programming has become a recently buzzed-out topic in the field of nutrition in fishes thus progressing towards more

sustainable feed diets replacing high-cost fish diets namely fish meal, shrimp meal, etc.

## Concept of Nutritional Programming

Nutritional programming also called metabolic programming is mostly studied for getting a successful outcome ignoring the cause of the study. Other relevant terms for nutritional programming include fetal programming, focusing on vertical transmission between mother and daughter/son, or developmental programming associated with regenerative processes. The concept of nutritional programming involves two different types of maternal diets likely the control diet and the low protein diet during pre-spawning and early larval stages. The shoal of fishes was cross-fostered at the time of spawning thus producing two pairs of nutritional treatment groups for the offspring i.e. control, low protein diet during pre-spawning and early larval stages, postspawning low protein (only during post-spawning phase) and pre-spawning low protein. By crossfostering, one can investigate whether programming works for the pre-spawning or larval period or both and whether the programming effect is reversible. Thereafter a challenging experiment was conducted at the end of some cross-fostering studies, to test whether nutritional programming gives out greater adaptability to

nutritionally suboptimal conditions. Subsequently, the fish fed on an experimental diet is transferred to a “normal” diet for several weeks to months (which implies an optimal diet, high-quality food, or a diet substituting the nutrients that lacked in the experimental diet, being referred to as “common feeding”). Then the experimental or a similar diet is given (referred to as the “challenge diet”) and is retaliated at the end of this “challenge phase”. Here, after the early nutritional stimuli were removed, a common feeding period portrayed a standard for determining whether a study measured the effects of nutritional programming. Hardly had an early nutritional stimulus (without a common feeding period) not rated to be programming when studies showed a response. A crossover feeding paradigm (the equivalent of cross-fostering) is not required.

## Advantages of using Fishes as a model to study mechanisms of nutritional programming

- (1) Their high batch fecundity makes it easy to obtain a large sample size with the same genotype.
- (2) Embryonic development and

**Aquaculture could benefit from nutritional programming as an approach. Early nutrition of fishes from both endogenous (maternally derived) and external sources could have similar developmental and metabolic programming effects. Survival, growth, brain development and nutrition metabolism are all factors that have been studied in fish.**



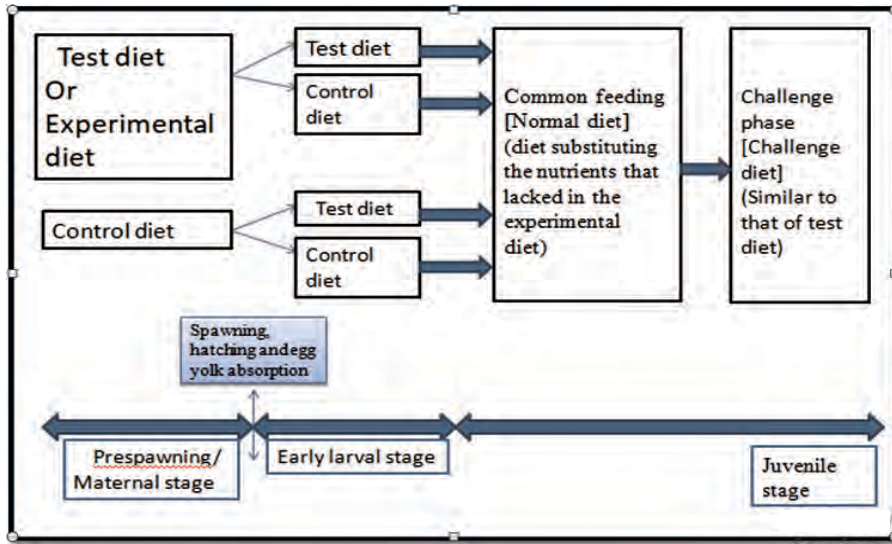


Fig 1: Procedure followed in nutritional programming of fishes

organogenesis occur externally, allowing easier access to the developing animal and control of environmental conditions.

(3) Quantification and assessment of the nutrients in the fish eggs is easier.

**Mechanism of action**

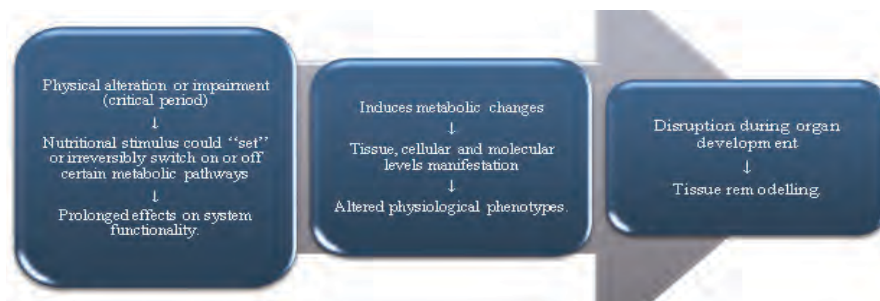


Table 1: Nutritional programming studies using fish models

Species	Programming window	Effects	Nutritional stimulus	References
Atlantic cod	Larval feeding	Growth	Copepod	Imsland et al. (2006); Koedijk et al. (2010); Øie et al. (2015)
	Larval feeding	Stress tolerance	Copepod	Øie et al. (2015)
Rainbow trout	Larval feeding	Growth, muscle growth	High fat	Alami-Durante et al. (2014)
	Larval feeding	Carbohydrate metabolism	Hyperglucidic+hypoxia	Liu et al. (2017); Hu et al. (2018)
	Larval feeding	Carbohydrate metabolism	Hyperglucidic	Geurden et al. (2007, 2014)
	Prior to spawning	Growth, survival; ingestion	Methyl group donor	Fontagne-Dicharry et al. (2017)
	Prior to spawning	Lipid metabolism; carbohydrate metabolism	Methyl group donor	Seiliez et al. (2017)
	Adult life cycle	Lipid metabolism; carbohydrate metabolism; muscle growth	Plant-based diet	Lazzarotto et al. (2016)

The above flowchart conveys the idea that this concept of nutritional programming involves physically altering or impairing somatic structures during a critical period and alternatively, the nutritional stimulus could set or irreversibly switch on or off certain pathways of metabolism leading to prolonged consequences on system functionality.

In general, nutritional programming brings out changes in metabolic activities that can be perceptual at the tissue, cellular and molecular levels leading to alteration in the physiological phenotypes i.e. changes in metabolism, growth rate, locomotory performances, phenotypic plasticity and selective mortality including energy requirement, aerobic and anaerobic capacity, tolerance to environmental stress followed by effects on foraging requirements and hunger (Table 1). The perceptible tissue manifestation affects immunology and defense mechanisms when something affects the fish body.

The disruption of either differentiation or proliferation processes under adverse conditions during organ development could yield tissue remodeling.

	Larval feeding	Ingestion	Plant based diet	Geurden et al. (2013)
	Larval feeding	Growth	Plant based diet	Geurden et al. (2013); Clarkson et al. (2017)
	Larval feeding	Lipid metabolism; muscle metabolism	Vitamin supplementation	Panserat et al. (2017)
European seabass	Larval feeding	Lipid metabolism	HUFA deficiency	Vagner et al. (2007, 2009)
	Larval feeding	Growth	Hyperglucidic	Zambonino-Infante et al. (2019)
	Larval feeding	Stress tolerance	Hyperglucidic	Zambonino-Infante et al. (2019)
	Larval feeding	Hypoxia tolerance	Hyperglucidic	Zambonino-Infante et al. (2019)
	Larval feeding	Carbohydrate metabolism	Hyperglucidic	Zambonino-Infante et al. (2019)
Gilthead seabream	Larval feeding	Carbohydrate metabolism	Hyperglucidic	Gong et al. (2015)
	Spawning	Growth; lipid metabolism	Plant based diet	Izquierdo et al. (2015); Turkmen et al. (2017)
	Larval feeding	Growth; digestion	Plant based diet	Perera and Yufera (2016a)
	Larval feeding;	Inflammation	Plant based diet	Perera and Yufera (2016a, b)
	Juvenile	Lipid metabolism, Growth	Plant based diet	Turkmen et al. (2017)
Zebrafish	Embryonic stage	Carbohydrate metabolism	Hyperglucidic	Rocha et al. (2014, 2015)
	Larval feeding	Carbohydrate metabolism	Hyperglucidic	Rocha et al. (2016a, b)
	Adult life cycle	Lipid metabolism	Maternal one-carbon micronutrient deficiency	Skjærven et al. (2016, 2018)
	Adult life cycle	Lipid metabolism	Maternal high ARA	Adam et al. (2018, 2019)
	Larval feeding	Inflammation	Plant based diet	Perera and Yufera (2016a, b)
Senegalese sole	Larval feeding	Growth	Intact protein (vs hydrolysate with polypeptides)	Canada et al. (2018)
	Spawning	Growth, development (deformity); lipid metabolism	Maternal PUFA and vitamin supplementation	Morais et al. (2014)

### Physiological mechanism

#### 1. Ingestion

The hypothalamus is responsible for appetite regulation and induces energy homeostasis influencing structural and functional

modifications of the hypothalamus as a result of early nutritional stimulation. This may further lead to modification in structure and function. Very few studies have been conducted on the feed

intake of fishes with reference to programming. A table is given showing variation in effect on the same species with respect to different programming windows and different nutritional stimuli (Table 2).

Species	Stage at which the nutritional stimuli given	Nutritional stimuli	Effects	Justification	References
Rainbow trout	Broodstock	Different levels of methionine	Offspring survival and growth	Alteration in the expression of an anorexigenic peptide (proopiomelanocortin A, POMCa) and an orexigenic peptide (NPY) in offspring after hatching and the effect on POMCa expression remained three weeks after initiation of exogenous feeding.	(Fontagne-Dicharry et al. 2017)
	Juvenile	Hyperglucidic diet	No effects on feed intake		Geurden et al. (2007) and Gong et al. (2015)

It is to be noted that the regulation of appetite in fish is not fully known. It has still not been clarified that when during the developmental stage, the internal appetite regulating mechanism becomes functional in the larval stages of fishes.

Also, it has been observed that fish larva feed constantly if prey or

feed supply is abundant thereby suggesting that the signal of feeding satisfaction regulated by the anorexigenic factors is not yet functional.

## 2. Digestion and absorption

For most fish species, digestive enzymes in striking amounts are present immediately after the

commencement of external feeding or at hatching (Oozeki and Bailey 1995; Lazo et al. 2011), though the digestive system is not completely developed then. This is a nutrient-sensitive process as the digestive enzymes are specific to their activity at different stages.

Species	Programming window	Nutritional stimuli	Effects	References
Juvenile rainbow trout	Larval feeding	Hyperglucidic diet	Upregulated expression of pancreatic $\alpha$ -amylase and intestinal maltase	(Geurden et al. 2007)
Adult zebrafish	First feeding	High glucose stimulus	Enhanced expression and activity of $\alpha$ -amylase	(Fang et al. 2014)
Gilthead seabream	Larval feeding	Soybean meal (for 2 weeks)	Decreased pancreatic enzyme activities (trypsin, chymotrypsin, amylase) and reduced growth	(Perera and Yu'fera 2016b).
		Removal of soybean meal after 2 weeks	Resumed chymotrypsin and amylase activities, but trypsin activity and growth did not recover	(Perera and Yu'fera 2016b).
	After 3 weeks of common feeding	Normal diet	enhanced fatty acid transport and suppressed peptide absorption, marked by upregulation of intestinal fatty acid binding protein 2 genes related to fatty acid transport and uptake and downregulation of solute carrier family 15 oligopeptides transported member related to dipeptide and tripeptide absorption and growth development	(Perera and Yu'fera 2016b)

**Epigenetic studies**

Epigenetics refers to the study of changes in organisms caused by modification of gene expression rather than alteration of the genetic code itself. Among other environmental stimuli, diet and dietary variations can trigger epigenetic modifications.

Methylation of CpG islands that are typically located at the promoter site of genes and are free of methylation is associated with transcription

repression. This transcription repression is an essential mechanism that precisely regulates gene expression by binding to nearby DNA and blocking the attachment of RNA polymerase to the promoter thus preventing the transcription of genes into mRNA.

Histone- lysine methylation can either promote or repress transcription depending on the lysine residue being modified. It is experimentally observed that the adaptive changes

in gene expression associated with nutritional programming remain silent until the identical or opposite environmental stimuli arise again.

Epigenetics bridges the time gap by giving cells “metabolic memory” of previous nutrition i.e. it links with the pre-spawning nutritional environment with metabolic variations in later life because epigenetic patterns are transmitted from one generation to another.

Species	Programming window	Nutritional stimuli	Effects with context on epigenetic studies	Justifying reason	References
Gilthead seabream	Larval feeding (early stage)	Soybean meal diet	reversible increase in global histone H3 acetylation	Alteration in the transcription of genes related to digestion and inflammation	(Perera and Yu’fera 2016b)
		Removal of Soyabean meal diet	Persistent global DNA hypomethylation		
Broodstock rainbow trout	Prior to spawning	Dietary methionine	mediated expression of several genes involved in the metabolism of sulfur-containing amino acids, cholesterol, and glucose	The epigenetic mechanism is still not clarified	Seiliez et al. 2017

**Noteworthy features of nutritional programming**

➤ Reversibility

Considerably it is evident that the nutritional programming has retaliated to a permanent effect on growth, metabolism, and critical organ functions even though it has been passed through a common feeding period being followed by an early nutritional stimulus.

Species studied	Programming window	Nutritional stimuli	Effects	References
Juvenile pike perch	Larval feeding	Dietary DHA deficiency	resulted in an irreversible reduction in cephalic index	(Lund et al. 2012)
	4 months of common feeding	Normal diet	mostly restored the fatty acid composition of the brain, although the DHA level failed to reach control levels	

➤ Adaptiveness

It speaks about the robustness of the nutritional programming studied fishes under varied conditions of nutritional diets by controlling the influence on phenotypic characteristics of the metabolism

and modulating the locus of growth accordingly.

Various challenge experiment studies have enlightened that early exposure could result in the successful adaptation of nutritionally inferior diets namely hyperglycemic,

low HUFA, or plant-based diets by improving utilization of those nutrients by enhancing to put up with or redesign modification in metabolic pathways without any compromise on its growth.

Species studied	Programming window	Nutritional stimuli	Effects	References
Rainbow trout	25 days after a 7month common feeding period	Plant based diet	Better growth, concomitant with higher feed intake and feed utilization efficiency, in comparison to fish that were fed the control diet*	(Geurden et al. 2013)
Atlantic salmon	Challenge feeding	Vegetable based diet	faster growth, better feed efficiency, and greater retention of EPA and DHA	(Clarkson et al. 2017)

### Limiting factors

- The studies that have been published to date employed a variety of experimental conditions likely dietary treatment, commencement, or duration of the nutritional stimulus making it difficult to detect the common factor between them. For instance, despite containing a lower amount of long chain HUFA and n3 fatty acids and a greater amount of shorter chain and n6 fatty acids, the specific composition, and essential fatty acid ratios vary among different vegetable oils.
- Most studies in fish nutritional programming highlight the presence of a particular class of nutrients ignoring changes in the dietary availability of non-target macro and micro nutrients that may occur simultaneously because of dietary consumption. Thus the other nutrients need to be considered for balancing the nutritional composition.
- It is strenuous to handle the absolute nutrient composition of broodstock or larva. Concerning interventions to the larval diet, factors that affect the nutritional profile of live prey includes the application of enriched products, and the culture method being applied alongside its metabolism. The metabolism of the live prey holds responsible for varying the nutritional profile by introducing variation to the nutrition received by the larva.

### Conclusion

- Emerging field of nutrigenomics.
- Lessons in sustainability: Sustainable aquaculture requires depletion in the use of fishery's non-renewable products in feeds and at least partial replacement with more sustainable ingredients. Thus the concept of nutritional programming is a promising strategy for enhancing fish production at a low input cost wise.
- It has been pointed out that many studies report programming effects without following the whole life course of the animals and this is especially true for studies on fishes, most of which were terminated during the juvenile stage or earlier. Extending the duration of experiments, perhaps to multiple generations could lead to important benefits to the biomedical, ecological, and aquacultural communities.
- Many current research efforts on fishes report responses in gene expression without confirmation of protein changes or functional significance. Changes in gene expression alone may not necessarily translate into a significant physiological impact, so the programming effects may be exaggerated or misleading if interpretation is based solely on gene expression results.
- Some recent research on finfish

aquaculture is motivated by the physiological adaptability exhibited by fishes via nutritional programming. This strategy has successfully been applied to several economically important fish species too.

- Additionally, more work is required to raise the marginal profit projectile so that it can be implicated commercially.

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\* More references can be provided on request.

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

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