English Monthly from Hyderabad, India

Aqua International

Estd. 1993

Health • Nutrition • Technology • Management

August 2025

Annual Subscription: ₹800 Foreign USD 100

Inside ...

Aqua International

English Monthly Magazine
(Established in May 1993)

Volume 33 Number 4 August 2025

Editor & Publisher
M. A. Nazeer

Editorial & Business Office:
AQUA INTERNATIONAL
NRS Publications,
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Website: www.aquainternational.com

Annual Subscription
India : Rs. 800
Foreign Countries : US $ 100
or its equivalent.

Aqua International will be sent to the subscribers in India by Book Post and to the foreign subscribers by AirMail.

Edited, printed, published and owned by M. A. Nazeer and published from BG-4, Venkataramana Apts., 11-4-634, A.C.Guards, Hyderabad - 500 004, India. Printed at Srinivasa Lithographics.

Registered with Registrar of Newspapers for India with Regn. No. 52899/93. Postal Regn. No. L II/ RNP/HD/1068/2021-2023.

NRS PUBLICATIONS
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Subscriptions for Aqua International, English monthly, should be sent to:
The Circulation Department, Aqua International, BG-4, Venkataramana Apartments, 11-4-634, A.C.Guards, Near Income Tax Towers, Hyderabad - 500 004, India. Email: info@aquainternational.in

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WAS to host World Aquaculture 2025 at Hyderabad, India

Medicinal plants offer eco-friendly, cost-effective alternatives to antibiotics in aquaculture, enhancing immunity and growth. Their bioactive compounds like phenolics, alkaloids, and terpenoids exhibit antiviral, antimicrobial, and immunostimulatory properties. They act by blocking virus entry, inhibiting replication, modulating immunity, and showing direct virucidal effects. Structure Activity Relationship (SAR) studies aid in understanding their mechanisms and improving antiviral drug design. Despite challenges like standardization and safety concerns, medicinal plants show great promise for sustainable disease control in aquaculture.

Dear Readers,

The August 2025 issue of Aqua International is in your hands. In the news section, you may find news about....

The World Aquaculture Society (WAS) informed that its World Aquaculture 2025 India (WA 2025) is set to take place on November 10-13, 2025 at the Hyderabad International Convention Centre – Novotel, India. Spanning three days of conference sessions and a concurrent three-day exhibition, WA2025 will offer a dynamic platform featuring technical presentations, workshops, exhibitions, and extensive networking opportunities. This landmark international event is proudly hosted by the Indian Council of Agricultural Research (ICAR) and the National Fisheries Development Board (NFDB) with strong support from P.V. Narsimha Rao Telangana Veterinary University and the Society of Aquaculture Professionals (SAP) reflecting a powerful collaboration between academic institutions, government bodies and industry stakeholders.

MPEDA holds Grand Finale of Skill Olympiad on seafood value addition in Chennai
India's skilled professionals in the marine sector will vie for top honours in a first-of-its-kind National Skill Olympiad held here on July 1, which aims to enhance skills in seafood value addition, build a trained professional pool and raise awareness on quality. In a keen tussle for top honours, Thanseer K R, who works with Abad Foods, Malipuram in Kerala, was adjudged the winner of the inaugural edition of National Skill Olympiad on seafood value addition, the grand finale of which was held during the Seafood Expo Bharat in Chennai.

Aqua International organised its 41st India International Aquaculture Expo at Vijayawada, on 17-18-19 July 2025 with 3-day Exhibition, Conference and AI Awards Presentation function. The Conference discussed the issues Aquaculture sector facing in India and the possible solutions. 13 individuals, institutions and organizations were honoured with presentations of AI Awards for achieving excellence, innovation and performance in the profession and for the contribution to Aquaculture sector in the country.

In the Articles section, article titled **"Selection for salinity tolerance in an SPF** *P. vannamei* balance genetic line", authored by Ms Natthinee, Mr Chotitat and Mr Craig

says that the global shrimp industry is evolving rapidly with farming operations expanding from traditional coastal ponds to inland, brackish and even freshwater environments. *Penaeus vannamei*, a euryhaline species is well known for its ability to grow across a wide salinity range, from near-freshwater conditions to highly saline, arid regions exceeding 50 ppt. Importantly, the efficiency of osmoregulation is under genetic control. Some shrimp families regulate internal salt balance

Contd on next page

NRS GROUP
Aqua International

Our Mission

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

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

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

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

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

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more effectively, allowing them to grow faster and convert feed more efficiently, even in challenging low-salinity environments. This makes broad salinity tolerance a highly valuable trait when developing genetically improved shrimp lines.

By measuring and selecting for multiple traits simultaneously using advanced genomic techniques, gains can be achieved steadily and consistently even for traits which may be negatively correlated. The key is a focused, data driven, disciplined and consistent approach applied across many generations.

Another article titled, **"Antiviral Properties of Medicinal Plants: Exploring Natural Compounds for Viral Inhibition",** authored by Mr Khusbu Samal, Ms Mutum Deepti, Mr Narendra Kumar Maurya, discussed that Medicinal plants have long been recognized for their therapeutic properties, and their application in aquaculture is gaining increasing attention. This review explores the antiviral properties of medicinal plants and their potential as eco-friendly alternatives to synthetic drugs for disease prevention and control in aquatic species. Medicinal plants contain bioactive compounds such as flavonoids, alkaloids, terpenoids, and phenolics, which exhibit antiviral activities through mechanisms like viral entry inhibition, replication suppression, and immune system modulation. Highlight Points - Medicinal plants offer eco-friendly, cost-effective alternatives to antibiotics in aquaculture, enhancing immunity and growth. Their bioactive compounds like phenolics, alkaloids, and terpenoids exhibit antiviral, antimicrobial, and immunostimulatory properties. They act by blocking virus entry, inhibiting replication, modulating immunity, and showing direct virucidal effects. Structure Activity Relationship (SAR) studies aid in understanding their mechanisms and improving antiviral drug design. Despite challenges like standardization and safety concerns, medicinal plants show great promise for sustainable disease control in aquaculture.

Another article titled, **"An account of a reputed Government fish farm and features of Litopenaeus vannamei farming in Purba Medinipur"**, authored by Mr Subrato Ghosh, says that the Government Fish Technological Station (GFTS), Junput, Dist. Purba Medinipur, West Bengal, is a fish farm under Department of Fisheries, Government of West Bengal. It is one of the three State Government fish farms in the state. Every year, seed (72-hour old spawn) production of Indian major carps, Labeo bata, L. calbasu, Chinese carps is done following the established science and technique of induced fish breeding in rectangular fish breeding chambers and circular egg incubation-cum hatching chambers.

Previously there was a hygienic fish drying unit at GFTS, meant for producing high quality sun-dried marine fish for human consumption. Till 1982-1983, there was a shark liver oil extraction unit which was meant for providing (supplying) Vitamin-A and Vitamin-D to common people at a low cost. Air-breathing catfish *Clarias magur* and giant prawn Macrobrachium rosenbergii were farmed in freshwater ponds of GFTS till recent past. Recently, the newly-constructed hatchery unit has been made fit for operation for seed production and propagation of threatened freshwater fishes like *Puntius sarana, Osteobrama belangiri, Ompak pabda, Heteropneustes fossilis*.

In general, some farmers have obtained 7000 - 9000 kg marketable sized *L. vannamei* in one crop from seven ponds, each 12000 sq feet or 1114 sq.mt in area. A sturdy bamboo-built walkway and feeding tray checking is common in every *L. vannamei* pond for monitoring feed consumption every time every day. Before seed stocking, preparation and application of organic juice in *L. vannamei* ponds using a mixture (water-soaked and fermented) of ground nut oil cake, yeast, sugarcane jaggery, soyabean powder, fish meal and wheat is a new concept. Another such mixture comprise of sugarcane jaggery, rice bran, dolomite, yeast powder and sour curd. The APL at GFTS, Junput is expected to support *L. vannamei* farmers' needs and curb incidences of diseases in farms

Another article titled, **"Successful induced breeding of Reba carp (Cirrhinus reba) under hill conditions of Meghalaya, Northeast India"**, authored by Mr Chandan Debnath says that this study reports the first successful captive breeding of Cirrhinus reba (Reba carp) under the hill conditions of Meghalaya, Northeast India. Fingerlings procured from Assam were reared to maturity in a hill farm environment, achieving successful gonadal development despite cooler temperatures. Using Ovafish hormone (0.25 ml/kg for males, 0.5 ml/kg for females), breeding was successfully induced with 85 - 90% fertilization and 75 - 80% hatching rates. Length-weight analysis revealed positive allometric growth ($W = 0.0068L^{3.11}$) with condition factor of 0.94, indicating successful adaptation to hill environments. This achievement creates significant opportunities for diversification of regional aquaculture with indigenous species, offering both food security and livelihood benefits while contributing to conservation of this vulnerable species with dual food and ornamental potential. Highlighted Points - The article reports the first successful captive breeding of Reba carp in Meghalaya's hill conditions, where researchers achieved 85 - 90% fertilization and 75 - 80% hatching rates using Ovafish hormone. The species demonstrated positive allometric growth, indicating successful adaptation to cooler hill environments despite challenging conditions. This achievement is particularly significant as Reba carp serves as a dual-purpose fish, offering both food security benefits and contributing to conservation efforts for this vulnerable indigenous species

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.

M.A.Nazeer
Editor & Publisher
Aqua International

Uni-President

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1. WATER QUALITY CONDITIONING

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

3. DECREASE AMMONIA CONTENT

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

5. ESTABLISH BALANCED POND BACTERIA SYSTEM

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

6. INCREASE AQUACULTURE PRODUCTION

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

* COMPOSITION:

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

* STORAGE:

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

* DIRECTION OF USE:

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

UNI-LIGHT PSB Funtion:

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- Purification of water quality

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7 days before stocking	800 g - 1,000 g	1,200 - 1,500 g	1,200 - 1,500 g
Day of stocking	300 g - 500 g	800 g - 1,000 g	800 g - 1,000 g
Every 7 - 10 days after stocking	300 g - 500 g	800 g - 1,000 g	3 - 5 days / use 1,000g - 2,000g

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

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India to host World Aquaculture 2025

at Novotel Hyderabad Convention Centre, Hyderabad, India, November 10-13, 2025

Dr Manuel Barange Plenary Speaker

Dr Manuel Barange is the Assistant Director General of the Food and Agriculture Organization of the United Nations and Director of its Fisheries and Aquaculture Division. He is an Honorary Professor at the University of Exeter, UK, and a visiting Professor of the Yellow Sea Fisheries Research Institute (CAFS), Qingdao, China. Prof Barange was the Deputy Chief Executive Officer and Director of Science at the Plymouth Marine Laboratory and Chair of the scientific committee of the International Council for the Exploration of the Sea (ICES). He is a global fisheries and aquaculture expert, with a particular focus on climate and anthropogenic impacts on marine ecosystems and on the role of aquatic foods in ending hunger and poverty. He has over 130 academic publications, and in 2010 was awarded the UNESCO-IOC Roger Revelle Medal for his contributions to ocean science.

World Aquaculture 2025 Announces Plenary Speaker, Our Partner, APC Travel Awards for Student, and Sponsor for Global Event in Hyderabad, India

Hyderabad, India – November 10–13, 2025, The World Aquaculture Society (WAS) is pleased to share exciting updates for World Aquaculture 2025 India (WA2025), set to take place at the Hyderabad International Convention Centre – Novotel. Spanning three days of conference sessions and a concurrent three-day exhibition, WA2025 will offer a dynamic platform featuring technical presentations, workshops, exhibitions, and extensive networking opportunities. **This landmark international event is proudly hosted by the Indian Council of Agricultural Research (ICAR) and the National Fisheries Development Board (NFDB), with strong support from P.V. Narsimha Rao Telangana Veterinary University and the Society of Aquaculture Professionals (SAP)—** reflecting a powerful collaboration between academic institutions, government bodies, and industry stakeholders.

Plenary Speaker Announcement

We are honored to welcome Dr. Manuel Barange from Food and Agriculture Organization of the United Nations, as a Plenary Speaker. With a distinguished background in aquaculture, he will share his insights and experience that will offer valuable insights to attendees from over 100 countries.

His plenary address, aligned with the conference theme **"Aquaculture Opportunities, Options, and Optimism,"** will take place on November 11, 2025, at 9:50 AM.

WAS-APC Student and Women Participation Travel Awards:

In support the next generation of aquaculture professionals, WA2025 is pleased to offer Student Travel Awards presented by WAS-Asian Pacific Chapter. These awards aim to encourage students' participation, attend the conference, providing them with the invaluable opportunity to present their research, submit an abstract, participate in discussions, and connect with leaders in the field. The award funds will be given to the recipient to assist with travel expenses to attend the conference and present their abstract.

For more information, please visit the WAS-APC website at https://www.was.org/APC, or contact the WAS- APC Chapter Executive Officer at apcsec@was.org.

Call for Abstracts – Deadline: July 15, 2025

WA2025 invites researchers, academics, and industry professionals to submit abstracts for oral or poster presentations. This is a prime opportunity to share groundbreaking research and innovations with a diverse, international audience.

Submission Deadline: July 15, 2025 Event Sponsor Partnership

WA2025 is proud to acknowledge the generous support of our premier sponsors**: Blue Aqua, Devee Group, INVE Aquaculture, MSD Animal Health, SyAqua, and Zeigler.** Their continued commitment plays a vital role in the success of this global event and the advancement of sustainable aquaculture practices. We are also delighted to welcome **QRILL Aqua, Aker BioMarine company**, as the newest sponsor of WA2025. QRILL Aqua Aker QRILL Company is an Antarctic krill-harvesting company dedicated to improving health across species.

MPEDA holds Grand Finale of Skill Olympiad on seafood value addition in Chennai

- Finals of first-of-its-kind Olympiad on July 1 during Seafood Expo Bharat
- Winners of preliminary round to compete for honours and prize money

Chennai, June 29: India's skilled professionals in the marine sector will vie for top honours in a first-of-its-kind National Skill Olympiad here on July 1, which aims to enhance skills in seafood value addition, build a trained professional pool, and raise awareness on quality.

The grand finale of the unique Olympiad, launched by the Marine Products Export Development Authority (MPEDA), will be held as part of Seafood Expo Bharat 2025 in the city.

As a prelude to the event, MPEDA had conducted multiple rounds of skill tests for trained professionals across the East and West coasts of India to assess the practical skills acquired during training. The preliminary rounds of the Skill Olympiad were held in Kochi on May 29 and in Visakhapatnam on June 5.

Five winners each from the West Coast and East Coast were selected for the semi-final to be held at Chennai on June 30. The top four performers from the semi-final will compete in the finale of the Skill Olympiad on Seafood Value Addition.

The winners of the final round will be awarded cash prizes and mementos, with Rs 1,00,000 for first place, Rs 75,000 for second, Rs 50,000 for third, and Rs 25,000 as a consolation prize for the fourth position.

The Skill Olympiad will be witnessed by stakeholders, including officials from the Central and State fisheries departments, seafood exporters, foreign buyers, and other delegates of Seafood Expo Bharat 2025. SEB 2025 will feature an exhibition area accommodating over 116 stalls, with more than 3,000 delegates expected to participate. It promises to provide a vibrant platform for exhibitors and visitors to engage in meaningful business interactions, exchange technological innovations, and stay updated on the latest industry developments.

The products prepared by the Skill Olympiad champions will be displayed for the audience. Further, a tasting session of the value-added seafood products will be held in the MPEDA's Skill Olympiad pavilion.

MPEDA Chairman Mr D V Swamy said there are plans to organise the Olympiad annually to strengthen India's seafood value addition sector and make the country a global hub for value-added seafood exports.

"The unique event, which was in tune with the Centre's Viksit Bharat 2047, supports the goals of Pradhan Mantri Kaushal Vikas Yojana (PMKVY) by promoting industry-relevant skills, recognizing trained seafood workers, and enhancing employability in the seafood sector," he added.

MPEDA has trained over 2,500 workers in seafood value addition through hands-on training programmes conducted by both national and international experts. Around 4,000 workers are currently engaged in the value addition sector across India.

Seafood processing professionals have been trained in preparing value-added products having high demand in the international market. These include different categories of shrimp, cephalopods, and fish products such as Nobashi (stretched shrimp), breaded Nobashi shrimp, breaded butterfly shrimp, cooked PDTO shrimp, butterfly sushi shrimp, marinated shrimp skewers, breaded fish fillets, fish fingers, squid cut rings, breaded squid rings, and mixed seafood skewers.

India exported seafood worth USD 7.44 billion in the FY 2024–25. At present, India has 650 processing units with a processing capacity of **more than** 35,000 MT. Over 100 of these units are involved in the processing of high-end value-added seafood products, contributing to 10 per cent (USD 0.74 billion) of total seafood exports.

India aims to double the exports of value-added seafood products to 20 per cent of its total seafood exports by 2030.

Thanseer K R of Kerala declared winner of MPEDA's National Skill Olympiad on value-added seafood exports

Chennai, July 01: In a keen tussle for top honours, Thanseer K R, who works with Abad Foods Malipuram in Kerala, was adjudged the winner of the inaugural edition of National Skill Olympiad on seafood value addition, the grand finale of which was held during the Seafood Expo Bharat in the city.

A total of four trained seafood processing professionals showed their expertise and competency in the final round of the Olympiad, a pioneering initiative of the Marine Products Export Development Authority (MPEDA) which aims to give an impetus to export of seafood products and build a skilled professional pool.

Balamurugan I (Edhayam Frozen Foods Pvt Ltd, Tuticorin, Tamil Nadu) came second while Ms Sandya Rani Palaparthi (Coastal Cooperation Ltd, Kakinada, Andhra Pradesh) was at the third place. Ms D. Anitha (Sandhya Aqua Exports Pvt Ltd, Kakinada) grabbed the fourth spot.

The awards were announced by Mr. Hibi George Eden, MP and Authority member of MPEDA, and Mr D.V. Swamy, Chairman, MPEDA.

During the finals, the contestants were asked to rustle up preparations from Breaded Butterfly Shrimp, Cooked PDTO (Peeled, Deveined, Tail-On) shrimp, Breaded Squid Rings and PDTO (Peeled and deveined tail-on) skewered shrimp in a time-frame of 80 minutes.

The products were judged on the criteria of quality, hygiene, execution and presentation.

The winner of the final round was awarded Rs 1,00,000 while the prize money was Rs 75,000 for second and Rs 50,000 for third place, respectively. An amount of Rs 25,000 was given as a consolation prize for the fourth position.

The winners were also given medals and certificates.

The panel of the judges comprised Dr Parvathy. U, Senior Scientist, ICAR-CIFT, Kochi; Mr B. Koteswar, Processing & Quality Assurance Supervisor, NIFPHATT, Vizag; Mr. Francis Assisi, Production Manager, Parayil Seafood Pvt. Ltd; Mr Jayan Jacob, General Manager, Sandhya Aqua Exports Pvt Ltd; and Mr Krishnan K, General Manager, Sagar Grandhi Exports Pvt. Ltd.

Mr Eden appreciated the efforts of MPEDA in conducting the Olympiad and taking the initiative of seafood value addition to greater heights.

The MPEDA Chairman lauded the participants, recognizing their dedication in preparing value-added seafood products and their efforts in attending the Olympiad.

The finale of the Skill Olympiad was witnessed by stakeholders, including officials from the Central and State fisheries departments, seafood exporters, foreign buyers, and other delegates of Seafood Expo Bharat 2025.

Mr Swamy said the Olympiad was a novel initiative to boost India's seafood value addition sector and make the country a global hub for value-added seafood exports. "MPEDA planed to make it an annual event. There is a growing demand for seafood value added products in international market. Such an event will give a fillip to seafood exports from India," he added.

As a precursor to the event, MPEDA had conducted skill tests for trained professionals across the East and West coasts of India to assess the practical skills acquired during training. The preliminary rounds were held in Kochi (West Coast Zone) on May 29 and in Visakhapatnam (East Coast Zone) on June 5. The finalists were selected from among the ten contestants in the semi-final round of the Olympiad on June 30.

The products prepared by the Skill Olympiad champions were displayed for the audience. A tasting session of the value-added seafood products was also held in the MPEDA's Skill Olympiad pavilion.

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IIAE discusses Aquaculture Issues

NRS Events organises 41st India International Aquaculture Expo at Vijayawada

Vijayawada: India International Aquaculture Expo 2025 (IIAE 2025) and India International Poultry Expo 2025 (IIPE 2025) a 3-day Exhibition, Conference and Awards Function was held in Vijayawada, Andhra Pradesh on 17-18-19 July 2025.

In his welcome address Mr M.A. Nazeer, Chief Executive of the Expo and Editor, Aqua International and Poultry Fortune said that he is indeed happy to see and meet all the participants. It's the cheerful and joyful thing that this Event is happening in Vijayawada, Andhra Pradesh, the hub for Shrimp and Fish production in India. Over 60% of Shrimps in India are produced in Andhra Pradesh State. Over 90% of shrimps produced in India are exported, but some of the consignments are rejected every now and then. Hence, it is important to avoid harmful chemicals and antibiotics during the culture period, and to safeguard the freshness of harvested shrimps before processing and exporting to overseas.

I hope this Expo was useful to bring

B. Masthan Rao, Member of Parliament (Rajya Sabha), Govt. of India. inaugurating India International Aquaculture Expo 2025 & India International Poultry Expo 2025 at Vijayawada on July 17. Dr K. Somi Reddy, Director, Srinivasa Farms Pvt Ltd, K.G. Anand, General Manager, Venkateshwara Hatcheries Pvt Ltd, Vijayakumar Yaragal, Joint Director, The Marine Products Export Development Authority, M.A. Nazeer and others are seen.

M.A. Nazeer welcoming

M.A. Nazeer presenting flower bouquet to K. Raghu Rama Krishna Raju

Lamp Lightening by K. Raghu Rama Krishna Raju, Deputy Speaker, Andhra Pradesh Legislative Assembly

M.A. Nazeer
Chief Executive, IIAE & IIPE 2025

Vijayakumar Yaragal
Joint Director, The Marine Products Export Development Authority, Vijayawada

Madhu Mohan Talluri
Technical Director, SGS Aqua Solutions, Kakinada, Andhra Pradesh

stakeholders of Aquaculture and Poultry sectors like Farmers, Raw Material buying Agents, Dealers & Distributors, Commercial & Technical Experts, and Suppliers of various products and services like Seed, Feed, Health & Nutrition Products, Aerators & Equipment, Processors & Exporters, Govt Officials together on a common platform during the three days event, and I hope this event helped all to meet, exchange ideas and gain knowledge on various aspects and for better business opportunities.

Speakers in the Conference – Update Knowledge on Aquaculture: Mr Srinivas Tetali, President, Aquaculture Profession Welfare Association. Mr Vijayakumar Yaragal, Joint Director, The Marine Products Export Development Authority (MPEDA), Vijayawada; Dr Amerneni Ravi Kumar from Alpha Biologicals. Dr R. Rajkumar Singh, Assistant Vice President, CPF India Pvt Ltd and Mr Madhu Mohan Talluri, Technical Director, SGS Aqua Solutions.

Mr K. Raghu Ramkrishna Raju, Deputy Speaker, Andhra Pradesh Legislative Assembly was the Chief Guest of the occasion and presented AI Awards to the Winners.

Srinivas Tetali
President, Aquaculture Profession Welfare Association

Dr Amerneni Ravi Kumar
Partner, Alpha Biologicals, Nellore

Dr R. Rajkumar Singh
Assistant Vice President, CPF India Pvt Ltd, Bhimavaram

A View of participants in the Conference "Update Knowledge on Aquaculture" held at Vijayawada on 17th July 2025

Asking a question to the Panalist

Asking a question to the Panalist

Asking a question to the Panalist

Asking a question to the Panalists

Asking a question to the Panalists

T Srinivas answering to a question of Audience

Dr Amerneni Ravi Kumar answering from the participants

Madhu Mohan Talluri answering to a question of Audience

Dr R. Rajkumar Singh answering to a question of Audience

Speakers and Panalists Dr Amerneni Ravi Kumar, Vijayakumar Yaragal, Tetali Srinivas, Madhu Mohan Talluri

Expo Chief Executive and Editor, Aqua International & Poultry Fortune, M. A. Nazeer presenting Mementos to Exhibitors at IIAE & IIPE 2025 in Vijayawada on 19 July 2025


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GROWTH RATE


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A view of India International Aquaculture Expo 2025 held at Vijayawada on 17-18-19 July 2025


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Zoea & Mysis:
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Post Larvae:
Stagewise control of *Vibrio sp.* results in remarkable reduction of *Vibrio sp.* load in post larval tanks. This results in high health seeds.

Works as an Alternative to Antibiotics and complies with International Seafood export regulations.

BEST APPROACH TO CONTROL PATHOGENIC VIBRIOS

V PHAGES HATCHERY	✓✓
PROBIOTIC	✓
SANITISER	✗
DISINFECTANT	✗✗
ANTIBIOTICS	✗✗✗

One Health unified approach for balanced welfare of people, animals and ecosystems.

ONE HEALTH APPROACH

BACTERI THERAPY T PATHOGEN

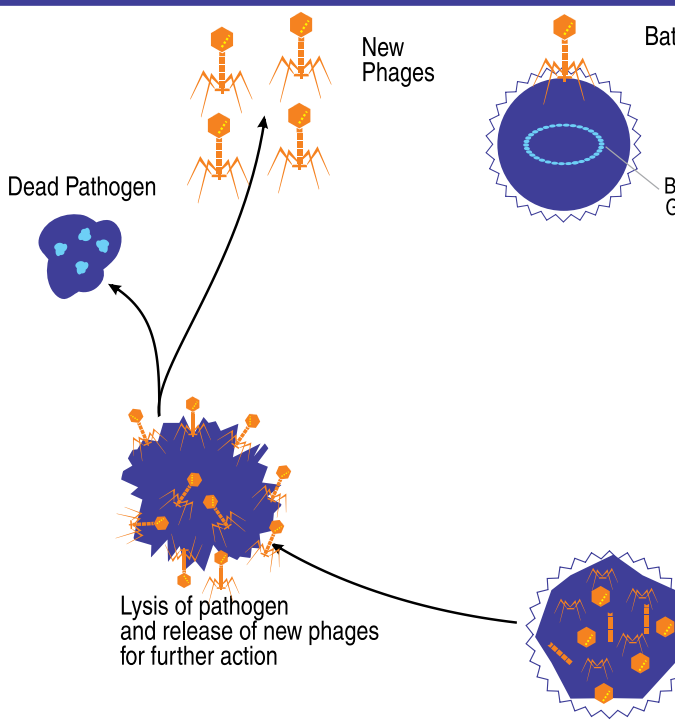
V PHAGES HATCHERY & V PHAGES GROWOUT are a co they are safe on aquatic animals, people and ecosystem resistant to antibiotics and incre

"V PHAGES" cocktail targets against most common pathog

- ***Vibrio parahaemolyticus***
- ***Vibrio alginolyticus***
- ***Vibrio h***

100 % Natural | Pathogen specific approach | Easy & Safe to use | Do

ILLUSTRATION OF ACTION OF PHA



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ns. This destroys the pathogenic bacteria which are even
eases the efficacy of probiotics.

enic *Vibrio species* in Shrimp Hatchery & Farming

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

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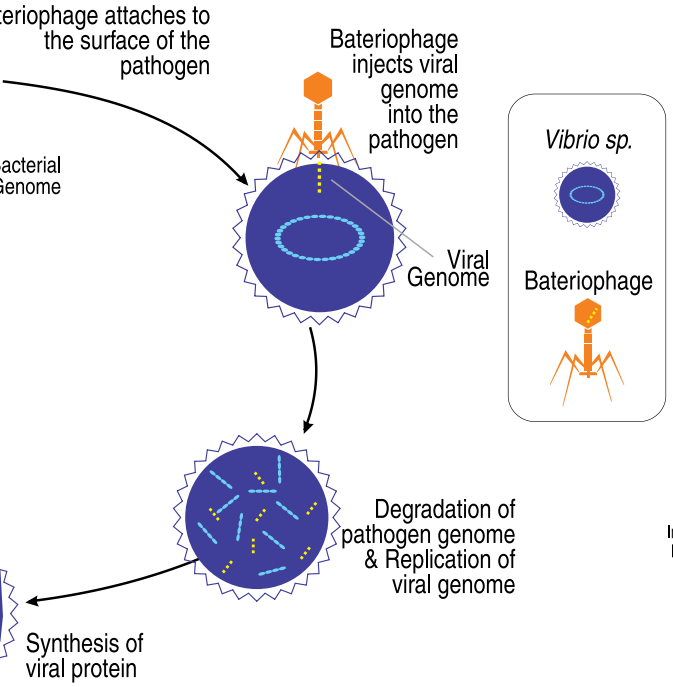
oes not leave any residues

GE ON A TARGET VIBRIO BACTERIA



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BENEFITS

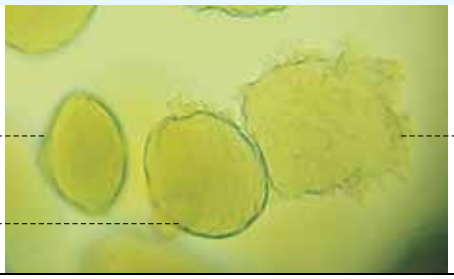
- Effective against Vibriosis, other Bacterial Infections and Running Mortality Syndrome (RMS).
- Effectively prevents Gut Infections and Improves feeding.
- Prevents sudden crop loss and extends Life of Pond during critical profit-making period.
- Enhances Probiotic performance.

Works as an Alternative to Antibiotics and complies with International Seafood export regulations.

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

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

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



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

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Aqua International presents AI Awards 2025 to the individuals, institutions and organisations

BMR Industries Pvt Ltd receives **Best Shrimp Feed Miller Award 2025**

BMR Industries Pvt Ltd receiving Best Shrimp Feed Miller Award 2025 from K. Raghu Ramakrishna Raju

Japfa Comfeed India Pvt Ltd receives **Emerging Aquaculture Feed Miller Award 2025**

Profile:
Japfa STP – Emerging Leader in India's Aquaculture Feed Industry:

Japfa STP, the aquaculture brand of **Japfa Comfeed India Pvt. Ltd.**, a subsidiary of the esteemed **Japfa Group, Indonesia**, is rapidly emerging as a game-changer in India's aquafeed industry. With a rich legacy of over 40 years in fish and shrimp nutrition across Asia, Japfa STP brings world-class expertise and innovation to Indian aquaculture.

In India, Japfa STP began its journey with the launch of a **state-of-the-art aquafeed mill in Kharagpur, West Bengal in 2024**, built with cutting-edge European technology and stringent quality standards. Today, it produces and supplies a full range of **floating and sinking fish feeds, shrimp feeds, and polyculture feeds** across all major aquaculture states.

Our feeds are known for their **exceptional performance on-ground**—delivering **superior Feed Conversion Ratios (FCR), enhanced livability, robust growth, healthier stock, and improved water quality**. The final produce—fish and shrimp—fed on Japfa STP feeds has also been widely praised for its taste and texture by both processors and end consumers. *Japfa STP is not merely selling feed—it is delivering a complete, integrated solution that empowers farmers through nutrition, technical support, and sustainable aquaculture practices.*

Supported by **Japfa Comfeed India's 25-year heritage** in Poultry, Cattle and Swine Feed sector with a network of

Japfa Comfeed India Pvt Ltd receiving Emerging Aquaculture Feed Miller Award 2025 from K. Raghu Ramakrishna Raju.

10 strategically located feed mills, we are now planning to **expand with a new aquafeed mill in Andhra Pradesh**, the hub of Indian aquaculture, to meet increasing demand and serve farmers more efficiently. Our vision is to bring consistent quality, technical support, and sustainable feed solutions to the grassroots level.

Japfa STP is not only feeding aquatic species — we are **empowering Indian farmers, elevating productivity, and contributing to a more resilient and profitable aquaculture ecosystem**.

We sincerely thank our farmers, channel partners, and stakeholders for their trust in Japfa STP. Together, we are building a future where quality nutrition leads to better farming and better livelihoods.

Ronald Robles Clemente receives **Best Marketing Man in Indian Aquaculture Award 2025**

Ronald Robles Clemente, Assistant General Manager, CPF (India) Pvt Ltd receiving Best Marketing Man in Indian Aquaculture Award 2025 from M.A. Nazeer.

Finray Biotech Pvt Ltd receives **Best Startup Aquaculture Healthcare Products Manufacturing Company Award 2025**

Finray Biotech Ltd receiving Best Startup Aquaculture Healthcare Products Manufacturing Company Award 2025 from M.A. Nazeer and Abir Mukherjee, Managing Director, Glamac International is also seen

Dr Surya Rao Irrinki receives **Best Domestic Shrimp Consumption Promotion Award 2025**

Profile:
Date of Birth: 10th November 1960
Educational

- Diploma in export management from Indian Institute of International Trade, Bangalore in 1999
- Schooling at Nirmala High School in Vijayawada

Occupation: Chairman and Managing director for Suryamitra Group of Companies

Experience: With nearly 40 years' experience in various allied businesses and farming industry, He has established Suryamitra Exim (Formally known as Surya Marine Exports) as a Merchant packer and exports in the year 1998. With a fore sight of export opportunity and creating livelihood to people He started his own factory at Yanamadurru Village in the year 2001. His first Unit was an example of the continuous production flow system with international standards at that time.

He was the first and foremost farmer in West Godavari region to pioneer Vannamie (transition from Black Tiger shrimp) in late 1990's at Losari Village. Later he has Travelled to most of the countries of World for developing export markets for shrimp.

His Vision to "make the company one of the leading Aqua producers and exporters in the world" has put the Bhimavaram region and West Godavari on the front seats of aqua culture, production and export to all parts of the world, thus providing lively hood to thousands of people around surrounding areas.

Dr Irrinki Surya Rao, Chairman and Managing Director, Suryamitra Group receiving Best Domestic Shrimp Consumption Promotion Award 2025 from K. Raghu Ramakrishna Raju.

His positive approach towards industry and the service he rendered made him win many appreciations in various forums, and he was honored with Doctorate from West Brooke University, USA.

Organizations Dr Surya Rao is associated with:

- Suryamitra Exim Pvt. Ltd., Bhimavaram, - Exports and Domestic
- Sunrise Seafoods India Pvt ltd. – Merchant Packer (Sister Concern)
- Siddhartha Hatcheries (Seed and Nauplii Brooding Centre)
- Sunshine Traders – Domestic and Trading Activity.

Dr Nitin Pipralia receives **Best Technical Services Provider Award 2025**

Profile:
Dr Nitin Pipralia: Pioneering Aquaculture counsellor and Advocate of Sustainable Shrimp Farming in North India.

Born and raised in Rajasthan.
Dr Nitin Pipralia stands as a testament to the transformative power of vision, grit, and science. Transitioning from a terrestrial biotechnologist to a marine biotechnologist under a prestigious DBT-sponsored Master's program at CAS in Marine Biology, Parangipettai (Tamil Nadu), Dr Pipralia's journey into the aquaculture world was anything but ordinary.

As a native of the desert state, his decision to pursue marine sciences often raised eyebrows. But instead of responding with words, Dr Pipralia resolved to answer through action — a promise he has more than fulfilled.

A Career Built from the Ground (or Water) Up
Dr Nitin Pipralia's journey — from the deserts of Rajasthan to the ponds of North India — continues to inspire and lead. He is more than just an aqua solution provider; he is a catalyst for change, shaping the future of sustainable aquaculture in India.

Dr Pipralia began his professional aquaculture journey in **2005** and gained critical expertise through research and field projects. As a **Senior Research Fellow** at Delhi University under a DST project, he assessed environmental impacts of aquaculture across India's coastline. His **International fellowship from GoI** enabled advanced training in **European aquaculture systems**, deepening his understanding of feed regimes, aquatic physiology, and sustainability.

North India: Turning Challenges into Opportunity
Post-COVID, in **2022**, Dr Pipralia relocated permanently to **Rajasthan**, bringing his expertise to the **emerging aquaculture belts of North India** — particularly **Rajasthan, Haryana, and Punjab**. He started from scratch, with his first breakthrough in **Churu District**, a region previously dismissed for aquaculture due to **brackish, non-potable water** and **infertile land**.

Started from his career with start up, followed by Tablets India, Prajakt life science (p) ltd to Glen Biotech as various Health care company, He **is associated with Skretting India feed Ltd, since 2024.**

In his words, *"There were two 'sins' here – unpotable water and infertile land. But with aquaculture, those sins became an opportunity."*

Now fondly known as the **"Red Car Wala Doctor"** (thanks to his signature red Volkswagen Polo), Dr Pipralia has become a **widely recognized figure in North India's aquaculture ecosystem due to his Farmer-Centric Philosophy.**

Dr Nitin Pipralia receiving Best Technical Services Provider Award 2025 from K. Raghu Ramakrishna Raju

Expertise That Makes a Difference
As a **full-time aquaculture consultant**, Dr Pipralia provides end-to-end technical support to shrimp farmers, covering: site selection , pond preparation until harvest management .

"My mission is not just a profitable harvest, but an environmentally conscious and technically sound approach to farming," he says

Vision for the Future
Dr Pipralia strongly believes that **aquaculture is key to India's food security and blue economy growth**. But for the sector to thrive, **collaborative action** is essential — from farmers, buyers, industry, scientists as well as policy makers.

"No single stakeholder can drive sustainable aquaculture alone. We need innovation, capacity building, financing mechanisms, and cross-sector partnerships to truly advance this vital industry."- Dr Pipralia says.

Message to Shrimp Farmers
"I salute all shrimp farmers who've embraced this profession. Always use certified quality seed, practice responsible stocking, feed nutritious diet and commit to sustainable aquaculture practices. Remember — profitability must go hand-in-hand with environmental care."

Recognition and Impact
In **2025**, Dr Pipralia is honoured with the **Best Technical Services Award** — a fitting tribute to his pioneering work, innovation, and unwavering support to the aquaculture community.

Dr Amernani Ravi Kumar receives **Best Technical Services Provider in Aquaculture Award 2025**

Dr Amernani Ravi Kumar receiving Best Technical Services Provider in Aquaculture Award 2025 from K. Raghu Ramakrishna Raju

M. Siva Prasad receives **Best Backbone of Industry Success (by Identifying Right Genetics for Indian Aquaculture Environment) Award 2025**

Profile: Siva Prasad Mallipudi was born in Razole, East Godavari, Andhra Pradesh, in 1975. He studied his postgraduate degree in Coastal Aquaculture and Marine Biotechnology at Andhra University, Visakhapatnam during 1995-97. Prior to joining Shrimp Improvement Systems as a Sales & Marketing Head in 2018, he worked for seven years at CPF worked as a technical sales executive between 1999- 2006. He then moved to Cargill as a Business Development Manager for the prawn and fish feed business development and grew to the position of National Level Strategic Marketing Lead between 2007-2013 and later he joined in PT. Central Proteina Prima (CPP) as a General Manager for Feed Sales between 2014-2017. He is proud of working with 4 global leading companies in aquaculture for a total of 25 years in sales and marketing divisions.

Mr M. Siva Prasad receiving Best Backbone of Industry Success (by Identifying Right Genetics for Indian Aquaculture Environment) Award 2025 from K. Raghu Ramakrishna Raju

Since genetics is the backbone of prawn farming success for his nation to continuously grow production, Siva views working with SIS in particular as a highly responsibility position.SIS is a pioneer in providing Best Genetics for Indian shrimp industry since beginning of vannamei era in 2009 and continue to be leading supplier by offering the finest genetically appropriate hardy line and hardy line plus for the Indian shrimp market and currently SIS is contributing over 60% of Indian shrimp production. Siva himself feel that he is lucky to get huge support from Mr David Leong, CEO of Shrimp Improvement Systems Dr Harris Wright, R&D director in proving best fit genetic solutions to Indian market.

Providing the best genetics is not the end of the story; it is crucial to maintain constant connection with the farmers' community and hatchery customers to handle the genetics in each area and ensure that everything is proceeding to lead the successful crop. Thanks to the great assistance of Dr Rushi, Yaumil Akbar, and Sai Teja, and supporting family to accomplish this.

Born in Razole, nestled in the heart of Aquaculture hub East Godavari, Andhra Pradesh, Mr Siva Prasad Mallipudi began his journey with humble roots and an ambitious heart. After completing his post-graduation in Coastal Aquaculture and Marine Biotechnology from Andhra University in Visakhapatnam between 1995 and 1997, he entered the aquaculture industry with a vision — not just to grow professionally, but to contribute meaningfully to the nation's seafood sector.

For the last 25 years, Mr Siva Prasad Mallipudi has been at the forefront of India's aquaculture revolution, working with four global leaders in the field - CPF, Cargill, CPP, and currently, Shrimp Improvement Systems (SIS). His

roles have spanned from technical sales to business development to strategic marketing at the national level, and now as the Sales & Marketing Head at SIS, he continues to shape the future of Indian shrimp farming through introducing tailer made genetics for Indian shrimp Industry.

What makes Mr Siva Prasad Mallipudi's contribution truly outstanding is not just his vast experience, but his deep understanding that genetics is the backbone of sustainable prawn farming. Under his leadership, SIS has emerged as one of the most trusted and widely adopted genetic suppliers in the Indian shrimp industry, delivering hardy and hardy Line Plus vannamei shrimp lines to thousands of farmers across the country.

He often credits his journey to the unwavering support of mentors like Mr David Leong and Dr Harris Wright, as well as his close collaboration with his core team like Dr Rushi, Yaumil Akbar, and Sai Teja. But those who know him best will say that it's his tireless commitment to connecting with farmers, hatcheries, and grassroots communities that makes him the true backbone of this industry.

Dr Vishnu Kiran Manam receives **Best Aquaculture Scientist Award 2025**

Dr Vishnu Kiran Manam, Senior Scientist, DGM – R&D,
ABIS Exports India Pvt Ltd, IB Group receiving Best Aquaculture Scientist Award 2025 from K. Raghu Ramakrishna Raju

Profile:

Dr Vishnu Kiran Manam, Ph.D. in **Applied Microbiology with a specialization in Nanotechnology** from the University of Madras, Chennai, is a distinguished scientist with over 19 years of multidisciplinary experience spanning Research and Development, Academics, Aquaculture, Analytical Sciences, Data Analysis, and Team Management. A certified **Six Sigma professional (Yellow, Green, and Black Belt)**, he has significantly contributed to the advancement of sustainable aquaculture and life sciences.

His exceptional scientific achievements have been recognized with several prestigious honours, including the **Best Scientist Award** from IARDO, the **Young Scientist Award** from Elsevier SSRN, the **Research Excellence Award** from RES, the **Best Researcher Award** from ISCAW–ESM (2021), the **Best Scientist Award** from HyEdge (2022), and the **Rising Star Award for Excellence in Scientific Research** from Heights of Success, Magzter (2025).

Dr Manam's intellectual contributions include **15 research grants**, **4 US patents**, **55 Indian patents**, **37 Research Indexed Publications**, **14 Review Indexed Articles**, **29 Books**, and **24 Book Chapters**. He has innovated several indigenous probiotic strains and nanoparticle formulations tailored for aquaculture and animal-based applications, significantly enhancing animal health, disease resistance, and sustainability.

A pivotal figure in aquaculture infrastructure development, he has spearheaded the establishment of **15 Advanced Laboratories**, including **RT-PCR, algal culture, microbiology**, and **quality control labs**, greatly improving diagnostics, feed standards, and biosecurity protocols. His hands-on research in **Indian Major Carps** and **Marine Cage Culture of Silver Pompano** under an MoU with ICAR-CMFRI has yielded vital insights into **FCR optimization**, **growth performance**, and **eco-friendly farming practices**.

Moreover, he has isolated novel microbial and algal strains with applications in replacing harmful chemicals, contributing to cleaner, safer aquaculture systems. His work in **strategic feed monitoring** has led to reduced antibiotic usage, enhanced feed efficiency, and improved health and yield in both shrimp and fish culture.

Dr Manam's forward-looking research focuses on **nanoparticle and nanomaterial innovations**, **species diversification**, and **biosecurity-driven disease management**, all aimed at fostering a **resilient, antibiotic-free blue economy** rooted in sustainability and scientific excellence.

Megaplast India Pvt Ltd receives **Best Equipment in Aquaculture Award 2025**

Profile:

Mr C V Rajesh has done Bachelor of Engineering in Civil from Osmania University, India. He is a Techno-commercial Professional with a proven a track record, with the expertise gained, coupled with the appetite to strive for the best. He has experience in Marketing over 33 Years & 15 years in Geosynthetics. Currently he is responsible for marketing of Geomembranes in Domestic market since 11 years.

Megaplast India Pvt Ltd, Mr C. V. Rajesh, General Manager, receiving Best Equipment in Aquaculture Award 2025 from K. Raghu Ramakrishna Raju

Grasim Industries Ltd receives **Best Disinfectant Product in Aquaculture Award 2025**

Grasim Industries Ltd, Mr A. Ramesh, receiving Best Disinfectant Product in Aquaculture Award 2025 from K. Raghu Ramakrishna Raju

Madhu Mohan Talluri receives **Best Aquaculture Laboratory Services Award 2025**

Madhu Mohan Talluri, M.Sc, Technical Director, SGS Aqua Solutions, receiving Best Aquaculture Laboratory Services Award 2025 from K. Raghu Ramakrishna Raju

Duggineni Gopinadh receives **Best Shrimp Farmer Award 2025**

Duggineni Gopinadh, President, Prakasam District Prawn Farmers Association, receiving Best Shrimp Farmer Award 2025 from K. Raghu Ramakrishna Raju

AI Award Winners together: B. Masthan Rao; Amiya Dharmapada Nath; Ronald Robles Clemente; Dr Irranki Surya Rao; Dr Partha Bandyopadhyay; Dr Nitin Pipralia; Dr Amerneni Ravi Kumar; M. Siva Prasad; Dr Vishnu Kiran Manam; C V Rajesh; A. Ramesh; Madhu Mohan Tallu; Duggineni Gopinadh, along with K. Raghu Ramakrishna Raju and M.A. Nazeer

Selection for salinity tolerance in an SPF P. vannamei balance genetic line

Natthinee, Chotitat and Craig

Chotitat

Introduction

The global shrimp industry is evolving rapidly, with farming operations expanding from traditional coastal ponds to inland, brackish, and even freshwater environments. *Penaeus vannamei*, a euryhaline species is well known for its ability to grow across a wide salinity range, from near-freshwater conditions to highly saline, arid regions exceeding 50 ppt.

However, shrimp farming at lower salinities introduces physiological challenges. Shrimp must expend energy on osmoregulation, maintaining internal salt balance especially when external salinity deviates from their optimal range. The ideal salinity balance point for *P. vannamei* is approximately 24.7 ppt (Castille and Lawrence, 1981; Li et al., 2015). As external salinity shifts away from this value, more energy is diverted from growth and feed utilization toward maintaining internal homeostasis.

Importantly, the efficiency of osmoregulation is under genetic control. Some shrimp families regulate internal salt balance more effectively, allowing them to grow faster and convert feed more efficiently, even in challenging low-salinity environments. This makes broad salinity tolerance a highly valuable trait when developing genetically improved shrimp lines.

Recognizing this need early, SyAqua committed to developing a genetic selection strategy incorporating breeding for broad salinity tolerance and consistent performance. Applying our balance selection strategies SyAqua simultaneously measures and improves performance for multiple traits while minimizing inbreeding and potentially negative interactions. This article highlights how exclusive R&D and large-scale farm validation demonstrate that SyAqua genetics provide accurate, precise, and stable outcomes across a wide variety of salinity zones, with minimal performance variation between environments.

Craig

Selection and Laboratory Testing for Salinity Adaptability

Starting in 2017, SyAqua launched a dedicated breeding program targeting shrimp performance under both high salinity (~30 ppt) and low salinity (~5 ppt) conditions. Rather than selecting for salinity-specific lines, SyAqua focused on building robust, versatile genetics capable of thriving across environments.

Natthinee

Key outcomes from internal trials include:

- **44% improvement** in ADG under low salinity conditions across 9 generations.
- **22% increase** in survival rates under low salinity conditions.
- **High phenotypic (0.55–0.75)** and **genetic correlations (0.75–0.93)** between growth traits at high and low salinities — ensuring genetic stability and predictability.

These strong genetic linkages provided the basis for selection decisions assuring that the selected families could deliver consistent improvements and high performance across multiple salinity environments, without the need for specialized or segmented shrimp lines.

Commercial Validation: Consistent Outcomes Across 98 Commercial Ponds

In 2024, SyAqua tested this breeding philosophy at scale, analyzing real-

Table 1: Average performance across 3 salinity ranges in commercial farms.

Salinity Level	Number of ponds	Days of Culture	Stocking density (PL/m²)	Final ADG (g/day)	Yield (Kg/m²)	Survival Rate (%)	FCR
>25 ppt	28	88 days	78	0.20	1.13	80%	1.33
16–25 ppt	52	87 days	85	0.21	1.28	79%	1.29
6–15 ppt	12	90 days	88	0.22	1.51	86%	1.19

world performance across 98 relatively well performing ponds spanning high (>25 ppt), medium (16–25 ppt), and low (6–15 ppt) salinity ranges. Only ponds with normal harvest cycles and no acute health issues were included in the dataset for performance analysis.

Key Observations:

- **Average Daily Growth (ADG)** remained remarkably consistent across salinity levels, ranging narrowly from 0.20 to 0.22 g/day, reflecting strong stability in SyAqua's genetic line.
- **Yield** were highest in low salinity ponds due to slightly higher stocking densities and survival rates. However, all salinity groups showed comparable and reliable production outcomes.
- **Survival rates** stayed high and stable across conditions (79–86% range).
- **Feed Conversion Ratios (FCRs)** varied somewhat between farms but remained efficient in all environments.

Performance variation across different salinity levels was minimal, confirming that SyAqua balance line animals maintain stable and profitable performance levels under diverse salinity conditions as designed by the genetic selection strategy.

Bridging Laboratory Models to Real-World Success

The direct alignment between internal controlled trials and commercial farm outcomes provides strong evidence for the effectiveness of SyAqua's balanced genetic approach.

- **The stability and consistency of performance** of SyAqua balance line across salinities was confirmed over many ponds across many farms in 2024.
- Laboratory tests correlating performance between high and low salinity environments enabled selection of the fast-growing strains. Pond data confirmed that laboratory-based predictions were **accurately reproduced on farms**.
- **No major trade-offs** were observed in growth, survival, or feed efficiency across the salinity gradient in well managed farm ponds.
- **Farmers across different geographies** can expect predictable, high-quality results with SyAqua balance line in well managed ponds.

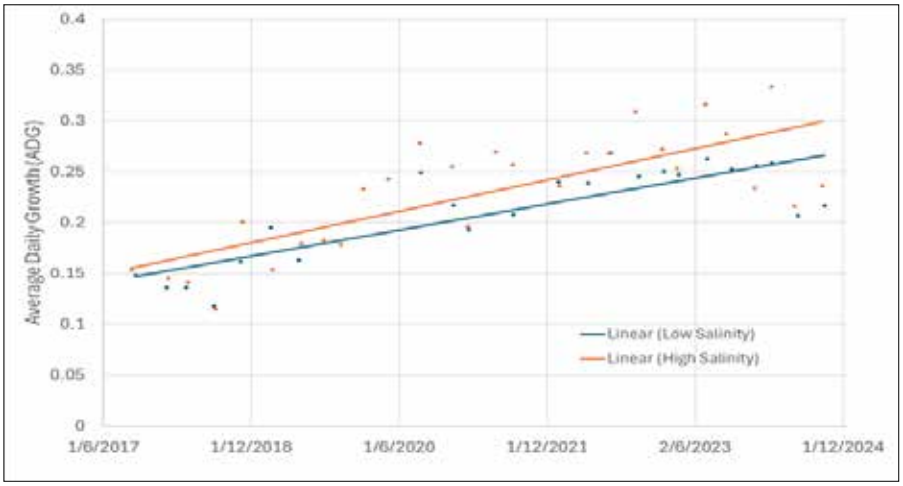

Figure 1: Average daily growth of SyAqua genetics tested in high and low salinity tested from multiple batched across 9 generations during 2017 – 2024.

In short, SyAqua genetics deliver what they promise: stable, adaptable, and profitable shrimp performance across all salinities.

Practical Advantages for Farmers

For shrimp producers, this consistency translates into major operational benefits:

- **Broader farming flexibility:** Stock shrimp in freshwater, brackish, or seawater ponds with confidence.
- **Reduced production risk:** Stable survival and growth minimize the impact of environmental changes.
- **Higher and more predictable returns:** Efficient feed usage and strong yields across salinities improve profitability.

As global shrimp farming continues to diversify, SyAqua is committed to providing a leadership role in development and application of reliable genetics across environmental extremes.

Conclusion

Through a combination of **effective R&D**, well managed and **consistent breeding strategies** and **large-scale, real-world validation**, SyAqua has developed shrimp genetics capable of delivering **consistent high performance across the full range of salinity conditions**. By measuring and selecting for multiple traits simultaneously using advanced genomic techniques, gains can be achieved steadily and consistently even for traits which may be negatively correlated. The key is a focused, data driven, disciplined and consistent approach applied across many generations. With minimal variation in growth, survival, and FCR across high, medium, and low salinity environments, SyAqua shrimp offer **unparalleled consistency, flexibility and reliability** for today's farmers.

"Wherever your farm is, SyAqua shrimp are ready to thrive."

Antiviral Properties of Medicinal Plants: Exploring Natural Compounds for Viral Inhibition

Khusbu Samal[*1], Mutum Deepti[2], Narendra Kumar Maurya[1], Sourabh debberma[3], Superna Deb[4], Jham Lal Jhangde[5], Chonyo Shinglai[1]*

Corresponding Author: khusbusamal96@gmail.com (Khusbu Samal)
Khusbu Samal, PhD Scholar ,Contact: 9178650288

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2 College of Fisheries, GADVASU, Ludhiana, Punjab, India.
3 College of Fisheries, TNJFU, Nagapattinam, Tamil Nadu, India.
4 College of Fisheries, CAU, Lembucherra, Tripura, India.
5 College of Fisheries, (Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg), Kawardha, Chhattisgarh, India.

Abstract

Medicinal plants have long been recognized for their therapeutic properties, and their application in aquaculture is gaining increasing attention. This review explores the antiviral properties of medicinal plants and their potential as eco-friendly alternatives to synthetic drugs for disease prevention and control in aquatic species. Medicinal plants contain bioactive compounds such as flavonoids, alkaloids, terpenoids, and phenolics, which exhibit antiviral activities through mechanisms like viral entry inhibition, replication suppression, and immune system modulation. Given the rise of antimicrobial resistance and the limitations of conventional treatments, phytomedicines offer a promising solution for sustainable aquaculture. However, challenges such as variability in efficacy, lack of standardization, and potential toxicity necessitate further research. Gaining insights into the structure–activity relationships of plant-derived compounds may facilitate the development of targeted antiviral agents for use in aquaculture. This research highlights the importance of further investigating medicinal plants as a promising approach to promote fish health and productivity, while simultaneously minimizing environmental impact.

Highlight Points

- Medicinal plants offer eco-friendly, cost-effective alternatives to antibiotics in aquaculture, enhancing immunity and growth.
- Their bioactive compounds like phenolics, alkaloids, and terpenoids exhibit antiviral, antimicrobial, and immunostimulatory properties.
- They act by blocking virus entry, inhibiting replication, modulating immunity, and showing direct virucidal effects.
- Structure Activity Relationship (SAR) studies aid in understanding their mechanisms and improving antiviral drug design.
- Despite challenges like standardization and safety concerns, medicinal plants show great promise for sustainable disease control in aquaculture.

Introduction

Medicinal plants have been applied to treat numerous diseases for thousands of years and are being increasingly used in aquaculture (Khan et al., 2005). Medicinal plants are known as "green medicine," with some advantages over chemically synthesized medicines:

1. Medicinal plants provide eco-friendly compounds for replacing antibiotics,
2. Medicinal plants are used in different forms, including aqueous extracts, ethanol extracts, and active ingredients, which could serve as immunostimulants to prevent and control pathogens; furthermore, medicinal plants at different concentrations and through different ways, such as injection or immersion or oral administration, could cause various levels of immune stimulation
3. Medicinal plants have positive effects on cultured fish, including increasing digestive enzyme activities, stimulation of growth, weight gain, early maturation, and meat quality, and
4. Medicinal plants could obviously inhibit pathogens (bacteria, virus, and parasite) and medicinal plants with immunostimulatory and antiviral properties applied in aquaculture have attracted increasing attention (Mukhtar et al., 2008). For example, licorice is one common medicinal plant that has been used for

centuries. There have been about 300 flavonoids and more than 20 triterpenoids isolated from licorice, which possess many pharmacological activities, such as antimicrobial, antiviral, and antitumor activities. Ma et al. (2002) generated 27 of 44 medicinal plants, which showed potent or moderate antiviral activities against the respiratory syncytial virus (RSV), and further identified some active extracts (anagyrine, oxymatrine, sophoranol, wogonin, and oroxylin A) as potent anti-RSV components (Ma et al., 2002). Moreover, the total flavonoids extracted from Lonicera japonica Thunb have effective anti-influenza activity against H9N2 (Wang et al., 2006).

Aquatic products currently contribute around 17% of the global animal protein intake, with some nations relying on them for over 50% of their total protein consumption. Although wild capture fisheries have stabilized at approximately 90 million tonnes annually (FAO, 2020), overfishing combined with rapid population growth poses a serious challenge to the sustainability of this sector. On the positive side, aquaculture has demonstrated consistent growth, reaching 80 million tonnes in 2016, establishing itself as a vital and expanding global economic industry (FAO). Nevertheless, the sector now faces a significant threat from infectious diseases. Pathogens including bacteria, viruses, and parasites have a profound impact on the health of cultured +aquatic animals, resulting in substantial economic losses. Unfortunately, most viral, parasitic and fungal diseases of aquatic animals lack effective and safe treatments, which prevents effective control and eradication of aquatic disease outbreaks (Dadar et al., 2016). Furthermore, the emergence of new disease outbreaks is a continuing risk for the fish farming industry.

Phytomedicines, also known as phytobiotics, encompass crude plant extracts, their active constituents, and derived analogues, and have long been utilized in aquaculture. Their popularity has surged globally due to their simple preparation, cost-effectiveness, and low toxicity to both animals and the environment. Within aquaculture, these plant-based products are commonly applied as therapeutic agents and feed additives, offering benefits such as growth promotion, immune system enhancement, and antibacterial properties. Numerous plant species and their by-products serve as promising natural alternatives to antibiotics, chemical treatments, vaccines, and other synthetic substances.

Moreover, one of the most critical strategies in drug development is the application of structure–activity relationship (SAR) models. SAR helps elucidate the link between a compound's chemical structure and its biological activity, allowing for predictions about its mechanism of action. This approach also facilitates structural modifications to enhance efficacy and reduce toxicity. Notable examples of SAR-based drug design include the development of anti-HIV medications like saquinavir, ritonavir, indinavir, and nelfinavir (Gu et al., 2014), as well as the successful marketing of seven statins used to treat hypercholesterolemia (Istvan et al., 2001).

This article explores the current use and underlying mechanisms of medicinal plants in the prevention and management of viral infections in aquatic animals. It emphasizes their potential as environmentally sustainable and effective alternatives for disease control in aquaculture, underlining the necessity for deeper investigations into their antiviral actions. Furthermore, the article delves into the SAR profiles of bioactive plant compounds against aquatic viruses, paving the way for the development of next-generation, eco-friendly aquaculture therapeutics.

Role of medicinal plants as a source of natural antiviral compounds

Medicinal plants are rich in antioxidant compounds that have a strong ability to neutralize free radicals, which can otherwise interfere with normal cellular functions. The build-up of these free radicals in body tissues is linked to the development of chronic conditions such as cancer, cardiovascular disease, diabetes, and arthritis. It has been reported that some of the ethnomedicinal plants such as *Cinnamon zeylanicum, Andrographis paniculata, Eugenia polyantha, Curcuma xanthorrhiza, Angelica sinensis and Orthosiphon staminеus* are proven to fight various illnesses ranging from a common fever to metabolic disease in Asian regions. Herbal plants contain a considerable number of antimicrobial substances potentially utilised as herbal medications to fight a wide range of pathogenic microbes. Different plants contain considerable bioactive compounds, including steroids, proteins, tannins, saponins, terpenoids and alkaloids. These phenolic compounds are proven to resist against a range of bacteria pathogens *(Salmonella typhi, Bordetella pertusis, Corynebacterium pervum, Klebsiella pneumoniae, Mycobacterium and Escherichia coli)*, fungi *(Aspergillus flavus, Aspergillus fumigatus, Fusarium solani and Pseudomonas aeruginosa)* and viruses (retrovirus, simian-virus). For a long time, different medicinal plants were screened to isolate a variety of commonly used antibiotics such as tetracycline, terramycin, and ampicillin.

In response to the overall adverse effect of resistant antimicrobial drugs in aquaculture through a direct effect on fish health and aquatic habitat and indirectly on human health, medicinal plants are suggested to be a promising alternative to prevent fish disease. The application of medicinal plants in aquaculture is not limited to only chemotherapeutics but also could be used as feed additives, since the latter contains a considerable amount of functional nutrients and bioactive compounds. Medicinal plants have numerous biological functions such as antimicrobial activities, ameliorating stress, promoting growth, orexigenic and immune booster in fish. Furthermore, studies indicated that the mechanistic action

of herbal and other medicinal plants are associated with possession of dense principal precursors including flavonoids, glycosides, phenolics, saponins, alkaloids, terpenoids, tannins and steroids. Medicinal plants could be sustainably used as they are easily accessible, readily available to be applied in intensive farming in aquaculture to ensure improved productivity and health of the aquatic system. Medicinal plants could be applied in different ways, as an active substance or extractor crude. Moreover, they could be applied in association with live beneficial bacteria or yeast, and other products of animal origin.

Mechanism of Actions of Antiviral Secondary Metabolites in Medicinal Plants

Secondary metabolites in plants are organic compounds that do not play a direct role in their growth, development, or reproduction. Instead, these compounds are synthesized as part of the plant's adaptive strategy to cope with environmental stressors and to perform essential physiological functions (Guirrero et al., 2018). There are various criteria used in determining the classification of secondary metabolites in plants. and include chemical structure, composition of constituent elements, and how soluble they are in water or organic solvents. The most commonly accepted criterion however is their biosynthetic pathway. Based on these pathways, three classes of secondary metabolites have been identified in medicinal plants: (1) Alkaloids, (2) Terpenoids and (3) Phenolic compounds (Garcia et al., 2009). Each exhibit different phytochemical constituents and pharmacological effects against various viral agents. Commonly reported mechanisms of action of plant-derived secondary metabolites against viruses include: (1) Virus entry attachment, (2) Inhibition of viral replication, (3) Protein synthesis inhibition, (4) Modulation of the host's immune system (Alhazmi et al., 2021), (5) Modulation of cellular signaling pathways (Bhuiyan et al., 2020), and (6) Direct virucidal activity.

Phenolics

Phenolic compounds are a diverse group of plant-derived organic molecules structurally characterized by at least one phenol group. They are the most widely distributed secondary metabolites in plants and are synthesized as an adaptive

Table 1: Different medicinal plants and the common names with the antiviral components

PLANT SPECIES	COMMON NAME	COMPOUND/COMPOUND CLASS
Phyllanthus brasiliensis	Jamaican Gooseberry	Justicidin B (polyphenols)
Hibiscus sabdariffa	Roselle	Protocatechuic acid (hydroxybenzoic acid derivatives)
Euphorbia amygdaloides ssp. semiperfoliata	Wood Spurge	Jatrophene esters (terpenes)
Helichrysum aureonitens	Golden Everlasting or Yellow Everlasting	Chlorogenic acids
Ephedra sinica	Ma Huang	4,6-dihydroxyquinoline-2-carboxylic acid, 4-hydroxyquinoline-2-carboxylic acid, and 4-hydroxy-6-methoxyquinoline-2-carboxylic acid (quinoline carboxylic acids)
Rhinacanthus nasutus	Snake Jasmine or White Crane Flower	Rhinacanthins C, D, N, Q, and E (naphthoquinones)
Tabernaemontana cymosa	Lechoso or Milkwood	Coumarin A and B (benzopyrone)
Lampranthus coccine-us and Malephora lutea	Red Ice Plant & Yellow Ice Plant	Green synthesized silver nanoparticle (AgNPs)
Elaeodendron croceum, Artemisia afra, and Adansonia digitata	Saffron Wood, African Wormwood or Wilde Als., Baobab Tree or Monkey Bread Tree	13-Hydroxy-9Z,11E-octadecadienoic acid (fatty acid), 13S-Hydroxy-9Z,11E,15Z-octadecatrienoic acid (fatty acids)
Garcinia cambogia	Malabar Tamarind or Brindleberry	Naringin (flavonoid)
Scaevola spinescens	Spiny Fanflower or Maroon Bush	Ammarin (phenolic compounds), nodakenetin (psoralens)
Swietenia macrophylla	Big-leaf Mahogany	3-hydroxy caruilignan C (polyphenolic compound)
Phyllanthus urinaria	Chamber bitter	Loliolide (benzofurans
Pinellia ternata	Crow-Dipper	Pinellic acid (long-chain fatty acids)
Bombax ceiba	Red Silk Cotton Tree,	Bombasinol A (polyphenols)

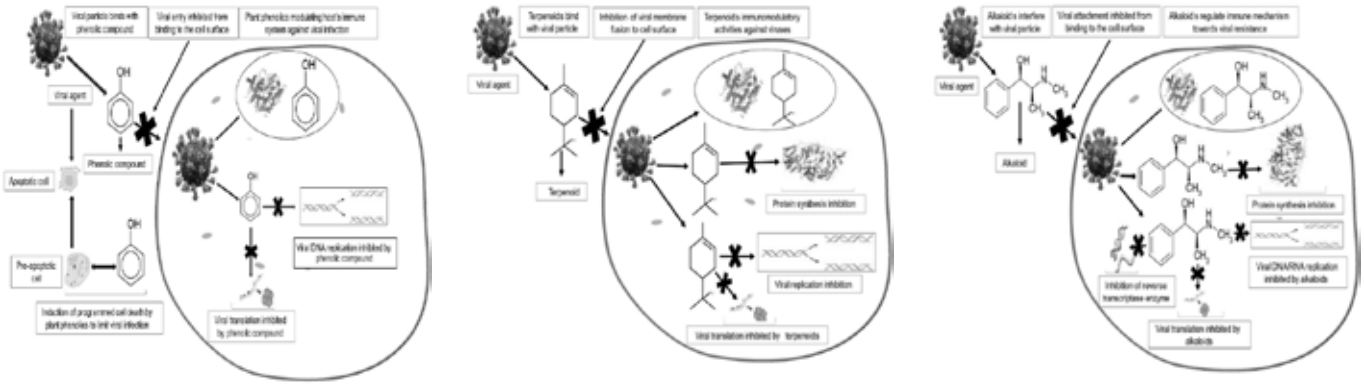

Fig 1. The mechanism of action of different compounds like phenolic compounds, terpenoids and alkaloids

response to unfavourable conditions (Kumar et al., 2023). Phenolic compounds are widely distributed throughout various plant organs and are abundantly present in fruits, vegetables, beverages, cereals, and legumes. Notable phenols with documented antiviral properties include flavonoids, tannins, and phenolic acids. The antiviral mechanism of phenolic compounds varies depending on both the specific type of phenol and the virus being targeted.

Alkaloids

Alkaloids, primarily but not exclusively present in plants, are a class of naturally occurring organic compounds containing at least one nitrogen atom. They can be found in many plant structures and have been reported to have pharmacological effects against various microbial diseases and viruses. Alkaloids have in particular been highlighted for their broad-spectrum activities against both DNA and RNA viruses. Due to their importance, they have also been identified as the largest class of plants' secondary metabolites investigated to date. The most well-known plant alkaloids found in nature include cocaine, morphine, and quinine.

Terpenoids

Terpenoids are a large group of diverse organic products that are ubiquitous in nature. They exist in six categories namely: hemiterpenes, monoterpenes, sesqui-terpenes, diterpenes, sesterpenes, triterpenes, and tetra-terpenoids (Abdallah, 2017). As an essential component of all living cells, they are products of both primary and secondary cellular metabolism. Terpenoids, predominantly found in the leaves and fruits of higher plants, often contribute to their vivid coloration. These compounds are volatile and combustible, and as aromatic metabolites, they play a major role in defining the distinctive flavours and fragrances of plants. Due to their diverse and potent pharmacological properties, terpenoids have attracted considerable attention in medicinal chemistry (Ashnour, 2010). Notable examples of terpenoids include citral, menthol, camphor, and salvinorin A.

Some of the plant species are being tabled in the table no.1 for information.

Challenges and limitations

There is no doubt that the medicinal plants have always given a better-alternatives in terms of using antibiotics but still there are a lot of areas needed to be taken into consideration for better results. Variable Efficacy and Specificity of the medicinal plants could create challenges in this field including the lack of standardization protocols and homogenization. There is a lack of standardization in the extraction, preparation, and administration of plant extracts, which can affect their efficacy. The limited knowledge of mechanism of action of the antiviral drugs com-pel us to elucidate more towards this section of research. Potential Toxicity and Safety Concerns are also the important as some medicinal plants can be toxic or have adverse effects on fish or the environment if used improperly. More research is needed to determine the long-term effects of plant extracts on fish physiology and to establish appropriate treatment strategies. The cost of using medicinal plants in aquaculture can be a barrier, especially for small-scale farmers. Lastly, clearer regulatory frameworks are needed to ensure the safe and effective use of plant products in aquaculture.

Conclusion

In summary, medicinal plants have become vital to modern aquaculture due to their wide-ranging benefits, including stimulating appetite, enhancing metabolism, promoting protein synthesis and enzyme activity, and boosting immunity and disease resistance in aquatic animals. However, the complex chemical makeup and variable bioactivity of these plants demand further research to identify their active constituents and elucidate their mechanisms of action. This article underscores the antiviral potential of medicinal plants and their bioactive compounds against aquatic pathogens, offering valuable direction for discovering future drug leads. It also emphasizes the importance of structure–activity relationship (SAR) studies in guiding the development of targeted antiviral agents for aquaculture. Ultimately, this work lays the groundwork for creating safer, more effective, and environmentally sustainable plant-based therapeutics for use in the aquaculture sector.

References

References can be given on request*

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An account of a reputed Government fish farm and features of Litopenaeus vannamei farming in Purba Medinipur

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This write-up speaks about the services provided by GFTS presently for benefit of freshwater fish farmers doing carp culture in Contai-1 and nearby Blocks in Purba Medinipur, the leading district in commercial culture and production of major carps and shrimp *Litopenaeus vannamei* in West Bengal. Author presented field experience on state-of-the-art of *L. vannamei* farming in Contai-1, indigenous Prebiotic and necessary inputs - GFTS will contribute towards increasing carp production and managing good health and growth of farmed *L. vannamei* effectively.

GFTS, Purba Medinipur

Government Fish Technological Station (GFTS), Junput, Dist. Purba Medinipur, West Bengal is a fish farm under Department of Fisheries, Government of West Bengal. It is one of the three State Government fish farms in the state. Every year, seed (72-hour old spawn) production of Indian major carps, *Labeo bata*, *L. calbasu*, Chinese carps is done following the established science and technique of induced fish breeding in rectangular fish breeding chambers and circular egg incubation-cum-hatching chambers. A part of the produced carp spawn is harvested and sold to customers (fish farmers) in oxygenated packets, and rest is stocked and maintained in nursery ponds of GFTS, reared scientifically upto fry stage. In addition to the fish hatchery complex (seed production unit) at GFTS, there exists well-maintained brood stock ponds, nursery ponds, rearing ponds, stocking-cum-marketing (grow-out) ponds (altogether 41nos having zero salinity out of total 48, perennial ponds; each specified with a local name and number) where modern practices and technologies have been adopted.

Sale of carp spawn and higher stages

Like spawn, carp fry are both sold to public and reared after stocking upto fingerling stage (20-50g) in rearing ponds. Interested freshwater fish farmers from nearby and distant places (upto 30-32km) come to GFTS to buy good quality carp spawn, carp (major and minor carp) fry comprising two different size, normal fingerlings, stunted fingerlings or IMC yearlings, naturally-produced *Tilapia nilotica* fry as per their requirement – thus GFTS fulfills their demand with trust and faith. The proper methods of pond management are informed

to spawn, fry and fingerling buyers according to their pond size. Big-sized adults of carps and *T. nilotica* are sometimes sent to local fish auction market. Brackishwater fish culture is done in 7nos of ponds using naturally-occurring seeds and tidal canal water. Total area of GFTS is 67 hectare, out of which effective water area is 41 hectare. GFTS ponds are managed and maintained in proper condition all throughout the year by permanent fishermen staff, field staff, experienced and skilled daily-waged workers and Officers posted at GFTS. Every year, revenue is earned, *i.e.*, a good amount of total income is generated at this State Government fish farm from the sale of above-mentioned living materials, which is related to GFTS's primary operations and is considered as an achievement.

Training imparted on fish farming

The two-storied residential training building at GFTS is a State-level fishery training centre. Since 1997-1998, students of UG colleges studying fisheries and aquaculture, students from WBUAFS, State Government officers and progressive fish farmers obtain Internship training and Hands-on training every year. There is an actively-working small laboratory where important physico-chemical parameters of pond water and soil samples are assessed – both that of GFTS ponds and local farmers' ponds. GFTS is headed by an Assistant Director of Fisheries, Government of West Bengal. It was established in the early 1950s by Government of West Bengal, situated in Junput, a coastal village which is 10km south-eastwards from Contai Sub-Division and Contai town in Purba Medinipur district towards Bay of Bengal under the jurisdiction of Majilapur Gram Panchayat (GP) of Contai-1 CD Block and Junput Coastal Police Station; is 158km from Kolkata city by road. Junput sea beach - serene, unspoilt and unpolluted, is only 1.2km distance from GFTS.

Previously there was a hygienic fish drying unit at GFTS, meant for producing high quality sun-dried marine fish for human consumption. Till 1982-1983, there was a shark liver oil extraction unit which was meant for providing (supplying) Vitamin-A and Vitamin-D to common people at a low cost. Air-breathing catfish *Clarias magur* and giant prawn *Macrobrachium rosenbergii* were farmed in freshwater ponds of GFTS till recent past. Recently, the newly-constructed hatchery unit has been made fit for operation for seed production and propagation of threatened freshwater fishes like *Puntius sarana*, *Osteobrama belangiri*, *Ompak pabda*, *Heteropneustes fossilis*.

Abhoy pukur and APL

For in-situ conservation and propagation of small indigenous fish species, two small split bamboo and nylon net-fenced ponds at GFTS have been earmarked as Abhoy Pukur or fish sanctuary where water quality and feed management are properly done, controlled growth of aquatic weeds maintained. Aim is to conserve and restore local fish biodiversity using habitat restoration programme followed by ecosystem management. Details of Abhoy Pukur have been mentioned in News published in November 2024 issue of this magazine. Recently, a State-level Aquaculture Pathology Laboratory

(APL) has been established at GFTS, where activities like presumptive diagnosis of diseases of farmed shrimps *Litopenaeus vannamei* and *Penaeus monodon* at pond site of nearby farms, collection and preservation of diseased/ infected shrimp samples and tissues, molecular PCR-based detection of shrimp pathogens and diseases, isolation of pathogenic bacteria from shrimp samples will be carried out. It will help to prevent occurrence of familiar viral and bacterial diseases of shrimps. Contai-1 CD Block is a major shrimp farming region in West Bengal.

L. vannamei farm of Sri M. Shyamal

On 19/6/2025, in association with Yard Manager (DFO), GFTS, Junput, author visited a medium-scale *L. vannamei* farm quite near to GFTS (2km), running since year 2020 and owned by Sri Manik Shyamal. It is the fourth *L. vannamei* farm in Contai-1 CD Block that author has visited in the last six years. The upper 0-220 feet deep layer of underground water in this region bears 8-9ppt salinity and is used in his six *L. vannamei* ponds, available round the year. Submersible pump used to draw in water and fill the ponds, each 1000sq.mt in effective water area and water depth 5 feet. The 0.5-0.7cm (PL-8/PL-10 stage) Chennai hatchery seeds are bought and stocked @ 30000-40000nos per pond, which costs Rs 0.40 per piece. The 20g and 30g size (0 to 100 days culture period) export-quality *L. vannamei* (all males) are sold by Sri Shyamal @ Rs 320/- and Rs 400/- per kg respectively. He uses Avanti Brand shrimp feed, four times every day (at 6am, 10am, 2pm and 6pm), water quality in all ponds (pH, ammonia, nitrate content, DO, salinity, others) is estimated and paddle wheel aerators operated routinewise.

His growing *L. vannamei* weighs 10gm in 50 days duration. Water exchange upto 1 foot depth is done every 20-30 days interval. When pond water pH goes down, 10kg lime stone powder (LSP) is applied in every pond. Growing shrimps observed in healthy condition, when sampled from every pond. Sri Shyamal stated that *L. vannamei* fails to moult and White Faeces Syndrome appears when feed is applied in excess, bottom soil turns unhygienic, water condition deteriorates. Before seed stocking, on the 3rd day of application of LSP @ 20kg per pond, 25kg bleaching powder is applied, followed by 10kg Zeolite. Two crops are produced every year, *L. vannamei* farming isn't done during mid-November to end-January of next year. Zeolite and medicine as remedy for toxic gases are applied at every ten days interval after seed stocking, commercially-available Minerals (@ 5kg/5lit water) every four days interval, and Probiotics every ten days interval only when aerators are in operation. Sri Mohan Giri, farm technician and representative of PVS Company and three labours takes care of Sri Shyamal's *L. vannamei* ponds, shrimp health and growth. Sometimes gills turn blackish due to melanization, which happens after few days of continuous rainfall, feeding rate consequently decreases.

L. vannamei farming practice in general at Contai-1 Block

Like Sri Shyamal, the *L. vannamei* scenario in different GPs of Contai-1 CD Block is more or less the same for other shrimp farmers by profession. Water is taken into ponds from nearby brackishwater canal by pumping, no sluice gate in some of the farms. Few farmers have reported about occurrence of white faeces from 25-30th day and Running Mortality Syndrome from 60th day of culture. Seed cost varies between Rs 0.35-0.65 per piece, pond area

between 1000-1200sq.mt. For some farmers, *L. vannamei* had attained 40g on 95th day of culture. On little high density stocking @ 50nos per sq.mt, *L. vannamei* attained 29-32g on 105th day of culture. When stocking is increased to 90000nos/1000sq. mt pond, *L. vannamei* attains 22-23g in 90 days with a production level of 1.5tonnes/1000sq.mt pond. Many farmers stock *L. vannamei* seeds @ 50-70nos per sq.mt, then 3750-4000kg production is obtained from every 1 acre (4000sq.mt) water area, considering 75-80% survivability and 25g weight at harvest (50nos/sq.mt). Deep tube well water having 9ppt salinity is used in ponds by some farmers. At harvest, some farmers reported growth of *L. vannamei* to be 32g on 102nd day and 39g on 114th day of culture. Brownish gills observed in some shrimp samples, Benzalkonium chloride applied to eradicate it. Bleaching powder, Minerals, remedy medicines for toxic gases, Probiotics – all are applied in ponds 15 days prior to seed stocking and filling in water; Minerals, medicines and Probiotics applied after stocking also.

In order to kill *Enterocytozoon hepatopenaei* spores, drying and disinfection of bottom soil is done, CaO is applied in ponds @ 6000kg per hectare. It is ploughed into dry pond sediment (10-12cm), sediment is moistened and pond left for one week before filling with water. Heavy aeration in ponds is required when stocking density is increased beyond 30nos per sq.mt. Disease occurs on conditions of mismanagement (poor maintenance of Better Management Practices), low DO content, high stocking density (i.e., *L. vannamei* biomass) overpassing pond's carrying capacity. These do not feed properly on rainy days. From 7.00pm till 5.30am of next morning, growing *L. vannamei* are not fed, and all paddle wheel aerators are kept in continuing operation in full phase in every pond - for total 16-17 hours in every 24 hours. Rainfall leads to poor growth of *L. vannamei* as salinity of pond water is reduced.

Farmers produce two crops every year, first from February-March till May-June and second from July-August or August-September till October-November or November. Sufficient aeration is provided to avoid DO stress and susceptibility to diseases, balanced profile of Minerals is maintained to encourage proper moulting and healthy growth of *L. vannamei*, feeding schedule is maintained strictly in every pond. Commercially available aquaculture products like ammonia adsorber, Mineral mix enriched with trace minerals, multi-strain soil and water Probiotics, nutrient mixture are used in culture ponds judiciously in recommended dose. Drying and tilling of pond bottom, treatment with LSP, organic black soil scrapping off (3 inches thick) are done at the end of one crop.

In general, some farmers have obtained 7000-9000kg marketable sized *L. vannamei* in one crop from seven ponds, each 12000sq. feet or 1114sq.mt in area. A sturdy bamboo-built walkway and feeding tray checking is common in every *L. vannamei* pond for monitoring feed consumption every time every day. Before seed stocking, preparation and application of organic juice in *L. vannamei* ponds using a mixture (water-soaked and fermented) of ground nut oil cake, yeast, sugarcane jaggery, soyabean powder, fish meal and wheat is a new concept. Another such mixture comprise of sugarcane jaggery, rice bran, dolomite, yeast powder and sour curd. The APL at GFTS, Junput is expected to support *L. vannamei* farmers' needs and curb incidences of diseases in farms. Author joined as Assistant Fishery Officer at GFTS, Junput on 2/6/2025; help and cooperation received from higher officers DFO and ADF, GFTS in office work and the field visit on 19/6/2025 is gratefully acknowledged.

Successful induced breeding of Reba carp (Cirrhinus reba) under hill conditions of Meghalaya, Northeast India

Tasso Tayung, Sadokpam Gojendro Singh, Prasanta Mahanta, Chandan Debnath

This study reports the first successful captive breeding of *Cirrhinus reba* (Reba carp) under the hill conditions of Meghalaya, Northeast India. Fingerlings procured from Assam were reared to maturity in a hill farm environment, achieving successful gonadal development despite cooler temperatures. Using Ovafish hormone (0.25 ml/kg for males, 0.5 ml/kg for females), breeding was successfully induced with 85-90% fertilization and 75-80% hatching rates. Length-weight analysis revealed positive allometric growth ($W = 0.0068L^{3.11}$) with condition factor of 0.94, indicating successful adaptation to hill environments. This achievement creates significant opportunities for diversification of regional aquaculture with indigenous species, offering both food security and livelihood benefits while contributing to conservation of this vulnerable species with dual food and ornamental potential.

Highlight Points

- **The article reports the first successful captive breeding of Reba carp in Meghalaya's hill conditions, where researchers achieved 85-90% fertilization and 75-80% hatching rates using Ovafish hormone.**
- **The species demonstrated positive allometric growth, indicating successful adaptation to cooler hill environments despite challenging conditions.**
- **This achievement is particularly significant as Reba carp serves as a dual-purpose fish, offering both food security benefits and contributing to conservation efforts for this vulnerable indigenous species.**

Introduction

Cirrhinus reba (Hamilton, 1822) is a commercially important freshwater minor carp species indigenous to the Indian subcontinent. Belonging to the family Cyprinidae under the order Cypriniformes, this species is popularly known as "Reba carp" and is widely distributed throughout India, Bangladesh, Nepal, Pakistan, Myanmar, and Thailand. In India, this species is commonly found in the Gangetic belt of the northern region and in the Cauvery River in the south. The fish is known by various regional names: bata/kharkebata/rewa in India; raikhar/tatkini/aikhor/bangla/bhagna in Bangladesh; soonnee/rewah in Pakistan; and striped carp/reba carp in Nepal.

Aquaculture production in hill regions like Northeast India faces significant challenges that have hindered its development compared to plain land aquaculture. The drastic fluctuations in water temperature characteristic of hill climates impose considerable stress on fish physiology. The prolonged cold climate in these regions suppresses fish immunity and growth, resulting in extended production cycles and higher vulnerability to diseases. Currently, hill aquaculture depends on a very limited number of fish species that can withstand these challenging conditions, with most of them being exotic introductions rather than native species. This dependency on exotic species is particularly concerning given that Northeast India is recognized as a global hotspot for fish biodiversity. Despite this rich diversity, aquaculture seed availability is limited to only 10-15 species, representing a fraction of the region's indigenous ichthyofaunal wealth. There have been limited systematic efforts to bring indigenous species into the fold of regional aquaculture, creating a disconnect between the region's natural biodiversity and its aquaculture practices. This gap underscores the need for indigenous species that can withstand cold climates while offering production and market advantages.

Despite its commercial importance and consumer preference, *C. reba* has received limited attention in controlled aquaculture settings, particularly in the northeastern region of India where environmental conditions differ significantly from traditional carp farming areas. This study represents the first successful captive breeding and larval rearing of *C. reba* under the hill conditions of Meghalaya, opening new possibilities for diversification of regional aquaculture with indigenous species.

Morphological and biological characteristics

Cirrhinus reba possesses a slender body with the dorsal profile slightly more convex than the ventral profile. The mouth is terminal with a slightly projecting snout, more distinctly in immature specimens. The lips are fleshy, with the upper lip fringed in young fish and sometimes entire in adults. A thin cartilaginous layer covers the lower jaw. The species has one pair of short, stiff rostral barbels. One of the most distinctive identifying features of *C. reba* is its hexagonal scales, which give the fish a unique appearance, especially when light reflects off its body. These distinctive scales, combined with the dark transverse band running along its body, make it visually appealing, particularly at the juvenile stage.

Males mature earlier than females, with the length at first maturity being 11.5 cm and 13.5 cm respectively.

The species is highly fecund, with reported fecundity ranging widely from 20,722 to 437,400 eggs, showing a linear relationship with gonad weight and body weight. Across studies in Bangladesh, Pakistan, and India, researchers have consistently found that fecundity increases with fish size and weight, with mature females of 14-24 cm in length producing anywhere from 19,500 to 265,000 eggs.

Cirrhinus reba is an annual breeder with a single spawning period. Studies across the subcontinent indicate breeding seasons that vary slightly by region: April to October in Bangladesh (with peak in June-July), June to August in Pakistan (peak in July), and April to November in India. Temperature and rainfall are the most critical factors influencing breeding patterns. While maximum reported length is 60 cm, most specimens range between 18.4 cm to 32.5 cm. The species inhabits rivers, reservoirs, streams, lakes, tanks, ponds, canals, beels, and inundated fields. As a bottom dweller, it prefers deeper water but often swims throughout the water column for feeding and breeding. Fry and fingerlings typically move along the surface and middle waters. Adult *C. reba* is predominantly herbivorous, while the fry exclusively feed on animalcules and water fleas. Fingerlings consume vegetable debris, unicellular algae, detritus, and mud, making them well-suited for pond culture systems where they can utilize naturally available food resources.

Aquaculture potential as a dual-purpose fish

Cirrhinus reba presents significant potential for aquaculture development in Northeast India for several compelling reasons. The fish is widely preferred by consumers for its taste and texture, commanding a market price of Rs. 200-250/kg in northeastern India. Biochemical analysis of *C. reba* reveals a nutritionally favorable profile with 78.56% moisture, 19.46% protein, remarkably low fat content at 0.22%, and 1.33% ash in its edible portion. The species is also rich in essential minerals, containing 172.60 mg of phosphorus, 136.46 mg of potassium, 88.28 mg of sodium, 68.92 mg of calcium, and 1.24 mg of iron per 100g of edible portion. This combination of high protein, minimal fat, and substantial mineral content makes it an excellent choice for health-conscious consumers seeking nutritious fish options.

The herbivorous feeding habit of *C. reba* allows for cost-effective feeding with readily available plant-based diets, reducing production costs. Unlike major carps that require longer growing periods, *C. reba* reaches marketable size at 100-150g, making it particularly suitable for Northeast Indian aquaculture systems characterized by seasonal water bodies with retention periods of 5-6 months annually.

Beyond food production, *C. reba* offers ornamental value due to its distinctive hexagonal scales and the dark transverse band running along its body, creating an attractive appearance particularly at the juvenile stage when light reflects off its body. This dual-purpose potential—both as food and ornamental fish—enhances its economic viability. Furthermore, the species can tolerate temperatures as low as 8°C or even lower, making it an excellent candidate for aquaculture in hill agro-climatic conditions like Meghalaya.

Broodstock development at ICAR Meghalaya fisheries farm

Broodstock raising

In 2022, 1000 numbers of *C. reba* fingerlings (4-5g) were procured from Assam and stocked in a 0.1-hectare pond at the ICAR Research Complex fish farm in Meghalaya. The pond featured an earthen basin with concrete embankment, providing appropriate conditions for the fish development. To ensure optimal growth under hill conditions, the fish were reared in monoculture to eliminate competition from other species. Water depth was consistently maintained at 1-2 meters, with replenishment conducted as needed. Throughout the culture period, water quality parameters were monitored regularly to ensure suitable growing conditions. Temperature fluctuated seasonally between 15-26°C, with winter months recording considerably lower temperatures (15-18°C) compared to summer (22-26°C). Dissolved oxygen was maintained above the critical threshold of 5.0 mg/L, while pH remained within the optimal range of 7.0-8.0. Total alkalinity was sustained between 80-130 mg/L, providing appropriate buffering capacity for the aquaculture system.

The fish were fed with a combination of rice polish and mustard oil cake (MOC) at a ratio of 1:1, with a feeding rate of 3-5% of fish body weight, adjusted according to water temperature and fish response. During winter months when temperatures dropped below 18°C, the feeding rate was reduced to 1% of body weight due to decreased metabolic activity and feeding intensity. Due to the prolonged cold period characteristic of Meghalaya's hill climate, which typically suppresses growth in warm-water fish species, *C. reba* took more than a year to reach maturity, considerably longer than the 8-9 months typically observed in plain regions with warmer climate. Despite these challenging conditions, *C. reba* showed remarkable adaptability to the hill environment. Males matured faster than females, reaching 13-14.5 cm in length and 90-120g in weight, while female broodstock attained 15.5-16 cm in length and 200-250g in weight by the end of the rearing period. This successful maturation under hill conditions demonstrated the species' adaptability to the cooler climatic regime of Meghalaya, though requiring an extended growth period compared to warmer regions.

Length-weight relationship and condition factor

Length-weight measurements were conducted on the reared *C. reba* population to establish their growth parameters under Meghalaya's mid-hill climate. Based on the data collected, the length-weight relationship was calculated using the equation $W = aL^b$, which when

transformed to logarithmic form becomes: log W = log a + b log L. Analysis of the data yielded the following relationship: $W = 0.0068L^{3.11}$. The b-value of 3.11 indicates positive allometric growth (b>3), suggesting that the fish becomes heavier for its length as it grows larger. This positive allometric growth pattern demonstrates that the hill conditions of Meghalaya provide favorable conditions for *C. reba* development. The mean condition factor ($K = 100 \times W/L^3$) was calculated as 0.94, which falls within the range considered normal for healthy fish populations. This further confirms the successful adaptation of *C. reba* to the Meghalaya hill environment and validates the suitability of the management practices employed during broodstock development.

Breeding attempt

The breeding trials were performed in the Chinese eco-hatchery facility at the ICAR Research Complex at Meghalaya during the optimal breeding season (May-June 2023) when water temperatures consistently reached 23-26°C. Following successful broodstock development, mature specimens were identified based on distinctive sexual characteristics. Males displayed roughened pectoral fins and released milt upon gentle abdominal pressure, while females exhibited swollen abdomens, reddish genital papillae, and released eggs with gentle pressure—characteristic reproductive indicators coinciding with monsoon onset. For the induced breeding protocol, 20 females and 60 males (maintaining a 1:3 ratio) were carefully transferred from rearing ponds to the breeding facility. Prior to hormone administration, the selected brooders underwent a 24-hour conditioning period with adequate water flow and aeration to minimize stress. During this preparation phase, male and female brooders were kept in separate breeding hapas within the spawning pool of the carp hatchery, with breeding activities scheduled during cooler evening hours to optimize conditions.

While previous studies have utilized various hormones, our research exclusively employed Ovafish (BhoomiAqua International, Maharashtra), administered via intramuscular injection at precisely calibrated dosages of 0.25 ml/kg for males and 0.5 ml/kg for females. Following hormone administration, males and females were released together into the spawning pool. The hormone effectively triggered reproductive behavior, with courtship commencing approximately 4-5 hours post-injection and culminating in complete egg release after 7-8 hours. Eggs were collected the following morning, while spent broodfish were treated with potassium permanganate solution before being returned to the stocking pond. The fertilized eggs underwent incubation for 18-24 hours, with duration primarily influenced by water temperature. The newly hatched larvae, initially sustaining themselves through yolk sac reserves for 3-5 days, were subsequently transferred to nursery ponds for further rearing once yolk absorption was complete (Table 1).

Table 1. Breeding performance of *Cirrhinus reba* under Meghalaya hill conditions

Parameters	Details
Breeding season	May-June
Hormone used	Ovofish
Hormonal dose (male)	0.25 ml/kg body weight
Hormonal dose (female)	0.50 ml/kg body weight
Breeding ratio (male:female)	3:1
Female broodstock size	15.5-16 cm / 200-250 g
Male broodstock size	13-14.5 cm / 90-120 g
Absolute fecundity (eggs per female)	25,000-30,000
Latency period	7-8 hours
Water temperature during breeding	23-26°C
Fertilization rate	85-90%
Incubation period	18-24 hours
Hatching rate	75-80%
Yolk sac absorption period	3-5 days
Survival rate (spawning to fry stage)	60-65%

Our absolute fecundity observations ranged from 25,000-30,000 eggs per female, which aligns with previously documented findings across the region. Comparative research provides context for these results: studies in Pakistan documented fecundity between 20,722 and 211,200 eggs in specimens measuring 15-29 cm, while Bangladesh research reported values from 20,722 to 265,042 eggs in fish of comparable dimensions. Our measurements fall within the lower-middle range of these established parameters, a finding consistent with the specific conditions of our study. This positioning is attributable to two primary factors: our broodstock consisted predominantly of first-time spawners at the smaller end of the mature size spectrum, and the water temperature in Meghalaya's hill conditions remained comparatively lower than in the plains regions where previous studies were conducted.

Conservation status and implications

Recent assessments indicate declining populations of C. reba in natural habitats due to overfishing, habitat loss, and ecological changes resulting from anthropogenic activities such as pollution and habitat fragmentation. The species is currently documented as vulnerable in India and Bangladesh, though classified as "least concern" under the IUCN Red List of threatened species. Our successful captive breeding of C. reba in Meghalaya contributes significantly to conservation efforts by establishing protocols for controlled reproduction in hill conditions, creating a pathway for reducing pressure on wild

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populations, reserving genetic resources of this indigenous species and developing techniques that can be replicated for other minor carp species. Beyond conservation, this achievement offers substantial benefits for regional aquaculture diversification in Northeast India. The introduction of C. reba into controlled aquaculture systems provides fish farmers with an additional indigenous species that is well-adapted to local conditions, enjoys strong market demand, and requires shorter production cycles than major carps.

Future research directions

Building on this initial success, several promising avenues for future research and development warrant exploration. Investigations into polyculture systems integrating C. reba with other compatible indigenous and exotic carps should be prioritized to optimize production efficiency and resource utilization. The species' bottom-dwelling and herbivorous feeding habits position it as an excellent candidate for polyculture environments where it would occupy a distinct ecological niche, minimizing competition with other cultured species. Additionally, the development of species-specific, cost-effective feed formulations using locally available ingredients merits attention to enhance growth performance and reproductive outcomes. Parallel research should explore value-added products derived from C. reba to expand market opportunities and enhance economic returns for producers throughout the region. Further scientific assessment should evaluate the species' resilience to climate variables, particularly within the context of changing rainfall patterns and temperature fluctuations in Northeast India. This knowledge will be crucial for developing climate-adaptive aquaculture practices. Finally, the development of farmer-friendly protocols and comprehensive extension materials will be essential to facilitate wider adoption of C. reba culture across the region, ensuring that research outcomes translate effectively into practical applications at the farm level.

Acknowledgements

The senior author extends his sincere gratitude to Dr Sanjay Kumar Das, Principal Scientist (Fisheries) for his valuable guidance and technical inputs throughout this research. The support provided by the ICAR Research Complex for NEH Region, Umiam, Meghalaya, in terms of facilities and resources is gratefully acknowledged. We also thank the technical staff of the fisheries division for their assistance in broodstock management and breeding operations.

Figure 1: Mature female *Cirrhinus reba* displaying characteristic rounded abdomen and prominent dark lateral band typical of breeding readiness.

Figure 2: Mature male *Cirrhinus reba* exhibiting distinctive slender body profile, roughened pectoral fin base, and the unique hexagonal scales that characterize this species.

Figure 3: Administration of Ovofish hormone via intramuscular injection

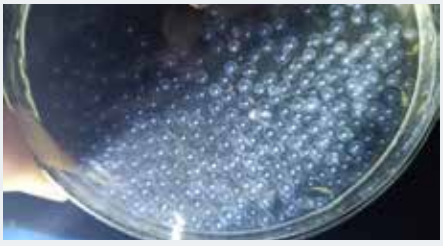

Figure 4: Fertilized *C. reba* eggs at water hardening stage approximately 2-3 hours post-fertilization

Figure 5: Chinese eco-hatchery facility at ICAR Research Complex, Meghalaya

Figure 6: Three-day-old *C. reba* spawn produced from the first successful captive breeding in Meghalaya, showing healthy development and active swimming behavior.

Figure 7: Newly hatched *C. reba* larvae with visible yolk sac (18-24 hours post-hatching)

Figure 8: Advanced *C. reba* fingerlings (45-50 days post-hatching) ready for stocking in grow-out systems, representing the first generation of this indigenous carp species produced under Meghalaya hill conditions.

Date of Publishing:
7 August 2025

RNI Regn. No.: 52899/93
Postal Regn. No.: HCD/1068/2024-2026

Date of Posting:
8th, 9th August 2025

Posting at BPC-IV, Patrika Channel, Nampally, Hyderabad - 500 001