

WORLD AQUACULTURE 2025



Aquaculture: Opportunities, Options, and Optimism

November 10 - 13, 2025

Hyderabad, India

Hyderabad International Convention Center - Novotel

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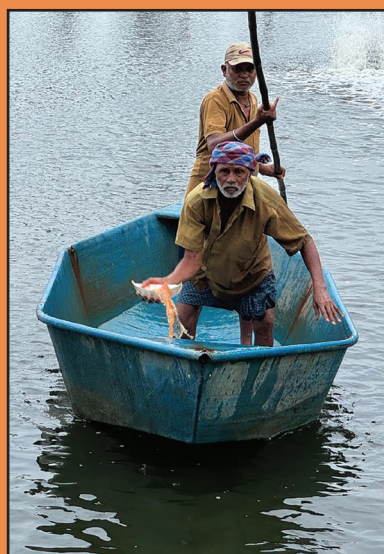
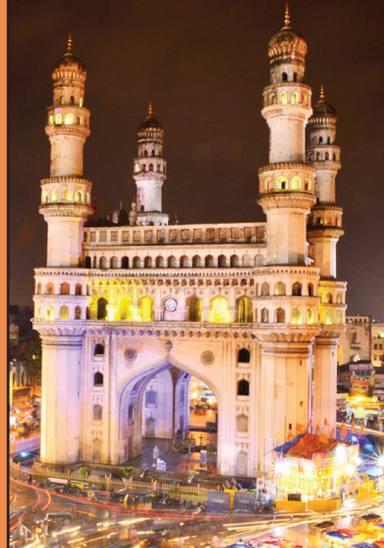
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Welcome to World Aquaculture India 2025



Dear Delegates and Friends,

Greetings from India!

It is a well-known fact that aquaculture is one of the fastest-growing food-producing sectors globally. The development in the large sections of the globe, however, is largely varied with regard to aquaculture species, systems, and production levels. Almost a threefold increase in aquaculture production in the last two and a half decades is largely attributed to the widespread adoption of scientific technologies and increased investments. During these

years, the farming practices have shown a remarkable shift from small-scale farming operations to large-scale commercial enterprises. In the context of increased realization of the necessity of the scientific knowledge exchange, Conferences/Seminars are considered important platforms for experience sharing among the researchers and other stakeholders. At a time when the global aquaculture and fisheries are subjected to a host of natural and anthropogenic issues and challenges, the sectors expect to overcome such real-world problems through knowledge-based solutions to have resilience, besides achieving a production leap.

The World Aquaculture Society (WAS) is known to be an important non-governmental scientific organization that has been promoting aquaculture development through the organization of conferences in different parts of the world. The World Aquaculture 2025, India, is one such important event of WAS, which is going to be held at Hyderabad, India during 10-13 November 2025. This international conference, being organised with the theme “Aquaculture: Opportunities, Options, and Optimism”, offers a wonderful opportunity for the researchers and other stakeholders associated with aquaculture and fisheries around the globe to have an excellent meeting point.

The support of the National Fisheries Development Board (NFDB), Indian Council of Agricultural Research (ICAR), P.V. Narsimha Rao Telangana Veterinary University (PVNRTVU), and Department of Fisheries (DoF), Government of Telangana, for hosting the event at Hyderabad has been significant. After a successful organization of Asian Pacific Aquaculture 2019 at Chennai, this is another global conference of the World Aquaculture Society being held in India, for which I would like to convey my sincere appreciation and thanks to the President and all other associate Members of WAS for choosing India as the venue of this international conference. It is really a proud moment for all of us to host such an event of global importance.

I cordially welcome all of you to the World Aquaculture 2025, India, and the city of Hyderabad. Known as one of the vibrant metropolitan cities in India, Hyderabad possesses a large number of agricultural and biotechnological research organizations, a hub for pharmaceutical research, and also historic tourism. I am sure this will provide enough opportunity for all of you to spend your leisure time exploring these places of importance and also enjoy the Hyderabadi cuisine.

The conference will bring scientific and entrepreneurial minds together to share knowledge, experience, and ideas, encompassing aspects of research outputs, development, environmental concerns, and global partnership. I sincerely believe the participants of the conference would bring his/her your own knowledge, expertise, and experience, which will help to foster scientifically-enriched aquaculture development in

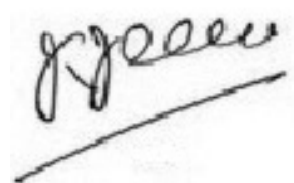
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different parts of the world. It would be a unique platform for the young researchers to make contact with international experts in varied fields that transcend continents. We are also honoured to have internationally-recognized speakers who will share their experience, ideas, and vision in different sessions during the four days of the conference. Let this conference not just be about sharing information and discussing only about fisheries and aquaculture, but about building a pragmatic roadmap and developing region-specific action plans aimed at holistic development of the sectors, with much-discussed expectations of sustainability, resilience, and equity.

I would like to thank and convey our sincere gratitude to all the delegates and participants of the trade show, especially our international guests who travelled from a distance for participation in the conference. I honestly believe that the conference would provide an excellent platform for sharing mutual respect, thoughts, and pleasantries, besides having enriched scientific deliberations. I want to thank all the organizing members, partner institutions, sponsors, volunteers, and all those who have worked very hard over the last few months to make this event possible.

I sincerely thank you all once again, convey my whole-hearted greetings, and welcome each one of you to the World Aquaculture 2025.

Best regards,

A handwritten signature in black ink, appearing to read 'J.K. Jena', with a long horizontal line drawn underneath it.

Dr. J.K. Jena
Deputy Director General (Fisheries Science),
ICAR, New Delhi, India & Conference Chair

Welcome Message

It is my great pleasure and honour to extend a warm welcome to our esteemed Chief Guest, Honourable Chief Minister Mr. A. R. Reddy, distinguished delegates: Dr. Jena, Dr. Behera, Dr. Sarat and Dr. Kandan. Our plenary speakers Dr. M. Barange and Dr. M. Vijay. Gupta, as well as all exhibitors and participants joining us for *World Aquaculture India 2025*, being held in the vibrant city of Hyderabad.

I would like to express my sincere appreciation to our host organizations, NFDB Hyderabad, ICAR, P.V. Narsimha Rao University, and the Government of Telangana for their vision and dedication in making this conference possible. My sincere thanks also go to MPEDA and SAP for their valuable support and active contribution to the successful organization of the event. A special note of thanks is extended to the International Program Chair, Dr. Yeong Yik Sung, the National Program Chairs, Dr. Iddya Karunasagar, and Dr. B.K. Behera for their exceptional efforts in designing the scientific sessions and selecting dedicated session chairs, ensuring that each discussion brings valuable insights to the aquaculture community. My heartfelt gratitude also goes to the Steering Committee members for their continuous guidance, thoughtful decisions, and unwavering commitment that have shaped the overall success of *World Aquaculture India 2025*.

Over the next three days, this event will serve as a unique platform for researchers, industry leaders, policymakers, and students to share knowledge, exchange innovative ideas, and explore sustainable solutions for the aquaculture and fisheries sectors, areas that are not only for food security and livelihoods but also for maintaining the ecological balance of our aquatic ecosystems.

This year's conference theme, "Aquaculture: Opportunities, Options and Optimism", focuses on innovation, sustainability, and collaboration. We hope that the technical sessions, workshops, and networking opportunities will foster meaningful collaborations, promote research and innovation, and strengthen the global aquaculture community. May this gathering inspire new initiatives and reaffirm our shared commitment to advancing sustainable aquaculture practices worldwide.

I also gratefully acknowledge the support of our premier sponsorship partners: DSM – Firmenich, INVE Aquaculture, Blue Aqua, Devee Group India, Avanti Feeds Limited, Aker Qrill Company, SyAqua, and Zeigler. Our sincere thanks also go to our Silver Sponsor DNV and our session sponsor ICC and to our Media Partners, International Aquafeed Magazine, AquaFeed.com, AquaStar, Aquaculture Asia Pacific, Hatchery International, Info Fish, Trobos Aqua, and VietFish Magazine, whose continued support ensures the success and broad outreach of this conference.

Once again, I extend my heartfelt welcome to our Chief Guest, host organizations, Program Chairs, Steering Committee, exhibitors, sponsors, media partners, and all participants. We look forward to your active engagement, insightful discussions, and a memorable experience at *World Aquaculture India 2025*.

Thank you.



Dr. Bibha Kumari
President, World Aquaculture Society – Asian Pacific Chapter

Welcome Message

It is with great pleasure and pride that I welcome all delegates, researchers, industry partners, and aquaculture enthusiasts to *World Aquaculture India 2025*, being held in Hyderabad, Telangana, from November 10 to 13, 2025. This prestigious event is jointly organized by P. V. Narsimha Rao Telangana Veterinary University (PVNRTVU) in collaboration with the Indian Council of Agricultural Research (ICAR), the National Fisheries Development Board (NFDB), the Society of Aquaculture Professionals (SAP), and the Marine Products Export Development Authority (MPEDA). This event promises to serve as a dynamic platform for dialogue, discovery, and collaboration across the aquaculture community, encompassing scientific sessions, technical workshops, and international trade exhibitions.

Telangana, the youngest state of India, though landlocked, has rapidly emerged as one of the frontrunners in inland aquaculture through scientific innovation, infrastructure expansion, and farmer-centric governance. With a water spread area of approximately 5.72 lakh hectares, encompassing 77 reservoirs, 24,189 tanks, and 4120 ponds, Telangana currently ranks third in the country in terms of inland water resources and fifth in overall fish production. During 2023–24, Telangana recorded a fish production of about 4.56 lakh tonnes, contributing ₹7,059 crore to the state's economy, while prawn production surpassed 16,500 tons. Aquaculture is practiced in over 1,000 ha of ponds and community tanks, generating livelihood opportunities for thousands of rural families. Telangana is home to a strong fisherfolk base of over 27 lakh people, organized into nearly 5,900 fishermen cooperative societies to ensure equitable access to resources and strengthen the value chain from production to marketing.

At the national level, India remains the second-largest aquaculture producer in the world, with nearly 195 lakh tons of fish in 2024–25, accounting for over 8% of the global fish output. This expansion is largely driven by inland aquaculture and supported by flagship schemes such as the Pradhan Mantri Matsya Sampada Yojana (PMMSY). The fisheries sector continues to serve as a vital pillar of India's economy, providing direct and indirect employment to over 28 million people and generating export earnings of USD 7.45 billion (≈₹62,400 crore). Together, these advancements reflect both India and Telangana's shared vision toward a sustainable and inclusive Blue Revolution.

For farmers, it offers insights into improving productivity and profitability through modern, eco-friendly technologies. For students and young researchers, it presents an opportunity to engage with leading scientists and innovators. Industry stakeholders provide a forum for exploring partnerships, technology transfers, and market linkages.

As a National Organizing Secretary, I take immense pride in the leadership and vision of P. V. Narsimha Rao Telangana Veterinary University in hosting this event. This conference is a testament to our collective commitment to building a sustainable aquaculture ecosystem that supports food security, employment, and environmental stewardship.

I extend my heartfelt gratitude to the organizing partners, sponsors, scientific committees, and volunteers for their invaluable contribution in making this event a reality. I also warmly welcome all national and international delegates to the “City of Pearls, Hyderabad, which harmoniously blends tradition, technology, and hospitality.

May *World Aquaculture India 2025* serve as a catalyst for new ideas, meaningful collaborations, and a shared vision of a sustainable blue economy.

With Regards,
 Prof. A. SARAT CHANDRA
 REGISTRAR, PVNRTVU
 National organizing Secretary, WA2025 India

Welcome Message

Dear delegates,

On behalf of the World Aquaculture Society (WAS), it is my pleasure to welcome you all to the World Aquaculture 2025 India (WA 2025 India). WA 2025 India is set to take place in the vibrant Indian city of Hyderabad-fondly known as the “City of Pearls” and recognized by UNESCO as a “Creative City of Gastronomy”. India ranks as the world’s second-largest producer in both total fish production and cultured fish production, contributing approximately 8% to global fish output. Over the past two decades, its aquaculture sector has witnessed remarkable growth, reaching an impressive inland fish production of 14.74 million metric tonnes. The country’s fish and seafood exports are valued at approximately USD 7.45 billion, reflecting its growing prominence in global markets. In the fiscal year 2023-24, India exported 244 metric tonnes of ornamental fish, valued at INR 280 million-underscoring the sector’s expanding diversity and economic potential.

As WAS returns to India following the successful Asia Pacific Aquaculture 2019 Conference in Chennai, we hope the WA 2025 India organised by the WAS will serve as a catalyst for long-term advancement in both the Indian and global aquaculture landscapes. This optimism is fueled by the dynamic collaboration between international industry leaders, researchers, and the thriving Indian aquaculture community. Under the inspiring theme “Aquaculture: Opportunities, Options, and Optimism,” the event will highlight India’s expanding role in global aquaculture through expert sessions, a premier trade exhibition and dynamic collaborative forums. WA 2025 India offers a distinctive backdrop for meaningful dialogue and exchange. The ideas shared and partnerships forged during this conference are poised to make a lasting contribution to the advancement of aquaculture-both within India and across the globe.

I warmly encourage you to utilise fully the diverse and thoughtfully curated program we’ve prepared for WA 2025 India. Your participation is vital in shaping the future of aquaculture, and I am confident that together, we can advance toward a more sustainable and resilient blue economy. I extend my heartfelt thanks to our hosts, supporters, sponsors and the organizing team for their invaluable contributions to this much-anticipated event. Thank you for choosing to be part of WA 2025 India. We look forward to a transformative exchange of ideas, innovations, and partnerships that will shape the future of aquaculture worldwide.

With warm regards,

Dr. Bijay Kumar Behera,
Chief Executive, National Fisheries Development Board

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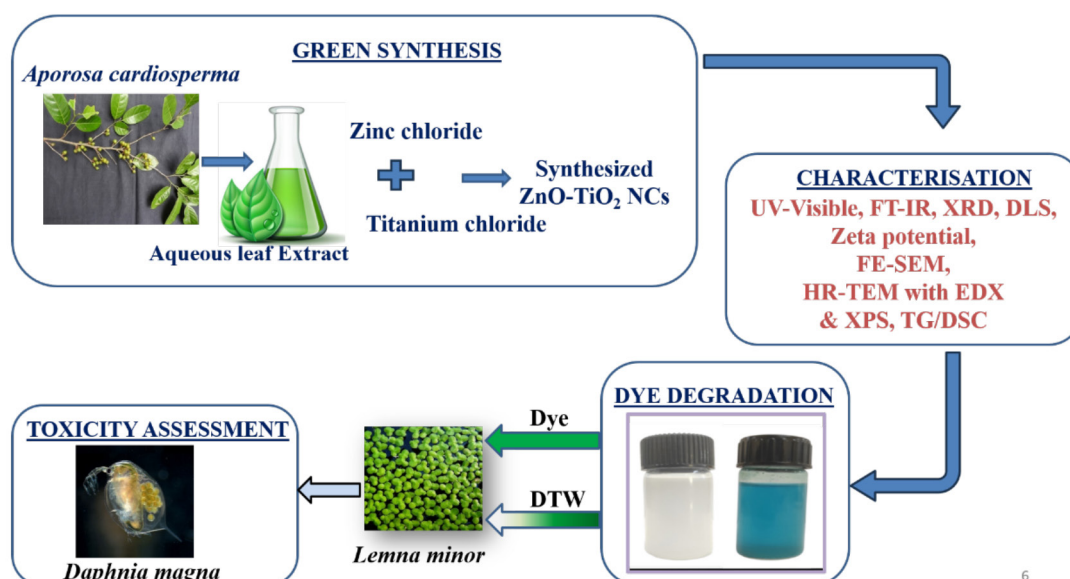
ECO-FRIENDLY DEGRADATION OF HAZARDOUS MALACHITE GREEN DYE USING ZNO-TIO₂ NANOCOMPOSITES AND DUCKWEED: A SUSTAINABLE APPROACH FOR INDUSTRIAL WASTEWATER REPURPOSING IN AQUAPONICS

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This study developed an eco-friendly and integrated strategy to treat malachite green (MG) pollution using green-synthesized ZnO–TiO₂ nanocomposites (NCs), followed by phytoremediation with *Lemna minor*. The ZnO–TiO₂ NCs were synthesised via a one-pot green chemistry approach using *Aporosa cardiosperma* leaf extract, and thoroughly characterised through UV–vis spectroscopy, FT-IR, DLS-Zeta potential analysis, FE-SEM, HR-TEM, XPS, and TGA/DSC. These NCs demonstrated high photocatalytic efficiency, achieving 91.05% degradation of MG under sunlight and 74.79% under UV light within 60 minutes, along with strong reusability across treatment cycles. Then, in dye-treated water, degraded dye residues and NCs were present. They were absorbed by *L. minor*, aiding in water purification. Toxicity evaluation using *Daphnia magna* revealed significant morphological and cellular damage upon MG exposure, while ZnO–TiO₂ NCs provided moderate mitigation. Remarkably, subsequent treatment with *L. minor* dye-treated water preserved organism health, as confirmed through CLSM and SEM-EDS analyses, indicating effective pollutant removal and reduced toxicity. Water quality parameters, including pH, dissolved oxygen, BOD, total solids, and hardness, showed notable improvements after treatment, aligning with global standards for safe drinking, agriculture, and aquaculture use. This study highlights a sustainable, nature-based approach for effective pollutant removal and water quality restoration, supporting broader environmental conservation and circular water management applications.

Graphical abstract



A COMPARATIVE INVESTIGATION OF DEMERSAL FISH STOCK *Pomadasys olivaceus* IN BALOCHISTAN AND SINDH, PAKISTAN, UTILIZING CMSY/BSM AND ASPIC METHODOLOGIES

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Fish stock assessment is essential for the sustainable exploitation of fish populations. The stock status of Olive grunt *Pomadasys olivaceus* in both coastlines of Pakistan (Balochistan and Sindh) was studied using CMSY, BSM and ASPIC models based on the catch and effort data (2000 to 2022). The findings of B/B_{MSY} in all models of Olive grunt were <0.5 pinpointing the stock is grossly overfished on both Coasts of Balochistan and Sindh. The estimated values of MSY using CMSY and BSM methodologies were 2440mt, 2670mt and 2430mt, 2650mt of Balochistan and Sindh respectively. A comparative analysis has also indicated while using the ASPIC model (Fox and Logistic) that Olive grunt was abundantly over-fished from Balochistan and Sindh Coast. The Fox and Logistic model estimated the MSY values 1585mt, 1379mt, 2990mt and 1697mt from Balochistan and Sindh for Olive grunt showing overfished correspondingly. These results showed that the Sindh coast was extremely overfished in the Olive grunt fishery compared with the Balochistan coast in the analysis with CMSY, BMSY and ASPIC. This study may provide scientific background to the government of Pakistan for the establishment of strategies for management and conservation policies of olive grunt fishery on both coasts of Pakistan, especially focusing on the Sindh Coast.

ASSESSMENT OF EFFICACIES OF 17 α METHYL TESTOSTERONE HORMONE AND SOME SELECTED ESTROGENIC PLANTS EXTRACTS ON THE SEX REVERSAL OF NEWLY HATCHED *Oreochromis niloticus*(TILAPIA) (LINNAEUS, 1758)

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The 17 α -methyltestosterone is the most common synthetic hormone used in male mono-sex production of Nile tilapia, *Oreochromis niloticus*. The current study was aimed at finding out the efficacies of 17 α methyl testosterone hormone, *Carica papaya* (pawpaw) and *Moringaoleifera* (Moringa) seed extracts and *Mangifera indica* (Mango) leaves extracts on the sex reversal of newly hatched *oreochromis niloticus* (Tilapia) for a period of sixty (60) days. A total of 600 fry were randomly allocated to 24 experimental ponds. The hormonal diets were formulated by adding 17 α - methyl-testosterone (Tc), *Caricapapayaseeds* extracted with methane (T1), *Caricapapayaseeds* extracted with hexane (T2), *Moringaoleifera* seeds extracted with methane (T3) *Moringaoleifera* seeds extracted with hexane (T4) *Mangifera indica* leaves extracted with methane (T5), *Mangifera indica* leaves extracted with hexane (T6) and basal feed with neither hormone nor plant extracts as negative control (T7) at an inclusion of 40ml/ kg diet on the treatments .

The fry were fed at 20% body weight during a 30 day feeding trial and a gradual reduction of feed to 10% during the second months rearing period. Results of the growth parameters showed highest weight value of (7.66 $\pm$ 0.00 g) in T2 followed by (7.19 $\pm$ 0.00g) in T1, the lowest mean weight value of (5.06 $\pm$ 0.01g) was observed in negative control group T7. The maximum length value was recorded as 10.77 $\pm$ 0.01 cm in T1, followed by 10.56 $\pm$ 0.01cm in T2, followed by 9.96 $\pm$ 0.00 cm in TC (positive control). The lowest length value was recorded as 6.99 $\pm$ 0.01cm in T7 (negative control). The highest value of SGR (%) occurred at (11.07) from T2 followed by T1 (10.96) and T7 recorded the lowest SGR with (10.37). The maximum survival rate (97.88 $\pm$ 2.25) was observed in the negative control group (T7), survival rate of 95.79 $\pm$ 3.29 was observed in TC (positive control) and (96.50 $\pm$ 2.26) in T1. However, there were no significant differences ($p > 0.05$) in the survival rates among the treatment groups. The results of the physicochemical parameters showed no significant differences ($p > 0.05$) among all the treatments and the results were within the recommended ranges for the growth and survival of *O. niloticus* (Table 2). Results from the gonad examination (Table 3) revealed that Nile tilapia fry fed with 17 α methyl testosterone hormone diet (Tc) produced the highest phenotypic males of 87%, while T1, T2, T3, T4, T5, T6 gave males of 80%, 77%, 73%, 69%, 60%, 63% and 27% respectively. Further studies are required to understand the exact mechanism through which the Pawpaw and Moringa seeds and Mango leaves exert their effect of sex differentiation in newly hatched *O. niloticus*.

Table 2: Water Quality Parameters during the treatment
Period of 60 days

Month / week	Temperature ($^{\circ}$ C)	pH	Dissolved Oxygen (mg/l)
First week	27.43 $\pm$ 0.51 ^a	7.17 $\pm$ 0.29 ^a	5.26 $\pm$ 0.19 ^a
Mar	27.53 $\pm$ 0.50 ^a	7.56 $\pm$ 0.17 ^a	5.34 $\pm$ 0.32 ^a
Apr	27.90 $\pm$ 0.17 ^a	7.20 $\pm$ 0.35 ^a	5.57 $\pm$ 0.12 ^a

Table 3: The Male and Female Sex ratio in *O. niloticus* after 60 days treatment

Treatment	% Male	% Female	M:F Ratio
Tc	87	23	3.8:1
T1	80	20	4.0:1
T2	77	23	3.3:1

PHYTOCHEMICAL CONTENT OF SYNDERELLA WEED (*Synedrella nodiflora*) OIL AND ITS IMPLICATION ON THE GROWTH PERFORMANCE ON *Clarias gariepinus*

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The enhancement of nutrients utilization is one of the ways to boost aquaculture production. This has achieved severally with the use of some additives. However, some of the additives do not come cheap. Moreover, the residual effects of some of the additives on fish have been called to question. This has necessitated the need for natural additives. *Synedrella nodiflora* (SN) weed extract has been used for various nutritional purposes in human, however, there is no record of its use in aquaculture. This study therefore focused on analyzing the phytochemical content of SN and determining its implication on growth performance of *Clarias gariepinus*. Fresh leaves of SN were taken, the extracts gotten with a Soxhlet apparatus and subjected to gas chromatography-mass spectrometry (GC-MS) for phytochemical analysis. Five isonitrogenous diets were made with the extract included at 0% (TRT1), 0.5% (TRT2), 1.0% (TRT3), 1.5% (TRT4) and 2.0% (TRT5). Juveniles of *C. gariepinus* (n=300, average weight, 6.03±0.03g) were fed with the formulated feeds for 84 days. Data were subjected to analysis of variance and means were separated using Duncan multiple range system.

The obtained results showed that SN extract contained L-Pyroglutamic acid (8.16%), Caryophyllene (11.05%), linoleic acid at (12.63%), and squalene (0.79%) among others (Table 1). Growth performance metrics showed that the highest weight gain (9.85±0.90g), specific growth ratio (1.72±0.09%/day), and feed conversion ratio (1.51±0.21) were gotten in TRT3 which significantly different from the rest (p≤0.05) while the best survival rate (86.67±3.33%) was recorded in both TRT2 and TRT3. It is however not significantly different from the rest.

It is therefore concluded that SN extract is rich in bioactive phytochemicals that can positively affects the growth performance of *Clarias gariepinus* at an optimal inclusion level of 1.0%.

Table 1: Phytochemical contents of Cinderella weed extract

SN	Compound	Concentration (%)
1	L-Pyroglutamic acid	8.16
2	Caryophyllene	11.05
3	Pentadecane	2.37
4	Pentadecanal-	4.47
5	Tetradecanoic acid	7.37
6	n-Hexadecanoic acid	7.37
7	Linoelaidic acid	9.21
8	Octadecanoic acid	2.11
10	Oleic Acid	7.63
11	Squalene	0.79
12	Stigmasterol	1.84
13	γ-Tocopherol	1.58

RECIRCULATING AQUACULTURE SYSTEMS (RAS) IN INDIA: CATALYZING SUSTAINABLE DEVELOPMENTAL BENEFITS FOR HIGH-VALUE SPECIES AQUACULTURE

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This abstract provides a technical overview of the developmental benefits associated with the adoption of Recirculating Aquaculture Systems (RAS) for cultivating high-value aquatic species in India. Traditional aquaculture practices in India, primarily reliant on open-pond or cage culture, face increasing constraints from water scarcity, land availability, environmental degradation, and vulnerability to exogenous pathogens and climatic fluctuations. RAS technology offers a robust solution by enabling intensive, bio-secure, and resource-efficient aquaculture.

RAS operates as a closed-loop system, fundamentally relying on advanced water treatment processes including mechanical filtration for solids removal, biological filtration (nitrification) for ammonia and nitrite conversion, degassing for CO₂ stripping, and oxygenation. This intricate environmental control permits significantly higher stocking densities and optimized growth rates for high-value species, transcending geographical and climatic limitations. Water reuse rates of 90-99% dramatically reduce freshwater consumption, mitigating the agricultural sector's hydrological footprint and fostering water-use efficiency in water-stressed regions of India.

From a developmental perspective, RAS directly contributes to enhanced food security through consistent, year-round production of high-quality protein. Its land-independent nature allows for peri-urban establishment, minimizing logistics costs and ensuring fresh product availability for burgeoning urban markets. Economically, the cultivation of high-value species in RAS yields superior profitability and return on investment (ROI) due to reduced feed conversion ratios (FCRs) under controlled conditions, lower disease incidence, and premium market pricing. The controlled environment also facilitates genetic selection and improved biosecurity, minimizing crop losses. Furthermore, RAS creates skilled employment opportunities in aquaculture engineering, water chemistry, fish health management, and system operation, contributing to rural and semi-urban socio-economic upliftment. The potential for precision farming in RAS also aligns with India's digital agriculture initiatives.

NEW DEVELOPMENTS IN ARTEMIA AQUACULTURE IN IRAN

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The rapid development of Iran's aquaculture industry—particularly in shrimp, marine fish, and sturgeon farming—has created a strong and growing demand for Artemia as a live feed resource. Current national requirements are estimated at approximately 50 tons of Artemia cysts annually, underscoring the organism's critical role in supporting the sector's expansion. The endemic species *Artemia urmiana* from Lake Urmia is recognized for its superior cyst quality and remarkable tolerance to extreme salinity. However, the prolonged desiccation of Lake Urmia due to drought and unsustainable water management has caused a severe decline in natural Artemia populations. To meet aquaculture demand and ensure long-term sustainability, Iran has adopted a dual strategy focused on (1) developing pond-based Artemia production systems and (2) partially restoring Lake Urmia to rehabilitate its natural Artemia populations.

The Artemia & Aquaculture Research Institute, in collaboration with the International Artemia Aquaculture Consortium, is planning to implement a phased program for Lake Urmia's ecological restoration, with the support of the Urmia Lake Restoration Program. This project emphasizes ecosystem recovery and localized Artemia reproduction, with the goal of producing over 500 tons of Artemia cysts annually from restored sections of the lake. Complementary to this effort, extensive pond culture projects have been established in West Azerbaijan, East Azerbaijan, and Chabahar, covering approximately 1,300 hectares. These initiatives, largely financed by private investors, make innovative use of unconventional saline water resources such as saline groundwater, treated municipal effluents, and agricultural drainage—resources available in many Iranian provinces.

In southern Iran, desalination plants built to supply freshwater for agriculture and industry produce high-salinity effluents (≈ 70 ppt) that are ideal for Artemia culture. Plans are underway to establish an initial 1,000-hectare *Artemia franciscana* culture farm near the Oman Sea, with a subsequent expansion to 5,000 hectares following successful pilot production. Integrating these artificial production systems with ecological restoration initiatives is expected to enhance Iran's self-sufficiency in Artemia supply, strengthen aquaculture resilience, improve export capacities of Artemia products, and contribute to the recovery of key saline ecosystems.

Keywords: *Artemia urmiana*, *Artemia franciscana*, pond culture, Lake Urmia restoration, Unconventional saline water resources

EFFECT OF SUGARCANE YEAST CELLWALL SUPPLEMENTATION ON GROWTH PERFORMANCE, IMMUNE STATUS, AND RESISTANCE AGAINST *Vibrio harveyi* AND *Vibrio parahaemolyticus* IN PACIFIC WHITE SHRIMP *Litopenaeus vannamei*

Gustavo de Aguiar*, Melina Bonato, Graziela Valini, Rajib Dutta, Orapint Jintasataporn.

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Vibrio harveyi and *Vibrio parahaemolyticus*, causative agents of vibriosis and Early Mortality Syndrome (EMS), respectively, are major bacterial threats in shrimp aquaculture. Among the strategies to mitigate these pathogens, functional yeast derivatives stand out. The ethanol fermentation of sugarcane yields a yeast cell wall particularly rich in β -glucans (1,3 and 1,6 linkages) and mannan-oligosaccharides (MOS). β -glucans are recognized for their immunomodulatory effects, while MOS can bind gram-negative bacteria, reducing adhesion to the intestinal epithelium and enhancing pathogen clearance. This study evaluated the dietary supplementation of sugarcane-derived yeast cell wall (IMW) on growth performance, immune modulation, and disease resistance in Pacific white shrimp (*Litopenaeus vannamei*).

A completely randomized design was conducted with four treatments (0, 0.25, 0.5, and 1.0% IMW) and eight replicates. Weight gain, specific growth rate, feed conversion ratio, and mortality were recorded on days 14 and 28. Immune responses (total hemocyte count, total protein, and phenoloxidase activity) were evaluated, followed by a bacterial challenge with *V. harveyi* (1.0×10^6 CFU/mL) and *V. parahaemolyticus* (2.6×10^6 CFU/mL). Data was analyzed by one-way ANOVA followed by Duncan's Multiple Range Test, and a linear regression model was fitted to evaluate the dose-response effect of IMW on shrimp performance and mortality.

Results showed that IMW significantly improved feed consumption, growth performance, and immune parameters compared to the control ($P < 0.05$). Shrimp fed IMW also exhibited enhanced immunity and lower mortality after *Vibrio* challenge. The inclusion of 0.5% IMW presented the most consistent benefits. In conclusion, IMW supplementation strengthened the innate immune defense of shrimp and increased resistance against *V. harveyi*, representing a promising nutritional strategy to mitigate vibriosis in intensive aquaculture systems.

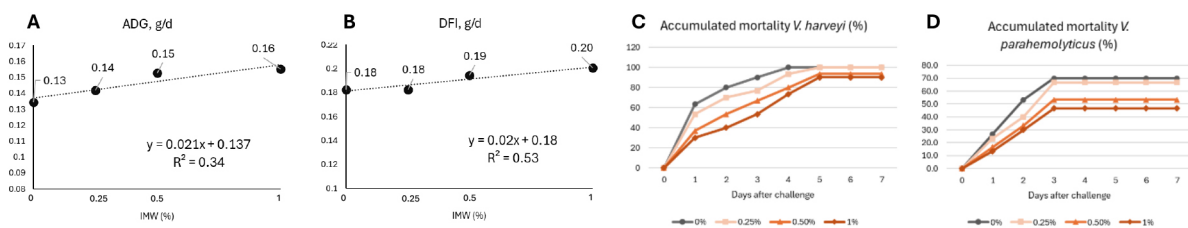


FIGURE 1. (A) Average daily gain (ADG) and (B) daily feed intake (DFI) of shrimp fed diets containing 0, 0.25, 0.5, and 1% of IMW. Accumulated mortality after *Vibrio harveyi* (C) and *Vibrio parahemolyticus* (D) infection.

TABLE 1. Immunity of shrimp after challenge.

	0% IMW	0.25% IMW	0.5% IMW	1% IMW	P
<i>Vibrio harveyi</i>					
POA	510 ± 19	527 ± 60	531 ± 81	545 ± 29	0.87
HP	2.6b ± 0.1	3.0b ± 0.3	3.8a ± 0.2	3.9a ± 0.3	0.00
THC	1.1b ± 0.2	1.3b ± 0.1	1.5ab ± 0.4	1.7a ± 0.1	0.04
CA	4.7 ± 0.3	4.3 ± 0.9	4.2 ± 0.5	4.2 ± 0.4	0.68
<i>Vibrio parahemolyticus</i>					
POA	290 ± 49	339 ± 51	351 ± 70	367 ± 58	0.44
HP	3.0 ± 0.5	3.4 ± 0.3	3.5 ± 0.2	3.6 ± 0.4	0.27
THC	2.6b ± 0.5	3.7ab ± 0.3	4.7a ± 1.0	4.7a ± 1.0	0.03
CA	5.7 ± 0.1	5.5 ± 0.1	5.5 ± 0.2	5.5 ± 0.2	0.22

POA = Phenol Oxidase activity (unit/mg protein); HP = Hemolymph Protein (mg/dl); THC = Total haemocytes count ($\times 10^5$ cell/ml); CA = Clearance ability (Log cfu/ml). Different letters in a row indicate significant differences ($P < 0.05$).

ONE SIZE DOESN'T FIT ALL: DESIGNING CUSTOM PROBIOTIC FORMULATION FOR SHRIMP AQUACULTURE USING NEXT-GENERATION SEQUENCING BASED MICROBIOME OPTIMIZATION

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The sustainability and productivity of shrimp aquaculture are increasingly threatened by disease outbreaks, widespread usage of antibiotics and competitive drive to achieve high feed conversion ratios for minimizing production costs. Although probiotic supplementation is a promising alternative, many commercial formulations lack specificity and efficacy across diverse environmental conditions, geographic locations and types of farming.

Luminis Water Technologies employs next-generation sequencing (NGS) to profile the metagenome of water and gut of various aquaculture stocks under different life stages and culture conditions. Metagenomic data helps us to characterize the microbial community with their functional potential. Further, bioinformatic analysis is used to identify key bacterial taxa associated with immune modulation, digestion efficiency, and pathogen resistance. From these data, we developed a pipeline for designing custom probiotic consortia tailored to specific shrimp cohorts and environmental conditions. More than 1,000 bioactive microbial strains were isolated and cultured, which were then validated *in-vitro* for traits such as antimicrobial activity, biofilm formation and enzyme production. Subsequent *in-vivo* trials demonstrated improved growth performance, enhanced immune response and reduced mortality under challenge conditions in various shrimp aquaculture systems. This biological bank serves as a foundation for our probiotic formulations.

Our results demonstrate that NGS-guided probiotic design is a viable strategy in next-generation health management for sustainable aquaculture. This approach paves the way for precision aquaculture practices that reduce antibiotic use, enhance resilience in farming systems and promotes 'One-health' mission.

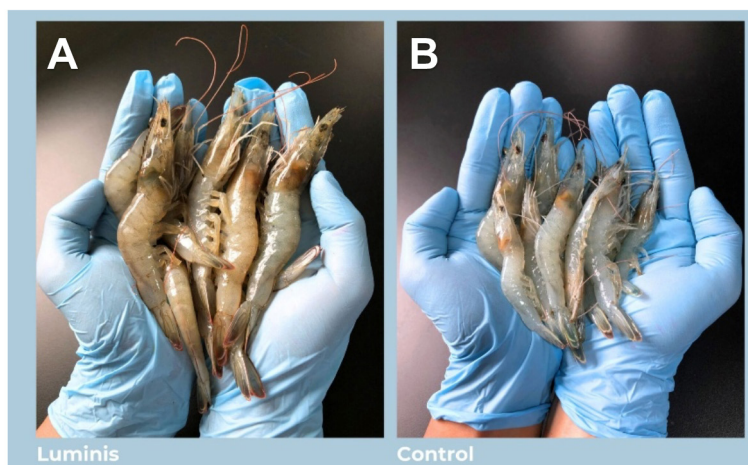


Fig: A: Luminis-optimized microbiome boosts *L. vannamei* growth by 56% **B:** Control

MICROPLASTIC CONTAMINATION IN SELECTED BIOTA INHABITING DIFFERENT TROPHIC LEVELS AT ANAWILUNDAWA MANGROVE RESTORATION SITE, SRI LANKA

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Microplastics (MPs) persist in aquatic ecosystems, posing risks to marine life and humans via bioaccumulation and trophic transfer. Mangroves can serve as reservoirs for MPs, potentially impacting conservation and restoration. This study investigates MPs contamination in fish at the Anawilundawa Accelerated Natural Regeneration of Mangroves (ANRM) site in Sri Lanka, now in its fifth year of restoration.

Three fish species namely *Carangoides fulvoguttatus* (carnivore), *Chanos chanos*, and *Oreochromis mossambicus* (omnivores) were collected from water channels during November–December 2024 and their gut and muscles were extracted. Extracted tissues from five specimens of each species between 12–20 cm total length underwent organic digestion (10% KOH, 60°C, 24 hrs), density separation (NaCl, 1.2 g/ml), and filtration (0.45 µm filters). MPs were characterized by shape, size, color, and abundance under a stereo zoom microscope. One-way ANOVA revealed significant differences in gut contamination, mainly due to higher levels of MPs in *C. fulvoguttatus* ($\pm SD$) (1.89 ± 0.81), as confirmed by Tukey's test ($p < 0.05$). No significant differences were found in muscle tissue MPs across species. Only filaments were observed in all species. Paired t-tests between gut and muscle tissues showed no significant differences, except a suggestive one-tailed significance for higher levels of MPs in gut of *C. fulvoguttatus*. Blue and transparent filaments were most common, especially in the muscles of *O. mossambicus*.

These findings represent the first evidence of MPs contamination in fish within this mangrove restoration area, highlighting the need for further surveillance of MPs in mangrove ecosystems.

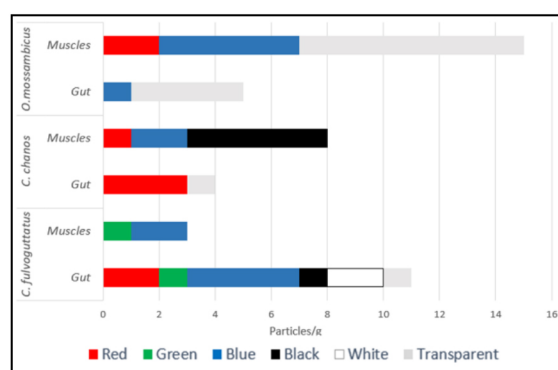


Figure 1: Observed Microplastic filaments content in muscles and gut of each studied fish species, indicating the color.

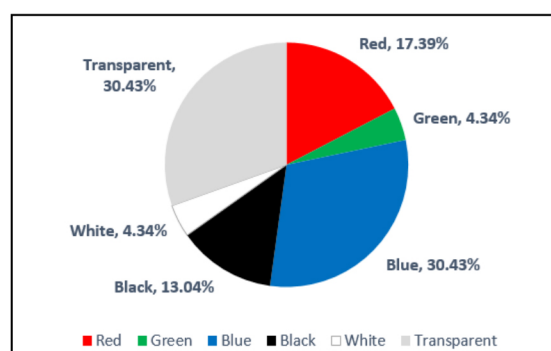


Figure 2: Overall observed color occurrences of Microplastic filaments in the studied fish species.

GROWTH PERFORMANCE AND PROFITABILITY OF GENETICALLY IMPROVED AND COMMERCIAL LOCAL ROHU (*Labeo rohita*) IN BANGLADESH

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Rohu (*Labeo rohita*) is a major aquaculture species in Bangladesh, but poor broodstock management has compromised seed quality and growth performance. To address this, WorldFish launched a genetic improvement program in 2012, yet the on-farm performance of the widely available third generation (G3) rohu remains poorly studied. This study aimed to evaluate and compare the growth and profitability of G3 rohu and commercial local rohu under typical smallholder pond polyculture systems in Bangladesh. A total of 120 ponds across two locations were randomly assigned to Selected (30 per location, G3 rohu) or Control (30 per location, local rohu), with rohu stocked at an average of 2,470 ha⁻¹ in typical smallholder polyculture systems alongside 5,287 ha⁻¹ of other co-cultured species. The study was conducted over a full production cycle from July 2023 to March 2024, and differences in performance were assessed using multivariate regression and ANOVA models. Water quality remained within acceptable ranges for aquaculture, despite fluctuations. The Selected rohu demonstrated significantly higher ($p \leq 0.05$) harvest weight, weight gain, survival rate, and specific growth rate (Table 1), growing 32.6% faster than Control rohu. Productivity of co-cultured species did not differ significantly ($p \geq 0.05$) between ponds with Selected or Control rohu. Furthermore, G3 rohu yielded significantly higher returns per ha than local rohu, with total productivity, gross revenue, gross margin, net margin, and benefit-cost ratios all significantly higher ($p \leq 0.05$) in ponds with Selected rohu. Regression analysis identified pond size, commercial feed use, inorganic fertilization, and stocking density as positive drivers of rohu productivity, whereas pond age had negative effects. Findings are based on data from two districts in southern Bangladesh and may vary elsewhere depending on local farming intensity and management practices. These results suggest that wider dissemination of genetically improved fingerlings, coupled with improved pond management, could enhance smallholder productivity and profitability in Bangladesh.

Table 1: Key production and economic performance characteristics of rohu-based aquaculture by location and strain.

Variable	Location				Strain			
	Khulna		Barguna		Selected		Control	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Pond size (ha)	0.06	0.33	0.06	0.30	0.06	0.36	0.06	0.25
Pond depth (m)	1.76	0.19	2.07	0.18	1.97	0.18	1.86	0.23
Pond age (years)	13	0.35	13	0.35	13	0.37	13	0.32
Stocking density (n ha ⁻¹)	4867	0.27	5720	0.36	5296	0.35	5276	0.32
Supplementary feed (t ha ⁻¹)	1.56	0.52	0.72	0.50	1.16	0.74	1.13	0.56
Rohu mean weight gain (g)	492	0.24	480	0.23	550	0.21	415	0.15
Rohu survival rate (%)	82	0.17	86	0.12	87	0.10	80	0.19
Rohu SGR (%)	0.84	0.13	0.79	0.12	0.87	0.11	0.76	0.10
Rohu production (t ha ⁻¹)	0.92	0.31	0.72	0.41	0.97	0.32	0.66	0.31
Total fish production (t ha ⁻¹)	3.02	0.24	2.64	0.28	2.94	0.26	2.72	0.26
Rohu gross revenue (USD ha ⁻¹)	1729	0.63	1304	0.42	1915	0.53	1085	0.36
Total gross revenue (USD ha ⁻¹)	4552	0.28	4166	0.24	4709	0.28	3981	0.20
Gross margin (USD ha ⁻¹)	3201	0.27	2752	0.28	3287	0.27	2643	0.25
Net margin (USD ha ⁻¹)	3112	0.27	2660	0.29	3192	0.28	2558	0.26
Benefit-cost ratio (BCR)	2.44	0.42	1.91	0.38	2.38	0.42	1.96	0.40

RL-DRIVEN PREDICTIVE CONTROL FOR SMART AQUACULTURE WATER QUALITY MANAGEMENT

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Maintaining optimal water quality is fundamental to aquaculture productivity and sustainability. Conventional practices rely on manual sampling or static rule-based systems, which are labor-intensive, reactive, and often delayed in responding to dynamic environmental changes. Key water quality parameters—dissolved oxygen (DO), pH, temperature, biochemical oxygen demand (BOD), and coliform counts—must be continuously managed to safeguard aquatic health and ensure high yields.

This work proposes a reinforcement learning (RL)-based predictive control framework for real-time monitoring and adaptive management of aquaculture water quality. By framing water management as a sequential decision-making problem, the system learns optimal interventions such as aerator activation, water flow adjustment, or chemical dosing. A Double Deep Q-Network (DDQN) agent was employed to overcome overestimation bias and enhance learning stability. The model continuously receives feedback from water quality sensors, evaluates states, and recommends corrective actions to maintain parameters within optimal ranges while minimizing energy consumption.

- Key contributions include:
- Integration of RL-driven adaptive control with real-time water quality monitoring.
 - Use of DDQN agents for stable policy learning and improved decision-making.
 - Demonstrated ability to maintain DO levels within safe ranges for ~90% of cycles, while reducing aerator energy usage by 25%.
 - Comparative results show superior adaptability, responsiveness, and efficiency compared to manual and rule-based systems.

This RL-driven predictive control approach establishes a scalable and intelligent foundation for sustainable aquaculture water management, reducing operational costs and supporting India’s Blue Transformation vision through AI-enabled environmental resilience.

Table 1. Performance comparison of water quality control approaches

Metric	Manual Control	Rule-based System	RL-based Model
DO Stability (%)	~60%	~75%	90%
Aerator Energy Use	High	Moderate	Optimized (↓25%)
Reaction Time	Slow	Fixed Interval	Adaptive
Learning Capability	None	Static	Dynamic

AUTOMATED FISH DETECTION FOR PRECISE AQUACULTURE MONITORING

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Automated fish detection represents a pivotal advancement in aquaculture management, enabling real-time monitoring that addresses key challenges in the industry. This work focuses on developing a robust detection system to accurately identify and track fish populations, which serves as the foundation for critical applications such as biomass estimation, behavioral analysis, optimized feeding strategies, and health monitoring. By providing continuous, non-invasive insights, real-time detection can significantly reduce operational costs by minimizing the need for manual labor and overcoming human limitations like fatigue and subjectivity. Furthermore, it facilitates precise control over individual parameters, including water purification levels, feeding amounts, disease detection, and other environmental factors, thereby optimizing overall fish farming efficiency and sustainability. Focusing on *Tilapia nilotica* (Nile tilapia), we implemented a machine vision-based approach to detect and quantify fish in real-time within commercial tanks.

The methodology utilized image processing algorithms to identify fish based on shape and motion characteristics under varying environmental conditions. Our approach leverages deep learning models to enhance detection reliability across diverse settings, such as fluctuating light and water turbidity. As illustrated in Figure 1, the system marks detected fish with red bounding boxes, demonstrating effective identification in a sample image.

Preliminary results show a fish detection accuracy exceeding 94% across diverse real-world conditions. We evaluated YOLOv5, YOLOv8, and YOLOv11 models on our dataset, with precision values depicted in Figure 2, demonstrating YOLOv5's superior performance. These findings highlight the effectiveness of our automated detection system for aquaculture monitoring, offering a scalable solution for real-time fish tracking.

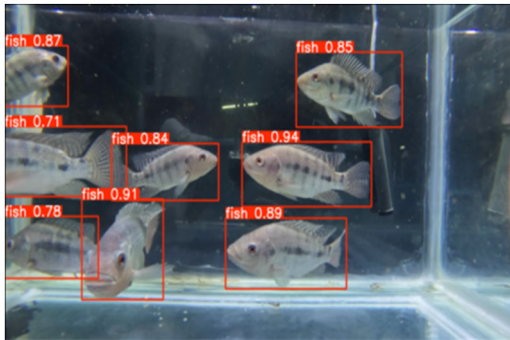


Figure 1: Sample fish detection output.

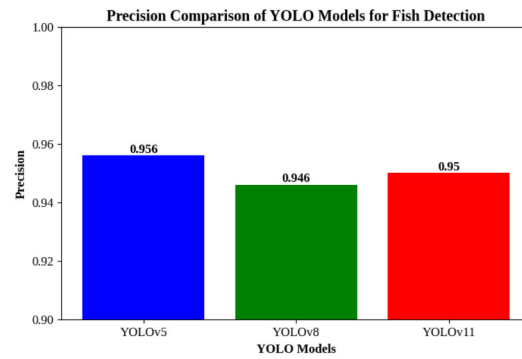


Figure 2: Precision of models.

THE FUTURE OF AQUACULTURE FINANCING: CHILE ATLANTIC SALMON

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Chile's salmon aquaculture, developed over the past four decades, has become one of the country's most dynamic export sectors and the second largest globally after Norway. The industry's success was built essentially on Chile's natural comparative advantages, and a supportive regulatory framework—combined with early state involvement, international cooperation, and the catalytic role of Fundación Chile. The sector developed its own technological and organizational capacities, creating a strong innovation ecosystem that links industry, academy and public institutions. Salmon aquaculture has delivered significant economic and social benefits, generating more than 70,000 jobs, fostering regional development in Chilean Patagonian regions, and contributing over USD 6 billion annually in exports. Financing structures evolved from pioneer capital and government-backed incentives to diversified mechanisms including insurance, bank loans, stock markets, strategic partnerships, and more recently green loans, reflecting the industry's increasing alignment with sustainability standards.

The trajectory has not been without challenges. The ISA crisis in 2007–09, climate-related harmful algal blooms, and conflicts with Indigenous and coastal communities underscored the importance of governance, biosecurity, and social license to operate. Lessons learned include the risks of overproduction and farm concentration, the necessity of adaptive regulation, and the value of coordinated sanitary and environmental strategies. Chile's experience offers critical lessons for emerging aquaculture nations: leverage natural and institutional advantages; ensure early alignment of state, industry, and science; diversify financing instruments; and embed sustainability and community engagement at the core. These elements have enabled Chile to build a world-class industry with global reach and ongoing potential for sustainable growth.

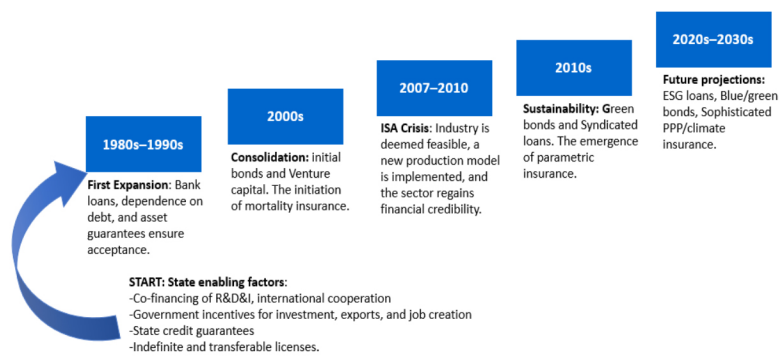


Figure 1. Financing instruments evolution

SALINITY TOLERANCE IN FRESHWATER DRUM *Aplodinotus grunniens* INVESTIGATING BIOCHEMICAL, ANTIOXIDANT, DIGESTIVE ENZYME, AND GENE EXPRESSION RESPONSES TO ACUTE SALINITY STRESS

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Variations in salinity levels in aquaculture significantly influence fish physiology, impacting population dynamics and industry viability. This study aimed to examine the physiological response of the freshwater drum (*Aplodinotus grunniens*) to differing salinity conditions, assessing its potential for cultivation in brackish water environments. Fish averaging 45 ± 0.1 g were subjected to acute salinity tests across three groups: a control group at 0 ‰ and experimental groups at 7.5 ‰ and 15 ‰ over four days. Initial findings indicated that *A. grunniens* could tolerate salinity levels up to 15 ‰ without adverse effects.

Key biochemical markers, such as aspartate aminotransferase and alanine aminotransferase, exhibited significant fluctuations but decreased over time. Antioxidant enzyme activity increased relative to the control, while malondialdehyde levels declined, indicating effective oxidative stress management. Additionally, digestive enzymes like amylase and lipase demonstrated adaptability to changing salinity. The expression of heat shock proteins 70 and 90 in the gills and liver varied initially but showed no long-term changes. Overall, the results suggest that *A. grunniens* possesses notable resilience to salinity variations, indicating its suitability for brackish water aquaculture and highlighting optimal salinity ranges for promoting growth. Suggestions for long term effects are warranted to fully ascertain salinity effects in the freshwater species.

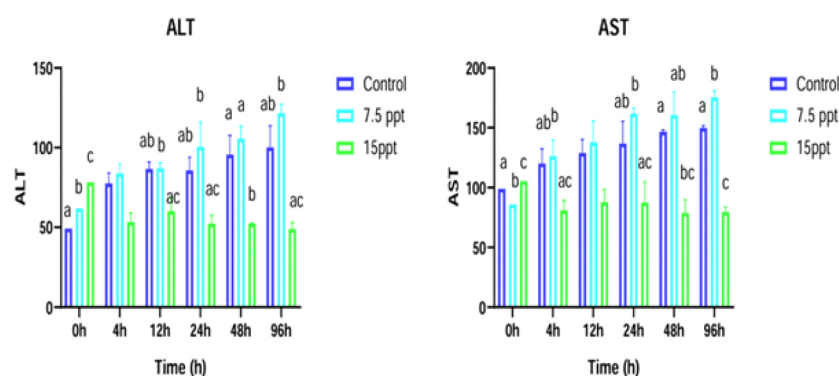


Figure 1 illustrates the activities of Alanine transaminase (ALT) and Aspartate transaminase (AST) under varying salinity conditions across standard errors (SE), with matching letters denoting no significant difference ($P > 0.05$).

FUNCTIONAL NUTRIENTS OF ANTARCTIC KRILL MEAL HELPS IN IMPROVED HEALTH AND GROWTH IN THE WHITE LEG SHRIMP, *Penaeus vannamei*

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The finite supply of fish meal and increasing prices spurred the aqua nutritionists to experiment with several nutritional alternatives to be able to lower fishmeal inclusion levels. However, replacement of fish meal resulted in imbalances in nutrient profile, palatability issues and also reduced immune competency. Therefore, the search for new alternatives having functional nutrients in the health of shrimp has acquired significant importance. Krill meal has quality protein containing balanced amino acid profile, higher phospholipids, EPA and DHA, cholesterol and carotenoids, which are considered as functional nutrients in the diets of shrimp. The present study aimed to assess the potential of krill meal as a functional ingredient in feeds of the shrimp, *P.vannamei* under two different levels of fish meal inclusion.

An eight-week feeding experiment was conducted to investigate the functional effect of dietary krill meal in diets with moderate (12%) and low (6%) fishmeal concentrations for *Penaeus vannamei*. Eight isonitrogenous and isolipidic diets were formulated to contain 36% crude protein and 5.5% crude lipid. Krill meal was included at 0, 2, 4 and 6%, in both levels of fishmeal included diets. Shrimp with a starting body weight of 0.55 ± 0.02 g were stocked at 22 animals per tank of 350 l capacity and fed three times daily. The influence of krill meal inclusion on various growth performance were assessed and the functional effects were studied through biochemical analysis of shrimp, quantification of immune gene expression, hepatopancreas histopathology and hematological indices.

Results revealed that dietary krill meal and fish meal inclusion levels significantly increased growth performance ($P < 0.05$). Shrimp fed 6% krill meal diet had the highest final body weight of 11.61 g, weight gain of 11.05 g, weight gain % of 1969.38%, specific growth rate of 5.41%/d and yield of 229.42 g/tank. Dietary change did not affect feed conversion ratio, protein efficiency ratio and apparent protein utilization ($P > 0.05$). Survival was significantly increased in the groups containing 6 and 4% krill meal diets compared to 0% krill meal diet ($P < 0.05$). Inclusion levels of krill meal showed non-significant differences in post-fed body composition except for crude lipid and crude fibre content. krill meal inclusion levels showed significant variation in the all n-3 fatty acids only. Immune-related gene expression was significantly ($P < 0.05$) upregulated in the shrimp fed high fishmeal diets (12%) for all the analyzed genes *ProPO*, *PPAE*, *SP*, *BGBP*, *SOD*, and *HC*. The dietary change led to a significant difference in both histology and hematology parameters ($P < 0.05$). The results inferred that krill meal could be used as a potential functional ingredient in *Penaeus vannamei*.

UTILIZING HOUSEFLY LARVAE FOR BIOCONVERSION OF AQUACULTURE WASTE AND SUSTAINABLE AQUAFEED PRODUCTION: VIABLE ALTERNATIVE TO FISHMEAL

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Aquaculture waste production has been a significant concern to health and the environment. Bioconversion of these wastes through insects are the promising environment-based solution. The present study focused on the bioconversion of aquaculture wastes by utilizing housefly larvae (HFL). On a dry basis, the proximate composition of HFL contains crude protein (38.91%), moisture (8.98%), fat (28.46%), fibre (9.04%), and ash (11.38%). Larval meal (HFL) was used as a fishmeal replacement in diets for *Cyprinus carpio*, formulated as a control, 25%, 50%, 75%, and 100% HFL integrated diet. The findings revealed significant morphometric improvements such as weight gain (WG) at 25%, length gain (LG) at 50% and 75%, and specific growth rate (SGR) at 75% and 100% HFL diet. The feed conversion ratio was significantly reduced in the 75% and 100% HFL diets. The protein efficiency ratio (PER) peaked with the 25% HFL diet. Feed properties like sinking velocity (SV) and water stability (WS) were optimized at 25% and 75% HFL diets. Histology, haematology, and serum biochemistry analyses showed notable enhancements with 50% and 75% HFL diets. Digestive enzyme activities (amylase, protease, trypsin) were higher in control and 25% diets, indicating efficient nutrient absorption. Antioxidant activity was most prominent in the 100% HFL diet except for the lipid peroxidation shows better activity in control. Overall, the present study recommended that HFL meal can replace fishmeal in aquafeeds, with up to 75% inclusion improving *C. carpio* growth and health.

INVESTIGATING THE RESISTANCE OF RICE-FIELD FISHERIES TO TRANSITION INTO RICE-FISH FARMING AND POND AQUACULTURE IN CAMBODIA

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For centuries, Cambodian traditional rice-field fisheries (RFFs) have sustained rural livelihoods and food security. However, the transition to more intensive rice-fish farming (RFs) and pond aquaculture systems still needs to grow despite global trends toward expansion and intensification. This study investigates the socioeconomic and structural barriers hindering this transition, focusing on farmer resistance to adopting these more productive systems. Conducted in the rice-producing provinces of Battambang, Kampong Thom, and Takeo, the research examines four production models: RFFs, community fisheries, RFs, and pond aquaculture. Our findings indicate that RFs present a viable intermediate step for small-scale farmers with limited access to capital, infrastructure, and technology to transition to pond aquaculture, offering economic advantages with lower financial risks than pond aquaculture. However, significant obstacles persist, including limited technical knowledge, inadequate feed, seed, and equipment supply, and restricted access to capital and infrastructure (Figure 1a). Policy recommendations emphasize the importance of educational outreach through awareness campaigns and technical training to ensure farmers' confidence in adopting RFs. Additionally, targeted financial support, such as low-interest loans and subsidies for essential inputs, would reduce economic burdens (Figure 1b). Species diversification is also identified as an effective risk management strategy, particularly beneficial for regions with variable climates, such as Africa, as it enhances resilience and stability in farming operations. The study outlines a pathway for sustainable and resilient aquaculture systems in Cambodia and other regions with similar socioeconomic and environmental contexts by addressing these barriers.

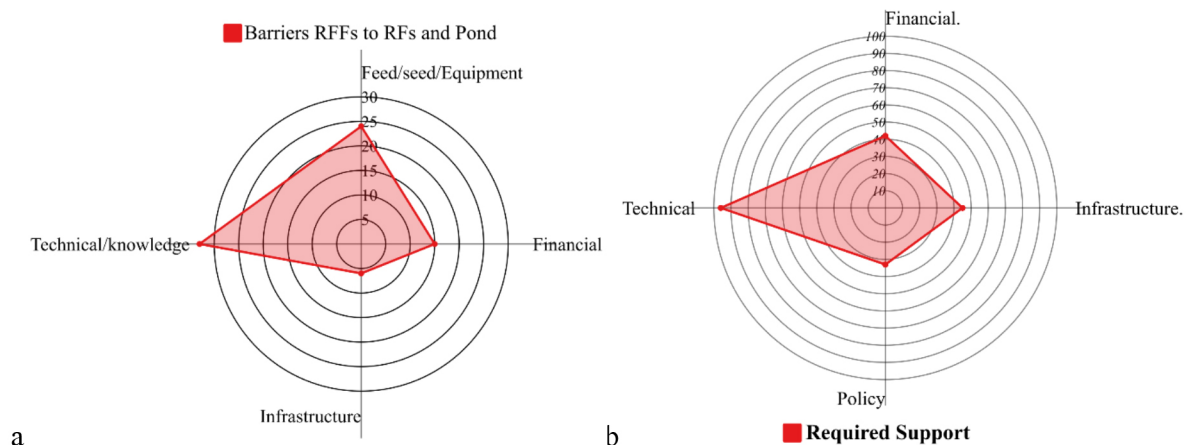


Figure 1: (a) What are the potential barriers that prevent the transition from rice-field fisheries to rice-fish farming or rice-fish-farming to pond aquaculture? (b) What is the required support that will help make the transition?

EMERGING INTEGRATED TECHNOLOGY FOR BRACKISHWATER SEAWEED–SHRIMP FARMING: A SUSTAINABLE MODEL FOR COASTAL AQUACULTURE

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A novel integrated seaweed–shrimp farming system was developed and validated to enhance the productivity, environmental sustainability, and economic resilience of coastal aquaculture. The experiment was carried out in 500 m² HDPE-lined ponds, each stocked with *Penaeus vannamei* post-larvae (PL12) at a density of 40 individuals/m². Two treatments were implemented: (i) control ponds without seaweed, and (ii) seaweed-integrated ponds, wherein *Gracilaria salicornia* was stocked at 7.5 kg per monoline tube net across 30 lines per pond. Over a 110-day culture period, the integrated system exhibited significantly superior performance ($p < 0.05$), with shrimp achieving an average body weight of 23.2 ± 1.1 g, feed conversion ratio (FCR) of 1.38, and survival rate exceeding 98%. In contrast, the control ponds yielded shrimp with an average weight of 19.8 ± 0.98 g, FCR of 1.48, and 97% survival. Simultaneously, the integrated ponds produced approximately 1.2 tons of *G. salicornia* across two harvests, without the application of external feed or fertilizers. The inclusion of seaweed significantly enhanced water quality by assimilating dissolved nutrients, thereby reducing organic load and supporting a more stable and favourable environment for shrimp culture. This integrated farming model offers a sustainable alternative to conventional monoculture, providing synergistic benefits in terms of improved shrimp growth, health and survival, environmental remediation, and an additional revenue stream through seaweed biomass, thus supporting ecosystem-based and economically viable coastal aquaculture.

LIFE CYCLE ASSESSMENT OF SHRIMP FEED USING BLACK SOLDIER FLY LARVAE MEAL FROM SEAFOOD WASTE: A CLOSED-LOOP CIRCULAR ECONOMY MODEL FOR SUSTAINABLE AQUACULTURE

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This study evaluates the environmental performance of a circular economy model in shrimp aquaculture, where seafood processing waste is converted into Black Soldier Fly (BSF) larvae and reused as a sustainable feed ingredient. The system establishes a closed nutrient loop in which harvested shrimp are processed for human consumption, and the resulting by-products are valorized as substrates for BSF rearing. The larvae are then dried, milled, and incorporated into shrimp feed, replacing fish meal and soybean meal to enable continuous resource recovery and minimize waste across the aquaculture value chain (Figure 1).

A life cycle assessment (LCA) was conducted for one kilogram of shrimp feed under five substitution scenarios, from 0% BSF + grid electricity (control) to 100% BSF + 100% solar energy. Fish meal and soybean meal were progressively replaced by BSF meal, while grid electricity (0.10 kWh/kg) was gradually substituted by solar power to examine combined feed and energy transition impacts.

Increasing BSF inclusion and solar energy use significantly improved environmental performance. The Global Warming Potential (GWP₁₀₀) declined from 2.92 kg CO₂ eq in the control to 2.01 kg CO₂ eq (–31%) at 50% substitution and 1.11 kg CO₂ eq (–62%) under full replacement. Fossil fuel depletion decreased from 14.7 MJ to 11.5 MJ (–22%), while acidification and eutrophication potentials fell by 25% and 23%, respectively. Freshwater ecotoxicity and photochemical oxidation were reduced by 24% and 41%, respectively, although a minor rise in marine ecotoxicity occurred due to seafood waste valorization.

The baseline impacts were primarily driven by soybean cultivation, fishmeal production, and coal-based electricity generation. The 50% BSF + 50% solar scenario provided the optimal balance between environmental benefit and feed quality. This closed-loop model effectively demonstrates circular economy and renewable energy integration in shrimp aquaculture, lowering carbon emissions, conserving resources, and enhancing sustainability.

The major factors that impact the baseline, the need for effective replacement of traditional feed ingredients, which would lead to more energy efficient, environment friendly and sustainable solutions, are discussed.

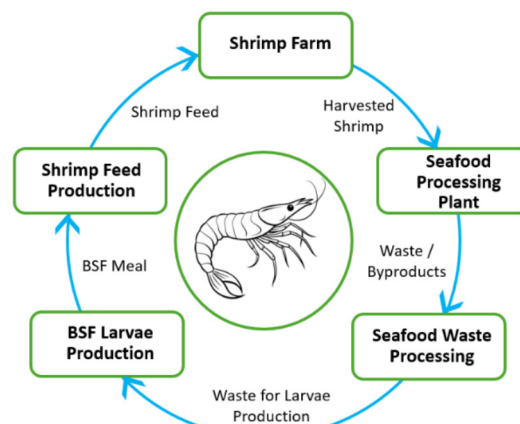


Figure 1: Circular Economy in Shrimp Aquaculture

COMPARATIVE OF SPAWNING INDUCTION METHODS ON BREEDING PERFORMANCE OF MANGROVE RED SNAPPER *Lutjanus argentimaculatus* BROODSTOCK FROM EARTHEN POND-REARED

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Mangrove red snapper (*Lutjanus argentimaculatus*) is a high demand in Southeast Asia for both consumption and aquaculture, yet over 90% of its fingerlings were sourced from the wild, putting pressure on natural populations. Moving towards hatchery-based production of fish is therefore critical to sustainability. This shift depended on developing high-quality, sustainable broodstock to ensure reliable and consistent fingerling output. This study aimed to the feasibility of using earthen pond-cultivated red snapper as broodstock to reduce dependence on wild populations. By investigating different spawning induction methods.

Researchers selected mature broodstock from grow-out ponds at Klongwan Fisheries Research Station, Kasetsart University, where they had been cultivated for 3.2 to 3.7 years. Males had a mean length of 58.3 ± 1.2 cm and weight of 2.7 ± 0.2 kg, while females had a mean length of 56.3 ± 0.9 cm and weight of 3.1 ± 0.2 kg. In 15-ton spawning tanks with a 2:3 male-to-female ratio, the brooders were divided into three groups to test different spawning induction methods. Each method had three replicates and was observed over a 30-day period.

Results indicated that (Figure 1) Method I, which involved environmental manipulation through a 70% water exchange per week, resulted in a mean of 1.3 ± 0.5 spawning events but produced no fertilized eggs. Method II, which applied hormonal injections of $30 \mu\text{g}$ LHRHa + $10 \mu\text{g}$ Dom/kg for females and $15 \mu\text{g}$ LHRHa + $5 \mu\text{g}$ Dom/kg for males, led to a mean of 2.6 ± 0.5 spawning events, with a mean fertilization rate of $70.1 \pm 8.8\%$ and hatching rate of $69.8 \pm 7.8\%$. Method III, using a higher dose of hormonal injections ($60 \mu\text{g}$ LHRHa + $20 \mu\text{g}$ Dom/kg for females and $30 \mu\text{g}$ LHRHa + $10 \mu\text{g}$ Dom/kg for males), resulted in a mean of 2.3 ± 0.5 spawning events but produced a low mean fertilization rate of $3.8 \pm 5.2\%$ and hatching rate of $0.9 \pm 1.5\%$ due to the high proportion of defective eggs. Overall, Method II significantly outperformed Method III in both fertilization and hatching rates, while Method I was determined to be unsuitable for the broodstock used in this study.

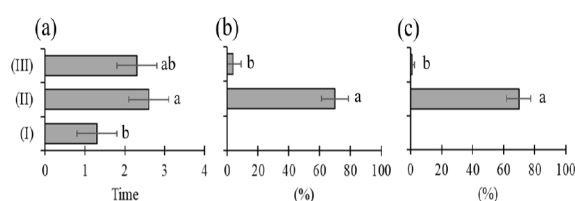


FIGURE 1. Overview of (a) spawning events, (b) fertilization rates, and (c) hatching rates of mangrove red snapper (*Lutjanus argentimaculatus*) broodstock under various spawning induction methods: (I) environmental manipulation, (II) standard hormonal injection, and (III) increased hormonal dosage. Different lowercase letters denote significant differences between methods ($P < 0.05$).

HOW DO I MAXIMIZE VALUE AND DETERMINE THE RIGHT NUMBER OF MARKERS FOR LONG-TERM GENETIC SUCCESS IN AQUACULTURE BREEDING PROGRAMS?

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Genetic improvement programs play a pivotal role in maximizing productivity and profitability in various industries, including aquaculture. This talk presents a comprehensive analysis of the Investment Returns (IR) for genetic improvement in shrimp, specifically focusing on different breeding strategies: mass selection, family selection, and genomic selection.

Multi-trait breeding programs often require higher marker densities to capture genetic variation across traits such as growth, disease resistance, quality, and reproduction. Genome size also impacts marker density needs, influencing genome-wide coverage. LD breakdown and recombination rates affect marker effectiveness, requiring strategic placement to ensure critical trait regions are adequately covered. Balancing marker density with LD decay and recombination events is essential for long-term breeding program success.

Analysis shows genetic improvement investments utilizing different breeding strategies offer substantial IR in the long term. While genomic selection stands out as the most efficient and accurate approach, mass selection and family selection remain viable alternatives depending on the specific needs and resources of the company. Understanding the economic impact and trade-offs of each breeding strategy enables companies to make informed decisions and optimize their breeding strategies.

It is equally important to consider an adaptive approach to marker density planning, ensuring genotyping tools align with breeding program goals. By optimizing marker selection, aquaculture breeding programs can enhance genetic improvement efficiency, maximize selection accuracy, and sustain progress over generations.

FIVE YEARS OF GENOMIC SELECTION IN ECUADOR WHAT'S NEXT?

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Christina Kriaridou, Alejandro Gutierrez and John Buchanan

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The increasing ability to extract the power of genomics is forcing a rethinking of aquaculture genetic improvement strategies. Successful breeding programs will always be built on the careful selection of the next generation of broodstock, detailed record keeping, and accurate collection of phenotypic data. Genomics allows this base of phenotypic selection to be enhanced and ultimately accelerated to increase genetic gain per generation. In shrimp, this is currently done at the most sophisticated level using Genomic Selection.

In Ecuador, Genomic Selection started in 2020, ahead of most countries. One major advantage of Ecuador's shrimp industry has been the ability to harness important interactions between genetics and environment. The best animals for one environment - or management practices - are not necessarily the best for another.

There is also another exciting technology on the horizon that will fundamentally change how we deliver genetic improvement. This technology is Genome Editing. The implementation of Genome Editing in Pacific White Shrimp (*P. vannamei*) will be important for the aquaculture industry.

The potential of genome editing in any species, including shrimp, is an exciting innovation, but it won't replace selective breeding. Rather, it will complement it. Where selective breeding builds the foundation for continuous improvement, genome editing offers the ability to make very precise and substantial changes in a single generation.

Several methods of genome editing have been reported in shrimp, with varying degrees of success. These methods are limited by the issues of the delivery of the gene editing enzymes and the survival of the larvae to adulthood on a commercially relevant scale. The progress in developing genome editing tools for shrimp remains complex.

In this presentation, we review five years of experience with genomic selection in Ecuador and highlight recent successes in genome editing in *P. vannamei*. We will also discuss the potential of genome editing to advance shrimp aquaculture and explore the opportunities ahead for integrating this technology into breeding programs.

DIETARY KRILL AS A NUTRITIONAL INTERVENTION FOR *Penaeus vannamei* SHRIMP INFECTED WITH *Enterocytozoon hepatopenaei* (EHP)

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The global shrimp farming industry is increasingly challenged by diseases, with Hepatopancreatic Microsporidiosis (HPM) caused by the microsporidian *Enterocytozoon hepatopenaei* (EHP) emerging as a significant concern. HPM, also causes symptoms similar to acute hepatopancreatic necrosis disease (AHPND). HPM currently lacks a pharmaceutical treatment and leads to significant economic and production losses. However, nutritional strategies may offer a promising solution to mitigate EHP infection and associated growth retardation. We hypothesized that Krill Meal (KM) could be an effective component of a nutritional strategy to alleviate EHP infection, given its rich content of high-quality nutrients, particularly phospholipids and long-chain polyunsaturated fatty acids, such as EPA and DHA.

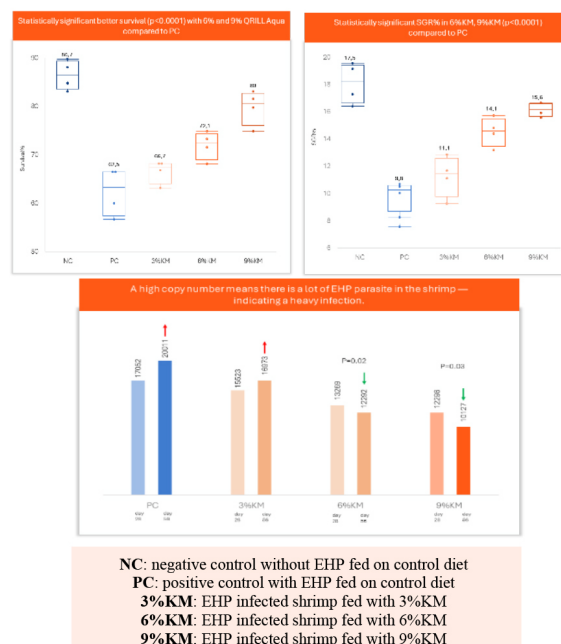
To test this hypothesis, a trial was conducted to evaluate the efficacy of dietary KM incorporation at three different inclusion levels (3%, 6%, and 9%) on the growth and survival of *Penaeus vannamei* shrimp challenged with EHP, comparing results to infected and non-infected control groups. Shrimp, with an average weight of 4-5g, were sourced from a single farm and reared in Fiber Reinforced Plastic (FRP) tanks in four replicates, where they were fed their respective test diets for 8 weeks. Additionally, two more groups were included in the study, where shrimp were fed either a control diet or a 6% KM inclusion for 25 days before being infected with EHP by feeding the minced hepatopancreatic tissue from EHP-infected shrimp.

After 8 weeks of feeding, all KM diet groups showed better growth, FCR and survival rates compared to the control group, as shown in Figures 1 and 2.

To further examine the impact of KM on hepatopancreatic function, histological analysis was performed, revealing a significantly higher number of R cells in shrimp fed KM-supplemented diets, indicating the enhanced functional capacity of the hepatopancreas in these groups.

Additionally, a notable reduction in EHP copy number was observed in KM-fed shrimp at 6% and 9% inclusion levels compared to the control group, indicating an improved ability to cope with EHP infection (Figure 3).

To gain deeper insights, proteomic analysis was conducted to assess changes in protein expression and related biochemical pathways associated with KM inclusion. The findings revealed a more regulated and targeted immune response to EHP in shrimp fed with KM, aligning with the observed improvements in survival and growth performance.



PROBIOTIC *Bacillus velezensis* STPB10 SOURCED FROM *Schizothorax richardsonii* (GRAY, 1832): IMPROVING REARING WATER QUALITY IN FRESHWATER AQUACULTURE

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The present study evaluated the probiotic potential of *Bacillus velezensis* STPB10, isolated from the gut of *Schizothorax richardsonii*, with emphasis on water quality improvement in freshwater aquaculture. Common carp (*Cyprinus carpio*) fingerlings were reared in tanks supplemented with STPB10 at 3.0×10^8 and 3.0×10^9 CFU mL⁻¹, alongside an un-supplemented control. Probiotic addition, particularly at 3.0×10^9 CFU mL⁻¹, significantly reduced nitrite (125 → 30 ppm), nitrate ($\geq 45 \rightarrow 10$ ppm), phosphate (2 → 0.2 ppm), and CaCO₃ ($\geq 45 \rightarrow 30$ ppm) compared to the control. The improved water stability was directly associated with fish survival, with the highest resilience observed in the 10^9 CFU mL⁻¹ group, partial survival in the 10^8 group, and complete mortality in the control. These findings highlight *B. velezensis* STPB10 as a promising water-enhancing probiotic for sustainable freshwater aquaculture. STPB10 also demonstrated robust adaptability with survival rates of 31–75% across acidic pH (2–4), >99% survivability in 0.3% bile salt, and tolerance to 15–35 °C. It produced strong biofilms, adhered efficiently to intestinal mucus (63.67%), and significantly reduced the adhesion of major pathogens (*Aeromonas hydrophila*, *A. veronii*, *A. salmonicida*, and *Vibrio anguillarum*). The strain was γ -hemolytic, antibiotic-susceptible, and non-pathogenic to common carp, confirming its safety.

Overall, supplementation of *B. velezensis* STPB10, particularly at 10^9 CFU mL⁻¹, markedly improved rearing water quality and fish survival, establishing it as a promising probiotic candidate for sustainable freshwater aquaculture.

Figure 1. Effect of *Bacillus velezensis* STPB10 on water quality parameters (Nitrite, Nitrate, Phosphate, CaCO₃)

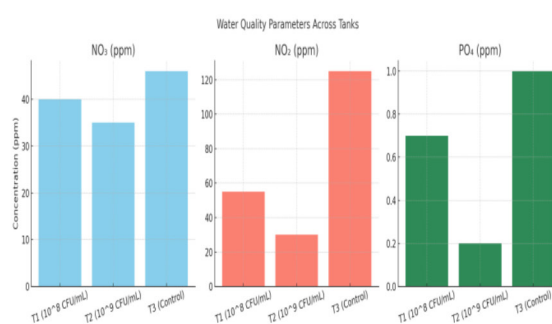
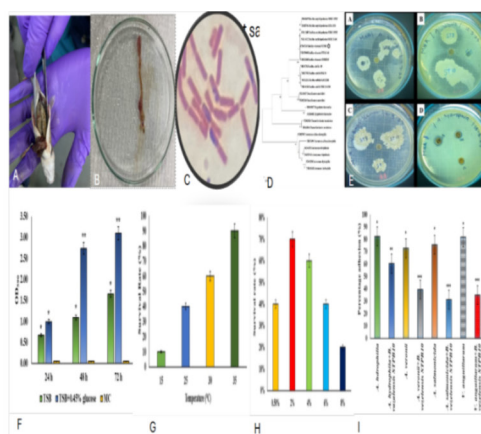


Figure 2. *In vitro* evaluation of probiotic properties of *Bacillus velezensis* STPB10



ANTIMICROBIAL POTENTIAL OF PHLOROTANNINS FROM THE BROWN SEAWEED *Stoechospermum marginatum*: A SUSTAINABLE ALTERNATIVE TO CONVENTIONAL ANTIBIOTICS

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The increasing incidence of antimicrobial resistance and antibiotic toxicity highlights the urgent need for novel antimicrobial agents that are biocompatible and environmentally sustainable. Phlorotannins, a unique class of phenolic secondary metabolites biosynthesized exclusively by brown seaweeds, have emerged as promising bioactive compounds. The present study investigated the antimicrobial potential of phlorotannins extracted from *Stoechospermum marginatum* against seafood-borne human pathogenic bacteria, including *Staphylococcus aureus* ATCC BAA 976, *Bacillus subtilis* ATCC 9372, *Listeria monocytogenes* ATCC 19111, *Escherichia coli* ATCC 4157, *Escherichia coli* AS-EC114 and *Klebsiella pneumoniae* AS-KP53. Phlorotannins exhibited significant antibacterial activity, with inhibition zones ranging from 16.7 ± 0.33 mm to 21.2 ± 0.44 mm and minimum inhibitory concentrations (MICs) between 32 and 128 $\mu\text{g mL}^{-1}$. Gram-positive bacteria were more susceptible than Gram-negative strains. Time-kill assays demonstrated concentration- and time-dependent bactericidal effects, with complete inhibition achieved within 6-8 hours of exposure. Furthermore, synergistic interactions were observed when phlorotannins were combined with conventional antibiotics-trimethoprim, imipenem, ciprofloxacin, and cefepime-against multidrug-resistant *E. coli* AS-EC114 and *K. pneumoniae* AS-KP53, yielding mean fractional inhibitory concentration indices between 0.16 and 0.31. Scanning electron microscopy revealed substantial structural damage to bacterial cell walls, corroborating the antimicrobial effects. These findings indicate that phlorotannins derived from *S. marginatum* represent a potent, renewable, and environmentally benign source of natural antimicrobial agents with potential applications in combating antibiotic-resistant pathogens.

ASSESSMENT OF THE GROWTH AND NUTRIENT UTILIZATION OF *Clarias gariepinus* FINGERLINGS FED DIFFERENT INCORPORATION LEVELS OF PREPARED *Moringa oleifera* SEED MEAL

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Introduction: Exploration of alternative plant protein sources for their prospect as potential replacements for fish meal has been intensified in recent times and *Moringa oleifera* (Lam) has been identified as one of such prospective candidates (Nsofor *et al.*, 2012). However, the elimination of undesirable anti-nutritional substances from plant protein sources is imperative to improve their nutritional quality and maximize their full potential as components in fish feed.

Methodology: The trial took place at the Teaching and Research Fish Farm within the Department of Fisheries and Aquaculture at Usmanu Danfodiyo University in Sokoto located on latitude 13° 07' 47.6"N, longitude 05° 12' 11.3"E and altitude 275m above sea level (Google MAP, 2015). Five experimental diets were formulated, and fishmeal was replaced with the processed (B90min/S72hrs) *Moringa oleifera* seed meal at 0, 20, 40, 60 and 80% inclusion levels and fed to the fingerlings for twelve weeks. Fish growth, feed conversion and nutrient utilization indices were determined.

Results: Highest weight gain (12.77±1.14g) was recorded in the fish with diet T1 which is the control diet but, the difference was not significant from dietary treatment T2 with 20% MSM replacement level. Lowest FCR was recorded with fish fed diet T2 and there was no statistically significant difference in the PERs of all the treatments.

Discussion and Conclusion: Diet with 20% substitution level that contributed 8.33% by gross composition enhanced good growth, and the fingerlings were still healthy at 80% substitution level. The findings of the feeding experiment revealed a similar ($p>0.05$) survival rate across the treatments. However, the growth response decreased with increased inclusion level of the test ingredient MSM in the diets.

Table 1: Growth parameters of *Clarias gariepinus* fingerlings fed diets incorporating different concentrations of *Moringa oleifera* seed meal.

Parameter	Treatments				
	T1 (0%)	T2 (20%)	T3 (40%)	T4 (60%)	T5 (80%)
No of fish stocked	20	20	20	20	20
Mean initial weight (g)	1.50±0.00	1.50±0.00	1.50±0.00	1.50±0.00	1.50±0.00
Mean initial length (cm)	6.17±0.06 ^a	6.17±0.06 ^a	6.13±0.06 ^a	6.17±0.06 ^a	6.17±0.06 ^a
Survival rate (%)	78.33±2.89 ^a	78.33±2.89 ^a	73.33±5.77 ^a	70.00±13.23 ^a	75.00±0.00 ^a
Mortality rate (%)	21.67±2.89 ^a	21.67±2.89 ^a	26.67±5.77 ^a	30.00±13.23 ^a	25.00±0.00 ^a
Mean final weight (g)	14.29±1.12 ^a	12.35±0.43 ^{ab}	11.08±0.13 ^b	8.48±2.27 ^c	8.21±0.36 ^c
Weight gain (g)	12.77±1.14 ^a	10.87±0.40 ^{ab}	9.57±0.12 ^b	6.97±2.25 ^c	6.70±0.35 ^c
Percentage weight gain (%)	849.13±72.06 ^a	720.39±27.85 ^{ab}	636.71±10.24 ^b	463.72±151.55 ^c	446.03±24.56 ^c
Specific growth rate (%/day)	2.26±0.08 ^a	2.12±0.03 ^{ab}	2.01±0.01 ^b	1.74±0.26 ^c	1.73±0.04 ^c
Mean final length (cm)	10.17±0.45 ^a	10.13±0.55 ^a	10.07±0.42 ^a	9.20±0.56 ^b	9.20±0.17 ^b
Condition factor (K)	1.36±0.11 ^a	1.20±0.15 ^{ab}	1.09±1.14 ^{ab}	1.14±0.49 ^{ab}	1.05±0.01 ^b

Mean values in row having different superscripts are significantly different ($p<0.05$)

ASSESSMENT OF THE GROWTH AND NUTRIENT UTILIZATION OF *Clarias gariepinus* FINGERLINGS FED DIFFERENT INCORPORATION LEVELS OF PREPARED *Moringa oleifera* SEED MEAL

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MOLECULAR PHYLOGENETICS OF *Pseudocheneis sulcata* (SILURIFORMES: SISORIDAE) INFERRED FROM MITOCHONDRIAL CYTOCHROME C OXIDASE I

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The phylogenetic status of *Pseudocheneis sulcata* (Siluriformes: Sisoridae), a less-studied sucker-throat catfish, remains unresolved due to limited molecular evidence. This research explores its genetic relationships through mitochondrial Cytochrome c oxidase I (COI) sequences. A total of 46 Sisoridae species, representing two subfamilies (*Glyptosterninae* and *Sisorinae*), were retrieved from the NCBI database through nucleotide BLAST searches, along with three newly generated sequences collected from natural habitats. Pairwise genetic distances were calculated, and a Neighbour-Joining (NJ) tree was constructed to evaluate divergence among species. Phylogenetic relationships were further analysed using Maximum Likelihood (ML) methods based on the best-fitting nucleotide substitution model. The resulting phylogenetic tree delineated several well-supported clades aligned with recognised taxonomic groups within Sisoridae. *P. sulcata* consistently nested within the *Sisorinae* lineage, forming a distinct clade closely related to some *Glyptothorax* species, indicating a shared ancestry and possible taxonomic revisions. Estimates of Genetic distance underscore intergeneric divergence, while revealing relatively lower divergence between *P. sulcata* and its closest congeners. These findings provide the first molecular insight into the phylogenetic position of *P. sulcata*, contributing to a deeper understanding of evolutionary relationships within Sisoridae. And highlights the utility of COI-based analyses in resolving systematics of Sisoridae, with implications for biodiversity assessment and conservation planning.

WINTER THERMAL TOLERANCE OF GOLDFISH, *Carassius auratus* AND KOI CARP, *Cyprinus carpio* IN BATHINDA, PUNJAB

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The study was conducted to estimate the growth and survival of gold fish, *Carassius auratus* (average weight 4.5 g) and koi carp, *Cyprinus carpio* (12.5 g) in FRP tanks (500 liter capacity) for 90 days with three different temperature treatments i.e. T_1 : 18°C, T_2 : 24°C and T_3 : natural water temperature. Temperature in T_1 and T_2 were maintained with thermostats (300 watt). The natural water temperature was recorded four times a day (6 am, 12 pm, 6 pm and 12 am) with digital thermometer. The lowest natural water temperature 4°C was recorded during early morning (6:00 am) in winter season (15th December, 2024 to 15th January, 2025) at Bathinda, Punjab. For both fishes, significantly higher growth performance were recorded in T_2 treatment and the lowest in T_3 treatment. In all treatments, there was 100% survival for both koi carp and gold fish. The results of above study indicated that both gold fish and koi carp could tolerate extreme winter (upto 4°C water temperature) in northern Indian state of Punjab.

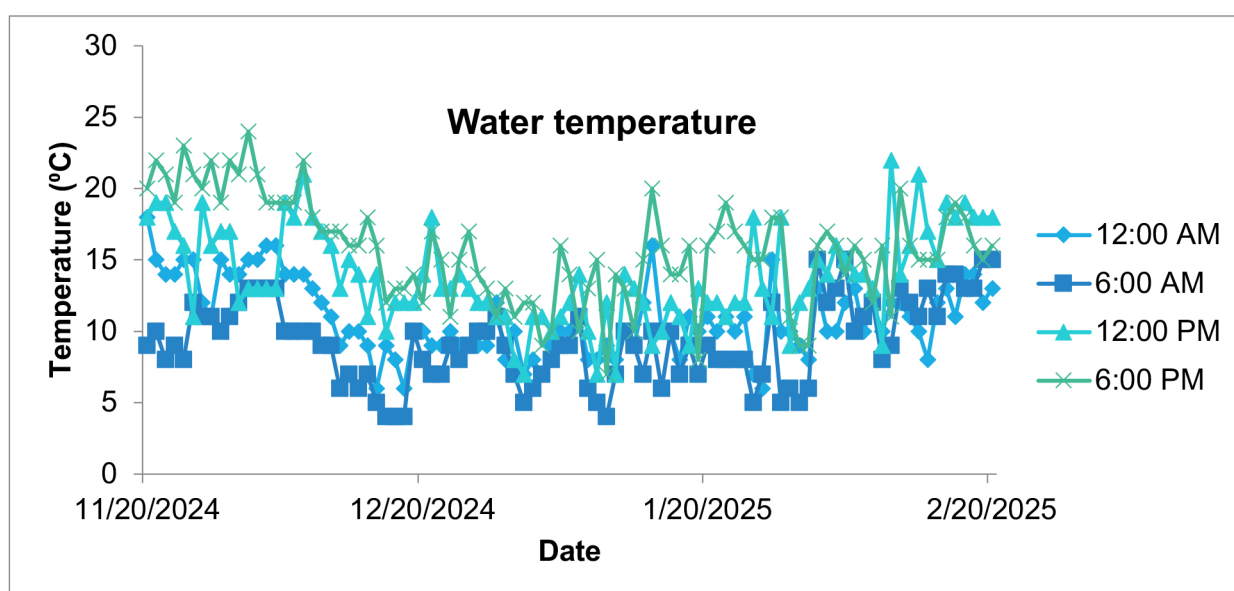


Figure 1: Natural water temperature (°C) recorded in tanks at Bathinda Punjab during 20.11.2024 to 20.02.2025

OPTIMIZATION OF STOCKING DENSITY FOR GOLDFISH *Carassius auratus* CULTURED UNDER DIFFERENT ENVIRONMENTAL CONDITIONS IN PORTABLE CEMENT TANKS

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The study was conducted to estimate the growth and survival of gold fish (average weight 1.15 g) in portable cements tanks (480 liter capacity) under different stocking density and environmental conditions. The portable cement tanks (diameter: 1 meter and height: 0.62 meter) were constructed with two cement rings. The fish were reared in three different stocking densities i.e. T_1 : 75 nos. /tank, T_2 : 125 nos. /tank and T_3 : 175 nos. /tank for a period of 60 days with two different tank environmental conditions i.e. (1) Tank without soil base and aquatic plant (2) Tank with soil base (4 inch soil base with cap cover (2 inch) of coarse sand) and aquatic plants (*Vallisneria spiralis*). Cleaning and water exchange (25%) was done weekly twice in tanks without soil base and aquatic plant whereas, monthly twice in tanks with soil base and aquatic plant. Water quality of the tanks were measured at 15 days interval. The growth performance of gold fish was not significantly different in T_1 and T_2 treatments for both the environmental conditions however it reduced significantly T_3 treatment. At the end of experiment, 100% survival was recorded in T_1 and T_2 treatments for both the environmental conditions compared to T_3 (64% survival). Improved water quality was recorded in tanks with soil base and aquatic plants. The results of above study indicated that stocking density at 125 nos./tank is optimum for gold fish culture in portable cement tanks. With this, environmental condition manipulation in cement tanks with soil base and aquatic plants have significant positive effects on water quality.

INDIA'S FIRST COLLABORATIVE TARGETED SHRIMP DISEASE INVESTIGATION PROGRAM (TASDIP)

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Shrimp farmers across India are facing a persistent, unexplained mortality pattern once known as Running Mortality Syndrome (RMS), which has now intensified into Aggressive Running Mortality Syndrome (ARMS). Crops rarely survive beyond 70–75 days, threatening farm viability and farmer morale.

In mid-2025, the Prawn Farmers Federation of India (PFFI) launched the Targeted Shrimp Disease Investigation Program (TaSDIP) MoU between ICAR–Central Institute of Brackishwater Aquaculture (CIBA), and PFFI was signed on 29 July 2025, followed by the official launch on 10 August 2025. MPEDA–Rajiv Gandhi Centre for Aquaculture (RGCA), joined as a key institutional partner, coordinating closely with CIBA and PFFI on laboratory analyses, field validation, and data integration in the pilot district of Nagapattinam, Tamil Nadu.

While farmers coordinate sample collection, field logistics, and data, scientists conduct pathogen screening, microbial profiling, and histopathology. In parallel, PFFI has forged a separate collaboration with the University of Arizona, USA, to pursue complementary research on pathogen characterization and genetic resilience.

The program has received support from over 30 private companies and eight national institutions, signaling a rare sector-wide unity to tackle India's most critical shrimp-health challenge. TaSDIP demonstrates how farmers and scientists can jointly lead change - for the farmers, by the farmers, with the scientists. Partner organisations are the National Fisheries Development Board (NFDB), Coastal Aquaculture Authority (CAA), Seafood Exporters Association of India (SEAI), All India Shrimp Hatcheries Association (AISHA), Society of Aquaculture Professionals (SAP), and leading aquaculture industry stakeholders.

The presentation outlines how Indian shrimp farmers, research institutions and industry partners come together under a structured framework to jointly investigate the cause of ARMS. This collaborative model represents the first of its kind research effort and how collective actions can address emerging disease challenges.

MARINE ENVIRONMENTAL POLLUTIONS AND COASTAL CONSERVATION: A REVIEW

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The major harmful impacts of various anthropogenic activities on the marine environmental pollutions were reviewed by live monitoring and studying literatures. Innumerable sources for marine environmental pollutions were identified and hypothesized and understood their impacts on climate change, coastal economy and relatively on human health and community development. Several materials such as plastic, sewage water, fuel spills including offshore oil and gas production and marine oil transportations and etc., let into the marine ecosystem either directly or indirectly by human activities. Over 80% of these marine pollutants are not biodegradable in addition to this, emission from the atmosphere are also pollution of the marine environment is enhancing at an alarming rate which to address this problem of marine environmental pollution and climate change forecast is a difficult task and significant approaches and various methods are required to control the marine environmental pollution. This study revealed that the increasing of marine pollution brought a significant modification in the climate change and relatively on human health and coastal economy.

TEMPORAL VARIABILITY IN PHYTOPLANKTON COMMUNITY COMPOSITION IN THE GODAVARI ESTUARY WITH REFERENCE TO RIVER DISCHARGE

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Estuaries are among the most productive marine ecosystems in the world (Gameiro *et al.*, 2004) and they act as transitional zones between land and sea and receive constant nutrient supply from rivers and land based discharges. In order to examine the phytoplankton community composition in the Godavari estuary, physicochemical and biological samples were collected during three discharge periods (June 2024 to January 2025) in the Godavari estuary. Even though the concentration of nutrients were high during peak discharge period, the phytoplankton content was less due to high suspended matter (>150 mg/l) and less light penetration. In contrast during moderate discharge period and when there was no discharge the phytoplankton biomass was high ($>5\mu\text{g/l}$) with the composition of *Coscinodiscus sp*, *Chaetoceros*, *Thalassiosera*, *Thalassiotrix*, *Ceratium* etc. This suggests that decrease in suspended load, decrease in river discharge and increase in stability of water column are the major controlling factors determining phytoplankton growth. Overall Phytoplankton cells showed a wide range from 1,000 to 45,962 cells/l (ave. 7,799 cells/l). Diatoms were the major dominant group. During peak discharge period phytoplankton abundance was contributed by diatoms with a range of 1,000 to 3,896 cells/l (ave. 7,135 cells/l), whereas during moderate and no discharge periods the numbers were more, 3,000 to 45,962 cells/l (ave. 11,738 cells/l) and 1,000 to 41,609 cells/l (ave. 7,527 cells/l) respectively. The variations were similar with biomass (Chl-a) during the three discharge periods. The variations of nutrients and salinity suggest that decrease in salinity and increase in nutrients enhanced phytoplankton growth in the estuary. These results suggest that changes in the freshwater discharge and salinity brought a significant variation in phytoplankton composition in the Godavari estuary.

EVALUATION OF ACUTE, BEHAVIOURAL, BIOCHEMICAL, STRUCTURAL ANALYSIS OF MANCOZEB (FUNGICIDE) TOXICITY ON ZEBRAFISH

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Mancozeb, a broad-spectrum di thio carbamate fungicide, is widely applied in agriculture but poses significant ecotoxicological risks when introduced into aquatic ecosystems. This study investigates the acute toxicity, behavioural changes, and biochemical disruptions induced by Mancozeb in adult zebrafish (*Danio rerio*). Fish were exposed to concentrations of 1, 2, 3 mg/L for 72 hours. A concentration-dependent increase in mortality was observed, with 50% mortality recorded at (LC50) 1 mg/mL and, 60% of mortality at 2mg/L at 48 hours and LC100 recorded at highest concentration 3mg/L after 72 hours.

Behavioral assays including the novel tank diving, light-dark preference, and shoaling tests revealed reduced exploratory behavior, increased bottom-dwelling, heightened anxiety, and altered group cohesion in exposed groups. Biochemical analysis of liver tissue showed a marked reduction in hexokinase activity from 2.75 U/mg protein (control) to 1.05 U/mg at the highest concentration, and glucose-6-phosphatase activity is 8.2 U/mg to 2.92 U/mg declined significantly, indicating metabolic suppression. Protein levels in muscle tissue declined from 8.30 to 2.50 mg/g while glycogen content in gills reduced from 8.20 to 2.5 mg/g. while cholesterol content 8.45 to 3.19 mg/g after 72 hours. These findings confirm that Mancozeb induces acute biochemical and behavioural toxicity in zebrafish, even at sub-lethal concentrations, emphasizing its potential threat to aquatic biota and the necessity for stringent environmental monitoring.

USE OF NATURAL RESIN ACIDS AS A TOOL TO REDUCE MORTALITY AND ENHANCE BIOMASS GROWTH IN NILE TILAPIA (*Oreochromis niloticus*)

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Mortality remains a major challenge in farmed Nile tilapia production, with rates in Brazil ranging from 5% to 10%. Resin acids are substances secreted by coniferous trees at sites of mechanical injury to prevent the invasion of pathogenic bacteria (Kettunen *et al.*, 2015). These resins contain compounds such as abietic and neoabietic acids, which form a diverse group of hydrophobic diterpene carboxylic acids with antimicrobial properties. The aim of this study was to evaluate the effect of resin acids in Nile tilapia feed on survival rate, biomass growth, and real-time PCR analysis of ISKNV/RSIV (Infectious Spleen and Kidney Necrosis Virus/Red Sea bream Iridovirus) and *Streptococcus agalactiae* in spleen, liver, and kidney tissues.

For this trial, evaluations were conducted at the experimental facilities of a Nile tilapia farm in Brazil in March 2025. The study involved two experimental treatments: CON – fish fed a commercial diet containing 50% crude protein; RAC – fish fed the same diet as the CON group, supplemented with 2 kg/t of Progres® (9% Resin Acid feed additive, AB Vista, UK). A total of 160,000 fish were used per treatment. Fish were distributed across two tanks, and the experimental period lasted 20 days. The tanks were located in an area confirmed positive for *Streptococcus agalactiae*. Performance parameters, including biomass weight gain, survival rate, feed consumption, and real-time PCR for ISKNV/RSIV and *S. agalactiae*, were evaluated. For the PCR analysis, 30 fish per treatment were collected on day 20. The fish were necropsied, and spleen, kidney, and liver tissues were homogenized in pools of 5 fish each, resulting in six evaluations per treatment. Table 1 presents the survival and weight gain results of the animals. It can be observed that the survival rate in the RAC group was 3.1% higher than in the CON group. Another observation is that the animals in the RAC group started the study with a biomass weight 25% lower than the CON group; however, after 20 days, the difference in the RAC group was reduced to only 10.7%. Table 2 presents the molecular biology data across treatments.

Table 1. Performance results of Nile tilapia consuming 0 or 2 kg/t of Progres® (9% acid resin-based product) in the feed.

Treat	Initial Biomass Weight, kg	Final Biomass Weight, kg	Survival Rate, %
CON	640	3,139	95.0
RAC	480	2,820	97.9
Difference, %	75.0	89.8	3.1

Table 2. The sampling results and associated isolates Nile tilapia consuming 0 or 2 kg/t of Progres® (9% acid resin-based product) in the feed.

Treat	Sampling Numbers	Isolate Numbers	Positive Rate, %
ISKNV/RSIV			
CON	6	4	66.6
RAC	6	3	50.0
<i>Streptococcus agalactiae</i>			
CON	6	5	83.3
RAC	6	4	66.6

Fish that received RAC showed a 25% lower positivity for ISKNV/RSIV compared to the CON group. Similarly, with respect to *S. agalactiae*, animals that consumed RAC showed a 20% lower positivity compared to the CON group.

In conclusion, the use of resin acids serve as tool to improve biomass weight and survival rate, while reducing the positivity rates for ISKNV/RSIV and *S. agalactiae* PCR in Nile tilapia.

HARMFUL ALGAL BLOOMS: EXPANSION, FOOD SECURITY, AND THE TRIPLE PLANETARY CRISIS

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Session: Environmental Management- Environmental Issues and Management

Harmful Algal Blooms (HABs) are the excessive outgrowths of several species of microalgae from dozens of genera, in coastal and marine waters but also in freshwater environments. These blooms are known to affect aquatic ecosystems and food webs, aquaculture, fisheries, as well as tourism and public health.

There has been an increase in the occurrence, frequency, and duration of HABs on a global scale linked to anthropogenic activities and in several instances to climate change. However, an apparent increase in the occurrence and severity of these blooms in both marine and freshwater environments has been occurring over the past years. For instance, a large-scale bloom of *Karenia brevis* has recently been estimated to have caused a loss of as much as 2.7 billion USD. A more recent instance of large-scale bloom of another species of HAB, *Karenia mikimotoi*, in South Australia, has caused a loss in fisheries and aquaculture preliminarily estimated to one third or even half of the total production with devastating impacts on marine ecosystems, ranging from mass mortalities in benthic ecosystems to mortalities in marine mammals. This event has prompted a call to consider the long-lasting bloom linked to climate-change induced Marine Heat Waves (MHV) as a National Disaster.

In the present talk, a historical overview of HAB occurrence in marine and freshwater ecosystems (e.g. CyanoHAB, *Alexandrium* spp., *Dinophysis* spp., *Karenias* pp., *Pseudo-nitzschia* spp., *Gambierdiscus* spp., *Ostreopsis* spp.) with a special emphasis on the recent trends linked to climate change and pollution will be given. Data on our ongoing research on the impacts of HABs on aquaculture and fisheries will also be presented. The link between the global expansion and geographic shifts of HAB, food security, and the triple planetary crisis (Climate Change, Pollution, Biodiversity) – coined in 2020 by the UN Environment Programme and being addressed within the UN frameworks (e.g. UNFCCC, UN Global Biodiversity Framework) – will be discussed.

CLIMATE CHANGE AND SUSTAINABLE AQUACULTURE PRODUCTION SYSTEMS: STATUS, CHALLENGES and SDGs

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Session: Policy and Legislations – SDGs

Blue Foods encompass over 3,000 species of animals and plants that are either captured through fisheries or produced in aquaculture farms. They are a pillar of food security, providing nutrition for over 3 billion humans and livelihoods to hundreds of millions of people.

Since 2017, aquaculture systems have become major contributors to the production of blue foods, surpassing the contribution of fisheries to food security due to several issues within the sector. Several culture systems have been used to produce a diverse array of aquatic products, ranging from small-scale ponds to large scale aquaculture farms in coastal areas and the open ocean, as well as inland systems and land-based systems.

These systems, however, do experience several difficulties in providing regular outputs linked to several constraints which include aquafeeds, disease control and outbreaks, genetic escapes, water quality and pollution, water scarcity, HABs, CHABs, energy, GHG emission, and climate change.

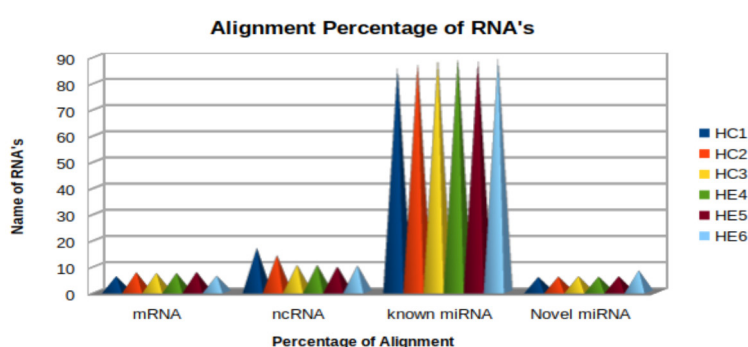
In this presentation, an overview of the different types of aquaculture production systems used in marine, brackish and freshwater environments with key produced Blue Food species/groups of species are given. The advantages and drawbacks of these systems are covered. The most sustainable aquaculture production systems are also presented with examples of successful systems (i.e. RAS, IMTA, Aquaponics, Shellfish Farms, Microalgae Farms, Macroalgae farms, BFT). The link between sustainable aquaculture systems, climate change and SDGs is discussed to reflect on the policy and legislation's strengths and gaps with an emphasis on environmentally-adaptive aquaculture systems and the role Artificial Intelligence (AI) can play in sustainable Blue Foods production.

DECODING NOVEL MICRORNA FOR REGULATING THERMAL STRESS RESPONSE IN FRESH WATER STINGING CATFISH *Heteropneustes fossilis* (Bloch 1794) FOR INSIGHTS INTO CLIMATE RESILIENT AQUACULTURE AND CONSERVATION

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Rising global temperatures have intensified the need to understand molecular mechanisms regulating thermal stress resilience in aquaculture species. This study explores the microRNA (miRNA)-mediated regulatory landscape in *Heteropneustes fossilis* (Bloch, 1794) exposed to thermal stress, aiming to identify key signatures involved in thermal adaptation. MicroRNAs (miRNAs) are small, non-coding RNAs of approximately 20–24 nucleotides in length that function as critical post-transcriptional regulators of gene expression, and govern adaptation to environmental stressors like temperature fluctuations, hypoxia, salinity, and pollution. Tissue samples were sequenced using the Illumina NovaSeq 6000 platform, yielding high-quality miRNA data with over 180 million total reads. Following rigorous pre-processing using FASTP and Trimmomatic, high-quality reads (15–30 bp) were mapped against the zebrafish (*Danio rerio*) reference genome and miRBase to identify known and novel miRNAs. *De novo* prediction via miRDeep2 revealed 313 known and 61 novel miRNAs with characteristic secondary structures (MFE < −20 kcal/mol; MFEI > 0.8). Differential expression analysis using DESeq2 (p-adj < 0.1; log2FC > |1|) identified significant upregulation and downregulation of key miRNAs in heat-exposed (HE) samples compared to control (HC). Expression data normalization (FPKM) and multivariate analyses including PCA, MA-plots, volcano plots, and heatmaps demonstrated clear clustering and separation of expression profiles, indicating a robust miRNA response to heat stress. Notably, miRNAs targeting stress-related pathways such as PI3K-Akt, MAPK, and HIF-1 signaling were differentially expressed, suggesting their central role in thermal tolerance. These findings provide valuable regulatory insights into the adaptive biology of *H. fossilis* and offer promising biomarkers for genetic improvement programs. This work contributes to the development of climate-resilient aquaculture strategies by integrating small RNA transcriptomics into functional genomics and breeding frameworks.



OPTIMIZATION OF CLIMATE SMART RECIRCULATORY AQUACULTURE SYSTEM TO DEVELOP FUNCTIONAL MILKFISH *Chanos chanos* BROODSTOCK FISHES FOR HATCHERY PRODUCTION

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Milkfish (*Chanos chanos*) is one of the most preferred brackishwater food fishes in South-East Asian countries and India. It is an herbivore fish, tolerates wide range of salinities and accept low protein pellet feed under culture conditions. ICAR-CIBA achieved breakthrough in captive breeding of milkfish in outdoor RCC tank-based system. Open tanks are subjected to environmental variations which limits milkfish sexual maturation.

Hence, we have developed a 60 t RCC indoor recirculatory aquaculture system (RAS) where abiotic factors i.e. salinity, water temperature and photoperiod are controlled as per the requirement. RAS is also sheltered with temperature insulated panels which can withstand strong winds. RAS is equipped with rapid sand filters, protein skimmer, biofiltration module, ozone filter and egg collection unit. A separate water heating tank (7t) is attached with thermostatic titanium heaters (2kv each) and warm water further pumps into RAS to continuously maintain the required temperature. Fishes were PIT tagged and screened for VNN negative. Fourteen fishes of adult milkfish (Average BW 6.26 kg, Average TL 98 cm) were stocked (1.75 kg/t) in RAS as per sex ratio of M: F: 1:1 during April 2025 and salinity, temperature, and photoperiod was set at 33-34 ppt, 31-32 °C, 14L: 10 D respectively. Fishes were implanted with cholesterol pellets having hormone (GnRHa + 17 α Methyl Testosterone each 50 μ g/kg bw) and subjected to ultrasonographic scanning to monitor gonadal developments. Fishes were fed with institute's milkfish brood^{plus} feed for maturation. Environmentally controlled RAS system improved female maturation and milting male % compared to open tank-based system which exists parallelly Post biopsy oocyte growth was monitored microscopically and milt quality was assessed under computer assisted sperm analysis software (CASA). Functional brooders at an early age and smaller size developed in this RAS can be supplied to other hatcheries as milkfish takes long time (> 5 years) for sexual maturation in normal both captive and wild conditions. This system holds potential to form prospective brood bank of milkfish for year-round maturation in captivity and timely supply to hatcheries to jump-start the milkfish seed production.

Table 1: Progress in broodstock maturation under RAS

Sex	Numbers	Average BW	Average TL	Maturity status
	(n)	kg	cm	
Male	7	6.27	99	Milting
Female	7	6.25	98	Oocytes (460-650 μ m)

BW : body weight , TL : total length

HILSA FISHERIES AT RISK: PATHWAYS TO RESILIENCE IN INDIA

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Hilsa (*Tenualosa ilisha*), an ecologically and culturally significant fish of India, is facing a sharp decline due to ecological degradation, hydrological alteration, and weak governance. This study assesses the socio-ecological vulnerabilities of small-scale Hilsa fisheries in West Bengal using Participatory Vulnerability Mapping (PVM) and the Socio-Ecological Vulnerability Index (SEVI). Data collected from 274 fishers across major Hilsa landing centres of West Bengal reveal that overfishing, pollution, climate variability, and institutional inefficiencies have severely reduced stocks and fishing income. Ecological stressors such as siltation, habitat loss, and disrupted migration routes are compounded by socio-economic constraints, including limited livelihood alternatives and weak access to financial and technical support.

The Causal Loop Diagram (CLD) illustrates the interlinked ecological, economic, and governance feedbacks driving vulnerability (Figure 1). Strategic actions addressing key challenges are outlined in Table 1. Adaptive strategies proposed include habitat restoration, strict enforcement of fishing bans and gear regulations, livelihood diversification, and co-management through fisher cooperatives. Strengthening adaptive capacity through training, gender-inclusive programs, and access to state support is critical for long-term sustainability. The findings underscore the urgent need for ecosystem-based management, community participation, and transboundary cooperation to safeguard Hilsa stocks and secure resilient livelihoods for dependent fishing communities.

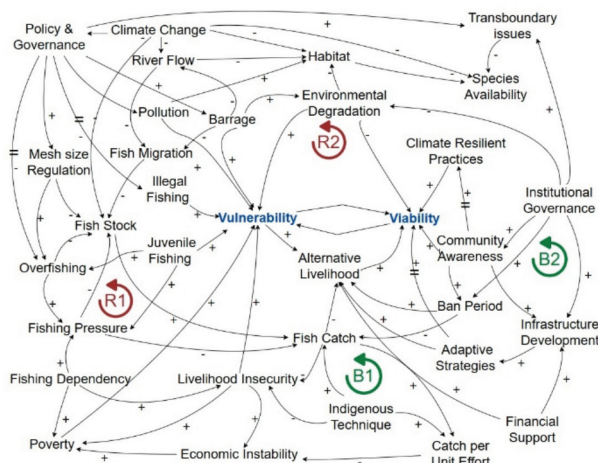


Figure 1 CLD for Hilsa Fisheries

Table 1. Actions to cope up the challenges

Actions	Problems Resolve
Habitat Restoration	Degrading breeding and spawning grounds
River-Specific Regulations	Hilsa migration behaviour varies by location and climatic factors
Co-management arrangements	Strengthens social resilience, balances power dynamics among stakeholders, and promotes sustainable fishery management through participatory governance.
Enhanced compliance and enforcement	Ensures sustainable Hilsa fishery management and biodiversity conservation, particularly within designated sanctuary areas.
Incentives for all stakeholders	Reduces social and economic conflicts by aligning stakeholder interests and encouraging responsible practices.
Education	Fosters awareness and creates alternative income sources, supporting long-term community development.
Compensation-based schemes	Provides incentives to fishers during the fishing ban period, supports biodiversity conservation, and promotes alternative livelihood options.
Improved financing mechanisms	Helps fishers escape the debt trap, alleviates poverty, and supports alternative income generation, especially critical during fishing bans.
Social-ecological trap interventions	Tackles the cycle of poverty and resource overexploitation by promoting sustainable practices and diversified livelihoods.
Awareness, empowerment, and participation	Facilitates sanctuary management, biodiversity conservation, and effective monitoring and enforcement through community involvement.
Social resilience initiatives	Addresses overexploitation, supports alternative livelihoods, and fosters community networks for shared responsibility in fishery governance.
Transboundary initiatives	Promotes regional coordination (Bangladesh, India, Myanmar) to ensure synchronised fishing bans and enhance sustainable fishery management.
Social welfare programs	Focuses on protecting and improving the overall well-being of fishers and their families.
Micro-enterprises	Reduces fishing pressure, alleviates poverty and debt, and supports fishers in acquiring sustainable gear and diversifying income sources.

RECENT DEVELOPMENTS OF AQUACULTURE IN THAILAND

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Thailand, a country of 70 million people, features a warm and humid tropical climate, with average temperatures ranging from 18-38°C. Its climate is characterized by tropical monsoon (May-October) with heavy rains. The country's geography is mostly covered by large central plains and plateau, full of rice fields, fertile river systems, swamps, and a long coastline very suitable for aquaculture. Freshwater aquaculture is crucial for rural food and nutrition security, with Nile tilapia, catfishes and many others being widely cultured. In the coastal areas, Pacific white shrimp contributes significantly to the value and volume of total aquaculture production. Aquaculture generates substantial portion of the total export revenue of over US\$7 billion each year maintaining Thailand's strong position as a global exporter of fisheries products. A widespread aquaculture engages over one million people and probably more are employed along its value chain.

Recent aquaculture development is driven by commercialization of genetics and breeding technologies and enhancing productivity through sustainable grow-out practices. Commercial exploitation breeding technologies can be seen in Nile tilapia. Nile tilapia (*Oreochromis niloticus*) along its hybrids e.g. red tilapia (*O. niloticus* x *O. mossambicus*) has been the no. 1 species by volume due to its remarkable development in hatchery technology. Some farms maintain a large number of broodstocks (e.g. 0.5 million broods and 200 family lines), produce mass-scale monosex high quality (99-100% male) fingerlings (200-300 million/year), use automatic packing using conveyor belts used in some other industries, computer aided machines for counting of fry and so on. Similarly, some catfish hatcheries inject more than 1,000 females, produce over 50 kg eggs and sell over 10 million hatchlings in a single day. Some other farmers, apply neo-female technique in *Macrobrachium rosenbergii* to produce monosex male PLs. Similarly, breeding of Asian sea bass (*Lates calcarifer*), snakehead (*Channa striata*), Giant Mekong catfish (*Pangasianodon gigas*), mud eels (*Anguilla* sp.), blue swimming crab (*Portunus pelagicus*) and mud crab (*Scylla serrata*), sand lobsters (*Thenus orientalis*), oysters, sea horse, squids have been successful and many other new species are being tried. Nursing of different species are done by different groups of specialized farmers who buy hatchlings or larvae to make them bigger in size and supply to grow-out farmers, they have high survival and attain marketable size in a short period of time. Doing nursing and selling feeds as a business, some farmers earn a lot, whereas in many other countries, nursing is a part of the hatcheries. Nursing is mostly done using hapas or in ponds covering by bird nets. Live feeds are fed during early stages of nursing e.g. *Artemia*, *Moina* etc. which are normally produced on-site or in different farms. Some farmers produce only *Moina* and sell daily to earn US\$100-200/day. Live *Moina* are normally fed to the carnivorous species e.g. sea bass, catfish, pangasius, same as artemia to larvae of shrimp and prawn. For the grow-out, large number of farmers still use extensive and semi-intensive systems, but smarter ones are shifting towards highly intensive with higher densities, heavy aeration and waste management systems. Pre/pro-biotics and phytogenic products are replacing antibiotics shifting to eco-friendly methods.

Our goal is to help transfer new knowledge and technologies for the benefits of other countries and their people with a view to ensuring food and nutrition security, income and employment. In cooperation with various government stations, we organize hands-on training in private fish farms and study visit to feed companies, processing factories and different types of markets. We also design community development projects as a part of outreach activities and also offer technical assistance to establish aqua farms, feed industry, fish processing and marketing facilities. This paper highlights the unique features of recent aquaculture developments occurring in Thailand.

TILAPIA FARMING IS GROWING RAPIDLY GLOBALLY BUT WHY SLOWLY IN SOUTH ASIA?

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Annual global production of Nile tilapia (*Oreochromis niloticus*) and its hybrids (*O. niloticus* x *O. mossambicus*) has become the number one species with the production of over 7 million tons surpassing the production of Grass carp (6.2 million tons). Tilapia farming, and its acceptance as regular diet, is expanding with significant investment in infrastructure and technology development with improved efficiency and sustainability augmented by the support of the government policies and priorities. Once considered as pest, it is becoming popular species farmed in more than 150 countries. It was dubbed as “aquatic chicken” long back but it is showing its potential to stand out among the aquatic species like that of chicken among the bird species becoming everyone’s fish which was once considered poor man’s fish.

According to FAO (2024), PR China dominates (67%) global Aquaculture production whereas in case of tilapia, China accounts for only 26.5% but is still the largest producer and exporter. Growth of tilapia aquaculture in many other countries is so rapid that they are narrowing down the gaps, for examples, Indonesia (21%) and Egypt (14.7%). Other significant producers include Bangladesh (6.2%), Thailand (4.1%), the Philippines (3.8%), and Vietnam (3%) in Asia, and Brazil (5.8), Colombia and Mexico and in Central and South America. While China remains a leader, other countries are also expanding production and developing their markets, especially in North America and Europe. The industry is also rapidly growing in South America, driven by both domestic consumption and export to North America. Some countries are trying to grow tilapia in saline water e.g. Indonesia, the Philippines, Singapore etc. and do processing and marketing value-added products like smoked tilapia, frozen fillet, vacuum packed etc. US is the largest tilapia importer. Value of tilapia import surpassed 1.2 billion USD in 2023 which is the third important farmed species after shrimp and salmon. Global tilapia market value has reached 15 billion USD in 2025 and expected to reach 24 billion USD by 2035.

In Africa there are different species of tilapias. Egypt is way ahead and its farming is growing fast also in other countries, especially in Ghana, Uganda, Nigeria, Zambia, Kenya, Tanzania, Zimbabwe, Côte D’Ivoire, Mali and so on. Most of these countries are using large circular cages (10-20 m diameter) in lakes and reservoirs. Nile tilapia accounts for over 90% of the total tilapia production in Africa. Their production is likely to come into the picture soon. However, in South Asia except Bangladesh, despite having so many efforts, its growth is very slow. There are several underlaying reasons which include; strong preference to carps especially Rohu, bad history and impression as invasive alien species, uncontrolled breeding and recruits in grow-out ponds, misconception about hormone used for sex-reversal, less meat compared to carps and other species, cold winter that restrict breeding and growth, and shortages of technical experts, promoters and advocate especially for its breeding and hatchery technology and marketing. Considering these, tilapia farming was officially or unofficially banned in India, Nepal and Pakistan until a decade ago. It has been officially accepted realizing the benefits such as availability of state-of-the-art hatchery technology capable of producing billions of high quality monosex fingerlings, fast growth, high density culture and potential for higher productivity, white meat with no Y-bones, firm and good taste suitable for producing boneless fillet for export and domestic markets. Sri Lanka has a long history of tilapia introduction but farming is limited. Afghanistan, Bhutan, and Maldives have no tilapia at all. Efforts are being made to accelerate its dissemination through training, outreach and consultancy services. More will be discussed during the presentation.

ENVIRONMENTALLY RELEVANT EXPOSURE TO DI-(2-ETHYLHEXYL) PHTHALATE DISRUPTS REPRODUCTIVE SUCCESS IN FEMALE KOI CARP (*Cyprinus Carpio*)

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Di-(2-ethylhexyl) phthalate (DEHP) is a widely used plasticizer and a pervasive environmental contaminant known to exert harmful effects on various animal species. While it is known to disrupt female reproduction in mammals, the effects on fish reproduction remain unclear. In this investigation, mature female koi carp (*Cyprinus carpio*) were exposed to nominal DEHP concentrations of 1, 10 and 100 $\mu\text{g/L}$ for a period of 60 days to assess reproductive performance. The results revealed a marked decline in the gonadosomatic index (GSI) of females exposed to 10 and 100 $\mu\text{g/L}$ DEHP. Histopathological examinations of ovarian tissues demonstrated severe structural damage, including oocyte atresia, intra-oocyte vacuolization and necrotic changes. Fecundity and oocyte diameter were significantly reduced in the same exposure groups. Biochemical analyses of ovarian fluid indicated notable alterations in glucose, cholesterol and total protein levels, while ionic concentrations of sodium, potassium, calcium and magnesium also showed significant variations among treated fish. Moreover, serum hormone assays demonstrated decreased levels of 17 β -estradiol and elevated concentrations of 11-ketotestosterone in DEHP-exposed females. Gene expression analysis using real-time PCR revealed concentration-dependent changes in the transcription levels of key reproductive genes, including *Fshr*, *Lhr*, *Ar*, *Er α* and *Er β* . When DEHP-exposed females were bred with unexposed males, substantial declines in fertilization, hatching and larval survival rates were observed. In summary, this study provides compelling evidence that chronic exposure to environmentally relevant concentrations of DEHP can impair reproductive physiology, disrupt endocrine function and diminish overall reproductive success in female koi carp.

POWDERED SALMON ROE PROCESSING LIQUID ON ENHANCING THE PALATABILITY OF TUNA BY-PRODUCT MEAL-BASED DIETS IN JUVENILE GREATER AMBERJACK (*Seriola dumerili*)

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In a recent study, palatability was an issue, while fish meal (FM) was replaced by tuna by-product meal (TBM) in the diet of juvenile greater amberjack, *Seriola dumerili*. To address this issue, powdered salmon roe liquid (PSRL) was added to identify suitable feeding attractants for TBM-based diets.

A two-factorial experiment was designed to evaluate the potential for improving the palatability and use of TBM as a replacement for FM by supplementing the diet of juvenile greater amberjack with PSRL. The FM protein in the control diet (C) was partially replaced with TBM at levels of 25% (T25R0) and 40% (T40R0). The PSRL was then added at 5% and 10% to both the T25R0 and T40R0 diets, resulting in the formulations T25R5, T25R10, T40R5, and T40R10. The experiment was set in triplicate by stocking 30 juveniles (mean weight approximately 1.7 g) in each 500 L tank.

After a 6-week rearing period, there were no significant differences in the final mean weight, weight gain, or specific growth rate among fish fed diets C, T25R0, and T25R5. However, the other experimental diets showed significantly lower values compared to the C diet. PSRL supplementation did not significantly enhance either palatability or feeding rate in TBM-based diets. Two-way ANOVA indicated that only FM replacement with TBM had a significant effect on the growth parameters mentioned above. A significantly lower whole-body crude lipid content was observed in all test diets compared to that of the C diet, resulting in significantly lower lipid retention efficiency in all test groups except T25R5 and T25R10. These results suggest that 25% of FM protein can be replaced with TBM protein in the diet of juvenile greater amberjack, but PSRL does not effectively address the palatability issues associated with TBM-based diets.

THE IMPORTANCE OF SUSTAINABLE MANAGEMENT OF NATURAL *Artemia* RESOURCES: A THIRTY-YEAR RETROSPECTIVE OF SUSTAINABLE MANAGEMENT PRACTICES IMPLEMENTED ON GREAT SALT LAKE AND A REVIEW OF WORLD-WIDE *Artemia* CYST PRODUCTION

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During the last three decades aquaculture has expanded rapidly. In 2022, for the first time in history, aquaculture surpassed capture fisheries with the production of more than 94 million tons of aquatic animals. *Artemia* has played, a crucial role in the sustainable production of marine fish and shrimp worldwide, and continues to do so. Annually, more than 10 million tons of marine fish and shrimp production relies heavily on *Artemia*, and it is therefore crucial that we continue to implement sustainable management of all *Artemia* resources worldwide.

Today, Great Salt Lake produces approximately 40 % of the world's *Artemia* cysts and is therefore vital to support sustainable marine aquaculture production. Adaptive management of the Great Salt Lake *Artemia* resource started in the mid-1990s with the creation of the Great Salt Lake Ecosystem program by the Utah Division of Wildlife Resources. Three decades of research focused on the four primary pillars of sustainable management of the Great Salt Lake *Artemia* resource i.e., the implementation of adaptive harvest management, nutrient management, salinity management and water supply.

We provide an overview of the extremophile *Artemia*'s habitats, its lifecycle and role in marine aquaculture and briefly review the efforts implemented by multiple Utah State agencies and the Utah State legislature on the four primary aspects of hypersaline lake management. We further detail the most recent implementation of active salinity management by the Utah Department of Forestry Fire and State Lands, which examines salt mass and salinity data in support of these management actions as well as the positive outcome on the Great Salt Lake *Artemia* population. Finally, we contrast the Great Salt Lake cyst production against other world resources and conclude that efforts to manage *Artemia* resources have resulted in an increase in the worldwide production of *Artemia* cysts in support of marine aquaculture.

SHRIMP BREEDING AND HATCHERY SYSTEMS FOR IMPROVED PL QUALITY AND RESILIENCE

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Sustained profitability in shrimp aquaculture begins with the careful selection and stocking of robust, genetically sound postlarvae (PL). The performance of each crop is largely determined by the genetic foundation, health status, and overall quality of the seed introduced to the pond. With the continued evolution of the shrimp-farming sector, producers now benefit from a wider range of options—genetically improved lines, advanced hatchery and maturation systems, and increasingly sophisticated quality assurance tools.

Modern breeding programs have produced genetic lines that combine rapid growth with enhanced resilience and tolerance to key pathogens. Reputable breeding companies have invested for decades to develop improved lines applying increasingly sophisticated genetic technologies. Broodstock production system technologies are critically important in assuring subsequent hatchery performance. Nevertheless, maintaining genetic integrity throughout the production chain remains a fundamental challenge for ensuring farmer confidence and long-term industry stability. New tools have been developed to differentiate between stocks for better assurance that the farmer is getting the genetic lines requested and to enable identification of operators attempting to shortcut the process by combining F2 stocks of questionable origins.

Hatchery operators today have access to improved biosecurity protocols, refined water quality management, better feed formulations, and high-quality nauplii sources. The introduction of standardized, technology-supported assessments—ranging from morphometric screening to health diagnostics—has further strengthened the decision-making process for PL procurement and stocking.

As Dr. M.S. Swaminathan, widely recognized as the father of India's Green Revolution, emphasized, "Quality seed is the first step towards a good harvest." This guiding principle remains equally valid in aquaculture. Although seed costs represent a relatively small share of total production expenses, their influence on survivability, growth performance, and profitability is profound. Investing in the consistent supply and verification of high-quality, genetically improved PL is therefore essential for both economic and environmental resilience in shrimp farming.

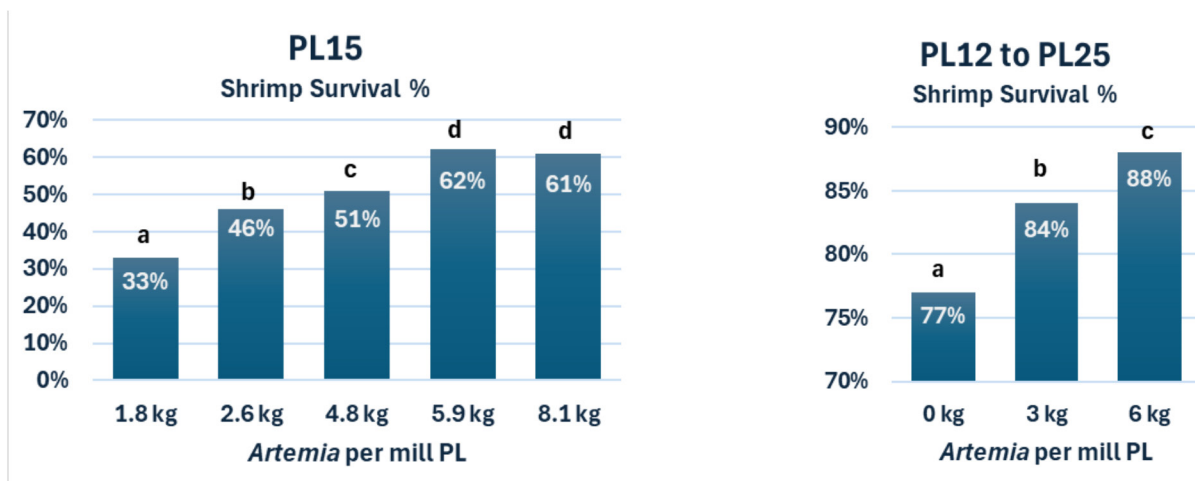
INCREASED *ARTEMIA* USE RESULTS IN IMPROVED HATCHERY, NURSERY, AND GROW-OUT OUTCOMES: A SUMMARY OF RECENT TRIALS ON *Penaeus vannamei*

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Artemia nauplii are a foundational and essential component of larval and post-larval penaid shrimp production due to the favorable nutritional profile, digestibility, and free-swimming behavior. Partial replacement of *Artemia* nauplii with formulated feeds has been successful at reducing *Artemia* use rates, but attempts at complete replacement have led to nearly universally poor outcomes despite years of concentrated effort. The numerous inherent benefits of *Artemia* have remained distinct and irreplaceable, and improved shrimp survival and health is possible by increasing *Artemia* feeding rates above the levels currently in use in many areas.

Multiple trials were conducted over a multi-year period to examine the effects of increased feeding rates of *Artemia* nauplii on the survival and condition of whiteleg shrimp (*Penaeus vannamei*). The trials occurred at multiple scales, from university experiments to commercial field trials, and across multiple global regions. Initial university trials found significantly improved survival with increased *Artemia* use rates through both the hatchery (PL15) and nursery (PL25) phases, as well as increased heat shock protein expression. Follow-up commercial-scale field trials resulted in higher survival, growth, and stress tolerance, and increased pond production in Mexico. A university-led experiment at the hatchery scale in Vietnam found significantly higher survival and much larger animal size at PL12. Commercial hatchery trials in Ecuador also resulted in higher survival and growth by PL12, and the potential for earlier harvesting. Taken together, these results demonstrate a substantial net benefit from greater *Artemia* use which could lead to improved revenue for hatchery and nursery operators



TOWARDS PRECISION AQUACULTURE IN SHRIMP LARVICULTURE: A CASE STUDY ON THE APPLICATION OF VISUAL ARTIFICIAL INTELLIGENCE ON SHRIMP LARVAL STAGES IDENTIFICATION AND POPULATION ESTIMATION

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In recent years, Artificial Intelligence, and more specifically Visual Artificial Intelligence (Visual AI), has emerged as a transformative tool in aquaculture. While its application has been explored in fish farming, its potential in shrimp aquaculture is now only beginning to be realized. This study presents a case study on the implementation of visual AI technology developed by INVE Aquaculture in collaboration with ARIS BV, aiming at enhancing the monitoring and management of marine shrimp larviculture.

The SnappArt 360 system, initially introduced for counting *Artemia* and rotifers utilizes deep learning-based object detection networks, trained on images sourced globally and annotated by experts to accurately identify shrimp across all larval stages, from nauplius to postlarvae. A standardized sampling protocol was established to gather representative samples from transport bags, pooled tanks, and culture tanks.

The key outcome of this study was the ability to track shrimp larval development, indicated by the Larval Development Index (LDI), enabling rapid and accurate tracking of larval shrimp development. The AI system demonstrated high accuracy in detecting developmental stages and quantifying population dynamics, providing insights that traditionally required expert analysis or were previously inaccessible.

This technology allows data-driven decision-making in feed management by offering real-time stage-specific information thereby optimizing feed allocation and reducing feed waste, which remains one of the most significant costs in aquaculture. Furthermore, the system includes reports for real-time monitoring and historical data retrieval, supporting performance analysis and culture benchmarking.

In conclusion, the integration of visual AI into marine larval shrimp represents a significant advancement in precision feeding, offering expert insights that enhance operational efficiency.

IMPACT OF ARTEMIA ENRICHED WITH COMMERCIAL ENRICHMENT PRODUCTS ON LARVAL DEVELOPMENT AND STRESS RESISTANCE OF SHRIMP (*Litopeneus vannamei*) AND PRAWNS (*Macrobrachium rosenbergii*)

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Commercially cultured shrimp and prawns still rely on high-quality live prey for optimal growth performance. Artemia plays a prominent role in this, and various products and protocols have been developed to enhance its nutritional profile. A line of Selco (Self-Emulsifying Liquid Concentrate) products has been developed to improve the nutritional profile of Artemia, in terms of HUFAs, vitamins, minerals and other nutraceuticals, providing nutritional benefits to the aquatic animals fed with the enriched Artemia. In this study, a protocol for the combined hatching and enrichment of Artemia nauplii was developed, using EG SEP-ART® cysts, Sanocare Ace Pro and different enrichment products (S.presso, A1 DHA Selco and Easy DHA Selco from INVE AQUACULTURE, Thailand). Following enrichment, the Artemia nauplii were fed to shrimp and prawn larvae. As a control, non-enriched Artemia was used to assess the impact of enrichment on larval growth and survival.

During the culture of *M. rosenbergii* larvae, replacing wild zooplankton with Easy DHA Selco-enriched Artemia significantly accelerated development from mysis stage to post-larval (PL) stages, reducing the culture period by three days. Moreover, larvae fed with enriched Artemia were notably larger, showing a $\pm 14\%$ increase in dry weight at the PL stage compared to those fed a control diet of non-enriched Artemia combined with wild zooplankton.

In *L. vannamei* larviculture, feeding enriched Artemia resulted in improved culture survival at PL 11 compared to the control group (78% vs 74, respectively), a lower number of PL per gram (147 vs 156), higher Individual Wet Weight (6.8 mg vs 6.5 mg) and a better survival after a salinity stress (95% vs 91% in the control group) demonstrating enhanced physiological resilience and a superior growth performance. Furthermore, there was a significant presence of lipid droplets in the hepatopancreas compared to the control. These results highlight the nutritional advantage and growth-promoting effect of enriched live food during early larval development and show that enriched Artemia not only enhances growth but also improves stress resistance and muscle development in shrimp post-larvae.

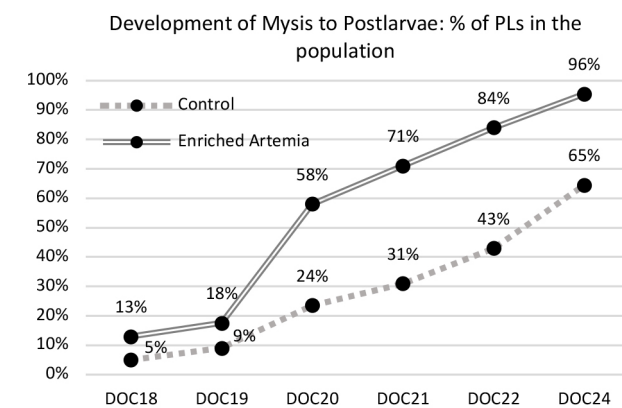


Figure 1. Development of *M. rosenbergii* mysis into postlarvae.

PILOT-SCALE CULTURE OF THE PURPLE SEA URCHIN (*Paracentrotus lividus*) AT THE EPPO-IPMA AQUACULTURE RESEARCH CENTER

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The purple sea urchin (*Paracentrotus lividus*) is a key species of ecological and commercial interest in European. Due to the high international market value of its gonads (also known as “uni”) and the overexploitation of natural stocks, the development of efficient aquaculture techniques is essential to support sustainable production. Over the past years, the EPPO-IPMA, in collaboration with industrial partners (SPAROS), has established a complete pilot-scale production system covering all life stages of *Paracentrotus lividus* under controlled conditions.

The main objectives of this work were to (1) control and maximize reproduction, (2) analyze and enhance gamete quality, (3) develop optimized larval and juvenile culture procedures, (4) establish land- and sea-based fattening systems, and (5) evaluate nutritional requirements to design sustainable inert formulated feeds. Broodstock were fed macroalgae (*Ulva spp.*) and maize, and spawning was induced through KCl injection, followed by gamete preservation and quality assessments. Larvae were cultured at 20 °C under controlled conditions for 20–30 days, using mixed microalgal diets (*Skeletonema costatum*, *Emiliania huxleyi*, *Phaeodactylum tricornutum*, *Rhodomonas salina*), which significantly influenced larval growth and survival. Settlement success was enhanced by introducing substrates colonized with benthic diatom biofilms, particularly *Phaeodactylum tricornutum*. Juveniles were reared in fiberglass tanks and fed *Ulva spp.* and crushed maize, achieving >2 cm test diameter after 250 days post-hatch, with high survival rates. Fattening trials in coastal lagoon and offshore systems demonstrated the potential of integrating locally available and invasive macroalgae, such as *Rugulopterix okamurae* into formulated diets to promote sustainable growth and gonad development. The use of macroalgae such as *Gracilaria gracilis* produced as a by-product in IMTA and RAS has also shown great potential in feeding these echinoderms.

Overall, domestication positively influenced gamete quality, and short-term sperm preservation at 4 °C proved effective for reproductive management. The combination of optimized feeding regimes and controlled culture conditions allowed the successful completion of the full *P. lividus* life cycle in captivity. These results provide a solid basis for the expansion of sea urchin aquaculture in Europe, supporting emerging production initiatives and contributing to the conservation of wild populations. Current work focuses on formulating diets that promote growth during the fattening phase and also the refinement of the gonads on the other, in order to meet commercial requirements for final consumption.

Acknowledgments: Projects INOVAQUA (MAR-021.1.3-FEAMPA-00004) and AQUAFISH 0.0 (Interreg Atlantic Area Programme) for financial support.

MICROENCAPSULATED PHYTOGENIC BLEND BOOSTS SURVIVAL AGAINST *Enterocytozoon hepatopenaei* (EHP) IN *IN VIVO* INFECTION MODEL

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Enterocytozoon hepatopenaei (EHP) is a microsporidian parasite that infects farmed whiteleg shrimp (*Litopenaeus vannamei*), causing significant issues such as growth retardation, increased mortality, and economic losses in shrimp aquaculture. Various functional feed additives have been investigated to boost shrimp immunity and resilience to EHP, though with inconsistent results. Among these, phytogetic compounds have shown promise in inhibiting both aquatic and terrestrial parasites, therefore incorporating such compounds into shrimp diets may represent a promising practical strategy to reduce the impact of EHP infections.

This study evaluated the efficacy of a microencapsulated phytogetic blend (MPB), previously shown to suppress EHP spore germination *in vitro*. The experiment included four dietary treatments: (1) Negative Control (NC): basal diet only; (2) Positive Control (PC): basal diet + EHP challenge; (3) basal diet + MPB at 250 ppm + EHP challenge; and (4) basal diet + MPB at 500 ppm + EHP challenge. Shrimps (50 ind/tank) were stocked in 350 L tanks, with six replicate tanks per treatment. The trial lasted 63 days, including a 7-day EHP exposure phase followed by 42 days of post-challenge monitoring. EHP infection was induced by oral administration of feed coated with a homogenized suspension of EHP-infected faeces. Growth performance, feed utilization, survival, and immune parameters were monitored throughout, and data were analyzed via one-way ANOVA followed by Duncan's *post-hoc* test.

At the end of the 42-day post-challenge period, survival rates were as follows: NC (80.80%), PC (55.43%), MPB 250 ppm (64.13%), and MPB 500 ppm (73.19%). Survival was significantly higher in the NC group compared to all challenged groups. Among the infected treatments, shrimp fed MPB at 500 ppm showed significantly higher survival than both the PC (+32.04% Relative Percent Survival) and MPB 250 ppm groups. These results indicate that dietary inclusion of MPB enhances shrimp survival following EHP challenge, with 500 ppm offering the most pronounced protective effect. Nevertheless, the MPB 250 ppm dose also conferred improved survival over the challenged control.

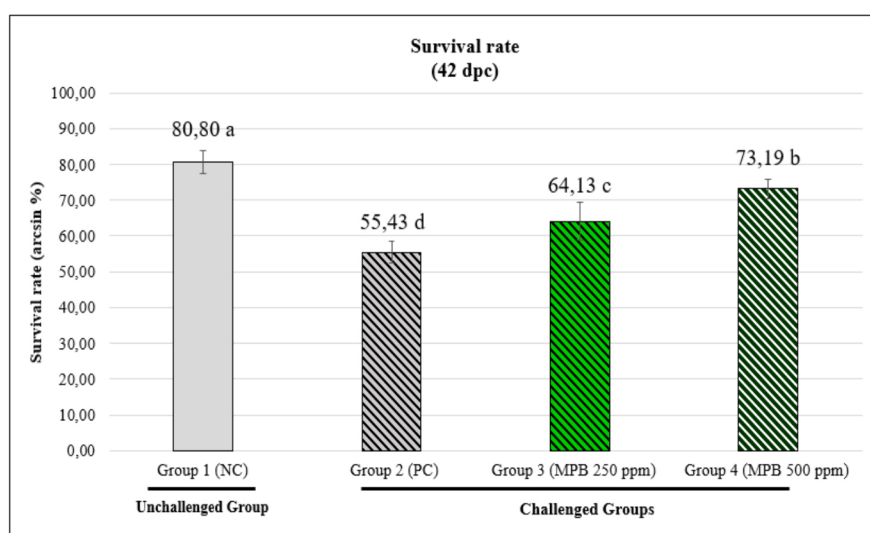


Figure 1. Survival rate of shrimp at trial termination, 42 days post-challenge, values are mean $\pm$ SD, $n=6$. Values in the different superscripts among groups indicate significant differences ($P < 0.05$).

FORMULATION OF FEED FOR ROHU *Labeo rohita* WITH FRESHWATER MACROPHYTES *Lemna minor*, *Pistia stratiotes* AND *Ipomoea aquatica*: ASSESSMENT OF ITS IMPACT ON THE NUTRITIONAL VALUE OF CULTURED FISH

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Freshwater macrophytes are considered as valuable fish feed ingredients for their rich nutritional profile. Six *Lemna minor* based pelleted diets LM-0, LM-0-IA-PS, LM-30, LM-40, LM-50 and LM-60 were formulated using the Interactive Fish Feed Designer (IFFD) software. There was no plant ingredient in one control diet, LM-0 while in other control diet, LM-0-IA-PS 3% *Ipomoea aquatica* and 2% *Pistia stratiotes* were incorporated. In diets LM-30, LM-40, LM-50 and LM-60, *L. minor* was incorporated 30, 40, 50 and 60% levels and 3% *I. aquatica* and 2% *P. stratiotes* were added to each diet. There was no significant ($P>0.05$) difference among the six formulated diets, except ash and calorific value. There was significant ($P<0.05$) difference in the fatty acid profiles of the six formulated diets. Significantly ($P<0.05$) higher total n-3 PUFA content was found in LM-60 diet compared to others. Rohu *Labeo rohita* fry (0.81 ± 0.01 g) were cultured under six different feeding regimes. The stocking density was 30 fish/aquarium (60 L each). Fish were fed ad-libitum twice daily.

A direct relationship was found between the final body weight of fish and increasing level of *L. minor* in the diet till LM-50 diet fed group. The growth rate was significantly ($P<0.05$) lower in LM-60 diet fed group compared to other *L. minor* incorporated diets fed rohu. The specific growth rate showed the similar trend. The feed conversion ratio was significantly ($P<0.05$) lower in LM-50 diet fed fish compared to others. There were significant ($P<0.05$) differences in the proximate composition among different diets fed rohu. Significantly ($P<0.05$) higher EPA and DHA contents were observed in LM-50 diet fed fish compared to others. The amino acid profile study of six different diets fed rohu showed interesting results. Significantly ($P<0.05$) higher amylase, protease and lipase activities were found in LM-50 diet fed fish compared to others. The trypsin and chymotrypsin activities were significantly ($P<0.05$) higher in LM-40 diet fed fish compared to others. Significant ($P<0.05$) differences were observed in the expression of genes involved in the biosynthesis of fatty acids of fish cultured under six different feeding regimes.

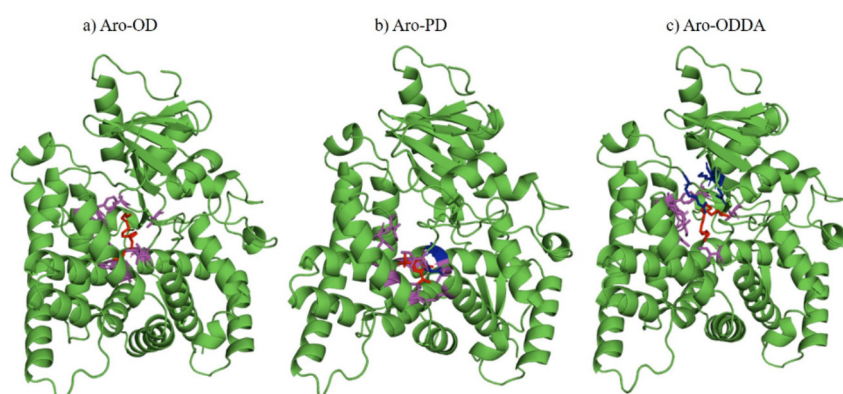
EFFECTIVENESS OF BIOACTIVE COMPOUNDS FROM FOUR MEDICINAL PLANTS TO INDUCE SEX REVERSAL IN NILE TILAPIA: A CHROMATOGRAPHIC PERUSAL

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Ethanol extracts of *Basella alba* leaves (EB) and *Tribulus terrestris* seeds (ET), and methanol extract of *Asparagus racemosus* roots (MA) and *Mucuna pruriens* seeds (MM) were found effective to induce masculinization in Nile tilapia. The present study intends to evaluate the anti-aromatase activity of EB, ET, MA and MM, to identify the androgenic bioactive compounds in the extracts, and to determine their pharmacokinetics. The crude plant extracts were first fractionated through column and thin layer chromatography (TLC). Three days old Nile tilapia juveniles (mean weight 0.025 ± 0.009 g; $n = 50$ fish/replicate, 3 replicates/treatment) were fed diets fortified with the obtained fractions for 30 days. Fish were then sacrificed and gonad aromatase mRNA expression, and 11-ketotestosterone (11-KT) and estradiol (E2) levels were measured. Fractions yielding the highest male percentage for each plant were subject to gas chromatography-mass spectrometry (GC-MS) analysis. The *in silico* docking and SwissADME study were conducted with the components showing higher peak percentage in chromatogram. EB, ET, MM and MA yielded 6 (EB1 - EB6), 8 (ET1- ET8), 14 (MM1-MM14) and 5 (MA1- MA5) fractions, respectively. Fish fed EB2, ET2, MA2 and MM13 fraction fortified diets showed significantly ($p < 0.05$) higher male percentage (92.32%–98.39%) compared to other treatment groups. EB2, ET2, MA2 and MM13 fed fish showed significantly higher 11-KT level compared to control male and lower E2 level compared to control female. Aromatase mRNA expression was significantly down-regulated by all these four fractions (-1.32 to -5.65 folds) with respect to control female. GC-MS analysis revealed the presence of 1-Octadecene (OD) in EB2, Phenol, 2,4-bis(1,1-dimethylethyl) (PD) in ET2 and MA2, 9,12-Octadecadienoic acid (Z,Z)- (ODDA) in MM13. *In silico* molecular docking indicated that PD was more effective than ODDA and OD to inhibit aromatase (Figure 1). PD showed better pharmacokinetics and more drug-likeness compared to OD and ODDA in SwissADME analysis.

FIGURE 1. Protein-ligand interaction profiles between the Aro protein (green) of Nile tilapia and three ligands (red) a) 1-octadecene (OD), b) Phenol 2,4-bis(1,1-dimethylethyl) (PD) and c) 9,12-Octadecadienoic acid (Z,Z)- (ODDA), illustrated using PyMOL.



PROTEOMICS ANALYSIS OF SERUM IN FEMALE ANADROMOUS HILSA: *Tenualosa ilisha* (HAMILTON, 1822) AT VARIOUS LIFE STAGES

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To elucidate the functional dynamics of the serum proteome in relation to conservation, aquaculture, and population sustainability, the proteomic profile of female *Hilsa* (*Tenualosa ilisha*), a species of significant ecological and economic value, was investigated across multiple age classes. Using advanced LC–MS/MS–based proteomics coupled with bioinformatic analyses, diverse proteins were identified and annotated with Gene Ontology (GO) terms and enriched KEGG pathways—including phagosome, mTOR, Apelin signaling, and herpes simplex virus pathways—implicated in immune regulation and defense responses.

Age-dependent differences were evident in the expression levels of key immune-related proteins, particularly those associated with inflammatory and cellular defense processes. A total of 952, 494, 415, and 282 proteins were annotated from year class IV to class I, respectively, revealing a more than threefold increase in novel protein identification from the youngest to the oldest group. Protein–protein interaction (PPI) network analyses further illustrated the functional complexity of these stage-specific variations.

This study provides the first comprehensive characterization of the serum proteome of *T. ilisha* across developmental stages, offering new insights into the molecular mechanisms underlying proteomic modulation during migration. The findings contribute valuable information for understanding immune adaptability and may support future efforts in *Hilsa* management, conservation, and captive propagation.

BIOFLOC - AN ECOFRIENDLY AND SUSTAINABLE FISH FARMING FOR FOOD SECURITY IN INDIA

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Sustainability of food production especially protein source is going to be crucial in the coming years. Growing population especially in countries like India have created a huge demand of natural resources like, land, water etc. This situation has to be dealt with advanced bioscience and its technology where we can intensify the food production without damaging or competing for natural resources. Intensified culture systems like cage culture, RAS and Biofloc technology in aquaculture will be the crucial production systems. Impact of each culture system in terms of requirement of land, water is analyzed in this presentation. A detailed plan of operations of Biofloc technology with potential scientific calculations are presented. A food product with minimum land area, low FCR, low nitrogen, phosphorus emissions, low water foot print, low carbon foot print/ CO₂ emission is the main goal of this study and trial.

MULTIFACETED STRATEGIES FOR SUSTAINABLE AQUATIC FOOD SYSTEMS IN THE FACE OF CLIMATE CHANGE: BLENDING TRADITIONAL KNOWLEDGE, INNOVATION, AND GOVERNANCE FOR RESILIENCE

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The fisheries sector is currently confronted with several challenges and risks, including climate change, overfishing, and unsustainable practices which threaten global food security and ecosystem health. In this context, aquaculture plays a fundamental role in ensuring global fish food security, supporting economic growth, and promoting nutritional well-being. However, ensuring the sustainable management of aquatic food systems requires a multifaceted approach that integrates innovation, traditional ecological knowledge (TEK), governance, and technological advancement. Innovative management strategies are increasingly being adopted to address the ecological and socio-economic challenges associated with aquaculture and fisheries. Simultaneously, rapid advancements in aquaculture technology, including precision farming, biofloc systems, and recirculatory aquaculture, etc., and other technology such as Integrated fish farming are redefining production efficiency and environmental stewardship while advancing circular economy models. Yet, technological innovations alone are insufficient to catalyze the systemic transformation required in aquatic food systems. Achieving sustainability necessitates a rethinking of innovation itself: fostering inclusive innovation ecosystems, strengthening policy and governance frameworks, and ensuring equity through the active involvement of farmer's groups. Multi-stakeholder collaborations, capacity building, and the integration of diverse knowledge systems such as scientific, indigenous, and localized are vital to creating nature-positive outcomes. On the other hand, traditional ecological knowledge offers valuable insights into ecosystem resilience, biodiversity conservation, and community-based stewardship. Harnessing indigenous knowledge alongside modern science and digital technologies not only enriches resource management but also strengthens capacity against the growing impacts of climate change such as rising temperatures, shifting precipitation patterns, and extreme weather events. The review emphasizes that achieving long-term sustainability necessitates inclusive innovation ecosystems, equitable governance, multi-stakeholder collaborations, and the blending of scientific, indigenous, and localized knowledge systems. Together, these strategies strengthen adaptive capacity against climate change impacts and pave the way for sustainable and climate resilient aquatic food systems.

MAPPING OF WATER SPREAD DYNAMICS OF THE BAKHIRA WETLAND, UTTAR PRADESH, WITH SPECIAL REFERENCE TO FISHERIES

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Wetlands are among the most productive ecosystems on earth, serving as a rich repository of biodiversity and providing vital resources for both nature and people. The hydrological services provided by wetlands have multiple benefits and include flood control, water storage, groundwater recharge, water filtration, and river flow maintenance. The most important wetland ecosystem services affecting human well-being involve food and fisheries, freshwater supplies, livelihoods, water purification, carbon sequestration, offering cultural and recreational services, also help in the regulation of global climate change. Wetland ecosystems have been continuously decreasing, and as the groundwater table quickly reduces, permanent wetland regions have changed into semi-permanent wetlands, so mapping of water spread is essential. In present study examined the water spread dynamics and water presence frequency of the Bakhira, an internationally important Ramsar Wetland in Eastern Uttar Pradesh, for three decades, 1994-2024. The Landsat-based modified normalized difference water index (MNDWI) was used to determine WSA and WPF. The results of the study reveal that the seasonal mean water spread recorded for post-monsoon is 1678 ha, 1412 ha for winter and 961 ha for pre-monsoon. The results of the study indicate that the wetland follows declining water spread trends. The possible impacts of declining water spread area of wetlands lead to loss of fish biodiversity, reduced groundwater recharge, increased flood and drought risks, decline in fisheries, poor water quality, reduction in winter migratory birds, and reduced livelihood opportunities for local communities. Climate change may exacerbate the impacts of threats to wetlands through predicted reductions in rainfall and increased temperature, decreasing flow, and altering the timing and variability of flow regimes

SALINITY EFFECTS ON THE MORPHOMETRICAL CHARACTERIZATION OF PARTHENOGENETIC *Artemia* (Crustacea: Anostraca) POPULATION

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In *Artemia* strains, morphometrical studies can be helpful for fish farmers and aquaculturists and will help for the best possible food source. Here, the main objective was to study the thickness of untreated and de-capsulated cysts and the chorion diameter, naupliar and morphometrical characterization of adult females from parthenogenetic *Artemia* populations located in Korangi Creek, Karachi Saltern. Population was examined at three different salinities at 60, 80 and 100 g.l⁻¹. We analyzed data using Tukey's test ($P < 0.05$), one-way ANOVA and discriminant analysis (DA). Findings showed that the diameter of un-treated cysts $260.24 \pm 10.35 \mu\text{m}$; de-capsulated cyst $245.51 \pm 10.85 \mu\text{m}$; naupliar length $502.68 \pm 31.68 \mu\text{m}$ and chorion thickness $7.4 \mu\text{m}$. The discriminant analysis performed, based on the morphometrical variations, registered as much as 75.2% and 24.8% with female morphotypes. The highest weight of morphotype variations examined positively for antenna length and abdominal length and negatively examined for total body length and length of furca.

HARNESSING THE WATERS: A TRILLION DOLLAR INVESTMENT OPPORTUNITY IN SUSTAINABLE AQUACULTURE

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Aquaculture has emerged as the fastest-growing food production sector globally, now accounting for over half of aquatic food supply. This report revisits the sector's evolution since the 2007 World Bank publication "Changing the Face of the Waters," with a renewed focus on finance and investment. It synthesizes insights from seven case studies across Asia, Africa, and Latin America, highlighting how financial systems, public-private partnerships, and technological innovation have shaped aquaculture development. The report underscores aquaculture's low carbon footprint, its role in food security, and its potential to generate up to 22 million new quality jobs by 2050. It is expected that under an upside case, aquaculture production (excluding seaweed) would grow by 97 million metric tons to reach 255 million metric tons by 2050 (Fig. 1).

A transition from small-scale to intensive systems, supported by enabling policies and inclusive financial instruments, is imperative to achieve this potential. Mobilization of financing and investment of up to US\$1.5 trillion will support sustainable growth, particularly in emerging markets. Key emerging markets in 2050 include Brazil (15.1 m Mt), Turkey (4.3 m Mt), Mexico and Colombia (3.3 m Mt), Peru and Nigeria (1.9 m Mt) among others. Blended finance, credit guarantees, and investment in infrastructure and alternative feeds are key enablers for this to happen. As a nature-based solution, aquaculture brings significant environmental, economic, and social returns which calls for coordinated action among public, private, and philanthropic investors to unlock its trillion-dollar potential.

ACCELERATING ARTEMIA AQUACULTURE PRODUCTION AND CONSERVATION FOR A RESILIENT BLUE ECONOMY

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This work presents a comprehensive assessment of the Artemia agribusiness sector, focusing on the development potential of Artemia production within the broader context of agricultural transformation and rural economic growth. The analytical work explored the status of Artemia cultivation, including patterns of harvest, yield productivity, and regional production trends.

It draws from both quantitative and qualitative data to present a market analysis identifying demand drivers, value chain bottlenecks, export opportunities, and pricing dynamics. Key stakeholders—ranging from smallholder farmers and producer cooperatives to aggrotech startups and large-scale processors—have been mapped to highlight their roles, incentives, and capacity for innovation within the Artemia business ecosystem.

In addition, the study reviews the existing regulatory and institutional framework governing Artemia production, including quality standards, certification processes, land-use policies, and trade regulations, identifying both enabling and constraining factors. A special focus is placed on innovations in cultivation techniques, digital technologies, and sustainable practices that are shaping the sector's evolution. A series of illustrative case studies that showcase successful Artemia agribusiness models, including public-private partnerships and community-led initiatives, provide actionable insights for policy and investment. These cases serve to demonstrate scalable strategies for value chain development and rural livelihood enhancement. Figure 1 summarizes the list of objectives of the present work.

Overall, this study informs policy dialogue, investment planning, and capacity-building efforts to support the sustainable and inclusive development of Artemia agribusiness sector, aligning with national priorities for economic diversification and food systems resilience.



Figure 1: Outline of the objectives

ARTEMIA APPLICATIONS IN ANIMAL FEEDS

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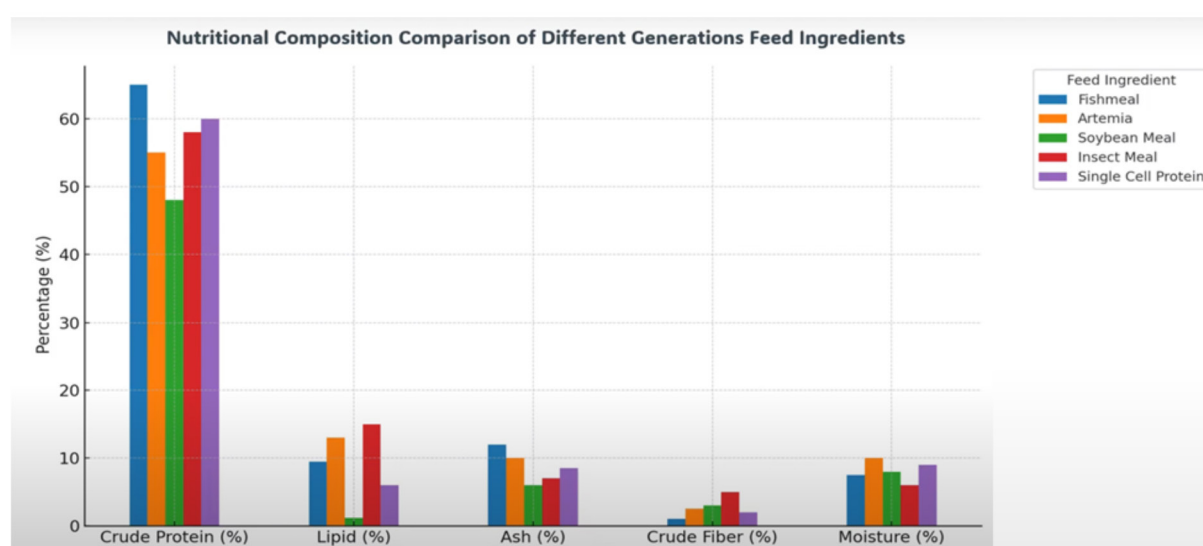
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Artemia, commonly known as brine shrimp, plays a pivotal role in global aquaculture as a live feed for larval fish and crustaceans due to its exceptional nutritional profile and ease of enrichment (Figure 1). However, commercial applications beyond hatchery feed remain underexplored. This PROBLUE initiative investigates feasibility of expanding Artemia use into broader animal feed sectors, including finfish grow-out diets, poultry, and ornamental species, with a focus on sustainability, cost-effectiveness, and supply chain resilience.

The research evaluates key parameters such as protein digestibility, amino acid composition, lipid enrichment potential, and functional properties (e.g., immunostimulant and gut health). Comparative feeding trials were conducted using Artemia biomass—both dried and processed as meal—against conventional protein sources such as fishmeal and soybean meal. Preliminary findings indicate that Artemia-based feed formulations enhance feed conversion ratios, improve survival rates, and stimulate pigmentation and growth performance in select species. Furthermore, we assess the economic viability of scaling Artemia production through integrated saltworks, solar ponds, and circular aquaculture systems in developing countries. Particular attention is given to gender-inclusive value chain development and climate resilience in developing states.

The Artemia study demonstrates that Artemia is not only a premium hatchery feed but also a versatile ingredient with cross-sectoral potential in sustainable animal nutrition. These findings support the case for strategic investment in Artemia production as part of blue economy development frameworks.

Figure 1. Nutritional Composition Comparison of Different Feed Ingredients



ARTEMIA APPLICATIONS IN HUMAN FOOD

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Artemia, widely cultivated for aquaculture feed, possesses unique nutritional properties that position it as a promising candidate for human consumption. Rich in high-quality protein (up to 60–65%), omega-3 fatty acids, carotenoids, and essential micronutrients, *Artemia* offers potential as a sustainable alternative to conventional animal- and plant-based protein sources. Figure 1 provides a comparison of the protein content between *Artemia* and various aquatic species.

As part of the World Bank’s PROBLUE initiative, this study assesses the feasibility of integrating *Artemia* into human food systems, focusing on nutritional value, safety, cultural acceptability, and market opportunities.

The research evaluates processing techniques—including drying, milling, and extraction—for generating *Artemia*-based food ingredients suitable for incorporation into snacks, functional foods, condiments, and nutraceuticals. Comparative analysis against established insect and microalgae proteins highlights *Artemia*’s favorable amino acid profile, digestibility, and natural pigmentation properties, which may enhance both nutritional and aesthetic value in food products. Initial sensory trials in select regions demonstrate consumer openness when *Artemia* is incorporated into familiar formats such as protein powders, crackers, and seasoning blends.

Beyond product development, the study explores inclusive value chains that could enable *Artemia*-based foods to support livelihoods in saline-prone areas, in Small Island Developing States (SIDS) and arid coastal regions.

Environmental assessments indicate that *Artemia* farming has a significantly lower ecological footprint than terrestrial livestock systems, with potential synergies in integrated saltworks and circular aquaculture operations.

The PROBLUE *Artemia* study reveals strong potential for *Artemia* as a novel, climate-resilient, and nutritionally superior food resource. Scaling its application in human nutrition could contribute meaningfully to global food security, health, and blue economy strategies.

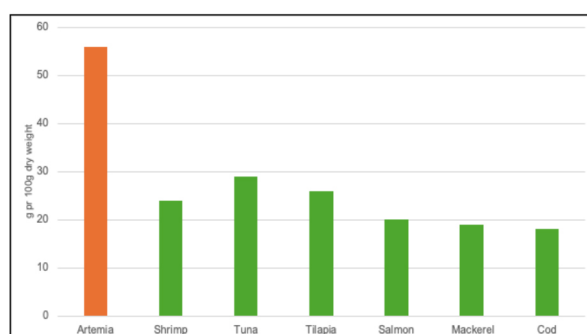


Figure 1. Protein content comparison of *Artemia* vs. fish species (g per 100g dry weight)

INVESTMENT OPPORTUNITIES AND SCALABLE BUSINESS MODELS IN ARTEMIA AQUACULTURE

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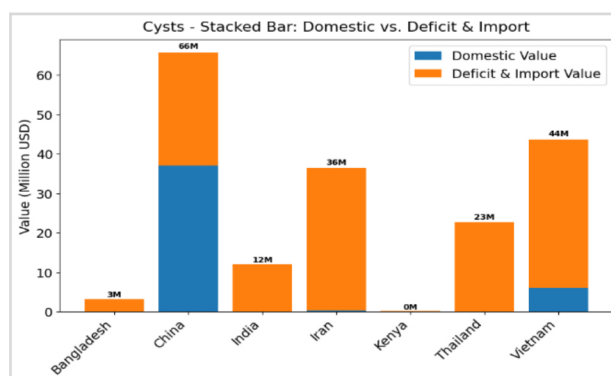
Artemia cysts are a critical live feed in shrimp and fish hatcheries worldwide, with increasing demand driven by global aquaculture growth. However, over 90% of Artemia cysts used globally still originate from wild salt lakes, which face ecological stress, supply volatility, and climate pressures. With the market remaining supply-constrained and dominated by a few producers, Artemia aquaculture can create substantial opportunities for new entrants, particularly in saline or coastal regions with limited agricultural viability.

The World Bank's PROBLUE Artemia initiative aimed at mapping investment opportunities and scalable business models for Artemia farming systems across diverse geographies. All target Artemia producing or potential countries show a general supply deficit (Figure 1).

We conducted technical, environmental, and economic feasibility of Artemia production across multiple geographies (China, Vietnam, Thailand, Bangladesh, and Kenya), identifying scalable models suitable for both public and private sector investment. Business opportunities were identified in cyst harvesting, processing, hatchery integration, and in value-added products such as enriched Artemia and biomass for nutraceutical use. The report also evaluates enabling conditions, including water salinity, land availability, infrastructure, and governance frameworks.

This paper serves as a foundational resource for stakeholders seeking to invest in or support the development of Artemia value chains, positioning it as a high-value, low-footprint aquaculture frontier with significant socio-economic and environmental co-benefits.

Figure 1. Artemia cysts: domestic values and deficits/import value



ARTEMIA SUPPLY CHALLENGES AND OPPORTUNITIES

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Artemia, or brine shrimp, is a cornerstone of global aquaculture, especially as a live feed during the early life stages of shrimp and fish. However, the Artemia supply chain faces mounting challenges due to rising demand, climate-induced disruptions in Salt Lake ecosystems, habitat degradation, and overharvesting of cysts. These pressures have led to inconsistent quality, supply volatility, and limited adoption of sustainable aquaculture practices.

This paper explores strategic opportunities to strengthen Artemia supply systems, with a focus on aquaculture as a transformative intervention. It highlights the vast potential of unexploited saline regions, particularly in arid and semi-arid zones where salt is already produced but Artemia cultivation is not practiced. By introducing Artemia aquaculture in these areas, countries can create new employment opportunities, diversify rural livelihoods, and enhance food security.

Innovations such as hatchery technology, public-private partnerships, and policy frameworks supporting integrated coastal resource management are key enablers of supply resilience. Beyond aquaculture, Artemia biomass presents untapped potential for food and nutraceutical applications, offering protein, omega-3 fatty acids, and bioactive compounds.

Aligning Artemia aquaculture with environmental sustainability and inclusive value chain development can foster resilient ecosystems, promote green growth, and unlock economic opportunities in salinity-prone coastal areas. Aquaculture policy dialogue and investment planning should prioritize Artemia farming and conservation strategies.

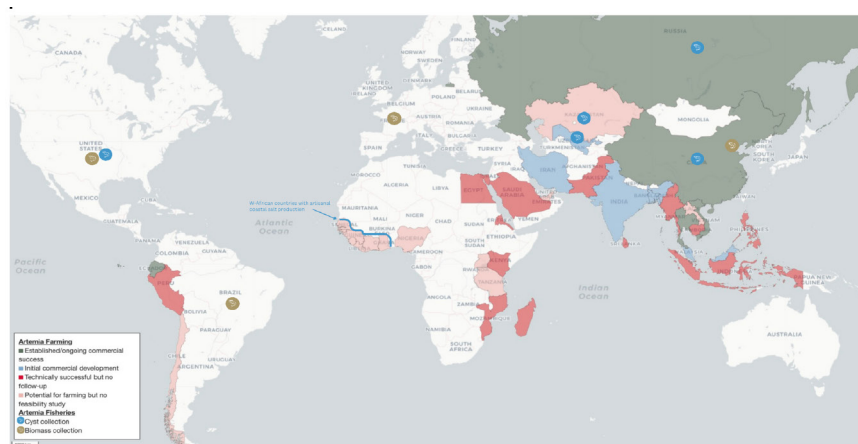


Figure 1. Status and potential for Artemia farming (cysts and biomass) around the world

ARTEMIA FUTURES - CATALYZING INNOVATION & INVESTMENT

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Artemia is widely used in aquaculture hatchery. This study highlights the untapped potential of Artemia as a scalable protein source for both animal feed and human food markets. It considers the steps needed to catalyze Innovation & Business Investment in these new markets.

A new Artemia innovation and business ecosystem is proposed connecting research, producers, investors, policymakers, and markets.

The core functions of the ecosystem include:

- Matchmaking between innovators, entrepreneurs, and financiers.
- Business incubation and technical support to develop scalable, cost-competitive Artemia enterprises.
- Market development through awareness, branding, and integration into regional and global supply chains.
- Investment readiness and blended financing strategies to attract climate- and impact-oriented capital.

By linking innovation to investment, the approach aims to move Artemia beyond its important but niche role in hatcheries into mainstream markets. Opportunities include biomass protein for aquafeeds and livestock, premium human nutrition products, and integrated saline agriculture systems. Early pilots in Asia and Africa demonstrate feasibility, but scaling requires structured coordination, cost competitiveness, and policy alignment.

The approach proposed here offers a potential platform to deliver these outcomes, creating enterprises that generate food and employment in salt-affected regions, reduce dependence on fishmeal and soy, and explores the role of Artemia as both a feed ingredient and a sustainable human food source. Research support, policy and regulatory framework and quality standards are vital for catalyzing investments and shaping scale-up opportunities (Figure 1).

Figure 1. Keys to catalyzing Artemia investments



DEVELOPMENT OF STANDARDIZED *Enterocytozoon hepatopenaei* (EHP) CHALLENGE MODELS FOR VALIDATING DISEASE CONTROL TECHNOLOGIES IN PENAEID SHRIMP (*Penaeus vannamei*)

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Enterocytozoon hepatopenaei (EHP) has become a persistent and economically devastating pathogen in shrimp aquaculture, especially in Asia. The inconsistency between field outcomes and laboratory trials has posed major challenges for the effective evaluation of disease control strategies.

In response, ShrimpVet Laboratory has developed and refined a series of standardized EHP challenge models designed to address this critical gap. This presentation outlines the design, optimization, and validation of three laboratory-scale EHP challenge protocols, grounded in real-world epidemiological observations and disease expression patterns from the Mekong Delta region. These include: **(1)** a cohabitation challenge model using spore-shedding donor shrimp to mimic chronic infections; **(2)** a per os challenge model using homogenized feces collected from EHP-injected shrimp, with a known density of spores, to ensure standardized oral exposure; and **(3)** a combination model, integrating EHP challenge with the induction of White Feces Syndrome (WFS) to better mimic complex, multifactorial field scenarios commonly observed in commercial shrimp production.

Quantification of infection intensity is performed through molecular diagnostics (qPCR), with evaluation of model reproducibility, host response, and sensitivity to treatment efficacy. These models have since been applied to screen a wide range of novel functional feed additives, probiotics, and microbial solutions under standardized yet field-relevant conditions.

By reproducing realistic infection dynamics, ShrimpVet's platform enables precise benchmarking of candidate technologies prior to field deployment. The standardization of EHP challenge models represents a critical advancement for the shrimp health sector, offering a robust and scalable platform for validating next-generation disease management tools. This work supports both innovation and resilience in sustainable shrimp farming systems.

A SINGLE-TUBE PCR TEST FOR IDENTIFICATION OF *Clarias magur*, *Clarias gariepinus* AND HYBRID TO STRENGTHEN CONSERVATION AND AQUACULTURE OF THE INDIAN CATFISH

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Clarias magur (Hamilton, 1822), a popular Indian catfish, is of significant ecological and economic importance, and found across India, Nepal, Bhutan, and Bangladesh. The taxonomic characters of *C. magur* exhibit a high degree of homogeneity with the exotic African catfish *C. gariepinus* that has a widespread unauthorized presence in India. Only the shape of the supraoccipital process is considered a diagnostic morphological characteristic, but it is useful only in adults, and intermediate shapes and inter-species hybrids have also been reported, leading to widespread misidentification. Further, due to the decline of its wild populations, *C. magur* is classified as ‘Endangered’ by the IUCN (2022), and accurate species identification is essential for conservation and implementation of the ban on the exotic species. DNA barcoding based on the mitochondrial COI gene fails to distinguish the species from their hybrids, and NCBI/ BOLD databases too have sequences of misidentified species.

Here, we report multiplexed Sequence Characterised Amplified Region (SCAR) markers developed from the carefully identified specimens of the two species and their experimental hybrids. Seven multiplexed primer sets observed to produce diagnostic agarose gel profiles in the lab, were used to genotype 190 fish specimens being sold as “magur” in fish markets across 19 districts in seven Indian States (Maharashtra, Tamil Nadu, Odisha, West Bengal, Bihar, Uttar Pradesh, and Jharkhand) by isolating DNA from fin clips. The sampled fish were also photographed for visual identification based on the shape of the supraoccipital process.

Results reveal that multiplexed SCAR markers proved effective in distinguishing between *C. magur*, *C. gariepinus*, and their hybrid, overcoming limitations of traditional morphological methods. The study confirmed widespread sale of *C. gariepinus* in urban fish markets of India, and the 190 sampled fish being sold as magur or hybrid by the vendors were 82% gariepinus, 15.4% magur, and 2.6% hybrids.

One SCAR primer set that generates a single 449 bp band in *C. magur*, a 319 bp band in *C. gariepinus* and both bands in the hybrid proved to be most reliable for identification by a single PCR reaction. This genotyping kit to be produced by ICAR-CIFE, Mumbai in public private partnership mode will strengthen targeted conservation efforts and also enable aquaculturists to confirm the identity of magur brooders for better outcomes of induced breeding. The paper discusses the development of these molecular markers and presents evidence of their robustness.

PROVEN EFFICACY OF A PHYTOBIOTIC ADDITIVE AGAINST EHP-WFS ACROSS TRIALS

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Enterocytozoon hepatopenaei (EHP) co-infection with pathogenic *Vibrio* spp., which drives white feces syndrome (WFS), undermines survival and feed efficiency in shrimp aquaculture. As the syndrome involves both parasitic invasion and bacterial colonization, an effective countermeasure must target spore viability and bacterial proliferation while supporting host immunocompetence and gut health. This report consolidates results from a series of *in vitro*, laboratory, and field trials evaluating the efficacy of a phytobiotic-based additive (Sanacore GM, Adisseo) with broad-spectrum disease management properties against EHP-WFS in shrimp.

The *in vitro* assay evaluated the direct effect of the additive on EHP viability by incubating it with EHP spores and monitoring spore germination. A detailed laboratory challenge was conducted in *Penaeus vannamei* co-infected with EHP and *Vibrio* spp., following a strategic application protocol consisting of a continuous preventive dose, boosted with a corrective dose upon disease symptom onset. Shrimp received a preventive dose of 0.3% for a 14-day pre-challenge period, followed by a corrective dose of 0.5% for 10 days during the challenge phase, and then returned to the preventive dose for a 35-day post-challenge period. Further field validations applying the same preventive-plus-corrective strategy were carried out in Indonesia, Malaysia, India, and China, each with differing disease histories, to evaluate the additive's performance under varied farming conditions.

The phytobiotic-based additive exhibited strong anti-EHP activity, effectively inhibiting spore germination *in vitro*. In the EHP-*Vibrio* co-infection challenge, it suppressed EHP replication, reducing spore load by 97% at the early infection stage and 40% at later stages compared to the positive control. Shrimp fed with the additive showed improved performance, with a 7.7% increase in average daily gain (ADG), a 13% reduction in FCR, and a 17% increase in survival post-challenge. Enhanced immunocompetence was supported by elevated total hemocyte counts, indicative of a strengthened disease control. Field results further confirmed the additive's effectiveness: while survival in control ponds ranged from 35 to 55%, farms with additive supplementation achieved delayed disease onset and survival rates of 66-99% under the preventive plus corrective program. FCR dropped by 25-33%, and crop yields increased on average threefold. Taken together, the phytobiotic additive limits early parasite establishment and significantly improves survival and productivity when a continuous preventive base is supplemented with short-term corrective dosing during outbreak periods.

ENHANCED BIOAVAILABILITY OF HYDROXY-SELENOMETHIONINE IMPROVES ANTIOXIDANT STATUS AND MITIGATES NITRITE STRESS IN WHITELEG SHRIMP, *Penaeus vannamei*

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Selenium is an essential micronutrient that plays a key role in mitigating oxidative stress, an escalating challenge in intensive shrimp farming. Selenium's biological effectiveness is highly dependent on the form in which it is delivered. This study aimed to evaluate how hydroxy-selenomethionine (OH-SeMet), compared to sodium selenite (SS) and selenium yeast (Se-Yeast), enhances stress resistance by improving the shrimp's antioxidant status, and how this benefit translates into better performance and final product quality.

The trial was conducted on whiteleg shrimp (*Penaeus vannamei*, 0.15 g), which were fed diets supplemented with three different selenium sources, sodium selenite (SS), selenium yeast (Se-Yeast), or OH-SeMet (Selisseo[®], Adisseo), each at 0.3 mg/kg. After a 127-day grow-out period, the shrimp were subjected to an acute nitrite toxicity challenge at an acute lethal dose resulting in 100% mortality within 8 hours. Key assessments included selenium deposition in tissues, antioxidant defense activity (GSH, T-AOC), growth performance, flesh quality parameters such as fillet yield and cooking loss after frozen storage and survival under stress challenge.

Supplementation with OH-SeMet significantly improved shrimp resistance to physiological stress. After a 4-hour nitrite challenge, survival in the OH-SeMet 0.3 mg/kg group remained at 70% compared to 0% in the SS group, and 50% in the Se-Yeast group ($P<0.001$). This resilience was linked to enhanced antioxidant defenses, as evidenced by significantly higher levels of total antioxidant capacity (GSH, T-AOC), attributed to the greater bioavailability of OH-SeMet. Selenium deposition in tissues was 23% higher than in the SS group (2.538 vs. 2.056 $\mu\text{g/g}$, $P<0.001$), and 6.5% higher than in the Se-Yeast group (2.538 vs. 2.383 $\mu\text{g/g}$, $P<0.001$). This improved physiological status translated into better growth performance. Shrimp fed OH-SeMet reached a higher final body weight (11.6 g vs. 10.4 g for SS and 10.9 g for Se-Yeast, $P<0.001$), higher survival (83% vs. 67% for SS and 75% for Se-Yeast, $P<0.001$), and a more efficient FCR (1.8 vs. 2.3 for SS and 2.0 for Se-Yeast, $P<0.001$) after the 127-day grow-out period. The antioxidant benefits of OH-SeMet extended beyond stress resistance to meat quality. Shrimp from the OH-SeMet group yielded the highest fillet percentage (50%, $P<0.001$) and the lowest cooking loss (28%, $P=0.0354$) after 60 days of frozen storage. In conclusion, OH-SeMet enhances shrimp health and productivity through a well-defined mechanism: improved selenium deposition boosts antioxidant capacity, which in turn strengthens stress resistance, growth performance, and meat quality.

TABLE 1. Analyzed Selenium in the test feeds (mg/kg)

Basal diet	Sodium selenite 0.3	Selenium yeast 0.3	OH-SeMet 0.3
0.73	1.10	1.00	1.10

COMMON PITFALLS AND MANAGEMENT CHALLENGES IN SHRIMP RAS

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Recirculating aquaculture systems have emerged as a key technology for sustainable and biosecure shrimp production, offering water reuse, improved disease control, and environmental compliance. However, the successful operation of shrimp RAS requires far more than the installation of advanced equipment. Many farms encounter performance instability, poor water quality, or inconsistent survival due to weak understanding of system integration, incorrect design assumptions, or inadequate daily management. A major weakness in many shrimp RAS operations begins before culture even starts, during the disinfection and preparation phase. Inefficient pond or tank disinfection leaves residual pathogen communities that quickly destabilize system water. Inadequate maintenance between production cycles also allows biofilm and sludge to accumulate within piping, sump tanks, and filters. These biofilms serve as reservoirs for opportunistic pathogens such as *Vibrio* spp., which can rapidly proliferate when environmental conditions fluctuate. Filters, aeration lines, and tank surfaces require thorough cleaning and drying to prevent biofilm hardening and pathogen persistence. During production, poor biosecurity planning and enforcement further compromise performance. Staff movement between tanks without proper disinfection, shared equipment across systems, and the absence of a clear “clean-to-dirty” workflow create continuous risks of cross-contamination. Shrimp RAS facilities require strict standard operating procedures that include quarantine of new post-larvae, regular sanitation of tools and nets, and dedicated water loops for different production stages. The system’s complexity magnifies the impact of even small oversights. Neglecting routine hygiene or skipping downtime maintenance can lead to rapid water quality deterioration and increased disease susceptibility. Ultimately, successful shrimp RAS operation depends on disciplined implementation of fundamental farm hygiene and biosecurity practices.

GRADED LEVEL OF HYDROLYZED YEAST (HILYSES®) IMPROVED FCR, GUT HEALTH, AND EXPRESSION OF FOUR CANDIDATE GENES OF NILE TILAPIA

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The study investigates the effects of supplementing graded level of hydrolysed yeast on Nile tilapia (*Oreochromis niloticus*). A high-fiber (7.7±0.3% CF), isoproteic (29.8±0.09% CP) and isoenergetic (3415.5±31.1 kCal/g) diets were formulated and supplemented with graded level (Control – ‘0.0’, HL0.5 – ‘0.5’ g/kg, HL1.0 – ‘1.0’ g/kg and HL2.0 – ‘2.0’ g/kg) of hydrolyzed yeast (Hilyses®, ICC Animal Nutrition, Sao Paulo, Brazil) in a 14-weeks feeding trial.

Despite no differences in most growth parameters, a positive trend was observed in feed efficiency ($t=2.535$, $P<0.024$), protein efficiency ratio ($t=2.572$, $P<0.022$), and the feed cost/ kg fish ($t=-2.074$, $P<0.047$). Protein deposition, protein retention and energy retention efficiency were responded linearly with the increasing dosage of hydrolyzed yeast ($t=2.179$, $P<0.047$; $t=3.056$, $P<0.009$; and $t=2.154$, $P<0.049$, respectively). Among haematological parameters, only haematocrit content decreased significantly with the increasing level of the yeast. The expression of all four target genes i.e., Insulin Like Growth Factor-I (IGF-I), Glyceraldehyde 3-Phosphate (G-3-P), Ghrelin, and Hepcidin were significantly different among the treatments, and linearly increased with the increasing level of dietary Hilyses® (Table 1). Similar results were also observed in villi length ($t=3.006$, $P<0.009$).

It can be concluded from the study that dietary supplementation of graded level of hydrolyzed yeast (Hilyses®) significantly improved feed utilization, protein and energy retention, intestinal health reflecting in the higher expression of growth (IGF-1), cellular glucose production (G-3-P), iron homeostasis (hepcidin), and hunger (Ghrelin) genes.

Table 1. Expression of Insulin Like Growth Factor-I, Glyceraldehyde-3-Phosphate, Ghrelin, and Hepcidin in the spleen of tilapia fed the graded level of hydrolyzed yeast (mean ±SD). Different letters in superscripts denote significant differences at $P<0.05$ among treatments.

Parameter	ANOVA					Regression	
	Control	HL0.5	HL1.0	HL2.0	P-value	‘r’	P-value
IGF-1	2.96 ^b ±0.03	2.97 ^b ±0.03	3.00 ^{ab} ±0.04	3.04 ^a ±0.04	0.038	3.648	0.003
G-3-P	2.66 ^b ±0.03	2.67 ^b ±0.03	2.70 ^{ab} ±0.04	2.74 ^a ±0.04	0.038	3.648	0.003
Ghrelin	2.16 ^b ±0.03	2.17 ^{ab} ±0.03	2.20 ^{ab} ±0.04	2.22 ^a ±0.03	0.029	2.848	0.013
Hepcidin	2.57 ^b ±0.03	2.58 ^b ±0.03	2.61 ^{ab} ±0.04	2.66 ^a ±0.04	0.047	3.494	0.004

“BETTER WITH LESS”: REVIEW OF THE BENEFITS OF FISH PROTEIN HYDROLYSATES FROM PELAGIC SPECIES IN SHRIMP AND FISH FEED

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Due to limited availability and price fluctuations of marine ingredients, plant sources have increasingly been used as substitutes affecting palatability, zootechnical performance, and animal health. The production of standard fish meals (FM) still remains the main industrial process of marine ingredients. Meanwhile, the hydrolyzation process better preserves the unrivalled benefits of marine sources thanks to a gentler process.

Fish Protein Hydrolysates (FPH) feature major key advantages including high water solubility, low molecular weight distribution or bioactive peptides. These properties have tremendous interest in aquafeed by increasing feed palatability in high plant diets or facilitating the nutrient uptake, even at low inclusion. Various studies have confirmed the positive effects on growth and feed efficiency either for farmed fish and shrimps. Some peptides derived from FPH have proven to enhance various physiological mechanisms such as antioxidant, antimicrobial, or immunomodulatory activities. In response to specific infections either viral, bacterial or parasitic, animals fed with FPH have been found to increase innate immunity and disease resistance.

This review provides an overview of the use of FPH from pelagic species such as sardines and mackerels, using the BLUE FISH FACTORY in Morocco as a case study, within the context of industry efforts toward efficiency and sustainability.

NEW HIGHLIGHTS ON THE BENEFITS OF NATURAL CAROTENOIDS FROM PARACOCCLUS CAROTINIFACIENS (PANAFERD-AX®) FOR WARMWATER SPECIES UNDER CHALLENGING CONDITIONS

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Outside the known pigmentation effects, carotenoids, such as astaxanthin, have been found to play a crucial role in enhancing zootechnical performance, improving antioxidant status, boosting immune function, and increasing disease resistance in both fish and shrimp. Astaxanthin, primary carotenoid pigment in aquatic animals, is found in various organisms such as bacteria or algae, and known for several biological activities. It exhibits powerful antioxidant properties, neutralizing harmful reactive oxygen species (ROS) that can lead to oxidative stress and damage cellular structures. *Paracoccus carotinifaciens*, is a gram-negative, aerobic microorganism which contains up to 40 g kg⁻¹ of total carotenoids, including red carotenoids such as astaxanthin, adonirubin, canthaxanthin and adonixanthin. The commercial product known as Panaferd®-AX has been approved since 2007 by the European Food and Safety Authority (EFSA) as a feed additive in aquatic feeds for salmonids and its efficiency and added value well assessed for various species.

This review will update the benefits of Panaferd-AX natural carotenoids for two warmwater species and specific stages: Nile tilapia (*Oreochromis niloticus*) broodstock performances during the winter season; White shrimp (*Litopenaeus vannamei*) disease resistance against *Vibrio parahaemolyticus* (Fig.1) and mortality delayed after exposure to white spot syndrome virus (WSSV).

Natural carotenoids derived from *Paracoccus carotinifaciens* can enhance pigmentation but also greatly contributes to sustain the animal health status during challenging farming conditions..

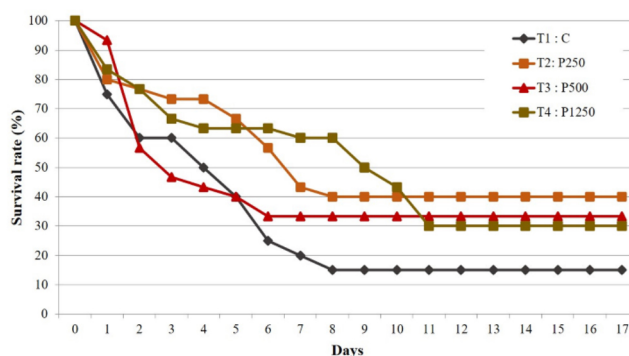


Fig.1 Survival (%) of shrimp from four dietary treatments after challenged with *Vibrio parahaemolyticus* for 17 days

SEAWEED CULTIVATION IN GUJARAT: SUSTAINABLE PATHWAYS FOR NET ZERO EMISSIONS

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Sustainable intensification in seaweed cultivation holds significant promise in addressing key sustainable development goals (SDGs), reduced land use resources, food security and gender inclusivity in coastal community development. Seaweed farming has emerged as a climate-resilient practice that not only provides ecological benefits, but also serves as a sustainable livelihood option for vulnerable coastal communities. Through Seaweed Mission, the government aims to boost seaweed production in the potential area from 30,000 tons to 11 million tons by 2025. Recent estimates by ICAR-CMFRI indicate that marine fisheries operations in India (across mechanized, motorized, and indigenous sectors) emit an average of 1.52 kg CO₂ (0.415 C) equivalent per kilogram of fish landed. According to a recent fish landing report by ICAR-CMFRI for 2023, Gujarat recorded a total fish landing of 822,786 tonnes, resulting in the release of approximately 12 Lakh tonnes of CO₂ and 5 Lakh tonnes of carbon. As per the scientific studies one hundred kilograms of seaweed can store approximately 2.72 kgs of carbon. Based on this data, an estimated production of 19 million tonnes of seaweed on an annual basis can offset the carbon emissions generated by fishing activities in Gujarat. According to recent ICAR-CMFRI estimates, approximately 2,796 hectares of coastal area in the Kutch region are suitable for seaweed farming. Based on a deployment capacity of 500 rafts per hectare, this area has the potential to accommodate nearly 1.4 million rafts. At this scale, seaweed cultivation has carbon storage potential of approximately 6,245 Megagrams of carbon per cultivation cycle. In contrast, mangrove forests typically store an average of 355.25 Megagrams of carbon per hectare. Accordingly, a single cultivation cycle of seaweed across the entire suitable farming area in the Kutch region can store carbon equivalent to that stored in approximately 17.5 hectares of mangrove forest. With its high productivity, shorter growth cycles and suitable farming areas, seaweed cultivation presents a more efficient alternative for blue carbon storage and coastal afforestation strategies. Seaweed farming offers a wide range of employment opportunities including cultivation, harvesting, processing, research, and sales. These roles include on-site farm workers, extraction assistants, scientists, quality control managers, and marketing professionals within the global seaweed industry. According to the Council on Energy, Environment and Water (CEEW), the cultivation of 26,000 hectares of *Kappaphycus alvarezii* and *Gracillaria* seaweed by 2030 has the potential to generate an estimated 108,300 full-time employment opportunities. This data will assist policymakers for effective decision making and provide recommendations for the implementation of sustainable practices. This carbon storage has significant implications for future evaluations of the Net Zero concept, carbon sequestration, and climate change mitigation.

EVALUATION OF THE FATTY ACID PROFILE OF THE AFRICAN CATFISH *Clarias gariepinus* FED THREE DIFFERENT COMMERCIAL FISH FEEDS: IMPLICATIONS FOR AQUACULTURE NUTRITION AND HEALTH

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The African catfish (*Clarias gariepinus*) is the most cultured and consumed fish in Nigeria. Thus, it is crucial economically and nutritionally. One of the major constraints to the sustainable farming of *C. gariepinus* is the cost and quality of fish feed. High costs of traditional feed ingredients, particularly fish meal, has resulted in the use of alternative plant-based sources with varying effects on the nutritional quality of commercial feeds. Fish provide high-quality protein, essential omega-3 fatty acids, vitamins, and minerals crucial for human health. However, fish feed composition and quality are essential to fish composition and health and the benefits consumers derive thereof. The present study was conducted to investigate the influence of three commercial fish feeds on the growth performance and fatty acid composition of *C. gariepinus*.

An 83-days feeding trial was conducted in nine 1000-liter culture units. Each unit held sixty *C. gariepinus* fingerlings that were fed twice daily for 90 days with three different feeds (A, B, C). Their growth parameters, feed utilization efficiency, and fatty acid profiles were evaluated. Statistical analyses were conducted using one-way ANOVA, and Duncan's Multiple Range Test. The results (Table 1) revealed that Feed A exhibited the best growth performance with a mean weight gain (MWG) of 226 g, feed conversion ratio (FCR) of 0.76, and specific growth rate (SGR) of 2.13. Feed B achieved moderate performance with MWG of 140 g, FCR of 0.89, and SGR of 1.88. Feed C displayed the lowest growth performance, with MWG of 105 g, FCR of 1.01, and SGR of 1.73. Fatty acid analysis indicated significant variations in the feed and these reflected on the fish flesh (Table 2). Feeds A and C contained the highest concentrations of polyunsaturated fatty acids such as 22:6n-3 and 20:5n-3, making them nutritionally superior. Feed B lacked 22:6n-3 and so did the fish with them. These findings underscore the importance of feed composition on fish nutritional composition.

Table 1: Growth Performance of *C. gariepinus* fed three different commercial feeds.

	Initial Weight	Final Weight	Weight Gained	SGR	FCR	Survival (%)
Feed A	3.94±0.08	230.22±21.30	226.29±21.38	2.13±0.06	0.76±0.03	96.67±2.89
Feed B	3.98±0.08	144.07±5.56	140.10±5.54	1.88±0.02	0.89±0.04	97.22±2.55
Feed C	3.97±0.04	109.00±4.59	105.03±4.58	1.73±0.02	1.01±0.04	96.11±3.85

Table 2: Fatty acid composition (µg/kg) of *C. gariepinus* fed three different commercial feeds.

	18:0	18:2n-6	18:3n-3	20:4n-6	20:5n-3	22:6n-3
Feed A	4026.83	4042.46	89.45	1930.86	4102.83	4160.17
Feed B	872.99	985.99	50.92	559.56	42.79	0
Feed C	673.05	3017.68	59.97	520.08	1204.56	1069.94
Fish A	1477.94±172	3501.08±733	388.57±9.84	1015.57±6.4	1763.04±0	1750.905±325
Fish B	912.51±57	3500.34±561	100.48±0.64	812.75±6.8	99.88±1.3	0
Fish C	1501.66±139	5005.34±104	151.93±215	1105.89±0	1763.04±0	2792.36±426

DIGITAL TWIN-DRIVEN SMART FEEDING WITH MULTI-MODAL AI FOR SUSTAINABLE AQUACULTURE

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Feed accounts for the biggest portion of Indian aquaculture costs, but most farms use hand feeding or timing to administer it, resulting in wastage and water contamination that impacts production. We present “IntelliFeed,” a digital twin-based multi-modal AI platform that leverages real-time sensor fusion, edge reinforcement learning and virtual pond simulations to automate feeding. Preliminary simulations indicate that the amount of wasted feed can be cut in half and a better grown ratio feed is achieved. IntelliFeed provides a scalable and cost-effective route for profitable and sustainable Blue Transformation in Indian aquaculture.

Aquaculture is the backbone of rural livelihood in India, but feeding inefficiency remains a primary cause of financial loss and environmental pressure. Feed represents >60–70% of input costs and lack of responsive, inexpensive automation has led to 30–40% feed wastage and chronically unhealthy ponds. Even though automatic feeder systems based on simple internet-of-things (IoT) schemes do exist, most of them are too costly, closed source or not tailored enough to the existing local condition. To achieve India’s “Blue Growth” a new generation of intelligent feeding solutions, both improving the environmental footprint and increasing growth and efficiency is urgently required.

Existing aquaculture automation R&D, as well as commercial products are predominantly: Static or timer based feeders; Simple IoT-devices; Vendor lock-in hardware platform solutions. Few recent works use low-resolution sensors or cloud analytics for estimating appetite, but there is a delay in the response and little adaptability. Reinforcement learning (RL) offers promising avenues for dynamic scheduling in both agriculture and manufacturing, while digital twins are becoming powerful enablers of safe, low-cost testing and optimization. Yet, most of the existing Indian deployments do not adequately exploit multimodal sensor integration, edge analytics or sim-based RL training—constraining their effectiveness and accessibility for edgy farmers.

Proposed Work

Early digital twin-based RL studies [16] show that IntelliFeed is able to reduce wastage and increase yield when compared to timer-based and simple vendor IoT feeders. Their simulated deployment based on Andhra Pradesh pond parameters brought the water quality metrics into equilibrium and resulted in a clear reduction in FCR that could sustain pond health while reducing input costs. They are now in the process of scheduling full-scale field validation with small shrimp and fish farms within Taiwan to compare IntelliFeed performance-to-cost ratios against existing industry feeds.

IntelliFeed is the first Indian use case of a digital twin-centred reinforcement learning platform for aquaculture feed management. The strategy ensures remarkable economic and environmental benefits resulted from less waste, improved FCR and better management of ponds. Through providing farmers with affordable, flexible and data-driven solutions, IntelliFeed allows mass expansion of sustainable aquaculture and fits national and global Blue Transformation policies agendas. The next step will be full farmer validation, scalability techniques to make the tool more robust and integration with Government digital agriculture initiatives.

ASSESSMENT OF USAGE OF SEA SAFETY DEVICES AND OCCUPATIONAL HAZARDS FACED BY MARINE FISHERS OF WEST BENGAL

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Marine fisheries play a crucial role in the socio-economic development of coastal communities and contribute significantly to food security and livelihood generation. It is also reported to be one of the most hazardous occupations globally, exposing fishers to numerous occupational risks, vessel hazards, and personal injuries. This study was undertaken in West Bengal to analyse the occupational hazards experienced by marine fishers and to evaluate the knowledge and usage of sea safety devices (SSDs) among marine fishers. The study was conducted in two marine fishing districts of West Bengal-Purba Medinipur and South 24 Parganas-chosen for their extensive marine fishing activity. A total of 180 marine fishers were purposively selected, comprising mechanised (66.67%), motorised (22.22%), and traditional (11.11%) craft operators. Data analysis involved descriptive statistics, Kruskal-Wallis tests, and Mann-Whitney U tests to identify differences across fishing types and between districts. Information on occupational hazards both vessel hazards (capsizing, sinking, grounding, burning, collision) and personal hazards (mishaps, man overboard) was collected. The frequency, occurrence period, medical care received were analysed. Statistical tests like Kruskal Wallis test were used to identify variations across craft types. Knowledge and usage of ten SSDs life buoys, life jackets, first aid kits, GPS, magnetic compasses, distress alert transmitters (DAT), echo sounders, oil lamps, signalling torches, and fire appliances were assessed. Fishers' ability to operate these devices and their participation in safety training programmes were also recorded. Mann-Whitney U tests assessed differences in safety device adoption between districts. It was found that traditional fishers faced relatively higher hazards. Regarding SSD usage, mechanised fishers showed the highest awareness and usage, particularly for life jackets, first aid kits, and GPS devices, with usage rates exceeding 90% in many cases. While formal training programmes are conducted by the Government nearly 35% of traditional fishers reported never attending safety training. The study recommends implementing structured, craft-specific safety interventions for enhancing the safety and livelihood security of marine fishers in West Bengal.

COMPARATIVE EVALUATION AND DIURNAL VARIATIONS OF NITROGEN FIXATION IN FRESHWATER FISH PONDS UNDER DIFFERENT MANURIAL MANAGEMENT PRACTICES

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Seasonal diel variations of nitrogen-fixation in fish ponds under different manurial management practices were studied covering four seasons of a year. Water quality and bacterial populations with reference to aerobic heterotrophs and aerobic nitrogen-fixers were also assessed along with nitrogen-fixation rates at quarterly intervals covering all the seasons from 0900 hrs to 0900 hrs of the next day. The manurial treatments comprised pond fertilization with cowdung at 10 t/ha, poultry manure at 2 t/ha and inorganic fertilizers at 100 kg N and 50 kg P /ha/yr, along with a control and a natural swamp without any application. The nitrogen-fixation rates in terms of ARA increased during day and decreased during night hours. In general, poultry manure treatment showed higher nitrogen fixation activity than other fertilization measures. Nitrogen-fixation rates in terms of ARA in the water medium of the ponds during diel studies were in the ranges of 3.20-15.67, 3.09-16.47, 4.20-20.11, 3.22-20.17 and 0-16.26 n mol C₂H₄/l/hr. The nitrogen-fixation rates increased from morning till afternoon (3.72-20.11 n mol C₂H₄/l/hr) and then decreased to 1.83 n mol C₂H₄/l/hr except during February, where marginal variations were observed, with the rates increasing towards night hours. The natural swamp, showed a similar trend with increased values till afternoon (3.97-6.37 n mol C₂H₄/l/hr) and subsequently reduced towards dawn (3.67-3.81 n mol C₂H₄/l/hr). The diel variations of ARA in different treatments were significant between hours in February ($F_{6,24}=7.87$; $p<0.001$), May ($F_{6,24}=9.04$; $p<0.001$), August ($F_{6,24}=2.17$; $p<0.10$) and November ($F_{6,24}=2.80$; $p<0.05$).

BACMAP: A BIOINFORMATICS PLATFORM FOR ANALYSIS AND MANAGEMENT OF BAC RESOURCES

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Bacterial Artificial Chromosomes (BACs) are useful resource for various genomic applications, like improving genome assembly, understanding genome organization, constructing physical map, positional cloning, targeted marker development etc. Globally, a large number of BAC libraries are available, but databases and analytical tools are limited to few species. Here, we developed a state-of-the-art bioinformatics platform named ‘BACMAP’, that contains BAC database of *Clarias magur* and a web server with application software for BAC resources analyses and management to store, analyze, and visualize BAC sequences for advanced sequence analysis and functional annotation. BACMAP server enables analysis of BAC with mapping, repeat analysis, annotation and SSR information from the input of clones’ end sequences. The integrated tools of the BACMAP resource can be applied using ends’ sequences of the BAC clones of 9 species, including human, cow, rice, mouse and 5 fish species. The magur BAC database contains information on 6089 BAC ends’, where 1907 BAC clones harbour 5392 genes, 130,200 SSRs and 453,170 repeats. BACMAP is a powerful platform for researchers to analyse BAC data and aligned genome regions of 9 species. This information could be useful in genomic studies, marker development and for studying the genetic basis of traits.

THE ROLE OF FAT IN SHRIMP RESILIENCE: IMPROVED EMULSIFICATION LEADS TO IMPROVED ENZYME ACTIVITY, IMMUNE RESPONSE AND ANTIOXIDANT CAPACITY IN UNCHALLENGED AND *Vibrio* CHALLENGED SHRIMP

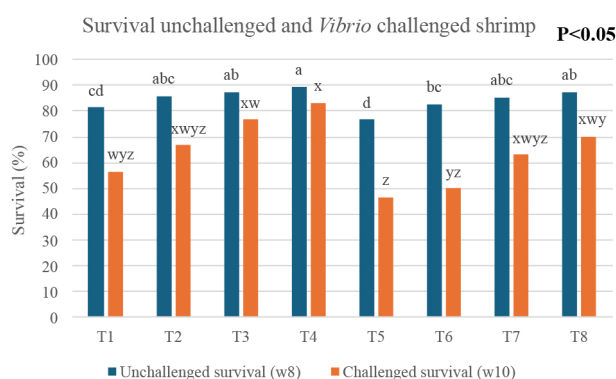
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Global shrimp farming continues to grow strongly. Asian countries such as China, India, and Vietnam were historically the leading producers. However, in recent years, Ecuador has experienced significant expansion and is now the world's largest shrimp producing country. One important factor for its success is the absence of *Vibrio parahaemolyticus* strains causing Acute Hepatopancreatic Necrosis Disease (AHPND), which has severely impacted shrimp production across Asia. AHPND remains one of the most devastating diseases in Asian shrimp farming, prompting the development of various mitigation strategies, with improved nutrition playing a key role. The use of nutritional emulsifiers may contribute to enhanced disease resilience by supporting lipid digestion, hepatopancreatic function, and overall shrimp health. This study investigates the effects of a high-hydrophile emulsifier on the health of challenged and unchallenged white-leg shrimp, in both high- and low-marine ingredient diets.

An eight-week feeding trial in juvenile *Litopenaeus vannamei* (~1 g) was conducted in a 2×4 factorial design to evaluate two diet types: high or low in marine ingredients (T1-T4 with 15% fishmeal and 1% fish oil, versus T5-T8 with 7% fishmeal and 0.5% fish oil, respectively), with per diet type four emulsifier levels (T1 & T5: 0 ppm; T2 & T6: 500 ppm; T3 & T7: 750 ppm; T4 & T8: 1000 ppm). Health was assessed via hepatopancreas lipid, glycogen, digestive enzyme activity, and immune parameters. A *Vibrio parahaemolyticus* (AHPND) challenge tested pathogen clearance. Growth, and survival were also recorded and analyzed using two-way ANOVA ($\alpha = 0.05$).

A diet low in marine ingredients significantly decreased growth performance ($P < 0.05$). Inclusion of the nutritional emulsifier significantly improved growth in both diet types, with the best results observed for 750 and 1000 ppm ($P < 0.05$). At inclusion of 750 and 1000 ppm, the emulsifier enhanced immune and antioxidant parameters, including hemocyte count, hemolymph protein, lysozyme, phenoloxidase, superoxide dismutase, and glutathione activity ($P < 0.05$). Digestive enzyme activities (lipase, amylase, and trypsin) were also increased significantly by addition of the nutritional emulsifier ($P < 0.05$). Collectively, these improvements resulted in higher survival and greater disease resilience in both challenged and unchallenged shrimp ($P < 0.05$; Figure 1). Additionally, the bacterial count in the hepatopancreas was significantly lower in shrimp fed emulsifier-supplemented diets ($P < 0.05$). The use of a nutritional emulsifier at 750–1000 ppm can play an important role in increasing the productivity and resilience of the global shrimp sector.



EVOLVING FISHERIES EDUCATION LANDSCAPE OF INDIA THROUGH THE LENSES OF ICAR DEANS' COMMITTEES

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Fisheries education in India has undergone a sea-change in the last three decades. At the same time, the sector has seen unprecedented growth in terms of resources, production, productivity, employment and exports. The present study looked at the restructuring of undergraduate course curriculum in Fisheries Science contemplated by Deans' Committees (DCs) constituted by the Indian Council of Agricultural Research. The recommendations of the 3rd (1995), 4th (2006), 5th (2017) and 6th (2024) Deans' Committees (DCs) were systematically analysed with reference to the prescribed courses and credit hours. The analysis involved compilation and tabulation of discipline-wise and semester-wise course structures, followed by a comparative assessment across the four Committees to identify similarities, changes and emerging trends in curriculum design and credit allocation. There were 60 core courses during 3rd DC with 130 credits, which were restructured/ abridged/ repealed to 47 courses with same credits during 4th DC. This phase (3rd to 4th DC) witnessed a significant increase in credits in the 'aquaculture' discipline from 13.1 to 24.6% with the concurrent increase in the number of courses from 7 to 12. Similarly, 'aquatic environment' also received more importance. The 5th DC could be considered as a milestone as it streamlined disciplines (departments) and the courses within them. It increased and renamed number of departments from five (*viz.*, Basic sciences and humanities, Fisheries resources and management, Aquaculture, Aquatic environment, and Harvest and post-harvest technology) in 4th DC to seven (*viz.*, Fisheries extension, economics and statistics, Fisheries resources and management, Aquaculture, Aquatic environment management, Aquatic animal health management, Fish processing technology, and Fisheries engineering) in 5th DC with concomitant increase in core credits (from 130 to 140) and number of courses (from 47 to 59). The most recent 6th DC further restructured/ added several courses to address and prepare the graduates for future challenges. Further, the addition of compulsory non-credit courses (*i.e.*, MOOCs/ SWAYAM), multidisciplinary courses, value-added/ ability/ skill enhancement courses were introduced to assist the students for self-employment or to make them industry-ready as well as to implement recommendations of NEP 2020 in agri-education. This paper will also provide insight into selected indicators of growth in the fisheries sector juxtaposed to recommendations of Deans' Committees over the last three decades.

INNOVATIVE WAY TO DELIVER ORAL PROBIOTICS: EXAMPLES FROM ASIA AND ECUADOR

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Effective microbial management is essential for successful shrimp farming and involves biosecurity, feed and water management, and microbial product application.

Gut microbiota plays a key role in nutrient absorption, immunity, and disease resistance. Studies show differences in gut microbes between healthy shrimp and those with diseases like AHPND or EHP, but the complex relationship between environment, pathogens, and microbiota is not fully understood. Probiotics can enhance gut health, digestion, and immunity, and are delivered via water, feed, or non-nutritional methods. *Bacillus*-based probiotics were shown to improve shrimp survival during laboratory vibrio challenge test (de la Peña et al., 2024; Hostins et al.).

An important point to consider is the reduced appetite of shrimp under stressful conditions, i.e. environment or disease. Maintaining a healthy microflora or reducing the risk of the pathogen becoming dominant in the microbiome is difficult when the shrimp stops eating. When shrimp are not feeding properly, the effectiveness of probiotics is greatly diminished because the probiotics must be ingested in adequate amounts to have a positive impact, and without proper feed intake, their delivery becomes increasingly difficult. Furthermore, the higher the number of active *Bacillus* cells delivered to the shrimp, the stronger the effect on the growth, survival, and immune parameters (Omar et al., 2024).

Innovative modes of delivery must be used, stimulating the shrimp to ingest despite their reduced appetite. Besides adjusting farming protocols and probiotic application, another alternative to face such challenge is to deliver the probiotics in a non-feed matrix which might be complementary to feed but especially formulated targeting high attractability and the grazing behaviour of shrimp. By aligning nutritional and behavioural aspects, we can create a powerful tool to bring probiotics to the shrimp gut, modulating the microflora in a more targeted way, reducing pathogen levels in the gut and potentializing the benefits of probiotics in challenging conditions.

de la Peña et al. (2024). In vitro and in vivo evaluation of the efficacies of commercial probiotics and disinfectant against acute hepatopancreatic necrosis disease and luminescent vibriosis in *Litopenaeus vannamei*. Res. Vet. Sc., 171, 105204.

Hostins et al. (2019). Managing input C/N ratio to reduce the risk of Acute Hepatopancreatic Necrosis Disease (AHPND) outbreaks in biofloc systems—A laboratory study. Aquaculture, 508, 60-65.

Omar et al. (2024). Effects of the putative probiotics *Bacillus licheniformis*, *Bacillus pumilus*, and *Bacillus subtilis* on white leg shrimp, *Litopenaeus vannamei*, immune response, gut histology, water quality, and growth performance. Open Vet J. 14(1):144-153.

INCREASING PROBIOTIC PERFORMANCE THROUGH IMPROVED GERMINATION PROCESS

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Bacillus is the main genus in commercial probiotics and bioremediation products for tropical aquaculture. Germinated *Bacillus* produce enzymes that improve digestion and feed utilization, leading to better growth rates and feed conversion ratios. They also compete with bacterial pathogens, reducing disease risks, and maintain water quality by breaking down organic waste. This work aimed to document Sanolife *Bacillus* germination and evaluate methods to enhance it.

Material & Methods: A phase-contrast microscopy method was adapted to document the germination process. The germinant receptor genes were identified from the whole genome sequence of 3 Sanolife *Bacillus* strains. The spore receptor-associated nutrients were used to select the suitable nutrients for each strain. Nutrients mixes were designed based on the information and included in germination trials. With the information generated, a shrimp trial was carried out to evaluate effects of the selected nutrient mix and protocol of germination on shrimp performance and survival. Samples of hepatopancreas were collected to determine the molecular levels of stress and immunity gene markers.

Results: Microscopic observations revealed that 50-60% of spores had germinated into vegetative cells after 1 hour in pond water, with this figure rising to nearly 90% after 4 hours. Gene receptors were identified during the genome annotation. Based on this, 3 specific nutrient mixes of amino acids, sugars and ions were formulated and tested. 2 of these mixes improved the germination of probiotics by 16%. One mix was selected for the shrimp trial. The combination probiotic-mix led to a significant improvement in final weight and FCR (Fig. 1) and an upregulation of immune and stress related genes.

Conclusions: *Bacillus* spores are germinated and active when added to the shrimp tanks. The germination process can be optimized and boosted, leading to an improvement in performance and health status of the shrimp. These findings contribute to a constant improvement of probiotic development, always focusing on practical solutions to add value to the shrimp aquaculture industry.

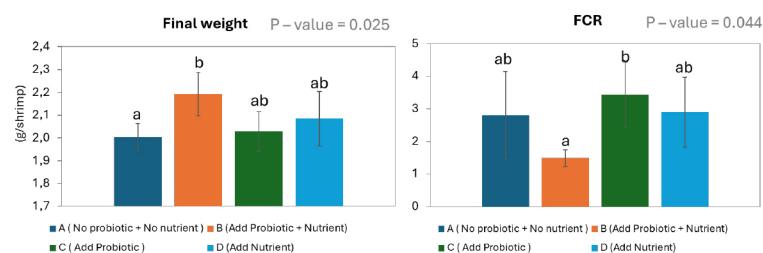


Figure 1: Final weight (g) and FCR of *P. vannamei* after treatment with probiotics and/or nutrients.

MULTI-USE IN OFFSHORE WIND FARMS – THE BELGIAN CASE FROM AN INDUSTRY PERSPECTIVE

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Offshore wind farms provide a unique opportunity to combine renewable energy production with sustainable food provision and ecosystem restoration. Belgium is pioneering this approach through integrated multi-use pilots that bring seaweed cultivation, shellfish aquaculture, and habitat enhancement into practice within offshore wind concessions, with a strong focus on industrial scalability.

Within the Horizon Europe project ULTFARMS, we developed and tested a novel submersible longline system for seaweed cultivation. The patented variable-buoyancy structure allows nets to be raised and lowered depending on hydrodynamic conditions. Trials demonstrated that submergence reduces storm impacts while still enabling robust growth of *Saccharina* and *Alaria*. We will show how these prototypes have been operated successfully at sea and how scaling scenarios indicate production potentials of 25–30 tonnes fresh weight per hectare per year with competitive CAPEX/OPEX profiles.

In parallel, acoustic monitoring of dropper lines using multibeam sonar was piloted to quantify mussel biomass and gear condition in real time. The first trials delivered reliable estimates of biomass accumulation and structural integrity under offshore conditions. These results demonstrate the potential of acoustic monitoring to support the operational management of shellfish culture, and we will show how this approach is being advanced toward practical application at larger scale.

Finally, through the Reefcovery and Horizon Europe Blue Connect projects, we have successfully settled the European flat oyster (*Ostrea edulis*) on rock substrates in hatchery and mobile on-land systems. These trials show that spat-on-substrate production is feasible at scale, and we are now preparing deployment on wind farm scour protection and cable crossings. We will present how these first steps are being translated into practical pathways for large-scale offshore restoration in collaboration with industry.

Together, these advances show how offshore wind farms can be transformed into multi-use platforms, generating renewable energy, seafood, and restored marine ecosystems. The Belgian case demonstrates that with technological innovation, monitoring integration, and industry partnerships, industrial-scale offshore multi-use is moving from concept to practice.

Acknowledgement



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GLOBAL *Artemia* GENE BANKS: COLLABORATIVE EFFORTS BETWEEN THE ASIAN REGIONAL *Artemia* REFERENCE CENTER AND THE *Artemia* REFERENCE CENTER, GHENT UNIVERSITY

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Artemia is the most widely used live feed in aquaculture and one of the best-studied model organisms for aquaculture research. Safeguarding its biodiversity is of great importance for both research and the aquaculture industry. To this end, two complementary *Artemia* gene banks have been established in Asia and Europe.

The Asian Regional *Artemia* Reference Center (AR-ARC), located at Tianjin University of Science and Technology, maintains more than 300 population samples from across China and Central Asia. These collections include native and introduced strains, cryopreserved and vacuum-packed, and are characterized through cyst quality traits, nutritional profiles, mitochondrial and nuclear DNA sequencing, and SNP fingerprinting. This resource provides a solid foundation for *Artemia* conservation, genetic research, and aquaculture application.

The *Artemia* Reference Center (ARC) at Ghent University hosts one of the longest-standing *Artemia* collections worldwide, established over four decades ago. It includes extensive strain archives, selective breeding lines, and ecological datasets. ARC has contributed significantly to *Artemia* research in live feed production, microbial management, nutrition, bioassays, and molecular conservation approaches, including gene databanking.

This joint initiative between AR-ARC and ARC illustrates the value of international collaboration to safeguard *Artemia* biodiversity. Integrating the databases and expertise of both centers will not only protect *Artemia* resources but also ensure sustainable access to high-quality live feed for aquaculture development worldwide.

STRUCTURE, DYNAMICS, AND WATER TRANSPORT MECHANISMS OF AQUAPORIN14 FROM EURYHALINE TELEOST *Tenualosa ilisha*: INSIGHTS FROM MICROSECOND SIMULATIONS IN LIPID BILAYER

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Aquaporin-14 (AQP14) is a newly discovered member of the aquaglyceroporin family, believed to transport both water and small solutes. Its detection in euryhaline teleosts such as *Tenualosa ilisha*—a species known for dramatic migrations between freshwater and seawater—implies a significant function in maintaining ionic and osmotic balance. However, the detailed structural and mechanistic insights of AQP14 remain largely unexplored at the atomic level. This study leverages extensive all-atom molecular dynamics simulations to elucidate the structure, dynamics, and function of AQP14 from *T. ilisha* embedded in a physiologically representative phospholipid membrane. A robust homology and AlphaFold3 derived models of *Ti*AQP14 was constructed and simulated for over one microsecond in a hydrated bilayer comprised of 1-palmitoyl-2-oleoyl-sn-glycero-3-phosphocholine (POPC) and cholesterol. Our simulations reveal a canonical aquaporin fold but identify unique structural features within the extracellular loops and the aromatic/arginine (ar/R) selectivity filter that distinguish it from homologous mammalian aquaglyceroporins. Analysis of the permeation events confirms the channel's primary function as an efficient water transporter, while the composition and dynamics of the ar/R constriction region suggest a potential for glycerol permeability. Furthermore, we observed key inter-helix interactions and intracellular loop dynamics that contribute to the stability and potential regulatory mechanism of the channel. These findings provide fundamental insights into the molecular basis of solute selectivity and transport in piscine AQP14, offering a crucial step towards understanding its contribution to the extraordinary osmoregulatory capabilities of Hilsa shad. Altogether our work establishes a structural platform for exploration of molecular basis for the exceptional osmoregulatory agility seen in Hilsa shad, and underscores the evolutionary conservation and regulatory complexity of AQP14 in teleosts.

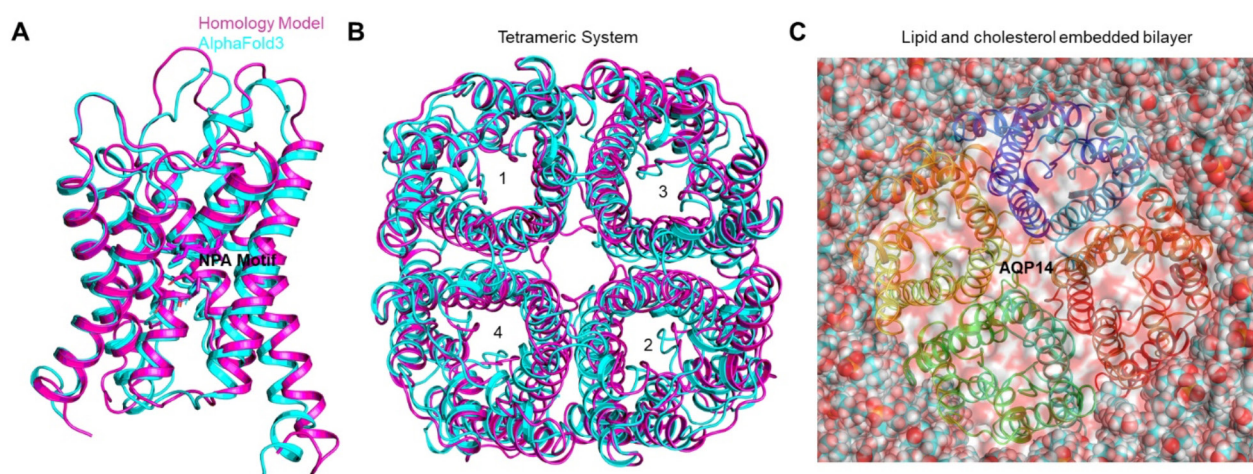


Figure 1. The three-dimensional modelled architecture of Aquaporin14 from Hilsa shad using homology modelling and AlphaFold3.

HORIZONTAL TRANSMISSION OF VIRULENCE AND ANTIBIOTIC RESISTANCE IN *Vibrio harveyi* FROM THE SOUTH CHINA SEA: MECHANISMS AND IMPLICATIONS

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Vibriosis is a global threat to aquaculture, with *Vibrio harveyi* being the most significant pathogen of marine fish in the South China Sea, accounting for up to 60% of vibriosis cases. The presence of various virulence genes (VGs) and antibiotic resistance genes (ARGs) complicates disease prevention and control. Horizontal gene transfer (HGT) enables rapid acquisition of VGs and ARGs, facilitating genetic information exchange within and between species, and even among probiotics, posing severe risks to environmental safety, food safety, and human health. Controlling the HGT of VGs and ARGs is crucial for sustainable aquaculture.

Our study focused on potential *Vibrio harveyi* pathogens isolated from infected marine fish in the South China Sea and investigated three key areas: evaluating HGT of VGs and ARGs in *Vibrio harveyi*, analyzing environmental factors influencing HGT, and elucidating molecular regulatory mechanisms of HGT. Results indicated that *Vibrio harveyi* can acquire atypical VGs through HGT from other *Vibrio* species, enhancing its virulence and host range. Additionally, *Vibrio harveyi* spreads ARGs and VGs via mobile genetic elements (MGEs) like pAQU plasmid and integrases. Environmental stresses such as temperature, pH, SDS, and EtOH significantly boost conjugation efficiency. TfoX promotes while BsuB I-R inhibits the acquisition of foreign plasmids by *Vibrio harveyi*, likely by facilitating transmembrane transport and shearing of foreign plasmids, respectively.

These findings enhance our understanding of *Vibrio harveyi*’s pathogenicity and antibiotic resistance transmission, providing scientific foundations for developing technologies to block conjugation-transfer processes. This approach aims to establish a disease control strategy based on preventing conjugation-transfer, effectively “masking” bacteria to curb the spread of harmful genes.

TABLE 1 Distribution of virulence factor genes

Typical virulence genes	% (n)	Atypical virulence genes	% (n)
cqsS	38.32 (41)	toxR _{vc}	28.04 (30)
luxN	54.21 (58)	hlyA	15.89 (17)
luxP	71.96 (77)	flaC	83.18 (89)
ahpA	85.98 (92)	tdh	8.41 (9)
Vhh	90.65 (97)	trh	0 (0)
Hflk	84.11 (90)	vvh	63.55 (68)
luxR	94.39 (101)	AtyAVG (n)*	1.99 ± 0.10
chiA	95.33 (102)	AtyAVG (n)/HN	2.30 ± 0.20
TyAVG (n) ^b	7.15 ± 0.19	AtyAVG (n)/GD	1.70 ± 0.10
TyAVG (n)/HN	7.39 ± 0.24	P _{A_{tyAVG}} (GD vs. HN)	0.002
TyAVG (n)/GD	6.91 ± 0.28		
P _{TyAVG} (GD vs. HN)	0.137		

*Average number of atypical virulence genes in each strain.
^bAverage number of typical virulence genes in each strain.

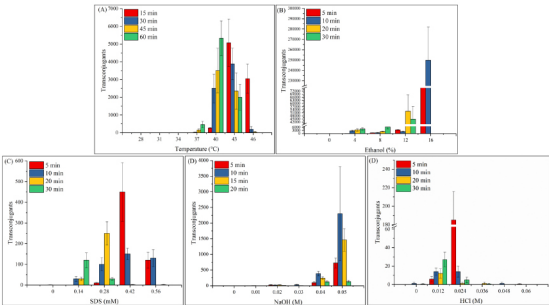


FIGURE I The induced interspecific mating ability of *V. harveyi* with exogenous stress.

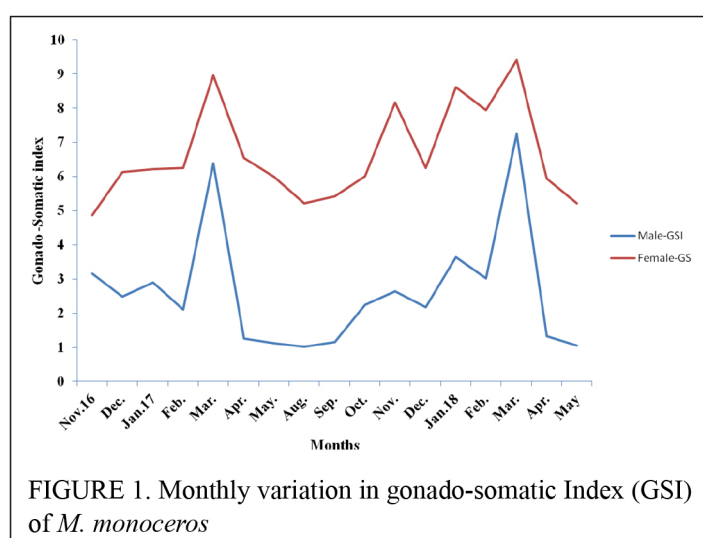
REPRODUCTIVE BIOLOGY OF SPECKLED SHRIMP *Metapenaeus monoceros* ALONG MANGALURU COAST, KARNATAKA, INDIA

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Speckled shrimp (*Metapenaeus monoceros*) represents an important shrimp in the penaeid group of crustaceans and form one of the major components of exploited marine fishery resources in Karnataka which have good domestic and export demand. The reproductive study of *M. monoceros* was carried out from November, 2016 to May, 2018. A five-stage classification for ovaries of female shrimp was adopted for describing the gross maturity stages. Based on the gross examination of gonads, microscopic observation and gonado-somatic index (GSI) the spawning season appears to extend throughout the year with peak from March to May and the secondary peak in November. The Gonado-Somatic index values for male ranged from 1.023 to 6.395, whereas for female 4.854 to 9.412. Although the peak during South-west monsoon has been observed during the course of the present study, the presence of the secondary peak is discernible in the samples obtained from Mangaluru waters. It can be conclusively inferred that *M. monoceros* breed throughout the year as evidenced by the appearance of all the maturity stages in most of the months during the study period.

The fecundity ranged from 86,251 to 4,05,264 with an average of 2,25,206 ova and observed that fecundity is in direct proportion to the total length, total weight and ovary weight. The ova diameter mode ranged from 0.0512 mm to 0.3248 mm. Studies on the size at first maturity revealed that females of the species mature at a smaller size than males. It can be concluded that speckled shrimp spawn more than once in a lifetime, since mature shrimps were seen in all the length groups from size at first maturity onwards and also throughout the season. The ovaries in the maturing and mature stages, encountered in the present study, had two widely separated groups of ova- one representing immature stock and another one maturing stock. This indicates that the spawning of individuals of the species is restricted to a short and definite period. The analysis of sex ratio indicate that females are more dominant than males in the population during almost all the months of the study period. However, during August to November 2017 the sex ratio is near to 1:1. This can be attributed to the fact that males move out of the fishing ground to the deeper water for spawning and that the breeding and fishing grounds for females is same. The results of sex ratio as analysed by Chi-square analyses for the homogeneity of sex ratio revealed that the season and sex are independent ($p < 0.05$).



DEVELOPMENT OF A FARMER CENTRIC INTERNET OF THINGS (IoT) PROTOTYPE FOR BIOFLOC AQUACULTURE MONITORING AND AUTOMATION

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The Internet of Things (IoT) holds transformative potential for aquaculture through real-time water quality monitoring, automated feeding, and data-driven farm management. Recognizing its importance, a study was undertaken to develop an IoT prototype for biofloc aquaculture system. Based on inputs from fisheries professionals and progressive fish farmers, a farmer-centred IoT system, was designed featuring threshold-based automation, offline autonomy, on-tank display and voice alerts, and an integrated mobile application. The system uses an Arduino Mega 2560 to interface with pH, TDS, temperature (DS18B20), turbidity, and water-level sensors for continuous monitoring, with live values shown on an LCD. It can continuously monitor key water quality parameters including pH (7.0–8.5), total dissolved solids (600–1500 ppm), turbidity (75–150 NTU), temperature (22–32 °C), and water level. Whenever these parameters deviate from their optimum thresholds, corrective actions can be automatically initiated: water pumps regulate inlet and outlet flow to restore water quality, heaters maintain optimal temperature, and an automatic feeder dispenses feed at scheduled intervals. Field validation demonstrated maintenance of key parameters within threshold values and timely automated responses. This IoT-enabled system is a farmer-centric solution designed for real-time monitoring, automated control, and data-driven decision-making in aquaculture. By addressing critical barriers such as cost, ease of use, and scalability, the prototype bridges the gap between technological innovation and farmer adoption. Field trials and validation were conducted at two progressive biofloc farms in Telangana Biofloc Fisheries, Shamshabad (26.4–28.9 °C; pH 7.20–7.61; TDS 1445–1481 mg/L; turbidity 83.77–89.84 NTU) and Dhana S Fisheries, Narketpally (27.3–28.3 °C; pH 8.13–8.31; TDS 1643–1703 mg/L; turbidity 81.64–82.59 NTU) with stable water levels throughout seven continuous hours per site. The prototype was also tested at ICAR-CIFE biofloc demonstration unit. Field validation has demonstrated its reliability, accuracy, and practicality for biofloc fish culture. Future IoT integration in fisheries and aquaculture needs to be up scaled to contribute to India's vision of a resilient, technology-enabled Blue Economy.

THERMAL BIOLOGY AND PLASTICITY OF METABOLIC RESPONSE OF HYBRID OF ABALONES (*Haliotis rufescens* (♀) X *H. fulgens*(♂)) AND (*H. rufescens* (♀) X *H. corrugata* (♂))

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This study determined the preferred temperature, critical threshold limits, represented by critical thermal maximum (CTMax) and critical thermal minimum (CTMin), thermal window width, and thermal metabolic scope of two hybrid of abalones *Haliotis rufescens* x *H. fulgens* (RB) and *H. rufescens* x *H. corrugata* (RP) acclimated to 18, 21, and 23°C ± 1°C. The preferred temperature was obtained for both hybrids by the gravitational method. It was not significantly different ($P < 0.05$) in the day and night cycle for both hybrids, being $22.7 \pm 1.9^\circ\text{C}$ for RB and $22.6 \pm 1.2^\circ\text{C}$ for RP.

Acclimation temperature significantly affected ($P < 0.07$). The thermal tolerance represented for CTMax and CTMin of both hybrid abalones increased with acclimation temperature. The thermal window was wider for RB (166.2°C^2) than that obtained for RP (125.5°C^2). The thermal metabolic scope obtained for RB hybrid had a mean value of $262.2 \text{ mg O}_2 \text{ h}^{-1} \text{ kg}^{-1} \text{ w.w.}$ and for RP was $191.4 \text{ mg O}_2 \text{ h}^{-1} \text{ kg}^{-1} \text{ w.w.}$ with a range of optimal physiological performance that closely matches the environmental conditions where it can be farmed. Therefore, the highest value of the thermal aerobic scopes corresponded to the intervals of the preferred temperature obtained for both hybrid abalones. These results may partially explain their distribution pattern, as well as their aquaculture potential in temperate regions.

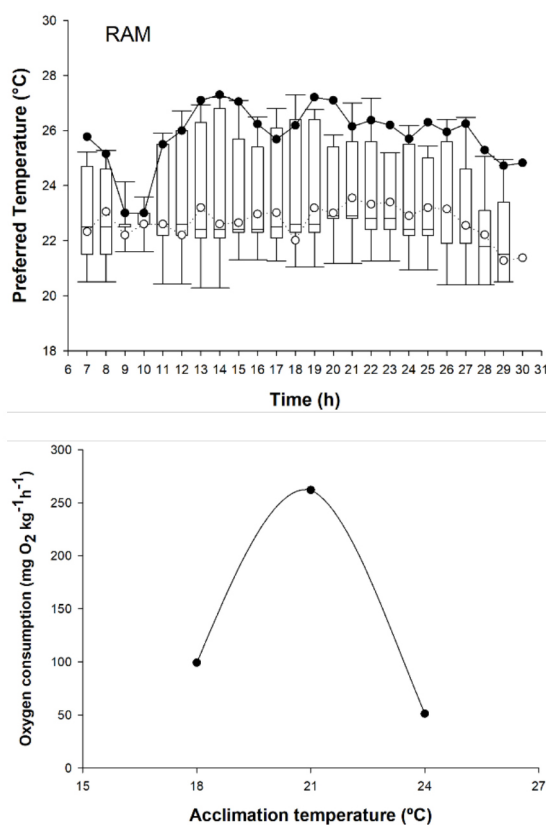


Figure 1. Preferred temperature and thermal metabolic scope of hybrid abalone *Haliotis rufescens* x *H. fulgens*.

ENSURING ENVIRONMENTAL COMPLIANCE IN AQUACULTURE: A RETROSPECTIVE REVIEW OF COMPLIANT PROJECTS IN GHANA'S LOWER VOLTA BASIN

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Ghana's aquaculture sector has experienced fluctuating growth patterns over the past decade, primarily due to the mitigating effects of the COVID-19 pandemic and outbreaks of the Infectious Spleen and Kidney Necrosis Virus (ISKNV) disease. Nevertheless, cage culture remains a significant contributor to the country's overall fish production, with Lake Volta alone accounting for over 80% of Ghana's annual farmed fish output. However, this intensive activity, if not properly managed, may result in adverse human health and environmental impacts; hence, the need to ensure that operations comply with the provisions of Ghana's environmental laws.

This will ensure sustainable growth, minimize environmental degradation, and safeguard public health by controlling practices like waste discharge, disease management, and chemical use.

This paper reviews aquaculture projects in the Lower Volta Basin that were duly registered with the Environmental Protection Authority and have operated in compliance with the Environmental Assessment Regulations, 1999 (LI 1652) and other statutory requirements since 2015. The paper will analyze trends in the number of compliant aquaculture projects in the study area and present key findings from compliance monitoring efforts. Recommendations will highlight issues hindering environmental compliance for regulators, informing policy development.

CRUSTACEAN VIROME AND THE DISCOVERY AND RESPONSE TO NOVEL VIRUSES

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Crustaceans, pivotal in marine ecosystems and global diets. However, our understanding of the diversity and evolution of viruses in crustaceans is still limited. Here, we collected 249 batches of crustaceans, including 20 species, from six continents, 21 countries, and over 100 geographic locations worldwide from 1977 to 2021. We identified 145 RNA viruses, 124 of which were divergent from known viruses. These were categorized into 18 viral families and three unclassified groups, often clustering with viruses identified from invertebrates. Notably, many crustacean viruses showed close ties to those infecting different species within the same ecological niche. In addition, the genome structures of the newly discovered viruses exhibited remarkable diversity. These findings provide novel insights into the diversity of viruses in crustaceans and offer essential data for understanding the prevalence and risk of viruses in the global aquaculture industry.

SUSTAINABLE, RESILIENT AND PRODUCTIVE AQUACULTURE: INTELLIGENT DECISION SUPPORT PLATFORM FOR BIOSECURITY MANAGEMENT

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Aquaculture is facing increasing pressure from environmental challenges, diseases, and the demand for higher production. In the face of these growing challenges, effective biosecurity management plays essential role as intensive production practices causes increased biosecurity risks. Aquaculture biosecurity management is a key concept to prevent and control diseases and to maintain a good environment in aquaculture production systems. It consists of practices that minimize the risk of introduction and spread of an infectious disease. A robust biosecurity system helps in maintaining the health of aquaculture stocks, preventing the spread of diseases, and ensuring the overall quality of the output. In the era of Big Data and AI, various digital technologies have emerged to offer potentials of smart biosecurity management based on better control of water quality, feeding and disease. A main challenge for the successful and wide adoption of effective smart aquaculture technologies is the lack of an integrated approach for effective biosecurity management decision support systems to assist farmers. For example, there is a lack of capability to accurately predict how water condition is affected by the environment condition, management practice and the growth of cultured species in time for precision control of production condition and disease prevention. This research proposes a framework (see below) for the development and integration of biosecurity intelligent decision support toolkits, IoT sensors, AI-driven biosecurity system modelling, and cloud-based data analytics to optimize aquaculture biosecurity measures and decision support. The proposed system also involves using novel physiologically-based modelling techniques.

BEHAVIORAL ALTERATIONS AND HISTOLOGICAL CHANGES IN THE GILL AND LIVER OF JUVENILE *Clarias gariepinus* FOLLOWING ACUTE EXPOSURE TO *Justicia extensa* LEAF AQUEOUS EXTRACT

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Justicia extensa is an ichthyotoxic plant extensively used to stun fish by artisanal fisher folks in south-south Nigeria. The effect of aqueous extract of this plant leaf was investigated on behavior and histology of juvenile *Clarias gariepinus*. The plant leaf extract was administered to the fish specimens at different acute doses (0, 25, 35, 45, and 60 mg/L) for 96 hours. During this time, the grouped animals' behavioral and histological (liver, gill) changes were evaluated. Based on our findings, the 96-hour LC₅₀ value of 46.59 mg/L was obtained. The study also showed that, with the exception of temperature, the plant influenced the test media's water quality parameters in a concentration-dependent manner. After 96 hours of exposure, *J. extensa* caused gill (necrosis, hyperplasia and hypertrophy of secondary lamella, mucous secretion, cartilaginous core and cellular degeneration) and liver (central vein congestion, coagulation necrosis, sinusoidal spaces dilation and inflammatory cells infiltration) histological abnormalities as well as noticeable behavioral aberrations (air gulping, abnormal opercula ventilation, loss of equilibrium, erratic swimming, sluggish movement and change in skin color) in *C. gariepinus*. Therefore, caution should be applied in the use of *J. extensa* to avert possible disaster in the aquatic ecosystem.

UNVEILING THE POTENTIAL OF BRACKISH SALMON SMOLT EFFLUENT FOR LETTUCE PRODUCTION: A COMPARISON BETWEEN AQUAPONICS AND HYDROPONICS

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Water salinity in salmon smolt operations using recirculating aquaculture systems (RAS) often ranges from 2 to 5 ppt to minimise disease and water quality issues. However, the sodium content in effluent can limit its reuse in aquaponics due to negative impacts on plant growth. This experiment tested mineral supplementation strategies to balance nutrients, mitigate sodium toxicity, and enhance plant performance in a decoupled aquaponics setting.

Four treatments (three replicates each) were applied: control, 0 ppt using hydroponics (HYD); ~5 ppt salmon effluent without supplementation (SAL); ~5 ppt salmon effluent + commercial liquid fertiliser blends (SAL+C); and ~5 ppt salmon effluent + precision supplementation with individual agriculture-grade fertilisers (SAL+P). Nutrient film technique (NFT) units (1.6 m², 100 L reservoir) were stocked with 26 lettuce seedlings at 16.5 plants/m². Salmon effluent was sourced twice from RAS smolt production and used in two consecutive crops of 22 days each, totalling 44 days. Water quality and nutrient profiles were monitored.

Both supplementation strategies at 5 ppt (SAL+C and SAL+P) significantly improved lettuce wet weight, length, and productivity compared with unsupplemented salmon effluent (SAL) ($P < 0.05$). Plant greenness (SPAD) and visual quality also increased with supplementation. The 0 ppt hydroponic control (HYD) outperformed all treatments in most parameters, except SPAD and plant quality. These results demonstrate that, with appropriate mineral supplementation, brackish RAS effluent from smolt production can be effectively upcycled to produce high-value, high-quality plants in a decoupled aquaponics system.



Figure 1 – Pilot-scale RAS smolt production and the experimental set up

FROM FOOD WASTE TO FISH AND GREENS: EXPLORING ALTERNATIVE FEEDS IN JADE PERCH (*Scortum barcoo*) AQUACULTURE VIA DECOUPLED AQUAPONICS

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Especially from a circular economy perspective, food waste has gained increasing attention in recent years as an alternative feed ingredient for several animal protein industries, including aquaculture. Positive results have been reported in different farmed fish species; however, the impact of effluents derived from food waste and non-fish meal alternative feeds on plant production in aquaponics remains unknown. This experiment evaluated three different feeds in the culture of Jade perch juveniles within a decoupled aquaponics system. Twelve individual aquaponics units were used, each consisting of a 240 L fish tank, 60 L clarifier, 40 L biological filter/sump, and a 320 L plant tank with a floating raft system. Three feeds were tested in triplicate: a fish meal-based diet (control), a non-fish meal diet (canola and poultry meal-based), and a food waste-based diet. A hydroponic treatment (no fish) was also included for comparison of plant production (27 days, single crop). Each experimental unit (except the hydroponics treatment) was stocked with twenty Jade perch juveniles (~20 g initial weight) and eighteen lettuce seedlings (~9 cm initial height), resulting in stocking densities of 83 fish/m³ and 19 plants/m², respectively. Plants were stocked three weeks after fish introduction to allow nutrient buildup in the water. Key water quality parameters were monitored throughout the trial. After 48 days of culture, 100% fish survival was observed across all treatments. Jade perch fed the fish meal (control) and non-fish meal diets showed similar performance ($P > 0.05$), with an average weight gain of ~54 g. Fish fed the food waste-based diet showed significantly lower weight gain (20% reduction; $P < 0.05$), with a similar trend in feed intake and FCR. Carcass yield was significantly lower in the non-fish meal group ($P < 0.05$), which also exhibited higher body fat content. For plant production, no significant differences were observed among treatments in SPAD values, total biomass, or aerial wet weight ($P > 0.05$). This experiment demonstrated that it is possible to cultivate Jade perch using food waste-based feeds while achieving comparable plant production. Although economically promising, further refinement of non-fish meal and food waste-based feed formulations is needed to optimise fish growth performance and carcass yield.

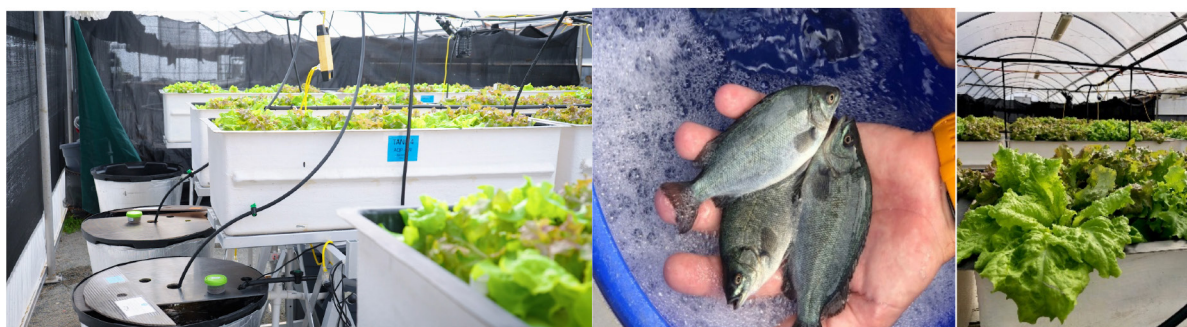


Figure 1 – Experimental set up, and fish and plant produced in a decouple aquaponics settings.

BIOFLOC TECHNOLOGY IN AQUACULTURE: WHAT GOES RIGHT, WHAT GOES WRONG?

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Biofloc technology (BFT) has grown and evolved quickly in the last few years, especially as a means to increase biosecurity, prevent disease outbreaks and mass mortalities, and increase farm productivity. However, during the evolution of BFT, the expected results were not always achieved, and commercial adoption around the world fluctuated vastly. From euphoria to disbelief, several fish and shrimp farmers who adopted BFT switched back to traditional production systems, with several factors influencing their decision-making. For those farmers who adapted and evolved, BFT provided and still promotes several farming and competitive advantages. However, for those who are struggling or have already switched back to conventional systems, challenges may include higher running costs, pathogen and waste (i.e. effluent, suspended solids, and sludge) management issues, lack of understanding of operational/aquatic/microbial dynamics, among others.

This paper discusses what goes right and what goes wrong in the recent biofloc-based context and highlights that, with further education, training, innovation adoption, and R&D, these challenges can often be overcome, and BFT could become a more widely understood and adopted technique. With a balanced approach, BFT can offset investments with improved yield, FCR, survival, and product quality, and de-risk farming operations, especially in areas prone to disease outbreaks.



Figure 1 – Biofloc technology deployed in commercial aquaculture farms

LOW-COST ROPE BED BIOFILM REACTOR FOR ENHANCED NITRIFICATION AND PRODUCTIVITY IN AQUAPONICS SYSTEMS

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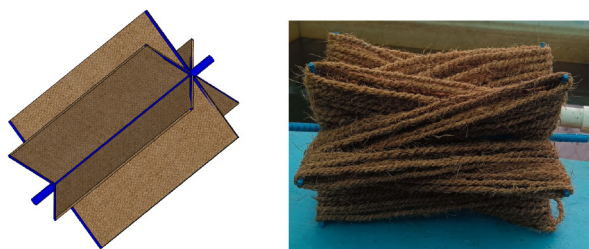
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Aquaponics represents a sustainable and resource-efficient approach to integrated fish and crop production; however, its productivity and long-term stability are often limited by the accumulation of ammonia and the inefficiency of nitrification, which compromise water quality, fish health, and plant performance. Conventional biofiltration systems are often expensive and inaccessible to smallholder farmers, underscoring the need for low-cost, scalable alternatives. Rope bed biofilm reactors (RBBRs) have been explored in wastewater treatment but remain underexplored in aquaponics applications. This study, therefore, aimed to design, fabricate, and evaluate a low-cost RBBR using jute ropes as biomedial, with a focus on enhancing nitrification efficiency and overall system performance. The experimental system consisted of a 20-litre reactor (14-litre of working volume) integrated into a recirculating aquaponics setup containing Nile tilapia (*Oreochromis niloticus*) and insulin plants (*Costus igneus*). The RBBR was operated at different flow rates to achieve variable hydraulic retention times (HRTs). Trials were conducted for 45 days in three replications, with systematic monitoring of key operational parameters including water temperature, pH, dissolved oxygen, chemical oxygen demand (COD), ammonia, nitrate, alkalinity, turbidity, as well as fish growth and plant biomass accumulation.

The RBBR demonstrated substantial improvements in water quality and system stability compared to the control. Ammonia removal efficiency reached 70% within a 6-hour HRT, while in the control setup, ammonia levels continued to rise, indicating poor nitrification. Turbidity levels were reduced to 32 NTU compared to 65 NTU in the control, which minimized sludge deposition and maintained cleaner plant beds. Enhanced biological filtration and effective ammonia conversion led to improvements of more than 40% in plant growth and fish performance compared with the control system. The findings indicate that the RBBR is an economical, scalable, and effective approach for enhancing nitrification efficiency, water quality, and the productivity of aquaponics fish and plants. The reactor addresses a significant issue in recirculating aquaculture by reducing ammonia levels, turbidity, and enhancing biological stability. The fundamental design, utilisation of low-cost locally available bio media makes it adaptable for resource-constrained small farmers.

Fig 1. CAD model and fabricated design of rope bed bioreactor



APPLICATION AND BENEFITS OF VIBRIO-FREE ARTEMIA USE IN HATCHERY AND NURSERY PRODUCTION

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Pathogenic *Vibrio* are a common problem in hatchery and nursery production of Penaeid shrimp. *Vibrio* species are ubiquitous in the marine environment and the rise in sea temperature due to climate change has resulted in increased incidence of *Vibrio* globally.

Live and fresh feeds are notorious for being a source of *Vibrio* contamination. Maturation feeds such as polychaetes and squid, are well known to be source of *Vibrio* contamination into the hatchery via the broodstock and nauplii. Mass culture of algae in outdoor tanks is also a significant source of contamination.

Artemia cysts have a low bacterial load but the release of nutrients such as glycerol during the hatching process provides an ideal medium for opportunistic bacteria, including *V. parahaemolyticus*, *V. harveyi*, *V. campbellii*, and *V. alginolyticus*. The newly hatched Artemia are highly susceptible to contamination with these *Vibrio* and can transmit them to the shrimp. Basic washing and disinfection of the nauplii post-harvest have limited effectiveness as the *Vibrio* attach to the chitin of the Artemia exoskeleton.

The production of *Vibrio*-free Artemia requires specific disinfection regimes to eliminate *Vibrio* and other pathogens during the entire hatching, harvesting and post-harvest process. Use of *Vibrio*-free Artemia not only reduces the risk of transmission of pathogenic strains but provides additional benefits in terms of larval growth and health.

The application of enriched, *Vibrio*-free Artemia Instar 2 can also provide significant benefits for PL growth and health, especially during the PL stages. Recent research work shows that feeding enriched, *Vibrio*-free Instar 2 not only results in improved PL growth and health but also reduces the mortality of PL following a challenge with AHPND. Field trials feeding enriched Artemia for several days during the nursery or post-stocking in farms suggest that the benefits can be maintained right through to harvest.

LIMITING *Enterocytozoon hepatopenaei* (EHP) EFFECTS USING PLANT BASED ADDITIVE AS A PREVENTIVE TREATMENT IN SHRIMP (*Litopenaeus vannamei*)

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Enterocytozoon hepatopenaei (EHP) is one of the major threats to shrimp farming in South East Asia. Its life cycle, includes a spore phase which makes it particularly challenging to control and eradicate.

After screening various plant molecules with potential effect on EHP sporulation, TECHNA designed an additive called EHPROTECT that prevent spore germination, thus reducing severity and occurrence of EHP outbreaks.

A challenge trial was held at ShrimpVet facilities, to evaluate the effect of EHPROTECT on survival, growth and FCR of whiteleg shrimp (*Litopenaeus vannamei*). The trial comprised four treatments:

EHP was collected from infected shrimp, standardized to create an inoculum, and coated onto the shrimp feeds after pelletization. The feed's EHP load was monitored to ensure exposure. EHP counts ranged from 1.7×10^6 to 5.44×10^6 spores. EHPROTECT was mixed with other ingredients during feed manufacturing. Trial was divided into 3 phases: 14 days pre challenge where shrimp consumed the additive followed by a 7 day challenge phase where treatments 2,3 and 4 received EHP spores through the feed and finally a 28 days observation phase to see the effects of EHP spore infection on shrimp survival and performances.

Each treatment was composed of six replicate groups of 50 shrimp (mean initial weight: 1.59g), maintained in 250 L tanks at a temperature of $27.9 \pm 0.25^\circ\text{C}$.

The results showed a strong effect of EHP infection on all parameters, with a final survival lowered from 92% down to 71.7%, a FCR increased from 1.31 to 3.66 and a final weight almost divided by 2 (15.4 vs 7.9g).

The inclusion of EHPROTECT mitigated the negative effects of EHP during this challenge, with a final weight of 9.2 and 11.5g and a FCR of 2.13 and 1.61 for the 2 and 4kg EHPROTECT treatment respectively. Survival was also improved at 79.3 and 86.7%.

In conclusion, this trial demonstrated the efficacy of EHPROTECT in limiting the effects of EHP outbreaks in challenge conditions. Positive effects were also seen on various farms in India, showing EHPROTECT as a promising solution against EHP.

Treatment	Challenge	EHPROTECT
1-Negative Control	No	No
2-Positive Control	Yes	No
3-EHPROTECT 2kg	Yes	2kg/MT
4-EHPROTECT 4kg	Yes	4kg/MT

Table 1: treatment groups of the trial

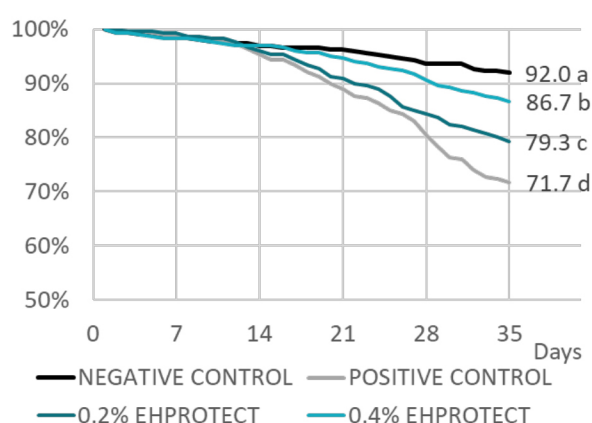


Figure 1. Survival of different treatments during this trial (challenged or not) and treated with different EHPROTECT doses

NURSERY AND GROWOUT PERFORMANCE OF HATCHERY PRODUCED *Scylla olivacea* - A STEP TOWARDS SUSTAINABLE MUD CRAB FARMING

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Mud crabs are a valuable crustacean resource in brackishwater aquaculture due to their high export demand. Recently, the market preference for mature female *Scylla olivacea* has increased. However, issues like cannibalism, dependence on wild seed and lack of formulated feed, etc. limit the scale of farming. In this context the feasibility of nursery rearing for crablet production and growout with formulated feed was studied. Hatchery produced, *S. olivacea* with 0.5-1 g body weight was stocked into earthen ponds at different stocking density viz; T1-5, T2-10 and T3-15/m² and fed with minced trash fish @ 10% of the bodyweight twice daily.

After 80 days, crabs attained a carapace width and bodyweight ranging from 34.07 ± 0.78 to 45.13 ± 1.36 mm and 7.91 ± 1.29 to 17.14 ± 1.22 g respectively with significantly higher growth in T3 (15/m²). However, survival remained low (20-30 %) across different stocking density. Appendage analysis showed significantly higher intact crablets in T1 ($82.22 \pm 1.76\%$), while T3 (Intact - $61.11 \pm 4\%$) had more individuals with all appendages missing ($12.22 \pm 2.22\%$).

Further, selected nursery reared crablets (20-25 g) were stocked in grow-out ponds at 0.5/m² and reared for 150 days under two feeding regimes: trash fish (D1) and pelleted feed (D2, 40% CP). Crabs attained an average body weight in the range of 102.92 to 210 g combining the females and males with no significant difference between diets, confirming the ability to utilize pelleted feed. Female crabs reached 80–120 g within 80 days, after which growth slowed, while constant growth in males were observed. Female crabs attaining a marketable size of 80-120 g within a period of 80 days is beneficial which can support the supply to box based fattening system. However, survival during the nursery phase needs further refinement to enable commercial-scale crablet production (Figure 2).

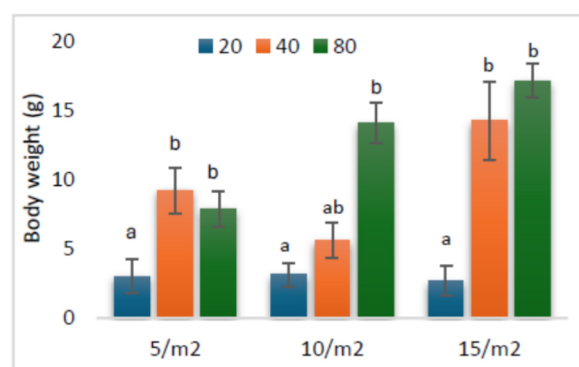


Figure 1. Growth of mud crab instar at different stocking density. Different alphabet within a culture duration depicts significant difference (n=30).

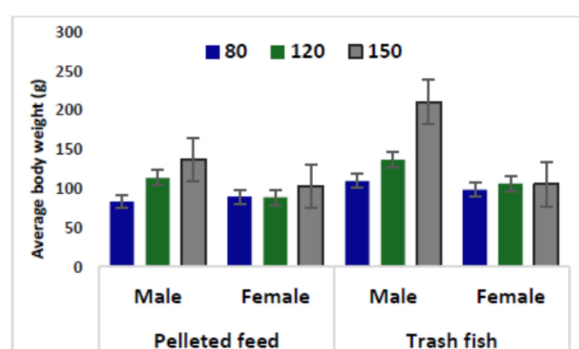


Figure 2. Growth of male and female *S. olivacea* in earthen pond fed formulated feed and trash fish.

ALTERATIONS IN BRAIN PROTEOMIC PROFILE ON CHRONIC EXPOSURE TO TRICLOSAN ON *Labeo catla*

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Triclosan (TCS), a non-antibiotic antimicrobial agent commonly found in personal care, household, and healthcare items, has become a growing concern due to its impact on aquatic organisms. While previous research has examined TCS toxicity in aquatic species, its effects on brain tissues remain insufficiently understood. In this study, we applied label-free proteomics (LC-MS/MS) to investigate the long-term influence of TCS on the brain tissue of *Labeo catla* (Catla). Fingerlings of Catla were exposed to a sublethal concentration of TCS (0.073 mg/L, equivalent to 1/10th of LC₅₀) for 30 days under controlled laboratory conditions in 50 L glass tanks (Fig 1). Post-exposure, brain tissues were collected and analyzed using LC-MS/MS. The proteomic data revealed that TCS exposure led to the up-regulation of proteins associated with motor function, neuronal development, and the semaphorin complex, while down-regulating proteins linked to myotube formation, meiotic chromosome segregation, the myosin complex, and the plasma membrane. These alterations suggest that TCS disrupts essential cellular growth mechanisms, RNA processing, and protein translation. The study identified consistently affected proteins such as actin alpha1a/1b, myosin heavy chain fast skeletal muscle, camsap1b, and plexin B1 as potential biomarkers for TCS-induced neurotoxicity, though further validation is needed. Overall, these findings emphasize the ecological and physiological risks of TCS contamination, indicating that its proteomic interference with neuronal and muscular pathways could compromise fish health and fitness in polluted environments.

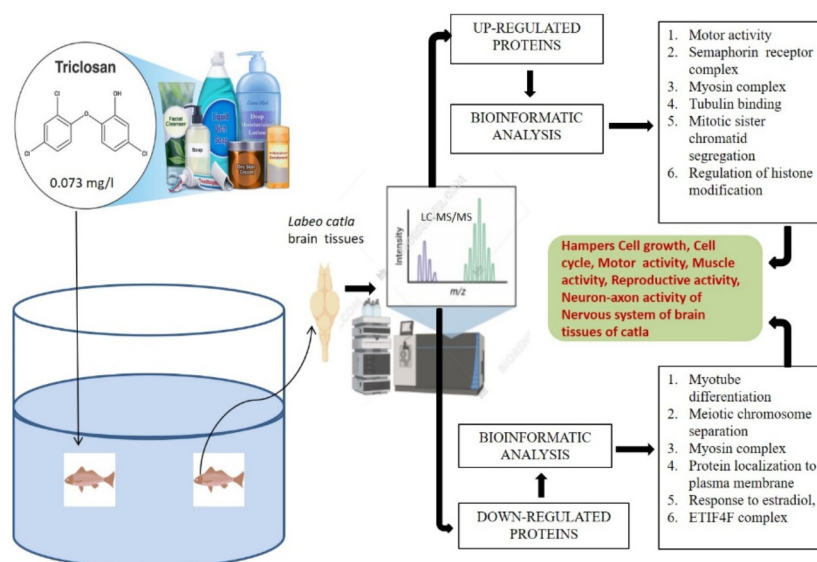


FIGURE 1: Schematic representation of the effect of chronic exposure to Triclosan on *Labeo catla*

CLIMATE CHANGE AND MITIGATION IN FISHERIES

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Climate change is one of the most pressing global challenges, and India is particularly vulnerable due to its extensive coastline, diverse ecosystems, and reliance on climate-sensitive sectors such as agriculture and fisheries. Rising temperatures, unpredictable monsoons, sea-level rise, and ocean acidification are altering the structure and functioning of marine and freshwater ecosystems, affecting fish distribution, breeding patterns, and productivity. These changes threaten the livelihoods and food security of millions of fishers and coastal communities. To address these challenges, India has implemented a comprehensive suite of scientific and policy-driven measures to mitigate and adapt to the impacts of climate change on its fisheries sector, integrating research, innovation, and governance. Under the National Action Plan on Climate Change (NAPCC), missions such as the National Mission for Sustainable Agriculture (NMSA) and the National Water Mission promote sustainable resource use and ecosystem resilience. Complementing these, the Pradhan Mantri Matsya Sampada Yojana (PMMSY) emphasizes sustainable fishing, habitat conservation, and climate-resilient aquaculture. Through the National Innovations in Climate Resilient Agriculture (NICRA) project, ICAR–CMFRI has developed upscalable climate-resilient technologies and mitigation strategies. As part of this initiative, the carbon footprint of Indian marine fisheries was scientifically quantified, revealing that India's marine fisheries emit 30% less carbon than the global average, with Indian trawlers showing 17.7% lower emissions due to improved energy efficiency and reduced fuel intensity. Comprehensive modeling approaches were conducted to assess the species environment interactions and fisheries sustainability in the Indian EEZ using species distribution models, surplus production models, and stock assessments, which identified sea surface temperature, salinity, chlorophyll, and mixed layer depth as key drivers of climate-driven variability in commercial fisheries. Integrated Multi-Trophic Aquaculture (IMTA), combining cage farming of cobia with seaweed cultivation, has been promoted to enhance environmental sustainability and economic stability by increasing carbon sequestration, diversifying income, supporting livelihoods, and enabling carbon credit opportunities. Furthermore, under PMMSY's Climate Resilient Coastal Fishermen Villages (CRCFV) program, approximately 112 coastal villages are being developed as climate-adaptive, economically sustainable hubs, with CMFRI promoting advanced mariculture technologies, including finfish cage culture, mussel and oyster farming, seaweed cultivation, and nutrient-enriched feeds, to strengthen livelihoods and community adaptive capacity. The Vulnerability Atlas of Marine Fisheries of India developed under NICRA provides a scientific framework for multi-hazard risk assessment across coastal districts using IPCC AR6 Climatic Impact-Drivers (CID). The atlas evaluates district-level exposure to cyclones, floods, heatwaves, sea-level rise, and shoreline changes, while also assessing fisher households' vulnerability. The Multi-Hazard Index (MHI), a composite measure of coastal districts' exposure to climate-induced physical hazards across India's coastline, revealed significant spatial variability, ranging from 0.18 to 0.58, with Andhra Pradesh (0.58) exhibiting the highest vulnerability, while Goa (0.24) and Sindhudurg district, Maharashtra (0.18), showed the lowest hazard severity. By integrating scientific research, technological innovation, risk assessment, and policy implementation, India is advancing toward a low-carbon, climate-resilient, and sustainable fisheries sector that safeguards both ecosystems and livelihoods in the face of climate change.

WETLANDS AS CARBON SINKS: ASSESSING THEIR ROLE IN CLIMATE CHANGE MITIGATION

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Wetlands provide a wide range of ecological and economic services to human societies. Among terrestrial ecosystems, wetland soils represent one of the largest carbon (C) sinks and play a significant role in mitigating atmospheric greenhouse gas (GHG) emissions. India is endowed with a rich diversity of wetland ecosystems that support unique and varied habitats. However, the carbon capture and sequestration potential of these wetlands remains largely unquantified.

This study aims to evaluate carbon capture from various sources and its subsequent sequestration in soil across four distinct wetlands in West Bengal, India: three closed floodplain lakes Akaipur, Kundipur, Bijpur, and an open wetland are Maniknagar. Seasonal sampling of water, macrophytes, and soil was conducted to determine primary productivity, dissolved carbon content, and carbon deposition in soils, which was then compared to adjacent reference upland sites.

All four wetlands were found to be highly productive, as indicated by the favourable physicochemical properties of both water and soil.

Carbon accumulation in the wetlands, measured up to a depth of 30cm depth, ranged from 45.36 to 105.42 Mg/ha-approximately 1.20 to 3.45 times greater than that in the corresponding upland reference sites.

These findings highlight that wetland ecosystems, are highly efficient in sequestering carbon in their soils. As such, they hold considerable potential to offset greenhouse gas emissions and contribute to climate change mitigation strategies.

Table. Primary productivity of the wetlands

Wetlands	Primary productivity (Algae)	
	Gross primary productivity (mg-C/m ³ /h)	Net primary productivity (mg-C/m ³ /h)
Maniknagar	156.25±104.0	93.75±40.12
Akaipur	750.02±252	540.12±229
Bijpur	445.51±250	255.41±198
Kundipur	438.12±147	163.74±34

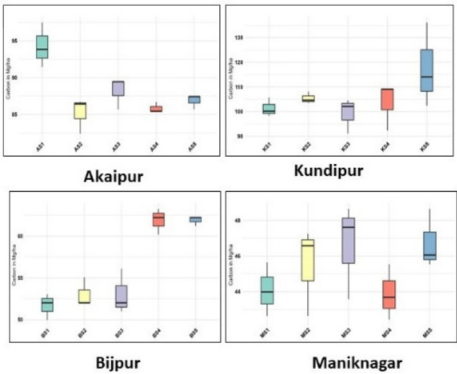


Fig. Sediment carbon content in wetlands

INDIAN MARICULTURE: THE WAY FORWARD

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India's mariculture sector offers immense potential to boost seafood production, strengthen the blue economy, and uplift coastal livelihoods. With over 11,000 km of coastline and a vast Exclusive Economic Zone, the country is well-positioned to become a global leader in marine aquaculture. Despite this, current output remains far below the estimated annual capacity of 4–8 million tonnes. ICAR-CMFRI has identified 146 cage farming sites and 24,000 hectares suitable for seaweed cultivation, while island territories like Andaman, Nicobar, and Lakshadweep provide ideal conditions for open-ocean farming.

The sector is diversifying beyond shrimp to include high-value finfish, mollusks, seaweeds, and ornamental species, supported by advancements in breeding and seed technologies. Scalable, eco-friendly models such as sea cage farming and seaweed cultivation are gaining traction, while bivalve farming in Kerala and Karnataka empowers women-led groups. Innovations like Integrated Multi-Trophic Aquaculture (IMTA) and Recirculating Aquaculture Systems (RAS) are enhancing sustainability and resource efficiency.

However, several challenges hinder growth. Inadequate infrastructure, high costs of advanced technologies, regulatory ambiguity, and environmental threats—including pollution, disease outbreaks, and climate change—limit productivity and investment. Dependence on wild-caught seed and expensive fish meal-based feed further restrict scalability. Conflicts with traditional fishing communities and limited access to credit, technology, and market data leave small-scale farmers vulnerable.

To unlock mariculture's full potential, India must invest in dedicated mariculture parks, implement the National Mariculture Policy to streamline regulations, and promote species diversification. Strengthening post-harvest infrastructure, expanding R&D for seed and feed innovation, and adopting climate-resilient practices are essential. Empowering coastal communities through financial inclusion, training, and participatory governance will ensure inclusive and sustainable development, positioning mariculture as a key pillar of India's future economic and ecological progress.

BREEDING OF GIANT TREVALLY (*Caranx ignobilis*): REFINEMENT OF BREEDING PROTOCOL AND NURSERY REARING IN NATURAL ECOSYSTEMS

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Giant Trevally (*Caranx ignobilis*) is gaining prominence as a candidate species for commercial mariculture owing to its rapid growth, adaptability, and market demand. This study reports refinement in induced breeding, larval rearing and nursery rearing (in natural conditions) of the species. Wild-caught sub-adults (50–110 g) were acclimatized and conditioned in recirculatory aquaculture systems (30–34 ppt), improving spawning efficiency and reducing stress. Induced breeding with GnRH analogues resulted in repeated spawnings, with fertilization rates refined from 64 to 92% through selective broodstock management. Larval rearing protocols incorporated copepods (*Parvocalanus crassirostris*) and microdiets, ensuring higher survival and growth. Transport of 10–15 DPH larvae using oxygen-packed containers recorded >90% survival, and nursery rearing in natural plankton-enriched tanks yielded juveniles of 2.0–2.5 cm by Day 45. These findings demonstrate the feasibility of large-scale seed production and provide a structured framework for expanding Giant Trevally farming in coastal and offshore systems, advancing sustainable mariculture practices.

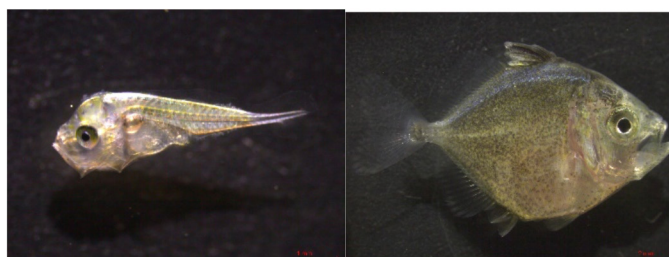


Fig.1. 11 DPH larva

Fig. 2. 20 DPH larva

GENDER MONITORING SCHEMA FOR NbCS IN AQUACULTURE

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&

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Nature Based Climate Solutions (NbCS) are being explored in various food systems including aquaculture. Projects implementing NbCS are looking at various technological and management solutions. These may have activities that are in variance to existing practices and may need capacities and skills. Monitoring such activities is crucial for successful implementation. The gender monitoring schema proposed by the GeNA project (<https://gena-project.ait.ac.th/>) is a prototype process monitoring system to be used during the implementation of development projects in NbCS aquaculture to ensure that women and other marginalized groups benefit from the project. In this process, women's roles in NbCS are documented; and any changes in gender roles and gender relations as a result of development projects is also recorded. The gender monitoring schema will consider strategies for better understanding intersectional gender concerns in context and for meaningfully engaging marginalized groups to advance gender equality, fairness, and inclusion. It will also prompt discussion on how we might monitor progress towards inclusion and equity throughout the project cycle in ways that are reflexive, ongoing, and empathetic to different actors' needs.

THE BENEFITS OF NOVEL METHANOTROPH-DERIVED PROTEIN IN SHRIMP FEEDS

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Protein remains the most expensive component of shrimp feeds, with fish meal (FM) traditionally serving as the primary source. However, rising costs and sustainability concerns have driven the search for alternative protein sources, including terrestrial animal by-products and plant-based ingredients. While plant proteins can partially replace fish meal, they often introduce anti-nutritional factors that impair feed digestibility and shrimp performance. Recent attention has shifted toward novel, high-quality, and sustainable protein sources capable of replacing FM without compromising production efficiency. One such alternative is methanotroph bacteria protein (MBP), derived from *Methylococcus capsulatus* through controlled fermentation process. MBP offers a consistent nutritional profile, high digestibility, and a markedly lower environmental footprint in terms of land use compared to other protein alternatives. Several feeding trials with *Litopenaeus vannamei* juveniles (0.3 – 1.1 g initial body weight; 7 – 8 weeks in length) have demonstrated the potential of MBP as both partial and total replacement for FM (Table 1).

The results summarised in Table 1 highlight that dietary inclusion of MBP at inclusion levels up to 15% can maintain growth and feed conversion ratios equivalent to FM-based feeds. Moreover, shrimp fed MBP exhibited enhanced gut and hepatopancreas morphology, and beneficial shifts in haemolymph biochemical parameters. Beyond performance, MBP supplementation supported oxidative stress resilience, as reflected in higher SOD and GPX activities, while also stimulating immune responses and improved survival under *Vibrio* challenges. Notably, total FM replacement with 15% MBP still yielded comparable growth while significantly increasing survival rates after pathogen exposure.

In conclusion, MBP represents a next-generation feed ingredient with the capacity to reduce dependence on marine resources, improve shrimp health, and support more resilient and responsible shrimp farming systems.

Table 1. Summary of several *L. vannamei* feeding trials, exploring MBP as an alternative protein source for FM.

Trial ID	MBP inclusion level (%)	FM replacement (%)	Performance outputs	Health indicators	Oxidative stress markers	Immune response
Chen <i>et al.</i> 2021	3.5, 7, 10.5	up to 11.25 (partial replacement)	Similar to control	mucosal folds ↑ height in gut	↑ SOD and GPX activities	↑ 50% survival 12 dpc with <i>Vibrio</i>
Jintasataporn <i>et al.</i> 2021	5, 10, 15	up to 15 (total replacement)	Similar to control	↑ secretory cells in hepatopancreas		↑30% survival 15 dpc with <i>Vibrio</i> , ↑ TP
Chen <i>et al.</i> 2022a	3.5, 7, 10.5	up to 11.25 (partial replacement)	Similar to control	↓ T-CHO, TG in hemolymph		
Chen <i>et al.</i> 2022b	1.5, 3, 4.5, 6, 7.5, 9	up to 10.7 (partial replacement)	≥ 6% MBP inclusion ↑ SGR, = FCR	↑ crude protein in whole body and muscle		↑ TP

MBP: Methanotroph bacteria protein; FM: Fish meal, SGR: Specific growth rate (%); FCR: Feed conversion ratio; dpc: days post-challenge; T-CHO: Total cholesterol (mmol/L); TG: Triglycerides (mmol/L); SOD: Superoxide dismutase (U/mg protein); GPX: Glutathione peroxidase (U/mg protein); TP: Total protein (g/L)

OPTIMIZING LIPID UTILIZATION IN SHRIMP FEEDS: DIGESTIVE ENHANCERS FOR COST-EFFICIENT FORMULATION

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Modern shrimp feed formulation demands greater flexibility and cost-efficiency without compromising growth performance and production outcomes. In recent decades, rising raw material costs have led to the reduction of key lipid nutrients, such as phospholipids, cholesterol and n-3 highly unsaturated fatty acids (HUFA), in commercial grow-out feeds. Formulating solely on minimum nutritional requirements increases the risk of underperformance due to variability in raw material composition. To address this challenge, metabolic enhancers such as lyso-phospholipids (LPL) and bile salts (BS) have emerged as promising functional feed additives. These compounds improve lipid emulsification, absorption and utilization, thereby supporting consistent growth and feed efficiency even under reduced lipid input strategies.

This presentation reviews a series of trials evaluating the use of LPL and BS in feed for *Litopenaeus vannamei*, focusing on their potential to optimize their performance quality under restricted essential lipids levels. The first trial investigated LPL in feeds with low EPA/DHA and cholesterol levels. Conducted over 7 weeks with 1 g shrimp, results showed cholesterol was more limiting than EPA/DHA, and LPL supplementation enhanced growth performance by 8% and 7%, respectively versus the negative control. Another 6-week trial with 3 g shrimp found that LPL supplementation improved growth performance by 14% and efficiency by 13% in feeds with reduced phospholipid levels (Table 1).

Regarding BS supplementation, a first 8-weeks trial with 1 g shrimp demonstrated that adding BS in feeds with restricted lipid levels restored the performance, improving by 14% growth and 16% feed efficiency compared to the negative control. A second trial with 3 g shrimp and running for 11-weeks, evaluated the partial replacement of supplemented cholesterol with BS and confirmed that BS can effectively maintain shrimp performance (Table 2). Together, these findings demonstrate the potential of digestive enhancers like LPL and BS to support nutrient utilization and production efficiency in shrimp feeds.

Table 1. Effect of LPL supplementation in shrimp feeds with restricted levels on key lipid nutrients

Treatment	Feed composition (%)				Change in performance output (%)	
	PLS	CHO	EPA/DHA	LPL	Weight gain (g)	Feed efficiency
POS	1.4	0.15	0.7	0		
NEG1	1.6	0.15	0.2	0		
NEG2	1.9	0.06	0.7	0		
TEST1	1.8	0.15	0.2	0.1	8%	0%
TEST2	1.6	0.06	0.7	0.1	7%	24%
POS	1.9	0.09	0.44	0		
NEG	0.9	0.09	0.57	0		
TEST	0.9	0.09	0.57	0.1	14%	13%

Table 2. Effect of BS supplementation in shrimp feeds with restricted levels on key lipid nutrients

Treatment	Feed composition (%)				Change in performance output (%)	
	PLS	CHO	EPA/DHA	BS	Weight gain (g)	Feed efficiency
POS	1.1	0.08	0.9	0		
NEG	0.8	0.06	0.75	0		
TEST	0.8	0.06	0.75	0.115	14%	16%
POS	1.9	0.09	0.36	0		
NEG	1.9	0.06	0.36	0		
TEST	1.9	0.075	0.36	0.075	18%	16%

POS: Positive control; NEG: Negative control; TEST: Test feed; PLS: Phospholipids; CHO: Cholesterol.

PRELIMINARY FRAMEWORK FOR FISH EMBRYO CRYOPRESERVATION AS AN EX SITU CONSERVATION TOOL

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India harbours over 3200 freshwater and marine fish species, many of which are increasingly threatened by habitat degradation, overexploitation, and climate change. In this context, the implementation of ex situ conservation strategies is critical for ensuring the sustainability of aquatic biodiversity. Embryo cryo banking offers a viable approach for long-term preservation of genetic material, thereby supporting biodiversity conservation and enabling genetic rescue through reintroduction of genetic diversity into endangered or inbred populations. However, unlike sperm banking, the major impediments in embryos cryopreservation of fish include structural complexities such as multi-compartmental structure of fish eggs, large yolk content, low membrane permeability, and high chilling sensitivity.

In current investigation, we conducted a pioneering feasibility investigation on the cryopreservation of fish embryos from carps and catfish species. Multiple embryonic stages were evaluated, and the toxicity of varying concentrations of several cryoprotectants was assessed. Key parameters investigated included embryonic developmental stage, chorion permeabilization, exposure duration and cryoprotectant concentration. Our results demonstrated that specific developmental stages exhibited increased tolerance to cryoprotectant stress and low temperature freezing. These findings provide a foundational framework for developing standardized protocols for fish embryo cryopreservation in India, with significant implications for biodiversity conservation and genetic resource management.

SPECIES AND GENETIC DIVERSITY OF *Labiobarbus* GENUS IN THE MEKONG DELTA

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Labiobarbus genus (Roberts, 1993), belongs to the family Cyprinidae. This genus is freshwater fishes, mainly distributed in several parts of Asia. Due to their morphological similarities, it can be difficult to distinguish between different species, which may result in an inaccurate assessment of species diversity. This study aims to determine the number of species and quantity of genetic diversity of the *Labiobarbus* genus in the Mekong Delta.

Seventy-five samples for morphological species identification, in which 30 samples for DNA analysis were collected in the flooding areas along the Tien and Hau Rivers, including Long An, Dong Thap, An Giang, and Can Tho. Species identification was based on morphology and DNA barcoding methods using the mitochondrial DNA cytochrome c oxidase subunit I (COI) gene.

Morphological results showed that the two species are significantly different. The phylogenetic analysis indicates that the *Labiobarbus* genus is divided into two large groups. COI sequences of two species *L. leptocheilus* and *L. siamensis* have high levels (99-100%) of similarities compared to the same species reported in the GenBank database (Table 1). The average congeneric (inter-specific) Kimura-2P genetic distance between the two species (8.42%) is much larger than the intra-specific (conspecific) genetic distances of each species (0.31-0.38%). Conspecific genetic distances between populations of *L. leptocheilus* range from (0.26-0.41%), indicating high divergence within species. Besides, the genetic diversity of two *Labiobarbus* species with a slightly higher value in *L. leptocheilus* (Hd=0.8700 and pi=0.0031) compared to *L. siamensis* (Hd=0.7000 and pi=0.0038).

Table 1: Results of blasting sequences of two *Labiobarbus* species

No	Species	Aligned species	GenBank		BOLD systems Identity
			Identity	Accession	
1	<i>L. siamensis</i>	<i>L. siamensis</i>	99%	MW147423.1	100%
2	<i>L. leptocheilus</i>	<i>L. leptocheilus</i>	100%	MK116329.1	100%

A NEW TYPE OF HIGH-EFFICIENCY, LOW-ENERGY-COST INDOOR RECIRCULATING AQUACULTURE SYSTEM

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The traditional flow-through or outdoor static-water aquaculture systems require frequent and substantial water exchange. In contrast, the Indoor Recirculating Aquaculture System (RAS) controls water quality by treating and reusing water through circulation, enabling smooth biological production. However, the establishment cost of RAS is relatively high, and energy consumption for water treatment exceeds that of traditional aquaculture ponds. Developing cost-effective and highly efficient RAS systems can significantly reduce the investment and operational costs of water treatment equipment, creating an economically viable recirculating aquaculture model.

We have established a novel, energy-efficient recirculating aquaculture system capable of supporting a stocking density of 20-30 kg per ton of water, over 10 times higher than the traditional outdoor pond stocking density of approximately 2-3 kg per ton of water. The system comprises three main components: the aquaculture zone, the physical filtration zone, and the nitrification and oxygenation zone. Organic particles discharged from the aquaculture tank first flow by gravity into the physical filter. A motor then pumps the filtered water into the biological nitrification tank. This filtration unit offers low construction costs, low energy consumption, and reduced maintenance requirements. The biological filter tank, approximately 1.6 meters tall, is filled with K1 plastic media with a specific surface area of $150 \text{ m}^2/\text{m}^3$. Intensive aeration enhances oxygen levels and maintains the media in motion, facilitating nitrification. Compared to conventional fixed-bed filters, this setup improves treatment efficiency by 8-10 times. Finally, the treated water flows back into the aquaculture tank by gravity, completing the cycle. The system's network monitoring unit, controlled by a microchip, integrates functions such as error detection, data upload, and interface display. In the event of abnormalities, the system triggers an alarm to alert management personnel for immediate resolution.



RISK-BASED EVALUATION OF FISH AND PRAWN CHUTNEY POWDERS: MICROBIAL SAFETY, QUALITY INDICATORS, AND RISK CATEGORIZATION

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Powdered seafood products such as fish and prawn chutney powders are widely consumed as flavoring agents and value-added products. While drying extends shelf life, dried seafood products remain vulnerable to microbial contamination, moisture ingress, and lipid oxidation. A systematic risk-based evaluation helps to prioritize quality control measures, identify high-risk batches, and to execute corrective actions. This study evaluates the microbial safety, physicochemical quality, and potential health risks associated with commercially available fish and prawn chutney powders. A comprehensive analysis of 73 samples was conducted, assessing parameters such as protein, moisture, fat, ash, water activity, Tri Methyl Amine (TMA), Total Volatile Base Nitrogen (TVBN), Peroxide value (PV) Free Fatty Acids (FFA), Thiobarbituric Acid Reactive Substance Value (TBARS), microbial load, Spoilage microorganism, bacteria of public health significance and pathogenic microorganism and histamine concentration. Additionally, heavy metal and elemental profiles were examined. The findings reveal significant variability in quality indicators and microbial contamination, necessitating a risk-based categorization to inform consumer safety and regulatory oversight.

Numeric parameters were min–max normalized (0–1), aggregated into a 1–5 risk score per sample, and categorized as Low, Medium, or High risk. The study identified samples with elevated risk associated primarily with higher microbial counts and moisture-related instability. No major human pathogens were detected in any of the samples studied.

A combined min–max normalization and aggregated scoring approach produced intuitive 1–5 risk scores and categorical flags (Low/Medium/High) useful for routine quality control. Water activity and moisture content are major determinants of microbial stability in dried fish products. No major human pathogens were detected in the analyzed dataset, suggesting a low imminent consumer food safety concern for the tested samples. Implementing improved drying and packaging practices is expected to reduce higher-risk samples and enhance shelf stability.

DISCRETE ELEMENT METHOD MODELLING OF AN AUGER-BASED LOBSTER FEED PELLET DISPENSER

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Commercial aquaculture of tropical rock lobsters requires the precise and timely delivery of micro feed pellets to juvenile lobsters. These cylindrical pellets, ranging from 0.5 mm - 1 mm in diameter, are challenging to handle due to their small size. Current dispensing methods often rely on manually pre-loading compartments and time-based release mechanisms, which are labour-intensive and prone to inconsistency in both delivery time and amount delivered.

An auger-based dispensing system offers a promising alternative by enabling controlled release of discrete quantities of feed from a larger hopper, thereby reducing the need for frequent manual handling. However, designing such systems requires accurate prediction of pellet flow to ensure consistent delivery while avoiding breakage and bridging.

The Discrete Element Method (DEM) provides a powerful numerical simulation technique for analysing particle behaviour in pellet flows. Recent advancements in DEM have greatly expanded its range of applications and the capability to simulate particle breakage and adhesion.

This study presents DEM simulations using ANSYS Rocky of an auger-based micro pellet dispenser designed for lobster aquaculture. The hopper was initially loaded with 25,000 pellets with representative size distribution. Following this, the auger was rotated six times to ensure it was fully primed before completing 20 discrete revolutions to quantify the mass of feed delivered per rotation. The frictional characteristics of the particles were determined from an experimental drawdown test and the particle breakage was simulated using a Tavares breakage model. The results from this study demonstrate that the DEM can effectively predict feed delivery and pellet breakage. The DEM simulations can provide valuable insights into optimal auger designs and significantly reduce the need for extensive physical prototyping.

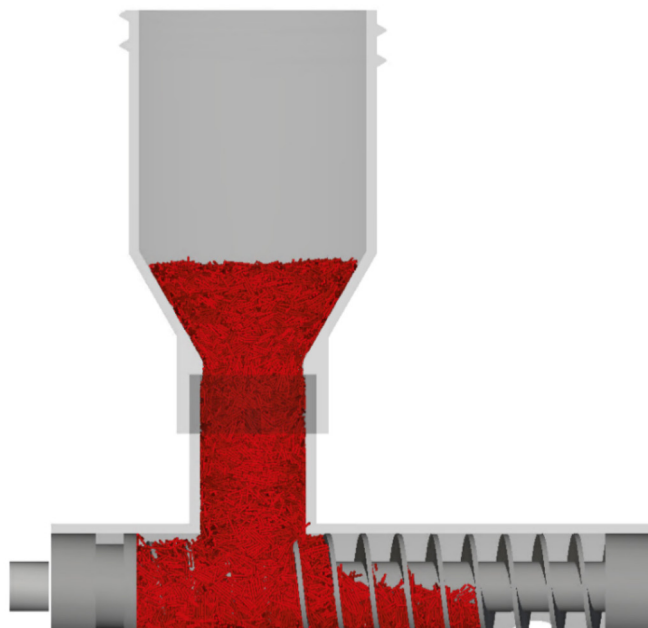


Figure 1: DEM model of auger-based feed pellet dispensing system

BIVALVE SHELLFISH MARICULTURE IN COASTAL AND MARINE ENVIRONMENT FOR A SUSTAINABLE BLUE ECONOMY: PRESENT STATUS, CHALLENGES AND PROSPECTS IN BANGLADESH

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Bangladesh's diverse coastal and marine waters, covering 8,500 km² with depths of less than 5 meters, offer significant potential for bivalve shellfish mariculture, contributing to environmental sustainability, food security, and long-term economic growth. Despite the favourable geographic location and rich biodiversity of marine bivalves, various technical, environmental, socio-economic, and regulatory challenges have hindered the widespread adoption of bivalve shellfish mariculture. Therefore, this study aims to provide a comprehensive assessment of the current status, challenges, and prospects for the sustainable development of bivalve shellfish mariculture in Bangladesh. A mixed-method approach was employed to achieve these objectives, combining an extensive literature review, key stakeholder interviews, field research, and development experiences related to bivalve shellfish mariculture along the Bay of Bengal coast, Bangladesh. The literature review revealed that Bangladesh's coastal and marine areas are home to approximately 140 bivalve species, 16 of which are commercially important. Among these, 3 to 4 species (*Perna viridis*, *Crassostrea* sp., *Meretrix meretrix*) are cultivated in nearshore areas of Bangladesh, primarily on a limited scale through donor-assisted, project-based initiatives. The study identified several barriers to the growth of bivalve shellfish mariculture, including a lack of site suitability mapping, technological inefficiencies, challenging coastal hydrodynamics, natural hazards, poor handling and processing, limited consumer acceptance, weak supply chains and logistical support, and insufficient research and development activities. Key findings suggest that implementing marine spatial planning, climate-resilient technologies, capacity building, market development, value chain integration, community engagement, targeted investments in infrastructure and research, public-private partnerships and collaboration, quality assurance and certification systems, and policy reforms are crucial for unlocking the sector's full potential. By embracing these interventions, the study identifies promising opportunities for bivalve shellfish mariculture, including horizontal expansion and integrated multi-trophic aquaculture to enhance food and nutritional security and improve livelihoods for vulnerable coastal communities. These efforts could drive a paradigm shift toward sustainable bivalve shellfish mariculture practices, contributing to a flourishing blue economy in Bangladesh where both people and nature can thrive in harmony.

FEEDING BEHAVIOR OF THE OYSTER (*Crassostrea madrasensis*) IN RELATION TO ECO-PHYSIOLOGICAL FACTORS, SEASONAL PLANKTON DYNAMICS, AND BIOMETRIC TRAITS ALONG THE SOUTHEAST BAY OF BENGAL

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Oyster feeding biology is strongly influenced by ecological and biological factors, and understanding these interactions is critical for successful aquaculture development. Accordingly, an extensive study was conducted using an integrated multivariate approach to explore the feeding biology of the oyster *Crassostrea madrasensis* (collected from the southeast coastal regions of the Bay of Bengal in Bangladesh), by examining the interrelationship between ecological factors, seasonal plankton dynamics, biometric traits, and plankton ingestion patterns. Field data were collected monthly from July 2023 to June 2024 at two sites in Cox's Bazar, Bangladesh (Maheshkhali and Khurushkul). Environmental parameters (temperature, salinity, pH, and dissolved oxygen) were recorded in situ, and plankton samples from both water and oyster gut contents were analyzed using a Sedgewick Rafter counting cell and identified to the genus level using microscopy. A total of 53 planktonic genera (47 phytoplankton, 6 zooplankton) were identified in the gastrointestinal tract of oysters in the present study. *Amphidinium* (17.5%) was the most ingested genus, followed by *Skeletonema* (15.1%), *Coscinodiscus* (12.0%), and *Cyclotella* (10.8%). Other major genera found in oysters' gastrointestinal tracts were *Lioloma*, *Thalassionema*, *Pleurosigma*, *Pseudo-nitzschia*, *Anabaena*, *Oscillatoria*, and Copepoda. Multivariate and correlation analyses revealed that seasonal variation and environmental factors significantly influenced plankton composition in both water and oyster gut contents. Principal component analysis (PCA) showed that the first two components explained 50.2% of the variation in gut plankton composition, primarily driven by seasonality. Cluster analysis indicated peak plankton ingestion during August, October–December, and February. Oysters ingested large amounts of Coscinodiscophyceae in November, Fragilariophyceae in June, Bacillariophyceae in August, Dinophyceae in February, and zooplankton in April. These findings enhance our understanding of oyster feeding behavior in relation to seasonal water quality, plankton availability, and biometric traits, offering valuable insights for oyster aquaculture expansion and blue economy development in Bangladesh.

MATERNAL WEIGHT, AGE AND THEIR INTERACTION HAS IMPACTS ON REPRODUCTIVE OUTCOME AND OFFSPRING PERFORMANCE IN BUTTER CATFISH, *Ompok bimaculatus*

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The weight and age of the brood fish are important factors in producing high-quality gametes and larvae in any fish. Therefore, two induced spawning experiments were conducted to ascertain the 1) effects of maternal weight, and 2) effects of maternal weight and age interaction on the reproductive performance, egg quality and larval quality of Indian butter catfish, *Ompok bimaculatus*. In first experiment, four size groups of female *O. bimaculatus* brood fish, with following size ranges, F50 (51.40 ± 5.22); F80 (81.60 ± 7.13); F120 (120.8 ± 6.37) and F160 (159.80 ± 7.66), were selected in addition to male brood fish in the same weight range. In second experiment, female brood fish of same age-class (<1, 1-1.5, 1.5-2.0 and 2+ year) were divided into two size groups. The brood fish in the large (L) group were, on average, approximately 1.3 to 1.4 times the body weight of the brood fish in the small (S) group. Males of equivalent weight of female were taken without considering their age. Fecundity, egg quality metrics like weight and diameter, fertilization rate, and hatching rate were evaluated. Larvae (5 DPH) were raised for 15 days on optimal diets to examine their growth parameters, survival rate, and deformation rate.

The results revealed that the total fecundity had a substantial positive relation ($r = 0.90$; $p < 0.01$), and fertilization and hatching rate had a non-significant negative ($r = -0.21$; $p = 0.367$) and strong significant negative ($r = -0.62$; $p = 0.003$) correlation to maternal size in experiment-1. Individually, fish age and fish size had significant relation with fecundity of female (GLM: $F = 124.70$, $p < 0.001$ for fish age; and $F = 40.04$, $p < 0.001$ for fish weight) and egg hatching rates (GLM: $F = 5.42$, $p = 0.004$ for fish age; and $F = 13.51$, $p = 0.001$ for fish size), however, their interaction effects (fish age x fish size) on fecundity, fertilization and hatching rates were found insignificant (GLM: $F = 0.299 - 2.269$, $p = 0.099 - 0.954$) in experiment-2. Hatchling deformation rate was found significantly higher in female brood fish of 160 g size and age of 2+ years. The survival rate, total length, and specific growth rate were found considerably ($p < 0.05$) higher in larvae of female brood fish of F80 and F120 and age of 1 – 2 years.

Overall, the findings suggest that maternal weight and age had a substantial effect on *Ompok bimaculatus* reproductive performance, egg characteristics, and larval fitness during induced captive spawning.

FECUNDITY VACCINE FOR FISHES: AN APPROACH TO IMPROVE REPRODUCTIVE PERFORMANCES UNDER CAPTIVITY

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Inhibins are disulphide-linked heterodimeric glycoproteins of the transforming growth factor- β superfamily that regulate ovarian function through the hypothalamo-pituitary-gonadal (HPG) axis. In captive teleosts such as *Clarias batrachus*, reproductive dysfunctions including poor oocyte maturation and reduced spawning success are common, often due to endocrine imbalances and inadequate gonadotropin release. While inhibins are known to modulate follicle-stimulating hormone (FSH) secretion in mammals, their structure and role in fish reproduction remain poorly understood. To address this, the present study characterized inhibin-A, designed a species-specific inhibin- α chimeric peptide (ICP), and evaluated the effects of its immunoneutralization on ovarian maturation in adult female *C. batrachus*. Homology modelling and circular dichroism revealed that ICP adopts a turn and random coil structure, while molecular docking demonstrated strong salt-bridge and polar interactions among inhibin- α , ICP, and betaglycan. Competitive ELISA confirmed the high specificity of anti-ICP antibodies to the inhibin- α subunit. Immunization with anti-ICP antisera significantly upregulated *FSHr*, *LHr*, *Act RI*, and *Act RII* expression, and increased serum concentrations of FSH, 17 β -estradiol (E2), and progesterone. Histological observations showed dose-dependent enhancement of oocyte maturation, with the medium dose (200 μ l) producing the highest number of developing oocytes. Overall, immunoneutralization of inhibin bioactivity enhanced gonadotropin signalling and oocyte development, alleviating reproductive constraints under captive conditions. This study provides the first molecular and functional characterization of inhibins in *C. batrachus* and highlights their potential in improving reproductive efficiency in aquaculture species.

GLOBAL TRADE DYNAMICS OF ORNAMENTAL FISH : EXPORT TRENDS, MARKET STRUCTURES, AND EMERGING PATTERNS

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The global ornamental fish trade has exhibited a remarkable resilience and growth, increasing from USD 12 million in 1988 to USD 329 million in 2023, a twenty-seven-fold increase over the course of 36 years. The analysis of UN COMTRADE data (HS Codes 030111 and 030119) reveals a long-term upward trajectory, with values stabilizing at historically high levels despite recent global economic uncertainties. Export patterns indicate a significant Asia-centric orientation, as seven of the top ten global exporters from 2019 to 2023 are from the region. The top three suppliers are Japan (14%), Singapore (10%), and Indonesia (10%), with Sri Lanka, Thailand, and Malaysia contributing between 4% and 6% per country. The region's dominance is underscored by the fact that these Asian economies collectively account for well over half of the world's ornamental fish exports. Conversely, Spain (7%), the Netherlands (7%), and Czechia (6%), which are critical non-Asian players, play significant yet relatively minor roles. The United States of America alone accounts for 24% of global imports, followed by China (8%), the United Kingdom (7%), Japan (6%), and Germany (5%). Malaysia, the Netherlands, France, Singapore, and Hong Kong SAR are additional substantial importers, each of which holds a 3–4% stake. This distribution emphasizes a global trade system in which Asia serves as the production base, while North America, Europe, and East Asia are the primary consumer markets. The continued growth of this industry is indicative of the increasing global popularity of ornamental fishes and the efficacy of captive breeding in mitigating dependence on untamed stocks. In order to ensure that this biodiversity-driven, high-value component of the blue economy continues to flourish in the years ahead, it is imperative to fortify certification, sustainability frameworks, and equitable benefit-sharing.

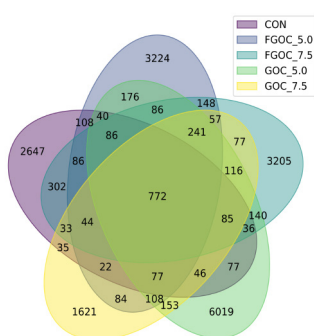
EFFECT OF FEEDING SOLID STATE FERMENTED SESAME *Sesamum indicum* OIL CAKE ON GROWTH, IMMUNITY AND GUT MICROBIOME IN SHRIMP, *Penaeus vannamei*

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Sesame oil cake, (Gingelly oil cake-GOC) was fermented with *Bacillus subtilis* and *Saccharomyces cerevisiae* by pilot scale solid state fermentation to ameliorate antinutritional factors and to improve its nutritional quality. Five experimental diets were prepared with 0%, 5%, and 7.5% levels of raw and fermented GOC. A 56-day feeding trial was conducted on juveniles (2.87 ± 0.12 g) of *Penaeus vannamei*. The best growth (weight gain $416.97 \pm 12.14\%$), digestive enzyme profiles (protease), nutrient utilization and immune parameters were observed in shrimp fed with fermented GOC at 5 and 7.5% levels compared to control and unfermented GOC fed shrimp. Total genomic DNA was extracted from shrimp gut samples, and the bacterial 16S rRNA (V3–V4 region) was amplified for microbiome analysis. Libraries were prepared using the Nextera XT Index Kit and sequenced on the Illumina NovaSeq platform. Sequencing data were processed using the QIIME2 pipeline for bioinformatic analysis. The linear discriminant analysis (LDA) effect size (LEfSe) method was employed to identify differentially abundant bacterial taxa between the treatment groups.

The Venn diagram shows that feeding shrimp with 5% GOC results in the highest number of unique ASVs followed by fermented GOC and the lowest in shrimp fed with 7.5% GOC. Shrimp fed with fermented GOC exhibited higher levels of known probiotic bacterial genus, *Bifidobacterium*, *Bacteroides*, *Prevotella*, *Parabacteroides* and *Geminobacterium* that primarily aid in digesting complex plant fibers and produce short-chain fatty acids (SCFAs) like acetate, propionate and butyrate, and support gut health. They also help regulate the immune system, modulate inflammation by inducing anti-inflammatory responses, and protect against pathogens. Improved gut microbiome from fermented GOC enhanced digestion, nutrient utilization, immunity, and growth in shrimp.



MISSION NAVSHAKTI: ADVANCING RURAL WOMEN'S EMPOWERMENT THROUGH ORNAMENTAL FISH FARMING-BASED MICRO-ENTERPRISES

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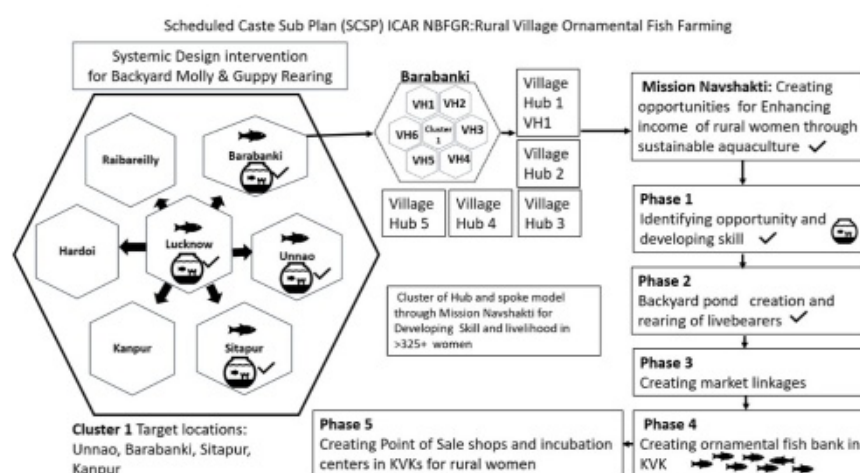
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Mission Navshakti, launched under the SCSP component of ICAR-NBFGR, has emerged as a transformative model that has empowered over 425 Scheduled Caste rural women through skill development in ornamental fish rearing and aquarium fabrication and has potential to scale up. Spread across four districts in Uttar Pradesh, Barabanki, Unnao, Sitapur, and Kanpur Dehat, the initiative has successfully introduced micro-entrepreneurship to women with minimal or no previous economic engagement. Through a hub-and-spoke model, in association with KVK Sitapur, KVK Unnao, KVK Kanpur Dehat, Hitech Fisheries and Aquaworld women were trained, provided with exposure visits, and equipped with start-up kits including aquaria and inputs like fish feed and accessories. Women turned backyards into functional cemented ponds, unlocking new sources of livelihood while remaining embedded in their communities. Digital handholding via WhatsApp ensured continuity in learning and collective motivation. To strengthen market linkages, Navshakti: Aquagri Business Incubation Centre (NABiC) has been established as a centralized platform for selling ornamental fish, aquaria, and locally crafted decorative items. What began in Dhankutti village with 50 women has now become a livelihood movement, expanding to Rajasthan and urban clusters of Lucknow. The impact is multidimensional economic, social, and psychological as women shift from subsistence farming to confident entrepreneurship, inspiring others in their communities. Mission Navshakti showcases how integrating traditional knowledge with modern techniques can reshape gender roles, foster resilience, and catalyse sustainable rural development through inclusive aquatic micro-enterprise. Mission Navshakti also empowers cobblers through basic startup kit, farmers with iceboxes and includes creativity and design thinking in school kids through aquarium fabrication and cognitive learning devices. Mission Navshakti and its incubation center NABiC and shops named “*Navshakti ki udaan*” were recognized by UN-FAO, during FAO's 80th anniversary for first ever “Global Technical Recognition in Sustainable Aquatic Food Systems” for technical leadership, collaboration, innovation and best practices in transformation, showcasing exemplary contribution, highlighting the initiative's role in uplifting Schedule Caste communities through women-led entrepreneurship and resilient fish farming practices. The collaboration among stakeholders has created a new model of rural urban market linkage that has potential to transform and empower lives through microentrepreneurship



EFFECTS OF DIETARY FENUGREEK MICROGREENS ON NUTRITIONAL, AND PHYSIOLOGICAL PERFORMANCE IN *Cyprinus carpio*: AN APPROACH TO SUSTAINABLE AQUAFEED MANAGEMENT

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Aquaculture depends on fishmeal (FM) as a major protein source, but sustainability concerns and rising costs necessitate alternative feeds. The potential use of medicinal plants, particularly fenugreek, as a dietary source can benefit carp farming, especially cyprinids. The present study intends to investigate the impact of FGM on growth performance, antioxidant defence, intestinal function, and fillet quality of the carp. Especially, investigated the effects of graded dietary inclusion of FGM (0%, 25%, 50%, 75%, 100%) as FM replacement on the growth, physiology, and nutritional quality of *Cyprinus carpio*.

Fish fingerlings (77 ± 9.5 g) were fed isonitrogenous diets (35% crude protein) for eight weeks. Growth performance, feed utilization, organosomatic indices, hematological and serum biochemical parameters, digestive and antioxidant enzymes, histology, carcass composition, and fillet amino/fatty acid profiles were evaluated after the feeding trial. Results from quadratic regression analysis revealed that moderate inclusion levels (~45–55%) improved weight gain ($y = -1.14535E-4x^2 + 0.006x + 4.413$) and specific growth rate ($y = 0.91625 + 1.39773E-4x - 3.34565E-6x^2$) peaking at 50% inclusion. Digestive enzyme activities (amylase, protease) were elevated in FGM25 and FGM50 groups, while antioxidant enzymes (SOD, CAT, GPx) increased across all FGM-fed groups, enhancing oxidative stress tolerance. Hematological and biochemical values remained within normal ranges. However, slight reductions in RBC counts were noted at lower and higher inclusions. Histological examination confirmed normal intestinal and hepatic structures at moderate inclusion, while high inclusion showed mild alterations. Fillet composition analysis indicated improved amino acid and fatty acid profiles, particularly essential amino acids and unsaturated fatty acids in partial inclusion. Overall, partial replacement of FM with FGM at ~50% is optimal for enhancing growth performance, digestive and antioxidant efficiency. This shows the potential of FGM as a sustainable functional feed ingredient in carp aquaculture.

Table 1. Morphometric parameters

Parameters	FGM0	FGM25	FGM50	FGM75	FGM100
Growth performance					
WG (g)	4.47 ± 0.02	4.5 ± 0.01 ^{ns}	4.53 ± 0.01 ^{ns}	4.45 ± 0.02 ^{ns}	4.38 ± 0.02 [*]
SGR (% day ⁻¹)	0.91 ± 0.2	0.92 ± 0.17	0.92 ± 0.22	0.90 ± 0.14	0.89 ± 0.25
CF (%)	0.98 ± 0.09	0.95 ± 0.22	0.99 ± 0.1	1.2 ± 0.17	0.8 ± 0.23
Organosomatic indices					
HSI (%)	1.37 ± 0.21	1.32 ± 0.15	1.15 ± 0.24	1.18 ± 0.30	1.1 ± 0.22
VSI (%)	1.90 ± 0.16	1.78 ± 0.25	1.63 ± 0.18	1.75 ± 0.32	1.64 ± 0.15
Feed utilization					
FCR (g)	2.23 ± 0.08	2.21 ± 0.17	2.19 ± 0.24	2.32 ± 0.19	2.35 ± 0.43
ADG (g day ⁻¹)	0.08 ± 0.06	0.08 ± 0.04	0.08 ± 0.06	0.07 ± 0.05 ^{**}	0.07 ± 0.05 ^{**}
SR (%)	100	100 ^{ns}	99.4 ± 0.15 [*]	100 ^{ns}	97.59 ± 0.4 [*]

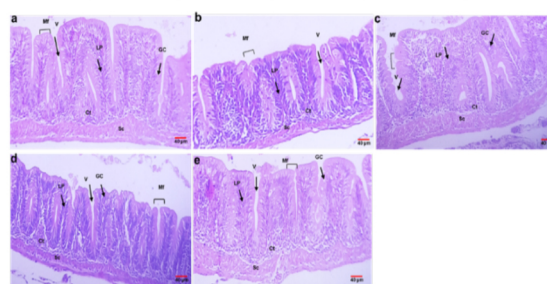


Figure 1. Histoarchitecture of *C. carpio* fed with FGM (intestine).

MARINE FISHERY RESOURCES MANAGEMENT: A QUICK SHIFT PARADIGM TO SMARTER MODES

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India's ongoing digital transformation is reshaping traditional sectors, including marine fisheries. The sector now stands at a pivotal point—balancing the management of wild stocks with the expansion of aquaculture under various government initiatives. This transition calls for a paradigm shift from conventional oversight to digitally informed, yet tradition-aware, governance.

The Challenge and the Digital Milieu

India's small-scale marine fishing fleet is swiftly embracing technologies like communication tools and Vessel Monitoring Systems (VMS), enabling near-real-time management. Yet, both policymakers and fishers struggle to keep pace with this rapid shift. Traditional stock assessment models, reliant on long-term processes such as Biological Reference Points (BRPs), are too slow for this dynamic context—making a hybrid management approach essential.

A Proposed Hybrid Assessment Paradigm

The most appropriate new paradigm is one that facilitates a hybridization of management timelines. This approach proposes a two-tiered system:

1. **Medium-Term Assessment:** Establishes multi-stock harvest indices through ecosystem-based tools such as Ecopath with Ecosim (EwE) to provide a stable strategic foundation.
2. **Short-Term (Seasonal) Tweaking:** Fine-tunes this baseline seasonally or annually using real-time field and institutional data—accounting for local stock fluctuations, regional dynamics, and market trends.

This system parallels climate forecasting: long-term trends guide broad strategy, while short-term inputs refine immediate actions.

The Integrated Information Cycle and Optimality

The model's success depends on a seamless “digital data continuum” linking institutions, management agencies, and fishers. This enables a continuous, feedback-driven information cycle—where real-time data generate actionable advisories that, in turn, enhance field-level decisions. Such integration supports optimal resource use by balancing capture fisheries with aquaculture, aided by geo-referenced advisories that direct effort and investment efficiently.

Conclusion

A “smarter” marine fisheries governance model for India must blend the strengths of traditional management with the agility of digital intelligence. By combining medium-term ecosystem assessments with short-term, data-driven adaptations, this hybrid paradigm offers a sustainable, inclusive, and adaptive framework suited to the small-scale nature of India's fisheries—ensuring long-term productivity and resilience.

VITAMIN B12 REQUIREMENT OF PACIFIC WHITE SHRIMP *Penaeus vannamei* FOR OPTIMAL GROWTH, FEED UTILIZATION AND HEALTH PERFORMANCE

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This study was investigated to establish the dietary vitamin B₁₂ requirement of sub-adult Pacific white shrimp. Six semi-purified diets were formulated by including cyanocobalamin at 0.0, 0.5, 1.0, 1.5, 2.0 and 2.5 mg/kg levels (designated as Con, Cb0.5, Cb1.0, Cb1.5, Cb2.0 and Cb2.5, respectively). The actual cyanocobalamin levels in the diets were 0.03, 0.48, 1.21, 1.78, 2.10 and 2.59 mg/kg, respectively. Total 216 shrimp (Initial weight: 12.94 ± 0.05 g) were randomly distributed to 18 tanks (300 L) in triplicate groups and fed the experimental diets for six weeks. Final mean body weight, weight gain (WG) percentage and specific growth rate were significantly increased in Cb1.0, Cb1.5, Cb2.0 and Cb2.5 groups than in Con group. Protein efficiency ratio was significantly higher in Cb1.0 and Cb1.5 groups than in Con group. Dietary vitamin B₁₂ supplementation significantly increased hemocyte counts, non-specific immune responses and antioxidant enzyme activity of shrimp. Hepatopancreas amylase activity was significantly increased in Cb1.0 group than in Con group. Intestinal histomorphology was not significantly affected, while hepatic and muscle vitamin B12 levels were increased in a significant linear trend. The expression of growth, vitamin B12 metabolism and immune-related genes were significantly upregulated by dietary vitamin B₁₂ supplementation. Based on polynomial regression analysis of WG to dietary vitamin B₁₂ levels, the optimal dietary vitamin B₁₂ requirement seems to be 1.48 mg/kg for Pacific white shrimp.

DEVELOPMENT AND TESTING OF A SMALL-SCALE FISH FILLETING MACHINE FOR ROHU (*Labeo rohita*)

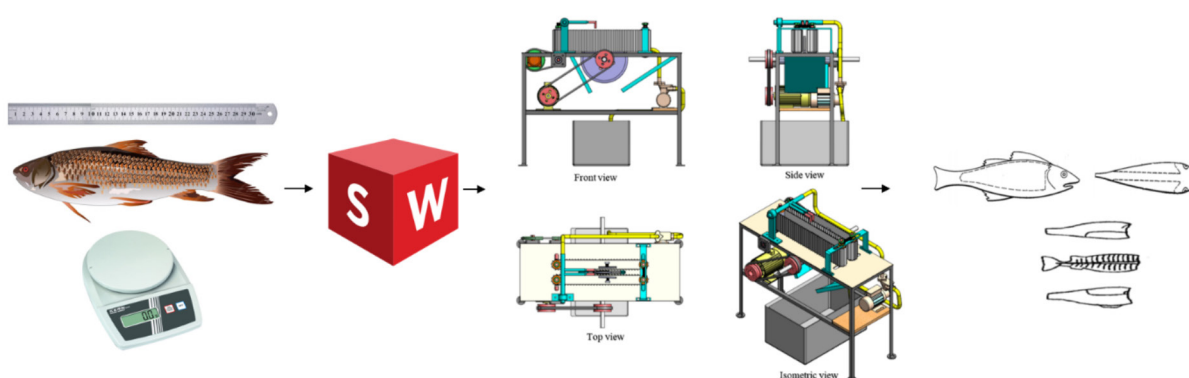
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Rohu (*Labeo rohita*) is a popular fish grown in earthen ponds in most Asian countries, with a production of 2.02 million tonnes and 3.70% of total aquaculture production (FAO 2020). However, it is sold locally in the form of steaks with traditional knives without proper processing and value addition due to the non-availability of proper processing and post-harvest infrastructure. To promote standardised processing and value addition, a small-scale fish filleting machine for rohu fish was designed, developed and tested.

The morphometric measurements and mechanical properties of the rohu fish within the commercial harvesting range (290 g to 2100 g) were used as the basic parameters for the design and development. The machine comprises three main units: (a) conveying, (b) filleting, (c) water spraying and collection. The filleting unit has two parallel disc blades for precise cutting, with adjustable spacing to accommodate a variety of rohu fish backbone thicknesses. The conveying unit employs belt drives and spring-adjusted entry for smooth transport, while the water spraying and collection unit sprays and cleans the filleting blades, ensuring smooth fish movement.

The machine was tested by carrying out a filleting operation using rohu fish within the weight range of 300g to 2000 g. The performance parameters assessed and optimised were capacity (33 ± 1 fish/min), overall filleting efficiency ($82.48 \pm 0.97\%$), and energy consumption (93.16 ± 0.28 W-h). Sensory evaluation of the fillets produced by the machine was performed by a trained panel of 25 members using a hedonic scale (1 to 5) to assess fillet quality in terms of tear, bruise, discolouration, skin condition, and overall acceptability. The ratings for all quality parameters given were within the range of 4 and 5, indicating good quality fillets produced by the machine. The total cost of the machine was Rs. 7000 (as of May 2020). The developed machine is cost-effective (Rs. 0.04/kg of dressed rohu fish) compared to manual filleting (Rs. 1.04/kg of rohu fish) and suits the economic condition of a small or medium freshwater fish processing industry in India and other developing countries.



DIETARY INACTIVATE YEAST *Pichia guilliermondii* PROMOTES SHRIMP GROWTH AND IMMUNITY

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Environmental and infectious stressors are ubiquitous in aquaculture. Achieving efficient and profitable production, especially with the increasing global threat on antimicrobial resistance, is critical for producers. Helping aquaculture species to better perform under multiple physiological and infectious stressors is therefore of high interest and a focus of intensive research.

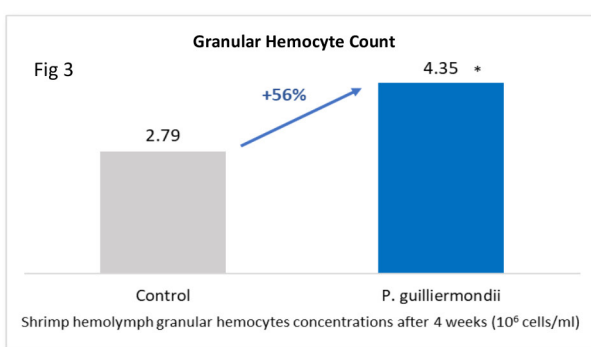
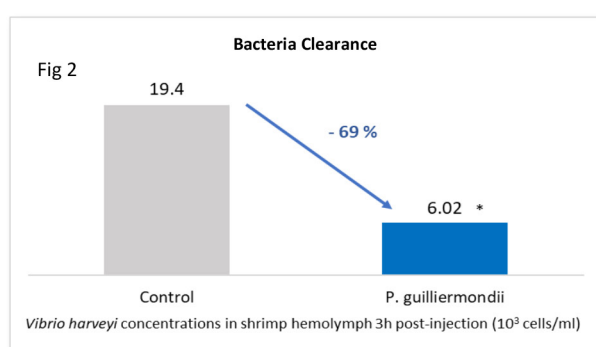
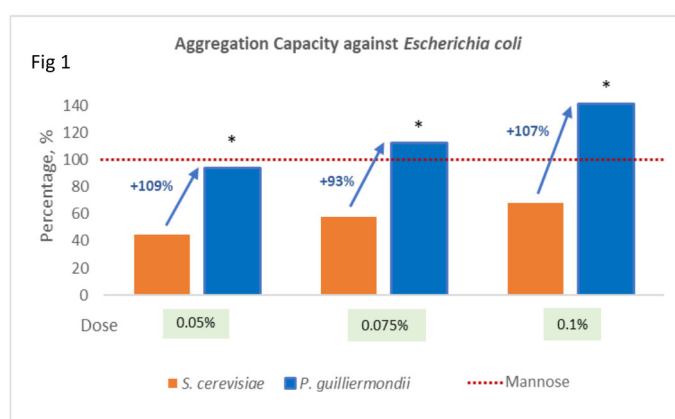
Cardozo *et al.*, 2018¹ compared *in vitro* bacterial aggregation capacity of inactivated *Pichia guilliermondii* (*Pg*) with *Saccharomyces cerevisiae* (*Sc*), taking Mannose as Control. *Pg* showed twice aggregation capacity at all commercial dosages compared to that of *Sc* (Fig 1). Bacteria aggregation is critical in first innate immunity, thus resilience and performance.

To assess bacterial aggregation capacity and immune potent activity of *Pg*, a bacterial clearance study was performed: *Litopenaeus vannamei* shrimp were injected (IM) with *Vibrio harveyi*. Three hours post-injection, *V. harveyi* concentration in the hemolymph of 4 weeks *Pg* fed shrimp was found to be reduced by 69% compared to control-fed shrimp (Fig 2). It was also shown that hemolymph granular hemocyte concentration was 56% higher compared to control³ (Fig 3). Granular hemocytes are key for an effective, rapid, and orchestrated immune response in shrimp.

In order to confirm the potential benefit of *Pg* in various shrimp culture conditions, challenge tests and growth studies were performed in *L. vannamei* shrimp supplemented with 0.1% *Pichia guilliermondii* feed additive²: Survivability of shrimp 5 weeks after White Spot Syndrome Virus challenge increased by 84% compared to non-supplemented Control shrimp, and was 76% higher 5 weeks post-*Vibrio parahaemolyticus* (VpAHPND) challenge vs Control³.

Interestingly, significant 10% higher growth performance were shown compared to control on shrimp fed with the same supplementation during 7 weeks in common field conditions³.

To conclude, inactivate whole yeast *Pichia guilliermondii* feed supplementation offers unique benefits to shrimp culture and daily management, significantly improving growth as well as helping shrimp to better cope with physiological and infectious stressors.



INTERACTIONS BETWEEN PLANKTON AND FISH COMMUNITIES IN A FRESHWATER RESERVOIR: A MULTIMETRIC ANALYSIS

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Reservoirs in semi-arid southern India are critical for irrigation, fisheries, and local livelihoods, yet their ecological functioning remains insufficiently documented. In particular, the trophic linkages between plankton and fish assemblages are central to sustaining fisheries production. This study investigates the interactions between phytoplankton, zooplankton, and fish communities in the Sathanur Reservoir (12.2064° N, 78.8567°E.), Tamil Nadu, India, using seasonal field data on plankton density, fish abundance, and water quality parameters. Phytoplankton abundance, dominated by Chlorophyceae and Cyanophyceae, peaked during the monsoon months under high nutrient inputs, while zooplankton biomass was highest in the post-monsoon period, driven largely by copepods and cladocerans. Planktivorous fish (*Catla*, *Labeo*, and *Cirrhinus* spp.) exhibited significant positive correlations with zooplankton biomass, particularly with a one-month lag, suggesting strong bottom-up regulation. In contrast, piscivorous fishes were negatively associated with planktivore abundance, indicating trophic cascading. Redundancy analysis highlighted water level fluctuations, Secchi depth, and dissolved oxygen as key abiotic drivers influencing both plankton and fish assemblages. Variance partitioning showed that plankton variables independently explained a considerable fraction of fish community variation, beyond the effects of environmental parameters.

The study demonstrates that Sathanur Reservoir is governed by dynamic plankton–fish interactions modulated by hydrological seasonality. Incorporating plankton indicators into reservoir monitoring offers a robust approach to predict fish productivity and guide adaptive management for sustaining inland fisheries in southern India.

DIETARY PHYTOCEE ENHANCE CLARIAS CATFISH GROWTH PERFORMANCE, AND CARCASS COMPOSITION

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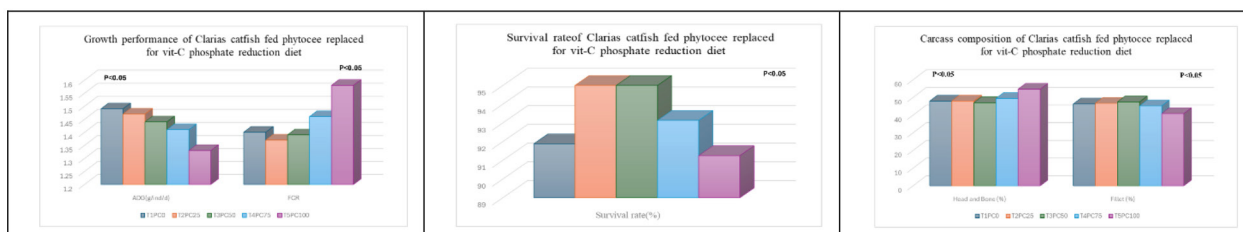
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This study was assessed the effects of dietary phytocee, crude herb mixture, on clarias catfish growth performance, and carcass composition under vitamin C phosphate (vitC-PP 35%) reduction. The experiment was assigned in CRD with 5 treatment diets and 4 replicates; a) T1PC0: diet with the vitC-PP 100%,175ppm(active) b) T2PC25 diet with the vitC-PP 75%,131.25 ppm, and phytocee 250 ppm c) T3PC50 diet with the vitC-PP 50%,87.5 ppm, and phytocee 500 ppm d) T4PC75 diet with the vitC-PP 25%,43.75 ppm, and phytocee 750 ppm. e) T5PC100 diet with the vitC-PP 0%, 0 ppm, and phytocee 1,000 ppm. Eight hundred clarias catfish with initial mean 15 gram/individual were randomly distributed into 1500L of 20 tanks that contained freshwater 500L and stocked 40 fish per tank (80 pcs/m³). Fish were fed experimental diets 3-7%BW, 3 times a day during 8 weeks of feeding trial. The growth performance and carcass composition were investigated. The results showed that the growth performance in terms of fish production, final weight, and average daily gain were significantly differences ($p < 0.05$). Feed conversion ratio was significantly low ($p < 0.05$) when increased phytocee from 250 to 500 ppm in vitC-PP reduction diets to 87.5 ppm (active). Moreover, the survival rate was significantly improved ($p < 0.05$) when increased phytocee from 250 to 750 ppm in vitC-PP reduction diets to 43.75ppm (active). Carcass composition in terms of percentage of fillet was not effected when increased phytocee from 0 to 750 ppm in vitC-PP reduction diets to 43.75ppm (active) but fillet yield was significantly decreased ($p < 0.05$) when reduced vitC-PP to 0ppm even adding phytocee 1,000 ppm still could not keep normal fillet yield range.

Therefore, dietary phytocee 250 to 750 ppm was recommended in vitamin C phosphate reduction diets from 175 to 43.75 ppm (active) for maintain normal growth performance, improving feed utilization, enhance survival rate and maintain normal fillet yield range under density stress condition of 80 pcs/m³.



MUSSELS WITH ALGAL TOXINS IN FISH FEED – WILL IT HAVE AN IMPACT ON FISH HEALTH?

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As the aquaculture industry moves toward more sustainable feed solutions, the use of low-trophic marine organisms such as mussels and tunicates is gaining momentum. Their favorable protein and fatty acid profiles make them attractive alternatives to conventional feed ingredients like fish meal and fish oil¹. However, filter feeders such as mussels and tunicates are known to bioaccumulate algal toxins during harmful algal blooms. Algal toxins, such as okadaic acid/dinophysistoxins (OA/DTXs) and saxitoxins (STX, NEO, GTXs, and C-toxins) can persist in the tissues of mussels² and, if incorporated into fish feed, could pose potential risks to both fish health and food safety, if transferred.

This study evaluates the potential impact and transfer of selected algal toxins in salmon feed through a controlled, stepwise feeding trial using Atlantic salmon (*Salmo salar*) parr and post-smolt. Diets were formulated using commercial ingredients and top-coated with purified OA/DTXs in ethanol, or saxitoxins in water. Fish were fed until they doubled in weight. All diets were well accepted, maintaining comparable growth performance and feed efficiency to their respective water- or ethanol-based controls. However, microarray analysis revealed altered gene expression in the mid intestine of fish exposed to okadaic acid toxin group. Preliminary LC-HRMS/MS analysis of parr tissue samples did not indicate any detectable transfer of two saxitoxins (STX and NEO) to the fillet. Analysis for the remaining saxitoxins and for three OA/DTXs is under way.

This study contributes to the ongoing risk assessment of novel, underutilized low-trophic marine feed ingredients, supporting the goal of sustainable, Norwegian-sourced aquafeeds. Understanding the fate and impact of algal toxins in fish feed is essential for ensuring fish welfare, consumer safety, and responsible feed innovation.

References:

- Miljøstiftelsen Bellona. (2022). “Hva Skal Laksen Spise? – Råvareløftets Veikart Og Barrierestudier for Nye Fôrråvarer [What should the Salmon eat? The roadmap and barrier studies of the raw materials initiative for new feed ingredients].”
- James KJ, Carey B, O’Haloran J, Van Pelt Fnam, Škrabakova Z. Shellfish toxicity: human health implications of marine algal toxins. *Epidemiology and Infection*. 2010;138(7):927-940.

TRANSFORMING UNDERUTILIZED RESERVOIRS INTO AQUACULTURE OPPORTUNITIES: A GIS-BASED APPROACH IN MADHYA PRADESH

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Madhya Pradesh hosts a vast network of large and medium reservoirs with significant untapped fisheries potential. This study presents a GIS-based framework to systematically identify aquaculture suitability zones across these reservoirs, with a detailed focus on selected reservoirs including the 26,000 ha Bargi Reservoir in Jabalpur. High-resolution Sentinel-2 satellite imagery was integrated with field-validated or secondary water quality parameters (dissolved oxygen, turbidity, temperature, nutrient levels) to generate spatial layers. Using supervised classification and multi-criteria evaluation, over 500 hectares of high-potential sites were delineated for cage culture, pen culture, and stock enhancement. Priority species included Indian Major Carps (Catla, Rohu, Mrigal), Tilapia, and Pangasius. Validation of suitability maps through pilot trials and stakeholder consultations projected a 20–30% increase in fish production. Socioeconomic integration was achieved by engaging Fisheries Cooperative Societies and tribal fishing communities, whose input informed site selection, capacity-building initiatives, and equitable benefit-sharing. Ecological risks, including nutrient enrichment and invasive species, were mitigated through zoning and exclusion areas. This integrated geospatial and participatory approach optimizes reservoir fisheries while maintaining balance with irrigation, biodiversity conservation, and tourism. The framework offers a scalable decision-support model for policymakers, enhancing fish production, food and nutritional security, and rural livelihoods across Madhya Pradesh.

INTEGRATED MULTI-TROPHIC AQUACULTURE (IMTA): A SUSTAINABLE STRATEGY FOR INDIAN MARICULTURE

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Integrated Multi-Trophic Aquaculture (IMTA) is an ecologically-engineered system designed to enhance the sustainability and resilience of marine farming by integrating species from different trophic levels (fed and extractive) in close proximity. This creates a balanced, circular system where the waste generated by one species becomes a valuable input (fertilizer, feed, or energy) for another, moving aquaculture away from the linear, monoculture model. IMTA operationalizes an ecosystem-based management approach that carefully considers site specifications, operational limitations, food safety guidelines, and regulations. The system's goals are holistic, which include: environmental sustainability achieved through biomitigation, the recycling of nutrients and wastes, which directly reduces eutrophication; economic stability is ensured by product diversification (cultivating multiple commercial crops) and risk reduction (less dependence on a single species) and social acceptability is supported by better management practices and a reduced ecological footprint. IMTA involves the intensive cultivation of species connected by nutrient and energy transfer through water, with the balance maintained by selecting appropriate species in the right proportions. Fed species (the input source) are high-value finfishes, such as cobia (*Rachycentron canadum*), Asian seabass (*Lates calcarifer*), pompano (*Trachinotus mookalee*, *T. blochii*), and orange spotted grouper (*Epinephelous coioides*), which serve as the major cultured components. Their metabolic waste and uneaten feed provide the primary nutrients for the extractive species (the biofilters/crops). These extractive species, which are more than just biofilters offer, commercial value, absorb and convert wastes into harvestable biomass. They include: organic extractive (suspension/deposit feeders) species, such as non-fed bivalves like mussels (*Perna viridis*, *P. indica*) and edible oyster (*Crassostrea madrasensis*), which filter the particulate matter and inorganic extractive species, primarily seaweeds, absorb dissolved nutrients. Red and brown seaweeds like *Gracilaria edulis*, *Gelidiella acerosa* and *Kappaphycus alvarezii* are widely used in IMTA. A successful IMTA results in better overall production and improved ecosystem health, even if the individual production of some species is slightly lower than in short-term, unsustainable monoculture practices. The scope for IMTA in India is exceptionally high due to the climatic advantage (tropical climate conducive to year-round farming), species diversity (established technologies for key finfishes and existing farming of extractive species), and increasing market demand for a variety of farmed species.

EFFECTIVE VACCINATION OF RED TILAPIA ENHANCES KEY PERFORMANCE INDICATORS

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Tilapia (genus *Oreochromis*), a staple in global aquaculture, is susceptible to various diseases, which can significantly impact farm yield and profitability. This study compares the performance and economic viability of a vaccinated batch with Tilavac S3 (Virbac) versus an unvaccinated control batch of Red Tilapia cultured in a cage system in a river Thailand. The objective was to assess the effectiveness of vaccination in improving key performance indicators and overall farm economics.

The study spanned in 2022 and both batches used the same feed and were sourced from the same supplier. Initial stocking rates and sizes were nearly identical for both groups. The vaccinated batch comprised 3,302 fish with a total stocking weight of 117.91 kg, while the control batch had 3,304 fish with a total stocking weight of 117.99 kg. The vaccinated batch also incurred a vaccination cost of 3,427 THB. At the end of the culture period, the performance of each batch was recorded, and a production cost analysis was conducted.

The vaccinated batch demonstrated superior performance in all key metrics. It achieved a survival rate of 95%, which was significantly higher than the 81% survival rate of the control group. The vaccinated fish also had a better feed conversion ratio (FCR) of 1.55 compared to the control group’s 1.71. Consequently, the vaccinated batch had a higher total harvested weight of 3,752.40 kg, yielding a profit of 42,481 THB. In contrast, the control batch’s total harvested weight was 2,945.60 kg, resulting in a much lower profit of 15,230 THB.

The results indicate that vaccination with Tilavac S3 significantly enhances survival rate, FCR, and total yield, leading to a substantial increase in profit.

Table 1. Production Cost and Profit/Loss Analysis of Vaccinated vs. Control Tilapia Batches

Metric	Vaccinated Batch	Control Batch
Survival Rate (%)	95%	81%
Total Weight Harvesting (kg)	3,752.40 kg	2,945.60 kg
Feed Conversion Ratio (FCR)	1.55	1.71
Fish Production Cost/kg (THB)	59.77	66.83
Total Cost (THB)	227,690	196,853
Total Profit/Loss (THB)	42,481	15,230

DIETARY PROTEIN REQUIREMENT OF FLESH PRAWN *Penaeus chinensis* IN POST-LARVAE STAGE

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Protein is the most important nutrient in aquafeeds. Establishment of optimal dietary protein level is essential to maximize growth and to reduce feed costs and nitrogen excretion. However, the dietary protein requirement of *P. chinensis* remains unknown. This study was conducted to determine the dietary protein requirement of *P. chinensis* at post-larvae stage.

Six experimental diets were formulated to contain 25%, 30%, 35%, 40%, 45% and 50% crude protein (designated as P25, P30, P35, P40, P45 and P50, respectively). Total 360 shrimp (initial BW: 0.50 ± 0.01 g) were randomly stocked into 18 tanks (96 L) with 20 shrimp per tank. Triplicate groups of shrimp were fed one of the diets four times daily for 42 days.

Growth performance (final body weight, weight gain and specific growth rate) was significantly higher in P30, P35 and P40 groups than in P25 group. Feed conversion ratio was significantly lower in P40 group than in P25 group. Protein efficiency ratio was significantly higher in P40 group than in P25 group. Survival was not significantly different among all the groups. Superoxide dismutase activity was significantly higher in P35 and P40 groups than in P25, P30 and P50 groups. Glutathione peroxidase activity was significantly higher in P40 and P45 groups than in other groups.

The results suggests that dietary protein level of 35% seems adequate to promote growth performance, feed utilization and antioxidant capacity of *P. chinensis* post-larvae. Based on the results of broken-line regression of weight gain, the dietary protein requirement for *P. chinensis* was estimated to be 36.3%.

SUSTAINING SMALL SCALE FISHING: CHANGING ROLE OF FISHERS IN INLAND CAPTURE FISHERY IN, KERALA, INDIA

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Inland fishery has got great significance in national and global food security and livelihoods of people. The inland sector of the Kerala contributes around 1.40 lakh metric tons of fish. The present case study provides a comprehensive overview of the current state of the small-scale fisheries in Kerala highlighting its potential and challenges, reinforcing the need for efforts to ensure its sustainability to ensure the well-being of the local community with a gender perspective. In-depth interviews were done with fishers, fisher women, processors and traders involved in the fishing and clam processing in and around Vembanad lake and Korapuzha river basin. We observed issues such as conflicting role between agriculture and fishery, between fisheries and tourism and between traditional fishery and introduced culture technologies. The findings of the study throw light into the need for sustainable fisheries management practices to ensure the long-term viability, effective utilization of existing infrastructure, dialogue between stakeholders with regard to conflicting issues, gender inclusive policies and entrepreneurial motivation for a sustainable inland fishery management

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COMPUTATIONAL FLUID DYNAMICS-BASED SIMULATION AND EXPERIMENTAL VALIDATION OF A SOLAR-ELECTRICAL HYBRID DRYER FOR SHRIMP DRYING

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Drying reduces water activity in fish, thereby extending their shelf life. Effective drying requires dryer designs that ensure proper airflow and heat transfer. This study employed Computational Fluid Dynamics (CFD) to optimize a Solar-Electrical Hybrid Dryer (SEHD) by analyzing the effects of chamber geometry, inlet/outlet position, heater placement, and blower arrangement on fluid flow and thermal distribution. The objective was to attain uniform airflow and temperature distribution in the dryer while reducing dead zones and hot spots before physical implementation. A 3D model of the SEHD was created in Fusion 360 and modelled using ANSYS. Boundary conditions, including velocity, pressure, and thermal inputs, were given. Simulations at an inlet air velocity of 1 m/s and 60 °C had nonuniform airflow, particularly in the lower tray areas (0.8–1.35 m/s), in spite of uniform temperature distribution. Increasing the inlet velocity to 5 m/s improved airflow (1.78–3.86 m/s) and thermal distribution. Optimal settings were observed at 3 m/s inlet and 2 m/s exhaust velocity, resulting in consistent airflow across trays (1.7–2 m/s) and improved temperature profiles.

To validate the simulation, shrimp drying experiments were conducted in the SEHD from 11:00 AM to 5:00 PM at 60 °C. Air temperature, velocity, relative humidity at three points, ambient and collector temperatures, solar radiation, solar energy harvested, and electrical energy usage were measured. Air velocity ranged from 0.8 to 1.6 m/s, with the middle tray showing the most consistent airflow. Drying air temperatures reached 67–68 °C, and collector temperatures measured as 77 °C, with the highest solar intensity reported at 965 W/m². Relative humidity decreased from initial highs (~99.5%) to 32–42% by the end, indicating efficient moisture removal. Total electrical energy usage was 3.69 kWh, supplementing solar energy, especially during low radiation periods. The shrimp's initial moisture content (78.28%) decreased to 12.04%, 11.16%, and 10.78% on the top, middle, and bottom trays, respectively, after 6 hours. Tukey's post hoc analysis showed significant differences ($p \leq 0.05$) in moisture content and drying rates among trays. The average drying rates were 0.62 (top), 0.75 (middle), and 0.86 kg water/kg solids/h (bottom). The drying efficiency of SEHD was reported to be 31.01%. A 1000 W heating coil and four fans used 40% energy from electricity, and the remaining 60% of thermal energy from solar radiation. The quality aspects of shrimp were optimal when dried in SEHD. CFD successfully shown design improvements, enhancing uniformity in drying and enhancing dryer efficiency. Experimental results validated CFD predictions, demonstrating the SEHD's capability to maintain stable conditions and effectively utilize hybrid energy for efficient shrimp drying.

USE OF MARINE-BASED GELATIN IN COMBINATION WITH ULVAN EXTRACTED FROM *Ulva lactuca* IN SCAFFOLD FORMATION AND ITS STRUCTURAL CHARACTERIZATION, PHYSICAL AND FUNCTIONAL PROPERTIES

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Gelatin used in the formation of scaffold is derived from fish-scales. Ulvan, a sulfated polysaccharide extracted from *Ulva lactuca*, was isolated using acidified hot water extraction method with a notable yield of 25.74%. The extracted ulvan was subjected to physical characterization through Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), and Thermogravimetric Analysis (TGA), while its chemical composition was confirmed by uronic acid determination. Ulvan was subsequently blended with marine-derived gelatin to fabricate bio-composite scaffolds aimed at tissue engineering applications. The scaffolds were evaluated for mechanical strength, thermal stability, porosity, water uptake capacity, and in vitro degradation profile. SEM analysis revealed a porous, interconnected microstructure favorable for cellular infiltration. The scaffolds demonstrated suitable physicochemical properties, including enhanced mechanical integrity and controlled biodegradability, indicating their potential for biomedical applications. This study highlights the promise of ulvan–gelatin scaffolds as a sustainable and functional biomaterial platform for regenerative medicine.



Figure 1. Gelatin Ulvan Scaffolds prepared at different ratios of gelatin & Ulvan

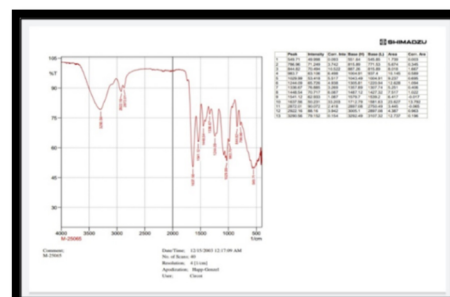


Figure 2. FTIR spectra of ulvan gelatin scaffold- A1 where gelatin and ulvan are in ratio of 7: 3

SEM Analysis

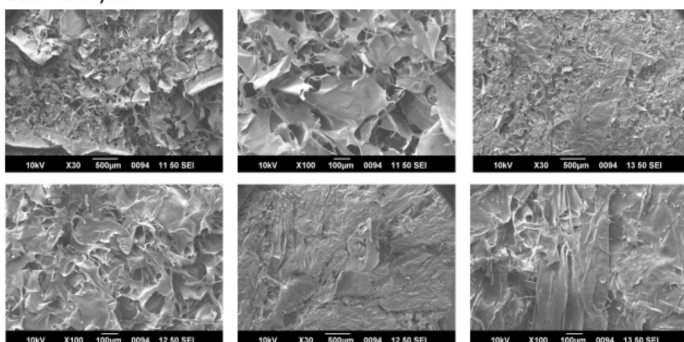


Figure 3. SEM micrographs of scaffolds with polymer ratios of gelatin and ulvan at 7:3 (a, b), 5:5 (c, d), and 3:7 (e, f) at 30× and 100× magnifications

PERCEPTIONS OF FARMED FISH WELFARE BY DIFFERENT STAKEHOLDERS: A FOCUS ON POMPANO *Trachinotus* spp IN VIETNAM

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While pompano is an important mariculture species in Vietnam, a lack of formal fish welfare standards and monitoring on the smallscale farms that are prevalent presents a concern regarding welfare of this fish in aquaculture; and varying levels of understanding among practitioners, coupled with traditional farming practices, may hinder adoption of species-specific welfare measures. This study investigated the perceptions and practices of fish welfare in small-scale pompano aquaculture in Nha Trang and surrounded areas. Structured questionnaires were used to interview key stakeholders - hatchery operators, grow-out farmers, and transporters.

A significant majority of stakeholders, particularly hatchery and grow-out operators, demonstrated a strong foundational understanding of key fish welfare concepts, acknowledging fish sentience and susceptibility to stressors. Furthermore, these groups largely accepted their responsibility for ensuring good welfare conditions for the fish, such as good health, freedom to perform natural behaviours, proper feeding, and absence of injury. This positive baseline of awareness and acceptance of responsibility provides a solid foundation for further welfare improvements within the sector.

Despite the generally positive awareness, notable gaps and challenges exist. Transporters exhibited uncertainty regarding behavioural welfare indicators. While operators expressed high awareness and responsibility, their self-assessment of actual welfare practices revealed a discrepancy between knowledge and implementation.

Specifically, hatcheries showed some uncertainty regarding the impact of chemical use, and a portion of grow-out farms expressed doubts about their disease control methods. Transporters, while recognizing transport-related stressors, lacked understanding of social stress and sedation techniques. A significant percentage of transporters also admitted to lacking sufficient knowledge about fish welfare, highlighting a critical need for targeted education. Moreover, a considerable proportion of hatchery and grow-out operators perceived a lack of resources as a barrier to implementing optimal welfare practices.

This study has laid the groundwork for significant welfare improvements in Vietnam's pompano aquaculture industry. With targeted training, stakeholder collaboration, and evidence-based policy support, the sector can align with international welfare standards while improving productivity, sustainability, and social license to operate.

QUANTUM-ENHANCED WATER QUALITY OPTIMIZATION IN AQUACULTURE USING QAOA

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Aquaculture sustainability relies on maintaining dissolved oxygen (DO) levels while minimizing the energy demand of aeration systems. Conventional optimization approaches, including linear programming and heuristic methods, struggle to manage the nonlinear, multi-objective nature of aquaculture environments. To address this challenge, we introduce a quantum-enhanced decision-support framework that integrates the Quantum Approximate Optimization Algorithm (QAOA) with artificial intelligence (AI), machine learning (ML) forecasting, and IoT-enabled Digital Twin simulations.

The proposed architecture consists of three layers: (1) a quantum optimization layer applying QAOA for aeration scheduling, (2) a classical AI layer for real-time prediction of environmental parameters such as temperature, pH, ammonia concentration, and stocking density, and (3) a sensor–actuator layer for continuous monitoring and control of pond conditions. The optimization process is evaluated using six performance indicators: Oxygen Utilization Efficiency (OUE), Fish Oxygen Demand Index (FODI), Ammonia Load Factor (ALF), Aeration Priority Score (APS), Environmental Stress Index (ESI), and Quantum Optimization Impact Factor (QOIF).

Simulation studies demonstrate a 22.5% reduction in daily aeration energy consumption and a 49.8% improvement in DO stability relative to classical optimization techniques, with estimated annual energy savings of \$954 per system. Beyond aquaculture, this hybrid approach can be adapted for industrial water optimization applications such as wastewater treatment and smart cooling systems.

This research represents the first implementation of QAOA in aquaculture optimization and highlights its potential to advance quantum-enhanced environmental management. By combining quantum computing, AI, and aquaculture science, the proposed framework offers a scalable and sustainable solution to support global food production systems.

INCLUSION OF ANTARCTIC KRILL MEAL IN LOW FISH MEAL FEEDS IMPROVES FEED INTAKE, GROWTH, DIGESTION, METABOLIC SCOPE AND THERMAL TOLERANCE IN RAINBOW TROUT JUVENILES

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Antarctic krill meal is a nutritional powerhouse which could minimize the over-reliance on traditional marine ingredients and add functional value in sustainable feed formulations for high trophic level fishes. To validate this, we carried out a 10-week study to evaluate the potential benefits of Antarctic krill meal inclusion in low fish meal feeds for rainbow trout. Five isonitrogenous experimental feeds with graded levels of high quality Antarctic krill meal (Aker QRILL - 0, 2.5, 5, 7.5 and 10%) and uniformly low fish meal content (15%) were fed to triplicate groups of fish, twice daily, to visual satiation. At the end of the trial, the effect of krill meal inclusion level on growth, feed use, carcass composition, tissue metrics, digestive enzyme activities, plasma metabolites, metabolic rates / scope, thermal tolerance limits and microanatomy of digestive organs was examined in the rainbow trout juveniles.

Regardless of the inclusion level, krill meal improved feed intake in rainbow trout. Correspondingly, thermal growth coefficient and specific growth rate was significantly higher in all the krill meal fed groups, without any difference in feed conversion efficiency. With respect to whole body composition, protein and ash content increased with krill meal inclusion. Daily nitrogen gain was high in the krill meal fed groups linked to high nitrogen intake. However, protein retention, protein efficiency ratio and nitrogen loss did not differ between the dietary groups. Daily lipid gain was significantly higher in KM2.5 and KM5 groups, whereas lipid retention decreased at high krill meal inclusion levels. Concerning phosphorus dynamics, whole body P content, daily P gain and P retention was high in the KM5 dietary group, consistent with higher intestinal alkaline phosphatase activity.

Krill meal inclusion was found to enhance intestinal trypsin activity. Particularly, KM5 dietary group showed coherently higher total protease, trypsin and leucine aminopeptidase activities. Likewise, intestinal lipase activity was significantly higher in the KM5 and KM10 groups. Intestinal microvilli height and density was also apparently higher in KM2.5 and KM5 fed fish. But intestinal amylase activity was found to decrease with krill meal inclusion. Plasma total protein and globulin levels, and hepatic total antioxidant capacity were high in KM5 and KM7.5 groups; whereas plasma triglyceride levels and aspartate aminotransferase activity were high in KM2.5 and KM7.5 groups. Irrespective of the inclusion level, krill meal elevated plasma albumin levels potentially indicating improved fish welfare. Conversely, hepatosomatic and viscerosomatic indices decreased in the krill meal fed groups, possibly linked to reduced fat deposition in the hepatocytes.

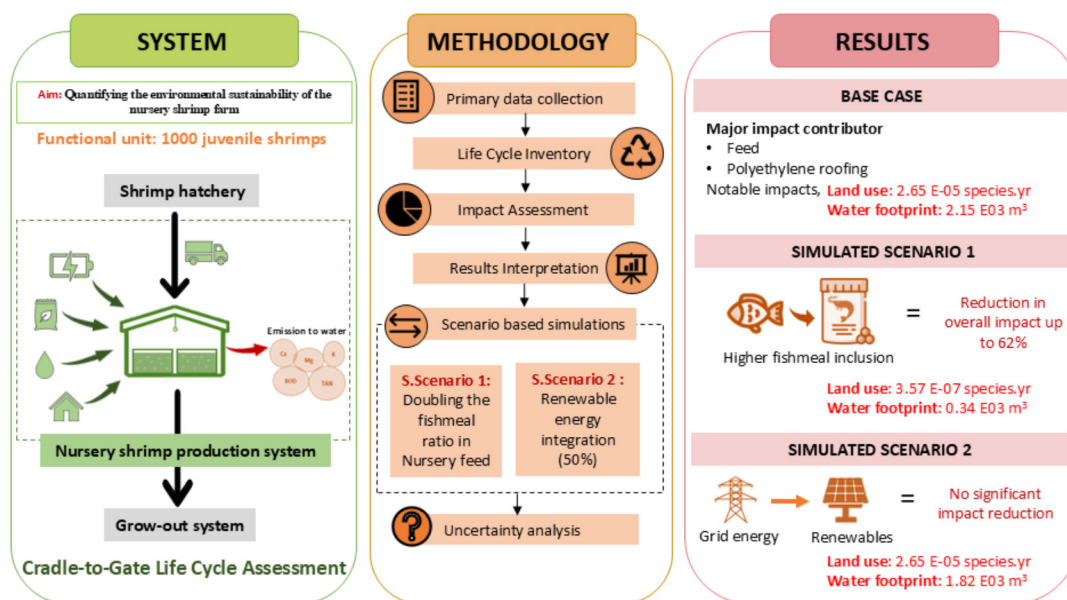
MO_{2max} showed no difference between dietary groups. But, MO_{2rout} showed significant decrease in KM5, KM7.5 and KM10 indicating improved energy homeostasis. The highest metabolic scope was observed in the KM5 dietary group. Dietary krill meal increased CT_{max} and also improved CT_{min} at high inclusion levels. Overall, 5% krill meal inclusion was found to be optimum to achieve improved feed intake, growth, digestion, carcass composition, antioxidant status, metabolic scope and thermal tolerance in trout fed low fish meal diets.

QUANTIFYING THE ENVIRONMENTAL SUSTAINABILITY OF THE NURSERY SHRIMP FARM: A CASE STUDY IN INDIA

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The nursery shrimp production system is a critical stage in the shrimp production lifecycle, where post-larvae are intensively reared under controlled conditions until they reach a suitable weight to be stocked in grow-out ponds. Typically operated as a closed production system, this stage requires substantial material and energy inputs, which may result in significant environmental impacts. Hence, environmental impact assessment on the nursery production system is essential to identify opportunities for reducing impacts and improving resource efficiency and overall sustainability. This study analysed the environmental sustainability of a commercial nursery shrimp farm (base case) in India. It tested changes in feed composition and energy source as potential impact reduction strategies through scenario simulations. The cradle-to-gate attributional life cycle assessment was conducted with a functional unit of 1000 juvenile shrimps produced at the nursery farm gate. The results indicated that feed is the significant impact contributor across all impact categories, including mid and endpoint categories, followed by polyethylene roofing. Feed accounted for 98% of land use impacts and 99% of the water footprint. Challenging the common perception of fishmeal as an inherently less sustainable ingredient in aquafeed formulations, our case study showed that increasing fishmeal inclusion can reduce overall environmental impacts by up to 62%, compared to the base case. Moreover, and again counterintuitively, simulating partial replacement of grid energy with renewables offered limited benefits in the studied case, except in water use. This study is the first to comprehensively evaluate the environmental impacts of the shrimp nursery system, establishing a benchmark for driving sustainability improvements in the shrimp supply chain.



LIQUID NITROGEN-BASED CHILLING: AN ECO-FRIENDLY AND ENERGY-EFFICIENT ONBOARD STORAGE SYSTEM FOR PRESERVING THE QUALITY OF BLACK POMFRET (*Parastromateus niger*)

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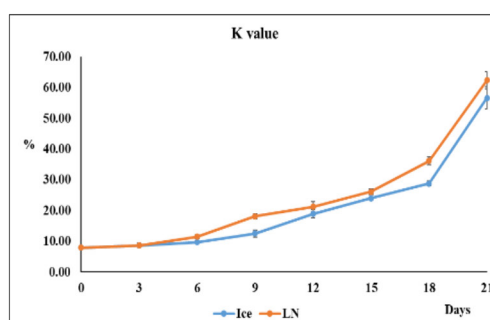
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A liquid nitrogen (LN₂)-based chilling system is an environmentally friendly, energy-efficient method for preserving fish on fishing vessels. It can quickly and evenly chill or freeze fish, preventing the formation of large ice crystals and reducing cellular damage, which helps maintain product quality during storage and transport. In this study, an LN₂-based refrigerant chilling system installed on board the ICAR-CIFT fishing vessel 'Sagar Harita' was used to store and assess the quality of black pomfret fish (*Parastromateus niger*) caught during the fishing operation. The refrigerant was replenished every three days to ensure a constant supply and maintain the temperature of 2° C throughout the 21-day storage period.

Various parameters, including microbial counts such as Total Plate Count, Psychrophilic counts, *Pseudomonas* sp., and biochemical characteristics like TBARS, TVB-N, and TMA, as well as the freshness indicator (K-value), were monitored throughout the storage period. The findings were compared with those of fish stored on ice.

In microbial analysis, there was no significant difference between samples in the total Plate Count and Psychrophilic counts. However, the *Pseudomonas* sp. count exceeded the acceptable limit on the 21st day of storage in both samples. Similarly, the biochemical parameter, such as the TBARS value, exceeded the limit at the end of storage in both samples. The K-value indicated the samples' freshness, and it increased as storage days progressed. Overall, the study reveals no significant difference between LN₂ and ice storage conditions, suggesting that LN₂ storage can provide a similar preservative effect with minimal storage space and energy requirements.

It could be one of the best options for the fishing industry to replace traditional icing, chilling, and freezing techniques onboard fishing vessels, owing to its advantages, including high efficiency, rapid freezing or chilling, energy savings, environmental benefits, and reduced volume.



COMPREHENSIVE POST-LARVAE SCREENING ENHANCES DISEASE RESISTANCE AND FARM SUCCESS IN *Litopenaeus vannamei* CULTURE

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Selecting high-quality post-larvae (PL) is very important for preventing diseases and achieving good growth in *Litopenaeus vannamei* shrimp farming. At the Hatchery level, microscopic tests were done to check the health and strength of the shrimp seed. More than 20 factors were examined, including the condition of the hepatopancreas, gut fullness, gill health, lipid levels, and ability to adapt to pond water (acclimation). Each factor was scored, and a total score of 90 out of 100 was set as the minimum passing mark by AquaExchange. Molecular testing using qPCR was also carried out to detect infections early. Between October 2024 and June 2025, this process was applied to 650 million seeds and achieved a 98.4% success rate. These results show that careful PL screening greatly reduces disease risk and improves overall farm performance.

REPLACE FISH MEAL WITH POTENTIAL UTILIZATION MORINGA (*Moringa oleifera*) AND *Leucaena leucocephala* LEAF MEAL ON GROWTH PERFORMANCE OF PANGASIOUS AND COMMON CARP FINGERLINGS

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As global protein consumption rises, fish protein has become an important component of food security. However, the scarcity of fishmeal necessitates the development of sustainable aquaculture solutions based on cost-effective plant-based alternatives. This study investigates the growth performance of replacing fishmeal with 0%, 30%, and 45% mixtures of *Moringa oleifera* leaf meal and *Leucaena leucocephala* leaf powder in the diet of pangasius and common carp. Each of the three-tank contained 5:1 pangasius and common carp, with an average weight of $2.80 \pm$ grams. Protein efficiency ratio (PER), feed conversion ratio (FCR), feed conversion efficiency (FCE), growth, survival rate, and specific growth rates (SGR) of pangasius and common carp were evaluated. The results of the study showed that the (T2) diet, which, had the lowest FCR and the highest mean weight growth, SGR, PER, and FCE. With a maximum survival rate, as compared to T1 and control. According to the current study's findings, the growth performances of pangasius and common carp were considerably impacted by the substitution of 30% and 45% *Moringa oleifera* and *Leucaena leucocephala* leaf meal.

FISH DIVERSITY AND WATER QUALITY OF SARESWAR BEEL, A FLOOD PLAIN WETLAND OF ASSAM IN NORTHEAST INDIA

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Beels or floodplain wetlands are low-lying areas along large rivers in India that flood seasonally due to spill over from the rivers. These are valuable fishery resources in India as they provide nutrients, livelihood, and opportunities for rural entrepreneurship. Assam has approximately 3,513 wetlands, which are often the sole source of fish for local underprivileged populations nearby. Notwithstanding the immense potential for beel fishery, very limited scientific effort has been made to evaluate the potential of beels for fish production in Assam, particularly in lower Assam. The Sareswar beel in the Kokrajhar District of Assam, India, is a freshwater beel with immense potential for developing beel fishery in the region. Information on the biodiversity, ecology, and various biotic and abiotic factors affecting them are essential for the conservation and development of sustainable beel fisheries. This study, therefore, evaluated the diversity, abundance and species richness of fish, and the water quality of Sareswar beel.

Sampling was conducted fortnightly for three consecutive years (2021-24) covering all the seasons viz., premonsoon (March-May), monsoon (June-August), retreating monsoon (September-November) and winter (December-February). Altogether 76 different fish species under 27 families were recorded, indicating a rich diversity of fish species in the beel. Family Cyprinidae recorded the highest number of species (27 species) followed by Bagridae (6), Ambassidae (4), and Channidae (4). Nearly 63% of the recorded species were small indigenous fish species (SIFs). The species richness was highest in monsoon (53 species), and the least during retreating monsoon (44 species). The overall Shannon-Wiener diversity index (H') was 3.15, and its value was maximum during premonsoon ($H' = 3.00$). Maximum species (86.84%) were found to be 'Least Concern' (LC), while five species were 'Near Threatened' as per IUCN (2024).

Majority of water quality parameters were found to be in the permissible range. Water depth was 129.88-298.72 cm during different seasons, while Secchi depth ranged between 113.92 to 146.45 cm. The mean water temperature ranged from 19.99-27.98 °C. The DO and FCO_2 ranged between 8.05-8.41 mg/L and 4.06-6.58 mg/L, respectively, while the mean water pH was 6.72-7.82. Results of other water quality parameters were: conductivity 104.39-120.00 $\mu\text{S}/\text{cm}$, total alkalinity 26.95-53.25 mg/L, total hardness 28.97-41.96 mg/L, turbidity 5.93-11.66 NTU, Nitrate-N 4.21-7.09 mg/L, calcium 6.85-13.86 mg/L and fluoride 0.07-0.10 mg/L. Additionally, correlation between fish diversity and water parameters was also observed. Results of this study may be useful for development of beel fishery in the region.

EVALUATING DIETARY SUPPLEMENTATION OF DUCKWEED ON THE GROWTH, PHYSIOLOGY AND CARCASS COMPOSITION OF *Anabas testudineus*

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With increasing population, the demand for dietary animal protein has increased. This highlights the crucial role of aquaculture in meeting the escalating global demand for nutrition. Sustainability and profitability of large-scale aquaculture production are strongly influenced by the availability and cost of feed, especially protein ingredients, which is not only the most expensive component but also a critical determinant of growth and feed efficiency. However, dependence on fish meal as protein source for aquafeed is increasingly unsustainable due to diminishing supply, escalating costs, and environmental concerns. Freshwater macrophytes such as duckweed (*Lemna minor*) offer a renewable alternative to traditional fishmeal due to their high nutritional value, rapid growth rates, and broad availability.

Anabas testudineus (Bloch, 1792), commonly known as the climbing perch, has high nutritional value, medicinal properties, and resilience, which makes it good candidate for aquaculture species expansion. However, its aquaculture production remains relatively limited compared to carps, primarily due to high feed costs driven by reliance on expensive animal-based protein ingredients. The development of cost-effective, digestible, and nutritionally balanced feeds is crucial for enhancing the aquaculture potential of *A. testudineus*. This study examines the potential of *L. minor* as a cost-effective, alternative protein source to traditional fishmeal in its feed. Juveniles of the fish were fed 60 days with test diets (TD) supplemented with graded levels of *L. minor*, viz., 0% (TD0), 5% (TD5), 10% (TD10), and 20% (TD20). Results indicate that a 15% inclusion of *L. minor* (TD15) resulted in optimal growth, feed conversion, and nutrient utilization without adverse effects. Significantly enhanced digestive enzyme activities and higher amino acid content were also observed in TD15 group. Immunoglobulin, lysozyme, alkaline phosphatase, and catalase activities were elevated in fish fed the *L. minor*-incorporated diet, while aspartate aminotransferase, alanine aminotransferase, superoxide dismutase activities, and thiobarbituric acid reactive substances remained unaffected. Polynomial regression analysis indicated an optimal inclusion range of 16.25% to 17.10%. These findings suggest that incorporation of *L. minor* in aquafeeds could substantially reduce production costs leading to sustainable aquaculture of the species.

DIETARY MANGANESE REQUIREMENT AND EFFECTS ON GROWTH, INNATE IMMUNITY AND DISEASE RESISTANCE OF PACIFIC WHITE SHRIMP *Penaeus vannamei* REARED UNDER LOW SALINITY CONDITIONS

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Manganese (Mn) is an essential trace element in shrimps serving as a cofactor for exoskeleton development, metabolic processes and immune responses. Limited information is available on Mn requirement for Pacific white shrimp under low-salinity condition. This study, therefore, was conducted to evaluate the requirement of dietary Mn and its effects on growth performance, innate immunity, antioxidant capacity and disease resistance of the shrimp reared under low-salinity condition.

A basal diet (Mn0) containing 10% fish meal (anchovy), 25% corn gluten meal and 3% fish oil (cod liver) was formulated. The experimental diets were prepared to contain 20, 40, 60, 80 and 100 mg/kg Mn (designated as Mn20, Mn40, Mn60, Mn80 and Mn100, respectively). Total 450 shrimp (initial BW: 0.62 ± 0.01 g) were randomly distributed in 18 tanks (240 L) with 25 shrimp per tank. Triplicate groups of shrimp were fed one of the diets six times daily for 56 days. Salinity of the rearing water was maintained at 10 ppt. After the feeding trial, a bacterial challenge test against *Vibrio harveyi* was conducted.

Growth performance (final body weight, weight gain and specific growth rate) was significantly higher in Mn60 group than in Mn0 group. Feed utilization efficiency (feed conversion ratio and protein efficiency ratio) and survival were not significantly different among all the groups. Superoxide dismutase activity was significantly enhanced in Mn40, Mn60 and Mn80 groups than in Mn0 group. Glutathione peroxidase activity was significantly improved in Mn60 group than in Mn0, Mn20 and Mn100 groups. Catalase activity was significantly higher in Mn60 group than in Mn0 and Mn100 groups. Disease resistance against *V. harveyi* was significantly improved in Mn60 group than in Mn0 group.

The optimal dietary Mn supplementation can improve the growth performance, antioxidant capacity and disease resistance against *V. harveyi* of Pacific white shrimp under low-salinity conditions. Based on quadratic regression analysis of weight gain, the Mn requirement was estimated to be 66.1 mg/kg for Pacific white shrimp under low salinity condition.

GENETIC DIVERSITY AND BIOMETRIC ASSESSMENT OF *Labeo rohita* POPULATIONS IN THE HARSİ RESERVOIR, MADHYA PRADESH

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The Harsi reservoir in Madhya Pradesh, an important freshwater ecosystem in the Bundelkhand region, supports both aquatic and terrestrial biodiversity as well as local fisheries. Despite its ecological and economic significance, there is limited information about the population structure and genetic diversity of *Labeo rohita* (rohu), a key aquaculture species in its upper stretch. Previous studies have mainly focused on general morphometric or ecological features, leaving a gap in genetic, biometric, and water quality data. This study aims to fill that gap by comprehensively assessing the biometric traits and genetic diversity of *L. rohita* populations in the Harsi reservoir using advanced techniques like Tross network analysis and molecular markers. Tross network analysis, based on anatomical structure geometry, along with mtDNA analysis, provides insights into genetic structure, gene flow, and inbreeding potential. The research integrates live fish and water sampling, catch composition analysis, morphometric measurements, DNA barcoding, and statistical methods to explore both physical and genetic diversity. The findings are considered in the context of regional factors, water management practices, and catch composition, with a focus on how water quality impacts growth and genetic makeup. This study underscores the risks of genetic erosion in unmanaged populations and shows that combining morphometric and molecular methods can help identify distinct fish stocks and guide effective breeding programs. The results offer actionable strategies for conserving biodiversity, reducing inbreeding risks, and enhancing fish stock management, contributing to the sustainability of fisheries and socio-economic development in Bundelkhand.

HABITAT RESTORATION INTERVENTION THROUGH ARTIFICIAL REEFS: ADDRESSING LIVELIHOOD AND SUSTAINABILITY CHALLENGES IN INDIAN MARINE FISHERIES

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The deployment of artificial reefs has emerged as a transformative intervention for coastal fisheries management and livelihood enhancement across maritime India. Under the Pradhan Mantri Matsya Sampada Yojana (PMMSY), approximately 947 reef sites have been strategically established along the coastline of Tamil Nadu, Kerala, Maharashtra, Karnataka, Goa, Puducherry, Andhra Pradesh, and Odisha, with technical expertise provided by ICAR-Central Marine Fisheries Research Institute (CMFRI). Additionally, complementary funding mechanisms have facilitated the creation of nearly 600 supplementary sites. Each installation encompasses an average area of 0.17 hectares and operates within the regulatory framework of respective State Marine Fisheries Regulation Acts, ensuring compliance with sustainable fishing practices.

Collectively, these artificial reef structures span over 263 hectares of coastal waters, creating substantial marine habitat and aggregation zones for commercially important fish species. The socio-economic implications are particularly significant for artisanal and small-scale fishing communities, who constitute the primary beneficiaries of this initiative. Direct fishing operations at the reef sites support approximately 47,350 fishers across primary deployment areas, while spillover effects and peripheral fishing grounds extend livelihood benefits to an estimated 94,700 additional fishers, bringing the total direct and indirect beneficiary base to approximately 142,050 fishing households.

The artificial reef programme demonstrates marked improvements in operational efficiency for traditional fishing communities, notably through reduced fuel consumption, minimized voyage duration, and enhanced catch per unit effort. These structures function as productive fishing grounds in proximity to coastal settlements, thereby diminishing the economic burden on resource-constrained fisherfolk while simultaneously contributing to the restoration of degraded marine ecosystems. When exploited within responsible fishing parameters, artificial reefs present a viable pathway toward achieving ecological sustainability while addressing the livelihood security of one of India's most vulnerable coastal demographic groups. This multi-dimensional approach represents a significant advancement in integrating conservation objectives with socio-economic development imperatives in the Indian marine fisheries sector.

THE MAGNITUDE OF ABANDONED BOATS IN NEGOMBO ESTUARY, SRI LANKA

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The absence of proper discarding facilities, regulations and monitoring has resulted in fishers dumping their gear and vessels into waterways resulting in huge environmental implications due to accumulation of Abandoned, Lost, or otherwise Discarded Fishing Gear (ALDFGs).

The Negombo estuary, spanning approximately 3,164 hectares, is located around 20 km north of Colombo fringed by mangrove and seagrass beds. As a vital fisheries hub in Sri Lanka, it supports significant fishing activities and acts as a focal tourist destination.

This study ground verified the spatial positions of each abandoned boat in the estuary and along its border from March 2024 to January 2025. Details such as boat type, level of sinking, degree of degradation. If visible the boat name, registration number, color, and any associated visible materials, were recorded. A total of 53 abandoned boats, of which 48% of them classified as multi-day boats (FRP) were recorded from the census. The rest were outboard engine FRP boats, non-mechanized watercraft such as canoes, catamarans and passenger boats. In terms of level of sinking, 44% of the boats were floating, other boats were partially or fully submerged. While 35% were largely intact, showing only minor damage. The density of boats at present is 1.64 per km². Spatial density mapping revealed the estuary mouth area as the abandonment hotspot. The amount of fiber plastics used to build is varied with the boat types. However, now it has the potential to enter fiberglass into this ecosystem. A plan to remove the already abandoned vessels and to stop this illegal practice is urgently needed to ensure health and safety of the people, livelihoods and ecosystem.

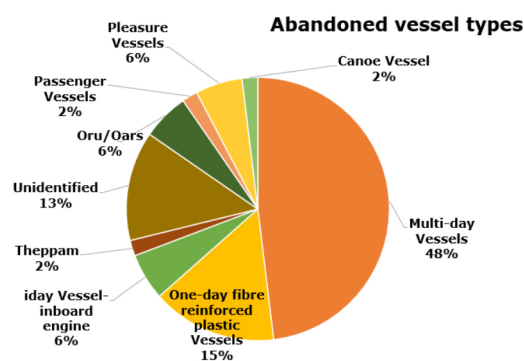


FIGURE 1. Overview of the types of abandoned vessels

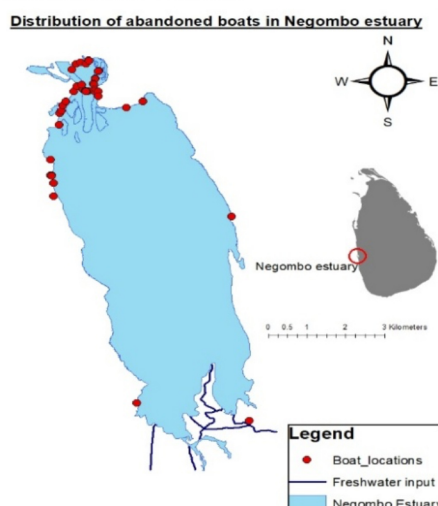


FIGURE 2. Distribution of abandoned boats in Negombo estuary, Sri Lanka

**FIELD TRIAL OF COMMERCIAL ESSENTIAL OILS AGAINST MARINE LEECH
Zeylanicobdella arugamensis INFESTATION IN HYBRID GROUPERS *Epinephelus* sp.**

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This study assessed the effectiveness of essential oils (EO) from cinnamon, garlic, and citronella mixed with feed pellets to reduce marine leech infestations in hybrid groupers. The trial involved 3,000 groupers fed a 14-day diet with specific EO, while another 1,000 received standard pellets before being placed in infested floating cages. Fish were divided into four groups, each with 1,000 individuals. Results showed that the group on standard pellets experienced a 100% infection rate and a mean intensity of 5.9 leeches. In contrast, the EO-treated groups showed significantly lower prevalence, with infections ranging from 53.3% to 75% and mean intensities between 1.1 and 2.4 during the first four weeks. The cinnamon EO group had the fewest leeches attached, demonstrating a notable advantage over citronella and garlic. These findings suggest incorporating EO into diets can effectively mitigate marine leech infestations, offering a viable strategy for protecting hybrid grouper during critical periods.

ASSESSMENT OF IMMUNOSTIMULATORY EFFECTS OF CHIRCHIRA *Achyranthes aspera* ENHANCED DIETS FED WITH ROHU *Labeo rohita* IN POND CULTURE SYSTEM

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Fish and fishery products are a significant source of protein and critical micronutrients needed for optimal health. Diseases and diverse parasite diseases cause significant losses to the aquaculture sector. Immunostimulation is an effective method for preventing infectious diseases in the sector. The use of herbal compounds as immunostimulants in aquaculture is fast growing to circumvent the usage of harmful antibiotics. Rohu (1.9 ± 0.08 g) were cultured in 3m² hapa under three different feeding regimes with three replicate of each treatment in the pond of ICAR-CIFE center Rohtak, Haryana. The feeding diets were seeds (0.5%) and leaves (0.5%) of *Achyranthes aspera* and diet without plant ingredients served as control. After 60 days of feeding fish were challenged with virulent *Aeromonas hydrophila* bacteria (5×10^6 cells/ml). The mortality was observed after 7 days; more mortality found in control fed then rest of the treatments. The major water quality parameters like temperature, pH, dissolved oxygen and conductivity were recorded regularly using HQ40d Multiparameter (Hach, USA) from four sides of the pond closer to the hapas. Water temperature and pH ranged from 28.5 to 31°C and 8.4 to 9.16, respectively throughout the culture period. Dissolved oxygen level ranged from 7.11 to 9.62 mg/L in the pond. Average weight, MPO and NOS levels were significantly higher in plant supplemented diets fed rohu compared to control group. TBARS and carbonyl protein concentrations were decreased in the experimental groups compare to the control group. The mRNA expression of immunological genes (*Lysozyme C*, *Lysozyme G*, *TNF- α* , *IL-10*, *IL-1 β* and *TLR-4*) also showed the positive results in the treatment diets. It showed that, the diets with plant ingredients increase the immunity in rohu in pond culture system.



DIETARY INCLUSION OF CONDENSED TANNINS ENHANCES THE PERFORMANCE OF WHITELEG SHRIMP *Litopenaeus vannamei*

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Recently, condensed tannins (CT) have been considered as a functional feed additive in the aquafeed industry, as they have antioxidant and anti-inflammatory properties leading to improved gut health, and ultimately enhance the nutrient utilization and overall performance of shrimp. Hence, this study aimed to evaluate the effects of dietary supplementation of increasing levels of CT on the performance, oxidative status, and meat quality of *Litopenaeus vannamei*. The experiment consisted of two phases, nursery and grow-out, and was conducted under controlled conditions at the Aquaculture Sector of UFERSA (Mossoró, Brazil), using low-salinity water (3 ppt).

In Phase 1 (nursery phase), the post-larvae were stocked in 500-L tanks and fed four experimental diets, i.e., basal diet, and three additional basal diets supplemented with CT (SetaGuard® Aqua) 50g, 150g, and 250g per ton feed for 28 days. Feed intake, growth performance, and feed conversion ratio were significantly affected by dietary treatments. Based on quadratic response, the optimal dose of CT for growth and FCR were 129.02 g/t, and 162.5 g/t, respectively.

In phase 2 (grow-out phase), the shrimp juveniles were fed four experimental diets i.e., 0g, 50g, 150g, and 250g CT per ton of feed, for 70 days. The highest final weight was observed at 50 g/t, with body weight uniformity highest at 124.83 g/t. Shrimp length improved significantly at 50 g/t, with higher tannin levels promoting weight uniformity compared to the control. Maximum weight gain and optimal FCR were recorded at 50 g/t, while survival rates showed no treatment effects.

In conclusion, the recommended dose of CT is 150 g/ton and 50 g/ton for the nursery phase and grow-out phase, respectively. These findings support the strategic use of condensed tannins as functional additives for sustainable shrimp production.

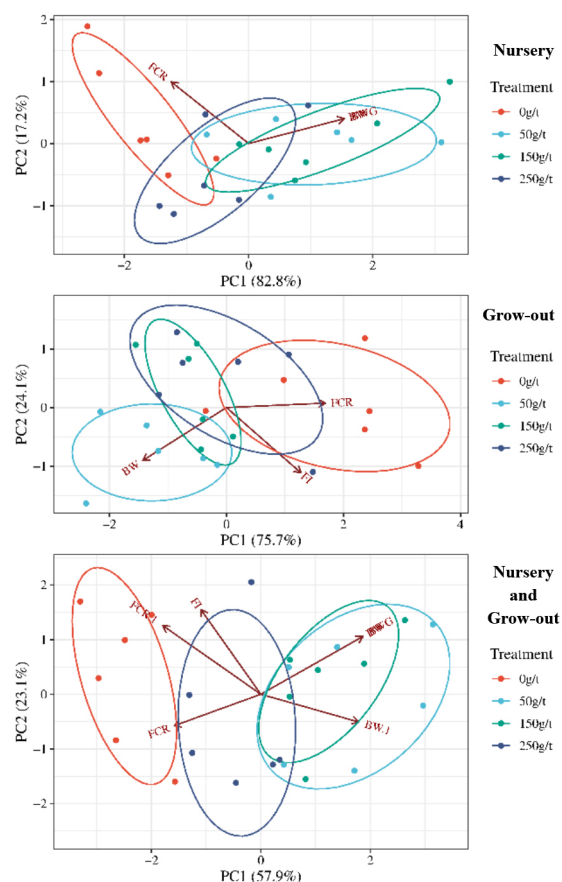


Figure 1: Principal Component Analysis (PCA) of shrimp performance data from the nursery and grow-out phases

EFFECTS OF CARBOHYDRATE SOURCES ON GROWTH PERFORMANCE AND MICROBIAL DYNAMICS IN STINGING CATFISH *Heteropneustes fossilis* CULTURED IN A BIOFLOC AQUACULTURE SYSTEM

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The present study aimed to evaluate the effects of different carbohydrate sources on water quality, growth performance, and microbial communities in *Heteropneustes fossilis*. The experiment was conducted for 120 days using 450 L tanks, with five treatments consist of three biofloc groupss, only probiotic group and a control group. *H. fossilis* fingerlings (2.86 ± 0.5 g) were stocked at a density of 700 individuals m^{-3} ($n = 210$ per tank). The results indicated significant improvements in water quality parameters in all biofloc treatments compared to the control, wherein T3 treatment (a combination of molasses and rice flour) showed the most pronounced effects. The treatment, T3 optimized flocc volume and enhanced microbial diversity was favorable for growth and survival of the fish. Growth performance metrics including harvested weight, net weight gain, specific growth rate, and feed conversion ratio were highest in the treatment T3, demonstrating the synergistic benefits of utilizing mixed carbon sources. Furthermore, the treatment T3 supported the highest proliferation of *Bacillus* spp. and total heterotrophic bacteria in both biofloc water and gut samples, contributing to better growth and survival. These findings underscore the potential of biofloc systems to sustainably enhance aquaculture productivity, particularly through the strategic application of mixed carbon sources as a means to improve water quality, microbial health, and growth outcomes in *H. fossilis* culture.

INTEGRATED SITE SUITABILITY ANALYSIS FOR CAGE CULTIVATION ALONG THE ANDHRA PRADESH COASTLINE CONSIDERING FISH LANDING CENTRES AND HYDRODYNAMIC FACTORS

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Cage cultivation has emerged as a sustainable and economically viable method for enhancing marine fish production while reducing pressure on traditional capture fisheries. Site selection plays a pivotal role in determining the success, productivity, and environmental sustainability of cage culture systems. This study focuses on identifying suitable sites for cage cultivation along the Andhra Pradesh coast, which extends over 974 km and possesses diverse marine and estuarine ecosystems. This region is also more prone to cyclonic event in the Bay of Bengal. The fish landing centres available in the regions is limited to less than 100 leading it to the increase in lead and transportation charges compared to other costal states.

Geospatial techniques were employed to analyze key environmental and socio-economic parameters. Criteria such as water depth, salinity, dissolved oxygen levels, chlorophyll concentration, current velocity, wave action, proximity to landing centers, and absence of conflict zones were considered. Multi-criteria decision support system (MCDSS) approaches, integrated with spatial datasets, were utilized to generate suitability maps for potential cage culture zones.

According to the study conducted by the CMFRI, there is 11,721 hectares of land suitable for cage cultivation. The delineated area is analysed for the proximity of fish landing centres and suitable proximity areas are given on this study. The results indicate that approximately 24% of the Andhra Pradesh coastal waters are highly suitable for cage cultivation, particularly in areas near Visakhapatnam, Kakinada, and Krishnapatnam, where optimal hydrological and logistical conditions prevail. The same locations are analysed for hydrodynamic impact assessment during the cyclonic events. Moderate suitability zones were identified in regions influenced by seasonal sedimentation and anthropogenic activity locations like Uppada regions in Kakinada. This study provides valuable proximity insights for aquaculture entrepreneurs and promoting environmentally responsible aquaculture practices along the Andhra Pradesh coastline.

DISTRIBUTION AND ANTIMICROBIAL RESISTANCE PROFILE OF *Aeromonas* spp. ISOLATED FROM THE ADI GANGA RIVER, WEST BENGAL, INDIA

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The detection of multidrug-resistant (MDR) *Aeromonas* spp. in aquatic environments presents a growing public health concern. This study focused on the Adi Ganga River, a heavily urbanized and polluted tributary of the Ganga River in West Bengal, India. Surface water samples were collected from multiple locations along the Adi Ganga, and 33 distinct *Aeromonas* spp. were isolated. The study aimed to investigate the prevalence of MDR, extended-spectrum β -lactamase (ESBL), and plasmid-mediated AmpC-producing *Aeromonas* spp.

The isolates demonstrated high levels of resistance to β -lactam/ β -lactamase inhibitor combinations (ampicillin/sulbactam: 94%, amoxicillin/clavulanic acid: 67%), carbapenems (imipenem: 91%), and cephalosporins (cephalexin: 61%, cefepime: 55%, ceftazidime: 47%, ceftriaxone: 39%). Resistance to tetracycline (18%) and chloramphenicol (15%) was comparatively lower.

ESBL production was confirmed in 56% of isolates, with blaTEM (94%), blaSHV (39%), and blaCTX-M group (27%) genes detected. Additionally, plasmid-mediated AmpC β -lactamase genes were found in 15% of isolates. The presence of MDR and ESBL-producing *Aeromonas* spp. in the Adi Ganga River underscores the environmental risk of antimicrobial resistance dissemination, posing serious implications for human, animal, and aquatic health.

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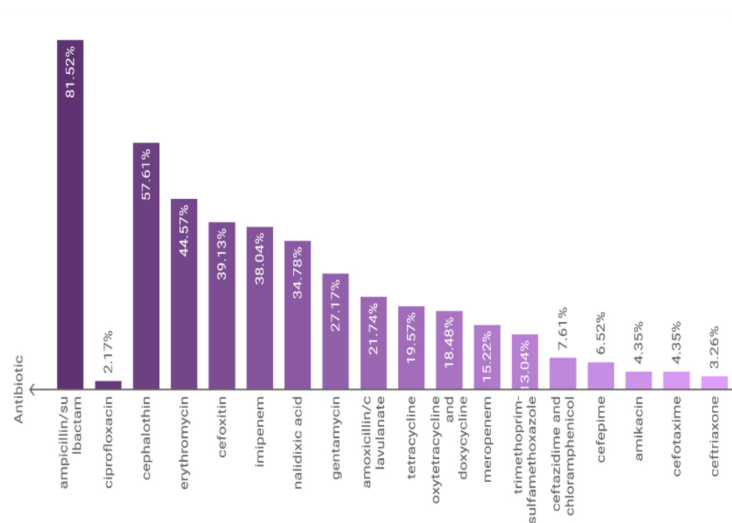


Figure 1: Antimicrobial sensitivity test of isolated bacteria

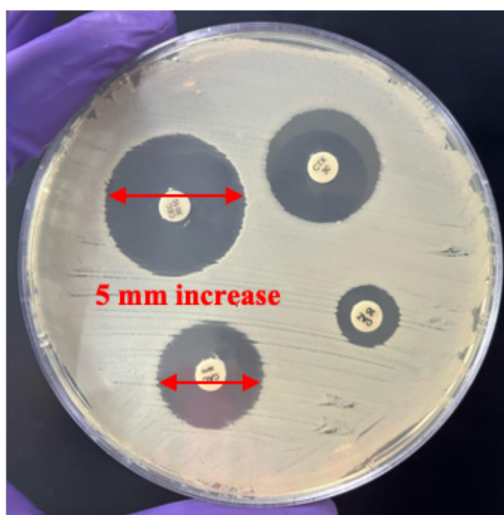


Figure 2: ESBL production assay of isolates

DIETARY EFFECT OF NON-ANTIBIOTIC ANTIMICROBIAL (NAAM) COMPOUNDS ON GROWTH, HAEMATOLOGY, DIGESTIVE ENZYME CAPACITY, ANTIOXIDANT STATUS, IMMUNE PARAMETERS, AND DISEASE RESISTANCE IN TILAPIA (*Oreochromis niloticus*)

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Diseases are a major limiting factor for sustainable aquaculture production, with lasting effects on socio-economic development and an increasing use of antimicrobials in fish. Imprudent use of such antibiotics has been subjected to criticism from scientists and environmentalists due to their negative impact on humans, animals, and the environment. The present investigation aims to study the dietary effect of NAAM compound on growth, haematology, digestive enzyme capacity, antioxidant status, immunity, and disease resistance in *Oreochromis niloticus*. The experiment compared fish in control and treatment (1 kg/ton feed) for a 45-day period. At the end of the feeding trial, the experimental animals were infected with *Aeromonas hydrophila*, *Edwardsiella tarda*, *Streptococcus agalactiae*, *Pseudomonas aeruginosa*, *Vibrio harveyi* and mortality was recorded for 21 days.

The treated group showed a significant increase in weight gain, specific growth rate and decreased feed conversion ratio compared to the control group. Further, NAAM compound supplementation in experimental fish significantly increased the digestive enzyme capacity (enteropeptidase, trypsin, pancreatic lipase, and amylase) in the treated group. Haematological parameters and antioxidant enzymes (superoxide dismutase, catalase, glutathione peroxidase) were significantly improved in fish fed NAAM compound-supplemented diets. Meanwhile, malondialdehyde levels were significantly decreased in serum and liver of fish fed with NAAM compound-supplemented diets. In the NAAM compound treated group, total protein and albumin were significantly decreased, while cholesterol and triglyceride levels were increased.

The dietary effect of NAAM compound caused significant improvements in innate immunity (NBT, phagocytic, and lysozyme activity) in tilapia compared to the control. The pathogen challenge study revealed that there was a significant difference in the survival rate of fish in the control (only feed), control + florfenicol, NAAM compound treatment (1 kg/ton feed), and NAAM compound treatment (2 kg/ton feed after pathogen injection). These findings revealed that dietary NAAM compound could exhibit a profitable effect on growth performance, haematology and serum biochemistry, antioxidant status, digestive enzyme capacity, immunity, disease resistance, and overall health status of *O. niloticus*.

ECOTOXICOLOGICAL RISK ASSESSMENT OF BISPHENOL A CONTAMINATION IN FISH, WATER, AND SEDIMENT FROM THE COASTAL ZONES OF THE RIVER GANGA

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Bisphenol A (BPA) is an endocrine-disrupting compound that pollutes aquatic habitats via plastic leaching, wastewater discharge, and landfill runoff. It functions as an environmental estrogen, resulting in reproductive anomalies, skewed sex ratios, and physiological damage to fish and other aquatic species. This study investigates the seasonal occurrence of environmental bisphenol A (eBPA) in the coastal region of the River Ganga, focusing on ecological risk assessment. The present study examined the concentrations of eBPA in surface water, soil, and fish at three sites. eBPA was quantified using a highly specific and sensitive ELISA method tailored for aquatic samples. eBPA concentrations ranged from 256.2 to 565.33 ng/L, 245.82 to 446.1 ng/L, and 295.32 to 667.19 ng/L in surface water; from 2145.29 to 2976.11 $\mu\text{g/kg-dw}$, 2017.8 to 2633.47 $\mu\text{g/kg-dw}$, and 2502.1 to 3966.46 $\mu\text{g/kg-dw}$ in sediment during the pre-monsoon, monsoon, and post-monsoon periods, respectively; and from 2.63 to 219.27 ng/g-dw in various fish species. Unlike surface water and soil, seasonal variations in eBPA concentration were not apparent at the species level in fish. The feeding zone of biota influenced the concentration of eBPA, demonstrating a trend of pelagic > demersal > benthic > benthopelagic. This research is the pioneering report on the impact of eBPA pollution on aquatic ecosystems, illustrating that fish exposed to eBPA pose health concerns to people. These findings highlight the imperative for additional research on fish contamination by eBPA for human food safety and the protection of the riverine ecosystem in the coastal region of the Ganga River.

EFFECT OF PARAQUAT DICHLORIDE TOXICITY ON ZEBRAFISH

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This study explores the toxic effects of herbicide, Paraquat Dichloride on Zebrafish (*Danio rerio*), a commonly used model organism in toxicological research studies. These fish are often used in research because they are small, easy to handle, and react clearly to harmful substances. In this experiment, healthy adult zebrafish were kept in clean water and water mixed with the herbicide at three levels: 1 mg/L, 2 mg/L, and 3 mg/L. The fish were observed for 72 hours to check how many survived and how they behaved.

No fish died in clean water or at 1 mg/L, but many died at 2 mg/L, and all died at 3 mg/L.

So, LC_{50} in 24 hrs is 3 mg/L, LC_{100} in 72 hrs is 3 mg/L. LC_{100} in 72 hrs is 1 mg/L, 2 mg/L, LOEC is 1 mg/L. Along with death, treated fish showed unusual behaviour like swimming alone, staying in dark areas for long, acting aggressively, and not swimming properly. These changes suggest the herbicide affected the fish's brain or stress levels.

To know more, biochemical analysis was done on fish tissues. The results showed reduced levels of important enzymes like Hexokinase (reduced from 192.9 U/g to 38.5 U/g), glucose 6-phosphate (reduced from 32.1 mg/gm to 12.8 mg/gm), along with decline in Glycogen (reduced from 3.0 mg/gm to 1.2 mg/gm), protein (reduced from 0.2 mg/gm to 0.05 mg/gm) and cholesterol (reduced from 3.3 mg/gm to 1.3 mg/gm). This suggests disrupted metabolism and possible liver damage.

In short, this herbicide can harm fish in many ways—not just killing them but also causing serious changes in behaviour and health. This shows the need to use such chemicals more carefully to protect aquatic life.

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ENHANCING THE VALUE OF LOCALLY-AVAILABLE INGREDIENTS IN *Penaeus vannamei* NUTRITION

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The limited and increasing cost of fishmeal and imported raw materials has spurred interest in sustainable alternatives for shrimp feed (FAO, 2022). Locally-available biomass as ingredients for shrimp feeds offers a cost-effective and sustainable option, but are often of poor quality and with low digestibility.

This study consisted of two (2) feeding trials in a RAS system. The first trial, shown in Table 1, was to compare a Positive Control, a Negative Control, and a Negative Control supplemented with digestibility enhancement mixture (Upgrade¹). The second study focused on fine-tuning the Upgrade mixture.

The *in-vitro* test confirmed the increased feeds digestibility (Table 2). *In-vivo* growth trials also confirmed the improvement in final body weight and FCR (Figure 1a,b). Also, fine-tuned mixture resulted in better FCR (Figure 2) than the Positive Control, .

This study showed that the inclusion of local plant-based materials resulted in subpar performance in *P. vannamei* as compared to fishmeal-based diet but such can be mitigated if the feeds digestibility is increased.

Table 1. Key differences in treatment feed formulation.

Raw Material	Positive Control	Upgrade	Negative Control
Soya bean meal	35.00	21.17	21.17
Fish meal	23.45	18.00	18.00
DDGS	-	5.00	5.00
PMBM	-	10.00	10.00
Palm kernel meal	-	3.00	3.00
Rice bran	-	3.00	3.00
Upgrade Mix ¹	-	0.50	-
Protein/Fat%	42/7	42/7	42/7

Table 2. *In-vitro* protein digestibility using ProDigest SPIME™ model.

Digestibility	Positive Control	Upgrade	Negative Control
%digestibility (3 hours)	79.13	78.98	76.33
%digestibility (5 hours)	83.55	81.14	79.57

Figure 1. Final shrimp mean body weight (a) and Feed Conversion Ratio (b)

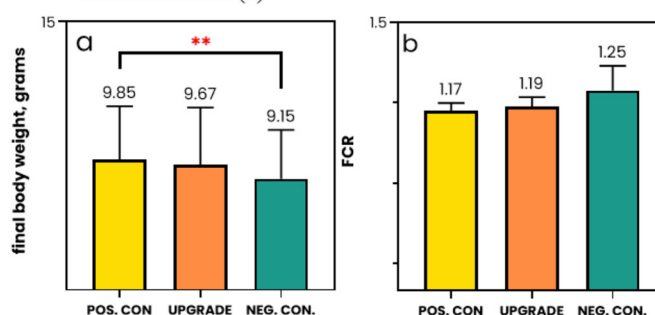
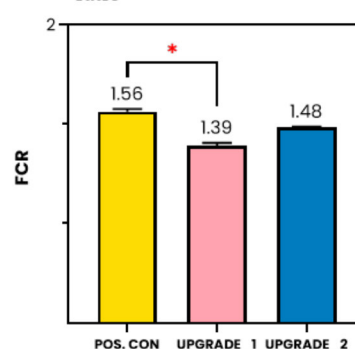


Figure 2. Feed conversion ratio



EFFECTS OF DIETARY VITAMIN D₃ LEVELS ON GROWTH, IMMUNITY, ANTIOXIDANT CAPACITY AND DISEASE RESISTANCE IN PACIFIC WHITE SHRIMP, *Penaeus vannamei*

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Vitamin D₃ is essential for calcium and phosphorus metabolism, antioxidant defense, and immune regulation in vertebrates, and recent evidence indicates similar roles in crustaceans. Pacific white shrimp (*Penaeus vannamei*) is the most widely farmed aquaculture species, yet its dietary requirement for vitamin D₃ remains unclear. This study therefore evaluated the effects of graded dietary vitamin D₃ levels on growth, antioxidant capacity, immunity, digestive enzymes, tissue histology, and disease resistance in *P. vannamei*.

Six experimental diets were formulated to contain 0, 37.5, 75, 150, 300 and 600 µg/kg vitamin D₃ supplementation (designated as CON, VD37.5, VD75, VD150, VD300 and VD600). HPLC analysis confirmed actual dietary vitamin D₃ levels of 4.8, 37.6, 78.4, 152.8, 313.7 and 609.4 µg/kg diet. A total of 600 shrimp (initial body weight: 2.02 ± 0.01 g) were randomly distributed into 24 tanks (240 L, 25 shrimp/tank) with four replicates per treatment and fed the diets at 3–6% of body weight per day for 10 weeks. After the feeding trial, a *Vibrio harveyi* challenge test was conducted by immersion at 8.1 × 10⁶ CFU/mL with 16 shrimp per tank in triplicate for 11 days.

Growth performance (final body weight, weight gain, specific growth rate) was significantly higher in VD75, VD150 and VD300 compared to CON ($P < 0.05$). Feed conversion rate was significantly lower in VD75, while protein efficiency rate was significantly higher in VD75 than in CON ($P < 0.05$). Survival and feed intake were not significantly different among groups ($P > 0.05$). During *Vibrio harveyi* challenge, all vitamin D₃-supplemented groups exhibited significantly higher survival than CON ($P < 0.05$). In hemolymph, lysozyme activity was significantly higher in VD300 and VD600 compared to CON ($P < 0.05$) and phenoloxidase activity was highest in VD75 compared to CON ($P < 0.05$). Hemolymph calcium level and alkaline phosphatase activity were significantly higher in VD150, VD300 and VD600 compared to CON ($P < 0.05$), while hemolymph inorganic phosphorus level was significantly higher in CON than in VD37.5 and VD75 ($P < 0.05$). In carapace, calcium content was significantly higher in VD300 and VD600 ($P < 0.05$), phosphorus content was significantly higher in VD37.5 ($P < 0.05$). In hepatopancreas, superoxide dismutase activity was significantly higher in VD37.5, VD75 and VD150 ($P < 0.05$), glutathione peroxidase in VD37.5 and VD75 ($P < 0.05$), catalase in VD37.5, VD75 and VD300 ($P < 0.05$). Malondialdehyde levels were significantly lower in VD37.5, VD75 and VD150 compared to CON ($P < 0.05$). Trypsin activity was significantly increased in VD37.5, VD75 and VD150 ($P < 0.05$), and lipase activity was higher in VD150 compared to CON ($P < 0.05$).

In conclusion, dietary supplementation of vitamin D₃ improved growth, feed efficiency, non-specific immunity, digestive and antioxidant enzyme activities, mineral deposition and *V. harveyi* resistance in *P. vannamei*. The quadratic-plateau regression model estimated the optimal dietary vitamin D₃ level for weight gain at 53.6 µg/kg.

RECIRCULATING HYBRID SYSTEM USING COMBINED TECHNIQUES: BIOFLOC-AQUAPONICS-NYTRIFICATION FOR FISH AND SHRIMP (*Peneus vannamei*) PRODUCTION

Carlos León Ramos*

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The world status requires more than one impact to have a reversible effect on the way we have deteriorated it. It requires a contribution of several actors with different parallel actions visualizing a Triple Impact to achieve a Zero Net Impact. Bio-Integrated Aquaponics 5.0 is a circular production system that is based on the integration of FIVE production components to make more efficient use of FIVE natural resources with FIVE principles that promote FIVE human values for the integration of FIVE business areas. This model of Aquaponics 5.0 has been able to be implemented from a home system or a rural system in which, in addition to obtaining Healthy Food, Education and Agrotourism are obtained, to a commercial system where the same integration produces by-products of high added value that increase profitability. of the company.

Bio Integrated Aquaponics is an example of the cyclical model of nature, which is based on the use of resources where the reduction of elements prevails. Aquaponics 5.0 uses Biomass conversion components that generate raw materials to convert them into insect or worm protein through Permaculture techniques, which are in turn used by Aquaculture crops that produce nutrients in the water for the development of plants that They rid the water of toxic waste. All this with the help of renewable energy that gives movement to the system and the water that is stored from rain and condensation.

A commercial system of Aquaponics 5.0 is based on a Hybrid Biotech Recirculating System composed of FIVE different processes such as filtration, nitrification, biofloc, microalgae, mineralization, and bioremediation. AKUA ZERO, is a project that combines the production of Tilapia & White Snook on a Aquaponic system that has a sub-production of Microalgae and Shrimp, in a zero waste recirculating water and air system.



MULTITROPHIC AQUAPONICS USING BRACKISH WATER FOR PRODUCING FISH AND PLANTS AS DESALINIZATION

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Saline intrusion is a phenomenon where saltwater from the sea intrudes into freshwater aquifers. In agriculture, saline intrusion poses a serious threat because high salinity water harms soil quality and reduces crop yields. Salt buildup in the soil blocks plants from absorbing water, lowers crop productivity, and can make large areas of land infertile. This causes significant economic losses and threatens food security in affected regions.

In the Middle East, this problem is particularly severe since 65% of water is used for agriculture, with over 80% coming from underground aquifers, many of which are depleting. In some farming areas, salinity levels in well water have exceeded 6,000 ppm (parts per million), far above recommended limits for irrigation. This salinization has caused a 30-50% drop in yields of sensitive crops like wheat, vegetables, and fruits.

While efforts are underway to use treated wastewater as an alternative resource, its role in agriculture remains limited. Therefore, it is essential to treat highly saline water and make it suitable for farming through brackish water desalination technologies. Additionally, improving irrigation efficiency and adopting comprehensive solutions that address the water, energy, and food nexus within a circular economy framework are crucial.

The Multitrophic Aquaponics project demonstrates a practical approach to achieving food security in arid environments. It relies on renewable energy, low-cost desalination methods, and salt-tolerant crops that help diversify feed sources and produce economically valuable crops. This project combines aquaculture (tilapia) to produce nutrients for hydroponic cultivation of salt-tolerant plants, along with microalgae bioreactors. It allows water and waste to be recirculated within a closed, solar-powered system. The project also includes a microalgae bioreactor and shrimp ponds to better utilize the salts and waste in the system.



ORGANIC TRACE MINERAL SOURCE ENHANCE THE BIOAVAILABILITY, HEALTH STATUS, AND GUT MICROBIOTA COMMUNITY IN WHITE SHRIMP (*Penaeus vannamei*)

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Trace mineral supplementation is critical for shrimp aquaculture sustainability, yet the bioavailability of conventional inorganic forms remains suboptimal. The study investigated the effects of inorganic (IM) and organic (OM) trace mineral premixes at varying doses on growth, physiological responses, and gut microbiota in white shrimp (*Penaeus vannamei*).

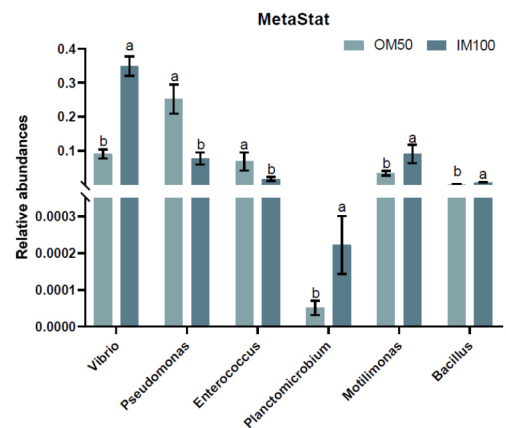
Five experimental diets were formulated: a basal control (no supplementation), full-dose IM (IM100), half-dose IM (IM50), half-dose OM (OM50), and one-third dose OM (OM33). A total of 800 shrimp were randomly distributed into 20 tanks for an 8-week feeding experiment. The results showed that shrimp fed diets OM50 and IM100 had significantly higher total protein content in the plasma, lower levels of total cholesterol and triglyceride, and enhanced antioxidant capacity and immune response (greater activities of T-SOD, GPX, and PO, lower content of MDA, higher content of hemocyanin, and upregulated expression of cat, gpx, and Hemo Table 1). Furthermore, OM50 group showed superior mineral bioaccumulation, particularly for Zn in the hepatopancreas and whole body, and Cu in the whole body, accompanied by upregulated expression of mineral transporter-related (ZIP14, ZnT6, and MT). Moreover, diet OM50 resulted in a higher abundance of potential probiotic bacteria (including *Pseudomonas* and *Enterococcus*) and a lower abundance of potential pathogenic bacteria (including *Vibrio* and *Planctomicrobium*) (Figure 1). The findings indicated that organic trace minerals premix at half the conventional dosage can effectively enhance its bioavailability, significantly improve the health status, and beneficially modify intestinal microbiota communities of shrimp, suggesting superior efficiency compared to inorganic forms.

Table 1: Plasma biochemical constituents of shrimp fed with organic or inorganic trace minerals premixes.

Diets	Contro l	IM100	IM50	OM50	OM33
T-CHO (mmol/L)	17.26 ± 0.58a	9.05 ± 0.41 c	14.75 ± 1.13 ab	12.27 ± 0.46 b	13.94 ± 0.88 b
TG (mmol/L)	3.53 ± 0.10 a	1.19 ± 0.07 c	2.40 ± 0.10 b	1.36 ± 0.11 c	1.53 ± 0.10 c
GLU (mg/ dL)	31.86 ± 1.83	32.90 ± 1.93	31.81 ± 1.11	32.24 ± 1.15	32.67 ± 0.70
TP (g/L)	39.32 ± 1.38 c	59.13 ± 1.46 a	49.31 ± 1.77 b	64.31 ± 2.69 a	44.20 ± 1.76 bc
ALB (g/L)	23.06 ± 0.88 ab	27.80 ± 1.96 a	25.82 ± 2.51 ab	27.84 ± 2.05 a	18.22 ± 1.75 b

Results are shown as means ± S.E. of four replicate. Different superscript letters in each row indicate significant differences ($p < 0.05$). T-CHO, total cholesterol; TG, triglyceride; GLU, glucose; TP, total protein; ALB, albumin.

Figure 1: Meta-statistical analysis of the intestinal microbiota of white shrimp at the genus level between the OM50 and IM100 group.



Results are shown as means ± S.E. of four replicates. Different superscript letters indicate significant differences ($p < 0.05$).

EVALUATION OF THE COMBINED IMPACT OF AFLATOXIN B1 AND DEOXYNIVALENOL FEED TO *Penaeus vannamei* AND MITIGATION PROPERTIES PROVIDED BY A YEAST CELL WALL EXTRACT

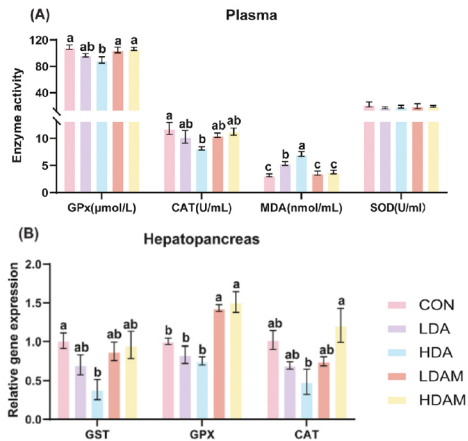
Gang Lin*, Xiao Li, Jinzhu Yang, Weijian Huang, Mingzhu Li, Kangsen Mai and Yanjiao Zhang

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The purpose of this study was to examine how white shrimp (*Penaeus vannamei*) responded to varying concentrations of combined mycotoxins (aflatoxin B1 (AFB1) and deoxynivalenol (DON)) as well as the mitigating effects of an adsorbent (yeast cell wall extract, YCWE).

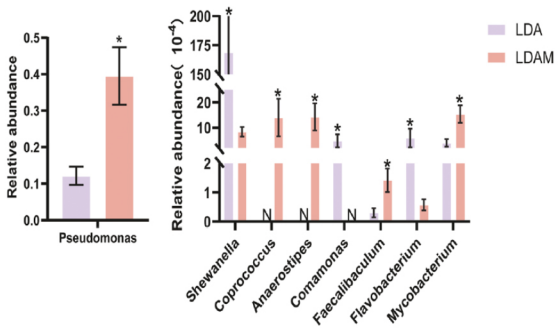
The experiment comprised of five groups receiving isonitrogenous and isolipidic diets: CON (control group), LDA (CON with 20 µg/kg AFB1 and 1500 µg/kg DON), HDA (CON with 100 µg/kg AFB1 and 3000 µg/kg DON), LDAM (LDA with 0.2 % YCWE), and HDAM (HDA with 0.2 % YCWE). Results showed that the contents of total protein, total cholesterol, hemocyanin, and enzyme activities (e.g., catalase, phenoloxidase) in plasma were lower in HDA group, while the alanine aminotransferase activity and malondialdehyde content were higher. The HDA group showed up-regulated expression of apoptotic genes in the hepatopancreas but down-regulated expression of immune-related and antioxidant genes. In the LDA and HDA groups, the higher expression of inflammatory genes in hepatopancreas, the lowest chewiness of muscle and the higher abundance of potential pathogens (e.g., *Escherichia-Shigella*) in the intestine were observed. However, LDAM and HDAM diets were able to enhance the immune response, antioxidant capacity, and hepatopancreatic and intestinal health of shrimp, especially increased the abundance of intestinal bacteria for detoxification (e.g., *Pseudomonas*). Moreover, dietary YCWE also led to significantly greater mycotoxin content in the feces. In conclusion, the combined mycotoxins AFB1 and DON can negatively affect the health of shrimp, even at lower doses. But adding YCWE to the diets can effectively mitigate these negative effects.

Figure 1: Effects of dietary DON + AFB1 and YCWE on shrimp’s antioxidant capacity.



(A) enzyme activities of plasma; (B) gene expressions of hepatopancreas. GPX, glutathione peroxidase; CAT, catalase; MDA, malondialdehyde; SOD, superoxide dismutase; GST, glutathione S-transferase. Values represented are means ± standard error. a,b,c Value bars sharing the same superscript letter or those without superscript letter are not significantly different, not sharing the same superscript letter are significantly different (P < 0.05).

Figure 2: Effects of dietary DON + AFB1 and YCWE on shrimp’s intestinal microbiota. The MetaStat analysis of intestinal microbiota communities of white shrimp.



THE CURRENT STATE AND PROSPECT OF RECIRCULATING AQUACULTURE SYSTEMS IN CHINA

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The Recirculating Aquaculture System (RAS) represents a sustainable and high-efficiency model for aquaculture in China's aquatic production. In China, RAS technology has undergone four development stages since its introduction in 1985: the technology importation phase (1985–1998), the exploratory development phase (1999–2006), the system integration phase (2007–2011), and the rapid growth phase (2012–present). With the continuous expansion of market demand, investments in water treatment technology R&D and theoretical RAS research have also increased significantly. At present, RAS technology has been successfully applied to the cultivation of several high-economic value aquatic species in China. By 2012, over 110 nationwide enterprises had established RAS infrastructure exceeding a total capacity of 1.4 million cubic meters (**Fig. 1**). Consequently, R&D in related engineering technology have also become a strategic priority for China's socioeconomic development.

In China, RAS systems can be categorized into three typical models based on production scale: automated precision systems for large-scale farms, semi-automated modular systems for medium-sized enterprises, and cost-effective basic systems for small-scale producers. While China has already achieved domestic production of core RAS equipments and reached internationally advanced levels in breeding technologies for certain marine species, in recent times, researchers are actively working to resolve key challenges with RAS, such as reducing production cost, technical optimization, and disease prevention.

Under the combined effects of policy support, improved environmental regulations, and market demand, currently, China's RAS industry exhibits following developmental trends: transformation of technical systems toward high-tech, large-scale, and industrialized models; partial RAS units achieving international standards; progressive refinement of industry technical standards and manufacturing management systems; projected cultivation area exceeding 7 million square meters by 2027; industrial-scale application of RAS in fry production. Overall, through continuous technological innovation and industrial upgrading, China's RAS sector is poised to attain global competitiveness and make substantial contributions to worldwide sustainable aquaculture development.

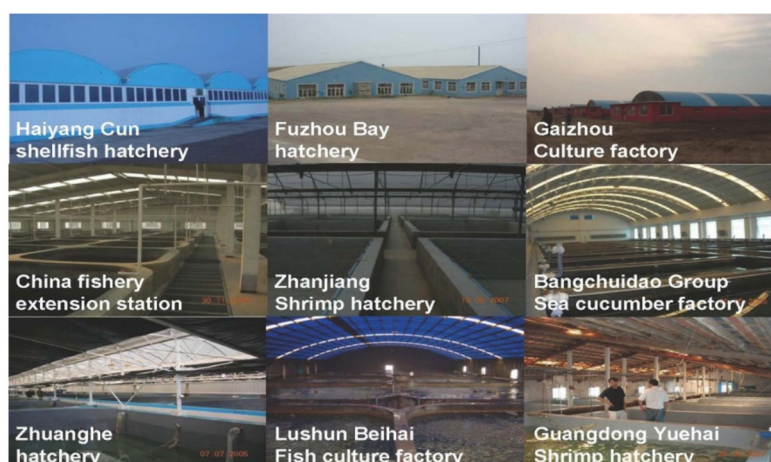


Fig. 1. RAS established at different cities across China

VACCINE DEVELOPMENT AGAINST SCALE DROP DISEASE VIRUS IN ASIAN SEABASS *Lates calcarifer*

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Asian seabass (*Lates calcarifer*) is an important farmed species in Southeast Asian aquaculture, valued for its nutritional benefits and market appeal. However, the widespread outbreak of scale drop disease virus (SDDV) has caused major production losses, posing serious financial risks to farmers and undermining food security targets. With mortality rates reaching up to 70%, there is an urgent need for an effective vaccine to protect seabass farming and reduce the impact of SDDV.

At A*STAR IDL, we focus on vaccine development and have taken a multipronged approach targeting viral protein fragments to stimulate adaptive immune responses in the host fish. In this study, 141 juvenile seabass ($10 \text{ g} \pm 2$) were divided into six groups. Four groups were vaccinated at week 0 and boosted at week 3 with either a B cell vaccine, T cell vaccine, combination B and T cell vaccine, or a subunit vaccine. The remaining two groups were unvaccinated controls.

Six weeks after priming, fish were challenged intraperitoneally with purified SDDV. At three weeks post-infection, the unvaccinated group showed 48% mortality, while the unchallenged control group had no mortality. Among the vaccinated groups, the combination epitope vaccine group showed the highest survival rate, indicating strong protection.

In summary, the combination epitope vaccine shows promising potential in protecting Asian seabass against SDDV. Further optimisation may improve efficacy and support disease management in the aquaculture sector.

EFFECTS OF POTASSIUM DIFORMATE ON VIBRIO SPP. REDUCTION IN ARTEMIA CULTURE

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Intensive production of the white leg shrimp, *Litopenaeus vannamei* (Boone 1931), in Central America and Asia is estimated to have reached 5.9 million t in 2024. The global shrimp market size is suggested to reach 130 billion USD in 2032. In such intensive aquaculture production, bacterial diseases have been identified as a major cause of economic loss to producers. Especially in live feed larviculture, where the brine shrimp *Artemia* spp. is the most widely used species, it has been speculated that *Artemia* can act as a carrier or reservoir for pathogenic bacteria, such as *Vibrio* spp. Antibiotics used to be common practice to treat such bacterial infections and the prophylactic use of antibiotics as growth promoters in aquaculture production has also been widely applied. Regulatory authorities in most exporting countries now focus on preventing misuse of antibiotics in aquaculture, while public attention has shifted towards sustainable production methods. Organic acids, and especially potassium diformate, which is the most widely tested organic acid salt in aquaculture, are among the various alternatives for environmentally friendly and nutritive-sustainable aquaculture. Potassium diformate (KDF, traded as AQUAFORM, ADDCON) has been tested in shrimp aquaculture since 2006 and since then numerous publications, conference contributions and review-papers on the use of KDF in aquaculture have been published worldwide. This study was designed to estimate the impact of potassium diformate on *Vibrio* spp. reduction in *Artemia* larviculture.

The final dataset contained the results of 5 trials at Indian shrimp hatcheries and their *Artemia* production, in which KDF was included. The KDF-dosages ranged from 10 to 30 g per 1000 L tank volume under commercial conditions – with an average of 22 g/cbm. The additive was added to the *Artemia* nauplii at 4 to 17 hours post-hatch – and the number of *Vibrio* colonies was compared between 24- and 32-hours post-hatch. Data were subjected to statistical analysis and a significance level of 0.05 was used in all tests.

The *Vibrio* counts in the treated groups was considerably reduced. In four out of the five trials, *Vibrio* spp. numbers were reduced to zero. The overall reduction rate was 99.1%. Due to the high variation, caused by the different production systems in the hatcheries, reduction only tended to be significant ($P < 0.097$). Water quality parameters remained stable, while *Artemia* health and activity was improved.

In general, results show a promising concept for reduction of pathogenic bacteria, and thus health status, with potassium diformate in *Artemia* hatcheries. These findings support the use of KDF in shrimp and *Artemia* culture as a promising alternative in ecologically sustainable and resource-optimized shrimp production.

GENETIC IMPROVEMENT OF BODY WEIGHT AND SURVIVAL IN *Litopenaeus vannamei* THROUGH PERSISTENT SELECTION

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Whiteleg shrimp (*Litopenaeus vannamei*) is a key species in global aquaculture. Vietnam’s whiteleg shrimp production grew by 82% from 2018 to 2024, according to the Vietnam Association of Seafood Exporters and Producers (VASEP). To support continued gains in productivity, genetic selection has become a core strategy in breeding programs at Viet-Uc Seafood Joint Stock Company (Viet-Uc hereafter). This study evaluates the effectiveness of selection for two traits — body weight (WT) and survival (SUR) — to enhance broodstock performance in Viet-Uc’s *L. vannamei* population raised under varying environmental conditions.

Phenotypic data for WT and SUR were collected from 697,382 whiteleg shrimp across 19 generations (2011–2023) by Viet-Uc. Post-larvae from the same family were reared together until ~5g, then elastomer-tagged and divided into broodstock (25 shrimp/m²) and progeny testing groups (150 shrimp/m²). Measurements were taken at approximately 142.38 ± 1.64 and 136.98 ± 2.94 days, respectively. Genetic parameters and Estimated Breeding Values (EBVs) for the traits were estimated using AIREMLF90 and BLUPF90+, respectively, based on detailed pedigree and phenotypic records.

Heritability estimates ($h^2 \pm SE$) were 0.25 ± 0.01 for WT and 0.04 ± 0.00 for SUR, with a mean survival rate of 74.4%, indicating high genetic potential for WT and strong environmental influence on SUR. EBVs across 19 generations showed consistent genetic gain for WT (FIGURE 1), reflected in increasing mean adjusted WT (g), while SUR showed moderate genetic improvement, with phenotypic gains becoming more apparent after generation 17 (FIGURE 2). A genetic correlation ($\pm SE$) of 0.35 ± 0.05 between traits suggests that selection for WT may offer modest indirect benefits for SUR, though further improvement in SUR will require strengthened environmental and health management strategies.

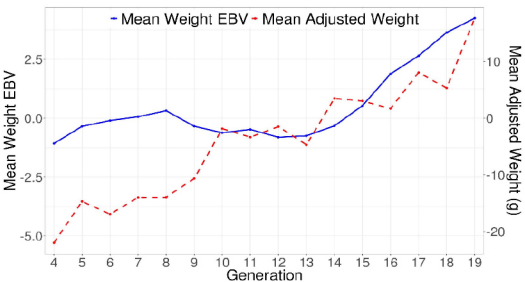


FIGURE 1. Trajectories of mean weight EBV and mean adjusted weight (g) across shrimp generations.

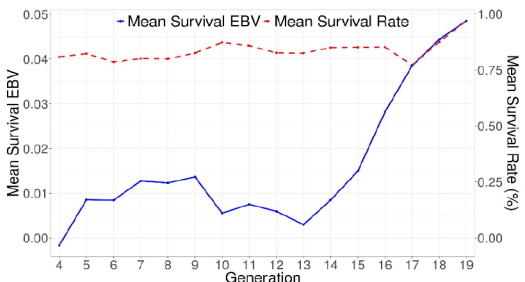


FIGURE 2. Trajectories of mean survival EBV and mean survival rate (%) across shrimp generations.

TOWARDS LOW IMPACT AND FUEL EFFICIENT FISHING: INNOVATIONS FROM ICAR-CIFT

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The ICAR–Central Institute of Fisheries Technology (ICAR-CIFT) has played a pivotal role in promoting responsible fishing practices in India through innovative vessel and gear designs, that enhance ecological sustainability and economic efficiency of marine fisheries in India. The major achievements include the development of an energy-efficient “green” combination vessel *FV Sagar Harita*, a 19.75 m multi-purpose training and research vessel that is found to significantly reduce fuel consumption and emissions when compared to conventional vessels in the fishery. The combined operations for gillnet, and longline fishing, serve as a model for sustainable and diversified fishing practices. In addition to this, innovations in solar powered boats for fishing and hybrid fishing vessels, now being experimented in different parts of the country, are other achievements to address the issue of GHG emissions.

A standardized design of Turtle Excluder Device (CIFT-TED), developed in collaboration with NOAA (USA), is found to achieve over 90% exclusion of sea turtles without compromising shrimp catch, thereby ensuring compliance with global sustainability and trade requirements. The V-form slotted otter boards (VSOB), which is a design modification of the existing V-form otter board, is found to significantly reduce the fuel consumption in trawling, thereby catering to the efforts towards adoption of renewable energy sources in the marine fisheries, for reducing operational costs and carbon emissions. Further innovations in green technologies by the institute include the development of low-drag UHMWPE, short-body trawls and cut-away trawl designs intended to address to reduce the annual diesel consumption of over 165 million liters in the country.

Square-mesh codend, a simple intervention that replaces the traditional codends in trawls, are found to significantly reduce the juvenile bycatch, combined with fuel savings, and this is being adopted by more than half of the maritime states of India. In addition, many bycatch reduction devices were also developed that address the issue of bycatch in fishing. Eco-friendly alternatives to lead sinkers in fishing gears is another innovation that tries to address the issue of lead pollution in the marine environment. Quantification and mitigation of fishing related plastics is another area, where ICAR-CIFT has focused on and the research on quantitative assessments and technical guidelines that inform national policies on reducing food and gear losses, is a major achievement.

The initiatives that underscore the leadership of ICAR-CIFT in integrating technological innovation with responsible fisheries management, contributing to reduced ecological footprints, enhanced fleet efficiency, and compliance with international sustainability standards is discussed.

THE INVESTIGATION OF THE RAPID TESTING OF AQUA INGREDIENTS AND OIL USING SPECTROSCOPY TECHNOLOGY

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Monitoring the quality of marine products, including fish oils and extracts, is essential throughout the supply chain to ensure product safety, efficacy, and compliance with industry standards. Traditionally, this has been achieved using wet chemistry methods in laboratories or via third-party testing. However, these processes are often tedious, time-consuming, and reliant on expensive instrumentation, creating bottlenecks in quality assurance.

Spectroscopic technologies, particularly near-infrared (NIR) and mid-infrared (MIR), offer a fast, reliable, and cost-effective alternative to traditional chemical methods. NIR technology, widely recognized for its ability to rapidly analyze chemical concentrations across various industries, remains underutilized in the marine sector despite its potential to revolutionize the field. The success of spectroscopic methods hinges on selecting the right spectrometers and developing robust calibrations tailored to specific processes and materials.

This research explores the application of spectroscopic methods in analyzing marine products such as fish meal, krill oil, filets, and surimi. It highlights the performance of these methods in quantifying key components, including EPA, DHA, phospholipids, peroxide value, moisture, protein, carbohydrates, and fat. The study evaluates suitable technology platforms for implementing these analyses and showcases their application across the entire supply chain—from fishing vessels and ports to in-line production analysis.

AI integration plays a pivotal role in enhancing these spectroscopic methods, particularly in in-line analysis. By leveraging machine learning-powered algorithms, automated systems can monitor real-time production data, detect anomalies, and adjust processes dynamically, ensuring consistent quality and efficiency. This automation significantly reduces human intervention, minimizes errors, and optimizes resource use.

Additionally, this paper addresses common challenges in developing reliable spectroscopic methods, such as selecting appropriate instrumentation, applying advanced modeling techniques, and overcoming the complexities of calibration. The discussion will also cover the substantial time and cost savings achievable through the adoption of these technologies, underscoring their transformative impact on the aqua industry.

CAPTIVE BREEDING AND PROSPECTS OF MARINE ORNAMENTAL FISHES IN INDIA

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The global ornamental fish trade, worth about US \$4.5 billion, is dominated by freshwater species (85%), with India contributing around ₹10 Crore mainly from freshwater fish. India, however, has vast potential for marine ornamental fish exports, especially from the Lakshadweep, Andaman and Nicobar Islands, Gulf of Mannar, and Palk Bay. Over 300 species occur in Lakshadweep alone, with wrasses, damselfish, parrotfish, and goatfish forming 85% of the population. Despite rich biodiversity and growing demand, India's marine ornamental fish trade remains underdeveloped due to limited technology and infrastructure. Sustainable growth requires non-destructive collection, strict environmental protection, captive breeding, and effective regulation. Developing hatchery and culture technologies is essential for a long-term, eco-friendly trade that supports both economic growth and coral reef conservation. In these juncture, CMFRI developed hatchery technology for about 40 marine ornamental fishes such as clown fishes *Amphiprion percula* (True percula/ clown anemone fish); *A. ocellaris* (Common Clown/False clown anemonefish); *A. sandaracinos* (Yellow Skunk Clown); *A. frenatus* (Tomato clown), *A. clarkii* (Clark's anemone fish), *A. sebae* (Sebae clown) *A. akallopisos* (Skunk Clown), *A. periderarion* (Pink anemone fish) *A. ephippium* (Red saddle back anemone fish), *A. nigripes* (Lakshadweep clownfish), *Premnas biaculeatus* (Maroon clown/ Spine cheek anemone fish, Hybridizing of Black ocellaris and Percula clown, Double dot domino clown, Production of designer clown fishes. The species under damsels for which technology developed under captivity included *Dascyllus trimaculatus* (Three spot damsel); *D. aruanus* (Striped damsel); *Pomacentrus caeruleus* (Blue damsel); *P. pavo* (Sapphire or Peacock Damsel); *Neopomacentrus nemurus* (Yellow tail damsel); *N. filamentosus* (Filamentous tail damsel); *Chrysiptera cyanae* (Sapphire devil); *C. unimaculata* (One spot damsel), *C. hemicyanea*, *Neopomacentrus cyanomos*, *N. nemurus*, and *Dascyllus carneus*, Two-tone chromis *Pycnochromis fieldi*, *Pycnochromis retrofasciatus*, *Chromis viridis* (Green chromis) and Black bar chromis *Pycnochromis retrofasciatus* Lemon Damsel *Pomacentrus moluccensis*; anthias *Pseudanthias marcia* and *P. squamipinnis* and also dotty back *Pseudochromis dilectus* (Redhead Dottyback), purple fire goby *Nemateleotris decora* for the first time in the world, Cleaner shrimp *Lysemata amboinensis*, red banded coral shrimp *Stenopus hispidus*, Wide bar shrimp goby *Amblyeleotris latifasciata*, ornate goby *Istiogobius ornatus* and Lemon coral goby *Gobiodon citrinus*.

WATER QUALITY AND GROWTH OF IMC IN A BIOFLOC SYSTEM

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Biofloc technology is a method for improving water quality in aquaculture by maintaining a balance of carbon and nitrogen in the system. The technology has recently gained attention as a sustainable method to control water quality, with the added value of producing proteinaceous feed *in-situ*. The present study was conducted to compare the effects of *in-situ* produced biofloc on the growth and production of IMC under different stocking densities in light limited Indore tank.

Experiments were carried out in nineteen FRP tanks (1000 L each) for a period of 90 days. The experimental design included *in-situ* biofloc and control treatments conducted at three different stocking densities (STD) 25, 50 and 75 no. fish per m³ of tank respectively with each experiment replicated thrice.

IMC of individual average weight 15 ± 1.6 g was reared in all treatments. In *in-situ* biofloc treatment, low protein (20%) commercial fish feed was added initially. Further, organic carbon in the form of wheat flour was added daily to maintain the C:N ratio at 10. The amount of feed and extra carbohydrate required in biofloc process varies with time as biomass density varies with time. Around 60% extra carbohydrate to be applied in a typical *in-situ* biofloc tank. In control treatment, high protein (30%) commercial fish feed was added. In all the treatments, TAN concentration was kept below 1 mg L⁻¹ through 50% water exchange whenever required (Table-1). Feeding rate, water quality parameter and fish growth parameter were determined following standard methodology. TSS and BOD levels were more in *in-situ* biofloc treatment as compared to the control treatments. The harvested weight of fish in *in-situ* biofloc treatment with STD 25 no./m³ were found to be significantly higher among all the treatments ($p < 0.05$). The results achieved in the study confirmed the trends of decrease in growth for IMC species with increased stocking densities. During the 90 days culture period net fish yield was highest (3905 ± 234) in externally added biofloc tank with highest stocking density (STD 75 no/m³). Fish survival was 100% in all the treatments.

The FCR values in *in-situ* biofloc treatment was less compared to the control treatment. SGR (Specific Growth Rate) value was more in *in-situ* treatment compared to control one. FCR, SGR and net fish yield (kg h⁻¹ in different treatments was presented in (Table-2).

TABLE 1 Details of water exchange in different treatments.

STD (no/m ³)	Treatments	Number of water exchanges	Days of water exchange
25	Control	4	30, 42, 60, 72
	<i>In-situ</i> Biofloc	3	53, 65, 86
50	Control	4	23, 50, 65, 83
	<i>In-situ</i> Biofloc	3	31, 62, 77
75	Control	5	20, 32, 47, 62, 77
	<i>In-situ</i> Biofloc	4	44, 59, 71, 83

TABLE 2 FCR, SGR and Net Fish Yield vale during treatment (The values bearing different superscripts in rows and columns differ significantly ($p < 0.05$).

STD (no/m ³)	Treatments	FCR	SGR(% day ⁻¹)	Net Yield (kg h ⁻¹)
25	Control	2.48 ± 0.15^b	0.76 ± 0.01^b	2005 ± 8.59^a
	<i>In-situ</i> Biofloc	1.82 ± 0.08^a	1.09 ± 0.11^c	2520 ± 24.79^{cd}
50	Control	3.76 ± 0.10^c	0.52 ± 0.01^a	2700 ± 45.45^b
	<i>In-situ</i> Biofloc	2.62 ± 0.20^b	0.75 ± 0.07^b	3104 ± 108.08^{ef}
75	Control	4.58 ± 0.74^d	0.43 ± 0.06^a	3070 ± 112^{bc}
	<i>In-situ</i> Biofloc	2.63 ± 0.25^b	0.77 ± 0.09^b	3905 ± 234.12^g

STATUS OF THE SHRIMP INDUSTRY

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Over the past three decades, the global shrimp industry has experienced remarkable growth. Production volumes have increased fivefold, from 30 metric tons per hectare to 150 metric tons per hectare (*Mai C. ADM*). Today, global shrimp production has reached approximately 5.5 million metric tons (*Rabobank, 2024*). The majority of this production originates from two key regions: Asia and Latin America.

This rapid advancement has been driven by improvements in genetics, the adoption of innovative technologies, the industrialization of farming practices, enhanced disease prevention strategies, and the development of precise nutritional solutions.

Nevertheless, the industry faces growing concerns regarding sustainability. These include the conversion of natural land for aquaculture, excessive use of antibiotics and chemicals, discharge of polluted water into surrounding ecosystems, and the overreliance on fishmeal. Since 1980, shrimp feed has become the largest consumer of fishmeal, accounting for approximately 25% of global fishmeal usage (*IFFO, 2022*). Additional challenges have emerged in recent years, such as market oversupply, declining prices, and the rise of new diseases.

Sustainability: The path forward

Despite these challenges, sustainability remains a fundamental pillar for the continued development of the shrimp industry and its long-term viability. As a global leader in animal nutrition, ADM is deeply committed to promoting sustainability, particularly through nutritional innovation.

In shrimp feed formulation, ADM emphasizes the importance of balancing rapid growth performance with environmental responsibility. This involves incorporating more sustainable ingredients that minimize ecological impact. Key trends in sustainable nutrition include the use of organic minerals, phytogenics, yeast-based products, probiotics, and plant sterols.

In alignment with our mission to enhance farmer efficiency and promote sustainable practices, ADM has developed a specialized feed solution for *Litopenaeus vannamei* (whiteleg shrimp), supporting both productivity and environmental stewardship.

Importance of sterols in shrimp feeds

One unique challenge that comes with formulating shrimp feeds is the essential nature of cholesterol as a nutrient. Cholesterol plays key roles in cellular structure, tissue lipid transportation, and the regulation of lipid metabolism. It is also the essential precursor molecule to an assortment of steroid hormones that regulate molting, energy use, and reproduction (Kanazawa 2001). Crustaceans cannot synthesize cholesterol from smaller molecules, and they need sources of it in their feeds to support growth and health (1-2.5 g/kg diet for optimal growth, depending on species/life stage). Traditionally, formulators met the cholesterol requirements of shrimp by including lots of cholesterol-rich ingredients in diets, such as fish and squid oils and fishmeal. As the feed industry has been shifting away from animal-source ingredients over the last three decades, the risk of cholesterol deficiency has become a major concern (Chen et al. 2023a). While some mitigating solutions have been adopted over time (phospholipid products and bile acids to increase bioavailability), meeting the cholesterol requirements of shrimp continues to be a costly endeavor.

Plant sterols as a cholesterol alternative

One potential solution for meeting the cholesterol requirements of shrimp that has not been widely explored is the incorporation of plant sterols into feed formulations. Plant sterols are similar to cholesterol in molecular structure and serve similar functions in plant tissues. Several research studies have suggested that plant sterols have similar growth and health-promoting effects on shrimp as animal cholesterol (Chen et al. 2023b; Guo et al. 2020). A recent study from ADM Animal Nutrition evaluated the supplementation of practically-formulated, extruded test diets with no additional sterols (basal diet), 1 g/kg of cholesterol concentrate (>92%), or 1 g/kg of plant sterols concentrate (>95%) and their effects on whiteleg shrimp growth performance and body composition. Shrimp were distributed to RAS tanks and fed one of the three experimental diets for 62 days (~0.5 g/shrimp starting weight to 10-15 g/shrimp final weight). The supplementation of the basal diet with either sterols source led to significant improvements in weight gain and FCR during the feeding period (Figure). There were no statistically significant differences in growth performance between shrimp fed the cholesterol supplemented and plant sterols supplement diets. Shrimp fed with the plant sterols supplemented diet had a similar concentration of cholesterol in hepatopancreas tissues as those fed with the cholesterol supplemented diet (Figure), which suggests that shrimp can convert plant sterols into cholesterol to meet their needs. The results of this study suggest that plant sterols can support the same growth benefits as cholesterol in practical shrimp feeds with better cost efficiency.

(Continued on next page)

The plant sterols advantage

With issues of cholesterol nutrition continuing to challenge feed formulators, ADM is happy to announce the launch of Plant Sterols AN. Plant Sterols AN is a highly concentrated plant sterols product (>95% total sterols) that can help meet the cholesterol requirements of shrimp with cost efficiency. Plant Sterols AN is a dry powder with high processing stability, a highly stable formulation, and a long shelf life. When added to shrimp feeds, Plant Sterols AN can support fast growth and feed utilization while allowing formulators the flexibility to shift away from cholesterol-heavy macro ingredients. Plant Sterols AN will be available for sale by ADM Animal Nutrition in Vietnam starting in early 2026.

References

Chen, Y., Mitra, A., Rahimnejad, S., Chi, S., Kumar, V., Tan, B., Niu, J., and Xie, S. (2023a). Retrospect of fish meal substitution in Pacific white shrimp *Litopenaeus vannamei* feed: Alternatives, limitations, and future prospects. *Reviews in Aquaculture*. 16. 382-409.

Chen, Y., Pan, Z., Li, X., Yao, X., He, G., and Xie, S. (2023b). Evaluation of Phytosterols as an Alternative to Cholesterol in Practical Diets on Growth and Nonspecific Immunity of *Litopenaeus vannamei*: *Aquaculture Nutrition*. 1. 7825559.

Guo, J., Hussain, A. S., Tacon, A. G. J., Moser, J. K., Holcomb, J., Salze, G., & Davis, D. A. (2020). Cholesterol requirement and phytosterols efficiency in semi-purified diets of juvenile Pacific white shrimp *Litopenaeus vannamei*. *Aquaculture Nutrition*. 26(4). 1231-1243.

IFFO, Global Fishmeal Consumption by aquaculture sector in 2020. (2022)

Kanazawa, A. Sterols in marine invertebrates. (2001). *Fisheries Science*. 67. 997-1007.

Mai, C. ADM Aqua Academy Presentation. Internal document. (2025).

Rabobank, Global Aquaculture Update (2024).

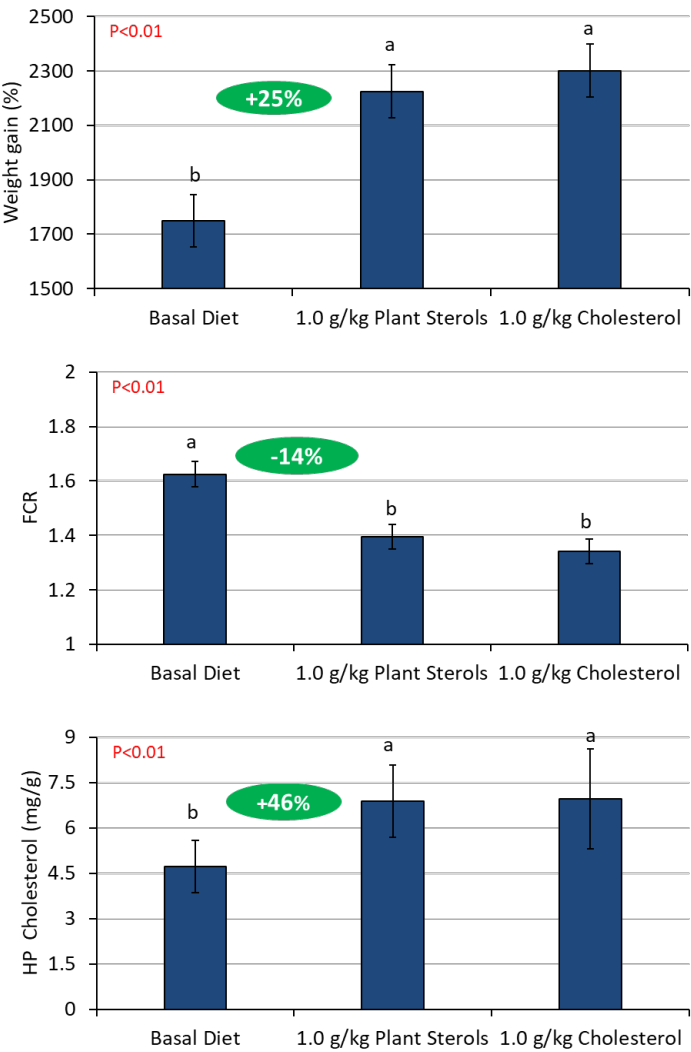


Figure. Total weight gain (%), FCR, and hepatopancreas (HP) cholesterol concentrations (mg/g) of whitleg shrimp after 62 days of feeding on practical test diets with supplemented plant sterols or cholesterol.

RESPONSE OF STERILE *Cyprinus carpio* IN SPAWNING: IMPLICATIONS FOR CONTROL OF INVASIVE FISH SPECIES IN OPEN WATERS

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Invasive fish species pose a significant danger to biodiversity and cost the economy billions of dollars by destroying ecosystem of open water fisheries. Currently, management propositions such as use of biocides, physical removal by repeated netting, barriers and lowering water levels to disrupt spawning ground are the only available approaches to control the non-native invasive fishes. Here, we demonstrated an alternative biological method, using common carp (*Cyprinus carpio*) as experimental model, to eradicate the non-native invasive fish species from large inland open waters. We first depleted the endogenous germ cells of adult *C. carpio* by combination of cytotoxic drug Busulfan (40mg/kg; total 5 dosages) and elevated water temperature (38°C) treatments within 10 weeks. The efficacy of treatments was evaluated by histological and *vasa* gene expression studies. Our study revealed that, at the end of 10 weeks treatment period, all the animals (n=5; each sex) turned sterile and remained in that condition post termination of recovery period (animals were reared at water temperature of 25°C for additional 10 weeks). Later, we paired them with the sexually matured wild counterparts in natural spawning trial. We observed that, although sterile male and female actively participated with their wild counterparts during the spawning trial, no progeny were detected in the tank; suggesting a viable approach to eradicate and/or control the non-native invasive fish species in open water bodies

Table 1. Results of spawning cross between GC-deficient *C. carpio* male and wild *C. carpio* female.

Trial set	Total number of eggs collected (n)	Fertilization (n; %)	Hatching (n; %)
#1	53	0 (0)	0 (0)
#2	42	0 (0)	0 (0)
#3	40	0 (0)	0 (0)
Control	57	51 (89)	46 (90)

Note: Control is the cross between wild *C. carpio* male and female.

FISH IN MURKY WATERS: EXPOSURE TO ACUTE SILTATION TRIGGERS STRESS, OXIDATIVE IMBALANCE AND GILL TISSUE DAMAGE IN RAINBOW TROUT JUVENILES

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Siltation resulting from heavy rainfall and soil erosion is a major environmental stressor in rainbow trout farms that are dependent on surface flowing waters. It often leads to significant fish mortality and severe economic losses for farmers in the Indian Himalayan region. Therefore, we investigated the short-term physiological responses of juvenile rainbow trout (*Oncorhynchus mykiss*, 15-20 g) exposed to suspended silt under controlled laboratory conditions. Fish were divided into two treatments: silt-exposed group (2.5 g/L of <100 µm natural stream-collected silt) and control (no-silt) group. The 24-hour silt exposure was conducted in 50 L aerated tanks maintained at 17 ± 1 °C. Silt was kept in suspension by continuous vigorous aeration (>170 NTU at 24 hour), and identical aeration was also provided in the control tanks. Water quality parameters such as turbidity, dissolved oxygen, temperature, pH and total ammonia nitrogen were monitored at regular intervals (0 - 24 hour). After the acute exposure, fish were subjected to various eco-physiological assessments. The routine metabolic rate showed a significant increase in the silt exposed group, indicating elevated energy demand for stress coping. Nevertheless, we observed no changes in the maximum metabolic rate, metabolic scope, incipient lethal oxygen concentration, and blood oxygen carrying capacity (haemoglobin and haematocrit levels) after the short-term silt exposure. Histological examination of gill tissues, however, revealed pronounced structural damage in the silt-exposed fish. It included lamellar disorganisation, epithelial lifting, hypertrophy, necrosis, and fusion of adjacent lamellae indicating inflammatory responses. Likewise, biochemical assays showed reduced activity of liver superoxide dismutase and glutathione S-transferase, as well as a significant decline in total antioxidant capacity in both liver and gill tissues of silt-exposed fish, suggesting compromised antioxidant defences. On the other hand, thermal tolerance assays revealed a paradoxical but concurrent increase in the critical thermal maximum by 1°C and critical thermal minimum by 0.7°C, in the silt-exposed group. Overall, this study demonstrates that even a brief (24 h) acute exposure to suspended sediments can disrupt aerobic metabolism, gill tissue integrity and anti-oxidative status in rainbow trout. Further long-term studies are warranted to ascertain the exact mechanisms underlying increased mortality during prolonged silt exposure in trout raceways.

AQUACULTURE SPATIAL PLANNING IN INDIA: PRESENT STATUS AND THE WAY FORWARD

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The unregulated fast growth has raised environmental issues and conflicts in many coastal states, leading to litigation and regulation issues. Thus present land utilization for aquaculture planning requires multi-dimensional approach integrating multiple layers of land use, water quality, soil characteristics and infrastructure in GIS platform. The present study discuss about the geospatial technique developed and its validation in different coastal states on India.

Aquaculture is regarded as a rapidly expanding sector for food production. In India, shrimp aquaculture has grown tremendously since 1990, by utilizing the land area of 2 lakh ha of coastal land to contributes 8 % of global aquaculture production of 185.4 million tonnes in 2022. However, the area expansion continues to encounter numerous challenges due to insufficient spatial planning. Some of the environmental conflicts include conversion of lakes, mangroves and agricultural lands to aquaculture farms and salinization of soil and drinking water resources adjacent to aquaculture farms. Earlier survey estimates indicated that 0.65 million ha in the east coast and 0.55 million ha in the west coast are suitable for the development of brackishwater aquaculture in India. But the present area of 2 lakh ha cannot be linked to the 1.2 million ha statistics, as the present aquaculture development is on pond based commercial aquaculture. The resource assessment of aquaculture will vary in the present context due to Coastal Aquaculture Authority (CAA) act requirement of environmental restrictions and compulsory buffer zone between land classes for the development of aquaculture. Multiple spatial criteria such as land resources availability, water quality, soil characteristics, water availability and environmental regulations needs to be considered for planning the aquaculture.

The present study used four dimensional approach viz land use, soil and water characteristics in identifying suitable areas for sustainable aquaculture. Remote sensing and GIS have been used for the decision making as it permits additional spatial data incorporation and advanced analysis to identify the suitable sites from the unused coastal resources without multi-user conflicts.

Studies have been carried out with different suitable criteria for cage aquaculture and pond based aquaculture planning. Combining multiple factors and land allocation for other sector development, multi criteria decision support analysis indicates land available for expansion in addition to present aquaculture. This methodology provides information on the extent, location, prior land-use of potential area for aquaculture with soil and water characteristics. The study has been validated and being used for assessing the resources availability for the planning of coastal and inland regions of coastal states viz Tamil Nadu, Puducherry, Maharashtra and Odisha.

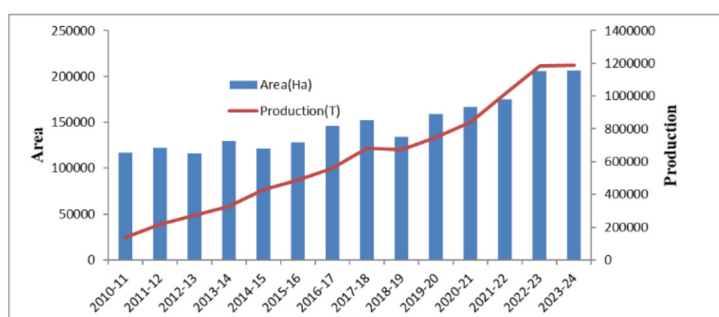


Fig. Status of area expansion in India indicating the stagnation

INTESTINAL HEALTH AND IMMUNE RESPONSE OF NILE TILAPIA (*Oreochromis niloticus*) FED BLACK SOLDIER FLY (*Hermetia illucens*) LARVAE FRASS

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Black soldier fly (*Hermetia illucens*) larvae frass is emerging as a promising, sustainable, cost-effective ingredient for aquafeeds. Although its nutritional potential in tilapia diets has been investigated, its effects on fish health and immunity remain unclear. This study evaluated the effect of BSF frass on intestinal health and immune response in Nile tilapia (*Oreochromis niloticus*).

A 6-week feeding trial was conducted with Nile tilapia (initial body weight: 120.74 ± 1.79 g) in tanks (300 L each) in a RAS. Two diets were formulated based on the known nutritional requirements of Nile tilapia (Table 1): a control diet and one containing 30% BSF frass. Fish were distributed into six tanks of 20 fish each, with triplicate tanks per treatment, and fed to apparent satiation three times daily (10:00, 12:00, and 14:00 h).

After the trial, light microscopy analysis of the distal intestine revealed that BSF frass inclusion did not significantly affect mucosal fold length (MFL), lamina propria width (LPW), intraepithelial lymphocyte abundance (IELs), or goblet cell density (GCD) compared with the control fed fish (Fig.1). However, electron microscopy analysis revealed a significant increase in microvilli density (MVD) and microvilli length (MVL) in BSF frass fed fish compared with the control (Fig.2). Intestinal transcriptional analysis showed no significant changes in cytokines gene (*il1*, *tnf*, *il10*, and *tgf*), whereas *hsp70* expression was significantly downregulated in the BSF frass group (data not shown). Additionally, growth performance remained unchanged across the diets. Overall, these results suggest that 30% BSF frass can be included in Nile tilapia diets without adverse effects on intestinal health, immune response, or growth performance, supporting its potential as a viable feed ingredient.

Table 1: Experimental diets formulation and composition.

Ingredient (g/Kg)	Control	Frass
Soybean meal	350.00	245.00
Wheat bran	250.00	175.00
Maize gluten meal	122.43	85.70
Black soldier fly larvae frass	0.00	300.00
Fish oil	40.27	28.19
Maize meal	66.42	46.50
Whole wheat	100.00	70.00
Fishmeal	51.10	35.77
Monoammonium Phosphate	15.10	10.57
DL-Methionine	0.83	0.58
Vitamin/mineral premix	3.00	2.10
Choline chloride	0.86	0.60
Proximate compositions (% wet weight)		
Dry matter	89.57	90.92
Crude protein	31.33	27.47
Crude fats	6.35	5.85
Ash content	4.92	5.10

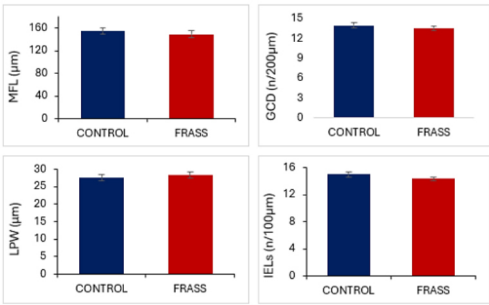


Figure 1: Histomorphometric analysis of the distal intestine of Nile tilapia fed experimental diets.

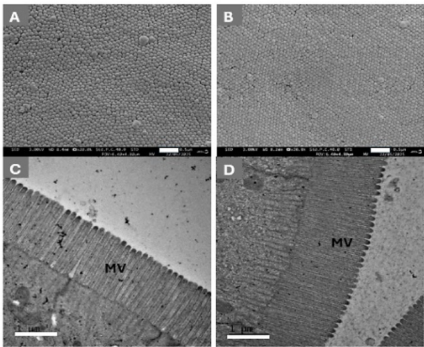


Figure 2: Scanning (A, B) and transmission (C, D) electron micrographs of Nile tilapia distal intestine fed a control diet (A, C; scale bars: 0.5 μm) and 30% BSF frass diet (B, D; scale bars: 1 μm).

GROWTH PERFORMANCE, PHYSICOCHEMICAL AND NUTRITIONAL PROPERTIES OF LARGEMOUTH BASS REARED IN POND AND RECIRCULATING AQUACULTURE SYSTEM (RAS)

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Largemouth bass (*Micropterus salmoides*) has emerged as an economically important species in China's freshwater aquaculture. Conventionally, traditional pond culture (TP) is a predominant method to rear largemouth bass in China. However, TP is associated with various shortcomings such as high stocking densities, limited swimming space, inadequate water circulation, poor water quality, and impeded water flow. Thus, it poses a substantial hurdle to the sustainable development of the aquaculture industry. Currently, recirculating aquaculture systems (RAS), a major advancement in sustainable aquaculture, have been widely employed to cultivate different fish species for high-density intensive aquaculture, reducing water usage, improving emission control, and minimizing environmental pollution.

With the sustainable development of the aquaculture industry, ensuring the quality of commercially important fish species has become equally crucial. Thus, the present study was conducted to explore the impact of TP and RAS on growth performance, color, textural properties, and nutritional composition of largemouth bass (**Fig. 1**). It was observed that weight gain, viscerosomatic index, and survival rate of fish in RAS group was higher compared to pond samples. Whereas the final length, specific growth rate, and condition factor were similar in both groups. Hardness was higher in pond samples, but other textural parameters, color values, pH, and conductivity presented insignificant differences. The volatile composition, amino acid, and fatty acid profiles of RAS and pond samples were significantly different. Geosmin, an organic compound responsible for the earthy smell in fish, was absent in both groups. Cadmium and lead were not detected in fish from both groups, whereas Fe was significantly higher in fish from the pond compared to RAS samples. In case of amino acids, samples from RAS presented high levels of essential amino acids. Moreover, pond-raised largemouth bass have higher levels of polyunsaturated and monounsaturated fatty acids compared to those raised in RAS systems.

Overall, the output of this study revealed that both TP and RAS resulted in high-quality, nutritionally rich largemouth bass. Thus, RAS can be employed as a viable and preferable option for cultivating high-quality largemouth bass owing to its distinct advantages of high production efficiency, sustainability, and long-term viability.

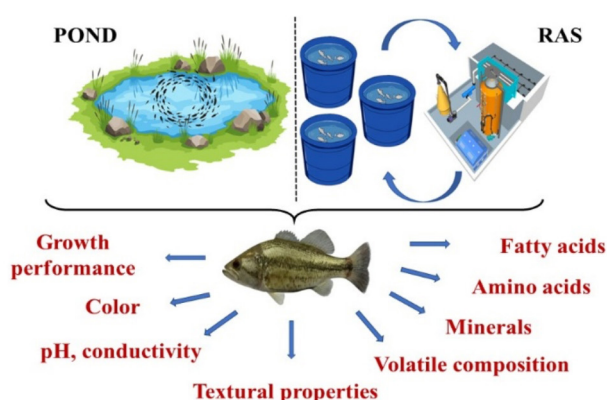


Fig. 1. Design of experiment to explore impact of different aquaculture modes on quality parameters of largemouth bass

INCLUSION OF NATURAL FUNCTIONAL INGREDIENTS MODULATES ANTIOXIDANT RESPONSES UNDER STRESS IN GILTHEAD SEABREAM (*Sparus aurata*) POST-LARVAE

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Aquaculture plays a pivotal role in ensuring global food security and nutrition. Current applied research in this field focuses on improving culture conditions, husbandry practices, and aquafeeds to enhance fish health, growth performance, and welfare. Within this framework, the identification of functional dietary ingredients has gained increasing attention due to their potential to enhance fish resilience under stressful conditions. This study aimed to assess the effects of natural extracts containing functional compounds on the stress response of gilthead seabream (*Sparus aurata*) post-larvae using a multidisciplinary approach. A one-week feeding trial was conducted to evaluate the impact of functional diets incorporating grape seed and *Ulva* extracts on 80DAE *Sparus aurata* post-larvae. The experimental design included a control diet (CTRL) and six test diets containing low, medium, and high levels of grape seed (NLOW, NMEDIUM, NHIGH) or *Ulva* (ULOW, UMEDIUM, UHIGH) extracts. At the end of the feeding period, growth performance and molecular biomarkers related to stress and antioxidant response were analysed.

Following the feeding trial, fish were subjected to two stress challenges: air exposure and bacterial infection with *Photobacterium damsela* subsp. *piscicida*. Survival was monitored throughout the trial and challenge period. Dietary supplementation with the tested extracts did not significantly alter stress biomarker expression under basal conditions. However, after exposure to acute stress, fish fed the ULOW diet exhibited significantly higher GPX1 and GPX4 expression and enzymatic activity compared to the control group, indicating a potential activation of the antioxidant response. Similarly, NLOW, NMEDIUM, ULOW, and UMEDIUM diets tended to increase SOD and HSP70 expression after stress, although differences were not statistically significant. Notably, mortality one hour post-stress was higher in the control group, suggesting a protective role of the supplemented diets against acute stress. Nonetheless, during the bacterial challenge, larvae fed experimental diets showed higher mortality than controls, suggesting that the protective effect observed under acute stress was not maintained against bacterial infection.

Overall, these findings indicate that incorporating bioactive biomasses and natural extracts into early-stage aquafeeds can enhance antioxidant responses and stress tolerance in *Sparus aurata* larvae. However, further optimization of inclusion levels is required to balance the benefits of functional ingredients and maintain robustness against disease.

Acknowledgments: This study was funded by Interface Mission, project (operation code 01/C05-i02/2022.P148) and by “Pacto da Bioeconomia Azul” (Project No. C644915664-00000026) within the WP5 Algae Vertical, both co-funded by Next Generation EU European Fund and the Portuguese Recovery and Resilience Plan (PRR), under the scope of the incentive line “Agendas for Business Innovation” through the funding scheme C5 - Capitalization and Business Innovation, and SAUDE&AQUA II (MAR-021.1.3-FEAMPA-00018). The technical assistance of EPPO and S2AQUAcoLAB staff was highly appreciated throughout the study.

CAN CLOSE-LOOP AQUAPONIC SUSTEMS PROVIDE SUSTAINABLE WASTE MANAGEMENT SOLUTIONS WITHIN ORGANIC STANDARDS?

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Closed-loop aquaponic (CLA) systems represent innovative, integrated food production systems that combine recirculating aquaculture (RAS) with hydroponic plant cultivation within a continuous water cycle. In these systems, nutrient-rich effluent from fish tanks undergoes biological filtration before being directed to hydroponic units, where plants assimilate dissolved nutrients and, in turn, purify the water prior to its return to the aquaculture component. This symbiotic interaction enables efficient nutrient recycling, reduces water consumption by 90–99% compared to conventional aquaculture, and substantially limits environmental discharge and pollution. CLA systems sustain water quality for both fish and plants through advanced filtration, oxygenation, and continuous monitoring technologies, thereby supporting high-density fish production alongside vigorous plant growth. Beyond improving resource efficiency and environmental sustainability, the closed-loop design provides additional economic and societal benefits, including reduced reliance on chemical inputs and the potential to localize food production in urban and resource-constrained environments. The discharge of aquaculture effluents which contains high concentrations of nitrogen and phosphorus represents a significant environmental challenge. Similarly, hydroponic and greenhouse cultivation generate considerable quantities of organic residues, including leaves, stems, and discarded vegetables, much of which remains underutilized. Addressing the above requires the development of effective and sustainable waste management strategies. One promising approach involves the upcycling of such low-value organic wastes through the use of insects as bioconverters. In addition, the reuse of treated municipal wastewater as a reclaimed water source for aquaponic systems presents both opportunities and challenges.

Within this context, the AWARE project aims to assess the potential of insect bioconversion as an innovative waste management solution contributing to sustainable and circular food production systems in an aquaponics system using reclaimed water. Furthermore, the study examines the potential of such systems to serve as effective waste management solutions while aligning with the principles and requirements of organic production. The study analyses nutrient cycling, waste minimization, and water reuse within a closed-loop aquaponic framework, with particular attention to regulatory definitions of “organic” in aquaculture and horticulture. Case studies and experimental data are used to assess the growth performance of fish and plants reared in aquaponics with reclaimed water and comparisons are made with conventional aquaponics production systems, highlighting both opportunities and constraints for organic certification. The findings suggest that while aquaponics can significantly reduce nutrient losses and promote circularity, regulatory barriers and definitional inconsistencies remain key challenges to its recognition as “organic.” Future research and policy development should focus on harmonizing certification standards and advancing low-cost, efficient waste management innovations to fully realise the potential of closed-loop aquaponics in sustainable and organic food production.

UNVEILING THE HIDDEN STATUS: SELF-RECRUITING FISH SPECIES OF UPPER LAKE, A RAMSAR SITE, OF BHOPAL

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The present rapid survey study was conducted to assess the ichthyofauna status of the Upper Lake, Bhopal, with a particular focus on the role and management of Self-Recruiting Species (SRS). Following the wetland assessment and monitoring framework of the Ramsar Convention and the Mediterranean Wetland, eight representative sampling stations were surveyed from September 2024 to January 2025. Fish specimens were identified using standard taxonomic keys. A total of 50 fish species belonging to 14 families were recorded, with Cyprinidae dominating (24 species), followed by Channidae, Mastacembelidae, Bagridae, Siluridae, and Ambassidae. The majority (85%) of the catch comprised self-recruiting native species, while only 15% consisted of stocked Indian Major Carps (IMCs). SRS, including several Small Indigenous Species (SIS), play a vital role in food security, livelihoods, and ecosystem stability, supporting over 500 fisher households dependent on daily catches. However, their populations are increasingly threatened by invasive exotic species such as *Oreochromis mossambicus*, *Hypophthalmichthys nobilis*, and *Clarias gariepinus*. A conceptual framework for SRS management was developed, integrating the assessment, monitoring, and community-based management strategies. The study emphasizes the urgent need for sustainable wetland management, regulation of invasive species, and protection of native breeding habitats to ensure the resilience of SRS populations and to secure nutritional and livelihood benefits for dependent communities.

OPTIMIZING RAS PERFORMANCE FOR RAINBOW TROUT CULTURE IN TROPICAL ENVIRONMENTS

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Rainbow trout (*Oncorhynchus mykiss*) is one of the world's most commercially important salmonid species, traditionally cultured in cold and temperate regions using flow-through or open-water systems. In recent decades, RAS technology has been increasingly adopted for salmonids in countries such as Norway, Denmark, and Canada, where it is primarily used for smolt production and sustainable grow-out operations. These systems offer precise environmental control, efficient waste management, and reduced water usage, making them ideal for high-value species. However, adapting this technology for rainbow trout production in tropical environments introduces unique biological and engineering challenges that must be carefully addressed to ensure system stability, fish welfare, and economic viability. In tropical regions, the ambient temperature often exceeds 30°C, far above the optimal thermal range of 12 to 18°C required for rainbow trout. Maintaining cold-water conditions in such climates demands energy-intensive chilling, high-quality insulation, and intelligent system design to minimize thermal gain. The primary challenge lies in balancing energy consumption with production efficiency. Farm models originally designed for cold climates cannot be directly replicated in tropical regions without significant modification. This paper presents an applied framework developed from tropical RAS operations for rainbow trout culture, addressing the technical, operational, and biological constraints that influence long-term system performance. Design adaptation begins with a detailed evaluation of the site environment, water source, and available infrastructure. Material selection, system layout, and insulation must be optimized to minimize heat transfer and reduce cooling load. Efficient water flow distribution, combined with modular system design, allows for flexible temperature control across different life stages. A RAS facility is a complex system, and even minor design inaccuracies can create compounding issues in water quality, biofilter performance, or fish health. Therefore, success lies not in adopting high technology alone, but in applying correct engineering principles and environmental understanding to establish the right fundamentals of design. When properly designed and managed, tropical RAS operations can achieve stable environmental control, efficient energy use, and high product quality, proving that cold-water aquaculture is possible beyond traditional geographic limits.

GENOME-WIDE CHARACTERIZATION AND SSR MINING IN *Labeo bata*: A GENOMIC RESOURCE FOR AQUACULTURE AND CONSERVATION

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Labeo bata, a commercially important minor carp of India, represents a species with considerable aquaculture potential and regional cultural value. Despite its economic significance, genomic resources for this species remain scarce, limiting progress in genetic improvement and conservation programs. To address this gap, short-read whole genome sequencing was carried out, generating 18.3 GB of high-quality data (mean quality score: 35.57). The assembly yielded a genome size of 952,061,765 bp distributed across 176,874 contigs. Microsatellite mining using MISA identified a total of 765,937 simple sequence repeats (SSRs), comprising 183,181 dinucleotide, 84,624 trinucleotide, 63,784 tetranucleotide, 16,973 pentanucleotide, and 877 hexanucleotide motifs. Gene prediction with AUGUSTUS identified 45,822 putative genes, of which 31,681 genes were annotated using NR database of Swissport and uniprot additionally KAAS analysis received 28,357 functional KO annotations in the KEGG database. Genome wide genic SSRs were mined in genic and intronic regions, within genes associated with different pathways i.e, Metabolism, Genetic Information Processing, Environmental Information Processing, Cellular Processes and Organismal Systems. These studies are the first comprehensive genome-wide Genic SSR loci resource for *L. bata*, opening avenues for the development of molecular markers, population genetic studies, and genomic-assisted breeding strategies. The outcomes of this study hold promise for enhancing aquaculture performance and ensuring the sustainable utilization of this valuable indigenous carp.

FATTY ACID PROFILE AND LIPID QUALITY OF SMALL INDEGENEOUS FISH, *Puntius sophore*, IN COMPARISON WITH THE SMALL FISHES

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Small Indigenous Fishes (SIFs) are gaining popularity due to their rich micronutrient content coupled with low cost. There is a need to bring these nutrient dense SIFs to major distribution channels which can lead to better price realization to the local community. This requires proper documentation of the nutritional benefits of SIFs in comparison to commercially available fishes. Present study aimed to assess the fatty acid profile and lipid quality of *Puntius sophore*, and compare with the small fishes, Anchovy (*Stolephorus commersonnii*) and Malabar sprat (*Ehirava fluviatilis*). Among the fishes studied, *P. sophore* had the least fat content (3.5%) and highest value was observed for Malabar sprat (6.5%). Palmitic acid followed by stearic acid were the major saturated fatty acids observed in anchovies and Malabar sprat in contrast to myristic acid and heptadecanoic acid in the *P. sophore*. Oleic acid was the major monounsaturated fatty acid in all the fishes studied. Among the polyunsaturated fatty acids, docosahexa enoic acid followed by eicosapentaenoic acid were predominant in the anchovies and Malabar sprat. For *P. sophore*, linolenic acid followed by arachidonic acid were the predominant PUFA observed. The variations in the fatty acid profile could be attributed mainly to the habitat and the feed of the fishes studied. In anchovies and Malabar sprat, docosahexaenoic acid was observed to be higher than eicosapentaenoic acid which was opposite in the *P. sophore*. Various lipid quality attributes studied indicated that the SIF, *P. sophore* lipid quality is comparable with other small fishes studied.

CHARACTERISATION OF PRODIGIOSIN FROM BIVALVE-ASSOCIATED *Serratia marcescens* AND ITS INHIBITORY ACTION ON FISH PATHOGENS

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The rapid rise of antimicrobial resistance (AMR) and limited effective treatments in aquaculture demand novel, eco-friendly alternatives. In this study, a red pigment-producing *Serratia marcescens* strain (IFSMLMEK1) was isolated from the freshwater bivalve *Lamellidens marginalis*. The extracted pigment, prodigiosin, was characterised using UV-Vis and FTIR spectroscopy.

Functional bioassays demonstrated significant antibacterial activity against major fish pathogens, including *Aeromonas hydrophila*, *Escherichia coli*, *Klebsiella pneumoniae*, and *Staphylococcus aureus*. Strong antibiofilm activity was observed, particularly against high biofilm-producing *Pseudomonas aeruginosa*, with dose-dependent inhibition.

Importantly, this is the first report of prodigiosin's antifungal activity against aquatic oomycete pathogens *Saprolegnia parasitica* and *Aphanomyces invadans*, known for causing high mortality in freshwater fish species. Antioxidant assays further indicated the potential of prodigiosin to mitigate oxidative stress in aquaculture settings. Whole-genome analysis confirmed the presence of a complete prodigiosin biosynthetic gene cluster with 100% similarity to known references.

In silico molecular docking revealed stable binding of prodigiosin with key extended-spectrum β -lactamase (ESBL) enzymes TEM, SHV, and CTX-M, highlighting its potential as a β -lactamase inhibitor. Moreover, this study identifies prodigiosin as a promising natural compound for controlling fish pathogens and combating AMR in aquaculture.

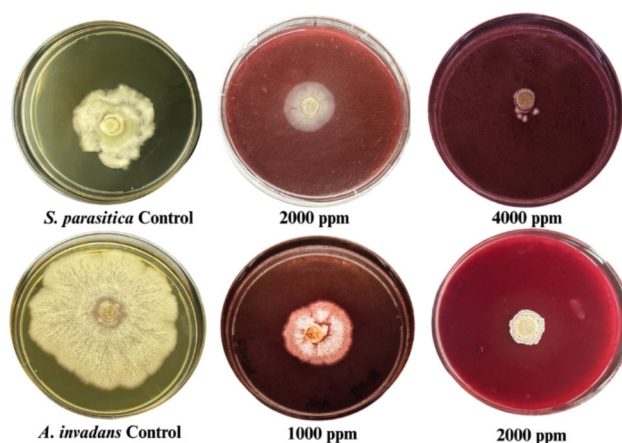


Figure 1: Antifungal efficacy of pigment

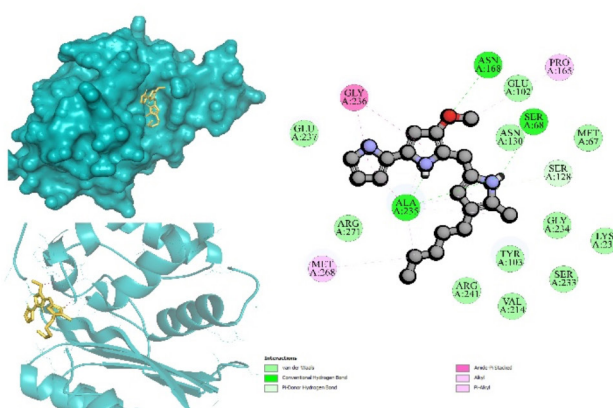


Figure 2: Insilico inhibitory activity of pigment against ESBL enzymes

USE OF DIFFERENT PLASTIC MATERIALS IN AQUAPONICS SYSTEMS

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Plastics play a vital role in agriculture including aquaculture as it is ubiquitous, long lasting, easy to fabricate, easy to manufacture, user friendly, highly chemical resistant, UV resistant, corrosion-resistant, fatigue resistant, floatable, flexible and yields high strength. This paper reviews the use of different plastic materials in different components of aquaponics / hydroponics systems.

In aquaponics different grow beds/media are used for plantation. The grow beds are usually made up of HDPE (High density poly ethylene) and PP (Poly propylene) as they are inert, resistant to breakdown in water and most importantly food safe. One can prefer FRPs (Fibre reinforced plastics), where customizable media beds are required. In Nutrient Film Technique (NFT), circulation of water is from fish tanks to hydroponic tanks *via* biofilter, sumps and pipes. The fish and hydroponic tanks are mostly made up of FRP. The fish tanks can be both circular and rectangular depending upon the capacity and type of fish to be reared. However, tanks made up of with HDPE and LLDPE (Linear low-density polyethylene) for mechanical strength, PP for impact resistance and performance in cold environment, PVC (Polyvinyl chloride) for rigidity are preferred. The hydroponics tanks are usually rectangular. Unlike concrete tanks these plastic tanks are easily customizable and portable, corrosion resistant and do not leach chemicals. The sump is made up of HDPE, because of its durability, food safe and UV resistant properties. FRP made up of epoxy/ polyester/ resin can be used where aquaponics is dealt upon a wider scale as it is lightweight, customizable, smooth, strong and has commendable durability. The biofilters are made up of HDPE for its highly UV resistant property, LLDPE for impact resistant and FRPs for customisability and durability. In case of small-scale production HDPE is preferred over other two and in case of large-scale production FRPs are preferred. Now a days the preferred biofilter media is also plastic-based, made either from PP, HDPE or PVC. In Moving Bed Biofilm Reactor (MBBR), PP is used, K1/K3 media, as it provides excellent surface area for biofilm. Sometimes PVC is used for moving bed biofilters. The bio-balls or plastic rings are made up of PP / HDPE / PVC. The pipes used in aquaponics must be of food safe, nontoxic, and durable as they carry nutrients and fertilizers. For the main supply of water, PVC pipes are used as they are strong, rigid and mostly inexpensive. HDPE pipes are used for underground lining. PEX (Cross-linked polyethylene) is used in smaller lines and drip irrigation systems as they are resistant to high temperatures. PP pipes are used where the pressure to be exerted is very high as they are durable. PVC pipes are preferred over HDPE pipes for cost effectiveness and easy usage. In Deep Water Culture / Raft aquaponics Expanded Polystyrene (EPS) and Polyurethane (PU) providing buoyancy, inexpensiveness and lightweight are used for making rafts for holding net pots. The net pots are made up of PP, HDPE, PS or PVC. Net pots need to be lightweight, reusable, water safe and food safe, so PP and HDPE are mostly preferred over PS and PVC.

Overall we can say plastics not only serve as a solution to aquaponics/hydroponics, but also remain indispensable.

COMPARATIVE EVALUATION OF MARIGOLD GROWTH IN NUTRIENT FILM TECHNIQUE AND RAFT AQUAPONICS SYSTEMS UNDER VARYING FISH STOCKING DENSITIES

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The growing need for sustainable agriculture has intensified interest in aquaponics, which integrates aquaculture and hydroponics for efficient resource utilization. This study evaluated the comparative performance of marigold (*Tagetes erecta* L.) under two aquaponic sub-systems, *i.e.*, Nutrient Film Technique (NFT) and Raft Aquaponics (synonymous to Deep Water Culture (DWC) system, combined with three fish stocking densities (200, 400 and 600 fingerlings of *Labeo rohita*). The water volume of fish rearing tanks of NFT system was 3.0 m³ and of DWC 10.0 m³. The experiment followed a Factorial Completely Randomized Design (FCRD) with six treatment combinations; each replicated twice, over a 75-days period at ICAR–CIFA, Bhubaneswar.

Results indicated that both system types and stocking densities significantly influenced marigold growth, flowering, water quality and economic returns. At 75 day after planting (DAP), maximum plant height was observed in NFT with 600 fish (average length 36.01 cm); while the lowest was in DWC with 200 fish (average length 29.06 cm). Flower count per plant was consistently higher in NFT, peaking at 171.94 flowers in the second harvest at 600 fish density. Water quality remained within optimal ranges, though NFT systems maintained higher dissolved oxygen compared to DWC, supporting superior nutrient uptake and growth. Fish survival ranged between 80.4–85.5% across treatments, with slightly better growth recorded in DWC due to reduced stocking density stress. Economic analysis revealed that although NFT required higher fixed capital investment (₹35,000) per unit, it generated greater gross returns at higher stocking densities (₹5,296 at 600 fish SD). However, DWC, with lower capital costs (₹1,800–3,600) per unit, produced higher net returns (₹1,341 at 600 fish SD), indicating better cost efficiency.

In conclusion, from the study, NFT proved superior for maximizing flower yield and system performance, while DWC (Raft aquaponics) offered a more economical option for small-scale adoption. This study demonstrates the potential of aquaponics for ornamental crop production and provides a framework for optimizing subsystem design and fish–plant ratios.

REARING OF FISH *Labeo rohita* FINGERLINGS AND CHERRY TOMATO *Solanum lycopersicum* IN DEVELOPED NFT AQUAPONICS SYSTEM

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An experiment was conducted for 76 days (26 October 2023 to 10 January 2024) in the Farm of ICAR-CIFA, Bhubaneswar focusing on the evaluation of the developed Nutrient Film Technique (NFT) aquaponics system for rearing of rohu (*Labeo rohita*) fingerlings and Cherry tomato (*Solanum lycopersicum*) plant. To optimize the stocking density of rohu fingerlings and cherry tomato, the experiment was conducted in six units of aquaponics system; taking three treatments (T1, T2 & T3) and a control (C) in duplicate. Fish culture tanks of C, T1, T2 and T3 were stocked with varying densities of fingerlings, *i.e.*, 250, 500, 750 and 1000 numbers of (8±2g average weight). Each hydroponics tanks were planted with 25 numbers of cherry tomatoes (F1 Hybrid Goldie variety, Known-you seed (India) Pvt. Ltd.) plant saplings. Regular feeding and monitoring of the experiment was done and the data were collected and analysed. After 76 days of the experiment, advanced fingerlings were harvested. Results showed that the significantly higher fish fingerling weight and lengths were found in Control (C) and Treatment T1 followed by T2 and T3. No significant differences were seen for fish survivability in the treatments. Tomato fruits harvest was significantly higher in T3 (564 nos) followed by T2 (470 nos) and T1 (322 nos). Plant growth in terms of height was observed maximum in T2 (192.87±14.63 cm), whereas maximum root development was found in T1 (137.45±8.15cm). The average numbers of internodes in plant were observed significantly higher in groups T2 and T3.

Growth of fish and plants at harvest

Fish

Treatments	Control	T1	T2	T3	<i>P Value</i>
Fish weight (g)	28.43c±2.90	26.49bc±1.97	18.52ab±2.25	15.54a±2.28	0.04
Fish length (mm)	77.85b±5.45	73.70ab±4.90	61.40ab±1.90	59.25a±3.45	0.04

Plant

Treatments	Plant height (cm)	Root length (mm)	Internode numbers	Number of fruits
T1	147.35±11.05	137.45±8.15	19.25±4.25	322.00 ^a ±9.00
T2	192.85±9.65	124.85±13.65	26.75±6.95	470.00 ^b ±12.00
T3	158.15±11.45	106.25±8.55	33.35±4.05	564.00 ^c ±10.00
<i>P Value</i>	0.11	0.25	0.31	0.00

COASTAL SEAWEED MAPPING THROUGH DEEP-LEARNING SEGMENTATION OFFERS PRACTICAL PATHWAYS FOR ECOSYSTEM MANAGEMENT AND EVIDENCE-LED POLICY FRAMEWORK

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Coastal seaweed plays a critical role in sustaining biodiversity, supporting fisheries and mariculture, providing raw material for food and pharmaceutical industries, and sequestering carbon, yet it also poses ecological and socio-economic challenges due coastal degradation and over exploitation. Accurate mapping of seaweed extent is therefore essential for both ecological monitoring and informed coastal policy. Conventional remote sensing techniques, however, are often limited in coastal zones due to spectral confusion with water, sediments, and other vegetation. This study addresses these limitations by integrating freely available Landsat-8 imagery with advanced deep-learning segmentation methods to provide a scalable approach for seaweed monitoring. Focusing on Palghar district, Maharashtra, India, we analyzed 231 cloud-free images spanning 2020-2024. Key spectral indices Floating Algae Index (FAI), NDVI, and a customized Seaweed Enhancement Index were derived to enhance detectability of seaweed canopies. Two segmentation architectures, U-Net and VGG-UNet, were trained using augmented datasets, with FAI serving as the primary input feature. Model performance was assessed with multiple accuracy metrics, including IoU, Dice coefficient, precision, recall, and F1-score.

Results demonstrated a clear advantage of VGG-UNet over U-Net, achieving precision of 0.90 and F1-score of 0.91 compared to U-Net's 0.43 precision and 0.54 F1-score. Seaweed extent was reliably quantified, with Dhanu showing 9.38% cover (5.54 km²) and Kelwa 7.26% (4.28 km²). Validation against field-based observations confirmed the robustness of the method, even in spectrally complex coastal environments. Beyond technical advances, the study highlights important policy implications. By offering a cost-effective and scalable tool, deep-learning segmentation can support coastal governance frameworks in balancing conservation with economic utilization. Applications include monitoring of invasive species such as Sargassum, early-warning systems for excessive biomass accumulation, seaweed vegetation and growth monitoring and spatial planning for seaweed mariculture and sustainable natural resource harvesting. Integrating such AI-driven monitoring into marine and coastal management policies could reduce ecological risks, enhance climate resilience, and provide decision support for resource allocation. Overall, this study demonstrates that combining Landsat-8 data with deep learning models not only advances remote sensing science but also offers practical pathways for evidence-based coastal ecosystem management and sustainability.

EFFECTS OF DIETARY YEAST CELL WALL SUPPLEMENTATION ON THE PERFORMANCE OF WHITELEG SHRIMP (*Litopenaeus vannamei*) UNDER COLD WATER CHALLENGE

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As aquaculture increasingly adopts functional feed additives to bolster resilience, interest is growing in strategies that enhance the tolerance of farmed shrimp to environmental stressors. The effect of a brewer's yeast (*Saccharomyces cerevisiae*) additive (Biolex® MB40, Leiber GmbH) on growth performance and stress tolerance in whiteleg shrimp (*Litopenaeus vannamei*) was evaluated using a thermal-challenge model.

Juvenile shrimp (3.2 ± 0.2 g) were reared for 28 days in a semi-recirculating aquaculture system (salinity 30 ppt; 12.5% daily water exchange). Two isoproteic and isolipidic diets (crude protein $43.8 \pm 0.8\%$; lipid $7.5 \pm 0.1\%$) were evaluated: a control diet without YCW supplementation (0-YCW) and a diet supplemented with 0.2% YCW (0.2-YCW). Each treatment was assigned to three replicate 16-L tanks containing six shrimp per tank. Water temperature was maintained at 26 °C from Days 0-14, then rapidly reduced by 4 °C per hour on Day 14 until reaching 16 °C, where it was held until Day 28.

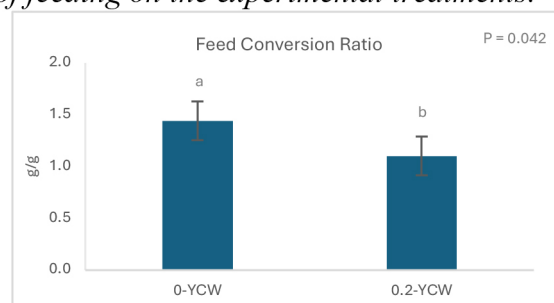
Data were statistically analysed at the pre-challenge (Day 14; 26 °C) and post-challenge (Day 28; 16 °C) phases using a two-sample *t*-test (Real Statistics® package, Microsoft® Excel). During the pre-challenge phase, survival was 100% across both treatments.

However, shrimp fed the 0.2% YCW diet showed significantly improved feed conversion ratio (FCR; $P = 0.042$; Fig. 1) and protein efficiency ratio (PER; $P = 0.027$; Fig. 2) compared with the 0-YCW group.

In the post-challenge phase (Days 14-28), following the rapid temperature drop, shrimp appetite declined, and the feeding rate was reduced from 3.6% of body weight per day in the first phase (Days 1-14) to 2.3% in the second phase. No significant differences ($P > 0.05$) were detected between treatments in growth performance, FCR, PER, or survival (with only one mortality recorded).

Collectively, the data indicate that dietary YCW at 0.2% can enhance FCR and PER in *L. vannamei*, but such benefits were not observed under severe cold stress (16 °C). Ongoing analyses of distal intestine, gill, and hepatopancreas (histology, gene expression, and 16S rRNA gene metabarcoding) is being conducted to determine whether the YCW confers immunological, mucosal, or microbiome-level protection during cold challenge.

Figure 1: FCR of *L. vannamei* after 14 days of feeding on the experimental treatments.



Different superscripts represent significant difference between the treatments.

Figure 2: PER of *L. vannamei* after 14 days of feeding on the experimental treatments.



Different superscripts represent significant difference between the treatments.

EFFECTS OF YEAST CELL WALL SUPPLEMENTATION ON GROWTH PERFORMANCE OF WHITELEG SHRIMP (*Litopenaeus vannamei*) UNDER SUBOPTIMAL TEMPERATURE

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Maintaining shrimp performance under environmental stressors remains a key challenge for aquaculture. Yeast cell wall (YCW) fractions derived from brewer's yeast (*Saccharomyces cerevisiae*) are increasingly investigated as dietary additives to enhance resilience. This study examined the effects of YCW supplementation (Biolex® MB40, Leiber GmbH) on growth performance and intestinal microbial communities of whiteleg shrimp (*Litopenaeus vannamei*) reared under suboptimal temperature (22 °C).

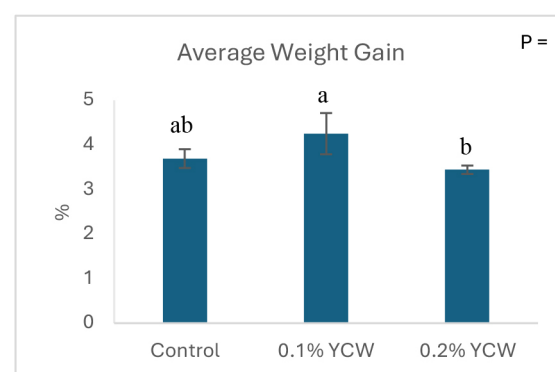
Juvenile shrimp (3.0 ± 0.1 g) were reared for 35 days in a semi-recirculating aquaculture system (salinity 30 ppt; 14% daily water exchange) and fed one of three isoproteic and isolipidic diets: a control diet (0-YCW), or diets supplemented with 0.1% (0.1-YCW) or 0.2% YCW. Each treatment was tested in four replicate tanks (10 shrimp per 30-L tank), with shrimp fed ~3.5% body weight per day.

At the end of the trial, survival ranged between 88–90% and did not differ significantly among treatments. Shrimp fed the 0.1-YCW diet attained the highest weight gain, which was significantly greater than that of the 0.2-YCW group ($P = 0.025$) but not different from the control. Specific growth rate showed a trend towards improvement in the 0.1-YCW group ($P = 0.054$), while feed conversion ratio and protein efficiency ratio were unaffected.

Preliminary intestinal microbiome analyses revealed treatment-associated shifts in community composition. Beta diversity differed significantly between groups (PERMANOVA, $P < 0.01$), alpha diversity varied by sampling timepoint, and random forest classification achieved high accuracy ($AUC \approx 0.97$) in distinguishing treatments. The intestinal microbiota of shrimp across dietary treatments was dominated by the genera *Cetobacterium*, *Burkholderia*, *Caballeronia*, *Paraburkholderia*, and *Aeromonas*.

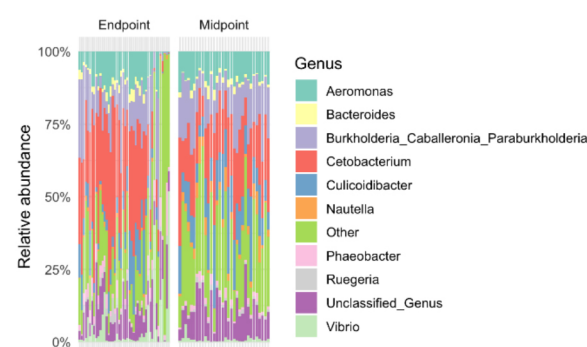
Overall, these findings indicate that 0.1% YCW supplementation supported higher growth than 0.2% YCW but did not significantly outperform the control diet. Microbiome analyses suggest dietary YCW influences intestinal community structure, which, alongside forthcoming histological, immunological, and gene expression analyses, will provide further insight into its potential role in enhancing shrimp resilience under prolonged suboptimal temperature.

Figure 1: Weight gain of *L. vannamei* after 35 days of feeding on the experimental diets



Different superscripts represent significant difference among the treatments.

Figure 2: Relative abundance of the ten most abundant bacterial genera identified in shrimp intestinal samples across treatments and timepoints.



IMPACT OF DIFFERENT INORGANIC FEED PHOSPHATES ON GROWTH, SURVIVAL AND IMMUNE DEFENSES AGAINST *Vibrio parahaemolyticus* IN WHITELEG SHRIMP (*Litopenaeus vannamei*)

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The whiteleg shrimp is the most produced aquatic animal globally, reaching 7.36 million tons in 2023 (FAO). Despite promising growth, whiteleg shrimp farming faces sustainability challenges such as nutrient sourcing (including phosphorus), environmental impact, and diseases like acute hepatopancreatic necrosis disease (AHPND) caused by *Vibrio parahaemolyticus*. Inorganic feed phosphates (IFP) are used to meet shrimp phosphorus (P) needs, but data on requirements and the efficiency of available IFPs are limited. It was observed that IFPs may modulate the innate immune response in fish and shrimp. Our study had two objectives: 1) compare the effects of different IFPs on shrimp growth and survival during a production cycle, and 2) evaluate their impact on shrimp immune response and survival against *Vibrio parahaemolyticus*.

In the growth trial, shrimps of 1.7g were distributed into 35 hapa nets and fed with a control diet (CTRL) or diets supplemented with IFPs: dicalcium phosphate (DCP), monocalcium (MCP), magnesium phosphate (MgP), monoammonium phosphate (MAP), monosodium phosphate (MSP), and a new IFP, calcium humophosphate (CHP). After 90 days, growth, survival rates, total hemocyte count (THC), and lysozyme activity (LA) were assessed. For the immune challenge trial, shrimp were fed experimental diets for 14 days before injection with *V. parahaemolyticus*, followed by daily mortality tracking and further analysis on immune parameters and histology of hepatopancreas.

Results revealed that IFP type significantly affects shrimp growth and survival, with MSP and MAP providing the best performance, followed closely by CHP ($p < 0.005$). DCP supplementation had minimal effects compared to CTRL. IFP sources also modulated immune parameters, enhancing THC for MCP, MAP, CHP, and MSP ($p = 0.032$) which increased also LA ($p = 0.018$). In the immune challenge, shrimp fed IFPs showed a trend of improved survival rate ($p = 0.07$), highlighting IFPs' potential contribution to immune resistance. Moreover, IFPs significantly affected *Vibrio sp.* count in the hepatopancreas before challenge ($p = 0.022$). Overall, this study demonstrates that IFP type significantly influences shrimp performances and potentially its susceptibility to *Vibrio sp.* infection.

Table 1. Final body weight, survival rate and lysozyme activity in hemolymph. Significant differences are indicated with different letters.

	CTRL	DCP	MCP	MAP	MSP	MgP	CHP
Final body weight (g)	16.97 e	17.87 d	18.82 c	20.19 a	20.28 a	18.64 c	19.56 b
Survival rate (%)	82.68 cd	81.63 d	83.91 bc	86.99 a	86.65 a	85.19 ab	86.13 a
Lysozyme activity (U.mL ⁻¹)	2.31 b	2.34 ab	2.37 ab	2.38 ab	2.39 a	2.34 ab	2.36 ab

STATUS OF AQUACULTURE PRACTICES AND DEVELOPMENTAL PROSPECTS IN RESPECT AN ASPIRATIONAL DISTRICT, NANDURBAR DISTRICT, MAHARASHTRA, INDIA

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Nandurbar, a Scheduled Tribe (ST)-dominated aspirational district of Maharashtra, possesses more than 10,000 ha of aquatic resources including reservoirs, irrigation ponds, and Sardar Sarovar backwaters. Despite this potential, aquaculture remains underdeveloped due to low awareness, weak infrastructure, and limited access to institutional credit. A field assessment conducted in October 2024 and evaluated the implementation of Pradhan Mantri Matsya Sampada Yojana (PMMSY), Fisheries and Aquaculture Infrastructure Development Fund (FIDF), and Kisan Credit Card (KCC). Encouraging outcomes were observed from biofloc farming in Patonda Shivar and cage culture in Bhaware and Dhankhedi, where yields exceeded 1,800–2,000 kg per unit. However, persistent challenges include inadequate seed and feed supply, lack of hatcheries, poor cold storage, weak market linkages, uptake of FIDF and KCC remains negligible due to procedural and financial barriers. Strengthening aquaculture through awareness programs, community-based cold chain facilities, simplified credit access, and adoption of scientific practices can improve food security and provide sustainable livelihoods for tribal communities.

CONTROLLED BIOASSAY ASSESSMENT OF *Enterocytozoon hepatopenaei* (EHP) TOLERANCE IN COMMERCIAL GENETIC LINES OF *Penaeus vannamei*

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Enterocytozoon hepatopenaei (EHP) is a pervasive microsporidian causing chronic sublethal effects on growth, feed utilization, and survival in *Penaeus vannamei*, posing significant challenges to shrimp farmers. This study evaluated three commercial genetic lines under a controlled EHP challenge using feces-top-coated feed to mimic natural infection while ensuring controlled exposure. All three lines demonstrated similar performance in negative control tanks. Following challenge, Line C consistently outperformed the other lines in survival, growth, feed conversion ratio (FCR), and delayed pathogen proliferation. After 28 days post-infection, Line C shrimp achieved $90.00 \pm 1.99\%$ survival, 5.80 ± 0.34 g growth, and an FCR of 1.26, whereas Lines A and B showed statistically significant lower survival (45.19–53.65%) and growth. Quantitative PCR analyses indicated that early pathogen replication was strongly suppressed in Line A. Additional research could explore possible host mechanisms in tolerant lines that delay infection and preserve hepatopancreatic function. This delayed disease progression allowed biomass accumulation prior to full EHP impact. Under commercial conditions, levels of tolerance demonstrated in the current study would reduce production losses, providing economic benefit to farmers. These results reveal substantial genetic variation in tolerance to chronic EHP infection and highlight the potential value of genetic selection for improving tolerance to EHP in shrimp aquaculture.

NATIONAL REPOSITORY OF FISH CELL LINES (NRFC): A STRATEGIC RESOURCE FOR *IN VITRO* AQUACULTURE RESEARCH

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Aquaculture is one of the most rapidly growing sectors in the world today and continues to expand as a sustainable food production system. There is a growing need for alternative research models that reduce reliance on live animals while enabling precise, reproducible and ethical experimentation. The role of fish cell lines is very imperative, especially in the context of sustainable aquaculture management, which aims to prevent and manage biological and environmental risks in aquatic systems. It also serves as *in vitro* models for understanding host-pathogen interactions, monitoring aquatic environments for pollutants and pathogens that could impact fisheries, public health and biodiversity.

National Repository of Fish Cell Lines (NRFC), at ICAR-National Bureau of Fish Genetic Resources (NBFGR), Lucknow, India, has the world's largest fish cell lines collection with 85 accessions, represented by 40 fish species and 1 shrimp-insect hybrid cell line (<https://mail.nbfgr.res.in/nrfc/>). Top five tissue-wise collections include fin (28 nos.), gill (10), heart (7), eye (6) and spleen (5) tissues. These fish cell lines can be used in toxicology, virology, disease diagnostics, environmental monitoring, functional genomics, and vaccine development studies. By providing access to authenticated and quality-controlled cell lines, the NRFC ensures research reproducibility and accelerates the development of *in vitro* systems that can simulate real-world aquatic environments. Additionally, the repository contributes to the conservation of aquatic biodiversity by preserving genetic material from threatened or endemic fish species.

NRFC has provided significant inputs to several programs to tackle the threat of aquatic diseases. Identification and isolation of viruses, like TiLV, RSIVD, Cyprinid herpes virus-2, nodavirus etc., using fish cell lines from NRFC has helped to screen infected individuals and chalk out strategies to reduce infection and boost aquaculture production. Cell line repositories may play a vital role in advancing and accelerating *in vitro* research by providing essential support for scientific studies, disease diagnostics and surveillance efforts.

RESTORATION OF INLAND OPEN WATER BODIES OF INDIA FOR BIODIVERSITY CONSERVATION AND SUSTAINABLE FISHERIES

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Rivers, rivulets, hill streams, reservoirs, lakes, wetlands, *beels* (Assam), *chaurs* (tectonic depressions) and *mauns* (oxbow lakes) (Bihar), *tals* and *talaws*, *jheels* (North & East India), estuaries, mangroves, and backwater/lagoons form the inland open water resources of India. These resources have been under enormous stress, mostly due to anthropogenic activities, which include construction (roads, buildings, railways, dams, canals etc.), over-fishing, irrigation, pollution, siltation, eutrophication, and encroachment. As a result, many water bodies and their ecosystems are being degraded; some have lost their natural ecological characteristics, and the habitats of others are in poor condition. These waterbodies need immediate attention from policymakers and scientists for taking appropriate measures for restoration, biodiversity conservation and sustainable fisheries in line of the UN Sustainable Development Goals (SDGs) and the European Union's Nature Restoration Law (NRL). Following the footprints of NRL, which is being implemented in European countries in June, 2024, an Indian Biodiversity Strategy for the restoration of inland water bodies and sustainable fisheries is the need of the hour. New technology interventions, empowering farmers/communities with appropriate skills, incentivizing sustainable practices, raising consumer awareness, and fostering constructive collaborations with all stakeholders are some suggested measures. This study provides insight into such issues, with an elaborate analysis of the restoration of degraded water bodies, the methods of their mitigation, and recommendations with reference to the NRL.

UPCYCLING ABANDONED, LOST, OR DISCARDED FISHING VESSELS AND GEARS: CIRCULAR SOLUTIONS FOR SUSTAINABLE MARINE ENVIRONMENT

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Abandoned, Lost, or Discarded Fishing Gear and Vessels (ALDFG/ALDFV) form a smaller fraction of total marine litter compared to domestic plastic waste, yet their ecological and economic consequences are high. ALDFG/ALDFV severely impacts marine biodiversity through entanglement and ingestion by fauna, damages benthic habitats, hampers fishing operations, and creates navigational hazards. Moreover, both fishing gear and Fibre Reinforced Plastic (FRP) debris derived from abandoned fishing boats contribute to secondary microplastics and heavy metal pollution in the marine environment. Despite these challenges, limited research exists on end-of-life management and recycling pathways for ALDFG and FRP debris from fishing vessels. To address this gap, ICAR-CIFT is developing technological interventions to convert fishing-related plastics into useful products, supporting Sustainable Development Goal (SDG) 14.1 and India's National Action Plan on Marine plastic Litter from sea-based sources. Systematic retrieval of ALDFG/ALDFV (FRP debris) was carried out from beaches, nearshore waters, and landing centres along the Kerala Coast. The recovered materials were alkali-cleaned and characterized to identify polymer types and degradation stages. Polyamide (PA) monofilament gillnets were identified as the dominant fishing-related plastic. Based on their quality, PA nets were sorted, shredded, and explored for upcycling potential. Shredded ALDFG and pulverised FRP debris were incorporated into cementitious composites by replacing 25% of natural sand and substituting conventional glass fibre reinforcement completely (100%) with shredded PA material, thereby conserving virgin resources. The developed composites exhibited good mechanical properties and water resistance, and were moulded into various architectural structures. Work is also being initiated to convert high-quality PA pellets from ALDFG into textile and geotextile fibres for applications such as apparel, industrial fabrics, erosion-control mats, and coastal protection under the NFDB-funded project "Exploring the Possibilities of Upcycling Abandoned, Lost, or Discarded Fishing Nets (ALDFG) into Textile/Geo-textile Applications. This initiative demonstrates that targeted, science-based management of even smaller fractions of marine litter can significantly advance circular economy practices, reduce marine plastic pollution, and support sustainable fisheries and coastal ecosystem management.

BLACK SOLDIER FLY LARVAE MEAL-BASED DIETS FOR IMPROVED REPRODUCTIVE PERFORMANCE AND GENE EXPRESSION IN GENETICALLY SELECTED MAGUR (*Clarias magur*)

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Black soldier fly larvae (BSFL) meal is a high-protein, sustainable food that can partially replace costly conventional proteins in aquafeeds. However, its limited essential fatty acids warrant careful evaluation in broodstock diets, where fatty acids play pivotal roles in reproductive physiology. The effectiveness of partially defatted BSFL meal on gonadal maturation, steroidogenesis, and reproductive output in *Clarias magur* broodstock was examined in this 90-day feeding trial.

Four iso-nitrogenous (36% crude protein), iso-lipidic (8.5% lipid), and iso-caloric (374–386 Kcal DE/100 g) diets were formulated viz., T10 (10% BSFL inclusion), T20 (20% BSFL inclusion), and T30 (30% BSFL inclusion). There was a fixed low amount of fishmeal in every diet. In female broodstock, the hepatosomatic index (HSI) remained unchanged, but gonadosomatic index (GSI) increased significantly at 10% BSFL (T10) before declining at higher inclusions. Absolute fecundity did not differ significantly, yet relative fecundity and egg quality parameters were highest in the T10 diet. Fertilization rate, hatching rate, and larval survival improved significantly in T10 and T20 groups, whereas both control and T30 exhibited lower outcomes. In males, HSI decreased in BSFL-fed groups, while GSI increased up to 20% inclusion, indicating enhanced gonadal development. Hormonal assays demonstrated that estradiol was highest in the control, while $17\alpha,20\beta$ -DHP and 11-ketotestosterone (11-KT) concentrations peaked in T10, followed by T20. In females, serum cholesterol levels decreased significantly in T10 and T20; similar patterns were noted in males, suggesting improved lipid mobilization and utilization. Reproductive gene expression analyses revealed unchanged FSHR expression in both sexes. In females, LHR expression increased significantly in T10 and T20, suggesting enhanced ovulatory potential.

This study demonstrates that partially defatted BSFL meal can replace soybean meal up to 20% in low fishmeal Magur broodstock diets, with 10% inclusion providing improved reproductive benefits.

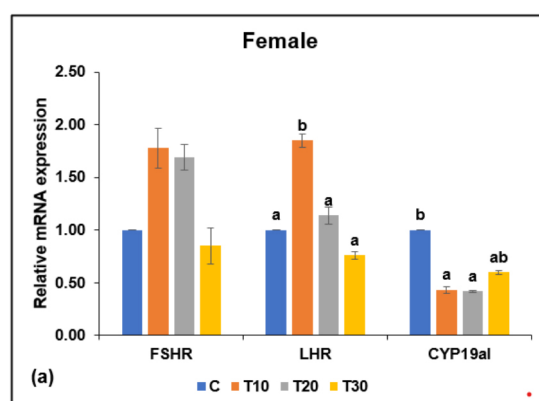


Fig. a.: Relative mRNA expressions of reproduction related genes in female magur fed experimental diets for 90 days

SAME-DAY RAPID ANTIMICROBIAL SUSCEPTIBILITY TESTING FOR FISH AND SHRIMPS PATHOGEN

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Inappropriate and excessive antibiotic use in shrimp or fish aquaculture leads to several harmful outcomes. These include the emergence of antibiotic-resistant bacteria, which undermines disease control efforts, poses health risks to consumers, and disrupts natural microbial communities. Furthermore, shrimp products containing antibiotic residues face import bans and consumption restrictions. The aim of this study was to detect and examine antibiotic susceptibility patterns in *Vibrio* species isolated from shrimp farming ponds in Goa, India. Microbial culture techniques were utilized to isolate *Vibrio* sp. antibiotic resistance was examined using indigenously developed rapid phenotypic antimicrobial susceptibility kit (ESKAPE kit). The results showed the supply brackish water consisted of 10³–10⁶ CFU/mL of *Vibrio* sp. which was identified as yellow colonies on the selective Thiosulfate-citrate-bile salts-sucrose (TCBS) agar. Antibiotic susceptibility testing using ESKAPE kit (Fig. 1) was completed within 6 hours and demonstrated resistant phenotype against tetracycline, oxytetracycline,cephalexin, erythromycin, trimethoprim-sulfamethoxazole, nitrofurantoin, ciprofloxacin, enrofloxacin, while intermediate phenotype for doxycycline and susceptible for amoxicillin.

Moreover, pH, dissolved oxygen, electrical conductivity were monitored in parallel for water quality analysis. This finding highlights the importance of selecting appropriate antibiotics in shrimp cultivation to stop the spread of resistant *Vibrio* bacteria.

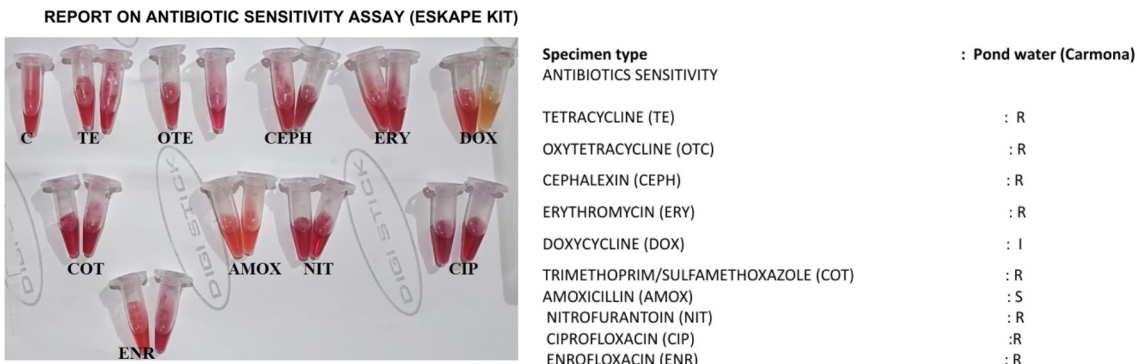


Fig. 1: ESKAPE Kit results observed with *Vibrio* sp. Isolates.

PHYSIOLOGICAL RESPONSES IN COMMON CARP *Cyprinus carpio* EXPOSED TO OXYTETRACYCLINE

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The widespread application of antibiotics in aquaculture raises concerns about their potential physiological impacts on cultured species and associated ecological risks. This study evaluated the physiological responses of *C. carpio*, a globally distributed freshwater fish of ecological and economic importance, when exposed to Oxytetracycline (OTC), a tetracycline-class antibiotic widely used in aquaculture. Juvenile *C. carpio* (5.3 ± 0.7 g) were fed for 45 days with experimental diets (35% crude protein) supplemented with graded concentrations of OTC (25, 50, 75, and 100 mg/kg diet) at 5% of body biomass.

A reduction in oxygen uptake was recorded in all concentrations of OTC with highest decline in 75 mg OTC/kg, relative to control, indicating respiratory stress. The highest final body weight and most efficient feed conversion ratio (FCR) were obtained at 50 mg OTC/kg diet (Fig. 1), whereas fish fed 75 mg/kg diet exhibited the lowest body weight and poorest FCR (Fig. 2), likely due to diversion of metabolic energy toward detoxification processes. Reduced growth, decrease in ammonia excretion and the increases in oxygen-to-nitrogen ratio at 75 mg/kg, suggests a metabolic shift toward lipid and carbohydrate utilization. Variations in oxygen consumption and excretory patterns may be attributed to gill damage, stress-induced metabolic suppression, and altered enzymatic activity caused by OTC accumulation.

These findings indicate that dietary OTC disrupts normal physiological functions in *C. carpio*. The observed alterations in respiratory activity, growth performance, and excretory patterns highlight the potential use of these responses as sensitive biomarkers for assessing environmental risks associated with antibiotic exposure.

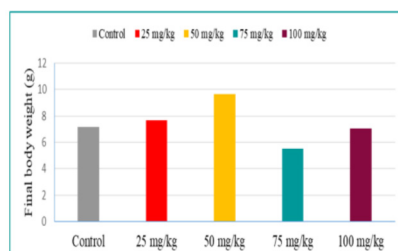


Fig. 1. Final body weight (g) achieved by common carp after fed with oxytetracycline supplemented medicated feed for a duration of 45 days

ENZYMATIC RESPONSES IN COMMON CARP *Cyprinus carpio* EXPOSED TO OXYTETRACYCLINE

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Aquaculture plays an increasingly important role in global food security, contributing nearly 8% of animal protein consumed worldwide. However, its expansion is paralleled by widespread use of antibiotics, of which oxytetracycline (OTC) remains one of the most common. Despite its efficacy in disease control, OTC has the potential to induce biochemical disturbances in aquatic organisms. The present study was conducted to evaluate the enzymatic responses of juvenile common carp, *Cyprinus carpio* (5.3 ± 0.7 g), to graded dietary concentrations of OTC (25, 50, 75, and 100 mg/kg feed) over 45 days. Enzymatic biomarkers including aspartate aminotransferase (AST), alanine aminotransferase (ALT), and lactate dehydrogenase (LDH) were assayed to assess metabolic disruption and hepatotoxic stress in liver.

Aspartate aminotransferase (AST) is a key enzyme in amino acid metabolism. In the present study, OTC exposure elicited a dose-dependent elevation of hepatic AST activity, with the highest increase observed in fish fed with 100 mg/kg (Fig 1). This elevation strongly suggests hepatocellular damage and leakage of transaminases into circulation, reflecting altered amino acid turnover and metabolic stress.

Alanine aminotransferase (ALT), another critical transaminase, exhibited a similar trend to AST, with a significant rise in activity corresponding to increasing OTC concentrations (Fig 2). Since ALT is predominantly localized in the liver, its marked elevation provides more direct evidence of hepatocellular damage compared to AST. Elevated ALT activity in OTC-treated groups indicates impairment of protein metabolism and transamination processes, which are essential for nitrogen balance and energy metabolism.

Lactate dehydrogenase (LDH), an enzyme central to anaerobic glycolysis, catalyzes the conversion of pyruvate to lactate. OTC exposure induced a consistent increase in LDH activity (Fig 3), reflecting a metabolic shift from aerobic to anaerobic pathways in response to cellular stress. Elevated LDH suggests compromised oxidative metabolism, increased energy demand under toxic stress, and possible tissue hypoxia.

The dose-dependent elevations of AST, ALT, and LDH demonstrate the hepatotoxic potential of OTC in *C. carpio* and establishes these enzymes as sensitive biomarkers for monitoring antibiotic-induced biochemical stress in aquaculture species.

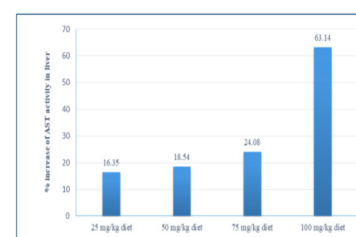


Fig. 1. Variation in activity of aspartate aminotransferase in liver as percentage over control in common carp fed with oxytetracycline for 45 days.

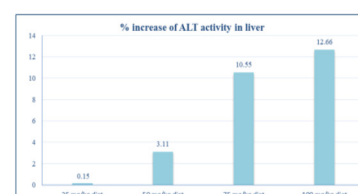


Fig. 2. Variation in activity of alanine aminotransferase in liver as percentage over control in common carp fed with for 45 days.

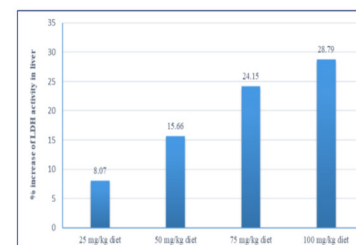


Fig. 3. Variation in activity of lactate dehydrogenase in liver as percentage over control in common carp fed with for 45 days.

FEED-BASED STRATEGIES FOR ENHANCING BIOSECURITY IN SHRIMP MATURATION SYSTEMS

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Viral and bacterial diseases remain the leading cause of economic losses in shrimp aquaculture and continue to constrain the industry's growth. Many of these outbreaks can be traced to the use of natural feeds in broodstock maturation systems. Fresh feeds such as polychaetes, squid, mussels, clams, and *Artemia* biomass commonly comprise more than two-thirds of the maturation diet, yet many of these natural ingredients are potential carriers of major shrimp pathogens.

Wild polychaetes are especially risky and have been identified as vectors for White Spot Syndrome Virus (WSSV), Acute Hepatopancreatic Necrosis Disease (AHPND), and the microsporidian parasite *Enterocytozoon hepatopenaei* (EHP). Mussels and clams have also been implicated as sources of WSSV, AHPND, and *Vibrio*. *Artemia* biomass from China has been identified as a potential vector for EHP and *Vibrio*. Even warm-water squid has tested positive for AHPND. Because hatcheries supply nearly all of the postlarvae used by shrimp farms, the introduction of pathogens through infected maturation feeds can result in widespread and costly disease transmission throughout the production chain.

Although these losses provide strong motivation to reduce reliance on risky natural foods, many hatchery managers remain reluctant to adopt prepared diets, believing that natural feeds are essential for successful maturation and larval rearing. However, this perception is outdated. Modern formulated maturation diets can be designed to closely match the nutritional profiles of natural ingredients. While no commercial product yet replaces all natural feeds without some reduction in fecundity, several formulations have successfully replaced 100% of polychaetes and bivalves with minimal effects on spawning performance. Eliminating the riskiest components of the diet has been shown to reduce bacterial loads and improve naupliar survival during larval rearing.

Although complete replacement of natural feeds is not yet feasible, hatchery managers can take practical steps to mitigate biosecurity risks. Replacing wild polychaetes with SPF farm-raised sources and implementing PCR testing of all fresh feed batches prior to use are effective preventive measures. Proper freezing of natural feeds at -10°C to -20°C can significantly reduce *Vibrio* counts, and freezing at -20°C prevents polar tube extrusion in EHP spores. Finally, treating nauplii with iodine and/or ozone before stocking can help interrupt vertical transmission of bacteria and EHP from broodstock to nauplii.

These measures, combined with the replacement of the riskiest fresh maturation feeds with formulated maturation diets, offer a practical and effective path toward improved hatchery biosecurity and healthier, more resilient shrimp production systems.

HABITAT-ENHANCED RECIRCULATING AQUACULTURE SYSTEMS IMPROVE POST-TRANSPORT RECOVERY AND SURVIVAL OF *Scylla serrata* (FORSSKÅL, 1775)

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Mud crab aquaculture is expanding rapidly, but its potential is undermined by high mortality rates associated with post-transport stress and suboptimal rearing systems. The industry's reliance on prolonged transport and clear-water recirculating aquaculture systems (RAS) is fundamentally misaligned with the physiology of *Scylla serrata*, the Indo-Pacific's most farmed crab species. This study evaluated a habitat-enhanced RAS that mimicked estuarine conditions using a mud substrate, turbid water, and shelters to mitigate these challenges. Crabs subjected to transport durations of 0 h, 24 h, and 48 h were reared in conventional clearwater or naturalized RAS. Results demonstrated that extended transport significantly increased *Vibrio* spp. loads in haemolymph and tissues, induced gill damage, and suppressed immune function. In contrast, naturalized RAS markedly improved outcomes, enabling 80% survival even after 48h transport. These systems also improved key health metrics including immune (THC, PO) and antioxidant (SOD, GPx) capacity while simultaneously increasing moulting frequency and growth rates compared to clear-water controls. Kaplan-Meier analysis confirmed a significantly lower mortality risk in naturalized systems. These findings establish that adopting naturalized, species-specific RAS designs is a viable and critical strategy for mitigating transport stress, improving animal welfare, and securing the commercial sustainability of mud crab aquaculture.

EFFECT OF REPLACEMENT OF FISH MEAL WITH FULL-FAT AFRICAN PALM WEEVIL LARVAE MEAL IN THE DIETS OF AFRICAN CATFISH *Clarias gariepinus*

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Introduction

Insects are good sources of nutrients and are cheap sources of animal proteins. African palm weevil larvae, *Rhychophorus phoenicis* (F) have high protein of about 66.3% (Elemo et al, 2011) which compares well with 65% protein in fish meal. This study investigated the effects of replacement of fish meal with full-fat African palm weevil larvae meal in the diets of African catfish for cost effective food fish production.

Materials and methods

Five isonitrogenous diets were prepared to contain 0, 25, 50, 75, 100% of the palm weevil larvae meal (PW) in replacement for fish meal in making diets 1 -5. The diets were fed to African catfish (5.60 g) for 70 days in indoor glass tanks. Standard procedures were used in data collection and analyses.

Results

Assessment of the mean weight gain, specific growth rate, feed conversion ratio and protein efficiency ratio indicated that PW can replace up to 100% of fish meal in the diet of the fish (Table 1). Replacement at 100% PW significantly increased the weight gain and specific growth in comparison with fish fed 100% fish meal. Similarly, dietary PW marginally improved Mg, Ca, P, Mn and Zn deposition in the fish and significantly reduced the liver enzymes, alanine aminotransferase (ALT) and aspartate aminotransferase (AST) in the fish fed 100% PW meal (Table 1).

Conclusion

African palm weevil larvae meal can replace 100% of fish meal in the diets of African catfish. Replacement of fish meal with PW also significantly reduced the liver enzymes ALT and AST levels.

Table. 1. Growth indices and liver enzymes of African catfish fed PW meal in replacement for fish meal

Parameters	Diet 1 0 % PW	Diet 2 25% PW	Diet 3 50% PW	Diet 4 75% PW	Diet 5 100% PW
Initial Wt. (g)	5.63	5.60	5.57	5.53	5.57
Final Wt. (g)	29.4 ^a	35.5 ^{ab}	35.6 ^{ab}	32.1 ^{ab}	40.2 ^c
Weight gain	23.7 ^a	29.9 ^{ab}	30.0 ^{ab}	26.5 ^{ab}	34.7 ^c
SGR	2.34 ^a	2.64 ^{ab}	2.24 ^a	2.50 ^{ab}	2.84 ^c
ALT	46.3 ^c	40.1 ^c	34.5 ^b	31.2 ^b	20.7 ^a
AST	26.7 ^c	19.9 ^b	19.8 ^b	10.0 ^a	9.59 ^a

FATTY ACID COMPOSITION OF THE AFRICAN CATFISH *Clarias gariepinus* FED BLACK SOLDIER FLY (*Hermetia illucens*) LARVAE

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Although a lean fish species, the flesh of the African catfish *Clarias gariepinus*, like many other fish species have been shown to incorporate essential fatty acids including the omega-3 very long-chain polyunsaturated fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) from their feed. Considering the immense benefits of these fatty acids to human health and the status of *C. gariepinus* as the most farmed and consumed fish species in Nigeria, it is important to understand how feeds influence the fatty acid profile of farmed *C. gariepinus*. This is more imperative as the traditional fish feed ingredients, fishmeal and fish oil, are being replaced with cheaper, more available and sustainable alternatives such as insect meals. In recent times, the black soldier fly *Hermetia illucens* has become increasingly farmed and touted as a suitable alternative. This research aimed to evaluate fatty acid composition of *C. gariepinus* fingerlings fed different percentages of black soldier fly larvae (BSFL).

A total of 450 *C. gariepinus* fingerlings were randomly divided into three groups (triplicate per group) of 60 per 1000-liter tank. Three experimental feeds were formulated, replacing fishmeal with BSFL at inclusion rates of 0%, 50%, and 100% respectively. After 72 days of feeding at 5% body weight, proximate and fatty acid analysis of the feed and fish were conducted.

Proximate and fatty acid analysis showed significant differences in the chemical composition of *C. gariepinus* fed the different feeds (Tables 1 and 2). Protein contents were higher in fish fed 0% BSFL. Except for arachidonic acid (20:4n-6), fatty acids were also higher in fish fed 0% BSFL (Table 2). Only fish fed 100% BSFL contained DHA. The 0% and 50% feed and the fish fed on them contained neither EPA nor DHA. Unfortunately, the fishmeal used was not analyzed and it can only be inferred to contain little to no EPA or DHA.

Table 1: Proximate composition of experimental feeds and *C. gariepinus*.

FEED	Moisture Content (%)	Ash Content (%)	Crude Protein (g/100g)	Crude Fibre (%)	Lipid/Crude Fat content (%)
0%	6.89	9.05	34.66	9.06	11.56
50%	4.92	7.16	25.12	7.89	10.21
100%	5.76	8.72	28.89	8.56	10.34
BSFL	2.73	9.93	22.7	40.19	29.42
FISH					
0%	40.09±1.38	7.10±0.11	57.13±1.48	8.43±0.57	10.61±0.08
50%	45.53±3.46	8.09±0.14	50.51±0.81	10.82±0.21	10.12±0.09
100%	45.98±0.20	7.32±0.45	52.66±0.66	10.77±0.07	10.13±0.30

Table 2: Fatty acid profile (µg/kg) of *C. gariepinus* fed the experimental feeds.

FATTY ACID	18:0	18:2n-6	18:3n-3	20:4n-6	22:6n-3
FEED 0%	1207.89	2013.03	2199.97	1998.96	
FEED 100%	1317.56	1610.77	1680.61	1588.09	
FEED 50%	1205.00	1533.89	1586.16	1505.77	
BSFL	19.60	9019.08	10061.61	1997.06	
FISH 0%	10804.38	17804.87	18082.32	10526.18	
FISH 100%	0.0000	11843.56	11761.62	5102.675	447.63
FISH 50%	8513.64	10976.39	15981.46	13834.41	

EFFECT OF BREWER'S YEAST ADDITIVES ON THE GROWTH PERFORMANCE AND INTESTINAL HEALTH OF MIRROR CARP *Cyprinus carpio*

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Aquaculture is the fastest-growing food production sector globally with *C. carpio* ranked among the top five finfish aquaculture species (FAO, 2024). However, sustainability, disease management, and antibiotic use remain key challenges. Brewer's yeast is a known source of nutrients and bioactive substances such as β -glucans and MOS which can potentially enhance the growth and overall health of aquatic species. This study explored the effects of three different commercial brewer's yeast additives (Leiber GmbH) on the performance and mucosal health of mirror carp, as well as their potential to mitigate antibiotic-induced dysbiosis.

A 10-week *in vivo* feeding trial was conducted with juvenile mirror carp (2.5 g) at the University of Plymouth. The feeding trial consisted of a control diet (T1) and six yeast-supplemented diets (T2–T7), each tested in triplicate tanks. All diets were formulated to be isonitrogenous and isolipidic ($\approx 49\%$ crude protein, 5% crude lipid). In Phase 1 (9 weeks), fish were fed either the control diet (T1) or the control diet supplemented with autolysed yeast (Leiber CeFi® Pro) at 0.1% (T2) or 0.25% (T3), unextracted brewer's yeast (Leiber Brewers' Yeast®) at 0.1% (T4), 0.25% (T5), or 2.5% (T6), or inactivated brewer's yeast with spent grains (Leiber YeaFi® BT) at 2.5% (T7). In Phase 2 (1 week), each respective diet (T1–T7) was further supplemented with oxytetracycline (75 mg kg⁻¹ biomass).

The fish were sampled at the end of phase 1 and phase 2. Intestinal samples were taken for various analysis including histology, gene expression profiling, and 16S rRNA gene metabarcoding.

The fish in all groups achieved 100% survival across both phases of the trial. Growth performance, recorded during phase 1, showed specific growth rates (SGR) ranging from 1.54 to 1.70 and feed conversion ratios (FCR) between 1.53 and 1.65. No significant difference ($p > 0.05$) among the groups were observed (data not shown).

At the end of phase 1, intestinal *cldn-7* gene expression levels were significantly higher in T4 (1.71 ± 0.34) fed fish compared to the control fed fish (0.89 ± 0.13) (Fig 1). *il-10*, *il-1 α* and *tnf- α* were stable across all groups with no significant differences between treatments (data not shown).

Histological analysis to quantify goblet cell counts, mucosal fold length, lamina propria width, and muscularis width, at the end of phase 1 were not significantly different ($p > 0.05$) between the control and the yeast treatment groups (data not shown).

Ongoing analyses on samples from both phases include gut microbiome profiling through full-length 16S rRNA gene metabarcoding, as well as qPCR to profile OTC resistance genes, such as *tet(A)* and *tet(B)*, (*tet(S)*), and *tet(X)*.

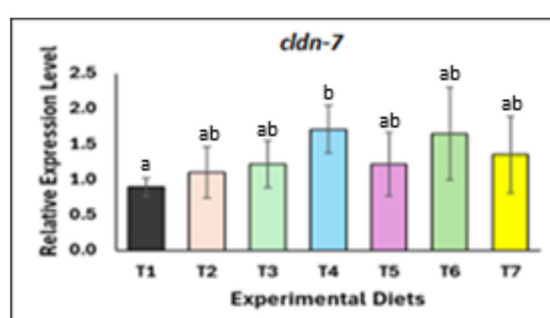


Fig 1: Relative expression of *cldn-7* in mirror carp intestine after phase 1

ASSESSMENT OF GROWTH PERFORMANCE AND MUCOSAL HEALTH OF ATLANTIC SALMON *Salmo salar* FED BREWER'S YEAST SUPPLEMENTED DIETS

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The Atlantic salmon (*Salmo salar*) is a prominent species in aquaculture, and optimising its growth and health is of paramount importance to improve welfare and support the growth of the sector. Brewer's yeast is a known source of nutrients and bioactive substances such as β -glucans and MOS which can potentially enhance the growth and overall health of aquatic species. This study investigated the impact of two distinct brewer's yeast feed additives, an autolysed brewer's yeast (ABY; CeFi® Pro, Leiber GmbH) and a soluble dried yeast extract (SDYE; Leiber GmbH), on the growth performance and mucosal health of Atlantic salmon parr.

A 9-week feeding trial was conducted using salmon juveniles (37 g) at the University of Plymouth. The fish were assigned to three isonitrogenous and isocaloric diets (49% crude protein, 24% crude lipid): a control diet (no yeast additive), a ABY-supplemented diet (0.25 g/100 g), or a SDYE-supplemented diet (0.25 g/100 g). Fish were fed daily at 1% of biomass.

At the end of the feeding trial, growth performance did not differ significantly among treatments (data not shown). Intestine, skin and blood samples were taken for various analysis, including histology, expression of immunoregulatory genes, haematology, and 16S rRNA gene metabarcoding of intestinal microbiota.

Histological analyses revealed significant improvements ($p < 0.05$) in intestinal and skin morphology in yeast-fed groups compared to the control fed fish. In the intestine, ABY-fed fish exhibited significantly longer mucosal folds, narrower lamina propria widths, and higher goblet cell counts, while in the skin increased goblet cell counts were observed (Table 1).

The intestinal gene expression analysis (Fig. 1) revealed a significant upregulation of *il-1 β* and *muc-2* ($p < 0.05$) in ABY compared to control. No significant differences between groups were observed for *tnf- α* , *il-10*, and *cldn-15*.

Haematological parameters remained within normal ranges across all treatments, with no significant differences among groups (data not shown).

In conclusion, supplementation with brewer's yeast, was associated with improved intestinal morphology (ABY and SDYE), intestinal and skin goblet cell counts (ABY) and upregulation of intestinal *il-1 β* and *muc-2* gene expression (ABY), without apparent negative effect on growth or haematological parameters. These findings highlight the potential of brewer's yeast as a functional feed additive to support mucosal health in Atlantic salmon.

Table 1: Intestine and skin histology results

	Control	ABY	SDYE
MFL (μ m)	203.74 $\pm$ 35 ^a	307.41 $\pm$ 66 ^b	375.98 $\pm$ 69 ^b
MT (μ m)	56.76 $\pm$ 13.73	72.97 $\pm$ 15.73	69.89 $\pm$ 13.11
LPW (μ m)	16.81 $\pm$ 6.13 ^a	11.86 $\pm$ 2.11 ^b	13.31 $\pm$ 3.02 ^{ab}
GC Int (n/100 μ m)	7.01 $\pm$ 1.71 ^a	9.44 $\pm$ 1.91 ^b	9.24 $\pm$ 2.44 ^{ab}
GC Skin (n/200 μ m)	14.56 $\pm$ 2.85 ^a	18.22 $\pm$ 2.48 ^b	14.44 $\pm$ 2.66 ^a

MFL: Mucosal Fold Length; MT: Muscularis Thickness; LPW: Lamina Propria Width; GC: Goblet Cell counts

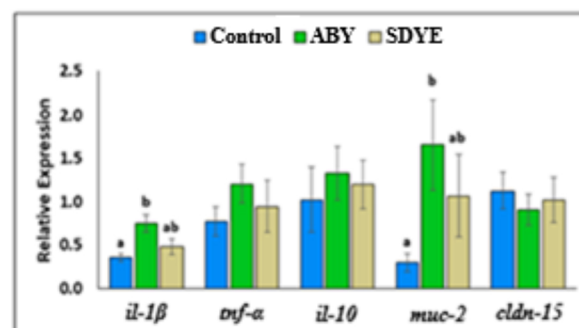


Fig 1: Intestinal gene expression data.

EVALUATION OF YEAST ADDITIVES IN MODULATING THE INTESTINAL MICROBIOME OF MIRROR CARP *Cyprinus carpio* AND ENHANCING RESILIENCE TO ANTIBIOTIC-INDUCED DYSBIOSIS

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Antibiotic usage, along with disease management, remains one of the key challenges in aquaculture. Functional feed additives such as brewer's yeast may provide a means to enhance microbial resilience and health of fish and reduce reliance on antibiotics. This study evaluated the impact of three commercial brewer's yeast additives (Leiber GmbH) on the intestinal microbiota of mirror carp before and after oxytetracycline administration.

A 10-week trial was conducted, with two phases. In Phase 1, mirror carp juvenile (2.5 g) were fed a control diet (T1) or one of six yeast-supplemented diets: CeFi® Pro at 0.1% (T2) or 0.25% (T3), Brewers' Yeast® at 0.1% (T4), 0.25% (T5), or 2.5% (T6), and YeaFi® BT at 2.5% (T7) for 9 weeks. In Phase 2, the same diets were also supplemented with oxytetracycline (at 75 mg kg⁻¹ biomass) for 1 week. Intestinal samples were taken for various analyses, including a full-length 16S rRNA gene metabarcoding.

At the phylum level, communities were dominated by *Pseudomonadota*, *Fusobacteriota*, *Bacillota*, and *Bacteroidota* (Fig. 1). In Phase 1, no significant difference ($p > 0.05$) was observed in the relative abundance of each phylum among different groups. *Fusobacteriota* relative abundance was consistently high (30-52%) across groups, followed by *Pseudomonadota* (14-34%) and *Bacillota* (6-35%).

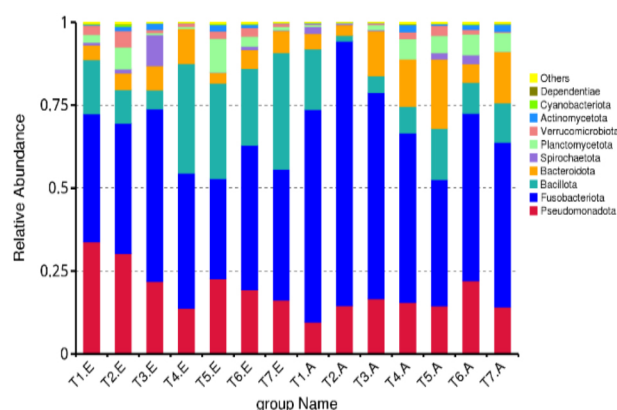


Fig. 1: Top 10 abundant phyla (E: Phase 1; A: Phase 2)

After the antibiotic intervention, *Fusobacteriota* relative abundance expanded (62-80%) across all groups, with a significant increase ($p < 0.05$) observed in T1 and T2 compared to pre-antibiotic levels. *Bacillota* abundance was significantly reduced ($p < 0.05$) in T2 and T4. *Bacteroidota* relative abundance significantly increased ($p = 0.012$) in T5 compared to pre-antibiotic levels. Although no significant difference ($p < 0.05$) was observed, the relative abundance of *Pseudomonadota* declined overall in each treatment across the phases, mostly in T1 (from 33.8% in Phase 1 to 9.7% post antibiotic intervention).

At the genus level, a similar trend was also observed. *Cetobacterium* was the dominant genus, increasing from 30-52% (Phase 1) to 38-80% (Phase 2), with a significant difference ($p < 0.05$) observed in T1 and T2. In contrast, *Culicoidibacter* relative abundance in T4 and T7 pre-antibiotics (33% and 35%) declined sharply after antibiotic intervention (8% and 10%, respectively). *Aeromonas* persisted at moderate levels (5-13%) across all treatments and both phases, while other opportunistic genera, such as *Acinetobacter*, were significantly reduced post-antibiotics.

Analysis of similarity (ANOSIM) confirmed significant shifts ($p < 0.05$) between pre- and post-antibiotic communities in most treatments, with the strongest effects in T2 ($R = 0.60$) and T4 ($R = 0.46$).

Overall, brewer's yeast supplementation modulated carp intestinal microbiota in a diet-specific manner. Treatments such as T4 (0.1% Brewers' Yeast®) and T7 (2.5% YeaFi® BT) reduced the abundance of some genera, such as *Culicoidibacter*, after antibiotic intervention, while others, such as T2 (0.1% CeFi® Pro), enhanced *Cetobacterium* dominance.

HEMATOLOGY, OXIDATIVE STRESS AND BIOCHEMICAL RESPONSES IN *Clarias gariepinus* POST FINGERLINGS EXPOSED TO SUBLETHAL DOSES OF EMAMECTIN BENZOATE

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Emamectin benzoate (EMB) is a highly neurotoxic insecticide used in agronomy, animal husbandry, and farming of aquatic organisms to control pests. Runoff from these sources can harm fish. In this work, experimental groups were subjected to four doses of $17 \mu\text{g L}^{-1}$, $34 \mu\text{g L}^{-1}$, and $68 \mu\text{g L}^{-1}$, and control without EMB for 14 days, after which fish was monitored for one week (7 days) depuration period to estimate recovery potential of the fish. In days 1, 7 and 14 durations of exposure, stress biomarkers including aspartate aminotransferase (AST), alkaline phosphatase (ALP), alanine aminotransferase (ALT) and blood Urea and Creatinine levels increased with dose and duration, and after 7 days depuration period, they maintained elevated values. The antioxidant enzymes superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) decreased significantly ($p < 0.05$), as did packed cell volume (PCV), mean corpuscular volume (MCV), hemoglobin concentration (Hb), and red blood cell count (RBCC). The trend continued after 7 days of depuration. There were significant ($p < 0.05$) leukocytosis, lymphopenia and neutrophilia in treated fish. In contrast, lipid peroxidation and glutathione reductase (GR) levels increased but returned to normal after 7 days of depuration. The altered hematological parameters were indicative of immune suppression and anemia in the exposed fish, while the altered antioxidant enzymes implied that reactive oxygen species (ROS) may have played a role in the toxic action of EMB. This study showed that 7 day depuration time was insufficient to repair the harm caused by EMB stress to the fish.

MULTI-SYSTEM METABOLIC ALTERATIONS IN TISSUES OF *Oreochromis niloticus* EXPOSED TO DICLOFENAC SODIUM SALT TOXICITY IN A MICROCOSM EXPERIMENTS

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The non-steroidal anti-inflammatory drug (NSAID) diclofenac is a pervasive aquatic contaminant. While its presence in water systems is well-documented, its sub-chronic impact on the fundamental energy metabolism of fish remains poorly understood. This study investigated the temporal effects of a high sublethal concentration of diclofenac sodium on the protein, lipid, and carbohydrate reserves of Nile tilapia (*Oreochromis niloticus*). The 96-hour median lethal concentration (LC_{50}) of diclofenac for *O. niloticus* was determined to be 18.5 mg/l. Based on this, fish were exposed to a sublethal concentration of 1.85 mg/l ($1/10^{th}$ LC_{50}) for 24, 48, 72, and 96 hours, and 7, 14, and 21 days. Tissues (gill, liver, kidney, blood) were analyzed using spectrophotometric methods to quantify concentrations of total proteins, lipids, and carbohydrates. Data were analyzed using two-way ANOVA. Diclofenac exposure induced a severe, time-dependent catabolism of essential macromolecules across all tissues. A consistent hierarchical pattern of mobilization was observed: Lipids > Carbohydrates > Proteins, indicating a strategic sacrifice of energy reserves. The kidney and liver were the most vulnerable organs, suffering near-total depletion of lipids ($\geq 96\%$) and carbohydrates ($\geq 85\%$), and extreme protein loss ($\geq 77\%$). The gill demonstrated the most severe relative carbohydrate depletion (90.4%). Kinetic analysis revealed a biphasic response: a rapid initial depletion phase (0-96 hours) followed by a slower, chronic exhaustion phase, indicative of recovery from shock and a progression from acute stress to systemic energy bankruptcy. This study demonstrates that sub-chronic exposure to diclofenac triggers a catastrophic multi-system metabolic crisis, forcing a hierarchical mobilization of energy reserves that compromises vital physiological functions. These findings provide a mechanistic explanation for the sublethal toxicity of diclofenac and highlight a significant threat to fish health, growth, and population sustainability, underscoring the ecological risk of pharmaceutical pollutants in aquatic environments.

AN OVERVIEW OF THE FISH ISSUES FACING GWAGWALADA'S FISH FARMERS AND TRADERS NIGERIA'S ABUJA

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Fish farming is currently one of the agricultural industries with the quickest rate of growth, making Nigeria the continent's second-largest producer of aquaculture. Furthermore, Nigeria leads the world in the production of African bonytongue (*Heterotis niloticus*) and African catfish (*Clarias gariepinus*). However, there are a number of disconnections between the fish marketers, sellers, transporters, in the Federal Capital Territory's Gwagwalada areas council. As a result, some of these places have high fish prices, in the markets, from which farmers often receive goods. Furthermore, most feed manufacturers utilize a fish waste, which affects fish availability, pricing, and demand, making it hard for most farmers to meet market demands for fish.

Additionally, there are unidentified and unacknowledged groups of people in charge of the marketing, processing, and sale of various fish products. Based on our analysis of this work, we have found that there is a significant lack of innovative fish drying and transportation methods. The entire value chain, in the marketing, preservation, and use of fish products, the lack of farm space, the inadequate power supply, the insecurity, the poor road system, the high cost of feed, the death rate, the contaminated water, the farm workers, and the storage of the fish products in the markets. Our paper therefore recommends solutions to address these issues and calls for research and development on how to approach this and conducted some oral interviews. The results indicate that most of them still think that there are various opportunities related to the value of marketing, transportation, and farming, and that we should investigate and manage them. Whereas the government was now unsure on how to solve the issues with transportation and fish drying in order to increase the productivity of the fish sector.

Pictorials representation of the field Survey in Gwagwalada, Abuja, Nigeria



IMPACT OF STOCKING DENSITY ON BIOECONOMIC PERFORMANCES OF BLUE SWIMMING CRAB *Portunus pelagicus* CULTURE IN GROW-OUT POND

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The blue swimming crab (*Portunus pelagicus*) is a valuable commercial species widespread across tropical coastal waters of the western Indian Ocean and eastern Pacific. In 2020, fishery trends showed that blue swimming crab (BSC) catches remained at their highest levels. Notably, the demand for seafood is increasing, while natural marine resources are decreasing, due to overexploitation and habitat destruction, with the BSC being one of the species under threat in many Asian countries. Culture development of the BSC is one potential and promising long-term solution to cope with this problem. This study examined the optimization of stocking density in grow-out ponds, where density affected growth, survival, and economic feasibility. Identifying an optimal density was essential to maximize production efficiency, and profitability.

The study was conducted at the Klongwan Fisheries Research Station in Thailand from April 2022 to March 2024. Juvenile BSC were reared in a 1,600 m² grow-out pond at three stocking densities: low (1 crab/m²), medium (3 crabs/m²), and high (5 crabs/m²). BSC were fed an artificial shrimp feed (No. 4S; pellet size 3.5 mm, 38% protein) at 5% of body weight per day, with feedings twice daily at 0900 and 1700 hours. Over a 90-day period, survival (SR), weight gain (WG) growth rates, and feed conversion ratio (FCR) were monitored, along with some economic metrics, including total revenue (TR), and payback period (PBP).

Results demonstrated that stocking density significantly impacted the SR, growth performance, and revenue in BSC cultivation. As density increased, SR declined, with low- and medium-density groups achieving better overall outcomes compared to high-density ponds. Higher densities resulted in lower growth rates (WG, ADG, and SGR), reduced TR, and an elevated FCR (Table 1). The stocking densities of 1 and 3 crabs/m² were more suitable for BSC cultivation compared to 5 crabs/m². Economically, the PBP for these two densities were 3.9 and 4.2 years, respectively. To promote sustainable commercial cultivation, further research is recommended to develop strategies for increasing production or reducing cultivation costs at these densities, thereby enabling a faster return on investment.

TABLE 1. Bioeconomic performance of blue swimming crab (*Portunus pelagicus*) cultured in 1,600 m² grow-out ponds over a 90-day period at different stocking densities (n = 3). Means in each column followed by different letters indicate a significant difference ($P < 0.05$).

Parameter	Density (crab/m ²)		
	1	3	5
SR (%)	45.5±5.9 ^a	18.5±1.2 ^b	10.1±1.2 ^c
WG (g)	85.4±10.2 ^a	77.3±6.2 ^a	55.9±6.4 ^b
ADG (g/day)	0.9±0.2 ^a	0.8±0.1 ^a	0.6±0.1 ^b
SGR (%/day)	7.6±0.1 ^a	7.5±0.1 ^a	7.1±0.1 ^b
FCR	1.4±0.2 ^a	2.2±0.1 ^a	5.4±1.4 ^b
Yield (kg/pond)	62.1±10.2 ^a	68.6±5.4 ^a	45.6±7.9 ^b
TR (USD/pond)	467.9±77.3 ^a	516.8±40.6 ^a	343.4±59.7 ^b
PBP (year)	3.9±0.6 ^a	4.2±0.3 ^a	7.5±1.4 ^b

THE TRIPLE NEXUS: ADVANCING AQUACULTURE AND REGIONAL DEVELOPMENT FOR NATIONAL SECURITY IN KENYA

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Understanding the key drivers of the blue economy and regional development presents a strategic opportunity for enhanced security and sustainable growth in Kenya, particularly in the Lake Victoria Basin. This region, home to more than 10 million Kenyans, is endowed with vast aquatic resources and holds immense potential for an ecosystem-based approach to aquaculture expansion. Such an approach can significantly enhance food security, improve nutrition, catalyze economic development, and promote security and environmental sustainability.

By fostering regional development through improved infrastructure, market access, and local capacity building, aquaculture can generate employment, alleviate poverty, and reduce resource-based conflicts. Integrating this approach with Kenya's national security priorities ensures that the region's stability and prosperity are safeguarded, mitigating the risks of illegal fishing, environmental degradation, and cross-border tensions.

This paper explores the interconnected pathways through which aquaculture can be leveraged to advance regional development in the Lake Victoria catchment area while contributing to Kenya's broader national security objectives. It emphasizes the promotion of aquaculture through Integrated Technology Transfer Centres (ITTC) of the Lake Basin Development Authority (LBDA), which provide a platform for transferring technologies to fish farming communities, access to certified high-quality fish fingerlings at subsidized rates, and collaboration with other institutions, including security agencies.

NANOTECHNOLOGY-DRIVEN BIOFOULING MITIGATION IN AQUACULTURE: SURFACE MODIFICATION OF NON-POLAR POLYETHYLENE NETS WITH PANI OR SILANE TO INCORPORATE NANO BIOCIDES

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Cage aquaculture has gained significant attention in recent years in India to address nutritional security of the growing population. A major issue in cage aquaculture is biofouling, and its management accounts 10 to 25% of the total project cost. Non-polar polymeric materials, such as polyalkenes (polyethylene/ polypropylene), are commonly used for cage construction. The current strategy to combat biofouling in aquaculture cage nets involves coating with binders or polymeric adhesives containing biocides. These methods are disadvantageous due to excessive use of biocides, its leaching to the environment, increased weight of the cage net, and disposal after the culture. Nano technology offers efficient solutions to mitigate the biofouling issue in aquaculture cage nets. Aquaculture cage nets mainly fabricated polyethylene, which is a non-polar polymer. The surface of the polyethylene is need to be modified to incorporate nano biocides to combat biofouling. ICAR CIFT developed two methods to modify the polyalkene surfaces using conducting polymers like polyethylene and organo silane molecule ((3-glycidyloxypropyl)trimethoxysilane) (silane) [1, 2]. Successfully embedded varied nano biocides like nano copper oxide, nano copper oxide – titanium oxide, nano carbondot- graphene, nano carbondot- titanium oxide, nano carbon dot –(CuO:TiO₂) etc, over polyethylene surface modified with polyaniline / organosilane. These biocides were effective to contain the accumulation of biofoulers in the aquaculture cage nets. The study aimed to evaluate the biofouling inhibition efficiency of coating of nano copper oxide and oleamide over both polyaniline and organosilane coated over polyethylene. Nano CuO and oleamide treated sequentially over PANI and silane surface modified polyethylene aquaculture cagenets (PE-PANI, PE-Silane). The CuO and oleamide respectively interacted with Si-O and C-O-C bonds through amide N-H in the silane-PE and in the case of PANI-PE both biocide strongly interacted through quinoid moiety of PANI. Surface morphologies of treated surfaces also showed uniform coatings and the introduction of oleamide made the surface of aquaculture cagenet more hydrophobic. Nano CuO (0.02%) : oleamide (0.04%) coated over PE-silane and / PE-PANI aquaculture cagenet exposed in the estuarine environment showed good biofouling resistance. The oleamide and nano CuO synergistically influenced to deter the micro and macro foulers.

AN INSIGHT INTO THE SOCIO-ECONOMICS AND LIVELIHOOD OF RIVERINE FISHERS OF INDIA

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River fishing is a vital component of the inland fisheries, contributing significantly to the life and livelihood of the millions of fishers. However, they face socioeconomic and environmental challenges such as pollution, inadequate water flow, uncertainty of fish catch and income etc. Hence, the resource-poor fishers adopt livelihood diversification to cope up with the uncertainty and inadequateness of the fisheries as a profession. The study was conducted taking riverine fishers as respondent involving 8 rivers of India. Data were collected from 500 fishermen from 66 villages along the Ganga, Tons, Torsa, Brahmaputra, Kolong and Narmada, Mahi rivers in 2021-2022.

The study showed that the average family size of the fishers was a little above 5 (5.2). The agricultural land holding was only 0.37 acres per household. To 87% of the respondents, fishing was the major occupation, which ranged from 75% in West Bengal and Assam to 89% in Gujarat. 71% of the fisher households had either *kachha* or *semi-pucca* houses whereas only 29% of the respondents had *pucca* houses. Around 80% of the fishers did possess nets and boats. Rest of the fishers hired these for fishing or acted as fishing labours. On an average every fisher house possessed fishing nets worth Rs. 20,044. The fishing in the rivers generated significant employment to the tune of around 20,000 in Assam to 69,000 in Gujarat in the selected stretches of the sampled rivers. To meet the livelihood needs, the fishers also engage themselves in different income generating activities, in addition to fishing in the rivers. As a result, the average number of income generating activities per household was found to be 1.85 which ranged from 1.66 in West Bengal to 2.11 in Assam. Further, it was found that their level of income diversification was quite low. The Simpson's index of income diversification was 0.41 ranging from 0.30 in West Bengal to 0.53 in Gujarat. No fishermen family in all the states possessed diversification index of more than 0.66. The diversification was found to be more in small/minor rivers. The major constraints reported by the fishers were declining fish catch, pollution, less/no water in the small rivers, invasion of exotics, declining biodiversity. The small scale riverine fisheries need immediate attention of the policy makers to restore and enhance the fish stock, providing sufficient e-flow, and securing the livelihood of the fishers. There is need to develop appropriate strategies to facilitate successful livelihood diversification.

APOPTOTIC AND ANTIMICROBIAL EFFECTS OF CRUSTIN, AN ANTIMICROBIAL PEPTIDE FROM THE CRAB *Scylla serrata* AGAINST SHRIMP VIBRIOSIS AND HUMAN CARCINOMA CELLS

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Shrimp vibriosis, caused predominantly by virulent strains of *Vibrio* spp., continues to pose a serious threat to global aquaculture. Outbreaks of the disease are often associated with mass mortalities in shrimp farms, reduced productivity, and severe economic losses. Conventional disease management strategies, including the use of antibiotics and chemotherapeutics, have proven increasingly ineffective due to the emergence of multidrug-resistant bacterial strains, besides raising concerns about environmental impact and food safety. Consequently, the search for sustainable alternatives has turned attention toward antimicrobial peptides (AMPs), naturally occurring defense molecules that offer broad-spectrum activity, low propensity for resistance development, and eco-friendly applicability in aquaculture systems.

In the present study, we explored the dual functional potential of crustin, a recombinant AMP derived from the crab *Scylla serrata*, with particular focus on its antimicrobial activity against vibrio species associated with shrimp vibriosis, and its anticancer properties against human breast (MDA-MB-231) and prostate (PC-3) carcinoma cell lines.

Antimicrobial assays revealed that recombinant crustin exhibited potent inhibitory activity against virulent *Vibrio* isolates, confirming its capacity to serve as a preventive or therapeutic agent in shrimp culture. Beyond its antimicrobial effects, crustin demonstrated significant anticancer potential. Cytotoxicity studies using MTT assays revealed dose-dependent inhibition of proliferation in breast (MDA-MB-231) and prostate (PC-3) carcinoma cell lines, with IC₅₀ values of 250 µg/mL and 300 µg/mL, respectively. Multiple complementary assays including propidium iodide (PI) staining, Annexin V-FITC analysis, dual acridine orange/ethidium bromide (AO/EB) staining, and DNA fragmentation provided clear evidence of apoptosis induction. Further, Rhodamine 123 staining confirmed mitochondrial membrane depolarization, implicating activation of the intrinsic (mitochondria-mediated) apoptotic pathway. Additionally, flow cytometry analysis revealed G0/G1 phase cell cycle arrest, supporting the role of crustin in suppressing tumor cell proliferation through both apoptotic and cell cycle regulatory mechanisms.

Overall, the findings highlight recombinant crustin as a multifunctional bioactive molecule with significant translational relevance. Its strong anti-*Vibrio* activity positions it as a potential natural alternative to antibiotics for sustainable aquaculture, while its selective anticancer effects underscore its promise as a lead molecule for novel therapeutic strategies. This dual functionality not only broadens the application spectrum of AMPs but also emphasizes the untapped potential of marine-derived biomolecules in addressing challenges in both aquaculture and human health.

UNDERSTANDING ENERGY FLOWS AND FOOD WEB INTERACTIONS IN TROPICAL RESERVOIR ECOSYSTEMS

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In a reservoir ecosystem, the energy flows from producers to consumers in a food web with a reduction in energy as it moves from lower to higher trophic levels. The food webs present multiple pathways through which the food web structure and interactions play an important role in ecological studies by determining the dynamics of an ecosystem. They illustrate the complex interactions between organisms, including predator-prey relationships and decomposition. The interconnectedness of food webs makes them resilient to disturbances, as energy can flow through alternative pathways. Reservoirs can have unique food web structure compared to other open water aquatic ecosystems. Anthropogenic activities, such as dam construction, pollution, fishing pressure, etc. can alter energy flow and food web dynamics in reservoirs. Hence, understanding the energy flow in reservoir ecosystems is crucial for managing these resources and maintaining their ecological integrity. Various ecological models have been developed for evaluating the food web interactions, and addressing ecological dynamics ranging from the conventional Lotka-Volterra predator-prey model to the more recent ecosystem-based or multispecies fisheries models. These models differ in their complexity, input data requirement and outputs. Ecosystem structure and function can be separated into subsystems that operate at different temporal and spatial scales. The relationships between the ecosystem and population modeling paradigms become apparent when they are related to a hierarchical view of ecosystem structure.

VALUE ADDITION AND PRODUCT DIVERSIFICATION OF NILE TILAPIA (*Oreochromis niloticus*) FOR SUSTAINABLE UTILIZATION

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Nile tilapia (*Oreochromis niloticus*) production in India is steadily increasing every year; however, the species continues to fetch a lower market price compared to other farmed fish. Product diversification through value addition offers a promising strategy for improving the market value and ensuring sustainable utilization of this low-cost fish. Few innovative processing technologies have been developed for the value addition of Nile tilapia. A minimally processed ready-to-cook product, *gravads*, prepared from Nile tilapia had a shelf life of 45 days at refrigerated temperature. The product has significantly lower moisture content (65-70%), which enhances the shelf life and hence reduces the post-harvest loss. Restructured and dried fish fingers prepared using microwave-vacuum drying technology present a nutritional and shelf-stable alternative to fresh fish fingers. Smoke-flavored cracker is another shelf stable product from Nile tilapia that can add value to the fish. Technology for preparing a low salt Ready-to-eat roasted stick from Nile tilapia shows promising applications in dried fish sector. The product had 16% moisture content and 7% salt content. All the restructured and dried products from Nile tilapia have a shelf life of 4-6 months at room temperature, indicating their potential for storage and marketing to remote areas without a cold chain. Overall, the studies suggest that Nile tilapia is a suitable candidate for value addition and the diversified products can add value to this low-cost fish, while contributing to nutritional security and sustainability

FROM SUBSISTENCE TO SUSTAINABLE AQUACULTURE ENTERPRISE: INSIGHTS FROM TIMOR-LESTE’S GIFT MODEL

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There is a growing appreciation of the role of aquaculture in improving food and nutrition security and diversifying livelihoods in smallholder farming systems. Using Timor-Leste, a small half-island state in Southeast Asia, as a case example—where the National Aquaculture Development Strategy (NADS) 2012–2030 aims to increase aquaculture production from just 45 t in 2010 to 12,000 t by 2030 and raise per capita fish consumption from 6.1 to 15.0 kg—this paper presents a holistic approach followed in developing a contextualized Genetically Improved Farmed Tilapia (GIFT) aquaculture model. It highlights the key interventions undertaken, the outcomes achieved, and the model’s potential for scaling.

Since 2014, WorldFish has been partnering with the Timor-Leste government and private sectors to support NADS implementation. Phase 1 (2015–2019) introduced GIFT, established seed supply through public and Public-Private Partnership (PPP) hatcheries, promoted locally formulated feed and pond fertilization, and implemented Better Management Practices (BMPs). Farmers adopting BMPs increased productivity from 1.0 to 4.3 t/ha per 11-month cycle, though scaling was limited by feed ingredient shortages.

Phase 2 (2020–25) adopted a holistic approach to improve fish availability, accessibility, and consumption by enhancing access to seed, feed, technology, markets, and nutrition messaging. Key interventions focused on sustainable intensification, harvesting, and marketing strategies. GIFT productivity rose from 4.3t/ha to 12.4 t/ha in 2022 and 17.3 t/ha in 2024, with culture period reduced to six months, enabling two cycles annually, comparable to leading Southeast Asian producers.

Currently, over 850 GIFT farmers across seven municipalities manage 1,800+ ponds linked to input and market systems via five state-of-the-art hatcheries, 17 local service providers (LSPs), and four market operators. Total aquaculture production was 45 t in 2010; GIFT alone reached over 800 t by 2025, generating USD 2.5 million annually. GIFT farming households earned USD 1,600 gross and about USD 700 net per cycle after USD 925 in costs (75% margin). LSPs earned USD 1,100–3,500 monthly.

The model has successfully transformed livelihoods, created widespread value chain jobs, and demonstrated strong scaling potential in Timor-Leste, Small Island Developing States (SIDS) and beyond.

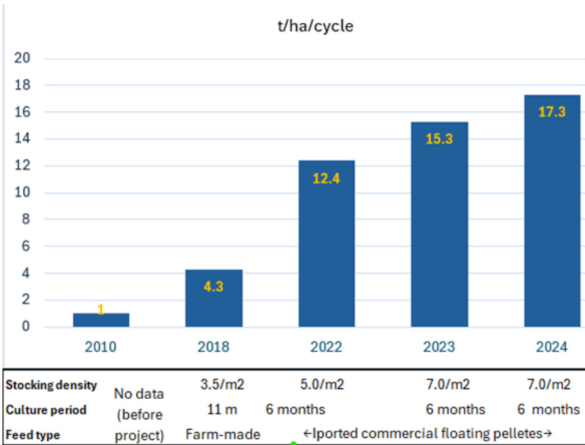


Figure 1: Increase in GIFT productivity (t/ha/cycle) by year (modified from Pant et al., 2024).

***Salmonella enterica* SEROVAR RICHMOND IN FARMED *Pangasianodon hypophthalmus*: WHOLE GENOMIC APPROACH FOR ZOONOTIC POTENTIAL, VIRULENCE AND ANTIMICROBIAL RESISTANCE**

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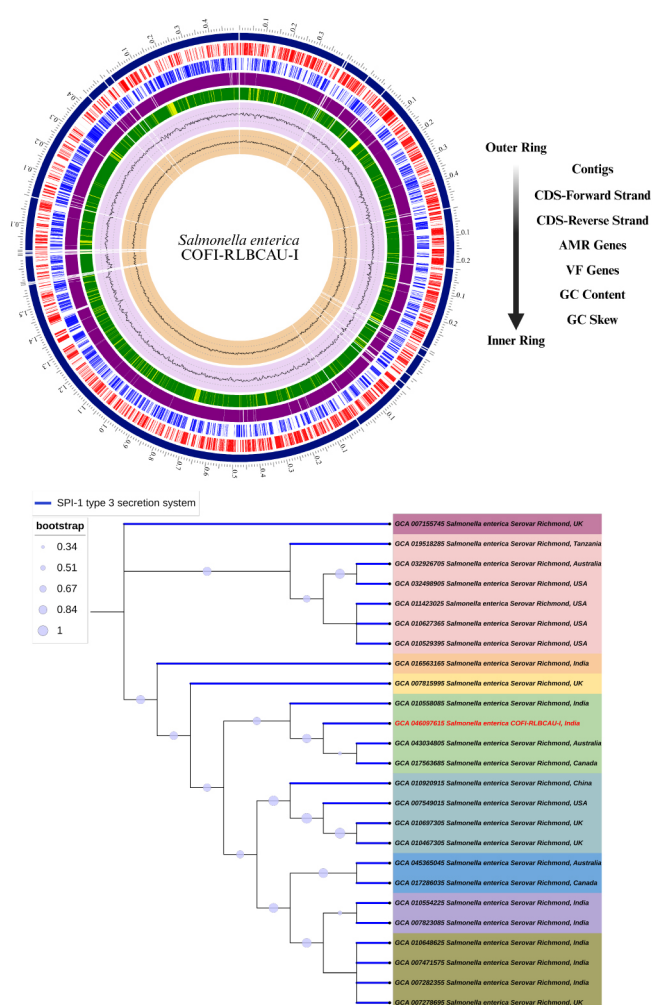
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In this study, an occurrence of *Salmonella enterica* in farmed *Pangasianodon hypophthalmus* was investigated. *Salmonella enterica* was isolated from the liver and kidney of *P. hypophthalmus* and characterized using biochemical, antibiogram, hemolysis assays, and whole-genome sequencing. The in-vivo challenge experiment revealed that *S. enterica* is non-pathogenic to *P. hypophthalmus*, *Labeo rohita*, and *Oreochromis niloticus*. The *de novo* assembled genome totalled 4,919,008 base pairs with a GC content of 52.06%. The in-silico serotyping identified this strain as *S. enterica* subsp. *enterica* serovar Richmond and is potentially pathogenic to humans with a score of 0.9637 out of 1. The study also identified 127 virulence genes and 66 antimicrobial resistance (AMR) genes.

The PHASTEST analysis for prophage sequences revealed six prophage regions, of which four were intact. The methylated bases across the genome showed that both the lagging and leading strands contained 1.74% methylation from the total Adenine positions present in the sequence. In cytosine methylation, the lagging strand showed 4mC (0.18%), 5mC (1.02%), and 5mCG (0.10%). Similarly, in the leading strand, these values were 4mC (0.16%), 5mC (1.01%), and 5mCG (0.9%). In the case of dam methylation, the lagging strand reported 87.54%, and the leading strand reported 87.73% of methylated bases among the total motifs in the GATC context. Moreover, in the case of dcm methylation, among the total CCAGG motif positions, the lagging strand reported 87.21%, and the leading strand reported 88.33%, respectively.

This work presents the first comprehensive study on *S. enterica* serovar Richmond isolated from farm-raised fish, highlighting its zoonotic potential for humans.



SEPTIN 6 AS A NOVEL IMMUNOMODULATOR IN ROHU *Labeo rohita* : MOLECULAR CHARACTERIZATION AND FUNCTIONAL ANALYSIS

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The fourth components of the cytoskeleton, septins, are evolutionary conserved GTP – binding proteins distinguished from microtubules and actin filaments by their non-polar filament structure. They play crucial roles in diverse cellular processes, including cytokinesis, vesicle trafficking, membrane remodelling, and host–pathogen interactions. Functionally, septins function as diffusion barriers to create subcellular compartmentalisation and as molecular scaffolds for protein recruitment. Despite their significance, the functional characterization of septins, particularly septin 6 in Indian major carps, is still unknown. In the present study, we cloned the full-length septin 6 cDNA from rohu (*Labeo rohita*), resulting in a 1203 bp open reading frame encoding 400 amino acids and the phylogenetic analysis revealed it's high sequence similarity to *Anabarilius grahmi* (99%) and *Danio rerio* (98.75%). Tissue-specific expression profiling revealed elevated septin 6 expression in the brain, spleen, and gills, while ontogeny analysis showed its upregulation during early developmental stages. Additionally, septin 6 transcript levels were significantly increased in response to three different infection models: *Aeromonas hydrophila*, poly I:C, and *Argulus siamensis*, suggesting its crucial role in immune responses. The production and intraperitoneal administration of a recombinant septin 6 protein (~46 kDa) modulated the expression of several immune-related genes, such as pro-inflammatory cytokines, antiviral proteins, antioxidant enzymes, apoptosis regulators, antimicrobial peptides, and toll-like receptors. In vitro studies revealed enhanced Lyso G expression in peritoneal macrophages co-incubated with bacteria and recombinant septin 6. In vivo experiment further conferred significant protection against *A. hydrophila* (91% relative percent survival) and delayed mortality in *A. siamensis* infections. Additionally, an indirect ELISA was developed to quantify septin 6 level following *A. hydrophila* post-infection, and it suggests a significantly higher level of septin 6 in liver, spleen, and brain tissues. Collectively, this study provides the first functional insights into septin 6 in rohu, highlighting their involvement in immune responses and offering potential application in fish health management.

“CRISPR/CAS9-MEDIATED GENETIC IMPROVEMENT OF FISH TRAITS FOR SUSTAINABLE AQUACULTURE”

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The rapid growth of aquaculture has intensified the need for sustainable approaches to improve fish production, disease resistance, and environmental adaptability. CRISPR/Cas9 genome editing technology has emerged as a powerful and precise tool for targeted genetic modification in various aquatic species. This innovative system allows for the efficient manipulation of genes associated with economically important traits such as growth rate, feed efficiency, stress tolerance, and reproductive control. Recent studies have demonstrated the successful application of CRISPR/Cas9 in model and commercially important fish species, leading to enhanced productivity and resilience. Moreover, its versatility in gene knockout, knock-in, and functional genomics offers immense potential for developing genetically improved strains with minimal off-target effects. Despite its promise, the implementation of CRISPR-based technologies in aquaculture faces ethical, ecological, and regulatory challenges that must be addressed before large-scale adoption. This paper discusses the current advancements, methodological considerations, and future perspectives of CRISPR/Cas9 applications in fish breeding programs. The integration of this technology with conventional selective breeding and genomic selection could revolutionize aquaculture by ensuring food security, sustainability, and improved fish welfare.

MOLECULAR DIAGNOSIS AND IMMUNOPATHOLOGICAL INSIGHTS INTO *Lactococcus garvieae* INFECTION IN CAGE-REARED *Puntius sarana*

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The study looks into the cause deaths of *Puntius sarana* in cage aquaculture at Maithan reservoir, Jharkhand, India. The infected fish exhibited symptoms as loss of appetite, lethargy, scale loss, bleeding and sores on their belly. Pathogens from the gut were identified as *Lactococcus garvieae* using morphological and biochemical tests, molecular work viz, *16S rRNA* PCR sequencing and phylogenetic analysis. Microbiological tests confirmed that *L. garvieae* was linked to the disease outbreak and deaths in the fish species. The findings were further supported by survival assays, biofilm formation and swimming motility assay. The strain showed resistance to several antibiotics, including streptomycin, enrofloxacin, ciprofloxacin, and tetracycline indicating multi-drug resistance. Histopathological assessment revealed significant damage to tissue architecture in liver, kidney and gill of *L. garvieae* infected *P. sarana*. To gain a better insight into the immunocompromised conditions of the fish and the host-pathogen interactions, qPCR assays were done to study the relative changes in the patterns of gene expression of immune-related genes. The transcriptional profiling of bacterium infected fish tissues (*i.e.*, liver, kidney and gill) showed statistically significant differences in the expression patterns of genes related to antioxidant activity and immune-related gene as compared to the control fish. The present study will serve as a basis for risk assessment and developing management strategies to reduce the harmful effects of the pathogenic bacterium, *L. garvieae*. Furthermore, it may provide practical guidelines for fish farmers to implement preventive strategies aimed at disease control.

LEVERAGING COMMUNITY-BASED RECREATIONAL FISHERIES AS AN AQUATOURISM STRATEGY TO IMPROVE THE SOCIAL, ECOLOGICAL, AND FINANCIAL RESILIENCE OF WETLAND FISHERS IN THE LOWER GANGETIC PLAINS

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Wetlands, often termed “biological supermarkets,” are rich in biodiversity and provide critical ecological services and livelihood support. In regions like West Bengal, where millions depend on these ecosystems, fishing, particularly culture-based practices in inland open waters remains essential for sustenance. However, income from fish sales alone often falls short, underscoring the need for alternative livelihoods to strengthen socio-economic resilience. A promising solution is aqua-tourism, which harnesses the scenic and ecological value of wetlands to create sustainable income opportunities. The Duma wetland in North 24 Parganas, a major floodplain wetland in the lower Gangetic delta, exemplifies this potential. Managed by a Primary Fisheries Cooperative Society (PFCS) with over 1,000 members, Duma’s fish yield rose from 48 to 82 tons annually after the implementation of an ICAR-CIFRI integrated management plan. Still, heavy dependence on fisheries strains the ecosystem. Emerging activities like sport fishing, boating, fish festivals, and kiosks offer viable supplementary income, engaging women and youth while reducing rural-urban migration. With supportive policies and investment, these ventures can spur local entrepreneurship, ensure ecological conservation, and promote inclusive rural development. The Duma wetland stands as a model for sustainable, community-based wetland governance, balancing livelihoods and environmental health.

ENVIRONMENTAL AND BIOLOGICAL IMPACTS OF PESTICIDES IN AQUATIC SYSTEMS: A COMPREHENSIVE OVERVIEW

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Pesticides play an indispensable role in modern agriculture by controlling pests and enhancing crop productivity to sustain the needs of an expanding population. However, their excessive and indiscriminate application has led to serious ecological and environmental consequences. This review provides an overview of pesticide use in India, emphasizing usage patterns, chemical compositions, and toxic effects on non-target aquatic organisms, particularly fish. Fish are widely regarded as sensitive bio indicators of aquatic health because of their ability to bio accumulate toxic compounds and their susceptibility to water quality alterations caused by agricultural runoff. Pesticides enter aquatic ecosystems through surface runoff, leaching, and atmospheric deposition, leading to bioaccumulation and bio magnification, which disrupt ecological balance and food web dynamics. Exposure to these contaminants results in several physiological, behavioral, and histopathological changes in fish, including impaired reproduction, reduced survival, and damage to organs such as the liver, kidneys, and gills. Behavioral abnormalities like erratic swimming and loss of equilibrium further indicate sub-lethal toxic effects. In addition, chronic pesticide exposure poses significant risks to human health through contaminated food and water, contributing to neurological, respiratory, and carcinogenic disorders. To minimize these detrimental impacts, sustainable agricultural approaches are essential. Practices such as bio pesticide application, organic farming, and the development of pest-resistant transgenic crops offer promising alternatives to chemical pesticides. Regular biomonitoring of aquatic systems, stricter regulatory enforcement, and integrated pest management strategies are crucial to safeguard aquatic biodiversity and ensure the sustainable coexistence of agriculture and environmental health.

PLANKTONIC DIVERSITY AND ASSEMBLAGE IN RESPONSE TO WATER QUALITY VARIABLES IN THE GODAVARI RIVER, MAHARASHTRA

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The plankton are the crucial component of the riverine ecosystem as primary producers, food web components, and indicate the ecosystem health to inform management strategies. Thus, plankton biodiversity directly influences aquatic system productivity and sustainability. A study was conducted to assess the phytoplankton and zooplankton diversity and assemblage in relation to water quality in the upper stretch of Godavari River (Maharashtra) during the post-monsoon (2024) and pre-monsoon (2025) seasons. Over 90 plankton species were documented, with the rich taxonomic diversity of the phytoplankton assemblage, comprising 73 species, encompassing 11 classes, 29 orders, 40 families, and 60 genera. The class Bacillariophyceae displayed the highest richness, followed by Chlorophyceae. The zooplankton community comprised 23 species, dominated by Rotifera > Arthropoda > Cladocera. The phytoplankton and zooplankton abundance ranged from $0.48 - 1.2 \times 10^{-5}$ cell L⁻¹ and $0.2 - 8 \times 10^{-2}$ cell L⁻¹. Spatially rich species diversity was recorded at Vishnupuri for both phytoplankton and zooplankton during the pre-monsoon season. Further, the highest Shannon-Wiener diversity index (phyto: 4.0; zoo: 2.75), Simpson's diversity index (phyto: 0.98; zoo: 0.93), and Margalef richness index (phyto: 3.94; zoo: 1.85) were recorded at Vishnupuri during the pre-monsoon season. This indicates a peak in species richness and evenness at this site and period. The diversity patterns suggest favorable ecological conditions supporting planktonic biodiversity during the pre-monsoon period. Statistical analysis revealed a significant correlation between the plankton groups and physicochemical parameters. This study results are crucial to understand the spatio-temporal variations in the plankton assemblage structure for monitoring the ecosystem health.

OCCURRENCE AND RESISTANCE POTENTIAL OF PATHOGENIC *Flavobacterium*, *Aeromonas* AND *Vibrio* spp. IN BELGIAN AQUACULTURE

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Pathogenic bacteria are a persistent threat to aquaculture sustainability, with *Flavobacterium*, *Aeromonas*, and *Vibrio* species being of particular concern due to their capacity to cause disease outbreaks and their potential for antimicrobial resistance (AMR). Among them, *Flavobacterium columnare* and *Flavobacterium psychrophilum* are well-recognized agents of columnaris disease and cold-water disease, respectively, both associated with high mortality in farmed fish populations. Opportunistic pathogens such as *Aeromonas* and *Vibrio* further exacerbate fish health challenges, particularly under suboptimal environmental conditions.

As part of the European Partnership on Animal Health and Welfare (EUPAHW), sampling campaigns were conducted during winter and summer-2025 across ten aquaculture farms in Belgium, including five trout farms in Wallonia and four farms in Flanders producing sturgeon, mussel, oyster, trout, burbot, bullhead, and pikeperch. Skin and gill mucus from finfish, whole organisms from shellfish, as well as water and sediment samples were collected to recover and characterize pathogenic bacteria. From the winter campaign, 86 presumptive isolates of *F. psychrophilum* were recovered on tryptone yeast extract salts agar (TYESA) supplemented with tobramycin and neomycin, while 39 presumptive *F. columnare* isolates were obtained on modified Shieh agar with tobramycin. Species confirmation is currently being carried out using matrix-assisted laser desorption ionization time-of-flight mass spectrometry (MALDI-TOF MS) and species-specific quantitative PCR. So far, four *F. psychrophilum* isolates have been identified, while no *F. columnare* isolates have been identified from the winter campaign; the remaining analyses are ongoing. In parallel, the recovery and identification of *Aeromonas* and *Vibrio* spp. from the same aquaculture environments are in progress. Minimum inhibitory concentration (MIC) testing will be performed upon completion of species confirmation to assess antimicrobial resistance profiles. This ongoing study aims to provide a comprehensive overview of the occurrence and resistance potential of *Flavobacterium*, *Aeromonas*, and *Vibrio* spp. in Belgian aquaculture.

FISH BIODIVERSITY AND HABITAT ASSESSMENT OF SUBARNAREKHA RIVER TOWARDS FULFILMENT OF OBLIGATIONS ON CATALOGUING, CONSERVATION AND MANAGEMENT OF THE RIVERINE BIODIVERSITY

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Subarnarekha River is an important riverine ecosystem inhibits both freshwater and estuarine fishes due to its diverse habitat condition. This river basin encompasses 0.6% of India's total geographical area and is trans state river that traverses up to 460 km passing through Jharkhand, West Bengal, and Odisha before discharging into the Bay of Bengal. Over the years, alterations in river's ecology, fish biodiversity and ecosystem services have substantially affected due to negative impacts of anthropogenic activities majorly by climate change, pollution, mining, land use change, overfishing and damming along the river. The change in riverine environment has disturbed the inhibited aquatic life and raised matter for assessing the riverine environment in consideration to fish biodiversity and habitat status in spatiotemporal scale with causative factors impacting fish and habitat. Henceforth, an exploratory survey was conducted during 2023-24 to assess fish biodiversity and habitat attributes along the entire stretch of the river from origin to destination.

The investigation from 10 sampling points along the river revealed 75 fish species of which 53.33% were estuarine fishes and 46.67% were freshwater. The taxonomic status of fishes belonged to 16 orders, 35 families, and 58 genera, with Perciformes (34.67%) as the most dominant order followed by Cypriniformes (21.33%). Cyprinidae family had the highest species diversity and the feeding pattern of the fishes were; carnivorous (44%), omnivorous (22.22%), herbivorous (12.5%), planktivorous (12.5%), detritivorous (6.9%), and larvivorous (1.38%). The IUCN Red List assessment of the species revealed 6.9% as Near Threatened, 2.7% as Vulnerable, and 1.38% as Endangered. The water quality assessment in Ranchi indicated increased levels of ammonia and chlorine, and reduced dissolved oxygen not suitable for fish propagation. Besides, water quality assessment in the two dams viz. Getalsud and Chandil along the river indicated low dissolved oxygen that could be due to excessive eutrophication.

The study emphasizes for improved conservation and management practices with hand holdings from government agencies and other stakeholders to improve the river health and its fish biodiversity by mitigating/ reducing the impacts of anthropogenic threats.

UNCOVERING THE RELATIONSHIP BETWEEN LIGHT INTENSITY AND *Tripneustes gratilla* (COLLECTOR SEA URCHIN): IMPLICATIONS FOR AQUACULTURE

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Tripneustes gratilla is a commercially valuable sea urchin known for its edible gonads, rapid growth, and aquaculture potential. However, large-scale production is limited by gaps in knowledge about optimal rearing conditions, particularly light exposure. The species displays covering behavior, likely in response to solar radiation or predation. This study examines the effects of solar radiation on *T. gratilla* in Seychelles to guide aquaculture practices and enhance production efficiency.

Methodology

Four experiments (exp) were conducted in fiberglass raceways. Exp1: 12 *T. gratilla* were offered opaque, semitransparent, and transparent plastic pieces; number of collected plastic pieces were recorded after 3 hours. Exp 2: 12 *T. gratilla* were exposed to 0%, 32%, 41%, and 77% shade using overhead materials on their respective crates; the number of collected plastic pieces (opaque, semi-transparent, and transparent) was recorded after 30 minutes. Exp 3: 60 *T. gratilla* were placed under 0%, 37%, and 100% shade; righting time was measured after 3 hours. Exp 4: 90 *T. gratilla* were reared under 0%, 37%, and 100% shade treatments for 67 days; growth, fitness, survival, disease, and GSI were monitored.

Results

No significant preference for cover materials was found ($p = 0.765$) in experiment 1, suggesting shading capacity does not drive covering material selection. However, in the second experiment higher light intensity significantly increased the number of materials collected ($p = 0.049$), indicating a behavioural response to solar exposure (Figure 1). In the third experiment short-term exposure to high light significantly reduced righting ability in urchins ($p = 0.027$), implying stress under sudden changes (Figure 2). In contrast, in experiment 4 the long-term exposure (67 days) showed no significant differences in fitness, growth, mortality, disease, or gonad index across light treatments ($p > 0.128$), highlighting their capacity to acclimate.

Conclusion

While short-term light exposure negatively affects fitness, the species appears capable of acclimatizing to different light levels over time. Covering behavior increases under intense light but is not dependent on material opacity. Overall, shading may not be necessary for long-term urchin production, highlighting the potential to simplify aquaculture systems while maintaining animal welfare and productivity.

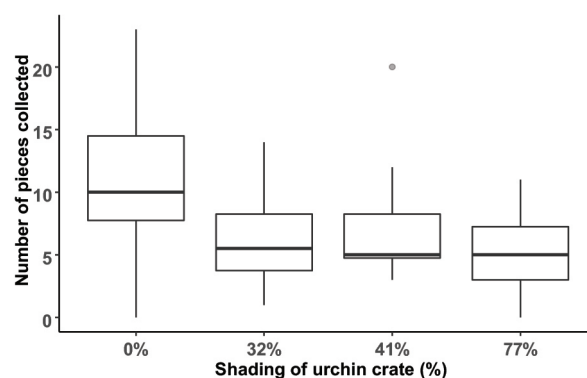


Figure 1. Covering material collected at varied shade levels.

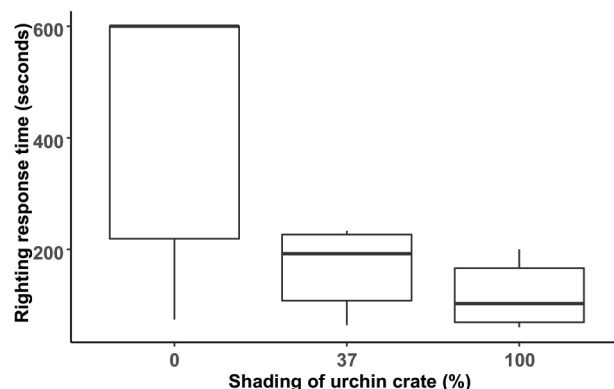


Figure 2. Righting time under 0%, 37%, and 100% shade.

REDEFINING DISEASE PREVENTION FOR INDIA'S SHRIMP FARMS

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Achieving consistency in shrimp production is fundamental to securing India's position as a global leader in aquaculture. Despite advances in genetics, nutrition, and management, disease outbreaks continue to be the most persistent constraint, undermining productivity and farmer confidence. Sustainable progress requires a shift from reactive disease control to proactive prevention and system stability, as most health failures in shrimp culture arise from management deficiencies such as inadequate pond preparation, ineffective water disinfection, and fragmented biosecurity protocols, rather than uncontrollable external factors. To eliminate recurring health failures, it is imperative to establish clear national standards and farm-level protocols that promote awareness, traceability, and consistency in aquaculture practice. In this direction, the Blue Aqua Farmers Centre (BAFC) has initiated specialized programmes on seed selection and farmer training, focusing on advanced PL screening using Digital PCR, early disease diagnosis, optimized biosecurity protocols, and training the farm workforce to detect early symptoms and monitor pond water quality changes, thereby strengthening on-farm health management and empowering farmers with data-driven decision-making tools. The development of a cluster farming approach further enhances productivity through organized and coordinated farming methods, minimizing horizontal disease transmission and ensuring better environmental control. Establishing a uniform system of best practices across the sector improves disease control, accountability, and transparency—key elements often missing in traditional operations. Aligning these national practices with internationally recognized frameworks such as the Aquaculture Stewardship Council (ASC) reinforces India's reputation for responsible and sustainable aquaculture, ensuring long-term competitiveness in the global shrimp industry.

OPTIMIZING VANNAMEI PRODUCTION WITH BIOSIPEC

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Disease is widely considered as one of the primary challenges in achieving successful vannamei production, resulting in substantial economic losses worldwide (Melba & Richard, 2018). Despite the introduction of several farming technologies, their success has been rather limited. To support shrimp farmers, ADM has developed an intensive farming system known as BIOSIPEC. The reliability of this system has been proven through over a decade of research and operation in an unfavorable farming area. BIOSIPEC enables shrimp farmers to increase productivity by increasing stocking density, while minimizing economic losses through improved survival and success rate. Notably, BIOSIPEC can adapt to different conditions, including areas with limited access to seawater, and can be used in multiple farming phases to optimize production costs. In the BIOSIPEC system, the nursery phase helps promote healthy environments and reduce production costs by lowering water treatment costs, while ensuring shrimp growth performance in the grow-out phase. The results of the nursery phase in BIOSIPEC are shown in Table 1. Further insights into BIOSIPEC will be shared and discussed during the presentation.

Table 1: Nursery results in BIOSIPEC

Parameters	Outcome
Number of crops	17
Successful rate (%)	88.2
Stocking density (PLs/m ³)	5,164
Day of nursery (days)	21
Daily gain (mg/PL/day)	16.7
Final live weight (mg/PL)	372
Feed conversion ratio	1.10
Survival (%)	87.8
Biomass (kg/m ³)	1.62

ENVIRONMENTAL SUSTAINABILITY BEYOND OPERATIONAL RESOURCE EFFICIENCY IN SHRIMP FARMING: AN EMERGY SYNTHESIS APPROACH

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Biofloc technology is often presented as a sustainability solution for shrimp farming because it has potential to improve operational efficiency, producing higher biomass per unit of land, reducing water exchange, and limiting the use of external inputs per kilogram of shrimp produced. Yet whether these efficiency gains translate into genuine environmental sustainability remains unclear, as holistic evaluations and direct comparisons with conventional semi-extensive pond systems are still lacking. To address this gap, we apply emergy (with “m”) synthesis, a biophysical accounting framework that expresses all inputs, whether natural, purchased, or ecological, in a common baseline of solar emjoules (seJ). We use it to assess and compare the environmental performance of shrimp farms in Tamil Nadu, India, operating with either earthen pond-based (conventional) or biofloc-based systems.

Farm-level data from representative farms of each system type were compiled into detailed emergy inventories. These were expressed per hectare per year of shrimp production and captured the quantity and quality of inputs such as feed, energy, water, carbon sources, labour, and infrastructure. Operational resource efficiency indices were calculated for water, land, feed, and electricity use. Emergy indicators, including transformity, renewability, emergy yield ratio, emergy investment ratio, emergy loading ratio (ELR), and emergy sustainability index, were then derived.

Operational resource data (Table 1) indicate that biofloc systems reduce water (1.9 vs 12.6 m³/kg) and land (0.33 vs 3.84 m²/kg) use, with similar feed demand and slightly greater electricity consumption. Preliminary emergy results suggest that while biofloc achieves higher operational efficiency, these gains do not consistently translate into emergy demand. Biofloc systems show higher dependence on non-renewable resources (higher ELR), whereas conventional ponds, though less efficient, rely more on local renewable inputs.

By integrating emergy with operational efficiency, this study highlights trade-offs hidden by narrow efficiency framings and provides a holistic basis for evaluating shrimp farming strategies and guiding sustainability policy.

Table 1. Operational resource use in shrimp farming systems in India. **per kg shrimp*

Resource	Unit*	Conventional	Biofloc
Water	m ³	12.55 ± 4.1	1.90 ± 0.1
Land	m ²	3.84 ± 0.4	0.33 ± 0.1
Electricity	kWh	4.18 ± 0.9	4.82 ± 0.4
Feed	kg	1.22 ± 0.1	1.33 ± 0.1

STUDY OF LAKE FISHERIES, CAGE AQUACULTURE, AND MANAGEMENT PRACTICES BY THE LOCAL COMMUNITY IN RUPA LAKE, KASKI POKHARA, NEPAL

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Rupa Lake, the third-largest lake in Pokhara Valley in Nepal, plays a crucial role in the livelihood of the local community, primarily through fisheries and cage aquaculture. However, fish mortality during the first monsoon showers in March and April has led to economic losses for the fishermen. One possible reason is the release of toxins from blooming forest plants, affecting water quality and aquatic life. Additionally, rapid siltation from the watershed area has contributed to the reduction in the lake's depth, ultimately decreasing natural fish feed availability and reducing fish production. Given that fish production is a key economic driver in the region, sustaining the lake's productivity is vital for both the local community and the cooperative managing these resources.

The Rupa Lake Restoration and Fisheries Cooperative has emerged as a unique model for balancing conservation with economic sustainability. With the active involvement of over 1,000 community members, the cooperative has implemented lake restoration efforts, fish farming initiatives, and sustainable management strategies. This study aims to assess the impact of cooperative-based fisheries management on lake conservation and local economic growth. Key research objectives include analyzing cage aquaculture, understanding the plankton-sediment nexus for sustainable fisheries, and evaluating the cooperative's role in local economic development. The study will use an analytical model integrating physical, chemical, and biological lake dynamics to assess fish yield as a function of nutrient concentration, primary productivity, and harvest rates. Water quality analysis, bathymetric surveys, fish stocking and harvesting data, and market dynamics will be key components of the study.

Findings from this research will provide policy recommendations for improving lake fisheries management and promoting sustainable livelihoods. The Rupa Lake Restoration Cooperative model, based on community-led conservation and economic empowerment, could serve as a replicable approach for wetland management across Nepal and beyond. The study's outcomes will offer valuable insights for policymakers, environmentalists, and cooperatives, emphasizing the need for a balanced approach between conservation and resource utilization for long-term ecological and economic benefits.



AQUA4ALL – TURNING WASTE INTO VALUE: MICROBIAL INSIGHTS FROM RECIRCULATING AQUACULTURE SYSTEMS

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The aquaculture sector is essential for food security, but its sustainable development depends on the efficient use of resources and the reduction of environmental impact. To ensure the sustainable growth of this vital sector, innovative solutions such as recirculating aquaculture systems (RAS), enabled by advancements in engineering design and monitoring technologies, are gaining global traction among investors and fish farms. RAS facilities are typically land-based super-intensive production systems that rely on advanced filtration and life support systems to recycle water for the culture of marine species. In response to these environmental challenges, the **AQUA4ALL** project aims to close the water and nutrient cycle in RAS systems through a circular economy approach, promoting a more sustainable aquaculture sector and improving the ecological status of surrounding marine environments.

Water samples were collected from four RAS systems: rotifers, turbot (*Psetta maxima*), sole (*Solea senegalensis*), and gilthead seabream (*Sparus aurata*), at multiple system points (rotifers: tank, biofilter, skimmer; turbot and sole: sludge after the drum filter, sludge after the skimmer and the overflow; seabream: effluent after the skimmer and overflow effluent after the biofilter).

Preliminary results revealed distinct bacterial dynamics across species and sampling zones, with notable differences in total marine bacterial load and *Vibrionaceae* levels, reflecting the influence of system design and biological activity. Microbiological assessment of RAS for rotifers, turbot, sole and seabream revealed distinct bacterial dynamics.

In the rotifer system, the water from the culture tanks showed the highest bacterial load, while the biofilter and skimmer remained stable with low *Vibrionaceae* levels.

Turbot RAS samples revealed temporal fluctuations, especially in *Vibrionaceae*. Sole RAS samples showed microbiological stability, with the highest *Vibrionaceae* proportion in the drum filter. In the seabream RAS system, bacterial load increased in the skimmer, while *Vibrionaceae* levels remained stable across sampling points. Distinct bacterial profiles were observed across RAS, with variations in total bacterial load and *Vibrionaceae* levels influenced by species and system components. The **AQUA4ALL** project aims to enhance sustainability in aquaculture by closing the water and nutrient cycle in RAS systems through a circular economy approach. By converting nutrient-rich effluents from fish farming into microalgae biomass for industrial use, the project aims to reduce environmental impact, support resource recovery, and foster the development of innovative, eco-friendly products. In essence, this project aims to turn waste into value.

Acknowledgements

AQUA4ALL was supported by Algarve 2030, by Portugal 2030 and by the European Union; Missão Interface, project co-funded by PRR - Plano de Recuperação e Resiliência pela União Europeia (operation code 01/C05-i02/2022.P148) and SAUDE&AQUA-II (MAR-021.1.3-FEAMPA-00018).

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EARLY NUTRITIONAL STRATEGIES TO IMPROVE LARVAL REARING IN EUROPEAN SEABASS (*Dicentrarchus labrax*)

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Larval rearing protocols for European seabass (*Dicentrarchus labrax*) are well established, and current research aims to optimize these practices, particularly during early life stages and under routine stress conditions. Early nutritional programming plays a critical role in shaping robustness, growth, and overall performance throughout the production cycle (Hou and Lee, 2020).

This study aimed to evaluate how different early feeding strategies – specifically, the use of novel dietary formulations produced by hot extrusion technology and the enrichment of feed with natural functional extracts – affect the performance and stress response of European seabass in early development stages.

Two independent feeding trials were conducted. In Trial 1, seabass larvae (62–86 days after hatching, DAH) were fed four diets: (A) control commercial diet, (B) adaptation of a commercial diet with a different extrusion technology, (C) adaptation of a commercial diet to a different extrusion technology and replacement of crustacean meal, and (D) adaptation of a commercial diet to a different extrusion technology and replacement of protein hydrolysates. At the end of the trial, fish underwent an air exposure stress test. In Trial 2, post-larvae (98 DAH) were fed for one week with diets supplemented with *Ulva* spp., *Tetraselmis* spp., *Euglena* spp., or grapeseed extracts, followed by air exposure and *Photobacterium damsela* subsp. *piscicida* challenge.

In Trial 1, no negative effects of the extrusion method or ingredient replacement were observed on growth, survival, or stress resistance, paving the way for the use of different technologies for microdiets manufacture and ingredient replacement. In Trial 2, functional diets had limited baseline effects on stress-related gene expression, but algae extract inclusion significantly reduced stress markers (e.g., *hsp90*) and modulated antioxidant players (such as *cat*, *sod*, *gpx* gene expression and enzymatic activity) after stress exposure, indicating a protective effect in stressful situations.

These findings reinforce the relevance of tailored early feeding strategies, from novel extrusion technology to functional supplementation in microdiets, as promising tools to promote fish robustness and performance. Optimization of diet formulation and timing is essential to achieve consistent and sustainable results in marine larviculture.

This work was supported by PACTO DE INOVAÇÃO BIOECONOMIA AZUL (Project No. C644915664-00000026), SAUDE&AQUA II (MAR-021.1.3-FEAMPA-00018), and INOVAQUA (MAR-021.1.3-FEAMPA-00004). The technical assistance of EPPO and S2AQUAcoLAB staff was highly appreciated throughout the study.

Hou, Z., Fuiman, L.A. Nutritional programming in fishes: insights from mammalian studies. *Rev Fish Biol Fisheries* 30, 67–92 (2020). <https://doi.org/10.1007/s11160-019-09590-y>

EMPOWERING MARINE AQUACULTURE THROUGH RESEARCH AND TECHNOLOGY

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The Portuguese Institute for the Ocean and Atmosphere (IPMA) is a public research institute that advises national authorities on oceanic and atmosphere matters. IPMA has a strong cluster of expertise in ocean and marine resource research, namely in aquaculture and fisheries.

The Aquaculture Research Station of Olhão (EPPO, figure 1) stands out for its exceptional experimental facilities, recognized both nationally and internationally. This core marine facility supports aquaculture research at all scales, ranging from bench-top laboratory studies to larger, semi-industrial production trials. EPPO spans approximately 7 hectares and includes over 250 tanks, a fully equipped hatchery for experimental production and various rearing systems such as flow-through, recirculation aquaculture systems (RAS), semi-intensive earthen ponds and intensive concrete and fiber glass tanks, for broodstock, larvae and juvenile rearing. The facility also features a support building with dedicated spaces for trophic chain production, daily operations and biological sampling; three RAS systems; analytical laboratories (biochemical, histological, molecular, microbiological and fish pathology); a seafood packing unit; a pre-fattening area; and 17 earthen ponds. EPPO maintains broodstock of several marine species (e.g., meagre, gilthead seabream, seabass, Senegalese sole and sardine), alongside microalgae and invertebrates, leveraging its expertise in their production.

The research focus at EPPO (Figure 2) includes new species development, nutrition, animal welfare, environmentally sustainable production systems, and the evaluation of both onshore and offshore production systems for fish grow-out.

Acknowledgments: To INOVAQUA(MAR-021.1.3-FEAMPA-00004) and SAUDE&AQUAII(MAR-021.1.3-FEAMPA-00018) projects for the financial support.



Figure 1 - Aerial view and RAS system on EPPO

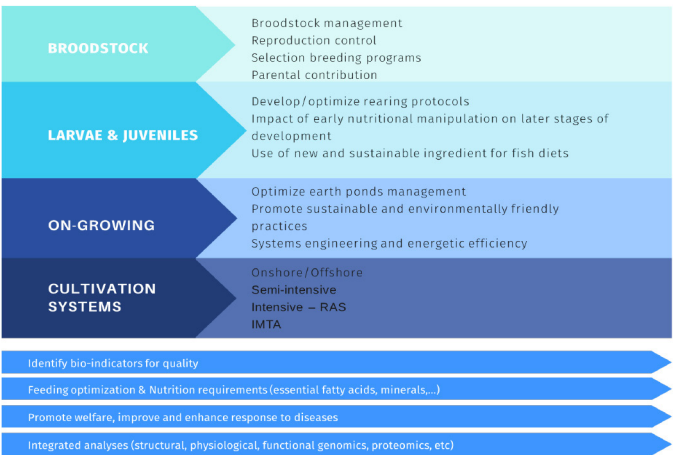


Figure 2 - On going research lines at EPPO

AQUATIC ANIMAL DISEASE SURVEILLANCE IN INDIA: A SUCCESS STORY

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Diseases remain one of the most significant constraints to aquaculture growth. Early detection plays a crucial role in effective disease control and can only be achieved through a well-structured surveillance programme. Recognizing this need, the Government of India has been implementing the National Surveillance Programme for Aquatic Animal Diseases (NSPAAD) since 2013. In its Phase I, the programme was launched across 14 major aquaculture states, and was coordinated by the ICAR–National Bureau of Fish Genetic Resources. To further strengthen the country’s aquatic animal disease surveillance, Phase II of NSPAAD has been initiated under the Pradhan Mantri Matsya Sampada Yojana, with pan-India coverage and participation of the State Fisheries Departments and the Marine Products Export Development Authority (MPEDA). The major emphasis of the programme has been to strengthen the passive disease surveillance in the country. The success of the same is evident with detection of 14 new pathogens from the country for the first time. Other significant achievements include establishment of a strong national network of aquatic animal health laboratories; development of diagnostic capacity for detection of World Organisation for Animal Health (WOAH)-listed and emerging aquatic animal pathogens; provision of scientific advisory support to farmers for effective disease management; establishment of mechanisms for first-time confirmation of exotic and emerging diseases, and dissemination of alerts/advisories to stakeholders to prevent their spread; dispelling speculations on the occurrence of Acute Hepatopancreatic Necrosis Disease (now a WOAHL-listed disease); development of a transparent disease reporting system that has enhanced India’s credibility in reporting aquatic animal diseases to international organisations like WOAHL and the Network of Aquaculture Centres in Asia-Pacific. To further strengthen farmer-based disease reporting, a mobile application named “ReportFishDisease” has been developed under the programme. The app is available in Hindi, English, and 11 regional languages, enabling farmers to report disease incidents in finfish, shrimp, and mollusc farms directly to field officers and fish health experts, and receive timely scientific advice for rapid problem resolution.

RAINBOW TROUT REARED IN SEA WATER PRODUCE FAECES OF DIVERSE TYPES AND COMPOSITION

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Faecal characteristics such as size, structure and consistency are widely recognized as indicators of gastrointestinal health and digestive functioning in humans and terrestrial animals. The Bristol Stool Form Chart (BSFC) has long served as a reliable method for classifying stool types in humans. Similarly for various terrestrial animals, including cattle, pigs and pets as well, faecal scoring systems have been developed for assessing the prevalence of diarrhea and other digestive disorders (Larson et al., 1977; Heaton and Thompson, 1999; Meyer et al., 1999; Pons et al., 2025). However, the variation in faeces types in terms of characteristics such as colour, shape, texture, composition remain unknown for fish species.

Recent studies suggest that dietary factors, such as ingredient and nutrient composition of diet as well as environment factors impact the characteristics of fish faeces. However, variation in faeces types in terms of characteristics such as colour, shape, texture and composition remains unknown. This study extends the concept of faecal scoring system to aquaculture by proposing a classification to describe faeces types of saline water reared rainbow trout (*Oncorhynchus mykiss*) as an example. Faeces used in this study were collected overnight by sedimentation. Fish were fed with 2 diets varying in protein to energy ratios: namely high protein to energy ratio and low protein to energy ratio diet. Collected faeces were categorized into four distinct types based on physical characteristics such as size, structure, colour and consistency. Identified faeces types were categorized as “mucosal envelopes”, “mineral precipitates”, “intermediate faeces”, and “feed-related faeces” (Fig. 1). The mineral composition and ratios were found to be different in different faeces types ($P < 0.001$). Stereomicroscopic observation revealed that all faeces types had a double layered slimy coating on its surface. To understand the chemical nature of mucoidal coating, faecal pellets of varying morphology were randomly selected and fixed overnight at 4 °C in Carnoy’s fixative (60% ethanol, 30% chloroform, 10% glacial acetic acid). Fixed samples were embedded in paraffin wax following standard histological procedures. Faecal pellets were positioned in longitudinal or transverse position and 6 µm thick faecal sections were cut using a microtome. Sections were deparaffinised with xylene and subsequently passed through a graded ethanol-water series beginning with anhydrous ethanol. Staining was done with Alcian blue, Periodic acid and Schiff’s reagent followed by Crossman’s trichrome (Mason) staining to visualise mucoidal covering over the faeces and the undigested matter trapped in the faecal matrix. Sections were viewed under Leica-DM6 inverted microscope using ×5 and ×10 objectives. Images of faecal pellets were captured with a DFC450C CCD colour camera (Leica Microsystems) and composite images were generated using datasets of 50 to 500 overlapping microscope views.

Based on the PAS-Alcian blue-Crossman staining of feed-related faeces, slimy coating were confirmed to be of mucoidal origin. The role of the mucoidal coating in determining the size, structure and consistency is discussed. Implications of the finding are discussed in the context of relevance to fish physiology and practical aquaculture.

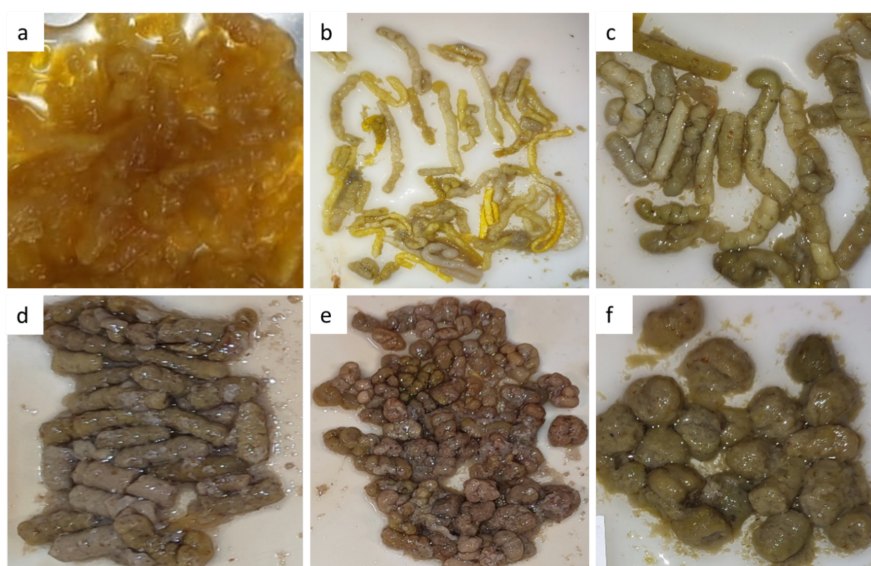


Fig 1. Classification of rainbow trout faeces into different types. “Mucosal envelopes” (a), “faecal precipitates” (b), “intermediate faeces” (c), “feed-related faeces” (d, e & f), which were separated into 3 classes: “feed-related faecal” class 1 (d), class 2 (e), and class 3 (f).

FAECAL QUALITY DETERMINANTS IN FISH – AN OVERVIEW

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Historically, aquaculture nutrition research was primarily focused towards understanding the impact of dietary factors, which affect fish growth and health directly. However, the diet is also the principal source of waste in aquaculture. In recent years, waste management has emerged gained prominence due to increasing emphasis on sustainability and stricter implementation of regulations concerning aquaculture waste discharge. This has directed attention towards interventions which can either reduce the amount of waste generated or enhance its effective removal from production system (i.e., water).

Recirculating aquaculture system (RAS) offers opportunity to minimize impact of aquaculture on the surrounding environment either by effectively removing the waste from the water or by converting the waste into less harmful forms. In RAS, effective solid waste removal is the first and a critical step in waste management. If not removed promptly from the system, these solids contribute to the accumulation of suspended solids and dissolved waste, which can hamper fish health and welfare. Suspended solids can also hamper the functioning of biofilters and UV units in RAS. In RAS farms with optimal feed management, faeces is the major source of solid waste. Thus a key objective in a RAS system is to ensure rapid and efficient removal of faeces, minimizing the accumulation of non-removed faecal waste.

Diet plays a critical role in determining the amount of non-removed faecal waste accumulating in a system. This is mediated both by determining the amount of faeces produced through impact on dry matter digestibility of diet and by altering faecal characteristics that govern faecal removal efficiency (by sedimentation and/or screen filtration). Characteristics of faeces relevant in determining the rate of solid waste removal are size, stability and density of faeces. Alongside these factors, system design and its interaction with faecal characteristics ultimately determine the efficiency of solid waste removal. At present, knowledge on factors determining faecal characteristics remains limited, with several unanswered questions as: what is a natural faecal pellet and stability; do faecal characteristics differ across fish species; which dietary factors govern removal efficiency; can dietary interventions improve faecal stability (i.e., reduce disintegration of faecal pellets); are faecal waste characteristic determined by ingredients or nutrients within a diet; are dietary factors determining faecal removal similar across fish species? Addressing these questions is essential to formulate optimal feeds for RAS. In recent years, several studies investigating the link between dietary factors and faecal waste management in RAS have been conducted at our group (Wageningen University, The Netherlands). This presentation will provide an overview of published and in-house data, highlighting the role of dietary interventions in faecal waste management. The impact of dietary interventions on factors such as size, stability and removal efficiency of faeces (Table 1) will be discussed for various fish species, like salmon, trout, tilapia, common carp, sea bass and striped catfish. Specific dietary factors that will be addressed include feeding level; dietary ingredient composition; type of carbohydrates; type of protein rich ingredients; dietary starch level; dietary viscosity etc.

Table 1. Range of faecal removal efficiency measured by settling for different fish species

Fish species	Faecal removal efficiency (%) range	Source
Nile Tilapia	56-80	Amirkolaie et al. (2006)
Sea bass	53-88	Fountulaki et al. (2021)
Sea bream	21-28	Inhouse data
Common carp	68-74	Prabhu et al. (2019)
Striped catfish	30-50	Tu-Tran et al. (2020)
Rainbow trout	55-85	Prakash et al. (2024)
Atlantic salmon	87-95	Prakash et al. (2024)
Arctic charr	47-63	Prakash et al. (2024)
Yellowtail kingfish	15-76	Horstmann et al. (2024)

PERFORMANCE EVALUATION OF AQUACULTURAL PROCESSING WASTE-DERIVED BIOCHAR AS A CATHODE CATALYST IN CONSTRUCTED WETLAND MICROBIAL FUEL CELL

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The swift development in aquaculture has resulted in the production of nutrient-rich effluents and organics that require a sustainable treatment solution. In this research, aquacultural processing wastes (fish scales and shrimp shells) were co-pyrolyzed to convert into a cathodic biochar-based electrocatalyst (AQ-900) for a vertical up-flow constructed wetland microbial fuel cell (CWMFC; Fig. 1). Physicochemical analyses of AQ-900 confirmed a hierarchically porous carbon matrix with a high content of calcium and phosphorus-containing hydroxyapatite phases and heteroatom functional groups to enhance electron transfer and catalytic capability. The electrochemical assessments established that oxygen reduction reaction kinetics in the cathode were amended. The catalyst-coated cathodes demonstrated a four times higher exchangeable current density (i_o , 2.88 mA cm⁻²) and much lower charge transfer resistance (R_{ct} , 8.92 Ω) than the original carbon felt (0.70 mA cm⁻² and 36.64 Ω, respectively). After an operation of 160 days in synthetic wastewater followed by real fish market wastewater, the CWMFC registered a maximum power density of 16.10 ± 2.27 mW m⁻². The system achieved a chemical oxygen demand (COD) removal of 85.63 ± 1.33%, and NH₄⁺-N removal of ~90%. Additionally, the amplified coulombic efficiency (6.41 ± 0.21%) and normalized energy recovery (184.01 ± 0.02 Wh kg COD⁻¹ removed) highlighted its superior electrocatalytic nature (Table 1). These contributions strengthen CWMFC technology and supports the principles of a circular bioeconomy, aligning with the Sustainable Development Goals that address clean water, affordable energy, and responsible consumption.

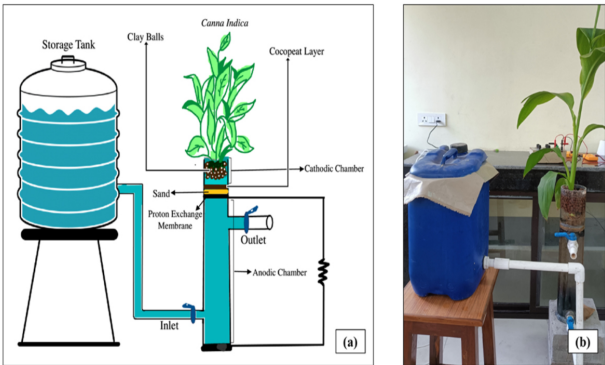


Fig. 1 (a) Schematic diagram of CWMFC; (b) Gravel-packed CWMFC reactor with *Canna indica*

Table 2 Cumulative performance of CWMFC by means of pollutant and energy recovery

CWMFC type	Type of cathode	Targeted wastewater	Power density (mW m ⁻²)	COD removal (%)	NH ₄ ⁺ -N removal (%)
Vertical up-flow	Carbon felt/biochar	Synthetic wastewater	16.10 ± 2.27	85.63 ± 1.33	90.35 ± 0.26
Vertical up-flow	Carbon felt/biochar	Fish market wastewater	14.60 ± 2.07	81.55 ± 1.26	90.04 ± 0.09

EVALUATION OF DOSE-DEPENDENT RESIDUE DEPLETION KINETICS OF ALBENDAZOLE IN GIFT TILAPIA (*Oreochromis niloticus*)

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Albendazole (ABZ), a benzimidazole anthelmintic, is widely used in aquaculture for parasite control. However, limited information is available on its depletion kinetics in tropical finfish. This study investigated the tissue distribution and elimination kinetics of ABZ in Genetically Improved Farmed Tilapia (GIFT) (*Oreochromis niloticus*) following oral dose of 10, 20, and 30 mg/kg body weight for 7 consecutive days. Tissue residues (muscle, liver, kidney) were analyzed and fitted to various kinetic models -Single First Order (SFO), Dual First Order in Parallel (DFOP), First Order Multiple Compartments (FOMC), Hockey Stick (HS)-using CAKE software to identify the best-fit model and calculate depletion half-life (DT_{50}) and 90% depletion time (DT_{90}).

In muscle, residue depletion exhibited dose-dependent kinetics. The best-fit model was DFOP for the 10 mg/kg dose ($DT_{50} = 4.9$ h), SFO for 20 mg/kg ($DT_{50} = 35.4$ h), and FOMC for 30 mg/kg ($DT_{50} = 23.3$ h). The results indicated biphasic elimination at the low dose and multi-compartmental kinetics at higher concentrations. ABZ showed higher persistence in the kidney ($DT_{50} = 0.5$ –15 h) and in liver, ABZ exhibited intermediate depletion profiles. The results confirm dose-dependent, nonlinear kinetics and highlight the need for multi-model evaluation to derive accurate withdrawal periods for tilapia raised under tropical conditions.

SHAPING MORTALITY PATTERNS IN WSSV CHALLENGE THROUGH DOSE OPTIMIZATION IN WHITELEG SHRIMP (*Penaeus vannamei* BOONE, 1931)

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White Spot Syndrome Virus (WSSV) is a highly aggressive pathogen in shrimp aquaculture, responsible for outbreaks that can cause devastating economic losses worldwide. Infected populations may experience mortality rates exceeding 90% within a matter of days, threatening both the productivity and profitability of shrimp industry. In response to this, the industry and researchers have pursued strategies such as selective breeding for resistance, development of vaccines and antiviral agents, and enhancements in farm management practices. Assessing the success of these approaches depends on having a dependable and standardized challenge model that can reliably produce WSSV infection under controlled conditions.

Many existing WSSV challenge approaches are constrained by the same issue: the onset of mortality is often too rapid and severe, producing acute die-offs that restrict observation windows and complicate the comparison of treatments. To address this, ShrimpVet conducted a dose optimization test in whiteleg shrimp (*Penaeus vannamei* Boone, 1931) to investigate how varying challenge doses influence mortality dynamics. By carefully modulating the viral dose, we aimed to shift mortality outcomes from uncontrolled acute peaks to more gradual and measurable patterns.

This approach is expected to allow mortality patterns to be shaped in ways more appropriate for experimental evaluation. Instead of abrupt and unpredictable die-offs, this approach will lead toward a WSSV challenge model that balances infection severity with experimental control. Such a model would provide a stronger platform for testing candidate interventions, improving reproducibility between laboratories, and supporting the broader efforts of the aquaculture industry to mitigate the devastating impact of WSSV.

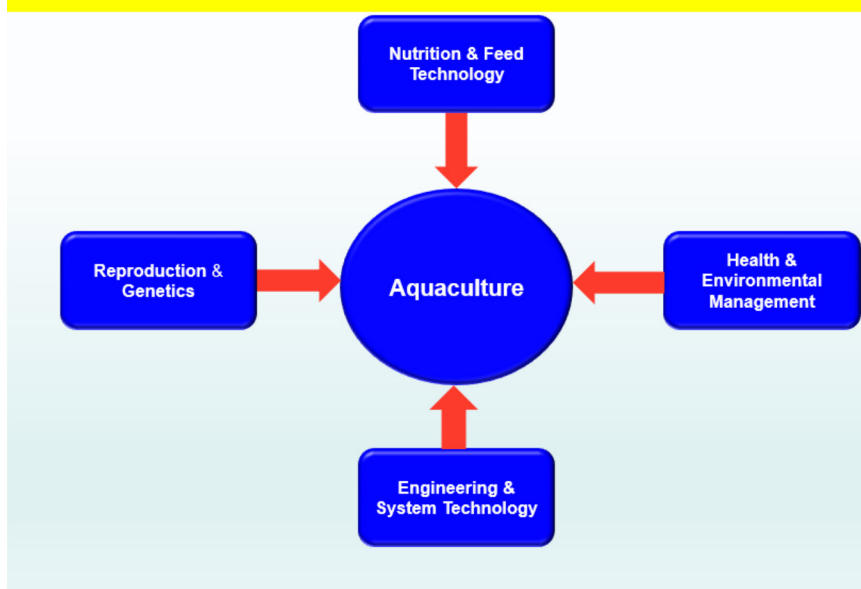
GLOBAL PERSPECTIVE OF AQUACULTURE RESEARCH DEVELOPMENT, PRODUCTION AND ACHIEVEMENTS

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World aquaculture production reached 131MT in 2022, and by-passed capture fisheries (92 MT), accounting for nearly 60% of the total seafood production. Aquaculture production in China reached 75MT, over 5-fold of capture fisheries (13 MT). In the past 10 years (2014-2024), China has topped the number of aquaculture publications, followed by the USA, India, Brazil, and Australia. The hot fields in aquaculture research include production/growth, health/disease and reproduction/spawning. World aquaculture production accelerated in the late 1990s due to scientific research and technological developments. This talk briefly goes through the recent history of aquaculture development and addresses the past and current achievements of aquaculture research from four supporting areas: reproduction/genetics, nutrition and feed technology, health management, and engineering and system technology. This presentation will highlight the constraints in aquaculture development and suggest strategies to overcome aquaculture development bottlenecks. The author will recommend aquaculture future development from the perspectives of economy, efficiency, technology, environment, ecology and the approach of future projects. It concludes that future aquaculture development depends on cultural acceptance, market demand, and scientific and technological support.

Four Major Pillars of Aquaculture Development



DEVELOPMENT AND EXPERIMENT RESEARCH ON THE FLOW-GUIDING FISH PUMP

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In response to the issues of fish injury and low working efficiency during the operation of vacuum fish pump (VFP), improvements were made to the process flow and internal structure of the vacuum tanks, leading to the development of a new type of fish pump, the flow-guiding fish pump (FGFP). The vacuum tank of the FGFP is placed vertically, with the fish intake pipe passing through the bottom of the vacuum tank and entering the interior. The top of the fish inlet pipe featured an inverted trumpet-shaped diversion structure. During the capture process, under the suction of the centrifugal pump, the fish and water mixture enters the vacuum tank, with the fish remaining inside the tank and the water being discharged. Through theoretical calculation, the catching efficiency of the FGFP and the VFP was compared, and the comparative analysis of the numerical simulation results of the FGFP and the VFP were carried out by the computational fluid dynamics method. A prototype of the FGFP was created and its performance experiment was carried out. The study found that, using the data with a fish-to-water ratio of 1:1 in the water pool and the vacuum tank as a benchmark, when the fish-to-water ratios in the water pool were 1:2, 1:3, 1:4, and 1:5, the FGFP took 20.4%, 30.6%, 36.8%, and 40.8% less time to transport the same mass of fish compared to the VFP. During the capture process, there was a large range of strong vortex in the vacuum tank of the VFP, which can easily cause fish injuries. In contrast, the vacuum tank of the FGFP has less noticeable vortices, making it more fish-friendly and significantly reducing the probability of fish injury. The conveying capacity of the FGFP does not change with the height of the fish. These research results can provide theoretical basis and references for the design of the FGFP.

INFLUENCE OF NOVEL FEED INGREDIENTS ON GROWTH, DIGESTIVE EFFICIENCY, BIOCHEMICAL PARAMETERS, IMMUNITY AND GENE EXPRESSION OF PACIFIC WHITE SHRIMP (*Penaeus vannamei*)

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An eight-week feeding experiment was carried out to investigate the potential of combination of various novel feed ingredients as fishmeal (FM) replacers and to determine their effects on growth performance, nutrient digestibility, enzymatic and immune responses, histology, and gene expression of Pacific white shrimp (*Penaeus vannamei*). Five isonitrogenous (36% crude protein) and isolipidic (6% crude lipid) diets were formulated using alternative protein sources. In the control diet (Diet 1), fishmeal served as the primary protein source. In Diet 2, FM was substituted with poultry by-product meal (PBM) and single-cell protein (SCP) in a 1:1 ratio; Diet 3 included insect meal (IM), rapeseed meal (RM), and SCP (1:1:1); Diet 4 contained fish waste (FW), peanut meal (PM), and SCP (1:1:1); while Diet 5 incorporated PBM, SCP, IM, FW, PM, and RM in equal proportions (1:1:1:1:1:1). Juvenile shrimp with an initial average body weight of 1 g were randomly stocked into experimental tanks following a completely randomized design (CRD) with triplicate groups for each treatment. Juvenile shrimps with an average weight of 1 gram have been stocked in different experimental tanks and fed with above diet following completely randomized design (CRD) in triplicates. Among the dietary treatments, shrimp fed Diet 5 demonstrated significantly higher ($p < 0.05$) weight gain, and specific growth rate (SGR) which was not different from Diet 1 and Diet 3. Significantly improved ($p < 0.05$) PER and FCR was observed in shrimp fed with Diet 1 and Diet 5. The whole-body crude protein content was significantly higher ($p < 0.05$) in shrimp fed Diet 5 and it was not different from Diet 1 and Diet 2. The plasma biochemical parameters of *P. vannamei* were not significantly influenced by the diets containing different combinations of novel feed ingredients. Diet 1 and Diet 5 showed significantly higher ($p < 0.05$) dry matter digestibility and crude protein digestibility. Prophenoloxidase activity was significantly higher ($p < 0.05$) in Diet 1, which was not different from Diet 5, while respiratory burst activity was significantly higher ($p < 0.05$) in Diet 1 and Diet 5 which was not different from Diet 3. Shrimp fed Diet 1 and Diet 5 exhibited significantly higher ($p < 0.05$) growth and immune gene expression compared to other diets. These findings suggest that a combination of PBM, SCP, IM, RM, PM, and FW in 1:1:1:1:1:1 ratio is an effective combination to replace fishmeal without compromising growth performance, nutrient utilization and health in Pacific white shrimp (*Penaeus vannamei*).

PARTICIPATORY BIODIVERSITY AND SOCIAL IMPACT ASSESSMENT OF SHRIMP FARMS IN COASTAL DISTRICTS OF ANDHRA PRADESH, INDIA – AN APPROACH FOR SUSTAINABILITY

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India today holds the distinction of being the world's largest exporter of shrimp, with estimated exports projected to reach \$7.5 billion by 2024. A staggering 60% of this comes from Andhra Pradesh alone. Andhra Pradesh contributes around 32 per cent of marine seafood exports and covers 2.26 lakh acres under aquaculture. The push for traceability and certifications aligned with global standards is enhancing the credibility of Indian shrimp in discerning markets. Studies on Environmental and Social Impact Assessment were conducted in Coastal districts of Andhra Pradesh such as Bapatla, Dr. B. R. Ambedkar Konaseema, East Godavari, Eluru, Guntur, Kakinada, Krishna, NTR, Palnadu, Prakasam, Sri Potti Sriramulu Nellore, West Godavari and in Srikakulam districts in about 70 shrimp farms selected based on their size and proximity to coastal zones; however, results may not be representative of all aquaculture operations in Andhra Pradesh due to limited sample size and selection criteria. Studies revealed that these farms are not having any negative impact on Native Mangrove vegetation as most of them were neither located in Mangroves nor have destroyed / encroached the native mangrove vegetation. Majority of the farms were in Coastal Aqua zone barring a few farms that were found in Agriculture rich areas especially in Krishna and Godavari districts where farmers have converted their agriculture farms into aquaculture for higher income and due to non-availability of labour due to increased costs. The profitability from aquaculture has increased and encouraged the farmers to convert their farms into aqua farms in these regions. Most of these farms have drawn water from canals having salinity ranging from 5-30 ppt and occasionally use saline borewell water in their farms when the water needs to be supplemented for culture. The farms under these studies also revealed that the farms were away from wildlife protected areas and also away from biodiversity rich areas and doesn't possess High Conservation Value species as located mostly in aqua zones in coastal districts. The social Impact studies revealed that there is an overall improvement in the standard of living, earning per family through gainful employment in aqua sector from hatchery to processing and related sectors. Even the revenue from leasing lands for aquaculture has yielded higher income compared to agriculture where one face shortage of labour. Mostly the feedboys are from adjoining states such as West Bengal, Odisha and other regions. Shrimp farming in Andhra Pradesh is not just about exports and economic metrics. It is about resilience, empowerment, and strategic foresight. It represents a sector that is future-ready, environmentally conscious, and globally competitive that captured the imagination of world seeking sustainable prosperity through blue economies. Thus, the study concludes that there could be neutral impact on biodiversity and positive impact on society with best sustainable management practices.

INTEGRATION OF BLACK SOLDIER FLY LARVAL MEAL IN THE DIET OF *Cyprinus carpio*: GROWTH, ENZYMATIC ACTIVITY, AND INTESTINAL HEALTH ASSESSMENT

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The necessity for seafood-based nutrition in food security concerns the aftereffects of biowaste accumulation. These bioorganic wastes pose significant environmental and health challenges. Thus, bioconversion of wastes through insect-based systems offers a sustainable solution advantageous to the circular bioeconomy. The present study examines the impact of black soldier fly larvae (BSFL) meal integration for fishmeal (FM) substitution in the diet of *Cyprinus carpio*. Initially, an isonitrogenous formulation of BSFL inclusions at various levels of fish meal substitution, including D0(control), D1(25%), D2(50%), D3(75%), and D4(100%). On a dry matter basis. Among the diets, D2 and D3 BSFL diets show significantly improved morphometric parameters such as weight gain (respective result), length gain (respective result), and specific growth rate (respective result) compared to the control. Feed conversion ratio (FCR) was lowest at D2, while protein efficiency ratio (PER) peaked at D3, indicating enhanced feed utilization. Physical properties, including sinking velocity and water stability, were optimal in D3 and D4BSFL diets (respective results). Haematological, histological, and serum biochemical analyses further justified the improvement in physiological as well as health status at D2 and D3inclusion levels (respective results). Furthermore, digestive enzyme activities (amylase, protease, trypsin) were elevated in higher inclusion level D4 (respective results), suggesting nutrient assimilation. Additionally, antioxidant enzyme activities (SOD, CAT, GSH, GPx) were significantly higher in the D4 group, indicating improved oxidative stress mitigation; comparatively, lipid peroxidation activity remained lowest in the D0. Overall, the findings highlight that BSFL meal can be utilised for replacing FM in aquafeeds up to 75% without conciliatory effects on growth, health, or nutritional efficiency in *C. carpio*.

REGIONAL CONTEXT SHAPES THE ENVIRONMENTAL IMPACTS OF SHRIMP FARMING IN INDIA

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India is the world's second-largest producer and exporter of farmed shrimp, yet the environmental performance of its farms remains poorly understood. Production practices and input use differ markedly across regions, but how these regional variations influence sustainability outcomes has not been systematically assessed. This study asks whether regional production contexts in India shape the environmental performance of shrimp aquaculture, and identifies the key input and management factors driving these differences. We use life cycle assessment (LCA) method to assess regional differences in shrimp farming across three major producing states on India's east coast, namely Tamil Nadu, Andhra Pradesh, and West Bengal, drawing on detailed farm-level data from 45 commercial operations, of which 24 (eight per state) were selected for systematic analysis. We developed a stoichiometric nutrient model to estimate nitrogen and phosphorus emissions, and constructed life cycle inventories using primary datasets supplemented with state-level proxy data. Environmental impacts were quantified using LCA-ReCiPe midpoint indicators in SimaPro, and statistical tests were applied to compare impacts across two perspectives: geographical clusters (states) and technical clusters (defined by days of culture and productivity). Results reveal clear regional heterogeneity. Inventories differed significantly across states in categories such as land use, electricity demand for aeration, operational hours of pumps and aerators, and dead shrimp disposal. At the impact assessment stage, 13 of 15 midpoint categories exhibited statistically significant state-level differences, as of the case of Global warming (kg CO₂ eq) shown in Fig 1(A). In contrast, technical clustering showed limited variation, with marine eutrophication as the only category significantly affected (Fig 1.B). Hotspot analysis further indicated that electricity use, not feed, was the dominant driver of environmental impacts, challenging the prevailing assumption that feed is the universal hotspot in aquaculture systems. Our findings demonstrate that shrimp farming in India cannot be treated as environmentally homogeneous, as sustainability outcomes depend strongly on regional production contexts. These results highlight the need for region-specific strategies, including targeted energy management, improved waste handling, and locally tailored best practices, to reduce the environmental footprint of India's most valuable aquaculture sector.

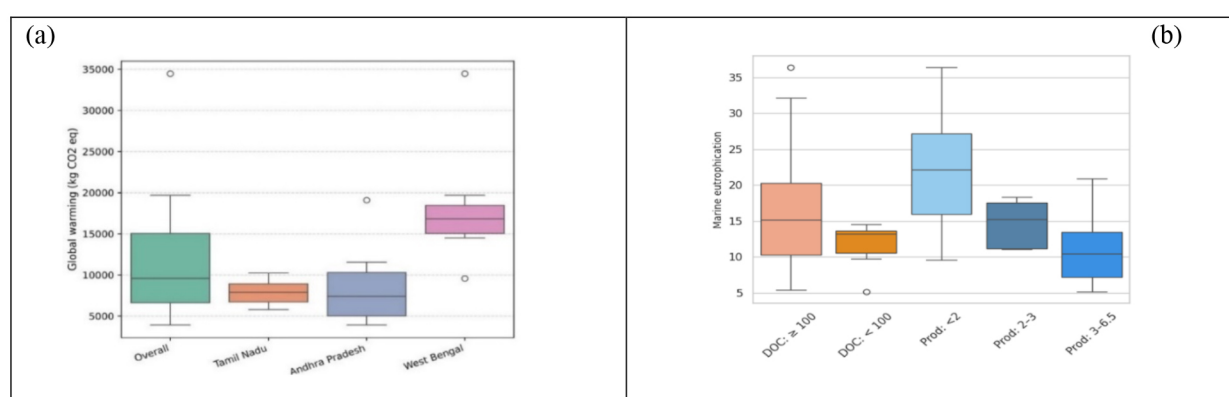


Fig 1. Variability of global warming potential across geographical clusters (A) and marine eutrophication across technical clusters (B) of shrimp farming in India.

ECOLOGICAL HEALTH OF A TROPICAL RESERVOIR: DEVELOPMENT AND APPLICATION OF A MULTIMETRIC INDEX

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Reservoirs are vital freshwater ecosystems that support irrigation, hydropower, fisheries, and biodiversity, but they are increasingly threatened by anthropogenic pressures and climate-induced stress. Conventional physico-chemical monitoring provides only short-term snapshots of water quality, often failing to capture ecological integrity. Biotic indicators such as fish, plankton, and macrophytes, on the other hand, integrate environmental changes over longer timescales and serve as reliable measures of ecosystem health. The present study applied a multi-metric index (MMI) framework to assess the ecological health of Poondi Reservoir, a medium-sized tropical reservoir in Southern India, by combining abiotic, biotic, and disturbance indicators across spatial (lentic, transitional, riverine) and temporal (pre-monsoon, monsoon, post-monsoon, summer) scales.

The assessment revealed significant spatio-temporal variation in ecosystem health. Fish assemblage scores ranged from 35.7 in summer to 80.0 in the monsoon, highlighting seasonal bottlenecks driven by hydrological stress and habitat connectivity. Fish production was highest in the lacustrine zone (73.3) and lowest in the riverine zone (40.0), reflecting differences in water depth and disturbance levels. Plankton indices averaged 62.9, with post-monsoon nutrient inputs enhancing productivity, while macrophyte scores varied widely (30–100), indicating both habitat value and eutrophication risk. Abiotic parameters recorded the highest average (65.7), reflecting generally good water quality, whereas disturbance scores (62.9) pointed to moderate human pressures from agriculture, domestic waste, and shoreline encroachment. Overall, the riverine zone maintained the best ecological integrity (67.3%), while the transitional zone and summer season emerged as the most stressed, with cumulative indices of 56.9.

These findings demonstrate the utility of integrative, multi-metric tools in capturing ecological health dynamics of reservoirs, especially in tropical systems where seasonal fluctuations strongly influence ecosystem function. The results underscore the need for targeted management interventions, including maintaining minimum summer water levels to reduce hypoxia, restoring riparian vegetation buffers to limit nutrient influx, and promoting community-based monitoring to address localized pressures. The study concludes that Poondi Reservoir is currently in “good” ecological condition but remains vulnerable to seasonal and spatial stressors. The multi-metric framework applied here provides a robust, evidence-based approach for reservoir health assessment and offers valuable guidance for sustainable fisheries, biodiversity conservation, and adaptive management under changing climatic and anthropogenic pressures.

EXOGENOUS ENZYME SUPPLEMENTATION IN BIOFLOC INOCULUM INFLUENCES WATER QUALITY, GROWTH, FEED UTILIZATION AND SURVIVAL OF GENETICALLY IMPROVED FARMED TILAPIA REARED IN INLAND SALINE GROUND WATER

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An experiment over 60 days assessed the impact of adding exogenous enzymes to the biofloc system with tilapia. A preliminary sludge hydrolysis experiment has been undertaken to fix the percentage of enzymes (amylase and protease) based on total solids (TS) level for which 4 doses (3,6,12,18% of TS) of a single enzyme (protease or amylase) and mixed enzymes (protease and amylase) in 250 ml aquaculture sludge. The 6% mixed enzyme was found to impart a better sludge hydrolytic effect and was chosen for the second experiment. The 6 % of mixed exogenous enzymes were supplemented in different ratios to the sub culture of biofloc inoculum (1:1, 1:2, 1:3 and 1:4 enzyme/ TS as T1-T4) in triplicates to follow a completely randomized design. A conventional biofloc group was maintained as a control (BC). Floc volume is significantly influenced by enzyme-supplemented biofloc tanks than BC. Enzyme addition significantly influenced the inorganic metabolites in the culture media over BC. However, the maximum mean nitrate-N level was observed in T4. The mean weight gain (14.15 ± 0.03 and 13.97 ± 0.01 g), percentage weight gain (638.76 ± 1.17 and 630.25 ± 2.79 %), specific growth rate (3.33 ± 0.003 and 3.31 ± 0.01) and thermal growth coefficient (0.29 ± 0.0003 and 0.29 ± 0.0002) were significantly higher in T3 and T4 than others. The maximum feed utilization was found in entire treatment groups compared to the control and the survival rate was 100 % in T2 and T3. The study found that a 6% concentration of mixed enzymes (amylase and protease) can effectively improve the hydrolysis of inorganic metabolites and accelerate the somatic growth and feed utilization parameters of GIFT tilapia reared in saline ground water.

EXPLORING ONE HEALTH PROBIOTICS IN FRESH WATER FISHES FOR MICROBIAL DISEASE MANAGEMENT

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One Health probiotics refer to beneficial bacterial strains that confer positive health effects across animals, humans and the environment. Comparative metagenomic analysis of the fish gut microbiome under healthy and diseased conditions can reveal critical host–microbe interactions and facilitate the discovery of novel, universal probiotic strains with One Health applications. In this study, the gut microbial communities of *Pangasianodon hypophthalmus* and *Labeo catla* fingerlings were analysed under control and *Aeromonas hydrophila*-challenged conditions using 16S rRNA amplicon metagenomic sequencing. The results showed a significant difference in the microbial composition as well as the relative abundance between treatments. Comparative post-challenge microbiome profiling identified Proteobacteria, Firmicutes and Bacteroidetes as the dominant phyla constituting the core microbiome of farmed freshwater fishes. Interestingly, *Lactobacillus* constituted only 0.08% of the microbiota in control *P. hypophthalmus*, whereas the abundance of *Aeromonas* increased by 459-fold (to 4.59%) in challenged fish compared to control. Similarly, the abundance of *Bacillus* was higher in control *L. catla* group and *Aeromonas* sp. was higher in the challenged group.

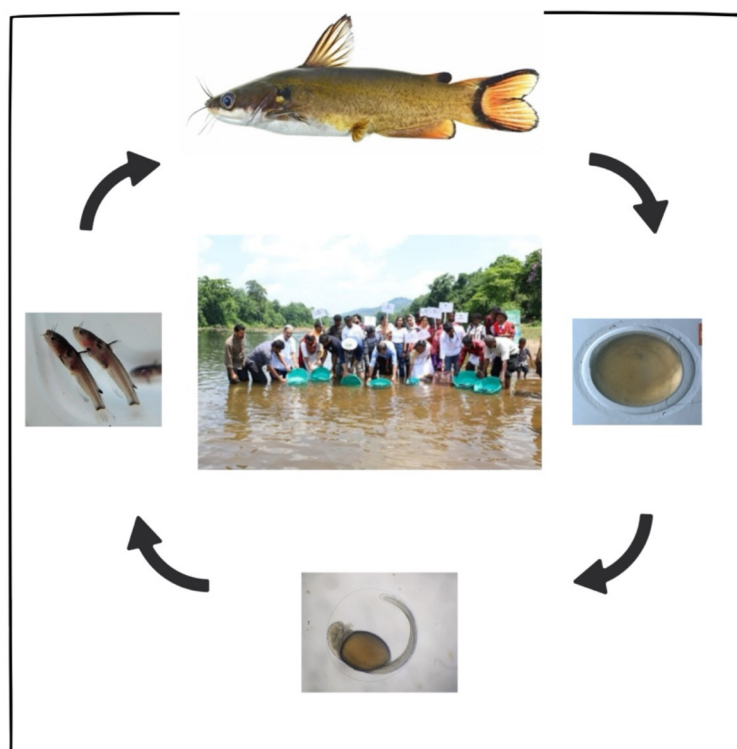
Several promising indigenous strains were also identified i.e. *Lactobacillus helveticus*, *Kocuria palustris*, *Rubrivivax gelatinosus*, *Reyranella massiliensis*, *Roseburia faecis* etc. In addition, Next-generation probiotic taxa such as *Akkermansia muciniphila*, *Faecalibacterium*, *Bacteroides* and *Odoribacter* were identified for the first time in farmed *P. hypophthalmus* and *L. catla*. These bacterial taxa have already been known to exert beneficial effects in human and animal health. The discovery of these NGPs in farmed freshwater fishes highlights their potential as universal probiotics, supporting a sustainable, One Health-driven strategy for disease prevention and health management in aquaculture.

CONSERVING THE CRYPTIC GIANT: BREAKTHROUGH IN CAPTIVE BREEDING AND LARVAL REARING OF THE NEWLY DISCOVERED CATFISH *Horabagrus obscurus*

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The genus *Horabagrus* (Siluriformes: *Horabagridae*), endemic to the west-flowing rivers of India's Western Ghats, represents a distinct and conservation-relevant catfish lineage. The recent discovery of the cryptic, range-restricted *H. obscurus* from the Chalakkudy River expands the genus beyond *H. brachysoma* and the endangered *H. nigricollaris*, highlighting the region's freshwater biodiversity. As the largest species in the genus (~2 kg) and a minor fishery resource, *H. obscurus* has been prioritised for conservation and sustainable management. We report the first successful captive breeding, larval rearing, and restocking programme for this species. Brooders induced with WOVA-FH (1 ml kg⁻¹ body weight) ovulated within 12–13 h. Golden-yellow eggs (1.8–2.1 mm) showed fecundity of 200–230 eggs g⁻¹ ovary and 80–90 % fertilisation success. Hatching occurred within 28–30 h, and yolk-sac absorption was complete by 72 h post-hatch, initiating exogenous feeding. Under optimised rearing conditions (26–28 °C, pH 6.8–7.4), hatching exceeded 90 % and larval survival surpassed 95 %, confirming high seed production potential. Hatchery-reared juveniles were released in their native stretch between Athirapilly and Thumburmuzhy, providing a practical model for population recovery. This study delivers the first comprehensive reproductive profile and standardised seed production protocol for *H. obscurus*, offering a scalable approach for its ex-situ conservation, ranching, and future aquaculture prospects.



ASSESSMENT OF THE REPRODUCTIVE POTENTIAL OF BOMBAY DUCK, *Harapdon nehereus* OFF THE MUMBAI WATERS, MAHARASHTRA INDIA

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The reproductive biology of Bombay duck, *Harapdon nehereus* off the Mumbai waters, Maharashtra India was investigated from August, 2023 to May, 2025. In our study, 1012 specimens were sampled from inshore and offshore vessels operating dolnets and trawlers respectively. The length range of the sample collected ranged from 3-33cm respectively. We assessed the main biological parameters that describe reproductive potential: maturity, spawning seasonality, fish condition, and fecundity. The length at which 50% of for male and female population matures (L50) was estimated at 19.6 cm and 19.8 cm for males and females in total length respectively.

The main spawning season was observed in April to June and minor spawning in January but the presence of Gravid and ripe females was observed throughout the year. This can be reflected with the presence of more juveniles in the catch during the succeeding months. The mean absolute fecundity for females 19–29 cm total length was estimated at 0.03 -1.1 lakh oocytes million oocytes. The use of histology gave the clear picture of asynchrony with unique morphology of the ova in the species was reported, provide an improved understanding of the reproductive cycle of Bombay duck in the Mumbai waters, Maharashtra, India.

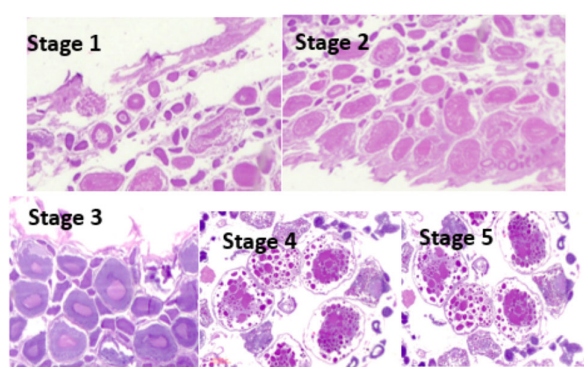


Fig. 1: Histological images at different stages (1 to 5) for *H. nehereus* off Mumbai coast

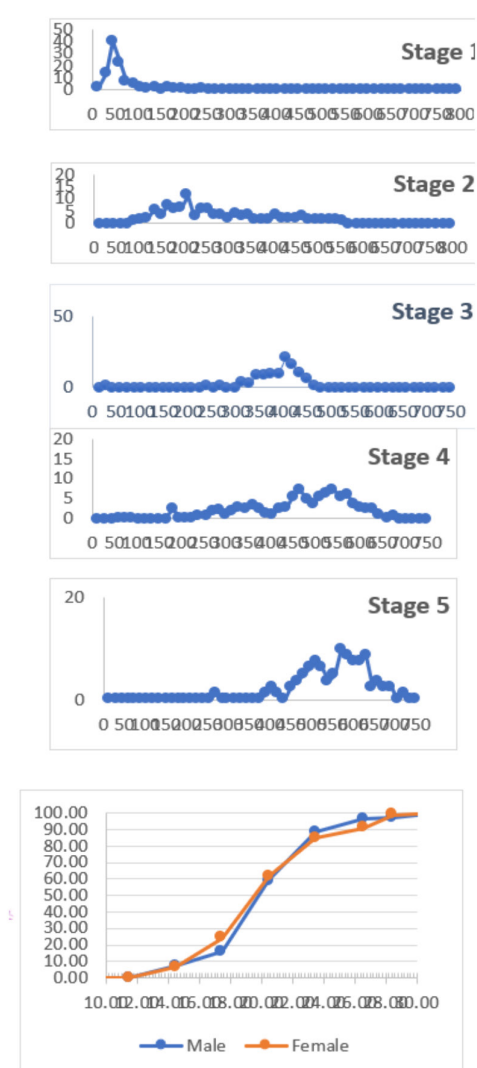


Fig. 2: Ova diameter (above) Lm 50 (below) for *H. nehereus* off Mumbai coast

EFFECT OF PROBIOTICS ON PATHOGENIC *Vibrio* BACTERIAL POPULATIONS IN CULTURE PONDS OF *Litopenaeus vannamei* AT SIVARAMPURAM, SRIKAKULAM DISTRICT, ANDHRA PRADESH, INDIA

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The current study was carried out for 147 days to assess the pathogenic *Vibrio* count of *Litopenaeus vannamei* culture ponds and the influence of probiotics from Mophus Bander, Srikakulam District, Andhra Pradesh, India. Three ponds were selected; one is control and other two were experimental (Pond A and B). The physico-chemical parameters of the culture ponds were recorded by adopting standard methods. During summer crop the control ponds were harvested at 24.0 gm on 107th day for the year 2025 due to the incidence of *Vibriosis* disease. The Experimental ponds were harvested normally in summer season at 30.5 gm on 124th day & 31.0 gm on 127th day during 2025.

This study suggests that the probiotics TOTAL as pond probiotic & LACTOMAX as feed probiotic are the key agents which have a great impact on the reduction of total pathogenic *Vibrio* count in culture ponds of *Litopenaeus vannamei*.

BALANCED NUTRITION STRATEGIES IN SHRIMP HATCHERIES FOR MORE SUSTAINABILITY

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Sustainable shrimp hatchery production requires a holistic approach that integrates balanced nutrition and optimized feeding management. Specialized starter feeds, growth-boosting post-larval diets, and health-promoting supplements improve larval survival, shorten production cycles, and enhance post-larval resilience. Additionally, using AI for growth monitoring and timely harvesting maximizes profits and promotes efficient use of resources or other inputs.

A proof-of-concept trial in Andhra Pradesh, India, demonstrated that balanced nutrition and improved feed management enabled post larvae to reach target size three days earlier, reduced resource consumption, increased survival, and ultimately improved production efficiency. Additionally, incorporating sustainably certified and novel feed ingredients can reduce dependency on marine proteins without compromising performance. Together, these strategies highlight that improving sustainability not only safeguards environmental resources but also directly enhances profitability for shrimp hatcheries.

THERMAL BIOLOGY AND METABOLIC SCOPE OF TWO SPECIES OF JUVENILE GASTROPOD MOLLUSKS INHABITING KELP FORESTS

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Temperature is one of the main abiotic factors that influence the growth, reproduction, food availability, distribution, and survival of many species of marine ectotherms. *Megastrea undosa* and *Megathura crenulata* are gastropod mollusks with economic, commercial, and biomedical importance that are part of the kelp forest community in the temperate waters of the northern Pacific of Mexico. As knowledge about the thermal biology of these two species is scarce, this study aimed to determine the effect of different acclimation temperatures on the thermal biology and metabolic scope of these two species. 120 *M. undosa* juveniles were collected from the wild and acclimated to four temperatures (13, 16, 19, and 22°C ± 1°C), while 90 *M. crenulata* juveniles were cultured in an aquaculture facility (Stellar Biotechnologies, Inc) and acclimated to three temperatures (17, 20, and 23°C ± 1°C). Subsequently, experiments were performed to determine the thermal tolerance, thermal window, thermal safety margin, future thermal safety margin, and thermal metabolic scope of these species.

The thermal tolerances of both species were relatively similar (*M. undosa*: CTmax = 25.3, 21.0, 25.4 and 27.4°C, CTmin = 6.0, 9.2, 16.3 and 17.3°C; *M. crenulata*: CTmax = 27.7, 28.1 and 28.8°C, CTmin = 11.2, 12.1 and 14.7°C). Both species had a small thermal window area (*M. undosa*: 77.2°C2; *M. crenulata*: 65.25°C2). The values of the thermal safety margin and the future thermal safety margin of both species were lower during the summer than winter. The optimal temperature proxies of *M. undosa* and *M. crenulata* juveniles were 16 and 20°C, respectively. This study shows that the two species of marine gastropods could be moderately affected by ocean warming, being forced to modify their current distribution patterns. The data on thermal limits and optimal temperatures can be used to initiate and maximize the cultivation of both species, which would also help mitigate the impact of overfishing on natural populations.

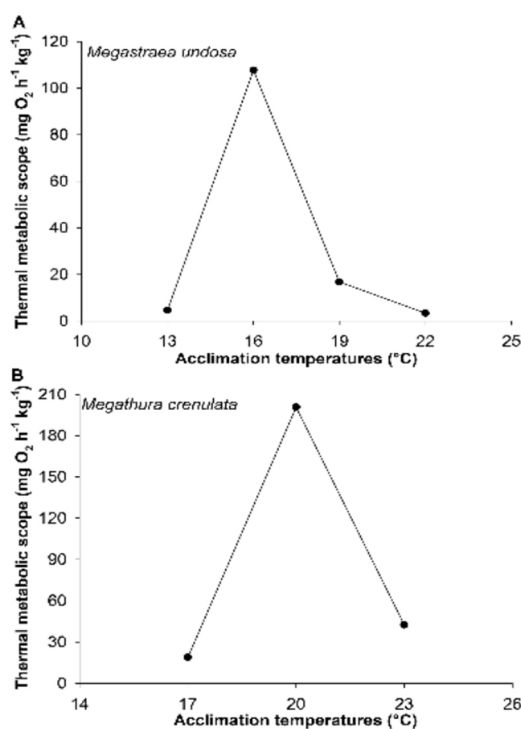


Fig. 1. Thermal metabolic scope of *M. undosa* and *M. crenulata* juveniles.

AN OVERVIEW OF LIVE SHRIMP BROODSTOCK IMPORTS TO INDIA OVER THE LAST SIXTEEN YEARS THROUGH AQF

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The Aquatic Quarantine Facility (AQF), located on the southeastern coast of India in Neelankarai, Chennai, Tamil Nadu, serves as the country's dedicated Centralised Shrimp Quarantine Unit, established by the Marine Products Export Development Authority (MPEDA) in 2009. This facility is one of its kind in Asia and adheres to the highest international standards required for quarantine units. The AQF was primarily established to mitigate the risks of pathogen entry associated with the transboundary shipment of the exotic Pacific white leg shrimp *Penaeus vannamei* to India, when the Indian Government permitted commercial culture of this exotic species. This facility provides quarantine services under the governance of the Ministry of Fisheries, Government of India. Setting a significant benchmark in the shrimp industry, the facility has successfully completed 16 years of service as of July 18, 2025, having quarantined over two and a half million brooders of *P. vannamei* and 36,212 brooders of black tiger shrimp *P. monodon* while ensuring their specific pathogen-free status. This paper presents a comprehensive analysis of shrimp imports to India over the past sixteen years, and highlights the pivotal role of AQF in enhancing shrimp exports and safeguarding the industry from diseases.

EXTRACTION OF CELLULOSE NANOCRYSTALS FROM THE AQUATIC WEED, GIANT SALVINIA, AS A REINFORCING AGENT IN BIODEGRADABLE FILMS FOR FISH PACKAGING APPLICATION

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In the current study, cellulose (C) was extracted from the aquatic weed, giant salvinia (*Salvinia molesta*) and converted into cellulose nanocrystals (CNCs) for utilizing as a reinforcing agent in biodegradable films for fish packaging applications. SEM and TEM micrographs confirmed the successful conversion of bulk cellulose into a crystalline (CNC) structure. FTIR spectra verified the removal of lignin and hemicellulose without altering the cellulose backbone. XRD analysis confirmed the cellulose I crystalline structure, showing an increase in crystallinity index from cellulose (59.2%) to CNC (69.4%), which indicates effective removal of amorphous regions. Particle size analysis revealed nanoscale dimensions for CNC (55 nm), and the zeta potential value of -53.9 mV indicated excellent colloidal stability. Further, a carrageenan-based active biodegradable film was developed by adding CNC at 5 % (w/w) by solvent casting. Pomelo peel (*Citrus maxima*) extract (PPE) was added at 5 % to the film-forming solution as an active agent. There was a significant ($p \leq 0.05$) increase in the tensile strength of the native carrageenan film upon CNC incorporation, and the antioxidant activity was improved by the addition of PPE into carrageenan films. A storage trial was conducted to evaluate the efficiency of the developed active biodegradable film on the shelf life of chilled stored (4 ± 2 °C) skipjack tuna (*Katsuwonus pelamis*). The results showed that the shelf life of tuna was extended from 8 days in the control, packed in synthetic plastic pouches, to 16 days when packaged with carrageenan + CNC + PPE.

INVESTIGATING THE FEASIBILITY AND CONDITIONS FOR OUTDOOR MICROALGAE CULTIVATIONS IN SEYCHELLES

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Microalgae are essential in aquaculture hatcheries during the early life stages of many marine species due to their high nutritional content. Conventionally, microalgae are cultured indoors under controlled conditions, but these systems are expensive and energy intensive. In tropical countries such as Seychelles, where high solar irradiance and stable temperatures prevail, outdoor cultivation could be a sustainable alternative. This study assessed the feasibility of outdoor cultivation of two species, *Tetraselmis* spp. and *Chaetoceros muelleri*, by comparing growth under different light and temperature conditions.

A total of fifteen 10L carboys were used in a factorial design outdoors: shaded-cooled, shaded-uncooled, unshaded-cooled, and unshaded-uncooled. An indoor control was maintained under continuous illumination at 25°C. Temperature and light were monitored twice daily, and cell densities were recorded every other day for five days. Trials were conducted separately for each species.

In the *Tetraselmis* spp. trial, cooled treatments maintained stable conditions compared to uncooled setups, which fluctuated more widely and reached higher light levels. The indoor control consistently produced the highest algal density (159,000 cells/ml), while outdoor treatments showed no significant differences, with unshaded-cooled reaching a peak of 101,000 cells/ml. For *C. muelleri*, uncooled treatments reached extreme temperatures, up to 43.8°C, while unshaded conditions, especially unshaded-cooled, promoted the highest algal growth (1.39 million cells/ml), significantly outperforming shaded treatments.

In conclusion, outdoor cultivation in Seychelles is viable, especially for *C. muelleri* under unshaded and moderately cooled conditions. This approach offers a promising, cost-effective solution for small-scale hatcheries in tropical regions. Further research should examine seasonal variation and long-term sustainability.

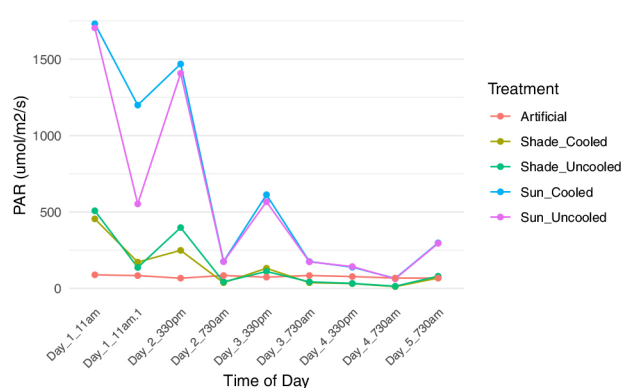


Figure 1. Light intensity recorded twice daily over a period of 5 days for *Chaetoceros muelleri* trial

REVOLUTIONIZING AQUACULTURE: THE POWER OF POSTBIOTICS FOR ENHANCING HEALTH AND PRODUCTIVITY

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The aquaculture industry is evolving rapidly to meet global food demands while addressing challenges related to animal health, welfare, and production efficiency. Among emerging strategies, postbiotics, which are nonviable microbial derivatives with bioactive properties, are gaining attention for their ability to reduce disease incidence, improve survival, and enhance overall productivity. Their stability during feed processing and storage, combined with a favorable safety profile, makes them a practical and effective option for sustainable aquaculture practices.

In 2 trials with white leg shrimp (*Litopenaeus vannamei*), dietary inclusion of a postbiotic product significantly improved survival and physiological robustness under Early Mortality Syndrome (EMS) and White Spot Syndrome Virus (WSSV) challenges, including salinity stress. Postbiotic-fed shrimp exhibited reduced mortality, improved gut and hepatopancreatic condition, and enhanced resistance to environmental and infectious stressors. These benefits translated into improved welfare and production efficiency, supporting the role of postbiotics in reducing economic losses due to disease.

Building on these *in vivo* results, and to support the introduction of postbiotics products into non-crustacean aquaculture species, an *ex vivo* screening platform was applied using fish gut explants. This model enables, among others, the evaluation of immunomodulatory and barrier-enhancing effects of the postbiotic product across a range of doses. In the experiments, gene expression was assessed for markers related to immune response (IL-1 β , IL-8, TNF α , INF γ), antioxidant defense (GR, GPx), and epithelial integrity (TJP1, OCL, CLDN15, Tric). The *ex vivo* platform provides a scalable and mechanistic approach to validate functional feed ingredients in fish species under controlled conditions.

Together, these studies demonstrate the cross-species potential of postbiotics as sustainable, health-promoting agents in aquaculture. The integration of *in vivo* and *ex vivo* approaches offers a robust framework for evaluating and optimizing functional feed additives that support animal welfare and productivity across diverse production systems.

METAGENOMICS ANALYSIS OF SEDIMENTS OF RIVER GANGA FOR BACTERIAL DIVERSITY, FUNCTIONAL GENOMICS, ANTIMICROBIAL RESISTANCE AND PLASTIC-XENOBIOTIC DEGRADING ENZYMES

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The Ganga is the largest river in India, functioning as a vital resource for agriculture, drinking water, and religious ceremonies. However, it became highly polluted due to the contamination of industrial effluents and untreated sewage, resulting in a loss of aquatic biodiversity. This research examined the microbial diversity, Functional Gene annotation, antibiotic resistance and plastic-xenobiotic degrading enzymes in sediment metagenomes from the river Ganga. We used a high-resolution metagenomics technique with the Illumina HiSeq 2500 to discover the structure of the community microbiome and its functions in the sediments of the river Ganga. Bacteria are more dominant in the microorganisms in sediment samples from the river Ganga. Pseudomonadota is the most abundant bacterial phylum in sediment samples. Genes involved in the breakdown of xenobiotic chemicals, such as nitrotoluene, benzoate, aminobenzoate, chlorocyclohexane, and chlorobenzene, were significantly overrepresented in the microbiome of contaminated areas. Pathway analysis using the KEGG database found a higher abundance of genes involved in energy metabolism, including oxidative phosphorylation, nitrogen, methane, sulfur, and carbon fixation pathways, in the Ganga sediment metagenome data. Pollutant degrading enzymes are more abundant in contaminated microbiomes, indicating that they play a role in plastic and dye breakdown. Overall, our study has provided information on bacterial diversity and dynamics in community structure and function from contaminated river microbiomes, which is predicted to pave the way for the discovery of novel functional genes/enzymes with potential applications in health and bioremediation. Further, this study will aid in pollution reduction and the sustainable management of river ecosystems.

COMPOSITION AND CONVERSION OF MARINE FISH WASTE INTO VALUE-ADDED PRODUCTS IN ODISHA'S COASTAL SECTOR

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The coastal regions of Odisha are rich in marine biodiversity and contribute significantly to India's fish production. However, a substantial portion of the total catch is discarded as processing by-products, including fish heads, frames, viscera, skin, and scales. These by-products, though often treated as waste, are rich sources of valuable nutrients such as proteins, lipids, essential fatty acids, and minerals. This study investigates the nutritional composition of selected marine fish processing by-products collected from fish landing centers and processing units along the Odisha coast. Proximate analysis revealed high protein content in frames and heads, significant lipid concentrations in viscera and skin, and notable levels of calcium and phosphorus in bones and scales. The study also explores the potential valorization routes for these by-products, including their application in animal feed, biofertilizers, collagen and gelatin production, and as sources of bioactive compounds for nutraceuticals. By highlighting their nutritional and commercial value, this research underscores the importance of adopting sustainable utilization practices for fish processing waste, thereby promoting environmental conservation and supporting local livelihoods in coastal communities.

FIRST REPORT OF WHOLE-GENOME ANALYSIS OF *Aeromonas dhakensis* FROM INDIAN CAGE FARMING ON COEXISTENCE OF PHENOTYPIC SUSCEPTIBILITY AND GENOTYPIC RESISTANCE: INDICATING THE PRESENCE OF A SILENT RESISTOME

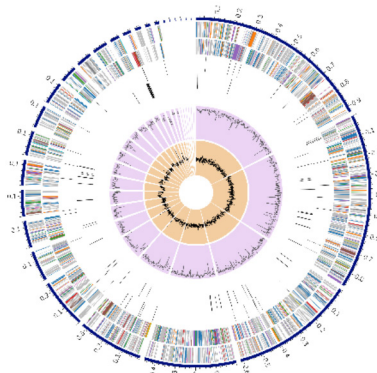
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Aeromonas dhakensis is a formidable pathogen and has emerged as a significant threat due to its ability to inflict severe infections in aquatic organisms and humans worldwide. The pathogenicity of *A. dhakensis* is multifactorial, involving a large number of virulence factors such as hemolysins, aerolysin, proteases, cytotoxins, and secretion systems (mainly Type II and Type III) which help the bacteria invade the tissue and evade the immune system. In this research, we report the first-time isolation of *A. dhakensis* from diseased mangrove red snapper reared in cage systems of Kerala, India.

In the present study, we also report the first whole-genome sequencing and analysis of *A. dhakensis* KS130825 strain, thus 35 million reads (Q30 > 94%) were generated and the genome was assembled into 27 contigs (total length = 4,725,118 bp; N50 = 614,135 bp; GC = 61.75%). Genome annotation revealed 4,380 coding sequences and Resistome analysis revealed a multitude of resistance determinants, such as β -lactamases, the quinolone resistance protein QnrB, and genes for a multidrug efflux pump (*macA*, *macB*, *tolC*). Besides this, resistance-conferring genes via target modification (*gyrA*, *gyrB*, *rpoB*) and regulatory proteins (OxyR, H-NS) were also detected. The virulome contained 136 genes (VFDB) associated with hemolysins, secretion systems (Types II/III), biofilm formation, and adhesion. Subsystem analysis showed the main functions to be stress response, metabolism of aromatic compounds, and metal ion transport. Phylogenetic analysis (RAXML) aligned the isolate with clinical *A. dhakensis* strains, thereby suggesting zoonotic potential. Parallely, antibiogram profile has been completed and found the isolate was phenotypically susceptible to the antibiotics tested. The presence of such latent genetic determinants represents a potential risk for the rapid emergence of resistance when selective antibiotic pressure exists in the environment. Interestingly, WGS also has uncovered the convergence of virulence, environmental persistence, and genomic plasticity in addition to the presence of unexpressed but yet potentially activatable resistome. This discovery underscores the limitations of conventional susceptibility testing and highlights that genomic surveillance is crucial to locating the cryptic antimicrobial resistance determinants.

FIGURE 1. *Aeromonas dhakensis* genome distribution map



EFFECTS OF BIOFLOCS RESIDUE ON THE GROWTH, BODY COMPOSITION, DIGESTIBILITY AND SURVIVAL OF AFRICAN CATFISH *Clarias gariepinus* FINGERLINGS

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The stagnating capture fishery has shifted the heavy responsibility of increasing fish production to aquaculture industry, however, the cost of fish feed amounting to over 70% of the total cost of fish production in aquaculture system has remained a challenge. There is intense competition for energy source feedstuffs like maize and wheat hence the need for sourcing for non-competitive energy source. Aquaculture has grown rapidly lately due to new technology advancements in fish production among which is the biofloc technology (BFT). Bioflocs residue are a mix of detritus with associated bacteria, protozoa, algae, copepods, nematodes, rotifers, fecal pellets, remains of dead organisms, invertebrates and other macro aggregate of organic material and micro-organisms that are very rich in proteins which are the basic of the food chain in water. Fish can passively ingest and digest some of those bacteria and would graze on the substrates to supplement feeds. Importantly, grazing on the flocs by the fish during culture enables reuse of protein that would otherwise be lost as a waste product.

The study evaluated the effects of sun-dried bioflocs residue (BR) obtained from a *C. gariepinus* pond on the performance of *Clarias gariepinus*. *Clarias gariepinus* fingerlings (2.3 ± 0.12 g) were fed varying inclusion levels of biofloc residue (0%, 25%, 50%, 75% and 100%) as replacement for maize meal for 56 days. Five tanks ($36,000\text{cm}^3$) with 20 litres of fresh water were randomly stocked with 20 fish each in triplicates in a randomized block design. Growth and nutrient utilization parameters such as mean weight gain, specific growth rate, protein efficiency ratio, apparent net protein utilization, apparent digestibility coefficient.

Results in table 1 shows that the fish fed 25% BR had the highest mean weight (20.15%), specific growth rate (4.02%/day), protein efficiency ratio (2.44%), apparent net protein utilization (321.14%) lowest feed conversion ratio (1.01), high body crude protein (80.50%) while fish that were fed 100% bioflocs residue gave a significantly lower ($P < 0.05$) mean body weight (8.65%), SGR (2.50%), PER (1.24%), ANPU (182.43%) high FCR (1.90%) low body protein (66.50%). The results revealed that inclusion of bioflocs residue in the diets of *C. gariepinus* had significant effects ($P < 0.05$) on the body compositions. Fish fed diet with 75% BR had the highest crude protein of 80.50% while diet containing 50% BR gave the least CP (61.25%). It was discovered that all bioflocs residue-based diets fed to *C. gariepinus* fingerlings had high digestibility. Diet with 75% BR gave a significantly ($P < 0.05$) higher digestible protein and lipid values of 99.59% and 99.62% respectively while diet with 25% BR had the least protein digestibility (58.59%).

The results of the study showed that the use of bioflocs residue can replace maize meal up to 75% in the diet of *C. gaiepinus*.

CHEMICAL FRACTIONS OF HEAVY METALS IN SURFACE SEDIMENTS OF NETRAVATHI-GURUPUR ESTUARY AND THEIR ECOLOGICAL RISK IMPLICATIONS

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The Netravathi-Gurupur (N-G) estuary, a highly urbanized waterbody on India's southwestern coast, faces significant environmental pressure from diverse anthropogenic sources. The N-G estuary receives continuous inputs of industrial effluents from petroleum, fertilizer, metal, ceramic, and food processing plants, agricultural runoff, along with municipal and domestic sewage, leading to the accumulation of heavy metals in its sediments. This study presents a comprehensive assessment of heavy metal contamination (Cr, Mn, Co, Cu, Ni, Zn, Pb, Cd) in the surface sediments of the N-G estuary. The spatial distribution of heavy metals, quantification their chemical fractions and their bioavailability using the European Community Bureau of Reference sequential extraction method was assessed, and the contamination extent through multiple pollution indices were evaluated in this study. Results revealed that concentrations of Zn, Cu, Ni, Co, Cr, Cd, and Pb exceeded background levels. The residual fraction was dominant for most metals; however, cadmium (Cd) exhibited alarming bioavailability, with 45.34% found in the exchangeable fraction. Comparison with sediment quality guidelines showed that average concentrations of Zn, Cu, Ni, Cr, and Pb exceeded Threshold Effect Levels (TEL), while Cu, Ni, and Cr surpassed Probable Effect Levels (PEL), indicating potential harm to benthic organisms. Ecological risk indicators, including the Risk assessment code (fig. 1) and modified contamination indices, specifically highlighted the considerable ecological toxicity and risk posed by Cd due to its high labile fraction. The study identifies the Gurupur stretch as a critical pollution hotspot requiring immediate monitoring and intervention. These findings underscore the necessity of prioritizing bioavailable metal fractions, particularly Cd, in future environmental risk assessments to better reflect anthropogenic influences and develop effective conservation strategies for the protection of the N-G estuary.

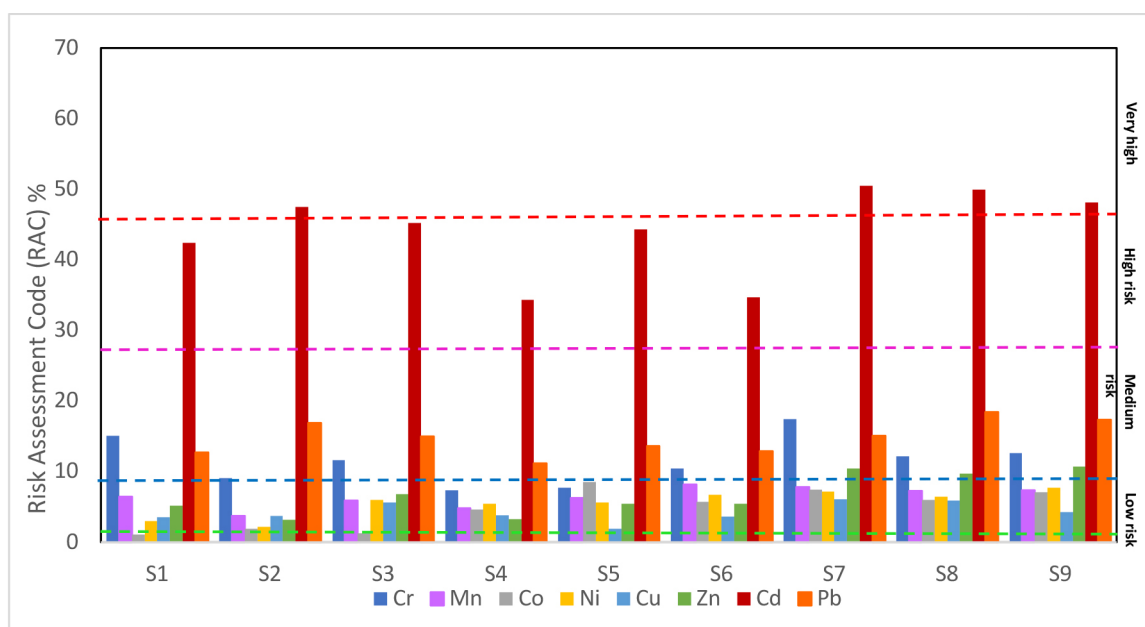


Fig. 1. Spatial distribution of Risk assessment code for metals in N-G estuary sediment

PHENOTYPIC CHARACTERIZATION OF F1 PROGENIES OF *clarias galmaensis* PRODUCED THROUGH HYBRIDIZATION AND GENOMIC DNA FROM *heterobranchus bidorsalis* USING SPERM MEDIATED GENE TRANSFER TECHNIQUE

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Studies on the phenotypic characterization of F1 progenies of *Clarias galmaensis* produced through hybridization and genomic DNA from *Heterobranchus bidorsalis* using sperm mediated gene transfer technique was carried out with the aim of determining the morphometric and meristic characters of the F1 progenies. Twenty one each of male and female *Clarias galmaensis* and three each of male and female *Heterobranchus bidorsalis* were used for the experiment. Female broodstock were induced with ovaprim and kept for latency period, after latency period, eggs from the females and testes from each male in each of the treatment were collected and weighed. Gonadosomatic index and fecundity rate were estimated. One gram (1g) of egg were collected from each fish and fertilized with 1ml of milt collected from the male broodstock. Treatment 1 to 5 involved introduction of genomic DNA of *Heterobranchus bidorsalis* to the milts at the concentrations of 0, 10, 20, 30 and 40µl before the fertilization while treatment 6 to 8 involved the use of hybridization between *Clarias galmaensis* and *Heterobranchus bidorsalis*. After fertilization, the eggs were incubated and reared for 30 days indoors. Thirty (30) fingerlings were collected in each treatment and reared for another 120 days outdoors for growth performance. After the growth performance, Three (3) samples were collected randomly for phenotypic examination. Data obtained from the phenotypic examination were subjected to analysis of Variance ANOVA. The results shows that the morphometric were mostly higher in treatment with crossing combination of ♀ Female *Clarias galmaensis* x ♂ Male *Clarias galmaensis* (♀Cg x ♂Cg) with 30µl of the genomic DNA. The meristic counts remain the same in all the crossing combination of ♀ Female *Clarias galmaensis* x ♂ Male *Clarias galmaensis* (♀Cg x ♂Cg) with 0, 10, 20, 30 and 40µl of the genomic DNA and also with hybridization combination of ♀ Female *Clarias galmaensis* x ♂ Male *Clarias galmaensis* (♀Cg x ♂Cg) with the absence of adipose tissue

“IMTA AS A PATHWAY FOR RESILIENT AQUACULTURE: BRIDGING GLOBAL INNOVATIONS AND INDIAN PRACTICES”

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Integrated Multi-Trophic Aquaculture (IMTA) is an emerging approach that promotes environmental sustainability, economic resilience, and social acceptability in aquaculture. By co-culturing species from different trophic levels—typically fed organisms such as Atlantic salmon (*Salmo salar*), extractive shellfish such as blue mussels (*Mytilus edulis*), and seaweeds—IMTA systems recycle waste nutrients into valuable biomass. Fed species release soluble inorganic nutrients (e.g., ammonia, phosphates) and organic particulates, which are subsequently utilized by seaweeds and filter-feeders, reducing eutrophication and improving water quality. This nutrient cycling not only provides environmental remediation but also enhances overall productivity and biodiversity.

Commercial-scale IMTA projects, notably in the Bay of Fundy (Canada), Norway, Scotland, and Ireland, have demonstrated the feasibility of combining salmon, mussels, and kelp in synergistic production systems. In India, initial efforts by ICAR-Central Institute of Brackishwater Aquaculture (CIBA) and ICAR-Central Marine Fisheries Research Institute (CMFRI) have explored IMTA models integrating shrimp, milkfish, pearl oysters, seaweeds (*Gracilaria*, *Kappaphycus*), and mussels in coastal waters of Tamil Nadu and Kerala. These systems highlight IMTA’s potential for nutrient recycling, livelihood diversification, and improved farm profitability under tropical conditions.

Economically, IMTA diversifies revenue streams and reduces market and environmental risks compared to monocultures. Socially, it enhances the public perception of aquaculture by addressing concerns about environmental impact. Scientifically, IMTA builds upon traditional polyculture practices but introduces modern principles of trophic integration, nutrient recovery efficiency, and ecosystem-based management.

In conclusion, IMTA represents a viable pathway for sustainable aquaculture development, balancing ecological health with commercial viability. Scaling up requires further optimization of species combinations, trophic ratios, and governance frameworks to ensure long-term sustainability.

TRACE METAL CONTAMINATIONS IN THE WATER, SEDIMENT, AND FISH OF SEWAGE-FED EAST KOLKATA WETLANDS

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East Kolkata Wetlands (EKW), a Ramsar site, receives ~900 MLD of urban sewage and is sustaining the aquaculture practices in the wetlands which are locally known as *bheries*. In the present study, assessed the contamination status of trace metals (Cd, Co, Cr, Cu, Ni, Pb, Zn) in different fish tissues, and also in the abiotic component (water and sediment) from 30 wetlands. The wetlands differ in the rate of intake of sewage. One group receives sewage once in every 7 days, the second group receives once in every month while the third group receives sewage very irregularly and termed as partially sewage fed.

Ten wetlands were selected from each group. The tissues (gill, liver, and muscle) of 5 fish species (a total of 30 samples from each fish species) including the 3 Indian Major Carps: rohu (*Labeo rohita*), catla (*Labeo catla*), mrigal (*Cirrhinus mrigala*), Minor Carp: bata (*Labeo bata*), and tilapia (*Oreochromis niloticus*) were assessed. All the studied trace metals were recorded at concentrations much below their respective permissible limits set for fish muscle consumption, with the exception of occasional higher Cd levels in mrigal (0.32 µg/g). The findings suggest that, overall, the muscle tissues of the studied fishes are safe for human consumption. The water samples from inlet, mid-pond, and outlet zones of all the 30 representative wetlands were analysed. Results indicated that the concentrations of all the studied trace metals were within the permissible thresholds. Notably, Pb exceeded the permissible limit with detected level of 0.03 mg/L particularly in sewage intake zones, while at the mid-pond and outlet regions the concentrations were significantly low. The findings suggest that the water quality across most wetlands was within safe limits for aquaculture.

The sediment analysis of weekly sewage-fed wetlands revealed significantly high trace metal pollution across all sites with respect to the UPSEA threshold limits. The spatial pattern indicated dominance of Cd in the inlet area, while Pb, Zn progressively towards the outlet sediments. The monthly sewage-fed wetlands also revealed significantly high trace metal pollution by Cr and Ni; while Zn and Pb showed moderate to heavy enrichment, particularly at outlet sites. The partially sewage-fed wetlands revealed that most of the trace metals (Cd, Co, Pb, Zn) were within the safe limits, while only Cr and Ni at inlet sites indicated moderate enrichment, likely linked to occasional sewage inflows. Spatially, concentrations decreased from inlet to outlet. Overall, the study highlights that sewage loading intensity strongly governed sediment trace metal accumulation. Weekly sewage fed wetlands are under ecological stress, monthly sewage fed systems are at moderate risk, whereas partially sewage-fed wetlands remains comparatively safe. These findings underscore the need for routine monitoring for management and production sustainability.

TEMPERATURE INFLUENCES THERMAL TOLERANCE AND METABOLIC SCOPE IN POSTLARVAE AND JUVENILES OF *Macrobrachium rosenbergii*

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Environmental temperature is one of the most significant factors for aquatic ectotherms because it affects their physiological and metabolic processes, as well as their growth, reproduction, survival and distribution patterns. Therefore, the aim of this study was to determine the effects of different acclimation temperatures (AT: 20, 23, 26, 29 and 32°C $\pm$ 1°C) on the thermotolerance, thermal window and thermal metabolic scope of postlarvae (PL) and juveniles (J) of *Macrobrachium rosenbergii*. A total of 250 PL (0.023 ± 0.008 g) of *M. rosenbergii* were acclimated for a week at five temperatures (50 PL per AT). Subsequently, for each acclimation temperature, the endpoint of maximum (CTmax) and minimum critical temperatures (CTmin) was determined using the dynamic method. Using the CTmax and CTmin values, the thermal window area was calculated, and the optimal temperature was determined through the thermal metabolic scope. At the end of the previous experiments, the PL were kept for one month at 26°C until they reached the juvenile stage (0.255 ± 0.151 g) and then they were acclimated for 21 days at five temperatures (40 J per AT) and the experimental stages were carried out.

Thermal tolerance of postlarvae and juveniles was significantly affected by acclimation temperatures. The postlarvae were slightly more thermotolerant (CTmax: 35.9-41.1°C, CTmin: 13.1-17.9°C) than the juveniles (CTmax: 35.4-41.2°C, CTmin: 15.5-18.3°C) in the acclimation temperature range of 20-32°C. The thermal window of the postlarvae was slightly wider (209°C²) than that of the juveniles (180°C²). The postlarvae and juveniles acclimated to 26 and 29°C achieved higher aerobic performance, respectively. Therefore, these were the optimal temperatures to optimize and maximize culture at both stages. Under a climate change scenario, the cultivation of postlarvae and juveniles of *M. rosenbergii* could likely be negatively affected.

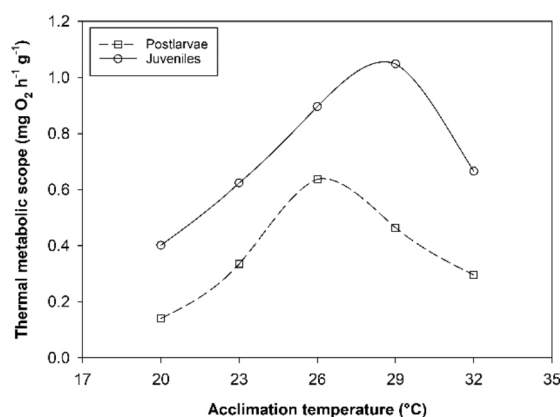


Fig. 1. Optimal temperatures of PL and J of *M. rosenbergii*.

CLIMATE CHANGE FROM AN ECOPHYSIOLOGICAL APPROACH: IMPLICATIONS FOR THE POTENTIAL DISTRIBUTION OF SERPULID POLYCHAETES

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Temperature is the main environmental factor moderating different physiological processes of marine ectotherms, as well as their distribution, survival, growth and reproduction. Climate change generated by high atmospheric CO₂ emissions is causing increases in ocean temperatures. Using integrative approaches to ecophysiological information, complemented by satellite temperature data, could help to more accurately determine the effects of ocean warming. Therefore, the aim of this study was to determine the effect of ocean warming on the distribution of two species of tubeworms from the temperate northern Pacific (*Spirobranchus spinosus*) and tropical eastern Pacific (*S. cf. corniculatus*). Adult worms of both species were collected and acclimated for 30 days at different temperatures to determine thermal tolerance, thermal window, optimal temperature, and thermal safety margins. All this information was complemented with satellite temperature data, which allowed the generation of potential distribution models for a present (2010-2020) and future (2090-2100) scenario of high CO₂ concentrations (SSP5-8.5).

The thermal tolerance of both species was significantly affected by acclimation temperatures (*S. spinosus*: CTmax: 13.7-22.7°C, CTmin: 8.3-15.6°C; *S. cf. corniculatus*: CTmax: 31.3-35.1°C, CTmin: 17.9-27.8°C) and had narrow thermal windows (*S. spinosus*: 37°C²; *S. cf. corniculatus*: 71°C²), characteristic of stenothermic species. The optimal temperatures for *S. spinosus* and *S. cf. corniculatus* were 14 and 30°C, respectively. By the end of this century, thermal safety margins will likely decrease, which will generate retractions and expansions in the distribution of both species. Therefore, it is important that countries worldwide join efforts to reduce CO₂ emissions and declare protected areas for the care and conservation of marine species.

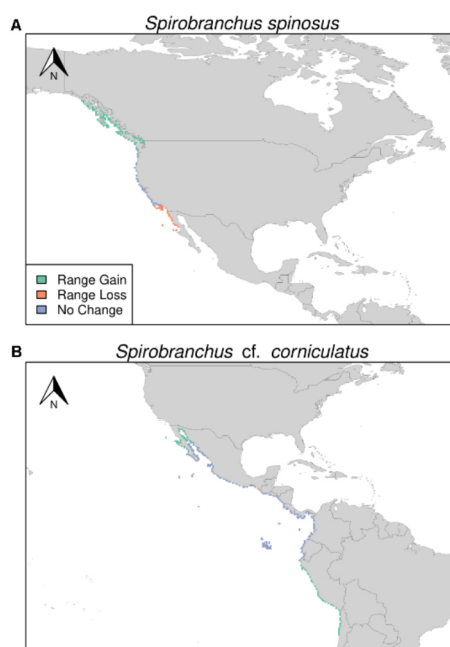


Fig. 1. Potential distribution of two species of marine tubeworms.

GEOSPATIAL TECHNIQUES FOR DELINEATING SEAWEED FARMING POTENTIAL: A REMOTE SENSING AND GIS APPROACH IN THE INDIAN EEZ.

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Mariculture envisions the potential and sustainable use of marine resources to enhance livelihoods and support marine ecosystem conservation and restoration. Seaweeds, also known as marine macro algae, are considered as the ocean’s nutritional powerhouse and are vital for sustainable development. They function as a carbon sink in along with sustaining other marine habitats, which include marine plants and animals. There are plenty of seaweed natural hotspots in India. Seaweed culture is additionally supported throughout India’s coast in recognition of its commercial, cultural, & economic value. Due to the rising demand, there is an immense requirement for conserving the natural seaweed bed and cultivation techniques should be harmonized accordingly. Mapping the suitability of seaweed sites using satellite remote sensing enabled by a GIS (Geographic Information System) is one such endeavour. This study identified potential seaweed cultivation zones along the Indian coast by remotely sensing environmental parameters like Sea Surface Temperature (SST), Sea Surface Salinity (SSS), Dissolved Oxygen, Water clarity, pH, Chlorophyll (Chl), Nutrients (Phosphate & Nitrate), Wind, Wave, Depth, etc. A weighted overlay analysis was done to classify regions as Highly, Moderately, or Not Suitable based on the optimal range of these environmental parameters required for the seaweed growth using the GIS Software. The present study resulted the mapping of Suitable Seaweed growing areas along the coasts within the Indian EEZ on March 2022, March 2023 and May 2023. GIS study versus validation with literature survey found High and Moderate zones from Gujarat (2), Maharashtra (4), Karnataka (3), Kerala (2), Tamil Nadu South (6), Tamil Nadu North (3), Andhra Pradesh South (4) and Andhra Pradesh North (2) respectively. Therefore, this research promotes evidence-based planning and sustained marine resource utilization by showcasing the prospect of integrating remote sensing and GIS techniques to locate economically and ecologically feasible seaweed cultivable locations in the Indian EEZ.

AIRLIFT BIOFLOC AQUACULTURE SYSTEM: INNOVATIVE APPROACH TO PREVENT SLUDGE FORMATION IN BIOFLOC TECHNOLOGY

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Biofloc technology (BFT) has gained popularity in aquaculture, but one of its major challenges is the accumulation of sludge at the bottom of tanks due to the settling of floc, uneaten feed, and fecal matter, which can create anaerobic conditions. This study aimed to evaluate the effectiveness of Airlift Biofloc Aquaculture System in preventing sludge formation compared to the conventional biofloc system. A completely randomized design was used for the experiment, with three groups: a control (six diffusion air stones), treatment 1 (T1, six airlift pumps), and treatment 2 (T2, two diffusion air stones and four airlift pumps), each with three replicates. The results showed that both T1 and T2 improved water quality and growth parameters compared to the control. The airlift biofloc system successfully reduced sludge formation. Total biomass production was highest in T1 (10.5 kg m⁻³), followed by T2 (9.7 kg m⁻³), and the control (8.3 kg m⁻³). The feed conversion ratio was lower in T1 (0.85) and T2 (0.899) compared to the control (1.07). The specific growth rate was also higher in T1 (2.73% day⁻¹), followed by T2 (2.65% day⁻¹) and control (2.5% day⁻¹). Percentage weight gain was better in T1 (1076%) and T2 (971%) than in the control (845%). Hematological analyses indicated better fish health in the airlift biofloc systems (T1 and T2) compared to the control. Additionally, antioxidant enzyme levels of SOD and Catalase were lower in T1 and T2 than in the control. This study highlights the benefits of the Airlift Biofloc Aquaculture System, showing enhanced growth performance, reduced sludge accumulation, and improved fish health compared to the conventional diffusion-based biofloc system. These findings provide valuable insights for optimizing biofloc aquaculture practices leading to commercialization of the technology.

RAISING POST-LARVAE STANDARDS FOR INDIA'S SHRIMP REVOLUTION

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The success of shrimp farming begins with the quality of post-larvae (PL), which determines growth, survival, and disease resistance throughout the culture cycle. Despite rapid advances in feed, pond design, and biosecurity, variable PL quality continues to limit production performance in many parts of the industry. Hatcheries often depend on visual grading or limited health checks, resulting in seed with inconsistent genetic strength or undetected pathogens. The root cause often lies in hidden threats from both vertical and horizontal transmissions of pathogens. Many post-larvae that appear healthy at stocking may carry subclinical infections such as *Enterocytozoon hepatopenaei* (EHP), White Spot Syndrome Virus (WSSV), or *Vibrio*-related pathogens, which later emerge under environmental stress, resulting in growth retardation, white faeces syndrome, or even mass mortality. These hidden infections compromise farm biosecurity and lead to unpredictable production outcomes. To overcome this, there is an urgent need to establish clear and measurable standards for PL health status supported by precise and reliable diagnostic tools. Molecular method such as PCR is a powerful tool for pathogen detection; however, conventional PCR typically allows testing of only one disease at a time. In practice, many hatcheries conduct only partial screening due to time and cost limitations, leaving room for undetected infections. The introduction of digital PCR represents a major advancement in diagnostic capability. Its multiplex approach enables simultaneous detection of multiple pathogens from a single sample, with higher sensitivity, reproducibility, and quantitative accuracy. This not only increases diagnostic efficiency but also provides hatcheries with a comprehensive health profile of each PL batch. Alongside advanced diagnostics, hatcheries must strengthen broodstock selection, maintain SPF-certified lines, and apply strict biosecurity and microbial management to minimise pathogen exposure. Raising PL standards through diagnostic innovation, improved management, and accountability between hatchery and farm will reduce disease risks, enhance consistency, and reinforce the sustainability of the shrimp industry.

FIRST REPORT OF *Lactococcus petauri* INFECTION IN FARMED RAINBOW TROUT *Oncorhynchus mykiss* OF INDIA: A COMPREHENSIVE PHENOTYPIC AND GENOMIC CHARACTERIZATION

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This study reports for the first time in India, recovery of *L. petauri* from clinical samples of farmed rainbow trout (*Oncorhynchus mykiss*). The clinical sign of the disease was hemorrhage in eye, fin erosion and melanosis. The isolate was characterized by biochemical tests, PCR and whole-genome sequencing (WGS). Biochemical test and WGS confirmed the identity of bacterium as *L. petauri* isolate PA1. The genome of *L. petauri* PA1 (GenBank accession number: JBMKJY000000000) comprises 2,708,129 bp with a GC content of 37.6%, encoding 3,489 genes, including 1,638 core, 859 shell, 934 cloud, and 58 RNA genes (49 tRNAs, 3 ncRNAs, and 6 rRNAs). Average Nucleotide Identity (ANI) of *L. petauri* PA1 showed 97.39 - 98.55% sequence similarity with other *L. petauri*. WGS of this bacterium identified 139 virulence and 162 antimicrobial resistance (AMR) genes. The *L. petauri* PA1 was positive for PCR amplification (465 bp) of the Lichenan permease IIC component gene, a molecular marker of *L. petauri*. *In vitro* virulence assay of extracellular protease (ECPs) of *L. petauri* PA1 in epithelioma papulosum cyprini (EPC) cells shows cytotoxicity and cell death within 60 h of exposure. *In vivo* virulence test of bacterium via intraperitoneal injection (2.9×10^6 CFU per fish) in rainbow trout (average body weight: 20.5 ± 4.37 g) reproduced clinical signs of lactococcosis, with histopathology confirming multi-organ damage. The LD₅₀ value of *L. petauri* PA1 in rainbow trout was 3.2×10^6 CFU per fish. Antimicrobial susceptibility test (AST) shows that the isolate is sensitive to majority of the antibiotics. Our findings establish *L. petauri* as a virulent pathogen in aquaculture, emphasizing the need for proactive surveillance and disease management strategies.

NUTRITIONAL EFFICACY OF INSECT HYDROLYSATE-BASED DIETS IN PROMOTING GROWTH AND GUT FUNCTION OF *Penaeus vannamei* POST-LARVAE

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The high lipid content of full-fat or partially defatted black soldier fly larvae (BSFL) meal limit its digestibility and nutrient utilization in the early life stages of shrimps. However, the hydrolyzed form of BSFL provides readily available nutrients and bioactive peptides that can promote growth and well-being. Hence, beyond serving as a fishmeal replacer, the present study attempted to understand the potential of enzyme hydrolysed BSFL meal as a functional ingredient supporting gut integrity and physiological performance.

Thirteen optimization trials were carried out to establish an efficient hydrolysate preparation protocol. A two-step enzymatic hydrolysis using 2% papain and 2% lipase for two hours resulted in 88.67% dry matter recovery, 64.57% protein content, and 5.35% chitin, indicating a high-quality protein hydrolysate suitable for feed application. Five isonitrogenous (36% crude protein) and isolipidic (9% crude lipid) diets were formulated by incorporating graded levels of BSFL hydrolysate (0%, 4.06%, 8.12%, 12.18%, and 16.24%), replacing fishmeal at 25%, 50%, 75%, and 100% levels for a 60-day feeding trial.

Results revealed that shrimp fed the diet containing 8.12% BSFL hydrolysate (T2) achieved significantly higher ($p < 0.05$) final weight, weight gain, daily weight gain, and specific growth rate, along with the lowest feed conversion ratio. Elevated protease and lipase activities and higher gut microbial diversity, indicated superior nutrient utilization in T2. Antioxidant enzyme activities (SOD, catalase) and survival did not differ significantly among treatments. Immune gene expression showed upregulation of *penaeidin*, *lysozyme*, and *HSPs* in the hydrolysate-fed groups, reflecting improved immune responsiveness and cellular protection. Histological examination confirmed intact hepatopancreatic structures in all treatments. Overall, dietary inclusion of 8.12% BSFL hydrolysate significantly enhanced growth and immunity in *vannamei*.

Table 1: Properties of BSFL hydrolysate

Crude protein (%)	61.01±0.16
Crude lipid (%)	9.86±0.02
Degree of hydrolysis (%)	9.06±0.03
Peptide length (no. of amino acids)	10.4±0.04

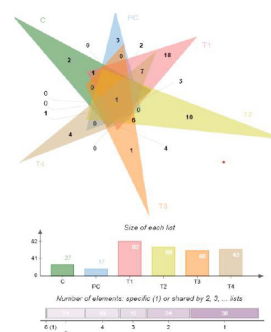


Fig1. Microbial diversity in shrimp gut

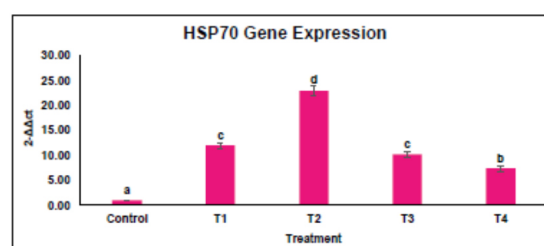


Fig 2. HSP 70 mRNA expression in hepatopancreas

THE STUDY OF IMPACT OF *Spirodela polyrhiza* BASED DIETS ON THE PREFORMANCE OF ROHU *Labeo rohita* FRY CULTURED IN AQUAPONICS SYSTEMS

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Aquaponics the bio-integration of aquaculture and hydroponics is a sustainable production system. Indian major carp rohu *Labeo rohita* fry (3.68 ± 0.001 g) were cultured in three different sets of Aquaponics Systems kept inside the Aquahouse. Each Aquaponics System was consisted of three tanks (3000 L each) for the culture of fish. The water spinach *Ipomea aquatica* were grown in the Aquaponics Systems. The stocking density of fish was 300/ tank. Twin-screw Extruder made pelleted diets SP-0, SP-30 and SP-40 were formulated with inclusion of greater duckweed *Spirodela polyrhiza* at three different levels of 0, 30 and 40% using the Interactive Fish Feed Designer, IFFD software. There was no significant ($P > 0.05$) difference in the protein, lipid and moisture contents of SP-0, SP-30 and SP-40 diets. The ash content and calorific value were significantly ($P < 0.05$) higher in SP-40 and SP-0 diets, respectively compared to other diets. The inclusion of duckweed *S. polyrhiza* influenced the fatty acid composition of diets. Rohu were fed with one of the three diets for 90 days.

The final average weight and specific growth rate (SGR) were significantly ($P < 0.05$) higher in SP-30 diet fed rohu compared to other two diets fed fish. The protein, lipid and ash contents were significantly ($P < 0.05$) higher in SP-30 diet fed rohu compared to others. The calorific value was significantly ($P < 0.05$) higher in SP-40 diet fed rohu fed compared to others. Feeding of rohu with greater duckweed supplemented diets influenced the fatty acid composition of fish. Total saturated (SFAs), monounsaturated (MUFAs), n-6 and n-3 polyunsaturated (n-6 PUFAs, n-3 PUFAs) fatty acids contents were significantly ($P < 0.05$) higher in SP-30 diet fed rohu compared to the fish cultured in other two feeding regimes. The palmitic, oleic and linoleic acids were the dominant fatty acids regardless of treatments. The α -linolenic acid, eicosapentaenoic acid, docosapentaenoic acid and docosahexaenoic acid contents were significantly ($P < 0.05$) higher in SP-30 diet fed fish compared to others. The amylase, total protease, trypsin, chymotrypsin and lipase activities were significantly ($P < 0.05$) higher in SP-30 diet fed fish compared to other treatments. Water temperature, pH, dissolved oxygen, ammonia, nitrite and nitrate were monitored regularly from the culture units. The Aquaponics systems helped in the maintenance of optimum water quality in the fish culture systems and *I. aquatica* (500 g/system/10 days) were harvested regularly from each system.

PHOSPHORUS MANAGEMENT IN YELLOWTAIL KINGFISH (*Seriola lalandi*) FARMING: EFFECTS OF DIETARY FISHMEAL AND PHOSPHORUS LEVELS ON RETENTION, DISCHARGE, AND FISH PERFORMANCE

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Yellowtail kingfish farming is growing in Europe with high emphasis on recirculating aquaculture systems (RAS), while in Australia, Japan and Latin America the industry continues to expand predominantly through sea-cage farming. It is a carnivorous species that requires high dietary protein, and to date, fishmeal (FM) -rich feeds are common to support its rapid growth. However, this brings the challenge of high phosphorus (P) content on these diets which could be poorly retained given a more complex matrix bone-bound P, resulting in significant P excretion and discharge. The latter continues to be of environmental concern and stricter regulations governing P release to the environment are arising across the globe regardless of culture systems. For instance, Australia is introducing discharge regulations to sea-cage systems to protect the Great Barrier Reef. Similarly, for European RAS yellowtail producers, addressing phosphorus management is now central for achieving both compliance with strict nutrient limits and broader sustainability goals. With this in mind, this study aimed to aid on the management of P in *Seriola* rearing facilities by investigating the effects of fishmeal inclusion and dietary P levels on performance, phosphorus retention, and effluent discharge.

A seven-week feeding trial was conducted with Yellowtail kingfish (initial weight 65 ± 1.5 g, final weight 340 ± 15.5 g) maintained at a constant temperature of 23 ± 0.2 °C at the BioMar Aquaculture Technology Centre, Hirtshals, Denmark. Four experimental diets were formulated and manufactured to provide two fishmeal (30 and 47%) and two total P levels (16 and 19 g/kg) on a factorial design basis. Results showed that lowering total dietary P significantly improved its retention, while decreasing excretion of ortho-phosphate and total phosphorus rejection by 23 and 19%, respectively. Importantly, fish performance was not affected with lower P in the diet. Similarly, reducing fishmeal also had an effect in the excretion of ortho-phosphate decreasing its discharge by 5.2%; however, no effects were found in total phosphate rejection. Moreover, no interaction was found between the two tested factors. This indicates that to help to mitigate the environmental impact while maintaining fish performance, it is fundamental not only the optimization of total dietary P, but also its bioavailability through the selection of proper sources.

ASSESSING ODOUR PERCEPTIONS IN FISH MARKETS THROUGH ENVIRONMENTAL PERCEPTION AND HEALTH BELIEF MODELS

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Urban fish markets and landing centres, particularly in cities like Mumbai, handle large volumes of fish and shrimp, resulting in significant challenges related to waste management and persistent odour issues. These odour problems frequently lead to complaints from local residents and citizens' associations, highlighting the need for effective interventions. In response to the on-going concerns especially at fish landing centres and fish markets like high Sassoon Docks a study was undertaken as part of the ICAR-funded research project titled Swachhta Action Plan and Commercial Utilization of Fish Waste From Urban Fish Markets. The primary objective of the study was to assess stakeholder perceptions of odour in fish markets. Sassoon Dock in Mumbai was selected as the focal site due to the high frequency of odour-related complaints and the efforts by local authorities to identify viable solutions. Through interviews, information was collected from vendors, consumers, nearby residents, and waste handlers. Environmental Perception Model and Health Belief Model were used for the study and the constructs used were sensory perception, behavioural response, environmental impact, perceived susceptibility, severity, barriers, cues to action, and self-efficacy enabling to capture sensory perception (odour intensity), emotional response (comfort, disgust), and behavioural outcomes (avoidance, time spent, coping). Each construct had statements which were rated on five-point Likert scale. Data were analysed using normalization and non-parametric statistical tests such as Kruskal-Wallis and Mann-Whitney to assess significant inter-group differences. Results indicated that while market workers displayed habituation to odour, residents and consumers showed high sensitivity, particularly in relation to perceived health threats and environmental nuisance. There were statistically significant differences observed across multiple perception dimensions. To address the issue of odour, efforts were made to develop odour adsorbent material. Different materials were tested and air quality was measured using air quality monitor capable of detecting gases commonly emitted from fish decomposition, like ammonia, hydrogen sulphide, sulfur dioxide, total volatile organic compounds and nitrogen dioxide. The study underscores the need of addressing issues of odour in fish markets and landing centres through stakeholder-centred, science-based interventions. The comprehensive approach adopted from perception mapping to lab-based testing offers a model for future interventions.

TRANSCRIPTOMICS ANALYSIS OF IMMUNE RESPONSE OF FRESHWATER FARMED ASIAN SEABASS, *Lates calcarifer* AGAINST *Pseudomonas putida* INFECTION

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The Asian seabass (*Lates calcarifer*) is a commercially valuable species in freshwater aquaculture, renowned for its rapid growth and high market demand. However, bacterial infections represent a significant challenge to its health and production. While bacterial diseases in Asian seabass are common, infection caused by has not been previously reported in this species. This study aimed to explore the host immune response of freshwater-farmed Asian seabass to *P. putida* infection at the transcriptomic level. Fish were experimentally challenged with a lethal dose of *P. putida*. A high-throughput RNA sequencing (RNA-Seq) on the Illumina MiSeq platform was employed to understand changes in the head kidney transcriptomics. Comparative analysis between the infected and control groups identified 944 differentially expressed genes (DEGs) ($p < 0.05$), comprising 679 upregulated and 265 downregulated genes. Functional annotation of these DEGs revealed biological processes, including immune responses, cellular processes, and stress-related pathways. This study provides the first transcriptomic analysis of the immune response of freshwater farmed Asian seabass to *P. putida*, offering novel insights into the molecular mechanisms of host defense. The findings also suggest that specific immune-related genes could serve as potential biomarkers for early disease detection and can help in the development of targeted disease management strategies in aquaculture.

TILAPIA VALUE CHAIN DEVELOPMENT: UNLOCKING ECONOMIC AND EMPLOYMENT POTENTIAL IN NEPAL'S AQUACULTURE

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Aquaculture in Nepal began as early as 1960s but it is still limited to the pond culture of Chinese and Indian Major carps especially in southern plains, and is characterized by low-input, low-output production systems. Aquaculture interventions in Nepal initially focused on large-scale farmers; however, the successful introduction of small-scale aquaculture in Chitwan and Nawalparasi districts in the early 2000s led to its expansion into the mid-hills and beyond. Fish production, including catch, has reached about 122,000 t per year, with 80% produced through aquaculture, using about 50,000 ponds that cover an estimated 15,000 ha - less than 1% of the arable land. About 0.5 million people belonging to 145,000 families are engaged in aquaculture and fisheries related activities which is only about 1.7% of the total population of about 30 million. Migration of youth is a critical problem as about 2,000 people leave abroad daily to work. Aquaculture could be a competitive business that could attract more people due to its potential for profit. Demand for fish is high and about over 10,000 tons of fish is imported annually which costs over 3 billion Nepali rupee each year (over US\$20 million). There is still a huge gap between the annual per capita consumption of fish in Nepal (4 kg) and the global average (20.5 kg).

To promote sustainable, commercial aquaculture and shift from traditional carp-based systems to more productive, commercially viable species with business potential, a state-of-the-art tilapia hatchery has been established at the Center for Aquaculture-Agriculture Research and Production (CAARP) in Chitwan, Nepal, with plans for its expansion. It serves as a good model for the development of diversified aquaculture and agriculture enterprises. CAARP strives to develop human resource by disseminating knowledge and developing technical skills required for aquaculture enterprises. At CAARP, high quality monosex tilapia fingerlings are produced. CAARP produced about 0.1 million monosex fry in 2024. Considering the rapidly increasing demand for high-quality monosex tilapia fingerlings in Nepal, CAARP plans to upgrade existing hatchery as the Tilapia Broodstock Center (TBC) and establish other franchise hatcheries. Similarly, it plans to expand tilapia farming by establishing several tilapia farming clusters nearby the hatcheries as a model for others to adopt. Aggressive promotion and dissemination of outcomes, lessons learned and findings are under plan.

CAARP is committed to promoting tilapia farming in Nepal, aiming to accelerate the sector's commercialization. Advanced technologies are necessary to enhance aquaculture production and productivity. Availability of high-quality seed and the hatchery or seed production is the main foundation for any type of aquaculture development. CAARP focuses primarily on tilapia, a promising fish species with the potential to combat poverty, malnutrition, and improve income. However, there are misconceptions about tilapia in Nepal and South Asia which need to be addressed through the introduction of the latest technologies and demonstrations that showcase its potential across the value chain. As a new species with commercial scope for domestic as well as export market, tilapia needs specialized technologies so that farmers can grow profitably and sustainably. On-farm testing and validation of tilapia farming technologies are needed in demonstration farms so that farmers could adopt easily. CAARP plans to establish specialized clusters or pockets for tilapia farming identifying potential areas. Drawing on proven models from elsewhere (Pant et. al., 2024), CAARP plans to establish more hatcheries, nurseries, local service providers (LSPs), markets (live, fresh, and frozen) and processors and cold storage to create and strengthen the entire value chain. CAARP aims to foster strong partnerships for research, training, outreach, and investment, and to establish itself as a center of excellence for tilapia aquaculture research and development in Nepal.

RETHINKING THE FOUNDATIONS OF SHRIMP FARMING: A CALL FOR CHANGE IN UNDERSTANDING AND PRACTICE

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Shrimp farming has entered a new era where productivity alone can no longer define success. Decades of expansion and intensification have revealed fundamental weaknesses in how farms are designed, managed, and evaluated. The industry's conventional focus on inputs such as feed, seed, and water exchange has often overshadowed the more critical elements of system balance, microbial ecology, and long-term pond health. As a result, disease outbreaks, unstable water quality, and inconsistent crop performance continue to limit sustainability regardless of technological progress. This paper calls for a shift in mindset from reactive correction to proactive understanding. Shrimp ponds should be viewed not as simple rearing enclosures but as living ecosystems where biological, chemical, and physical processes interact dynamically. The next evolution of farming must therefore emphasize ecosystem management rather than individual component control. Integrating modern diagnostic tools, microbial management, and precise monitoring of both water parameters and shrimp health is essential to close the knowledge gap between observation and action. Regular disease diagnostics can guide more informed decisions on feeding, aeration, and water adjustments, reducing dependency on emergency interventions. Equally important is the foundation on which every production cycle begins: hatchery quality, biosecurity, and trained manpower. Consistent seed health, pathogen screening, and a skilled technical workforce form the pillars of a truly sustainable production model capable of adapting to environmental and market pressures. The next generation of shrimp farming must evolve from imitation to innovation, where success depends not on how hard we work, but on how wisely we farm. By rethinking the very foundations of practice, the industry can move toward a more resilient, knowledge-driven, and sustainable future.

ROLE OF ARTIFICIAL INTELLIGENCE IN FISH HEALTH MANAGEMENT: A REVIEW

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Aquaculture is one of the fastest growing food producing sectors worldwide, contributing significantly to food security, nutrition, and the global economy. But disease outbreaks remain a serious problem, threatening sustainability and causing huge financial losses. Recent advancements in artificial intelligence (AI) provide new opportunities for early diagnosis, disease prediction, behavioral monitoring and decision support systems to improve fish health. This review examines the application of AI in fish health management, with an emphasis on machine learning, computer vision, sensor based systems and predictive modeling. The study also highlights current applications, limitations, and future prospects of AI in sustainable aquaculture practices.

THE DUAL EDGE OF NON-NATIVE FISH: OPPORTUNITIES AND ECOLOGICAL RISKS IN INDIAN AQUACULTURE & FISHERIES

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The rapid expansion of aquaculture in India has been largely driven by the introduction of non-native fish (NNF) species, such as tilapia, pangasius *Pangasianodon hypophthalmus*, vannamei *Litopenaeus vannamei*, tilapia *Oreochromis niloticus*, pacu *Piaractus brachipomus* and trout *Oncorhynchus mykiss*. These species are deemed to significantly boost food security, economy, and rural employment by enhancing food production and opening up export markets. Their adaptability and high productivity make them attractive for commercial aquaculture, contributing to economic upliftment across Asian countries. However, the growing reliance on NNFs presents serious challenges to biodiversity conservation and ecosystem functioning. The introduction of over 600 non-native freshwater fish species in aquaculture and aquarium trade, with 16 identified as invasive, has raised concerns about their ecological impact. These invasive species can disrupt native aquatic ecosystems through competition for resources, and the spread of diseases, often leading to the decline of native species with limited distribution ranges. Based on the field studies, interactions between native and non-native species have been understood to have cascading effects, mostly negative, on the entire community and threatening the conservation of native species, and leading to loss for commercial fishers when the native fish are of economic interest. Biological invasions, often driven by human activities and environment, have been severely impacting native species and ecosystem services. In India, numerous non-native species, introduced for aquaculture and the aquarium trade, pose risks through accidental or intentional releases into the wild leading to changes in the fishery dynamics particularly the catch of native species. Current regulatory frameworks in India are inadequate for managing these risks, as they often fail to balance the needs of aquaculture development with environmental protection (Figure 1).

This study highlights the need for a holistic approach, including quantitative risk assessments, to understand invasion pathways, the life history of non-native species, and their ecological impacts on inland fisheries. To address these challenges, this paper suggests strategic management action with new biosecurity protocols to minimise the adverse ecological impacts of potential non-native species on inland fisheries, while supporting sustainable aquaculture practices in India.

TEMPORAL VARIATION IN MICROBIAL COMMUNITY STRUCTURE IN SWEDISH RAS AND FLOW-THROUGH AQUACULTURE

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Swedish aquaculture is a growing industry that faces significant environmental and fish health challenges. Climate change and seasonal variations exacerbate these problems by promoting harmful bacteria in warmer waters and altering biofilm composition, increasing the risk of disease and fish mortality. Understanding the role of microbes and water quality in fish farms is crucial. The study was conducted to monitor the changes in microbial composition over the time in different fish culture systems. The microbial and water samples were collected from three farms situated in different parts of Sweden operating on recirculatory aquaculture (RAS) and flow through (FT) systems. Biofilms were collected from the inlet and fish tank once a week. The results shows that the overall abundance of microbiome is different for all the three fish farms. The RAS system was dominated by genus *Cypionkella*, *Rhodoferrax*, *Flavobacterium*, *Pseudomonas* whereas FT were dominated by *Cypionkella*, *Flavobacterium*, *Fuscovulum*. The clustering pattern of microbial communities shows that there were differences in composition for the inlet and fish tanks for respective farms. Previous studies suggests that *Pseudomonas* and *Flavobacterium* are more linked to stress related fish diseases and other genera like *Rhodoferrax* has diverse metabolic functions and can play role in aquatic environment where fish are cultured, and therefore, may influence fish health. Thus, by unravelling complex relationships, the study can provide insights to lower the negative impacts of climate change and seasonal variations on fish health and productivity. This will help to safeguard both the environment and the global food supply.

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AUGMENTATION OF NON-SPECIFIC IMMUNITY IN WALKING CATFISH *Clarias batrachus* (LINNAEUS 1758), BY DIETARY SUPPLEMENTATION OF LEAVES AND SEEDS OF *Achyranthes aspera*

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The walking catfish (*Clarias batrachus*) is well-suited for culture in warm climates and serves as an affordable food source in local markets. However, intensive aquaculture practices often face disease outbreaks, leading to substantial economic losses. While antibiotics, vaccines, and synthetic immunostimulants are commonly used for disease control, their application may pose risks to consumers and the environment. As an alternative, the medicinal plant *Achyranthes aspera*, widely found as a weed in India, offers an eco-friendly, sustainable, and cost-effective means of enhancing fish immunity. This study evaluated the effects of *A. aspera* leaf- and seed-supplemented diets on the growth and health performance of *Clarias batrachus* reared under pond conditions and experimentally challenged with *Aeromonas hydrophila*.

An 85-day feeding trial was conducted in hapas (2.0 m × 1.5 m × 1.5 m) placed within a pond at the ICAR–Central Institute of Fisheries Education, Rohtak Centre, Haryana, India. Juvenile fish (0.51 ± 0.032 g) were fed three experimental diets: 0.5% *A. aspera* seeds (D1), 0.5% *A. aspera* leaves (D2), and a control diet without plant ingredients (D3). Following the feeding trial, all fish (except the sham control group) were challenged intraperitoneally with 200 µl of virulent *Aeromonas hydrophila* (5×10^8 cells/ml). The sham control group was injected with 200 µl of PBS (pH 7.4). Each treatment was conducted in triplicate.

Following the challenge test, mortality was monitored for seven days, after which blood and tissue samples were collected for biochemical analyses. Fish fed the D1 diet showed significantly ($P < 0.05$) higher average weight and specific growth rate, and lower feed conversion ratio and cumulative mortality compared to D2 and D3. Immune parameters, including serum lysozyme, myeloperoxidase, nitric oxide synthase, and hemagglutination titer, were significantly elevated ($P < 0.05$), while oxidative stress markers (TBARS and carbonyl protein) were significantly reduced ($P < 0.05$) in D1, followed by D2 and D3. Moreover, the expression of immune- and apoptosis-related genes (iNOS, SOD-C, NF-κB, Bcl-2, BAX, Cytochrome-c, Caspase-9, and Caspase-3) was upregulated in the liver and head kidney of fish fed experimental diets compared to the control.

A. aspera seed- and leaf-enriched diets clearly enhance the innate immunity of fish and contribute significantly to programmed cell death via both intrinsic and extrinsic pathways.

MORPHOLOGICAL COLORATION INDUCED BY RIPE PAPAYA *Carica papaya* IN

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The study investigated the effects of carotenoid-rich ripe papaya *Carica papaya* pulp powder supplementation on the growth and pigmentation of commercially important indigenous ornamental fish species mottled loach *Paracanthocobitis botia*. During a 90-day feeding trial, fish were fed diets fortified with papaya pulp powder at a rate of 6 g per 100 g of feed. The experiment was conducted in eight 57-liter aquariums, each one stocked with 15 age-matched male fish and fed at a rate of 2% of their body weight daily. Total carotenoid content (TCC) in fins, skin, and muscle was measured spectrophotometrically at 30-day intervals. TCC ($\mu\text{g/g}$) values were significantly higher ($p < 0.01$) in the papaya pulp powder supplemented group compared to the control. TCC in fish receiving the papaya-enriched diet was $6.55 \mu\text{g/g}$ in fins, $7.89 \mu\text{g/g}$ in skin, and $1.33 \mu\text{g/g}$ in muscle. Ripe papaya pulp as an effective natural source of carotenoids for enhancing coloration and growth performance could induce morphological coloration in indigenous ornamental fish *P. botia*, offering a sustainable option for the ornamental fish industry.

The growing interest of millennials in colorful aquarium ornamental fish as a symbol of a luxurious lifestyle is expected to remain a key factor driving industry growth. Furthermore, pigmentation agents are essential for boosting the vivid colors of ornamental fish, which play a crucial role in their market value and attractiveness to consumers.

Table-1 Feed composition, proximate and carotenoid analyses of diets

Ingredients (%)	Control	Treatment
Fish Meal	25	25
Soyabean Meal	22	22
Groundnut Oil cake	15	15
Rice bran	20	14
Wheat flour	12	12
Papaya pulp powder	--	6
Starch	3	3
Soya oil	2	2
Vitamin & mineral mix	1	1
Chemical composition (% dry matter)		
Moisture	7.84 ± 0.03	7.89 ± 0.03
Crude protein	30.12 ± 0.02	30.23 ± 0.02
Crude fat	8.14 ± 0.01	8.43 ± 0.01
Crude fibre	6.32 ± 0.02	6.87 ± 0.03
Total Ash	11.46 ± 0.02	12.14 ± 0.02
Carotenoids (mg/g)		3.57 ± 0.03



Control (A)



Treatment (B)

Fig. Naked eye view of changes in body pigmentation of *Paracanthocobitis botia* Control (A), Treatment (B)

PREBIOTIC, PROBIOTICS AND SYNBIOTIC SUPPLEMENTATIONS IN DIETS FOR PARROT FISH *Oplegnathus fasciatus*

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Prebiotics, probiotics and synbiotics are widely recognized as functional feed additives in aquaculture. Probiotics can enhance intestinal health and immunity by modulating gut microbiota, while prebiotics selectively promote the growth of beneficial bacteria. Synbiotics, a combination of both, may provide synergistic effects on growth performance and disease resistance. However, limited information is available regarding their dietary application for parrot fish. This study was conducted to evaluate the effects of dietary supplementation with prebiotic, probiotics and synbiotic on the growth performance and health status of parrot fish.

A basal diet (Con) containing 45% fish meal (anchovy) and 15% soybean meal was composed of 42.2% protein and 15.9% lipid. Five experimental diets were formulated to include 0.4% mannan oligosaccharide (MOS), 0.4% *Lactobacillus plantarum* (LP), 0.4% *Bacillus subtilis* (BS), 0.4% *B. licheniformis* (BL) and 0.1% MOS + 0.1% LP + 0.1% BS + 0.1% BL (SYN). Total 360 fish (116 ± 1.01 g) were randomly distributed into 18 tanks (300 L) in three replicates and fed the diets for 49 days.

Final body weight was significantly higher in LP, BS, BL and SYN groups than in Con group. Weight gain and specific growth rate were significantly higher in all experimental groups than in Con group. Survival was significantly higher in BL and SYN groups than in Con group. Protein efficiency ratio was significantly higher in BL group than in Con group. Feed conversion ratio was significantly lower in BL group than in Con group. Trypsin and lipase activities in intestine were significantly increased in LP, BS, BL and SYN groups than in Con and MOS groups. Chymotrypsin activity was significantly increased in MOS, LP and BL groups than in Con group. Lysozyme and myeloperoxidase activities were significantly higher in LP group than in Con group. Immunoglobulin level was significantly higher in LP, BS and BL groups than in Con group. Superoxide dismutase activity was significantly higher in MOS, LP, BL and SYN groups than in Con group. Catalase activity was significantly higher in LP, BS, BL and SYN groups than in Con and MOS groups. Disease resistance against *Edwardsiella tarda* was significantly improved in BS and SYN groups than in Con group.

This study suggests that dietary supplementation of MOS, LP, BS, BL and SYN can improve the growth, feed utilization efficiency, survival, innate immunity, digestive enzyme activity, antioxidant capacity and disease resistance against *E. tarda* in parrot fish.

LIVE DISEASE-FREE *Artemia* NAUPLII IN PASTE FORM, AND *Artemia* BIOMASS PRODUCTION IN A NATURAL RECIRCULATING AQUACULTURE SYSTEM (NRAS), TWO EXAMPLES OF INNOVATIVE *Artemia* TECHNOLOGIES

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We present two novel applications on the use of *Artemia* in aquaculture, namely the production of live *Artemia* nauplii in paste form and the production of live *Artemia* biomass from a Natural Recirculating Aquaculture System (NRAS), both are used in shrimp hatcheries and nurseries. Both applications help optimize crustacean aquaculture by supplying essential, disease-free live feeds and optimizing or supplementing the use of *Artemia* cysts harvested from natural habitats.

The *Artemia* nauplii paste is produced in specialized *Artemia* nauplii hatcheries resulting in pure, disease-free nauplii with more than 95% survival. The technology allows for the production of 99% instar I nauplii using any species or strain of *Artemia* including *A. franciscana* from Great Salt Lake. Alternatively, enriched Instar II *Artemia* paste can be produced when nutritional requirements need to be enhanced for specific applications. The live *Artemia* paste is distributed to shrimp hatcheries and nurseries on a daily basis.

The live *Artemia* biomass is grown in an NRAS where the *Artemia* production runs parallel to the production of Asian seabass, tilapia, mud crab as well as *M. rosenbergii* and *P. monodon* broodstock and nauplii. The biomass which is free of shrimp pathogens, is typically a mixture of adult and juvenile *Artemia* and is sold in live form to shrimp hatcheries and nurseries for juvenile shrimp and broodstock feeding.

Both applications support marine aquaculture by optimizing and supplementing the use of the essential live feed *Artemia* harvested from natural habitats. *Artemia* hatcheries maximize the yield of *Artemia* cysts through the implementation of optimal hatching protocols. Furthermore, by providing disease free live nauplii paste, the *Artemia* hatcheries help reduce disease losses in larval and early PL stages. Live pathogen free *Artemia* biomass production provides an alternative live feed to supplements *Artemia* nauplii originating from natural habitats during late hatchery and nursery phases of shrimp production thus producing more robust juveniles and optimizing subsequent yields during the grow-out phase of shrimp production.

POPULATION DYNAMICS OF *Auchenoglanis occidentalis* FROM DADIN-KOWA DAM, GOMBE STATE, NIGERIA

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Fish and its resources has been an integral component of food security in many countries across the world, this is not limited to only coastal areas but also encompasses inland water bodies (Ahamed, Akter, Hasan, & Chakma, 2024). Human nutritional requirements depends also largely upon the resources obtained from fish such as lipids, high quality proteins (Nazeef, Ja'afaru, Ka, & Kabiru, 2021), and numerous minerals such as iodine and phosphorous (Ahamed *et al.*, 2024).

The population dynamic parameters of *Auchenoglanis occidentalis* from Dadin-Kowa reservoir were studied. Population dynamic parameters such as growth, mortality and recruitment patterns were analyzed using length frequency data over 12-month period employing FiSAT II software. Findings revealed that LWR (b - constant) = 2.88, $K = 0.72 \text{ yr}^{-1}$, $L_{\infty} = 40.91 \text{ cm}$ and $T_{\text{max}} = 3.57$ years and $\Theta = 3.14$. Mortality indices revealed that natural mortality ($M = 1.39$), fishing mortality ($F = 0.22$) and exploitation ratio ($E = 0.14$), $L_c/L_{\infty} = 0.48$, $E_{\text{max}} = 0.64$, while $L_{\text{opt}} = 26.4 \text{ cm}$. Uni-modal recruitment peak observed with $L_m = 27.3 \text{ cm}$. Restocking program is suitable to ensure its continuous existence as it seems to have low population.

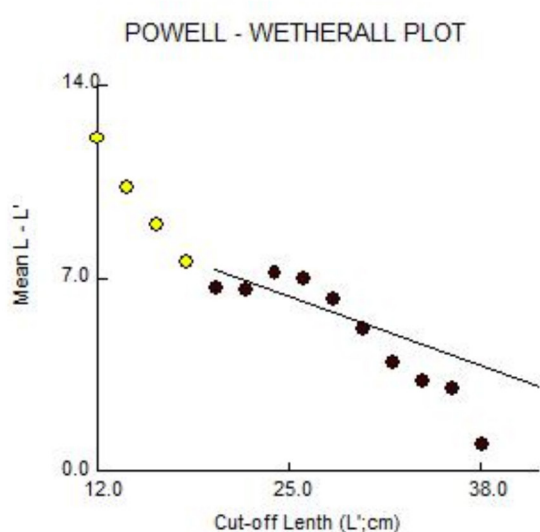


Figure 1: Powell Wetherall Plot of *A. occidentalis*

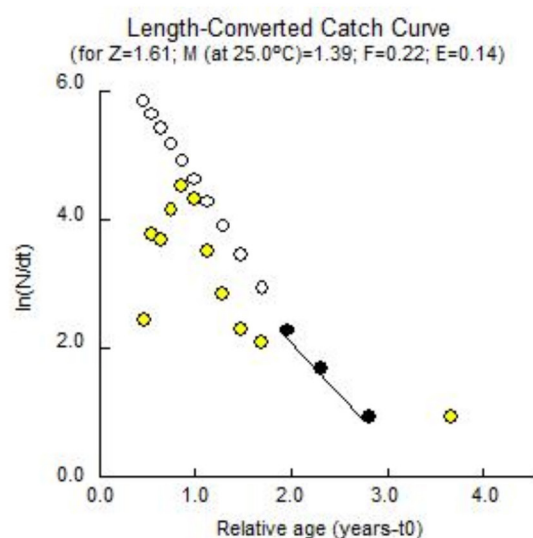


Figure 2: Mortality parameters of *A. occidentalis*

THE EFFECTS OF NONANOIC ACID ON THE GROWTH AND HEALTH OF *Artemia franciscana*

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Artemia is an important aquaculture feed organism, widely used in hatcheries. However, *Artemia* is prone to carrying pathogenic microorganisms such as *Vibrio*, posing potential threats to the breeding and cultivation of aquaculture species. With the rapid development of the aquaculture industry, there is an urgent need to enhance the growth and health of *Artemia* while reducing its pathogen load. Organic acids, such as nonanoic acid, have been applied in aquaculture and livestock farming because they promote animal growth, inhibit pathogenic microorganisms, and enhance animal immunity. In this study, nonanoic acid was combined with chitosan and added to the rearing water of *Artemia* to investigate its effects on the microbial community composition and growth performance of *Artemia franciscana*. The experiment showed that the relative abundance of *Vibrio* carried by *Artemia* adults decreased by 46.73% compared to the control, and the expression of lipogenesis gene (*acaca*) increased and was further confirmed by quantitative real-time PCR (qRT-PCR).

Briefly, nonanoic acid and chitosan were mixed in a 60:1 ($\mu\text{M/g}$) ratio to form particles. The cysts were treated with mixed particles then hatched and cultured for 7 days. After hatching, all samples were collected on day 2 and 7 for 16S rRNA sequencing and transcriptome analysis, respectively.

In *Artemia* nauplius samples, species of the genus *Psychrobacter* accounted for 54.8%, which was significantly ($P<0.05$) higher than the control (Fig. 1A). In adult *Artemia*, *Vibrio* accounted for only 10.35%, significantly ($P<0.05$) lower than the control (56.53%) (Fig. 1B). Transcriptome analysis revealed 3182 differentially expressed genes (DEGs) associated with 337 pathways, including growth- and immune-related pathways such as AMPK, PI3K-Akt, mTOR and Notch signaling pathway (Fig. 2). Additionally, genes related to innate immunity (*hsp90*) and growth (*pik3ca*, *mtor*, *pck*, and *acaca*) showed increased expression.

In the experimental group, qRT-PCR analysis confirmed that *acaca* expression was markedly higher than in the control.

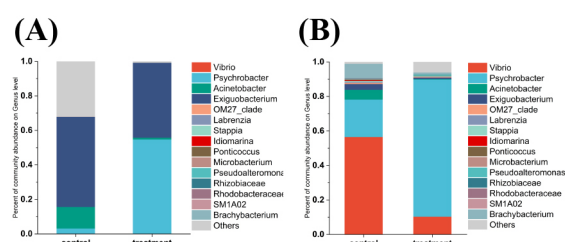


Fig.1. Relative abundances at the genus level of bacteria in *Artemia*. (A) *Artemia* nauplii; (B) *Artemia* adult.

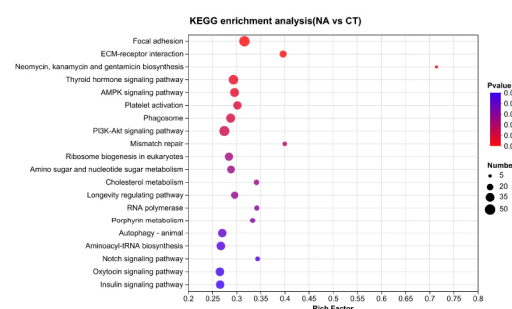


Fig.2. KEGG enrichment analysis of differentially expressed genes in *Artemia*. Y-axis: pathways; X-axis: Rich factors; dot color: P-values; dot size: DEGs.

PRACTICAL PERSPECTIVES ON SHRIMP (*P.vannamei*) HATCHERY OPERATIONS IN INDIA

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Shrimp hatchery operations of *P.vannamei* from the perspective our experience in commercial hatchery operations in India is briefly discussed under the following headings: Broodstock management, Live feed (Algae) culture and Artemia hatching, and, Larval rearing of shrimp.

Introduction of *P.vannamei* to India in the year 2009 brought about a paradigm shift in shrimp aquaculture industry resulting in substantial development both in infrastructure and production over these years. Currently PL production of shrimp in India ranges around 90 Billion from approximately 600 hatcheries. Our Company, Vaisakhi Marine Resources (P) Ltd., is one of the largest producers on shrimp seed in India, producing approximately 5 Billion postlarvae (PLs) from 8 hatcheries that we operate. Three out of our 8 hatcheries have been provided with broodstock management facility, wherein imported broodstock are maintained for maturation and nauplii production. Nauplii produced are supplied to all our hatcheries; excess nauplii is sold to other hatcheries also. Technical details of broodstock management, maturation and nauplii production are discussed Results on nauplii production is also discussed. Broodstock source selection is based on the following criteria viz., nauplii productivity, larval rearing performance, and more importantly farm performance of PLs.

Key points of algae culture discussed include use of multiple algal species such as *Thalassiosira* sp., and / or *Chaetoceros* sp., (main) supplemented by *Isochrysis* sp., *Nannochloropsis* sp., and *Tetraselmis* sp. Key points on larval culture discussed include use of Isolated, modular and biosecure facility, brisk stocking of nauplii, shutdown and disinfection after every production cycle, zero antibiotic use, regular use of probiotics and multi-species algal feeding. Cost of production of PLs and market price of seed over different years is also discussed. Reasons for India's success with *P.vannamei* could be attributed to the following: control and regulations on broodstock, previously developed technology with indigenous species, availability of trained & experienced technical manpower, relatively well-developed infrastructure and demand versus supply gap in the market that existed in the early days.

JUDICIOUS USE OF ANTIMICROBIALS FOR THERAPEUTIC MANAGEMENT OF BACTERIAL INFECTIONS IN INDIAN MAJOR CARPS AQUACULTURE

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Aquaculture contributes more than half of the world's fish production, and India is the second-largest producer, contributing to this blue food basket. The potential contribution of the Indian aquaculture is often limited by bacterial diseases. The economic loss due to diseases in Indian major carp farms is US\$996.01 M, from which the bacterial disease alone is US\$351.43 M, 35.28%. Disease prophylaxis in Indian aquaculture mainly comprises good management practices, including biosecurity. However, antimicrobial agents of natural and chemical origin are used in the therapeutic management of bacterial diseases in Indian carp culture operations. Regulatory guidelines require information on biosafety, environmental safety, efficacy, withdrawal period, pharmacokinetics and environmental degradation for the targeted aquatic species in their culture region. Presently, India has a list of prohibited antimicrobial agents for use in aquaculture. We have developed the required basic data for the safe use of antimicrobial agents in Indian carps aquaculture. The antimicrobial agents oxytetracycline, florfenicol, oxolinic acid, sulfadimethoxine + ormetoprim and sulfadimethoxine + trimethoprim were found to be safe for use in IMCs representative species (rohu, *Labeo rohita*). The pharmacokinetics studies revealed the distribution and elimination of these antimicrobial agents in different tissues with a withdrawal period of 7 days. The environmental safety of these antimicrobials was confirmed through degradation studies in soil and water, as well as their effect on indicator organisms. The *in vitro* and *in vivo* studies against the major fish pathogens confirmed their laboratory and clinical efficacy. The results of our study suggest that the listed antimicrobials can be used safely and effectively for controlling bacterial infections in Indian major carp culture. The outcome of the study helps agencies to develop regulatory guidelines for judicious use of antimicrobial agents, empowering fish farmers to reduce losses incurred due to bacterial infections.



A PRELIMINARY STUDY ON THE DEMOGRAPHIC PROFILE AND SOCIAL CHARACTERISTICS OF THE *SIDDI* ADIVASI TRIBES (AFRICAN ANCESTRY) IN GIR SOMNATH DISTRICT, GUJARAT

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The “*Siddi*” tribes are descendants of migrants from the African subcontinent who arrived in India during the 13th century A.D. They are predominantly settled in the taluk including Veraval, Kodinar, Talala, and Madhavpur in the Gir Somnath district of Gujarat. The *Siddis* of Saurashtra, along with four other tribes are accorded as “Primitive” group since 1982 because of their pre-agricultural level of technology, extremely low literacy rate, and more or less stagnant population. Traditionally they are the forest dwellers. Sidi tribe of Gujarat belonging to ST community. A total of 74.81 lakh people making up the State’s population, of which 14.76 percent are members belongs to scheduled tribes. Most *Siddis* are considered to fall below the poverty level, making them one of Gujarat’s most backward classes as they frequently engage in sporadic, seasonal, and ultimately unsustainable jobs and they primarily rely on agricultural pursuits for their means of subsistence. The ICAR-CMFRI Veraval Regional Station has actively engaged the *Siddis* in the institute’s Tribal Sub Plan Program and the members have been registered under the *Bharat Adim Juth Matsya Udhog Sahkari Mandali* who have been actively involved in open sea cage culture of the spiny lobster (*Panulirus polyphagus*) which has demonstrated consistent success in this field over the years.

A preliminary survey was recently conducted among 100 *Siddi* families, comprising a total of 525 members residing in Veraval, Jambur, Vithalpur, Talala, Shirvan, Thordi, Khilawad, Surva, Hadmatiya, Prabhas Patan, and Mangrol. For the purpose of the study, one member from each family was selected for the study. Out of the 100 family members selected for the interview, 46% were women and 54% were men. With respect to age distribution, 18% were categorized as young (<35 years), 41% as middle-aged (35–45 years), and 41% as older adults (>45 years). In terms of educational status, 28% were illiterate, 64% had completed primary education, 4% had attained secondary education, and another 4% had pursued college-level education. Regarding employment, 26% were engaged as daily wage labourers (stone, wood, etc.), 18% as agricultural labourers, 10% as farmers, 8% as drivers, 21% in fishing-related occupations (company, shop), 3% in non-governmental organizations, 6% in government services, and 8% in other occupations (including tailoring, housework, business, drumming, etc.) Many of the *Siddi* youths possess good diving skills and sea endurance, but they face lack of access and support to new and advanced technological interventions to improve their livelihood. This preliminary study highlights the unique demographic profile, socio-economic challenges, and livelihood patterns of the *Siddi* Adivasi tribes in Gir Somnath district. Strategic interventions through skill development, cooperative initiatives, and national missions like PMMSY, Institutional interventions and the Blue Revolution hold significant potential for their sustainable socio-economic upliftment.

ADVANCING BROODSTOCK MANAGEMENT THROUGH BIOIMPEDANCE-BASED GONADOSOMATIC INDEX (GSI) ESTIMATION IN ASIAN SEABASS (*Lates calcarifer*)

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Traditional methods to assess reproductive condition often involve lethal and invasive procedures, with limited applicability when managing valuable broodstock. This study investigates the potential for bioelectrical impedance analysis (BIA) as a non-invasive, alternative tool for estimating reproductive status in marine broodstock fish by examining the relationships between sex, BIA, GSI, and Fulton's condition factor (K) in Asian Seabass (*Lates calcarifer*).

A total of 45 mature individuals (26 females, 19 males) were examined. Total weight (TW), standard length (SL) and fork length (FL) were measured. BIA measurements were performed using a DFA100 Fish Analyser™ (Figure 1) at six positions of each individual (Figure 2).

Fish were dissected and sex-identified using gonad characteristics, and gonad weight was measured (GoW). Fulton's condition factor (K) and GSI were obtained with the following equations (West, 1990; de Vlaming et al., 1982):

$$K = (TW/SL^3) \times 100$$

$$GSI (\%) = (GoW/TW) \times 100$$

One-way analysis of variance (ANOVA) showed that females had a significantly higher GoW (females: 159.37 ± 92.6 g; males: 72.22 ± 110.21 g) and GSI (females: 2.91 ± 0.35 ; males: 1.02 ± 0.35), and significantly lower K (female: 1.57 ± 0.03 ; male: 2.50 ± 0.16). No significant differences were observed between sexes for TW, SL, and FL.

Using normalised BIA and GSI values, a fitted power regression model demonstrated a strong non-linear relationship ($R^2 = 0.9689$; high predictive performance), further validated through log-linear modelling ($R^2 = 0.964$; Adjusted $R^2 = 0.963$). A negative and highly significant slope coefficient ($\beta = -0.946$, $p < 0.001$) showed that resistance decreased with increasing GSI.

A simple linear regression showed a statistically significant but weaker correlation between BIA and K, suggesting that body condition may influence BIA.

The high predictive power ($R^2 = 0.964$) and statistically significant inverse relationship between log impedance and log GSI ($p < 0.001$) underscore the robustness of the relationship and support the use of impedance as a non-invasive proxy for GSI estimation. This establishes BIA analysis as a reliable, non-lethal method for estimating GSI in Asian Seabass broodstock, offering a practical solution for modern aquaculture.



Figure 1: DFA100 Fish Analyzer™ (Yamato Scale Co. Ltd., Japan)

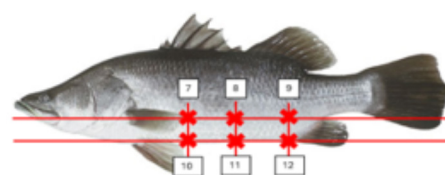


Figure 2: Bioimpedance (BI) measurement points on individual fish.

ENVIRONMENTAL DNA METABARCODING OF MARINE GASTROPODS (CLASS: GASTROPODA) FROM INTERTIDAL ROCKY COASTS OF PENINSULAR MALAYSIA, MALAYSIA

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Traditional visual census methods for assessing marine biodiversity are severely hampered by sampling biases, the presence of cryptic species, and the inherent difficulties of fine-scale taxonomic identification. This study implemented environmental DNA (eDNA) metabarcoding as a highly sensitive and comprehensive approach to accurately characterize the gastropod community structure across intertidal rocky shores in Peninsular Malaysia. The primary objective was to reveal the broad-scale patterns and fine-scale taxonomic diversity commonly overlooked by conventional surveys.

Marine water samples were collected from 20 stations. eDNA was extracted and specifically targeted the gastropod 16S rRNA gene using newly designed primers. Following successful validation, the amplified DNA underwent Illumina NovaSeq6000 high-throughput sequencing, yielding a detailed dataset for precise community analysis. A total of 345 amplicon sequence variants (ASVs) were derived, representing 50 identified gastropod species from the eDNA dataset. Crucially, while 68.1% of reads were identified to the species level, the remaining 31.9% represented unidentified gastropod taxa, underscoring eDNA's capability to detect cryptic or undescribed diversity. Analysis of the community structure revealed distinct patterns.

At the family level, Muricidae, Naticidae, and Nassariidae were overwhelmingly dominant, collectively constituting over 70% of taxa abundance at sampling sites like Pantai Teluk Penyabong, Pantai Teluk Aling, and Pantai Teluk Dalam. Conversely, Trochidae exhibited lower overall abundance but showed a pronounced site-specific distribution, reflecting significant ecological gradients. Granularity increased at the genus level: *Nerita* and *Planaxis* were widely distributed, while taxa like *Drupella* and *Echinolittorina* showed highly localized abundance (e.g., Pantai Pandak), suggesting specialized microhabitat preferences.

In conclusion, this study confirms the robustness of eDNA metabarcoding in providing an unparalleled resolution of marine community composition. The significant inter-station variation in abundance and composition strongly implies that local environmental factors (e.g., substrate, tidal range, and temperature) are critical drivers of these gastropod assemblages. These findings highlight eDNA's essential value as a future tool for biodiversity monitoring and conservation of complex, underexplored marine ecosystems.

IMPROVING PROTEIN DIGESTIBILITY AND REDUCE FEED COST IN SHRIMP WITH PLANT-BASED INGREDIENTS (ECONOMIX)

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Fishmeal (FM) is the primary protein source in aquaculture feeds, but its price has risen due to overfishing and climate change reducing supply. Alternatives like plant-based proteins, insect meals, and single-cell proteins are being explored, but their lower digestibility can hinder growth and feed efficiency. Enhancing their digestibility is key to meeting the nutritional needs of farmed species.

ECONOMIX is a plant-based feed additive produced by TECHNA (Couëron, France) that aims at enhancing protein digestibility. It offers a promising solution for reducing FM use and substituting it with more affordable plant proteins.

A growth trial was held at CIBA facilities, Chennai, India, to evaluate the effect of ECONOMIX on growth and FCR of whiteleg shrimp (*Litopenaeus vannamei*). The trial comprised five experimental diets, to evaluate the effect of feed formulation with or without ECONOMIX:

- Control diet
- Negative control diet
- Negative control + Rice DDGS
- ECONOMIX diet
- ECONOMIX + Rice DDGS

The ECONOMIX diets had lower fishmeal compared to the control diets (12% and 15.56% respectively) which was replaced by soybean meal, broken rice, and rice DDGS in test formulas. Crude protein content was also reduced by 1 and 1.5%. The diets allowed a formula cost reduction of 1.62 and 2.49% respectively, compared to the Control diet.

Negative control diets have the same composition as the ECONOMIX diets but the product ECONOMIX was replaced by wheat grain (0.2%).

Each diet was tested in triplicate groups of 15 shrimp (mean initial weight: 3.35 ± 0.4 g), maintained in 250 L tanks at a temperature between 27.0 to 28.3°C.

The results showed no statistical differences in terms of growth, although numerically better final weight for the ECONOMIX diet, and the lowest values for both negative control when compared to the control. FCR showed significant differences with the ECONOMIX diet having a lower FCR compared to both negative controls.

To conclude, ECONOMIX, with its ability to lower fishmeal and protein, offers a viable solution reduce feed costs by increasing the use of cheaper, more sustainable protein sources, while maintaining optimal performance in fish and shrimp.

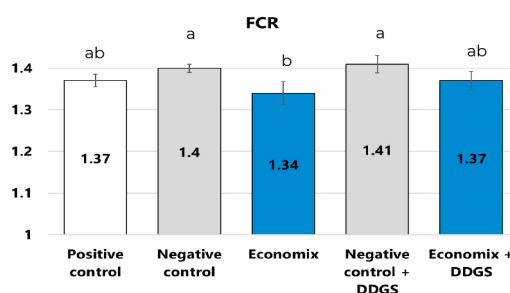


Figure 1. Effect of ECONOMIX FCR of shrimp (*Litopenaeus vannamei*)

SMART NUTRITION: BOOSTING GROWTH AND HEALTH IN AQUACULTURE FISH

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Sustainable aquaculture implies adequate knowledge of fish nutritional requirements to formulate diets that promote the best growth performance of the animals. Traditional formulas for carnivorous fish usually relied on fish meal and oil as major protein and lipid sources. Fish meal has a balanced amino acid profile. Also, it has a high content of taurine, which is essential for several marine fish. Fish oil is rich in omega-3 long-chain polyunsaturated fatty acids, essential for marine fish. Besides this balanced macronutrient profile, fish meal and oil also provide many other nutrients that contribute to the growth and health of aquaculture fish.

However, fish meal and oil no longer make up the bulk of feeds but are used as strategic ingredients. This led to the use of plant ingredients as the primary compound in fish feeds. Nonetheless, plant ingredients' nutritional composition is not well balanced, lacks or has low levels of some critical nutrients, has anti-nutritional compounds, and has low palatability. This introduces new challenges in formulating diets that are well accepted by fish, meet all nutrient requirements, and boost animals' health.

This presentation will focus on the new strategies for optimizing nutritional requirements of fish and on nutritional strategies to boost the health of aquaculture fish, which is particularly defiant in an era of global warming.

ESTABLISHING OPTIMIZED CHALLENGE METHOD FOR INFECTIOUS MYONECROSIS VIRUS (IMNV) IN WHITELEG SHRIMP (*Penaeus vannamei*)

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Infectious myonecrosis (IMN), caused by the Infectious Myonecrosis Virus (IMNV), is a rapidly expanding viral disease that severely impacts whiteleg shrimp (*Penaeus vannamei*) aquaculture, leading to high cumulative mortality and characteristic gross signs like whitened musculature. Conducted by ShrimpVet, the primary objectives of this study were to establish a validated, standardized experimental challenge method for IMNV infection in *P. vannamei* juveniles under controlled laboratory conditions, and to procure high-titer IMNV-infected shrimp for the consistent preparation of future inocula.

Healthy juvenile shrimp were acclimated and randomly allocated to experimental tanks in a recirculating system. The IMNV challenge inoculum was prepared from the abdominal muscle of infected shrimp, homogenized, and then serially diluted to create several distinct inoculum dose levels. These doses were administered to treatment groups via two methods: intramuscular (IM) injection and oral (per os) administration. The post-challenge period spanned 10-14 days.

Successful infection validation was confirmed using three criteria: (1) observation of characteristic gross signs; (2) histopathological confirmation of tissue pathology in moribund shrimp; and (3) quantitative detection of IMNV viral load in abdominal segments via PCR. The resulting optimized protocol and high-titer inoculum source provide a necessary and reproducible tool to advance clinical research against IMNV.

FUNCTIONAL EFFECTS OF BLACK SOLDIER FLY *Hermetia illucens* L. LARVAE MEAL IN LOW- AND HIGH-FISH MEAL DIETS FOR PACIFIC WHITE SHRIMP *Penaeus vannamei*

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This study was conducted to evaluate black soldier fly larvae meal (BSFLM) as a functional ingredient in diets for Pacific white shrimp. For a feeding trial (2×5 factorial design), a high fish meal diet (200 g FM/kg) and a low fish meal diet (100 g FM/kg) were formulated as a positive control (Positive) and a negative control (Negative), respectively. Eight other diets were formulated with BSFLM supplementation at 0, 2, 4, 6 and 8% levels into each control diets (designated as NP2, NP4, NP6, NP8, PP2, PP4, PP6 and PP8, respectively). Shrimp (initial weight: 0.20 ± 0.01 g) were fed each diet at 6-10% of their body weight for 10 weeks. All the data were subjected to Two-way ANOVA and the results revealed that FM level and BSFLM level had significant effect on final body weight (FBW), weight gain, specific growth rate and feed intake (FI) where FM× BSFLM interaction effect was present in FBW and FI ($P < 0.05$). FM level and BSFLM level significantly affected the non-specific immune responses and antioxidant capacities in shrimp hemolymph and FM × BSFLM interaction also significantly affected all the immune parameters except for phenoloxidase. Crustin and IGF-BP gene expressions were significantly affected by FM and BSFLM levels while HSP70 gene expression was significantly affected by BSFLM level alone ($P < 0.05$). Hepatopancreas digestive enzyme activity was significantly affected by FM level. BSFLM level and interaction of FM × BSFLM significantly affected digestive enzyme activity ($P < 0.05$) except amylase and chitinase respectively. Villus height in shrimp intestine was significantly affected by FM level, BSFLM level and FM × BSFLM interaction ($P < 0.05$). A digestibility test revealed that FM level significantly affected apparent digestibility coefficients (ADC) of dry matter, lipid, carbohydrate, energy, phosphorous, starch, non-starch polysaccharides and non-protein nitrogen (NPN) ($P < 0.05$). BSFLM level significantly affected ADC values of dry matter, lipid, carbohydrate, energy, chitin and NPN ($P < 0.05$). In muscle quality parameters, freezing loss was significantly affected by both FM level and BSFLM level and cooking loss was significantly affected by FM level, BSFLM level and interaction of FM × BSFLM ($P < 0.05$). In the challenge tests against *Vibrio parahaemolyticus* and ammonia stress, the survival of the shrimp was significantly affected by FM level, BSFLM level and the interaction of FM × BSFLM ($P < 0.05$). Overall, the inclusion of BSFLM in low- and high-fish meal diets exhibited positive functional effects on growth, immunity, digestive enzyme activity, digestibility, muscle quality and resistance to disease and ammonia stress in Pacific white shrimp.

BUILDING RESEARCH AND WORKFORCE CAPACITY IN SOILLESS AGRICULTURE THROUGH THE DARE-KY CONSORTIUM

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The Driving AgTech Research and Education in Kentucky (DARE-KY) project, funded through the NSF E-RISE RII program, seeks to strengthen Kentucky's competitiveness in sustainable agriculture technology (SAT) research and workforce development. Aligned with the Kentucky Science & Technology Plan, DARE-KY integrates inclusive networks, use-inspired research, and workforce pathways to establish Kentucky as a leader in agricultural technology (AgTech). This presentation aims to summarize the research outcomes and capacity building from the first year of the project.

The primary research focus of the DARE-KY project is implementing use-inspired research to discover the role of microorganisms in nutrient recovery from solid effluent (waste) from fish production and the potential of aquaculture effluent as a fertilizer for plant production across multiple industries. Two research projects have been completed in Y1 of the DARE-KY project. The first project involved the addition of mineralized aquaculture effluent to aquaponic systems and measuring the impacts on plant production, water quality, and nutrient/stable isotope dynamics. Preliminary results show significant increases in plant production and aqueous nutrient concentrations. The second project aims to determine the nutrient recovery outcomes of aquaculture effluent mineralization at different oxygen levels, along with determining the primary microbes driving the mineralization process. Preliminary results show significant changes in nutrient recovery rates and microbial community shifts within the first two weeks of mineralization.

Other project goals include the construction of research incubators at partnering institutions throughout the state and curriculum development. Completed facilities include a hydroponics research lab and replicated aquaponic systems and the capstone facility of the project, a 538m² greenhouse, is currently under construction. Several new courses, including an introduction to soilless agriculture class, are prepared for launch in the spring 2026 semester.

Overall, the DARE-KY has established a robust collaborative network, expanded Kentucky's AgTech research infrastructure, engaged students across educational levels, and developed new industry and community partnerships in Y1 of the project. These efforts are laying the foundation for long-term sustainability of translational SAT research, while cultivating the next generation of AgTech researchers and professionals in Kentucky.

SHRIMP FARMING IN VIETNAM: NEW MODEL FOR EFFICIENCY, SUSTAINABILITY AND TECHNOLOGY TRANSFER

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Vietnam's shrimp industry is undergoing a period of profound stress, driven by persistently low farmgate prices, escalating input costs, and increasing scrutiny over environmental sustainability. These structural challenges are further intensified by global competition, particularly from cost-efficient producers such as Ecuador and India, resulting in a prolonged price crisis and declining profit margins for Vietnamese farmers.

In response, EcoSeafood Group (E.S.G) - a newly established enterprise building upon the technological foundation and field experience of ShrimpVet - has introduced a novel, systems-based shrimp farming model. This model integrates modular farm design, advanced production technologies, and mangrove agroecological integration to enhance productivity while minimizing environmental impact. With a current pilot site of 30 hectares, the system is engineered to optimize resource efficiency, reduce labor dependency, and lower carbon footprint through automation and scale.

E.S.G aims to expand this model to 50 modules by 2030, accounting for just 1% of Vietnam's total shrimp farming area, yet potentially matching national production levels through intensified yield. Beyond economic efficiency, the model addresses a broader socio-structural issue: attracting a new generation of farmers by offering a high-tech, profitable, and sustainable alternative to conventional shrimp aquaculture.

This presentation outlines the conceptual framework, preliminary outcomes, and long-term vision of this transformative approach to sustainable shrimp production in Vietnam.

LONG-TERM IMMUNOMODULATORY EFFECTS OF GREEN AND RED MACROALGAE EXTRACTS FOR WHITELEG SHRIMP (*Litopenaeus vannamei*) ON GROWTH PERFORMANCE AND SURVIVAL

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Shrimp farming can suffer from significant economic losses due to diseases. Stress factors like water quality and weather changes, transportation, and stocking can cause disease outbreaks, so improving shrimp natural defenses is crucial. Seaweed extracts have recently been investigated as a natural tool due to its ability to enhance gut barrier function and modulate immune responses in aquatic animals. Field trials have demonstrated improved survival rates in shrimp challenged with major pathogens when fed with these bioactive compounds. To further evaluate the underlying molecular mechanisms, the University of the Philippines Visayas conducted a trial measuring the effects of seaweed extract on farmed shrimp gene expression.

An algae-based marine sulphated polysaccharides (MSP) extracts, from green *Ulva sp.* and red *Solieria chordalis* were used. Shrimp were assigned to two groups Control and Algae MSP 0.3% which was included before extrusion (three replicates), which were raised for 114 days. Growth parameters were weekly recorded, and mortality was recorded daily. Immune-related gene expression at 30 and 60 days after feeding was evaluated. Briefly, samples of hepatopancreas (local immune response) and hemolymph (systemic immune response) were collected and evaluated using RT-qPCR (n=9 shrimp/treatment in triplicate). The study focused on four key immune parameters: Anti-lipopolysaccharide factor (ALF), Crustin, Penaeidin, and Prophenoloxidase (proPO). Statistical analyses were performed using SAS software in which growth results were analyzed by one-way ANOVA and F test; and gene expression by non-parametric Kruskal-Wallis test, $p < 0.10$.

Shrimp fed the Algae MSP 3kg/T had significant modulation of the immune parameters, including the immune response in hepatopancreas after 30 days (Heat shock proteins and Crustins) and initiates the Phenoloxidase cascade in the hemolymph. HSP90 increased 500% ($p = 0.05$) and Crustin was expressed 100% higher ($p < 0.05$). After 60 days, the immune response is fully orchestrated in hemolymph; and in the hepatopancreas: proPO and ALF are upregulated while Peinaedins are downregulated. Specifically, proPO at DOC 60 was 340% higher in the hepatopancrease ($p = 0.05$) and 1172% higher in the hemolymph ($p = 0.05$), respectively. Similarly, expression of ALF increased by 75% in the hemolymph ($p = 0.05$) and by 158% in hepatopancrease ($p < 0.05$).

These results highlight the potential use of red and green algae extracts as a natural, sustainable strategy for enhancing shrimp health, regulate gene expression correlated with improved survival, and contributing to the long-term sustainability of shrimp aquaculture.

POTENTIAL FOR RED ALGA *Kappaphycus alvarezii* FARMING IN THE KORI CREEK REGION OF NORTHWEST INDIA

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India's 11,000-km coastline supports about 4 million fishermen, offering vast potential for commercial seaweed farming, yet national output is only about 5,000 t wet weight, far below demand for carrageenan, agar and alginate, driving heavy imports. Production is dominated by *Kappaphycus alvarezii* in Tamil Nadu, but disease outbreaks cut yields sharply after 2013. Expanding cultivation to other maritime states, especially Gujarat with its 2,340-km coast, is vital. CSIR-CSMCRI is mapping suitable sites across India, including Kori Creek in Kutch. Due to its border location, fishermen of Kori Creek often face challenges from border security forces during fishing, making their survival difficult through fishing alone. Seaweed farming could provide alternative livelihoods and reduce migration from this resource-scarce, border region. There are no prior reports on seaweed cultivation in the Kori Creek region.

This study assessed the cultivation of *K. alvarezii* at three sites of Kori Creek viz. Narayan Sarovar, Pipar, and Nani Cher, using the tube net method across three cycles. Daily growth rate (DGR), yield, carrageenan and biostimulant quality were determined from the *K. alvarezii* grown at all three sites. An economic projection was also carried out to check the commercial suitability of the sites.

Mean DGRs were 0.51–1.22% at Narayan Sarovar, 1.86–2.26% at Pipar, and 1.34–1.91% at Nani Cher, with corresponding yields of 0.11–0.41, 0.40–1.07, and 0.34–0.69 kg fresh weight m^{-1} . Semi-refined carrageenan yield (33–45%) and gel strength (318–636 g cm^{-2}) met commercial requirements.

Economic analysis (single farmer model) identified Pipar site as the most profitable site (Rs. 2,15,537/-), followed by Nani Cher (Rs. 1,34,676/-), at a raw seaweed price of Rs. 120 kg^{-1} . Further, large-scale demonstrations are recommended to better evaluate the region's economic viability and profitability.

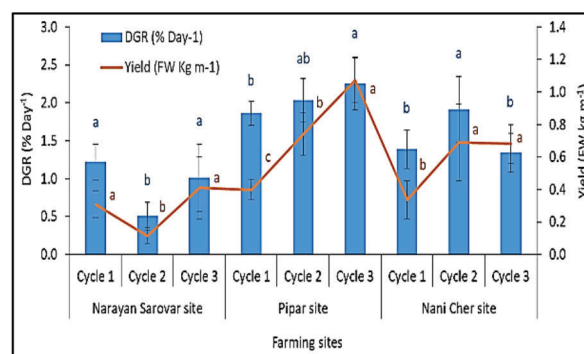


Figure 1. DGR and yield of 3 cycles performed at 3 various sites i.e. Narayan sarovar, Pipar and, Nani cher

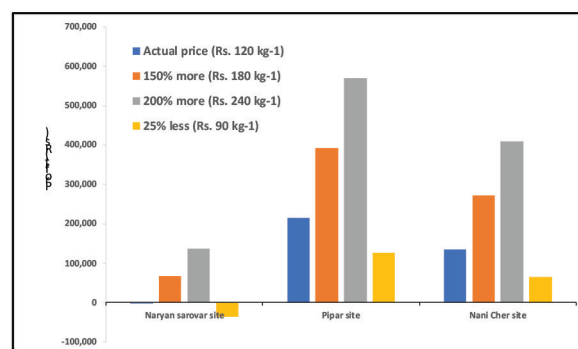


Figure 2. Profit in INR of seaweed harvested from of three different sites

MISLEADING MEANS: AQUACULTURE DIVERSITY DISRUPTS ENVIRONMENTAL IMPACT GENERALISATIONS

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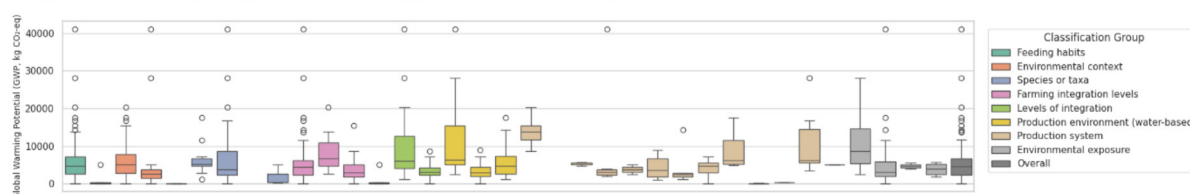
Unlike any other food sector, aquaculture encompasses vast diversity in species, feeds, environments, intensities, and integration. This diversity is both a strength, supporting adaptive capacity and nutritional variety, and a challenge, as it renders environmental performance highly context dependent. Life Cycle Assessment (LCA) is widely used to quantify aquaculture's impacts, yet many studies treat the sector as homogeneous or rely on averages that conceal differences. This risks misleading conclusions and poorly targeted policy. Our study addresses this gap by systematically assessing how aquaculture diversity shapes reported impacts and modelling practices in LCAs.

This study systematically reviewed 96 peer-reviewed aquaculture LCA studies, covering 93 models published over two decades. Using an eight-dimension diversity framework, systems were classified by feeding habits, taxa, production environment, integration level, intensity, infrastructure, water exchange, and exposure. Environmental impacts were converted to a consistent unit of one tonne of product and compared across diversity classes. We also examined how subsystem inclusion and modeller choices varied with system type.

Disaggregating results by diversity subclasses revealed extreme variation otherwise hidden by averages. Global warming potential ranged from 32 kg CO₂-eq in algae systems to nearly 14,000 kg CO₂-eq in aquaponics (Fig. 1), while marine eutrophication spanned from 0.05 kg N-eq in algae to 108 kg N-eq in recirculating aquaculture. Statistical tests confirmed significant differences across most diversity classes, particularly for global warming potential, acidification, and eutrophication. High-impact outliers such as RAS, IMTA, and aquaponics pushed sectoral means upward, despite these systems often being pointed as more sustainable, while extensive or nature-based systems consistently clustered at the low-impact end. Boundary analysis revealed that complex, high-tech systems often excluded infrastructure or downstream processes, whereas simpler systems were modelled more comprehensively, exaggerating their relative impacts. Collectively, these findings demonstrate that aquaculture sustainability cannot be generalised without accounting for system diversity.

These findings demonstrate that aquaculture diversity is a fundamental determinant of both environmental outcomes and how they are modelled. Robust, policy-relevant LCAs must therefore adopt diversity-aware frameworks, consistently include key subsystems, and transparently report modelling choices. Without this, averages and one-size-fits-all benchmarks risk misrepresenting sustainability patterns and undermining effective policy design.

Fig. 1. Variability in global warming potential across aquaculture diversity subclasses.



RECOMBINANT EXPRESSION OF A NOVEL *Aeromonas hydrophila* PHAGE ENDOLYSIN AND CHARACTERIZATION OF ITS LYTIC ACTIVITY

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Phage therapy has recently re-emerged as an alternative strategy for control of antimicrobial resistant (AMR) bacterial pathogens. Besides the whole phages, several of their encoded molecules also have antimicrobial properties. To develop a repository of therapeutic antimicrobials against AMR pathogens, identifying and characterizing novel phage endolysins is crucial. In the present study, an endolysin-encoding gene was identified in *A. hydrophila* phage CF7. The putative endolysin was named as CF7lysin. CF7lysin was 180 amino acids long, and its estimated molecular weight was 19.79 kDa. Hydrophobic amino acid residues were dominant at the N-terminal region of CF7lysin. Tertiary structure modelling revealed the globular structure of CF7lysin with one enzymatically active domain (EAD) and a major groove made up of highly conserved amino acid residues. After *in silico* characterization, *in vivo* expression of CF7lysin gene in *A. hydrophila* host was also confirmed with reverse-transcriptase PCR. Recombinant CF7lysin (rCF7lysin) completely lysed host cells when it was expressed in *E. coli* BL21 cells. Expression of rCF7lysin in *E. coli* was also confirmed by dot blot hybridization and bacterial growth curve assay. To confirm the role of N-terminal hydrophobic region in the holin-independent endolytic activity of CF7lysin, truncated CF7lysin gene (after removing the nucleotides encoding 24 N-terminal amino acid residues) was again cloned and expressed in *E. coli*. The truncated recombinant CF7lysin (trCF7lysin) did not cause host lysis during induced expression. The purified trCF7lysin protein showed lytic activity against Gram-positive bacteria during lawn assay. However, no lytic activity was observed against Gram-negative bacteria. The study provides important insights into the lytic activity of a novel phage endolysin. In the future, sequence manipulations in the endolysin gene sequence could be tried to enhance its lytic activity against Gram-positive and Gram-negative bacteria.

BLENDING BLUE AND GREEN PROTEINS: FUNCTIONAL OPTIMIZATION OF HYBRID FISH BALLS FROM TILAPIA

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Hybrid fish products represent an emerging category of value-added seafoods that integrate animal and plant derived proteins to achieve superior nutritional, functional, and sensory qualities while addressing consumer demand for sustainable and health-oriented alternatives. This study optimized hybrid fish balls by incorporating plant-based proteins from sweet potato (*Ipomoea batatas*) and chickpea (*Cicer arietinum*) in combination with tilapia (*Oreochromis niloticus*) meat. The approach sought to improve upon the conventional formulation methods, which predominantly employ corn starch as a binding agent, by substituting it with nutrient-dense plant ingredients possessing inherent functional and health-promoting properties. This substitution was intended not only to enhance the protein quality, dietary fiber content, and micronutrient profile of the product but also to contribute to clean-label and sustainable formulation practices.

Systematic optimization was achieved by Response Surface Methodology (RSM) to evaluate the influence of sweet potato and chickpea concentrations on key product characteristics viz., texture (hardness, cohesiveness, chewiness), cooking yield, fat uptake, protein content, and sensory acceptability. Validation studies were conducted to confirm the robustness and reproducibility of the optimized formulation.

The experimental results revealed that variations in plant ingredient proportions had a statistically significant ($p < 0.05$) impact on product quality. Chickpea incorporation markedly influenced the nutritional and processing parameters by contributing to enhanced protein content, improved coating adhesion, and reduced oil absorption during frying. However, higher chickpea levels ($>35\%$) resulted in excessive firmness and reduced sensory appeal due to denser protein matrix formation. Conversely, sweet potato addition improved moisture retention, reduced hardness, and enhanced mouthfeel and flavor balance, attributed to its starch and fiber content. Nevertheless, excessive sweet potato concentration led to increased fat uptake and a softer, less cohesive texture.

Optimization through RSM predicted an ideal formulation comprising 50% replacement of fish meat with a combination of 16% sweet potato and 34% chickpea. The optimized hybrid fish balls demonstrated superior sensory scores (8.4 ± 0.2 on a 9-point hedonic scale), moderate fat uptake, and higher protein content. The optimized formulation was subsequently validated through reproducibility trials and comparative assessments, confirming consistency in physicochemical, nutritional, and sensory parameters across batches.

Overall, the study highlights the feasibility of developing hybrid fish-based functional foods that combine aquatic and plant proteins to deliver enhanced nutritional value, improved sensory attributes, and economic sustainability. These findings substantiate the potential of hybrid fish products as next-generation value-added seafoods contributing to the diversification and sustainability of the fish processing sector.

INTEGRATING AI-DRIVEN STRUCTURAL HEALTH MONITORING FOR SUSTAINABLE AQUACULTURE INFRASTRUCTURE IN COASTAL REGIONS

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The rapid growth of aquaculture infrastructure in coastal regions has brought unprecedented challenges in maintaining the structural integrity and sustainability of facilities such as fish tanks, ponds, water containment barriers, and associated civil structures. Traditional monitoring methods often fall short in providing timely and accurate assessments necessary to prevent structural failures that can lead to significant economic losses and environmental degradation. This study proposes an advanced AI-driven Structural Health Monitoring (SHM) framework specifically designed for aquaculture infrastructure in coastal environments.

The proposed system integrates a network of state-of-the-art sensors, including strain gauges, corrosion detectors, and environmental sensors, with sophisticated machine learning algorithms capable of analyzing vast amounts of real-time data. This combination enables continuous monitoring and early detection of structural anomalies induced by factors such as saltwater corrosion, wave impact, soil erosion, and extreme weather events like cyclones and floods. By leveraging predictive analytics, the AI system forecasts potential failure points and deterioration trends, facilitating timely maintenance interventions.

Furthermore, this proactive maintenance approach minimizes operational downtime and repair costs, while significantly reducing the risk of catastrophic failures that can adversely affect aquatic ecosystems and local livelihoods. The implementation of such intelligent SHM systems aligns with sustainable engineering practices by optimizing material usage, extending infrastructure lifespan, and promoting environmental conservation.

Through field trials and simulations conducted in representative coastal aquaculture sites in India, the study demonstrates the effectiveness of the AI-based SHM framework in enhancing the resilience and sustainability of aquaculture infrastructure. The integration of civil engineering expertise with cutting-edge AI technology presents a transformative strategy to support the scalable and sustainable expansion of the aquaculture industry, ensuring food security, economic growth, and ecological balance in India's coastal regions.

UNTARGETED ¹H-NMR AND UPLC-QTOF-MS METABOLOMICS OF *Holothuria cinerascens* FROM KWAZULU-NATAL, SOUTH AFRICA: SEASONAL AND TISSUE-SPECIFIC INSIGHTS

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Sea cucumbers, soft-bodied marine invertebrates with significant ecological roles, are recognised as valuable assets in aquaculture systems and are known to possess potent health benefits attributed to their biologically active molecules. However, research has predominantly centred on high-value, commercially targeted species, neglecting the potential of others as sources of beneficial metabolites. This targeted focus has increased demand and commercial value of select species, leading to detrimental effects on natural populations due to exploitation and poaching.

This study presents the first metabolomics analysis of *Holothuria cinerascens* from KwaZulu-Natal, Southern Africa, aimed at utilising ¹H-NMR and UPLC-QTOF-MS metabolomics techniques to elucidate the metabolic composition and seasonal diversity across and within various tissues. Our findings reveal distinct metabolic and seasonal variations among the body wall, gonad, and gut/mesentery tissues of *H. cinerascens*, with the highest metabolic potential observed in the body wall and gut/mesentery tissues, while the gonadal tissue displayed the lowest potential. These results suggest untapped pharmaceutical and nutritional potential in overlooked species, highlighting the need to expand sea cucumber research and pave the way for future investigations into the metabolic pathways and biological significance of these compounds. The results from this study underscore the potential benefits of Southern African sea cucumber extracts as possible food sources and pharmaceutical components, advocating for further analysis of influencing factors and integration into sustainable cultivation systems. Furthermore, our findings advocate for future research to explore the bioactive potential of Southern African sea cucumber species through compound isolation utilising a wider range of metabolic techniques and further assess the effects of external factors on metabolite and nutritional composition, which may have significant implications in cultivation and nutritional monitoring.

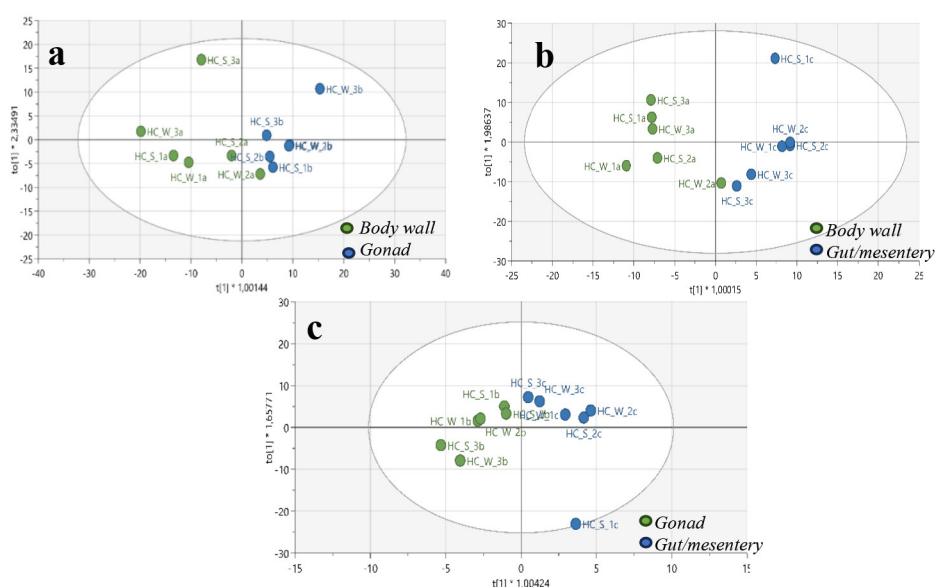


Figure 1: OPLS-DA score plots showing the body wall vs gonad (a), body wall vs gut/mesentery (b), and gonad vs gut/mesentery body tissue comparison in *H. cinerascens*.

SEASONAL VARIATION AND REPRODUCTIVE BIOLOGY OF SNOW TROUT *Schizothorax richardsonii* IN A HILL STREAM ECOSYSTEM OF ARUNACHAL PRADESH

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Hill streams in mountainous regions are fast-flowing, narrow watercourses that support diverse freshwater ecosystems. A study was conducted from 2022 to 2024 in the Bichom River, Arunachal Pradesh, to assess fish diversity and the reproductive biology of *Schizothorax richardsonii* (snow trout). Sampling was conducted at six sites across pre-monsoon, monsoon, and post-monsoon seasons. The riverbed, composed of boulders, cobbles, and gravel, supported typical hill stream features such as riffles, pools, and dense bank vegetation. *S. richardsonii* was the most dominant species, followed by *Neolissochilus hexagonolepis* and *S. progastus*. Both *S. richardsonii* and *S. progastus* undertake upstream migration during the breeding season and return downstream after breeding. Fish abundance and diversity were highest during the pre-monsoon and post monsoon periods, declining during the monsoon due to habitat disturbances. Spatial differences in fish assemblages reflected transitions between lotic and lentic habitats. The family Cyprinidae dominated the fish community, comprising approximately 85% of the total population, while Danionidae (2%), Balitoridae (1%), and Psilorhynchidae (1%) were least represented (Fig. 1).

S. richardsonii, locally known as ‘Asla’, is listed as Vulnerable (IUCN, 2025-1) and is threatened by habitat fragmentation, overfishing, and invasive species. A total of 120 specimens were examined, and six maturity stages were identified. Ova were large and distinct during pre- and post-monsoon seasons and smaller during the monsoon. Ova diameter ranged from 0.4 to 2.0 mm, with a mean absolute fecundity of 4,304 ova and relative fecundity of 12 ova/kg body weight. The gonadosomatic index (GSI) ranged from 0.11 to 3.83. Length at first maturity was 16.5 cm for males and 17.5 cm for females, with males outnumbering females across all seasons. The biological data generated through this study provide critical insights for the conservation and management of this indigenous species in the Eastern Himalayan region.

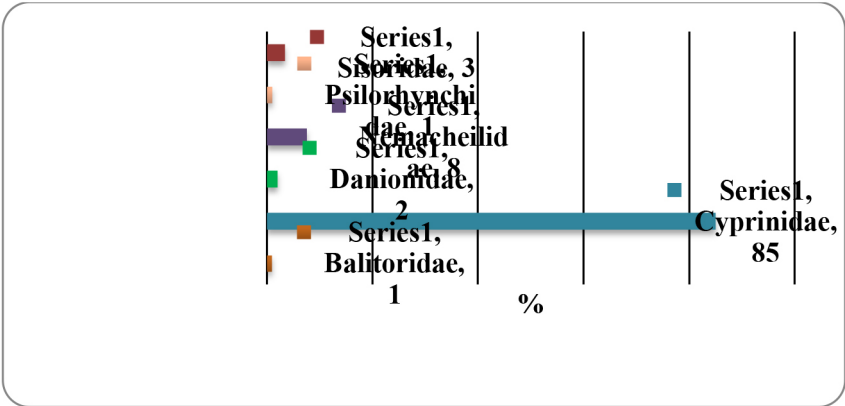


Fig. 1 Relative abundance (%) of fish families at sampling sites in the Bichom River during 2022-24

INSIGHTS INTO THE REPRODUCTIVE BIOLOGY OF ELECTRIC RAYS (TORPEDINIFORMES) CAUGHT AS BY-CATCH OFF VISAKHAPATNAM

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Electric rays (Order: Torpediniformes) are benthic elasmobranchs capable of generating electric discharges through specialized paired kidney-shaped electric organs derived from branchial muscles. Despite their ecological significance, they remain poorly studied, particularly in terms of reproductive biology, which is vital for effective conservation and fishery management. This study examines the reproductive physiology of four torpedinoid species commonly caught as by-catch off Visakhapatnam in eastern India. These species are *Torpedo panthera*, *T. marmorata*, *Narcine brunnea*, and *Narke impennis*. All species exhibit internal fertilization and aplacental viviparity, with embryos nourished initially by yolk and later by histotrophe or uterine milk. Sexual dimorphism in reproductive organs was evident. Males possess paired testes, coiled vas deferens, and claspers, which are soft and flexible when immature but become elongated, calcified, and functional at maturity. Female reproductive development progresses from juvenile ovaries to those containing yolky oocytes, fertilized eggs, and embryos. The uterus is thin-walled and sac-like, capable of accommodating multiple embryos.

Fecundity varied between and within species. Ovarian fecundity was generally higher than uterine fecundity, suggesting the possibility of oocyte resorption or embryo loss during gestation. Most females showed right-side dominance in ovarian development. Embryos were unencapsulated and free within the uterus, displaying adult like body shape and pigmentation, and often retaining visible yolk sac scars. Gestation was estimated to last six to seven months. *T. panthera* had the largest neonates (98-113 mm), while *N. brunnea* and *N. impennis* had smaller ones (41-59 mm and 42-46 mm respectively). Length at first maturity is a key management parameter. Sex ratios varied, with males often outnumbering females, except in some species like *N. brunnea*. Reproductive parameters of torpedinoid electric rays collected from Visakhapatnam are summarized in the table below.

Gravid females and neonates near Visakhapatnam indicate inshore nursery areas threatened by unselective fishing practices. Torpedinoid rays' lecithotrophic viviparity, slow growth, and late maturity increase vulnerability. This study provides essential baseline data on their reproductive physiology from Indian waters, highlighting the need for targeted research to support effective conservation and sustainable species-specific management.

Table. Reproductive parameters of Torpedinoid electric rays from Visakhapatnam

Species (n, ♀ & ♂)	1	2	3	4	5
Vitellogenic activity (months)	~ 6	-	~ 5	~ 6	-
Gestation period (months)	~ 6	-	~ 7	~ 7	-
Ovarian fecundity (eggs)	5-10	11-12	4-12	2-8	6-12
Uterine fecundity (embryos/foetuses)	5-10	1-11	2-8	1-6	9-13
Length at first maturity (mm TL) (♀, ♂)	338, 322	-	165, 155	120, 115	-
Sex ratio (♀:♂)	1:0.6	1:0.3	1:1.4	1:0.8	1:0.9
Size at birth (mm TL)	98-113	-	41-59	42-46	94-100

1. *T. panthera* (92, 37♀ & 55♂); 2. *T. marmorata* (46, 12♀ & 34♂); 3. *Narcine brunnea* (276, 161♀ & 115♂); 4. *Narke impennis* (250, 113♀ & 137♂); 5. *T. fuscomaculata* (45, 22♀ & 23♂)

TOXICOLOGICAL AND BEHAVIOURAL STUDY OF BISPYRIBAC SODIUM ON ZEBRAFISH *Denio rerio*

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This study explores the toxic effects of herbicide , Bispyribac Sodium on Zebra fish (*Denio rerio*), a commonly used model organism in toxicological research studies. These fish are often used in research because they are small, easy to handle, and react clearly to harmful substances. In this experiment, healthy adult zebrafish were kept in clean water and water mixed with the herbicide at three levels: 1 mg/L, 2 mg/L, and 3 mg/L. The fish were observed for 72 hours to check how many survived and how they behaved.

No fish died in clean water or at 1 mg/L, but many died at 2 mg/L, and all died at 3 mg/L.

So, LC 50 in 24 hrs is 3mg/L, LC 100 in 72 hrs is 3 mg/L. LC100 in 72 hrs is 1 mg/L ,2 mg/L, LOEC is 1mg/L. Along with death, treated fish showed unusual behaviour like swimming alone, staying in dark areas for long, acting aggressively, and not swimming properly. These changes suggest the herbicide affected the fish's brain or stress levels.

To know more, biochemical analysis were done on fish tissues. The results showed reduced levels of important enzymes like Hexokinase(reduced from 192.9 U/g to 38.5 U/g), glucose 6 phosphate(reduced from 32.1 mg/gm to 12.8 mg/gm) , along with decline in Glycogen(reduced from 3.0 mg/gm to 1.2 mg/gm), protein (reduced from 0.2 mg/gm to 0.05 mg/gm)and cholesterol (reduced from 3.3 mg/gm to 1.3 mg/ gm).This suggests disrupted metabolism & possible Liver damage.

In short, this herbicide can harm fish in many ways—not just killing them but also causing serious changes in behaviour and health. This shows the need to use such chemicals more carefully to protect aquatic life.

SUSTAINABLE AQUACULTURE BUSINESS MODELS – NEXRUR CASE STUDIES IN HUNGARY

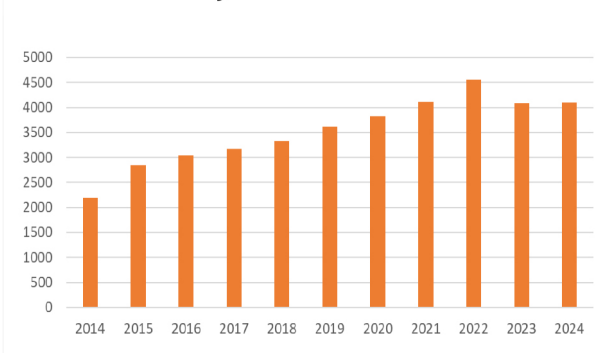
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The NEXRUR project (Next Generation Sustainable Business Models and Monitoring for Rural Resilience and Innovation, Project Nr. 101181273) is a Horizon Europe initiative addressing the economic, social and environmental challenges of rural areas in Europe and China led by the Leibniz Institute for Agricultural Engineering and Bioeconomy, (ATB) in Germany. It investigates community-led and sustainable business models across 22 case studies, including two Hungarian aquaculture examples coordinated by HUNATiP. The project aims to co-create innovative models that enhance farmers’ prosperity, strengthen rural communities, and improve environmental performance through inclusive and sustainable practices.

The pond aquaculture case study investigates the possible business model of ecosystem-friendly freshwater aquaculture products and ecosystem services. By strengthening and valorizing the ecosystem services of Biharugra fish ponds in Hungary—such as water retention, biodiversity support, and climate resilience—together with the local community, the project seeks to develop inclusive business models that boost fish farmers’ prosperity, rural jobs, and community awareness. The case also explores short food supply chains and certification systems to highlight the environmental and social value of pond products. The intensive freshwater aquaculture case study develop a new biobased circular economy business model for the rapidly developing African catfish farming in Hungary. In this circular economy model waste and by-products from intensive aquaculture will be processed in cooperation by a group of fish farmers and reused in local agriculture and horticulture. The goal is to minimize the environmental footprint of intensive aquaculture, promote circular practices, and enhance rural livelihoods through job creation and local food supply. By valorizing waste streams and integrating aquaculture with farming, this case provides replicable solutions for other landlocked countries with small-scale aquaculture.

FIGURE 1. Growth of African catfish production in Hungary (Tonnes of produced market size fish)



BOOSTING AQUAPONICS PRODUCTIVITY WITH FISH AMINO ACID AND SEAWEED-BASED BIOSTIMULANT SYNERGY

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Developing more efficient and potentially sustainable nutrient supplementation strategies, such as organic amino acids and biostimulants, is critical for advancing aquaponics and reducing reliance on synthetic inputs. This study evaluates the synergy of fish amino acid (FAA) - an organic nitrogen source that enhances nutrient availability and a seaweed-based biostimulant (SB) - rich in bioactive compounds that stimulate plant growth, in a coupled nutrient film technique (NFT)-based aquaponics system to enhance Nile tilapia (*Oreochromis niloticus*) growth and Brahmi (*Bacopa monnieri*) biomass. The research aimed to quantify the interaction effects of these SB and FAA on key performance indicators for both fish and plants, thereby identifying an optimal organic fertilization strategy.

To test this, four treatments combining different concentrations of SB and FAA were applied in triplicate for 6 weeks, alongside a no-input control. The treatments included supplementation with 25% SB and 2.5 mL/L FAA (SB25–FAA2.5), 25%SB and 5.0 mL/L FAA (SB25–FAA5.0), 45% SB and 2.5 mL/L FAA (SB45–FAA2.5), and 45% SB and 5.0 mL/L FAA (SB45–FAA5.0). These organic fertilizers were applied at 4-day intervals by foliar spray to the plants in the evening. Fish metrics (weight gain, specific growth rate, and feed conversion ratio) and plant metrics (height, shoot number, and fresh biomass) were monitored fortnightly. Water physicochemical parameters (nitrogen dynamics, pH, dissolved oxygen, total dissolved solids, electrical conductivity, alkalinity) were monitored once a week. The results demonstrated significant concentration-dependent responses to combined FAA-SB treatments, with SB45–FAA2.5 achieving optimal performance efficiency compared to the other treatments. As shown in Table 1, SB45–FAA2.5 exhibited the highest plant growth rate and fresh biomass accumulation. While SB45–FAA5 produced the highest absolute biomass, SB45–FAA2.5 demonstrated superior resource utilization, achieving 87.3% of SB45–FAA5.0's yield with 50% less FAA input. SB45–FAA2.5 also shown to be the most suitable for tilapia growth, with the higher weight gain and feed utilization in this treatment. These results validate the synergistic potential of FAA-SB combinations for commercial aquaponics applications.

Table 1: Growth response of Brahmi in the aquaponics system over different treatments.

Treatment	Initial mean weight (g)	Final mean weight (g)	Growth rate (%)	Relative growth rate (g/ day)	Plant height (cm)	Number of branches
SB25–FAA2.5	8.32±1.66	16.50 ± 6.63	106.65	0.0173	53.87±9.67	18.78±11.24
SB25–FAA5.0	9.33±1.94	19.50 ± 3.98	109.08	0.0176	56.53±10.12	25.56±12.17
SB45–FAA2.5	7.78±4.41	22.85 ± 8.51	193.91	0.0257	60.00±11.93	32.00±11.78
SB45–FAA5.0	9.98±3.24	26.17 ± 7.91	162.32	0.0230	71.72±15.28	40.00±9.84
Control	7.13±1.32	14.23±2.62	99.64	0.0165	50.24±6.35	16.14±8.34

GENETIC CHARACTERIZATION OF THE MEDIUM CARP *Barbodes carnaticus*, FROM PENINSULAR RIVER SYSTEM

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Barbodes carnaticus is one of the important freshwater fish species widely found along the Cauvery river system of peninsular India. *B. carnaticus* belongs to the group of medium carps and attains large size. Information on the genetic makeup of stocks is extremely vital as it forms the basis for future genetic studies to improve captive breeding of the species. We used COI genes of mtDNA of *B. carnaticus* stocks collected from its natural habitat of Cauvery River system in Karnataka (Ramanathapura (30), Shivanasamudra (20), domesticated stock from CIFA, Hesaraghatta (22) and Tamil Nadu (Hogenakkal (24) and Chalakudy River in Kerala (Peringalkuthu (21). MtDNA analysis of *B. carnaticus* using COI gene shows that it has 12 haplotypes with an overall haplotype diversity of 0.451 ± 0.062 and nucleotide diversity of 0.00097 ± 0.00016 . The data suggest that the Ramanathapura stock is having high diversity, while the Chalakudy stock is made of only one haplotype. The haplotype network revealed that there were differences in distributions and frequencies, and H1 was the most common and extensively distributed haplotype observed in the study. Each circle represents a haplotype and circle size is proportional to the haplotype frequency. The colors indicate locality according to the legend, and hatch marks represent the number of mutations by which haplotypes differ Fig 1. The observed unique haplotypes might be useful for differentiating the stocks. AMOVA analysis indicates that there is a significant genetic variation within the stock (89.74%), while between stocks the variation is around 10.26%. The genetic diversity studies help in identifying the similarities/ differences of the stock. Further, the study shows that it is important to form a base population from all the locations to conduct a breeding program of the species.

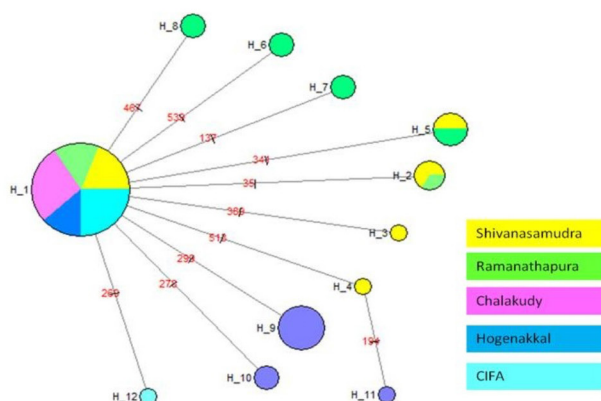


Fig. 1. Haplotype median joining network from sequences of COI of *B. carnaticus*

AWARE AQUAPONICS FROM WASTEWATER RECLAMATION

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The growing demand for sustainable protein and fresh produce in Europe coincides with increasing water scarcity and stricter environmental regulations that constrain traditional aquaculture and agriculture. Urban and peri-urban communities often face limited access to freshwater and arable land, calling for innovative food production systems that optimise resource use and close nutrient and water loops.

The EU-funded AWARE project (Aquaponics from WAstewater REclamation) pioneers the reuse of reclaimed municipal wastewater in aquaponics as a circular solution to these challenges. AWARE integrates an advanced quaternary treatment line - combining ozonation, advanced mixing (MITO X®), vacuum-UV irradiation, and biofiltration - within a municipal wastewater treatment plant in Castellana Grotte, Italy, and connects it to Europe's first demo-scale reclaimed-water aquaponic farm. The Recirculating Aquaculture System (RAS) currently grows Nile tilapia (*Oreochromis niloticus*) coupled with hydroponic lettuce (*Lactuca sativa*), and is enhanced by IoT-based water-quality monitoring, automated feeding and aeration, and real-time monitoring.

During Cycle I (August - December 2024), AWARE demonstrated that reclaimed water treated through the quaternary system meets is safe to use for aquaponic production. Tilapia grew from ~10 g to 65–95 g per fish in one cycle, reaching up to 17 cm in length. Lettuce increased from ~2 g to 57–65 g per head, with no differences between reclaimed-water and freshwater systems. Some nutrient supplementation (iron and salts) was needed, but once applied, production was steady. Despite the supporting scientific evidence, the project also evidenced a lacking regulatory framework, which presently does not allow to use reclaimed water in aquaculture for food production, regardless of its quality.

Comprehensive analyses confirmed that chemical contaminants, heavy metals, regulated food-borne pathogens, and key viruses in fish and vegetables were either undetectable or well below EU regulatory thresholds, validating both the safety and viability of the reclaimed-water value chain.

These results mark the first European proof-of-concept that reclaimed wastewater can sustain safe and productive aquaponics for human consumption. Building on this milestone, AWARE is now scaling up the system for continuous production in 2025-26 and supporting feeding trials to assess nutritional quality and consumer acceptance of reclaimed-water tilapia. The project contributes to EU ambitions for circular-water use, climate-resilient aquaculture, and innovative urban food systems while informing future regulatory frameworks for water reuse in food production.

SYMBIOSIS AND LOCALIZATION OF PROBIOTICS WITH NATIVE MICROBIOTA IN SUSTAINABLE SHRIMP AQUACULTURE

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Probiotics are pivotal in sustainable shrimp aquaculture, enhancing disease resistance, improving water quality, and maintaining overall pond health. Their efficacy depends on the ability to integrate and establish symbiotic relationships with native microbial communities in both the pond environment and the shrimp microbiota. Effective probiotics interact dynamically—competitively and cooperatively—with indigenous microbes to create a stable, functional ecosystem.

To establish early symbiosis, select a probiotic product capable of inhibiting pathogenic *Vibrio parahaemolyticus* through a three-day feeding trial at 1% inclusion, with green Vibrio counts measured before and after treatment. Probiotics should be applied two weeks prior to seed stocking and again two weeks after stocking. Preparation involves fermenting rice bran for 24 hours in liquid culture followed by 24 hours of wet proliferation. The fermented rice bran is then packed into 40-mesh net bags and hanged in front of water paddle wheels for one week to promote in-pond probiotic proliferation and integration. This procedure is repeated weekly for four consecutive weeks. In addition, copepod eggs can survive chlorine treatment and hatch; the emerging copepods act as carriers, delivering probiotics into the shrimp digestive tract and internal organs, thereby facilitating early host–microbe symbiosis.

Continuous administration of probiotic-enriched feed via automatic feeders ensures sustained gut colonization, promoting digestion, immunity, and growth, while aiding in post-excretion water purification. Additionally, co-application of probiotics with clay and zeolite supports the formation of biofilms and activated sludge. These carriers facilitate microbial attachment and nutrient cycling, improving water quality and pathogen suppression.

Over time, probiotic strains become localized in pond substrates and the surrounding environment, contributing to long-term biosecurity. This integrated and localized microbial management strategy enhances pond resilience and ecological balance, supporting the sustainable intensification of shrimp aquaculture systems.

INHIBIN PEPTIDE MODELING AND VACCINE DESIGN FOR ENHANCED FECUNDITY IN TROUT: A COMPUTATIONAL APPROACH

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Inhibins are heterodimeric glycoproteins that belong to the transforming growth factor- β superfamily known to selectively inhibit FSH secretion through negative feedback regulation. Inhibin neutralisation using antibodies or inhibitory peptides offers a promising approach for enhancing reproductive output in aquaculture broodstock. The Inhibin- α sequence of *Oncorhynchus mykiss* was retrieved from NCBI (Accession no. XM_021610999.2) and aligned using ClustalW with homologous sequences from *Clarias batrachus*, *Fundulus spp.*, *Salmo trutta*, and *O. mykiss*, *O. nerka*, *Carrasius auratus* and *Homo sapiens* to identify conserved regions. B-cell and T-cell epitopes were predicted using IEDB tools based on antigenicity, surface accessibility, hydrophilicity and flexibility. Out of the many predicted B cell epitopes, amino acid residues from 104-115 were. Similarly, prediction for T cell epitopes was done, and the region 333-347 was selected. The predicted epitopes were validated across various prediction tools. Surface exposure and spatial orientation were further confirmed using BepiPred-2.0 (DTU Health Tech), JSmol visualisation, and SwissModel 3D structural modelling, which located the epitopes on solvent-accessible regions of the inhibin- α protein, confirming their accessibility for antibody binding. The selected epitopic region was synthesized as a peptide, purified, and characterised by RP-HPLC and LC-MS. In RP-HPLC, a single sharp peak was observed at a retention time of 12.73 min. The molecular weight of the peptide was confirmed by LC-MS. The molecular weight of the synthesised peptide was found to be 3086.79 Da, corresponding to the expected value of 3086.16Da. The findings of the study demonstrate successful in-silico design and synthesis of a conserved surface-exposed inhibin- α peptide. The peptide is predicted to elicit a specific antibody response capable of improving FSH-mediated reproductive functions in *Oncorhynchus mykiss*.

A NATURAL FEED ADDITIVE ENHANCES THE GROWTH AND HEALTH OF WHITE SHRIMP *Penaeus vannamei*

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Vibrio parahaemolyticus commonly found in coastal areas and estuaries. It causes acute hepatopancreatic necrosis disease (AHPND), a condition previously known as early death syndrome (EMS). Phytogenics has been widely used in aquaculture because of their antibacterial activity and less pollution. The feeding and disease challenge trial was conducted to evaluate the impact and efficacy of a natural feed additive on the growth and health of *Litopenaeus vannamei*.

Four treatment groups were designed, among which, the control group was standard feed; the trial group 1 (T1) was standard feed with 0.2% natural feed additive; the trial group 2 (T2) was standard feed with 0.4% natural feed additive; the negative control group (NC) was standard feed with 0.0015% florfenicol which purity is above 98%. First, 360 shrimps with body weight of (2.30 ± 0.07) g were randomly divided into 12 buckets with 3 replicates in each treatment group and 30 shrimps in each replicate. During the trial, the water was natural seawater after gauze filtration and disinfection, and the water temperature was $29 \sim 31^\circ\text{C}$. The water was changed 4/5 per day, the feed was 4 times per day, the daily feed was 5% ~ 7% of the shrimp body weight. After 52 days of the feeding trial, the remaining shrimp after sampling were challenged with *Vibrio parahaemolyticus* at 10^8 CFU/ml. Mortality was then monitored for 72 hours.

As can be seen from Table 1, there was no significant difference in survival rate between all treatment groups. The final weight, weight gain rate and specific growth rate showed a similar trend, and the T2 group was significantly higher than that of control group and NC group ($P < 0.05$). According to the results of challenge test in table 2, shrimp in T1 and T2 groups had lower mortality than the control group and NC group after 72 hours.

TABLE 1. Initial weight, final weight, survival, weight gain and specific growth rate (SGR) of the four groups. Means in a column with different letters were significantly different ($P < 0.05$).

	Control	T1	T2	NC
Initial weight(g)	2.27±0.07	2.33±0.03	2.30±0.03	2.29±0.00
Final weight(g)	8.29±0.42 ^{bc}	9.24±0.23 ^{ab}	9.84±0.17 ^a	7.93±0.22 ^c
Survival(%)	92.22±4.01	95.56±1.11	91.11±2.22	90.00±0.00
Weight gain(%)	267.08±27.51 ^b	297.25±11.15 ^{ab}	328.27±9.63 ^a	245.81±9.56 ^b

TABLE 2. Mortality of four groups fed with different diet and challenged with AHPND-causing bacteria within 72 hours.

	0h	24h	36h	48h	60h	72h
control (%)	0.00	10.37	30.51	30.51	40.88	57.31
T1 (%)	0.00	8.46	16.62	16.62	32.68	36.01
T2 (%)	0.00	2.78	8.12	14.18	22.77	28.36
NC (%)	0.00	0.00	32.17	48.95	57.11	57.11

INTEGRATING METAGENOME AND TRANSCRIPTOME ANALYSIS TO UNCOVER THE HOST-MICROBIOME INTERACTIONS IN JUVENILE ASIAN SEA BASS (*Lates calcarifer*) FED DIETS SUPPLEMENTED WITH MANNAN OLIGOSACCHARIDES, *Yucca schidigera* EXTRACT, AND SOLID-STATE FERMENTED *Aspergillus niger*

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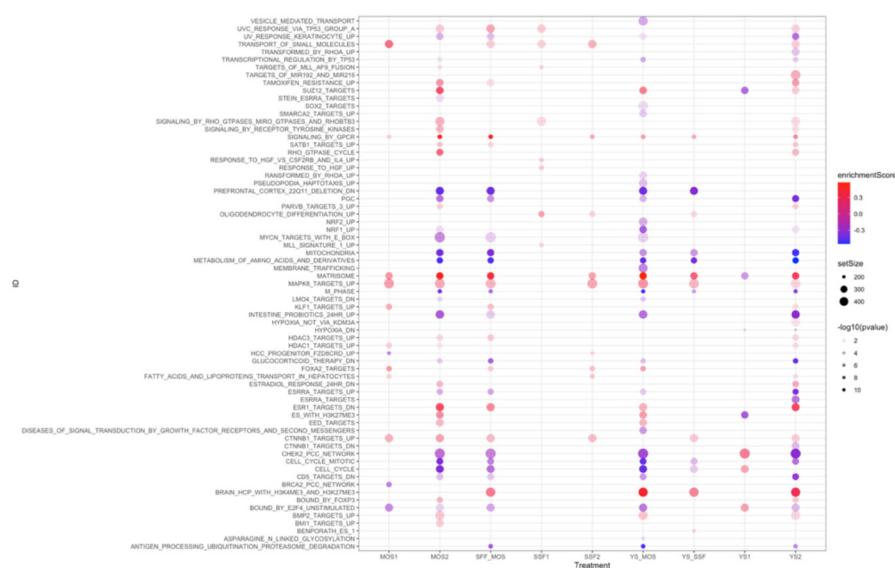
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Commercial diets are widely used in aquaculture due to their cost-effectiveness and adequate nutritional for broad-diet species. However, carnivorous marine fish such as Asian seabass (*Lates calcarifer*), with limited capacity to digest plant-based feeds, require specialized feed additives to improve digestibility, promote growth, and support gastrointestinal health. This study aims to investigate the effects of feed additives (mannan oligosaccharides (MOS), *Yucca Schidigera* extract (YS), and solid-state fermented *Aspergillus niger* (SSF)), individually and in combination, on the growth, gut microbiota, and transcriptomic responses of juvenile *L. calcarifer*. A 70-day feeding trial was conducted with 10 dietary treatments, and growth performance and gut microbiota composition were assessed. Notably, fish fed with YS+SSF diet showed upregulation of growth-related genes, including ACTA1, CKMA, AMPD1, AK1, ATP2A1L, and CASQ1 and enrichment of KEGG and GO terms and pathways which are critical for muscle development, energy metabolism, cellular function, and calcium metabolism. Although gut microbiota diversity were reduced in fish fed with YS+SSF diet, this diet had enriched beneficial taxa such as *Ralstonia* and *Lactobacillus* which are crucial in nutrient digestion and feed utilization. These findings indicate that the synergistic effects of YS and SSF not only optimize gut microbial composition. but also activate host molecular pathways function to improve the growth of *L. calcarifer*.



THE IMPORTANCE OF PROTEIN QUALITY IN LARVAL SHRIMP DIETS: STUDIES ON AMINO ACIDS, PEPTIDES AND DIGESTIBILITY

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The nutritional effectiveness of a protein source depends on its digestibility, its amino acid profile and the size of its peptides. All these characteristics significantly influence protein synthesis and growth in fast growing shrimp larvae and postlarvae. Diets based on fish or squid meals tend to give good results but can be improved considerably through the inclusion of additional essential amino acids and di- and tripeptides. To have a better understanding of the fundamental and zootechnic aspect of protein nutrition and protein quality, three studies with white shrimp *Litopenaeus vannamei* were conducted by INVE Aquaculture in co-operation with several academic institutions.

Amino acids – The first study applied a two-level fractional factorial Plackett-Burman design to identify the most important amino acids (variables) affecting growth of shrimp larvae and postlarvae. It allowed screening 20 amino acids in one single trial with 110 larval rearing tanks (22 treatments and 5 replicates). Those amino acids that had a statistically significant positive effect on growth were then added to a new experimental diet and a second shrimp hatchery test validated the usefulness of this approach.

Peptides – This study enabled profiling of different protein sources based on the molecular weight size distribution of the peptides with size-exclusion chromatography. Enriching feeds with the right combination of amino acids and small/medium-sized proteins helps avoid imbalances that can occur with free amino acids which may be absorbed too quickly or inefficiently, or with large proteins that need complete enzymatic breakdown.

Digestibility – The third study is a newly-developed *in vitro* assay with enzyme extracts of shrimp larvae and postlarvae that was used to screen (novel) protein sources for digestibility in zoea, mysis and PL stages.

The information obtained from this extensive research on protein quality has been employed to improve INVE's ingredient sourcing and feed formulation. This approach had a proven effect on growth and robustness of shrimp as demonstrated in many commercial hatchery trials with INVE's top feed range.

LIPID ASSIMILATION IN WHITE SHRIMP LARVAE AND POSTLARVAE

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In collaboration with Ghent University, a study on larval shrimp nutrition examined the assimilation and dynamics of lipid compounds during feeding. Biochemical screening was conducted on both the diets and on *Litopenaeus vannamei* larvae and postlarvae that consumed them. The screening included in-depth fatty acid (FA) profiling and fractioning into glycolipids, phospholipids and neutral lipids. A non-metric multidimensional scaling method was used to visualize similarity. Statistical analysis revealed that shrimp FA profiles reflected diet composition (Fig. 1). The best-performing feed was distinguished by three specific FA (not HUFAs). In shrimp samples, phospholipids (structural lipids linked to growth) responded differently to diets than glycolipids (involved in energy storage).

A second study assessed ontogenetic shifts in energy needs and allocation. Diets significantly influenced FA profiles in zoea and mysis stages, while postlarvae showed greater variability. Dietary lipids particularly impacted growth during early stages.

This research identified key fatty acids driving growth and clarified the distinct roles of phospholipids and glycolipids, offering insights for optimizing shrimp feed formulations in function of larval stage and the feed's targeted function (e.g. growth, robustness).

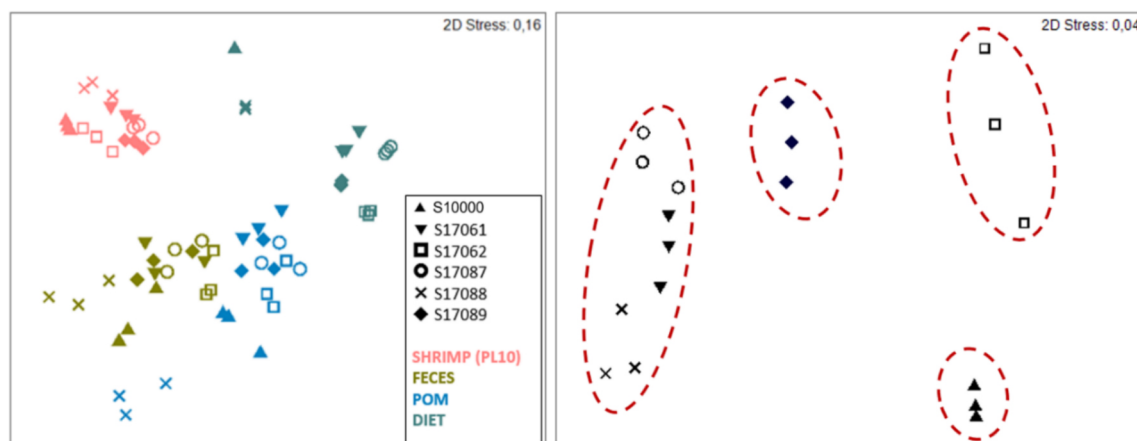


Figure 1: nMDS plot (Bray-Curtis similarity) of square root-transformed FA data by sample type and diet (left), and total lipids in PL10 postlarvae (right). POM refers to water samples. S-codes indicate feeds with varying lipid compositions or dietary treatments.

IMPROVED MACROBRACHIUM CULTURE THROUGH NUTRITIONAL UPGRADE OF THE CUSTARD RECIPE

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Previous studies suggest that egg custard, especially when combined with enriched *Artemia* nauplii, offers a cost-effective diet for *Macrobrachium rosenbergii* larviculture. While some research reports improved survival and growth with added ingredients to the basic egg and milk powder recipe, there is no consensus on the most effective formulation. In practice, custard feed recipes vary widely across hatcheries.

This study aimed to improve and standardize home-made custard feeds by testing two approaches: (1) adding a nutritional supplement mix (ADD) to the farmer's existing recipe, and (2) using a complete instant feed (INST) containing the same additives along with egg and milk powders, requiring only water for preparation. Both formulations included selected marine proteins, essential lipids, vitamins, minerals, and carotenoids.

The trial was conducted in a commercial hatchery in Chachoengsao, Thailand, in 3.5-ton tanks from first stage until late PL. All tanks received equal amounts of *Artemia*, *Moina*, and custard feed; the only variable was the method of custard preparation. The study evaluated the effects of the ADD and INST treatments compared to the hatchery's standard protocol.

The ADD and the INST approach yielded better survival and growth than the standard protocol of the hatchery. The results demonstrate the potential to increase culture efficiency of *Macrobrachium* through upgraded and standardized custard recipes.

Treatment	Survival, avg (%)	Wet weight, avg (mg)
Standard	26	3.3
ADD	33	3.6

Treatment	Survival, avg (%)	Wet weight, avg (mg)
Standard	40	3.9
INST	55	4.1

EFFICACY OF DIETARY PHYTOCEE (HERB MIXTURE) COMBINATION WITH VITAMIN C PHOSPHATE ON THE PERFORMANCE OF WHITE SHRIMP, *Penaeus vannamei*, UNDER DENSITY STRESS CONDITION AND DISEASE RESISTANCE AGAINST *Vibrio parahaemolyticus* AHPND

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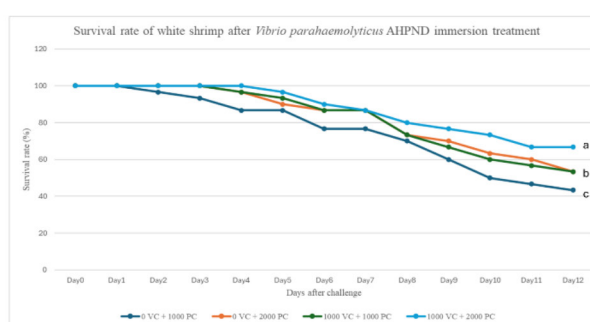
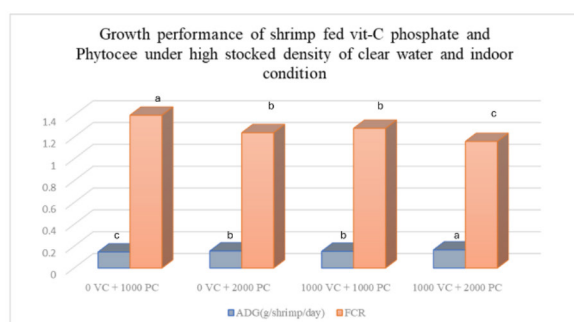
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This study was assessed the effects of dietary phytocee (herb mixture) combination with vit-C phosphate on the performance of white shrimp, *penaeus vannamei*, under density stress condition and disease resistance against *Vibrio parahaemolyticus* AHPND. The experiment focus on 2 factor; A) Vitamin C 0 and 1,000 ppm and B) Phytocee 1,000 and 2,000 ppm then factorial in CRD was assigned in 4 treatment diets and 6 replicates; a) diet with the sole Phytocee 1,000 ppm b) diet with the sole Phytocee 2,000 ppm c) diet with VIT-C PP 1,000 ppm and Phytocee 1,000 ppm, d) diet with VIT-C PP 1,000 ppm and Phytocee 2,000 ppm. Seven hundred and twenty juvenile shrimps with initial mean 1.4 gram/individual were randomly distributed into 240L of 24 glass aquarium that contained 120L of 15 ppt seawater and stocked 30 shrimp per aquarium (250 pcs/m³). Shrimp were fed experimental diets 3-8%BW, 4 times a day during 8 weeks of feeding trial. The growth performance and bath treatment of *Vibrio parahaemolyticus* AHPND 6.2X10⁵ CFU/ml was investigated. The results showed that the growth performance in terms of shrimp production, final weight, average daily gain, and feed conversion ratio were significantly differences (p<0.05). In addition, the survival rate was not significantly differences (p>0.05). After Vibriosis AHPND immersion treatment, the survival rate was significantly high in group of shrimp fed diet with VIT-C PP 1,000 ppm and Phytocee 2,000 ppm follow by group of shrimp fed diet with the sole Phytocee 2,000 ppm and group of shrimp fed diet with VIT-C PP 1,000 ppm and Phytocee 1,000 ppm and lowest in group of shrimp fed diet with the sole Phytocee 1,000 ppm (p<0.05).

Therefore, Dietary phytocee 2,000 ppm combination with vitamin C phosphate 1,000 ppm was recommended for the advantage on growth performance and feed utilization of white shrimp, *penaeus vannamei*, under density stress condition of 250 pcs/m³ and benefit of high survival rate presenting on disease resistance against *Vibrio parahaemolyticus* AHPND immersion treatment. Moreover, the sole phytocee 2,000 ppm and dietary phytocee 1,000 ppm combination with vitamin C phosphate 1,000 ppm were recommended for economic feed to enhance growth performance, feed utilization and survival rate during Vibriosis AHPND challenge test.



THE KEY TECHNOLOGY DEVELOPMENT AND INDUSTRIALIZATION OF FISH PUMP

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The fish catches and transportation is crucial in fishery production. With the development of modern fishery technologies, the application of fish pumps has become increasingly widespread. The use of fish pumps can transport fish in the shortest time and reduce the damage to the fish during the operation, thereby improving the survival rate of fish. The application of fish pumps can save manpower, improve work efficiency, and significantly improve economic benefits. Our team has the serialization design capability of vacuum fish pumps with single/double tanks. The team designed four sets of vacuum fish pumps for the world's first 100,000-ton smart fishery large-scale aquaculture vessel "Guoxin No.1" and successfully delivered them in June 2022. The vacuum fish pumps have the functions of catching adult fish, collecting dead fish and bilge dirt. Up to now, the equipment has caught nearly 10,000 tons of adult fish for "Guoxin No. 1". The shipowner of "Guoxin No.1" is highly satisfied with the operation effect of the equipment.

The team developed two new types of fish pumps and has the independent intellectual property rights: the vacuum water diversion fish pump and the flow-guiding fish pump. Compared with traditional vacuum fish pumps, centrifugal fish pumps, and jet flow fish pumps, the new types of fish pumps have significant advantages in terms of cost and energy consumption and cause no damage to fish. The team designed 12 sets of vacuum water diversion fish pumps for the 150,000-ton smart fishery large-scale aquaculture vessels "Guoxin No.2-1" and "Guoxin No.2-2." The product of vacuum water diversion fish pumps was delivered in May 2024. Compared with the vacuum fish pumps on "Guoxin No.1," the vacuum water diversion fish pump has increased the conveying capacity by 33%, reduced energy consumption by 80%, and reduced cost by 30%. Compared with the vacuum fish pumps of the same transportation capacity, the flow-guiding fish pump has reduced energy consumption by 50% and reduced cost by 30%. In 2025, the flow-guiding fish pump will be applied to the mechanized capture of *Penaeus vannamei*. In the future, our team will further optimize the process flow and key equipment structure of the new fish pumps and promote their wide application in the field of fish catches and transportation.

EPIGENETIC-BASED MOLECULAR MARKER SCREENING FOR GENOMIC SELECTION IN *Litopenaeus vannamei*

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Genomic selection, which uses genome-wide molecular markers to estimate breeding values, has become an essential tool in aquaculture breeding due to its high predictive accuracy. However, high genotyping cost and reduced model performance across populations and generations due to allele frequency change limit its practical application. Screening molecular markers with higher predictive accuracy and greater genetic stability is critical to reducing costs and improving performance. Histone modifications, as key epigenetic regulators, provide comprehensive information on cis-regulatory elements and chromatin states. This study presents an innovative histone modification-based SNP screening method for genomic selection of growth traits (body length) in *Litopenaeus vannamei*. Using resequencing and phenotypic data from 973 shrimp, genomic selection models (GBLUP, BayesA, BayesB, BayesC) were constructed. Prediction accuracy improved with increasing marker density, stabilizing after 20k SNPs, with BayesA achieving the highest accuracy (0.36 ± 0.01 at 30k SNPs). CUT&Tag technology was used to generate high-resolution profiles of H3K4me1, H3K4me3, H3K27me3, and H3K27ac from *L. vannamei* embryos at multiple developmental stages and adult muscle tissues. These profiles were used to annotate cis-regulatory elements across the genome, and SNPs in these regions were screened for predictions. In low-density intervals (0.5k-5k), SNPs in H3K4me1 and H3K4me3-enriched regions outperformed randomly selected SNPs, showing 5.56%-6.90% higher predictive accuracy and greater stability. Moreover, integrating multiple histone modifications revealed that SNPs in bivalent promoter/enhancer regions of adult muscle tissue significantly improved prediction accuracy across all tested densities (0.5k-15k). At 15k SNPs, accuracy improved by 26.71% (from 0.35 ± 0.02 to 0.44 ± 0.01), surpassing the maximum accuracy achievable using all SNPs in conventional methods. The method also improved predictions in distantly related populations, increasing accuracy from 0.22 ± 0.15 to 0.28 ± 0.11 at 15k SNPs. This study provides an efficient, cost-effective molecular marker screening strategy for genomic selection in aquaculture animals, advancing the practical application of genomic selection. Additionally, the cis-regulatory element annotations generated in this study offer valuable resources for functional genomics research in *L. vannamei*.

CAGE CULTURE OF *Cyprinus carpio* IN MID-ALTITUDE MAPITHEL RESERVOIR OF NORTHEAST INDIA

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Cage aquaculture is in its infancy in Northeast India and there is need to popularize this technology to sustainably utilize large and variety of available resources in the form of reservoirs and floodplain wetlands. In our present study, we assessed the performance of common carp, *Cyprinus carpio* in cages in a mid-altitude reservoir namely Mapithel reservoir of Manipur. Cages (individual dimension 6x4x4 m) were stocked with fingerlings of common carp, *Cyprinus carpio* (av. length: 12.43±0.67 cm; av. weight: 35.65±4.51 g) at stocking densities of 10, 20, 30, 40 and 50 fingerlings m⁻³ in triplicates. The reared fish were fed with floating pelleted feed at 3-5% of body weight for 5 months. The specific growth rates estimated at the different stocking densities were 1.08, 1.07, 1.00, 0.88 and 0.84, respectively. The gross fish yield increased up to a stocking density of 30 fingerlings m⁻³ beyond which there was no increase in fish yield. Therefore, for rearing *C. carpio* in net cages in Mapithel reservoir, the optimum stocking density was observed to be 30 fingerlings m⁻³.

TAPPING INTO THE GLOBAL ARTEMIA NETWORK: THE INTERNATIONAL ARTEMIA AQUACULTURE CONSORTIUM (IAAC)

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Artemia, or brine shrimp, is a critical live feed in aquaculture, supporting the early development of many commercially important aquatic species. Recognizing its strategic importance, the International Artemia Aquaculture Consortium (IAAC) was established and has since evolved into a global network of development agencies, academic institutions, and industry stakeholders. In 2023, the IAAC was formally recognized by the FAO Subcommittee on Aquaculture, and its secretariat is hosted by NACA in Bangkok.

This presentation explores how the IAAC facilitates knowledge exchange, capacity building, and the promotion of sustainable Artemia production, with a particular focus on Asia and Africa. We will showcase successful collaborative initiatives—including breeding programs, technology transfer projects, and environmental management strategies—and examine how multi-sector partnerships among private companies, universities, and government bodies are addressing pressing challenges such as climate resilience, biosecurity, and the sustainable use of Artemia resources.

By highlighting proven strategies and ongoing initiatives, this presentation aims to encourage broader participation in the IAAC network and promote inclusive, sustainable growth in the global aquaculture sector.

SUSTAINABLE ANIMAL AND AQUATIC FOODS SCIENCE PROGRAM IN THE NEW 2025-2030 CGIAR SCIENCE AND INNOVATION PORTFOLIO

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The Sustainable Animal and Aquatic Foods (SAAF) Science Program is one of CGIAR's flagship initiatives under its new 2025–2030 Science and Innovation Portfolio. SAAF addresses the urgent need for sustainable, inclusive, and resilient food systems in low- and middle-income countries (LMICs), with a focus on the dual sectors of terrestrial livestock and aquatic foods.

Building on the achievements of CGIAR's past initiatives, including Livestock and Climate, Sustainable Animal Productivity, One Health, and Resilient Aquatic Foods, SAAF aims to generate evidence and innovations that empower 1.7 million people to adopt improved animal and aquatic food system practices, enhance dietary diversity for 300,000 individuals, and increase resilience for 420,000 people, including women, youth, and marginalized groups. The program also targets policy change, with the goal of influencing 62 policies that support low-emission, equitable, and nutrition-sensitive food systems.

With a clear vision to improve lives and well-being in LMICs through inclusive, low-emission, and nutrient-dense food supply chains, SAAF is uniquely positioned at the intersection of food, climate, and equity. It collaborates with a diverse range of partners to co-create scalable solutions and tailor interventions to diverse food system contexts across 17 countries in Africa, Asia, and Latin America.

SAAF is articulated around six Areas of Work: (1) Productivity+, (2) Climate and Environment, (3) One Health, (4) Market Systems, (5) Policy Innovation and Scaling, (6) Gender, Youth and Social Inclusion, and (7) Data and Digital Solutions. Through these complementary and interlinked areas, SAAF develops and scales tailored innovations that boost productivity, strengthen market systems, and improve resilience. By working with a wide range of partners, SAAF applies cutting-edge research, data-driven insights, and locally grounded engagement to enable policy change and deliver long-term impact across food systems.

Considering the opportunities in nutrition, income generation, and climate resilience, SAAF program is setting a new paradigm for sustainable animal and aquatic food systems within the CGIAR framework across the Global South.

A POCKET GUIDE TO SCIENTIFIC WRITING IN AQUACULTURE RESEARCH

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As the former Editor-in-Chief of the Journal of Applied Aquaculture, I have experienced firsthand how difficult it is for many students and inexperienced aquaculture scientists to write aquaculture manuscripts. While I am of the opinion that there is no acceptable justification for poor writing skills, I have come to realize that not every aspiring aquaculture scientist (writer) has access to the training and exposure that are required to gain and strengthen scientific writing skills. Relating to my own academic path, which involved studying in Cameroon, Belgium, The Netherlands, Vietnam, Canada and the USA, I can say that being taught by Professors who actively publish scientific articles and studying at Universities where the library (physical and online) puts at the disposal of students and researchers tones of literature can substantially contribute to inspiring and motivating aspiring scientific writers and allow them to quickly acquire writing skills and tools. Given that not everyone would have the chance to follow the same path as me and learn how to write scientific manuscripts through international studies, editorial work and professional experiences across the world, I thought I would disseminate my insights with anyone who is wondering how to write good aquaculture publications.

My journey on the sharing of scientific writing skills started in 2014, when I published the paper titled “Writing a scientific manuscript from original aquaculture research” that was published in 2014 in the Journal of Applied Aquaculture. I then followed up in 2015 with other papers titled “Toward the Professionalization of Aquaculture: Serving as Peer Reviewer for an Academic Aquaculture Journal” that was published in World Aquaculture magazine, and “Misuse of multiple comparison tests and underuse of contrast procedures in aquaculture publications” that was also published in Aquaculture. Furthermore, I was invited to deliver a training workshop on “Improving scientific Writing and tools for research organization” at the World Aquaculture Society annual meeting and conference in Cape Town, South Africa, in 2017. All the experience gained through these science communication activities are collated in this book, in order to better equip the readers with the tools and methods required to write quality aquaculture manuscripts, and increase their chances of getting their aquaculture findings into print.

ASSESSING AQUACULTURE TRANSFORMATION INITIATIVES IN CHINA

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China has been the world's largest aquaculture producer over the last few decades, contributing 57% of global production in 2022. However, after decades of rapid growth, China's aquaculture sector faces significant challenges including environmental degradation, resource competition, aging labor force, and shifting from net exporter to net importer status. In response to these challenges and the rising philosophy of ecological civilization since the 2010s, China has implemented comprehensive transformation initiatives prioritizing green development and sustainability over pure production expansion. This study analyzes 85 transformation initiatives implemented across China's aquaculture sector from 2019 to 2024, evaluating their alignment with international frameworks and measuring their effectiveness. Key policy interventions include the Five Actions for Green and Healthy Development of Aquaculture, spatial planning designating aquaculture zones, restricted zones, and prohibited zones across 1,959 administrative regions, and expansion into new frontiers including offshore systems, saline-alkali lands, and recirculating aquaculture systems. Major achievements include the establishment of 1,614 demonstration farms covering 640,000 hectares, promotion of nine eco-healthy farming models, development of 98 new breeding varieties, 11.3% reduction in veterinary drug usage, and 33% substitution of trash fish with compound feed. The government invested 4 billion yuan (CNY) in standardizing 83,333 hectares of ponds with improved wastewater treatment during 2021-2023. National R&D programs allocated 300 million yuan (CNY) for innovation in blue granary science, intelligent equipment, and sustainable feed development. Results demonstrate that despite reduced farming areas due to environmental protection measures, productivity gains have been achieved through pond standardization, mechanization, and breeding improvements. Freshwater pond yields, unit value of products, and labor productivity all increased significantly since 2000. The transformation represents a paradigm shift from production-oriented to sustainability-oriented aquaculture, offering valuable lessons for other major producing nations facing similar environmental and socioeconomic pressures. This comprehensive assessment provides insights into policy effectiveness, innovation pathways, and the role of government investment in driving sectoral transformation toward ecological sustainability while maintaining food security.

SUSTAINABLE CARP AQUACULTURE IN CHINA: A REVIEW

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China's carp aquaculture represents the world's largest aquaculture industry, producing over 20 million tonnes annually and accounting for 65% of global carp production, yet remains inadequately documented in international literature. This comprehensive study analyzes the sector's evolution from traditional practices dating back to 6000 BC to modern intensive systems, examining its sustainability framework across economic, social, and environmental dimensions.

The research reveals how China's carp sector has transformed since 1978 through government support, technological innovation, and adaptive management. Pond-based systems dominate production, with yields increasing from 1,500 kg/ha in the 1990s to 7,830 kg/ha in 2022. The industry generates substantial economic value exceeding USD 48 billion while providing affordable protein to millions and supporting extensive value chains from seed production to retail distribution. However, intensification presents significant challenges. Environmental concerns include water pollution, eutrophication, and biodiversity impacts, addressed through stricter regulations and sustainable practices like polyculture systems and integrated rice-fish farming. Social considerations encompass smallholder participation, aging farmer demographics, and community engagement. Economic pressures include disease outbreaks causing losses of USD 58.9 billion annually, rising input costs, market volatility, and shifting consumer preferences toward higher-value species. Key success factors identified include robust property rights incentivizing farmer investment, extensive technical training programs, improved germplasm resources, government subsidies and infrastructure development, and adaptive responses to environmental regulations. The study demonstrates how traditional aquaculture can be modernized while respecting ecological boundaries, offering transferable lessons for global aquaculture development, particularly regarding sustainable intensification in smallholder-dominated systems and balancing economic growth with environmental protection.

ORAL TREATMENT PLATFORM FOR SHRIMP DISEASE PREVENTION

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The shrimp aquaculture industry faces significant challenges from disease outbreaks that reduce global shrimp production by 20–40%, causing annual economic losses of approximately €7 billion. These diseases, including White Spot Syndrome Virus (WSSV), *Enterocytozoon hepatopenaei* (EHP), and Infectious Myonecrosis Virus (IMNV), devastate shrimp populations, disrupt supply chains, and disproportionately impact small-scale farmers in developing regions, threatening livelihoods and intensifying poverty. As global demand for sustainable seafood rises, there is an urgent need for innovative, scalable, and eco-friendly disease management solutions to safeguard shrimp production, enhance food security, and support rural economies.

ViAqua has developed an innovative RNAi feed-based platform designed to address three primary pathogens affecting the shrimp aquaculture industry. The product combines double-stranded RNA (dsRNA) with a carrier molecule, creating a delivery system that allows dsRNA to be administered orally and efficiently absorbed by shrimp cells.

Oral trials against IMNV and WSSV were conducted at IMAQUA (Belgium). The trials lasted for 21 days and demonstrated relative percent survival (%RPS) between 77% to 40% depending on the treatment dose.

The oral trial against EHP infection was conducted at ShrimpVet (Vietnam), lasted for 52 days, and demonstrated an improvement in growth performance compared to the positive control group, with higher biomass gain, improved FCR, and more uniform size.

ViAqua's oral platform represents a breakthrough in aquaculture disease management by providing a robust, scalable, and environmentally responsible solution that addresses all major viral threats to shrimp health.