AQUAFOCUS

VOL. 2 / ISSUE 2 / JUNE 2024 / ENGLISH QUARTERLY / CHENNAI

FAITT Technology Transforming Cage Fish Farming at Nagpur

AQUAFOCUS

Dedicated to

Aquaculture Research & Development

English Quarterly Magazine

July 2024

Vol.2 / Issue-2

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FOUNDATION FOR AQUACULTURE INNOVATIONS & TECHNOLOGY TRANSFER

As we venture into the vibrant and ever-changing world of aquaculture, I am delighted to welcome you to the newest issue of Aquafocus. Serving as the Editor-in-Chief of this magazine is a profound honor, and I am eager to share with you the latest developments, insights, and trends that shape the aquaculture industry.

Aquafocus continues to grow alongside the aquaculture sector, constantly improving and broadening our content to address the dynamic needs of this field. Our goal is to cultivate a community of informed professionals dedicated to the health of aquatic environments and the sustainable practices of aquaculture production.

We encourage everyone to participate and share their views as we embark on this fascinating journey together. The aquaculture community, with its shared dedication to providing sustainable seafood to the increasing global population, is a powerful force. Aquafocus is committed to being your reliable source for thorough research and up-to-date information, and we are excited to be part of this collaborative effort.

In this edition, we are excited to offer a variety of articles that explore the transformative aspects of aquaculture, presenting new perspectives and innovative approaches within the industry.

In this edition of Aquafocus, we provide practical insights into various topics that highlight challenges and innovations within the aquaculture sector. Our feature articles delve into the complexities of Vibrio diseases affecting shrimp aquaculture with a detailed analysis of the virulence factors of various Vibrio species. We also examine the technological advancements in shrimp feed production at Srineedhi Feeds, where cutting-edge machinery and artificial intelligence play a pivotal role. Additionally, we explore using natural remedies like turmeric and neem for their antiviral properties in shrimp farming. Our case studies provide real-world insights, including the journey of young Haryana entrepreneurs who are navigating shrimp farming challenges with FAITT's support to enhance their practices and productivity. We also discuss using HDPE and PVC pond liners that help prevent soil-water interaction, significantly improving biosecurity and farm productivity. Moreover, we provide technical insights into the shrimp microbiome, emphasizing how environmental factors influence its composition and the health of shrimp, empowering you with the knowledge to make informed decisions in your aquaculture practices.

From sustainable alternatives to cutting-edge technology, we cover trends and innovations shaping the industry's future. We're here to keep you informed and inspired as we work together towards a sustainable future.

Happy reading!

Editor-in-Chief, Aquafocus

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Microbiome of shrimp : Composition and Significance

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Introduction

Due to the rising worldwide population and market demand, aquaculture must evolve to meet the growing requirement and desire for aquatic-based protein. Because of its economic importance, the shrimp industry has been regarded as one of the aquaculture systems with the quickest growth rate in recent decades. There has been an increasing effort to enhance aquaculture practices to boost the production of raised shrimp. However, numerous infections and a variety of environmental stressors have placed shrimp in threat in high-density shrimp farming, leading to significant differences in shrimp survival rates. Hence, comprehending the primary environmental and managerial elements that impact shrimp health could aid worldwide endeavors to advance sustainable shrimp aquaculture (Xiong et al. 2017). The ability of the host to live, grow, and develop is closely related to the creation of a unique intestinal microecosystem by the host's microbiota. Under normal conditions, shrimp intestinal microbiota maintains a state of dynamic balance to maintain the gut's regular physiological functioning. A category of microbial species specific to a given ecosystem is called a "microbiome" (Li et al., 2018). Shrimp has high diversity and dynamic composition of gut microbiota including Proteobacteria, Bacteroidetes, and Actinobacteria. There is a high correlation between the development of shrimp intestinal microbiota and environmental changes and, subsequently, the health status of shrimp. This correlation seems to be highly plasticity, even over short-term timescales (Huang et al., 2016). The changes in aquaculture ecosystem across age, environment, diet, and diseases or the exposure to new habitat has a significant impact on composition of shrimp microbiota. This article summarizes the methods of shrimp aquaculture and the effects of ecological factors (e.g. dietary manipulation, age, physiological development, and other environmental factors) on gut microbiota composition and the intervention approaches to modulate the intestinal microbial composition.

Shrimp Microbiome

Most research on the microbiome of aquatic species, like shrimp, has found that their microbial communities vary significantly from those of terrestrial animals. Xiong et al. (2017) stated that instead of Firmicutes and Bacteroides, Proteobacteria dominates aquatic animals. Although Firmicutes, Bacteroides, and Actinobacteria are all secondary contributors to the shrimp microbiome, they are highly affected by both diet and environment (Li et al. 2018) as well as cultivation regions (Cheng et al., 2021). The microbiome is altered by many things, such as changes in the environment, the stages of development, and overall health. All previous changes could happen by selection, drifting, diversification, dispersion, or mutation. The process by which species in the surrounding environment are ingested by the shrimp's digestive tract is called selection (Li et al., 2018). The gut microbiota of wild shrimp can be compared to the microbiota of a shrimp elevated in a pond to determine the diversity of microbiota in the population. Cornejo-Granados et al. (2017) stated that pond-raised shrimp microbiomes have a lower diversity because pond sediment and water do not have the diversity found in natural environments. Bacteria migrate to new areas and occupy niches, evolving or mutating to improve their place in the ecosystem Due to the constant contact of the environment, feed, and shrimp gut, dispersion is typically limited in the guts of aquatic species. Because both the host and symbiont benefit from a relationship of mutualism, the microbiome evolves to form such an association. Li et al. (2018) noticed that the three primary probiotic bacterial genera in the gut microbiome of shrimp are 1% for Lactobacillus, 0.93% for Streptococcus, and 0.37% for Bacillus spp. helped boost immunity in the species of shrimp known as P. japonicas, whereas the same bacterium in the species of shrimp known as L. vannamei boosted growth by making nutrients more digestible. Despite their constant presence in the microbiome, opportunistic pathogens are usually only found at low levels, and they remain harmless unless culturing conditions change. The most pathogenic shrimp bacteria belong to the family Enterobacteriaceae, such as Flavobacterium, Escherichia, Pseudomonas, Shewanella, Rickettsia, Vibrio, Aeromonas, and Desulfovibrio.

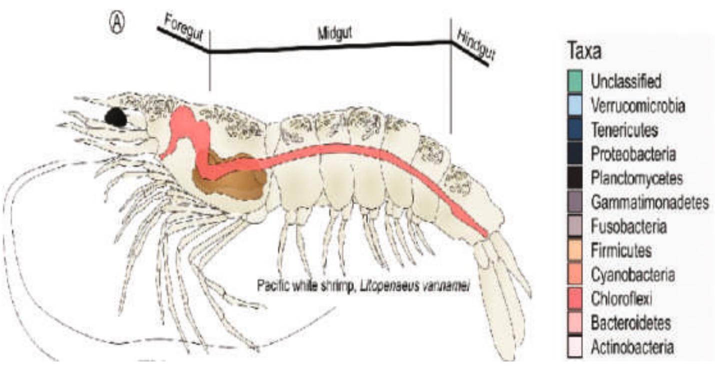
Microbiome of different organs of shrimps

1. Intestine microbiota

There were notable differences in the intestinal bacterial abundance between shrimps impacted by WFS and those that were not. In healthy shrimps, Candidatus Bacilloplasma, Photobacterium, Pirellula, Rhodobacter, and Lactococcus are prevalent at the genus level. The intestinal microbiota is closely linked to the state of health of the host. An increasing number of research have overlooked abiotic factors in favor of evaluating the effects of biotic factors on the host intestinal microbiota. In the majority of the samples, Proteobacteria and Cyanobacteria were the most prevalent phyla. Over half of all readings belonging to Vibrionaceae and Enterobacteriaceae, these were the most prevalent. The communities were abundant in Vibrio, Photobacterium, and Paracoccus at the genus level. More than 70% of the sequences isolated from the guts of wild-caught and domesticated P. monodon have been reported to belong to this class, primarily consisting of Vibrio and Photobacterium spp. The remaining classified sequences have been assigned to other high-level taxa, including Firmicutes, Bacteroidetes, Fusobacteria, and Actinobacteria (Rungrassamee et al., 2014). Numerous Vibrio species generate chitinolytic enzymes which could account for their prevalence in an environment high in chitin, such as the intestine of crustaceans, by offering a specialized substrate for their use.

2. Hepatopancreas microbiota

According to diversity indices, the bacterial diversity in healthy intestines was higher than in hepatopancreas. When compared to healthy farmed shrimp, the hepatopancreas from shrimp exhibited a considerably higher diversity of bacteria. The Enterobacteriaceae family accounted for 44% and 70% of the total cultured derived sequences, respectively, while the Proteobacteria phylum was the most prevalent. In samples, the Vibrionaceae, Moraxellaceae, and Pseudomonadaceae families accounted for 27, 12, and 1% of all reads, respectively; in cultivated samples, these families accounted for 7, 0.5, and 19% of all reads. In samples, the most abundant genus was Photobacterium (16%), followed by Acinetobacter 12% and Vibrio 8% (García-López et al., 2020).



Factors influencing microbiota structure

The composition of the gut microbiota of shrimp can be modulated with several factors such as diet composition, diet protein and fat sources, water salinity, light intensity, stock density, water temperature, microbial diversity of culture water, and indoor- vs pond-based culture. Moreover, shrimp gut microbiota has a remarkable plasticity to be altered with the environmental changes. The gut microbiome's impact on age and physiological factors days after hatching, the live feed supplied is the main factor in creating the shrimp's gut microbiota Li et al. (2018). *Actinobacteria*, *Proteobacteria*, and *Bacteroidetes* comprise the majority of the gut bacterial community at this point. The microbiome's makeup changes during developmental stages from being diverse to homogeneous, as suggested by Xiong et al. (2018) that although the microbiome may vary depending on diet, the host's developmental physiology is crucial to the microbiome's development and that changes in the normal microbiome may signal the advancement of disease.

Effects of nutrition on the gut microbiota Healthy digestion depends on gut microbiomes that can break down macro and micronutrients (Huang et al. 2016). Malnutrition and failure to thrive can happen if the gut microbiome is not formed, according to Xiong et al. (2018). Shrimp are pretty susceptible to illness once they are malnourished. Understanding shrimp nutrition requires an understanding of the microbiota and how it interacts with the food that shrimp are fed. The amount of fat, protein, and copper in the diet all have a significant impact on gut flora. This has occurred in the previous few decades as a result of humans switching from expensive and scarce animal-sourced nutrients to widely accessible and inexpensive plant-sourced nutrients (Huang et al., 2016; Li et al., 2018). Plant protein sources typically have higher carb counts than animal protein sources. Due to a small amount of Bacteroidetes in the microbiome that metabolize carbs, prawns are genetically predisposed to have difficulty digesting carbohydrates (Li et al., 2018). The microbiota of cultured prawns fed these kinds of diets quickly adapted to the rise in carbohydrate content (Huang et al. 2016). Furthermore, improving the C:N ratio of aqua feed is crucial for the growth and development of prawn gut microbiota, as well as for their overall health and growth.

Variations in the content and organisation of the bacterial community in shrimp culture suggest that various environmental conditions may have a substantial effect on the structure of the intestinal microflora of *L. vannamei*. Aquatic systems can introduce bacteria into the prawn gut by mixing them with sediments and water. More microorganisms are present in the marine environment where shrimps live than in the land. In pond sediment, prawn guts, and culture water, more than 90 different bacterial genera are frequently detected; the most similarity is seen between the stomach and sediment profiles (Li et al., 2018). The most numerous taxa in both the guts of prawns and sediment are *Streptococcus*, *Lactobacillus*, and *Bacillus*. Global shrimp farmers have lately included the aforementioned genera as probiotics as a result of these findings. Changes in the environment are directly linked to the formation of gut microbiota in shrimp. Additionally, it seems to be quite adaptable to short-term alterations. It's possible that changes in the surrounding environment have also affected the gut microbiota. The shrimp-fish polyculture system, stocking density, water salinity hypoxia, exposure to other environmental stressors, and the rearing system water recirculation rate can all have an impact on the microbiota in both the shrimp gut and the culture water (Kuthoose et al., 2021).

Shrimp health and illness due to changes in the gut microbiota 89% of shrimp health issues are related to nutrition, and the higher carbohydrate and fibre content of commercial diets, which are absent from shrimp regimens, makes these issues worse. Due to their ability to use dietary fiber as a carbon source to synthesize short-chain fatty acids and hence improve gut health, Firmicutes have increased as a result of this dietary shift. Firmicutes, however, metabolize a lot of fiber sources poorly. It was discovered that effective commercial diets must strike a balance between physiological and nutritional requirements to preserve shrimp health. It has been shown that the *Pseudomonadaceae* and *Vibrionaceae* families had greater relative abundances of shrimp infected with the white spot syndrome virus than other families (Pilotto et al., 2018).

Conclusions

Due to the optimal use of land and water, intensifying prawn culture has increased profit margins and economic outcomes. Additionally, super-intensive systems, which are capable of producing more crops annually, have been shown to potentially yield higher financial returns. The shape and form of the shrimp intestinal microbiota are strongly influenced by the various types of shrimp farming systems. Shrimp's health and performance are significantly influenced by their gut microbiota, which also affects the host's resistance to disease and ability to survive environmental stressors. But, there is still a lot to learn about the gut microbiota of prawns, especially about its taxonomy and modulatory effects on intestinal microbiota. The connection between gut bacteria and the host immune system is well-characterized. Therefore, by inhibiting pathogen colonization and adherence to intestinal epithelium and by triggering immunological responses, the restoration of the gut microbiome helps to lessen the severity of disease. It is essential to investigate the factors that influence the gut microbiota in order to improve the health and performance of shrimp. Furthermore, in order to ascertain the effects of this relationship on shrimp health, more structural and functional study is necessary to comprehend the underlying processes of the significant link between gut microbiota and aquatic environmental parameters. Specific intervention strategies, like adding probiotics, prebiotics, and other food additives to the diet, have been shown to significantly improve the gut microbiome's modification and shaping by increasing the relative abundances of beneficial bacteria and decreasing the number of pathogenic bacteria.

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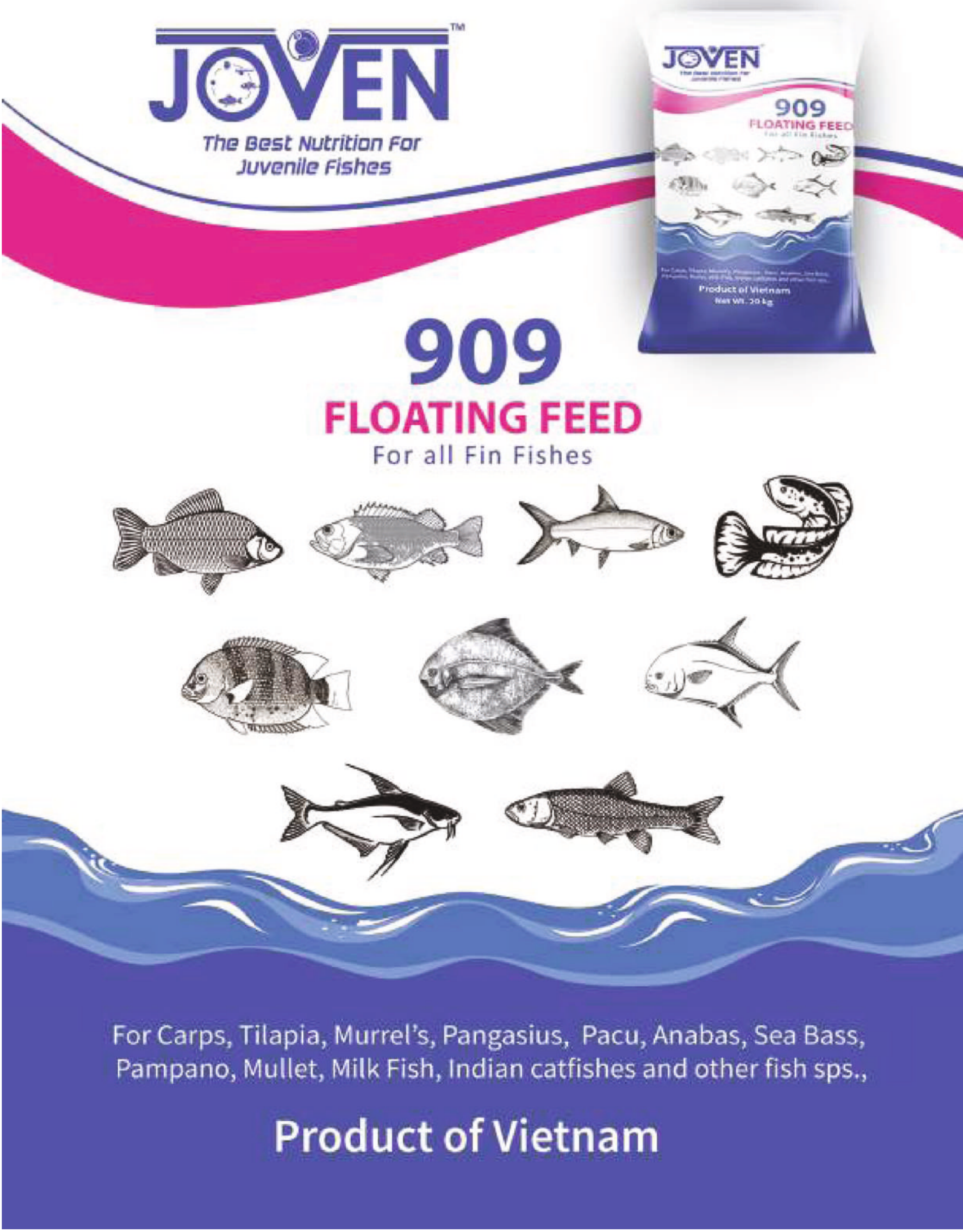
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Establishing Successful Young Aquapreneurs in Shrimp Farming in Lined Pond Through Interventions of FAITT at Haryana

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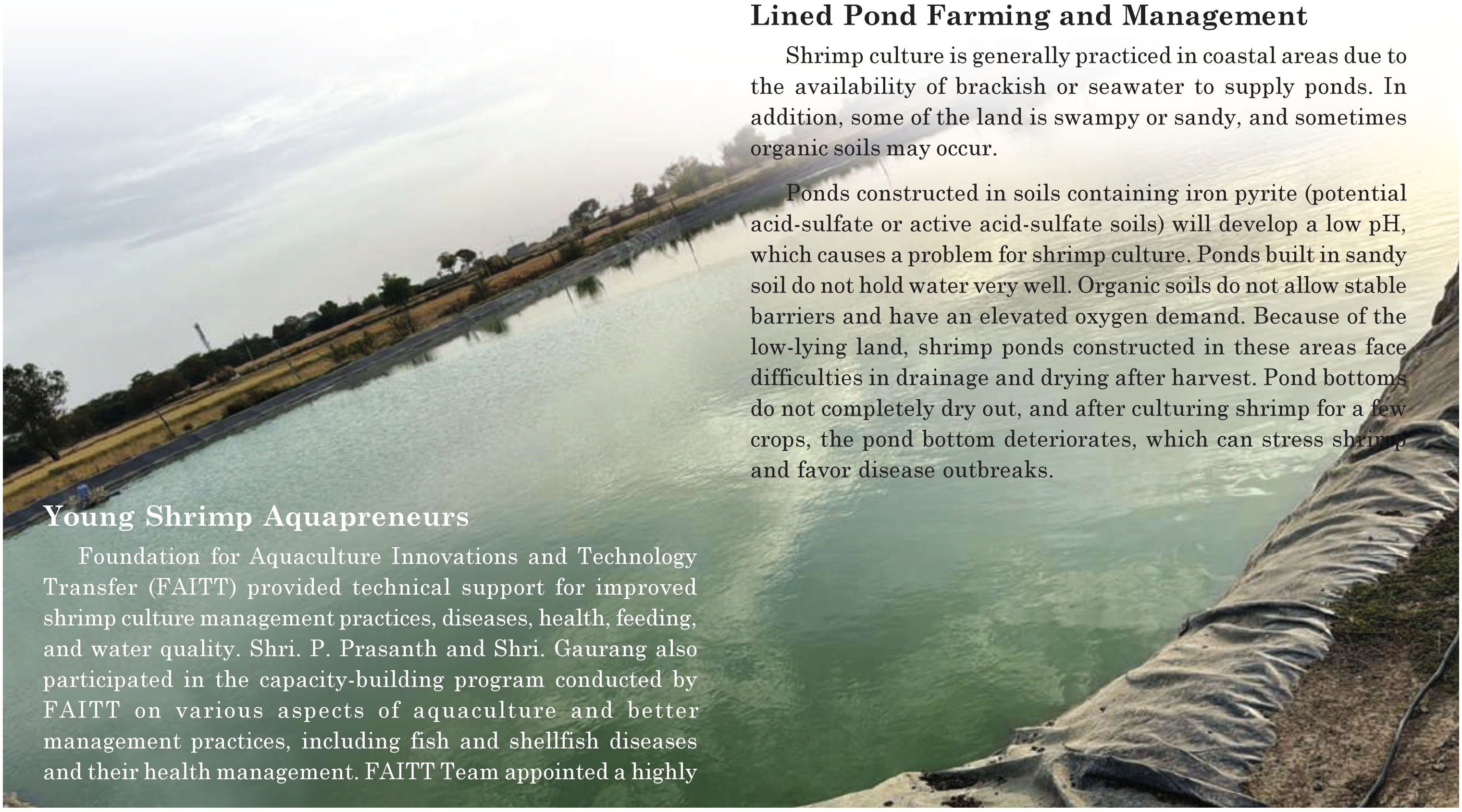
Shrimp farming has gained popularity in south India, especially in Andhra Pradesh, but today, the scenario has changed from North India to Viz. Punjab, Bihar, Haryana, Uttar Pradesh, etc., are getting attention, as a few farmers have started venturing into this remunerative business in shrimp farming. In 2024, Shri. P. Prasanth and Shri. Gaurang, two educated youths, began their shrimp aquaculture venture in Zahidpur, Jhajjar, Haryana. They started their venture in Haryana after gaining confidence in shrimp farms. However, their initial shrimp culture failed due to mass mortality of stocked seeds, resulting in a loss. Despite this, they remain committed to aquapreneurship and plan to give a second try to shrimp aquaculture with the support of professionals in the duo contacted the FAITT team from the Division of Agro Global Agency, Maharashtra, for technical support.



Young Shrimp Aquapreneurs

Foundation for Aquaculture Innovations and Technology Transfer (FAITT) provided technical support for improved shrimp culture management practices, diseases, health, feeding, and water quality. Shri. P. Prasanth and Shri. Gaurang also participated in the capacity-building program conducted by FAITT on various aspects of aquaculture and better management practices, including fish and shellfish diseases and their health management. FAITT Team appointed a highly qualified technical executive, Mr. Ashish Prakash, to take care of farming, and experts have started using the mobile application to address shrimp diseases, manage them, and report them in real time.

Glimpse of the harvested shrimp

The Aquapreneurs successfully stocked PL 12 of 9 lakh in 3.2 acres of three ponds. Partial harvesting is done at 6 tons, then a complete harvest of 8 tons, a total of 14 tons of production within 120 days of the crop.

The Aquapreneurs aim to expand the shrimp culture from 3.2 acre to 10 acre. The shrimp aquaculture sector is expected to be significantly transformed by improved management practices, thereby increasing productivity in North India.

Lined Pond Farming and Management

Shrimp culture is generally practiced in coastal areas due to the availability of brackish or seawater to supply ponds. In addition, some of the land is swampy or sandy, and sometimes organic soils may occur.

Ponds constructed in soils containing iron pyrite (potential acid-sulfate or active acid-sulfate soils) will develop a low pH, which causes a problem for shrimp culture. Ponds built in sandy soil do not hold water very well. Organic soils do not allow stable barriers and have an elevated oxygen demand. Because of the low-lying land, shrimp ponds constructed in these areas face difficulties in drainage and drying after harvest. Pond bottoms do not completely dry out, and after culturing shrimp for a few crops, the pond bottom deteriorates, which can stress shrimp and favor disease outbreaks.

Shrimp Sampling

Among several management schemes that can be used is separating the pond water and the soil by using plastic pond liners, which typically have achieved the best, cost-effective results in shrimp aquaculture. Plastic materials have been used for a long time in reservoirs, dams, and ponds for agricultural purposes. However, it has only been in the last few years that this technology has been widely applied to aquaculture.

HDPE (high-density polyethylene) and polyvinyl chloride (PVC) are plastic materials suitable for lining shrimp ponds. As both HDPE and PVC incorporate anti-ultraviolet substances, these two materials can resist deterioration by UV light, which allows them to last for many years. These flexible materials come in rolls of sheeting that can be easily fused or glued together during installation. The recommended thickness for a shrimp pond liner is at least 0.75 mm, and many suppliers of HDPE and PVC liners guarantee their product use under normal conditions for five to 10 years.

Pond liners

Lined shrimp ponds that are well-designed, built, and managed can efficiently manage organic matter and sludge. Note the central drain and accumulated sludge in the center of the pond.

Significance

Using plastics to line pond aquaculture bottoms and embankments prevents contact with acid-sulfate soils from avoiding low pH in pond bottoms and water, which generally would create problems in shrimp ponds, especially during the rainy seasons.

Pond water quality is more easily managed because there are no adverse effects on pond water quality from contact with bottom and dike soils. Liners effectively prevent soil-water interaction and avoid the issue of soil acidity, stop salinization of neighboring areas, and control seepage of water into the ponds in areas with a high water table.

Liners shorten pond cleaning and preparation time, requiring only four to eight days to complete the process compared with 30 to 45 days for the normal earthen pond cleaning and extensive drying process. Therefore, the number of crops per year can be increased to make annual pond productivity higher. In addition, harvesting can be more effective during the rainy season because plastic-lined ponds can still be cleaned. And no tractor earthwork is required after the liners have been installed.

During the culture period, suspended solids and other waste can easily be removed by gravity flow through drains (typically in the pond's center), so less organic matter will accumulate in the ponds.

Liners prevent the erosion of dikes and levees from waves, wind, and aerator-generated water currents, which reduces pond maintenance and repair expenses. Lined ponds can generally be aerated more intensively, supporting higher stocking densities and yields per unit area.

Because the pond bottom is cleaner, there are fewer shrimp with dirty gills (accumulated organic sludge) at harvest, and cleaner shrimp will command better prices.

Cultivated adult shrimp by Young Aquapreneurs

Pond preparation

Agricultural lime is applied @500-1000 kg/ha as a basal dose with 150 kg of dolomite and 25 kg of zeolite to adjust the pH, improve the plankton availability, and get a proper algal bloom. Sometimes, based on need, we can apply dolomite as a substitute to lime @ 750 kg/ha as a basal dose and, if necessary, top-dress with 50kg/ha once in 10-15 days to neutralize pH fluctuations. In addition, 10-12 kg of urea and 3-5 kg of sulphurphosphate are commonly applied when algal blooms are poor. Pond water parameters, including dissolved oxygen (DO), salinity, temperature, and transparency, are monitored regularly by the farmers.

Stocking

Shrimp (Leptopeneaus Vannamei) seed (PL-12) are from Tamil Nadu and Pondicherry commercial hatcheries. They are stocked at a density of 70/m2 in ponds. Before stocking, the seed was tested for its quality, including the PCR analysis for the white spot virus, in private laboratories.

Feeding

IB Group Company, ABIS Shrimp crumble, and pelleted feeds are used. The farmers use two feeding strategies - 'pre-starter' (38% c.p) for the first 30 days and 'Starter to Grower' (38% c.p) for the remaining period. Feeding frequency varied from 3-4 times during the culture period (3-4 times per day up to one month, 3-4 times/day up to the second month, and 4 times/day after 90 days). The average feed conversion ratio (FCR) for i-feeding was 1.1-1.3. Generally used commercial feed attractant (gut probiotic and micro mineral) only and Yeast @10g/ kg of feed mixed with Allgel Plus Gel as a binder. Commercially available probiotics and origo PB-15 kg per acre were also Zeo Pro applied once in 15-30 days, depending on the pond bottom condition.

Pond Management

There is no water exchange from the pond. They regularly add water to balance the evaporation, and only at the time of slug removal did 5 percent of water exchange occur. Aeration of the ponds using paddle wheel aerators (2/ha) for 4-6 hours/day is conducted by most farmers who also regularly monitor soil and water quality conditions of ponds, feed intake, and health of the animals. On average, two laborers per hectare are employed permanently for the routine culture operation. Additional casual laborers are employed during pond construction/preparation, harvest, and post-harvest operations. The daily wages range between Rs. 400-500 for men and Rs. 400-500 for women

Production and Marketing

Shrimp growth of the shrimp is better during the summer crop, with a yield of 0.8 to 2.0 t/ha/crop in 120-150 days. The yield during the winter crop is around 0.5-1.0 t/ha, but it is also more uncertain as per the scientific study and field.
However, the FAITT team was able to harvest 12800 m2 area 14tonns of shrimp within 120 days. After harvesting the crop, the animals were segregated/graded into different size groups, counted, weighed, and iced. The harvested crops are sold at the local market in Delhi. The price of harvested shrimp varied from Rs. 275- 400/kg depending on the season, stage, and time of harvest **(Fig.1-3).**

Conclusions

Shrimp farming is successfully practiced in South India. Everyone thought their soil, weather, and climate were more suitable for farming, but even other parts of India could be farming using lined pond systems.

FAITT has highly qualified experts in the aqua field, which is why we can stock high density, as it is done in another country with the same technology we transferred here. Water quality maintenance in the lined ponds is challenging, and bore water is used for this farming. To enrich the pond, health care products for that production cost Rs.40, which is the same in south India. We have technical expertise in Bore water pond management. Due to the higher temperature in Haryana than in south India, water evaporation and seepage, which are more so in lined ponds, could be controlled. Adjusting to shrimp farming, many were agriculture farmers. They should not face any challenges due to this pond water, and to reduce the risk, we did not exchange the water from the pond. It is proven that knowledge can be transferred very quickly if you have a fundamental mindset and effort. FAITT can support people with non-Aqua backgrounds in achieving this success rate in aquaculture.

Fig.1 Cultivation of shrimp by Young Aquapreneurs

Cresco

Live Goods

CRESCO Objectives

CRESCO aims to cultivate and produce huge quantitative of Algae for Aquaculture Industry for use as Feed and Nutrition agent It aims for Mass production of Spirulina and value added products with an initial Target of 1Ton per month. Gradually it aims to develop large scale Algae ponds and be one of the largest producer of Spirulina – both for domestic consumption and also for International exports.

CRESCO and MICROALGAE Production

Cresco aims to produce large quantities of Algae and Microalgae. This would encompass production of economically important algal species like *Spirulina sp, Chlorella sp, Dunaliella sp, Hematococcus sp, Nanochloropsis sp, Diatoms, etc.* These are highly useful in the Aquaculture industry as Fish Nutrition.

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Vibrio Becomes Lethal to Shrimp Aquaculture

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Introduction

Exploitation of marine living resources, including fisheries, is already at its peak. Yet the protein demand on our planet keeps increasing. Our oceans cannot supply the demand we require. Hence, aquaculture is the most feasible alternative that can fill the gap in the seafood supply. It has the highest protein retention and the lowest greenhouse gas emissions compared with other animal proteins such as chicken, pork, and beef (Global Seafood Alliance, 2019).

Shrimp farming is a rapidly growing aquaculture sector that is in demand in the world market for its high nutritional value and taste. The shrimp industry becomes an important source for the livelihood of many people in developing countries. However, this industry in India has been at a crossroads in recent times due to several reasons: production constraints, climate change, emerging diseases, etc. Production costs for shrimp farming are increasing steadily, mainly due to increasing electricity charges, feed costs, labour charges, land lease costs, etc. Rapid global climate change is proving to be another significant factor causing major problems in shrimp farming. The diel temperature fluctuations (early morning and afternoon) have been more than 14 !, which is reason enough for the health deterioration of the animals. The sharp rise in temperature, sudden cloudburst, and lack of water or increase in salinity due to low rainfall are economic losses to numerous farmers. Emerging disease is also a major problem in shrimp farming. Shrimps lack cell-mediated immunity or immune memory. Apart from viral infections, bacterial infections caused by members of the genus *Vibrio* have become lethal. These bacterial diseases are emerging as a serious problem in the industry.

Vibrio – opportunistic pathogen

Vibrio is an opportunistic pathogen, and can be devastating for the early life stages of shrimp development as well as in the culture pond (Goulden et al., 2012a; De Schryver et al., 2014; Kumar et al., 2017). These days, *Vibrio* is used as a microbial indicator for climate change (Baker-Austin et al., 2017). Though many strains of *Vibrio* are non-virulent, selected strains can cause higher mortality. Some virulent strains produce lethal toxins such as cysteine protease, haemolysins, Vibriocins, Pir A and Pir B, Vhvp1 and Vhvp2, and antibacterial effectors produced by the Type 6 Secretion System (T6SS) that can damage the intestinal epithelial cell lining, which consequently facilitates the infiltration of opportunistic bacteria into other tissues and organs of the body (Liu and Lee, 1999; Montero and Austin, 1999; Soonthornchai et al., 2010, Zou et al, 2020, Liu et al, 2023).

Zoae-2 syndrome and vibriosis

In the years 2017–18, we collected Zoea-2 syndrome samples from 3 coastal lines (Chennai-Pondicherry coast, Nellore-Babaatla coast, Kakinada-Tuni coast). These coasts have the highest number of hatcheries in India. In the collected samples, *Vibrio* was isolated and identified to establish the species associated with Zoea-2 syndrome. We found that the collected samples were positive for *Vibrio alginolyticus*. *Vibrio alginolyticus* is aggravated as a disease when it is present along with other *Vibrio* spp. such as *Vibrio harveyi*, *V. parahaemolyticus*, *V. campbellii*, *V. mimicus*. Kumar et al (2017) reported rapid proliferation of V. alginolyticus in the shrimp hatcheries.

Upon careful observation at the shrimp diseases, we found that *Vibrio* has becoming primary infection unlike secondary infection as in the past years.

Vibrio – acquiring virulence factors

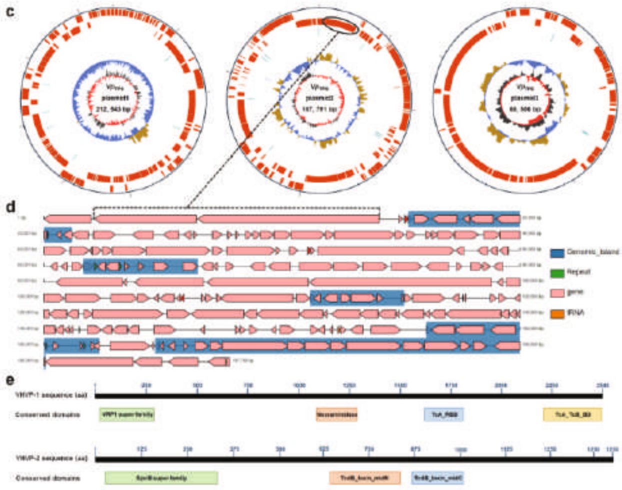
In the last decade, *Vibrio* has become more lethal to shrimp aquaculture because of its acquired virulent factors. These virulent factors were first reported in *Vibrio parahaemolyticus* and later in several other species. It suggests that the virulence factors might be able to transfer via-conjugation among different *Vibrio* spp. These virulence factors are acquired from virulent protein coding plasmids. Acute Hepatopancreatic Necrosis Disease (AHPND) and the highly lethal *Vibrio* disease, Translucent Post-Larvae Disease (TPD) or Glass Post-Larvae Disease (GPD) are examples of such vibrio diseases. Upon looking into available genetic information in the public databases and literature for the virulence factors of the AHPND samples, we found a fraction of samples do have both Pir toxins (Pir A, Pir B virulence factors), TPD virulence factors (vpvh1 and vpvh2). So, these virulence factors look like they are transferable and may cause more than one disease.

Table 1: Zoea syndrome samples and prevalence of Vibrio spp. based on real-time qPCR

Sampling locations for the Zoea syndrome samples	*Vibrio harveyi*	*Vibrio parahaemolyticus*	*Vibrio alginolyticus*	*Vibrio vulnificus*
Pondicherry –Chennai (Sample 1)	**Slight positive (Ct – 32.34)**	**Positive (Ct – 27.43)**	**Positive (Ct – 24.27)**	Negative
Pondicherry –Chennai (Sample 2)	Negative	**Positive (Ct – 29.27)**	**Positive (Ct – 26.57)**	**Slight positive (Ct –34.08)**
Pondicherry –Chennai (Sample 3)	**Positive (Ct – 28.86)**	Negative	**Slight Positive (Ct –32.53)**	Negative
Kakinada coast (Sample 1)	Negative	**Slight positive (Ct – 35.44)**	**Positive (Ct – 28.26)**	**Slight positive (Ct –35.04)**
Ongole	Negative	**Slight positive (Ct – 32.2)**	**Positive (Ct – 26.58)**	Negative
Ongole	Negative	**Positive (Ct – 29.34)**	**Slight positive (Ct-31.22)**	Negative
Kakinada coast (Sample 2)	**Positive (Ct – 32.34)**	Negative	**Positive (Ct – 29.63)**	Negative
Kakinada coast (Sample 3)	**Positive (Ct – 27.34)**	Negative	**Slight Positive (Ct – 30.52)**	Negative

Table 2 : Some the diseases caused by *Vibrio* in both hatchery and in the grow-out ponds.

Disease	Common *Vibrio* species	Known susceptible crustaceans		References
Zoea II Syndrome (larvae)	*V. alginolyticus* *V. campbellii* *V. harveyi* *V. mimicus* *V. parahaemolyticus*	Shrimp	*Penaeus stylirostris* *Penaeus vannamei*	Soto-Rodriguez et al. (2006a, b), Cullar-Anjel et al. (2014) Kumar et al. (2017)
Septic Hepatopancreatic Necrosis Disease (hatchery and grow-out)	*V. alginolyticus* *V. campbellii* *V. harveyi* *V. parahaemolyticus* *V. penaeicida* *V. vulnificus*		*All farmed shrimp*	Morales-Covarrubias and Gomez-Gil (2014) Stern and Sonnenholzner (2014) Morales-Covarrubias et al. (2018)
Luminescent vibriosis (eggs and larvae)	*V. campbellii* *V. harveyi* *V. splendidus*		*Penaeus indicus* *Penacus monodon* *Penaeus vannamei*	Lavilla-Pitogo et al. (1990) Diggles et al. (2000)
Shell disease (juvenile and adults)	Chitinolytic *Vibrio* spp. including *V. alginolyticus*		*Macrobrachium rosenbergii* *Penaeus sp.*	Cook and Lofton (1973) Porter et al. (2001) Vogan etal. (2002)
Acute Hepatopancreatic Necrosis Disease (postlarvae)	AHPND-causing *V. campbellii* AHPND-causing *V. harveyi* AHPND-causing *V. owensii* AHPND-causing *V. parahaemolyticus* (Vpayenp)		*Penaeus monodon* *Penaeus vannamei* *Penaeus chinensis** *Penaeus japonicus**	Yang et al. (2014) Kondoet al. (2015) Liu et al. (2015) Choietal. (2017) Dong et al. (2017a) Muthukrishnan et al. (2019) OIE (2019) Prachumwatet al. (2020)
Summer syndrome (grow-out)	*V.nigripulchritudo*		*Penaeus japonicus* *Penaeus stylirostris*	Goarant et al. (2006) Sakai et al. (2007)



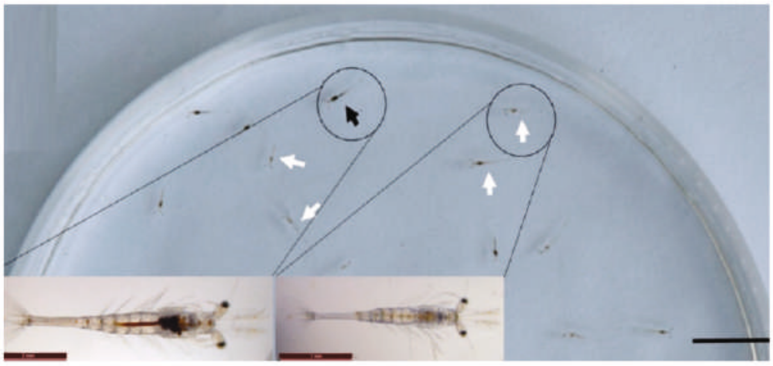


Figure1: *Vibrio* high virulent protein (VHVP) virulence factor
(Vhvp 1 & VhVp2) in *Vibrio parahaemolyticus* Plasmid 2 (VP_{TPD})– Ref –Liu et al, 2023)

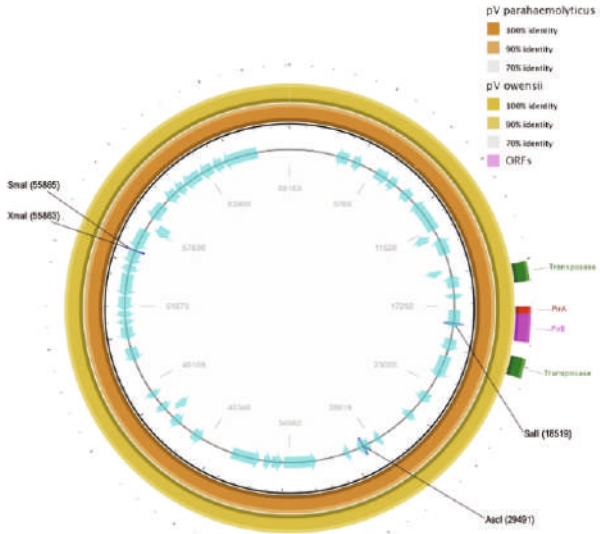


Figure 2: BLAST comparison with the plasmid of *V. parahaemolyticus* (orange) and *V. owensii* (yellow).
The transposase genes in green, red and purple represent the *PirA* and *PirB* genes (Restrepo L et,al. 2018)

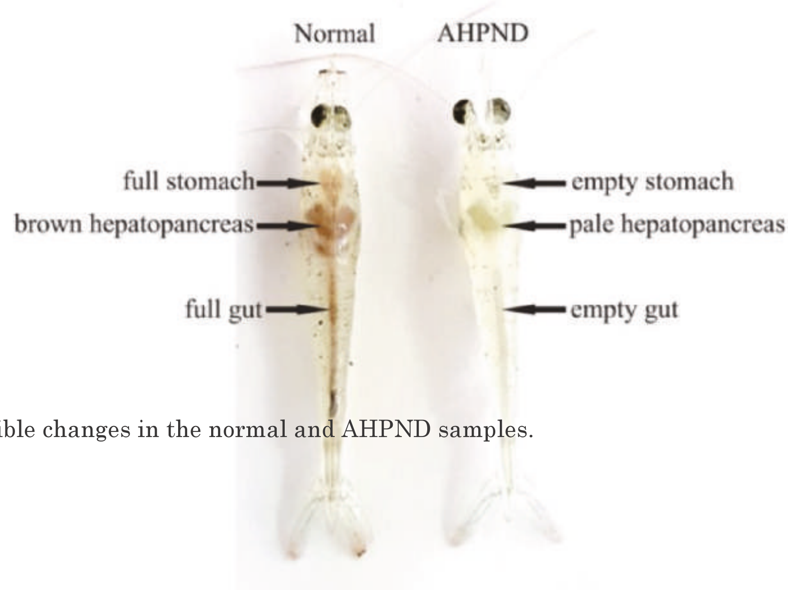


Figure 3: Comparison of visible changes in the normal and AHPND samples.

So far, AHPND and/or TDP cases have not been reported in our country. However, we have observed similar clinical characteristics of these disease, such as lethargy, slow growth, an empty stomach or midgut, and a pale to white atrophied hepatopancreas, etc. in the samples from the hatchery as well as the culture system. Hence, we propose an extensive surveillance program for *Vibrio* toxin as the need of the hour to better understand our current *Vibrio* causing disease status in the Indian shrimp aquaculture industry. The suspected positive samples should be studied at the genetic and genomic level to understand the cause and associated virulence factors. The preventive measures can be enforced if any indication of these diseases is found to help farmers overcome the disease and save them from economic loss.

A comparative table for TPD vs AHPND is given below :

Translucent post-larvae disease (TPD)	Acute Hepatopancreatic Necrosis Disease (AHPND)
Economic loss to 70%–80% coastal shrimp nurseries in China in the spring of 2020	Significant economic losses to shrimp producers in China (2009), Vietnam (2010), Malaysia (2011), Thailand (2012), Mexico (2013) and Philippines (2015).
The disease reported in *Penaeus japonicus, P. vannamei*	The disease can affect *Penaeus monodon, P. vannamei*
Vibrio parahaemolyticus strain (Vp-JS20200428004-2) containing *Vibrio* high virulent protein (VHVP) virulence factor (Vpvh1 & 2) causes the infectious TPD	Causative agent was *Vibrio parahaemolyticus* carrying a plasmid coding for the mortal toxins Pir A, Pir B
Lethal to post-larvae at 4–7 days old (PL4–PL7). The cumulative mortality of the infected post-larvae could reach up to 100% in 3 days in a typical disease case.	100% Mass mortality in cultured ponds has been observed 35 days.
Clinical symptoms are lethargy, erratic swimming behaviour, empty gut and off-white body colour, pale body colour & pale Hepatopancreas	Clinical symptoms include lethargy, slow growth, empty stomach or midgut, and a pale to white atrophied hepatopancreas, with dead shrimp on the pond bottom

***Enterocytozoon hepatopenaei* (EHP) or White fecal Syndrome in presence of *Vibrio* spp.**

Sometimes, *Vibrio* may also play a pathogenetic role as a secondary infection in *Enterocytozoon hepatopenaei* (EHP) disease and white faecal syndrome. Some countries, such as the United States of America, where shrimp aquaculture is performed in the lower density, get EHP contamination. However, it is not aggravated as a disease unlike in India and other countries where high density aquaculture is performed. In higher density culture, EHP infectious spores become more virulent, along with *Vibrio* and a few other anaerobic bacteria such as *Propionigenium* (Aranguren et al, 2022, GSA, 2024). Specific measures to remove the EHP spores, water and feed management, improve stress free shrimp culture environment help to overcome EHP problems (GSA, 2024). Hence, control over *Vibrio* and pond bottom is indispensable for the management of White faecal syndrome and EHP.

Surveillance and treatment measures

As mentioned earlier, invertebrates do not possess a well-developed immune system, hence, following biosecurity protocols is an important strategy for disease management. Routine surveillance, regular lab monitoring, and following up on the standard operating protocol (SOP) are part of biosecurity management. Farmers must go back to the fundamentals of shrimp aquaculture, and follow the biosecurity protocol without fail. The possible routine check-up protocols to keep the *Vibrio* infection away includes:

- Set up a biosecurity protocol.
- Routine check-ups for brooders, Live feeds: freeze the live feed before use. Nauplii, Post-Larvae, Algae, and Artemia
- In the pond: PL checking before stocking
- Pond water and animal monitoring during the culture period

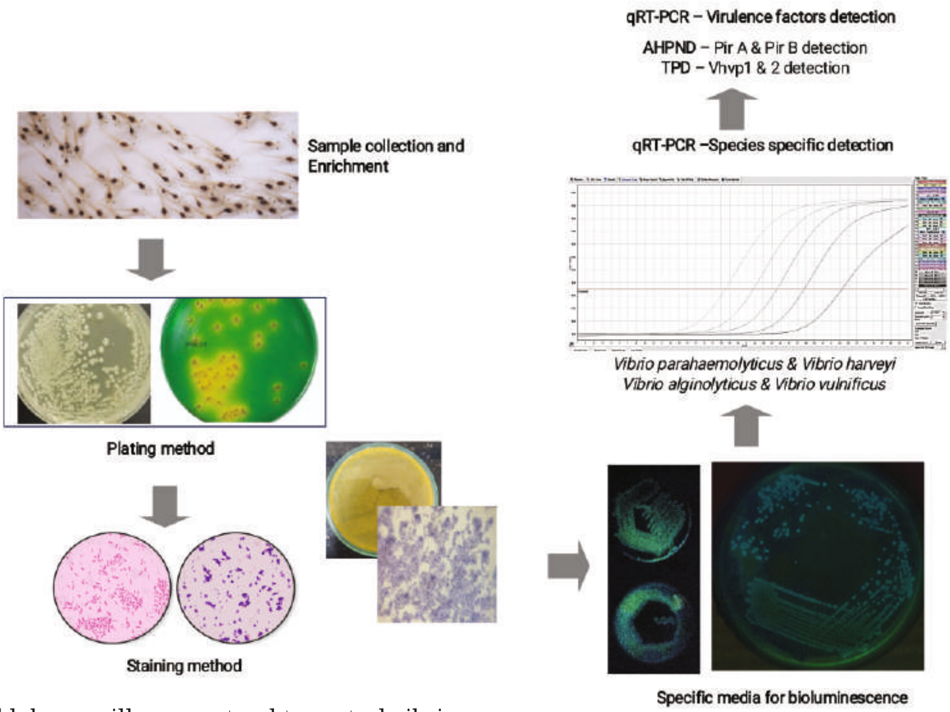


Figure 4: Proposed lab surveillance protocol to control vibrio

A suitable probiotic consortium can be used to control the vibrio growth. Use of postbiotics as short-chain fatty acids (SCFA) and natural anti-vibrio products such as biopolymers: polyhydroxybutyrate can be encouraged to keep *Vibrio* checked in the shrimp aquaculture industry.

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Harnessing Unity : The Power of Clusters in Fisheries Management

Introduction

The cluster-based approach (CBA) is a strategic framework designed to foster sustainable development, boost productivity, and enhance competitiveness in targeted industries or sectors. When applied to the fisheries sector, this approach involves the formation of geographic clusters that bring together different stakeholders such as fisherfolk, processors, traders, researchers, and policymakers. The main objective is to encourage collaboration, resource sharing, and collective action among these stakeholders. By promoting collaboration, the CBA seeks to improve productivity, competitiveness, and the overall socio-economic well-being of fisheries communities.

Background

Fisheries is essential for ensuring global food security, supporting livelihoods, and driving economic growth. Despite its importance, the sector encounters various obstacles such as dwindling resources, environmental harm, market instability, and inadequate technology and infrastructure. Conventional fisheries management strategies have frequently fallen short in tackling these multifaceted issues. As a result, there is a rising acknowledgment of the necessity for participatory, community-driven approaches that empower local stakeholders and foster sustainable progress.

Cluster - Based Approach

The strategy involves the formation of clusters or groups consisting of small-scale fishers and farmers. These clusters are created based on specific criteria such as proximity, fishing practices, or available resources. By bringing farmers together, CBA promotes the exchange of knowledge and encourages collaboration.

Each cluster focuses on a particular subdomain within the fisheries sector, such as aquaculture, capture fisheries, or post-harvest processing. Alternatively, they may share common resources like water supply channels, infrastructure, and knowledge. This approach allows for targeted interventions to address challenges within each subdomain.

The sharing of common resources among clusters leads to efficient utilization of these resources, resulting in improved productivity. Additionally, collective bargaining within the clusters enhances market linkages and enables better negotiation of prices. As a result, clusters facilitate improved access to markets and value chains.

Strategies for Implementation

A fisheries cluster refers to a concentrated group of interconnected businesses, suppliers, service providers, and supporting institutions within the fisheries value chain, located in a specific geographic area. The process of establishing fisheries clusters typically involves several important steps:

1. Cluster Identification :

This step entails conducting a comprehensive assessment of fisheries resources, infrastructure, market opportunities, and socio-economic conditions. The purpose is to identify regions that have the potential to become clusters.

2. Stakeholder Consultations : In this stage, engagement with various stakeholders is crucial. This includes local communities, fisherfolk, government agencies, research institutions, NGOs, and private sector actors. The aim is to gather support and build consensus for cluster formation. Additionally, mapping exercises are conducted to pinpoint geographic areas with significant fisheries activity and potential for cluster development.

3. Formation of Cluster Committees : Establishing formal or informal structures for cluster governance, which may include steering committees, working groups, and collaborative platforms to aid in coordination and decision-making processes.
4. Infrastructure Development : Investing in infrastructure development such as landing sites, cold storage facilities, processing units, and market centers to bolster cluster activities and enhance value addition.
5. Capacity Building : Enhancing the capacity of cluster members through training, technical assistance, and knowledge - sharing initiatives in various areas like sustainable fishing practices, fisheries management, post-harvest handling, value addition, quality control, market access, and entrepreneurship.
6. Market Linkages : Facilitating market linkages by forming partnerships with buyers, exporters, retailers, and e-commerce platforms to ensure market access and fair prices for cluster members.
7. Policy Support : Advocating for supportive policies and regulations that promote sustainable fisheries management, value addition, and market access for enterprises within the cluster.
8. Resource Mobilization: Mobilizing financial, technical, and human resources from government agencies, development partners, and private sector stakeholders to support cluster activities and initiatives.

Activities can be approached as a cluster

1) Hatchery development & Management- Stocking of fingerlings- Rearing- Seed transportation & available to local fish farmer.
2) Bio Floc- Storage System (Cold Storage)- Processing unit Retails Markets
3) Construction of Raceways- Refrigerated/Insulated vehicles Retails Markets
4) Cage culture (Reservoirs & Marine)- Live Vending Centres.
5) Pen Culture- Fish retail markets
6) Cold water fisheries- Fish markets/kiosks
7) RAS Crab system- Value addition products- Branding & Marketing
8) Brackish/Saline water Fisheries- Processing unit- Retail/ Wholesale market
9) Ornamental Fish (breeding & Rearing)- Live feed management- Advertising & Marketing- fish markets/kiosks.
10) Crustacean Farming- feed management- value addition in product- Advertising & Marketing.
11) Bivalve/Pearl Farming- Algae/spirulina farming- mussel processing- Branding & advertising.
12) Seaweed Farming- seaweed value addition- seaweed retail market.
13) Artificial reef culture- Medicinal use- R&D- Reef markets/kiosks.
14) Integrated Aqua Parks- Culinary experience- Processed Aqua products- Retail market- Fish museum- Fishing/ Boating

Development of Fisheries Clusters

Once formed, fisheries clusters undergo a process of development aimed at realizing their full potential and achieving sustainable growth. Key components of cluster development include:

1. Value Chain Integration : Promoting vertical and horizontal linkages along the fisheries value chain, from production and processing to marketing and distribution, to maximize efficiency, value addition, and competitiveness.
2. Innovation and Technology Adoption: Facilitating the adoption of innovative technologies, practices, and management approaches to enhance productivity, resource efficiency, and environmental sustainability within the cluster.
3. Market Access and Branding: Supporting cluster members in accessing domestic and international markets, establishing market linkages, and branding fisheries products to enhance their competitiveness and market visibility.
4. Infrastructure Development: Investing in infrastructure development, such as cold storage facilities, processing plants, transportation networks, and market infrastructure, to improve post-harvest handling, storage, and market access.
5. Socio-Economic Development: Promoting socio-economic development within cluster communities through initiatives such as skill development, income diversification, women's empowerment, and social welfare programs.

Case Studies : International

Norwegian Fishing Cluster : Norway's cluster - based approach in fisheries has led to the establishment of fishing villages and coastal communities that collaborate on resource management, research, innovation, and market development.

Vietnamese Aquaculture Cluster : Vietnam has success fully implemented aquaculture clusters, where fish farmers share infrastructure, technology, and best practices to improve productivity, quality, and market access.

Icelandic Seafood Cluster: Iceland's seafood cluster brings together fisherfolk, processors, and researchers to promote sustainable fishing practices, product innovation, and market expansion, contributing to the country's reputation as a global leader in seafood.

Case Studies : India

Shrimp Farming Clusters in India: Organizing shrimp farmers into clusters has led to better water management, disease control, and market access. Shrimp farming clusters in India are a testament to the country's capability in aquaculture. With continued support from government policies, technological innovation, and sustainable practices, these clusters have the potential further to strengthen India's position in the global shrimp market while contributing to local economies and livelihoods.

1. Andhra Pradesh

Regions: Krishna, East Godavari, West Godavari, and Nellore districts.

Andhra Pradesh is the largest shrimp-producing state in India, contributing a significant portion of the country's shrimp exports. The state benefits from an extensive coastline and favorable climatic conditions. Modern farming techniques, hatcheries, and processing units are well-established here.

2. Tamil Nadu

Regions: Nagapattinam, Thanjavur, and Ramanathapuram districts.

Tamil Nadu's coastal districts have developed robust shrimp farming practices, focusing on both traditional and modern aquaculture methods. The state government supports the sector through various initiatives, including training and financial assistance.

3. Odisha

Regions: Balasore, Bhadrak, and Jagatsinghpur districts.

Odisha has emerged as a significant player in shrimp farming, with a focus on sustainable practices. The Chilika Lake area is particularly notable for shrimp cultivation, leveraging its unique brackish water ecosystem.

4. West Bengal

Regions : South 24 Parganas, Purba Medinipur, and North 24 Parganas districts.

West Bengal has a long history of shrimp farming, especially in the Sundarbans region. The state employs both extensive and intensive farming techniques, and there is a strong emphasis on exporting high-quality shrimp.

5. Gujarat

Regions : Surat, Valsad, and Navsari districts.

Gujarat is rapidly developing its shrimp farming sector, supported by the state's proactive policies and investments in aquaculture infrastructure. The availability of suitable land and water resources facilitates shrimp farming.

6. Kerala

Regions: Alappuzha, Ernakulam, and Kollam districts.

Kerala's backwaters provide an ideal environment for shrimp farming. The state is known for its traditional farming methods, such as pokkali farming, which integrates rice and shrimp cultivation.

Fig.1. Shrimp Cluster activities carried out in various regions of India

Wetland Management Clusters : Community - based organizations managing water bodies collaborate through periodic sharing of lessons and mutual assistance. Wetland management clusters in India are essential for preserving the ecological integrity and biodiversity of these vital ecosystems. Through coordinated efforts involving government agencies, local communities, scientific institutions, and international organizations, India can ensure the sustainable management and conservation of its rich wetland resources.

1. Kolleru Lake, Andhra Pradesh

Type: Freshwater lake.

Kolleru Lake is one of the largest freshwater lakes in India and is a Ramsar site. It serves as a crucial habitat for various bird species, especially migratory birds. Management efforts focus on controlling pollution, preventing illegal encroachments, and maintaining water levels.

2. Chilika Lake, Odisha

Type : Brackish water lagoon.

Chilika Lake is the largest coastal lagoon in India and a UNESCO World Heritage site. It supports a rich biodiversity, including the Irrawaddy dolphin. Conservation efforts include regulating fishing practices, preventing siltation, and restoring natural habitats.

3. Sundarbans, West Bengal

Type: Mangrove forest.

The Sundarbans is the largest mangrove forest in the world and a UNESCO World Heritage site. It is home to the Bengal tiger and diverse aquatic species. Management focuses on protecting the mangrove ecosystem, mitigating human-wildlife conflict, and combating climate change impacts.

4. Vembanad-Kol Wetland, Kerala

Type: Estuarine and freshwater wetland.

This extensive wetland system includes the Vembanad Lake and surrounding areas. It supports agriculture, fisheries, and tourism. Conservation strategies involve controlling pollution, managing water flow, and protecting bird habitats.

5. Loktak Lake, Manipur

Type: Freshwater lake.

Loktak Lake is known for its floating phumdis (heterogeneous masses of vegetation). It is a Ramsar site and supports the Keibul Lamjao National Park, the only floating national park in the world. Management focuses on sustainable fisheries, preventing encroachments, and promoting ecotourism.

6. Harike Wetland, Punjab

Type: Riverine wetland.

Harike Wetland, located at the confluence of the Beas and Sutlej rivers, is a Ramsar site. It provides habitat for numerous bird species and supports local fisheries. Conservation efforts include water management, pollution control, and habitat restoration.

7. Bhoj Wetland, Madhya Pradesh

Type: Urban freshwater wetland.

The Bhoj Wetland consists of two lakes, Upper Lake and Lower Lake, in Bhopal. It is crucial for water supply and biodiversity. Management strategies include maintaining water quality, preventing encroachments, and promoting public awareness.

Advantages of Cluster-Based Approach in Fisheries

The cluster-based approach presents numerous potential advantages for fisheries development, which include:

The cluster-based approach facilitates collaboration and knowledge-sharing among stakeholders, enabling them to address common challenges and leverage collective resources and expertise.

By promoting innovation, technology adoption, and value chain integration, the cluster-based approach enhances the productivity, quality, and competitiveness of fisheries products in both domestic and international markets.

The cluster-based approach fosters sustainable fisheries management practices that promote conservation, biodiversity preservation, and ecosystem resilience.

This ensures the long-term viability of fisheries resources.

The cluster-based approach empowers local communities, fisherfolk, and marginalized groups by providing them with opportunities for participation, decision-making, and socioeconomic development.

By diversifying livelihoods, enhancing adaptive capacity, and strengthening social safety nets, the cluster-based approach builds resilience to external shocks such as climate change, market fluctuations, and natural disasters.

Conclusion

Cluster-based strategies in fisheries have emerged as a valuable tool for advancing sustainable development, boosting competitiveness, and elevating livelihoods within the industry. Through encouraging cooperation, skill enhancement, and market opportunities, fisheries clusters play a vital role in driving socio-economic progress in coastal areas, safeguarding marine ecosystems, and fortifying resilience against environmental adversities.

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Herbal Anti Virals In Aquaculture ;
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Aquaculture industry apart from many other problems faced is under a continuous threat due to viral infections, these have led to the collapse of this sector in many areas. Viral infections are complex and with no proper medication available, prevention and control are the only strategies that can restrict these.

Viral disease occurs when an organism is invaded by pathogenic viruses and infectious viral particles, the virons, attach, attack and enter the susceptible organs and cells of the body. Both DNA and RNA virus affect aquaculture, these again may be enveloped or non- enveloped causing commercially disastrous diseases in fish and shrimp.

Some important fish viral infections are Infectious hematopoietic necrosis, viral hemorrhagic septicemia, Lymphocystis, Abdominal dropsy and the important viral outbreaks in shrimp are Infectious necrosis, Yellow head disease, White spot disease etc. These viruses continue to mutate and develop resistance, causing great losses both functionally and commercially, thus are the focus now.

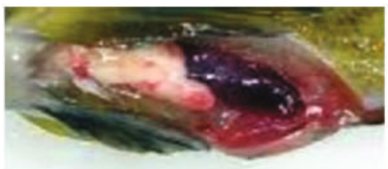
Since there are no effective anti virals, use of our age old tradition and yester year's knowledge, the wealth of the herbs, their phyto chemicals are efficient agents in this viral combat.

Using this herbal treasure an efficient, multi-faceted formulation that works on the virus in many ways, right from its mode of attachment to its reproduction and virulence has emerged, a result of relentless work in this arena.


Herpes Viral Infection


Lymphocystis


Infectious Haematopoitic Necrosis



White Spot Disease

Infectious Necrosis

Phytotherapy or herbalism, is defined as the usage of plants or herbs as medication to treat or prevent diseases and infections. This usage is gaining more attention, as antiviral agents apart from being a safer and cheaper alternative. These effectively reduce the incidence of drug resistance and may modulate the immune system in preventing viral incidences. Their antiviral effect and the mechanism of action is targeted to the viral replication and the effects on the host.

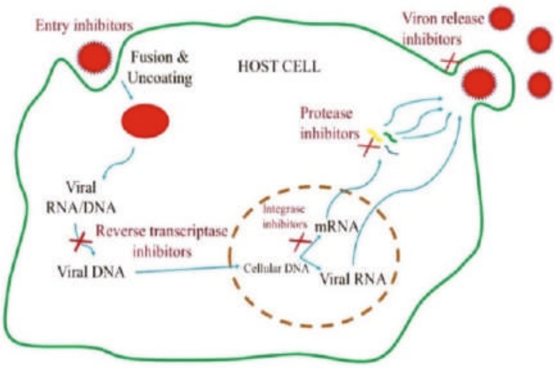
The formulation of this viral effective special is inclusive of Andrographis paniculata, Allium sativum, Azardiricta indica, Curcuma longa & Lauric acid as the active inclusions.

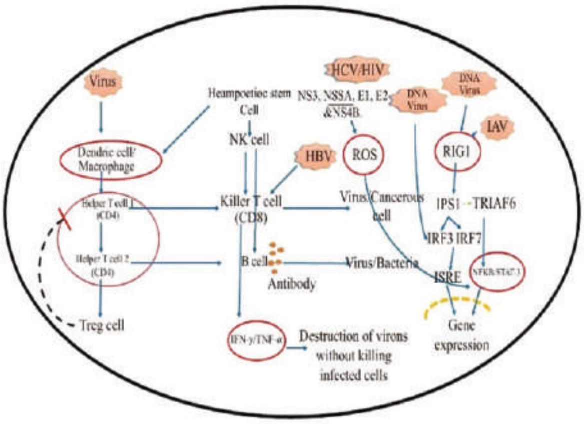
Andrographis paniculata

Andrographis paniculata used in traditional medicine since time immemorial due to its active phytochemical and rographolide and its analogs, in this case much interest is assigned for its potential against several many viral infections. The mechanisms of action being regulating the viral entry, preventing its spread and transmission to neighboring cells by interfering with the different cell signaling pathways of the cell, the gene replication and in the formation of functional proteins.

It suppresses viral production by up regulating heme oxygenase, inhibit protein synthesis and RNA replication and protection from oxidative stress. As Cytoprotective agent inhibits protease activity, thus preventing from viral replicating.

Virulence and antiviral activity





Inhibitory effect of Andrographolide on inflammation involving multiple pathway

Allium sativum

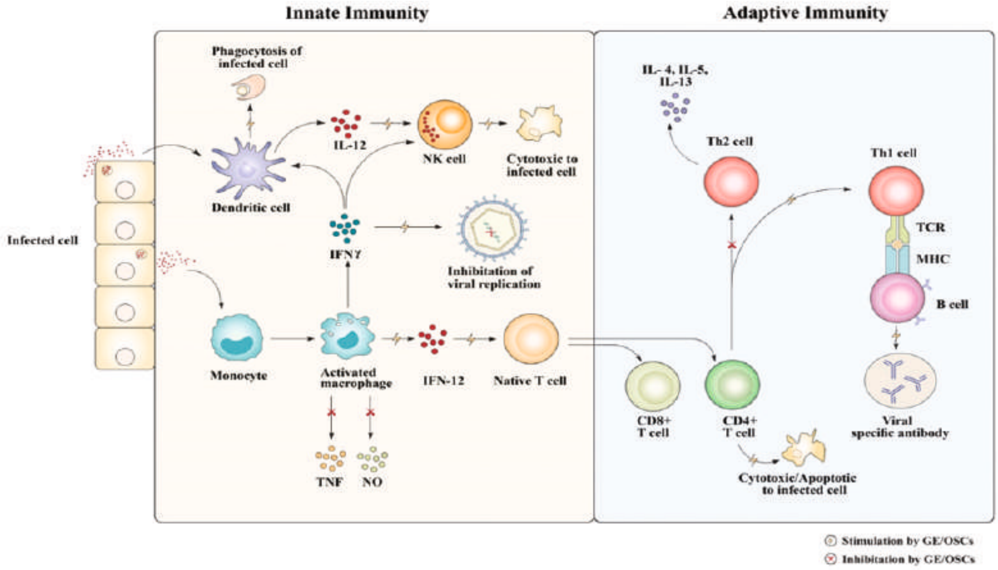
Garlic (Allium sativum L.) is a common herb, functional food and traditional remedy for the prevention of infectious diseases. Garlic and its active organo sulfur compounds have been reported to alleviate a number of viral infections with immuno modulatory effects.

Its antiviral activity is through interaction with the viral cell surface charged particles, inhibiting viral replication by inhibiting or blocking the viral fusion into the cells, causing detrimental structural changes of pathogen's proteins and by inhibiting the synthesis of viral nucleoprotein and polymerase activity making it viricidal.

The induction of cytokines and chemokines lead to vascular leakage and endothelial permeability of the host cell. Crucial role in alleviation of oxidative stress and inflammation.

Curcuma longa

Turmeric consists of three main compounds include, Curcumin, demethoxycurcumin, and bisdemethoxycurcumin. Curcumin (diferuloylmethane) is the primary curcuminoi, with anti-



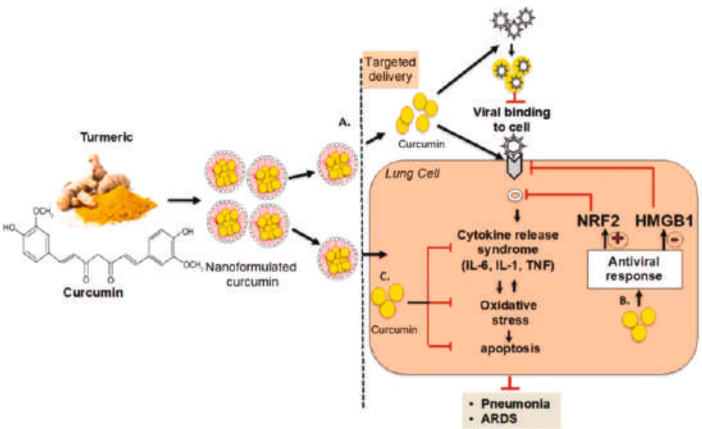
inflammatory, antioxidant and anti-microbial properties that limit the viral replication.

Curcumin exerts antiviral activity by mechanisms like the direct interaction with the proteins of viral envelope and their disruption, inhibition of viral proteases crucial for viral replication. Inhibits inflammatory cytokines, reduces virus attachment to host cell, inhibited viral protease activity and binds to and inhibit the action of surface glycoproteins on the virus also leading to actin filament disorganization, which prevents virus entry and replication in host cell.

Azadirachta indica

Azadirachta indica, recognized for its medicinal properties due to the different phytochemicals such as quercetin, azadirachtin, number of liminoids and nimbosterol like nimbin, nimbanene, nimbolidae, nimbandiol etc , while all of which are considered anti-viral.

Neem is vericidal, it extensively blocks viral entry into the host cell by the revention and modulation of host cellular pathways and by interfering with viral reproductive cycle, by the suppression of the viral cell viability leading to cell cycle arrest with cytotoxic effect.



Lauric acid

Lauric acid and its monoglyceride derivative, monolaurin, have been demonstrated to possess anti-microbial properties against gram positive bacteria and many viruses. Lauric acid has great antiviral properties, a broad spectrum antibacterial that boosts the immune system too.

Lauric acid inhibits the virus via its inhibitory mechanism during the maturation stage of the viral replication cycle. Supported by its amphiphilic properties modifies the viral cell membrane characteristics.

It changes the cell membrane characteristics by disrupting its phospholipid layers, preventing the binding of viral membrane M protein to the host cells and by the direct inactivation of virion particles of the virus. All these disintegrate the viral membrane causing its rupture and leading to its eradication. Through the indirect mechanism as a protectant due to its anti- retroviral agents, increasing its antiviral activity.

This special Herbal Anti-Viral combination is an assured, true herbal anti-viral adjuvant for aquaculture tested yet again from the house of Advance Aqua Biotechnologies whose Phytotherapy of each individual component had a unique way of working against virals and their infections, the activity of each proved and assessed. Significant reduction in the viral load due to the phyto chemicals like alkaloids, flavonoids, saponins, tannins, terpenoids, hydrolysable tannin and glycosides found in here which are considered novel antivirals having the capability to control viral outbreaks in aquaculture while also the drug resistance and drug residue problems of synthetic drug usage minimized with assured efficacy and safety.

A safe and economical alternative with many other beneficial effects apart from its antiviral activity – like enhanced body weight, improved feed efficiency, appetite and digestion stimulating, anti-bacterial and hepato-protective. Herbal usage has shown profound anti-viral activity, however the total viral elimination is possible and dependent on the biosecurity and good management practice of the farms.

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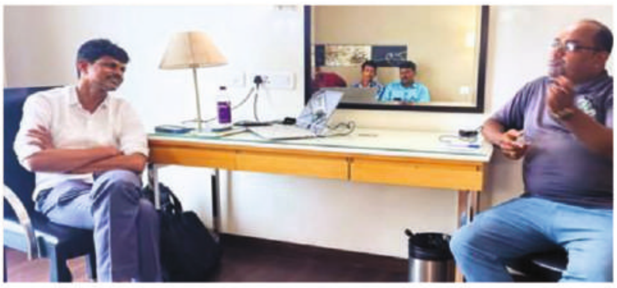
Dr. Rambabu Educates West Bengal Aqua Farmers along with FAITT

FAITT Leads Initiative to Educate Farmers on Fish and Shrimp Feed Quality and Nutrition



Dr Rambabu provided a comprehensive explanation to all the West Bengal Farmers. During a recent visit to Andhra Pradesh, a group of aquaculture farmers from West Bengal, had the opportunity to explore the latest advancements in aquaculture technology. Their visit included a valuable session with Dr. Rambabu, who generously explained the intricacies of fish and shrimp feed over four hours. His ability to communicate complex concepts in the farmers' language allowed for a deep understanding of how feed impacts the health and growth of aquatic species. This interaction provided the farmers with clear insights and resolved many of their queries, making the visit informative and impactful.

On various crucial aspects of feed quality. He detailed the processes involved in feed production, emphasizing the importance of matching feed with the appropriate nutritional requirements. He also explained the significance of vitamins and minerals in ensuring the health and growth of aquatic species.

Dr. Rambabu, in addition to the technical insights, used practical examples from human life and diet to make the concepts more relatable. He introduced the farmers to new technologies like amino acids and nutritional science, highlighting how these advancements can significantly improve fish and shrimp growth. Previously, the farmers relied on traditional methods and minimal use of formulated feed. However, after Dr. Rambabu's explanations, they gained the confidence to incorporate more advanced feed strategies into their practices. This shift is expected to lead to higher growth rates and increased profitability, instilling a sense of optimism and hope for the future of their aqua farms. The farmers returned with renewed confidence, ready to implement these modern techniques in their own aqua farms.

Faitt has Launched an Initiative to Educate Farmers on Feed Technology

Making Fish Feed is an Art

The art of feed production lies in the innovative use of by-products. Just as plastic waste poses a significant environmental challenge, agricultural by-products can either be wasted or transformed into valuable resources. Srinidhi Feeds turns these by-products into high-quality protein for fish and shrimp, ultimately contributing to a healthier diet for humans. By converting waste into wealth, Srinidhi Feeds exemplifies how feed manufacturing is not just a science but an art-one that holds the promise of a more sustainable and profitable future for aquaculture.

There is often confusion among farmers about the quality and nutritional value of feed. Many lack a clear understanding of how feed is manufactured, the steps involved in the process, and the rigorous quality controls that take place, from purchasing raw materials to delivering the finished product. Traditionally, farmers believed feed production involved mixing and grinding a few raw materials to create pellets. However, this perception overlooks the significant advancements in feed technology.

Overview

Today, feed manufacturing has evolved into a highly sophisticated process, beginning with the careful selection of raw materials. Modern feed mills, such as those at Srinidhi Feeds, utilize advanced machinery worth millions of rupees to analyze raw material quality in real time. These technologies ensure that only the best ingredients are used, leading to more nutritious and effective feed. The formulation process has been revolutionized by cutting-edge software and artificial intelligence, allowing for precise nutrient blending to meet the specific needs of fish and shrimp.

Srinidhi Feeds is at the forefront of this technological revolution. Their fully automated plant incorporates the latest machinery and processes to guarantee the highest quality feed, from raw material analysis to the final product. This includes automated steam processing, extrusion, and drying systems, ensuring consistency and quality in every batch produced. The founders of Srinidhi Feeds, themselves farmers, understand their peers' challenges. They have built this factory to address those challenges by providing top-tier feed that supports both the fish's health and the farmer' s profitability

FAITT has recently welcomed a delegation of aquaculture farmers from West Bengal to visit the Srinidhi Feeds factory. Throughout their tour, they observed the cutting-edge technologies utilized in feed manufacturing. This visit assured them they would adopt formulated feeds instead of traditional approaches. The farmers departed with a profound realization that these technologies go beyond feed production to enhance the sustainability and profitability of their farms.

Revolutionizing Aquaculture with Advanced Feed Technology and Sustainable Practices

FAITT Transforming the Cage Fish Farming in Bor Dharan Tiger Reservoir through Innovation, Nagpur, Maharashtra

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Introduction

As part of a pilot project aimed at increasing freshwater fish production in Maharashtra, many entrepreneurs have embraced cage fish farming under the Govt. of India (GOI) subsidized scheme. Many entrepreneurs operate in the Bor Dharan reservoir, a man-made Tiger Reserve forest reservoir. This project aims to encourage diversification into aquaculture, particularly cage farming, among IT software, Engineer, and MBA graduates in Maharashtra, which aligns with the state's Reservoir Fishery Policy.

The cages, which are of different dimensions and shapes, are enclosed spaces with intricate net walls that allow the exchange of fresh water. An opening on the top allows for feeding and maintaining the fish stock.

Maharashtra (MH) Cage culture

Maharashtra (MH) has one of India's highest fish consumption populations. The per capita fish consumption in the state was 4.72 kg in 2020-2021. 2021 -2022, MH produced 1.57 lakh metric tonnes of freshwater fish. However, the state imports freshwater fish from Andhra Pradesh to meet the demand for consumption. Experts say that the gap between supply and demand can be bridged with the cage culture technique for fish production. Cage farming has the potential to ensure the production of 20-40 kg of fish/per cubic meter, which can significantly contribute to meeting the demand and supply. In a reservoir-based cage culture, the minimum production in terms of biomass is at least 20-30 times more. Even the quality of fish is better because of the flowing water, compared to ponds where the water is stagnant.

At present, freshwater aquaculture in the state is very low pond-based. However, there are limitations to growth in pond-based aquaculture. "There are often conflicting cross-sectoral demands for water and land, and there is a huge capital investment required for pond-based aquaculture but without the adequate returns," Dr. Balaji, a fisheries and aquaculture specialist in India and lead of FAITT, a non-profit focused on sustainable aquaculture and fisheries. FAITT provides technical expertise to new entrepreneurs who have a passion for

Aquaculture. FAITT Experts and authorities envision cage aquaculture as a way to promote entrepreneurship in aquaculture and create job opportunities for local youth.

Young Entrepreneurs

MH's new initiative is considered investor-friendly, environmentally sound, and socially equitable, and it can be taken up by private entrepreneurs with FAITT partnerships. Expressions of Interest were invited from interested farmers and entrepreneurs to avail themselves of short/long-term leases of cages at Bor.

Bor is the bottomless freshwater reservoir, and we have seen that this tremendous freshwater resource has been lying unutilized," said Mr. G. Nanda, an entrepreneur who started cage culture farming with his partners. "A few years ago, when the government of MH started cage culture in a public-private partnership model, we had been following it up for results. And as the results were positive, we took up this opportunity." Mr. G. Nanda was the first entrepreneur to bring seed stock varieties. Together, they have four different blocks. One block can house 18 rectangular cages. The partners invested their hard-earned money for each block without expecting a subsidy.

Each block has a cage surface area of 1728 sq m and can accommodate a maximum of 18 rectangular cages of 6 m length x 4 m width x 4 m depth dimension cages of 16 m diameter. A target of around 4,000 - 5000 kg of fish can be harvested in a rectangular cage. After a one-time investment, however, there are monthly expenditures too. For instance, salaries for three farm members, including an aquaculture expert (FAITT), feed for nearly two lakhs (3,00,000) fish, fuel charges to ferry the boat, and other maintenance costs. The duo, however, is hopeful of returns. "This is the beginning for us," Mr. G. Nanda said. "But we have closely studied and researched cage culture. FAITT has supported it, and We have even visited other states where it has already been implemented to understand the results. Because this is a part of the food industry, a demand will always be to meet, ensuring sales and profit."

In their rectangular cages divided as nurseries (for fingerlings with more density) and grow-outs (for matured fish with less number per cage), they are growing the exotic *Pangasius* catfish (*Pangasius sutchi*) and tilapia variety of fish. Hardly 100 mts away from their cages, another young entrepreneur has invested in cages in 18 nos. His cages are the only ones that cultured Pangasius for two to three years but have not yet been harvested profitably due to improper management, improper feeding, and not having technical capability, skill, and knowledge.

These private entrepreneurs are leasing cage fish farming, completed for 6 months. Those entrepreneurs approached FAITT to support and transfer the technology of cage culture and target harvests of 150 to 160 tons of Pangasius with a 12-month culture period. FAITT is expecting a complete harvest before December 2024. Only then can they gauge profitability."

Encounters In front of FAITT

With a considerable investment, the new technology continues to face challenges in terms of market linkage, sustainability, disease outbreaks, poaching, and other input logistics. Cage culture, for now, relies on specific species that are not majorly found in local markets **(Fig.1)**. "There is a need to create a market locally for these species," Dr.Balaji said. "They are in demand in neighboring states where we can eventually export the fish, but that also adds to transportation cost." He has yet to harvest his first batch of fish, and the lack of processing units also poses a challenge.

The entrepreneurs depend on neighboring states like Andhra Pradesh and West Bengal for inputs like feeds or seeds. "There is a lack of good quality feed for these species here in MH," Sarada added. "So, we rely on feed from Andhra Pradesh. But this also allows us to diversify into fish feed to cater to the local market."

In the Nursery period, Mr. G. Nanda lost 30% of their fingerlings to overfeeding. "Initially, due to a lack of proper awareness, we overfed the seeds in the nursery, losing 30% of our stock. We hired an FAITT expert to check any disease outbreak and control the mortality due to internal or external factors," Mr. G. Nanda said.

FAITT Successfully Transferred Technology.

- Easier handling, less maintenance, and successful harvesting of fish
- Better control of fish, faster growth, and higher production in less time.
- Protection from predators and competitors.
Simple observation and sampling of fish.

- Efficient use of feed and feed formulation support and own manufacturing
- High stocking density in the Nursery and planned the grow-out
- Feed technology - nutritionally complete and produce fresh and use
- Less Manpower requirement plan growing the fish Minimize the supervision during feeding
- Total harvesting and immediate return on investment.
- Simplified Harvesting Techniques
- Observation and sampling of fish is simplified.
- Effective and maximum utilization of cages
- Water Quality challenges were monitored with easy measurement techniques.
- Fouling of net cage and cleaning procedures and intervals
- The incidence of disease can be high, and diseases may spread rapidly, which is well-managed
- Vandalism or poaching is a potential problem when managed
- Navigation issues and threads of cyclones and waves were managed during and after feeding
- Unused feed and excreta can pollute and eutrophicate water sources well. A Balanced diet
- Conflicts in the local community.
- Predation from aquatic animals and birds.
- Regularly inspect nets for toning and escape.
- Creating professional opportunities for unemployed youth

FOUNDATION FOR AQUACULTURE INNOVATIONS & TECHNOLOGY TRANSFER

FAITT

(A Non-Profit Private Aquaculture Research and Development Foundation)

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PREMIUM JOVEN

Nutritionally Balanced Microcoated Shrimp Post Larvae Feeds

Nutritional	Parameters
Protein (%)	56
Lipids (%)	12
Ash (%)	7
Fibre (%)	0.4

Feed Sizes (Microns)	Larval Stages
50 - 100	Zoea
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AQUA NEEDS

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