AQUAFOCUS

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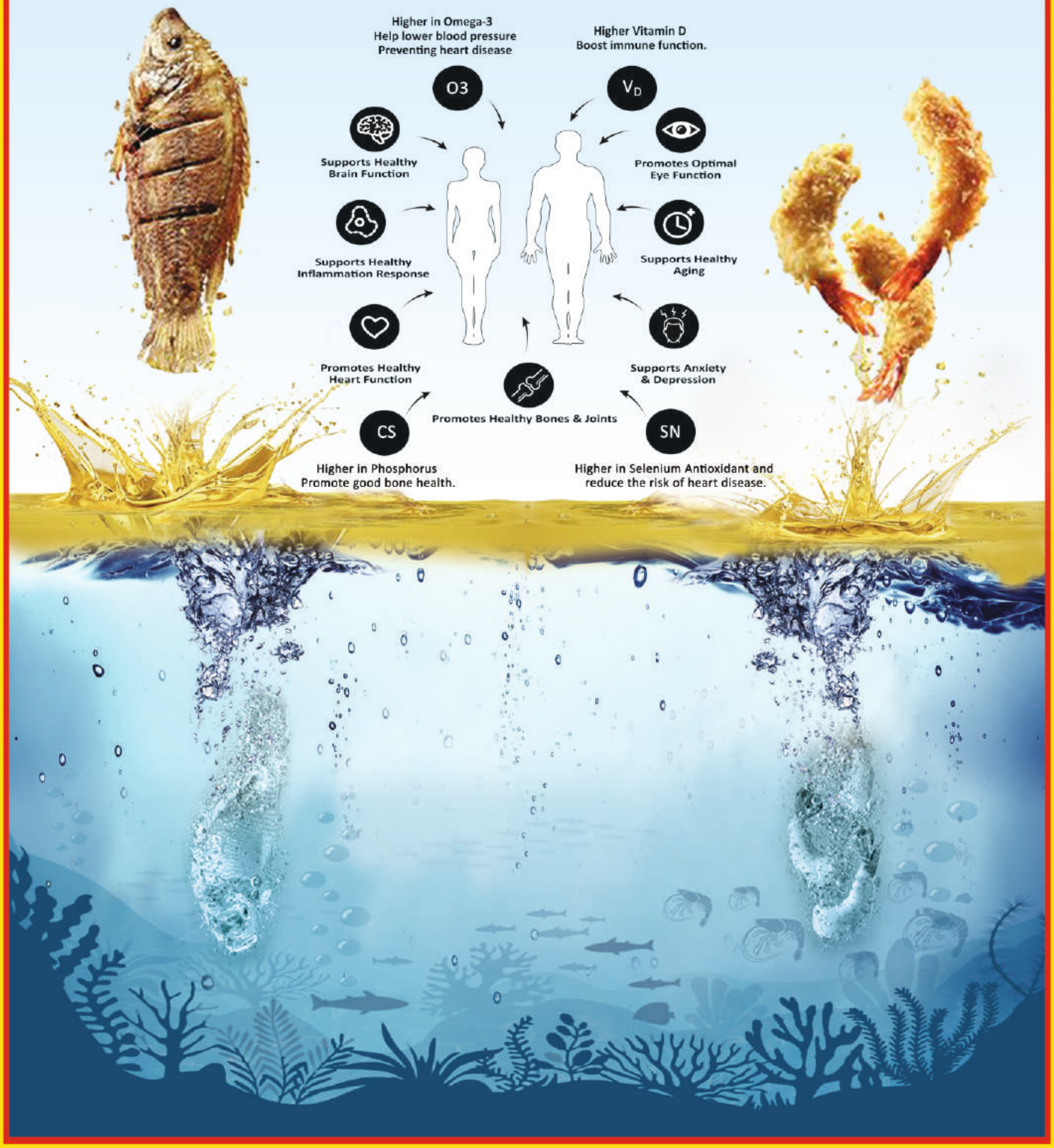

AQUAFOCUS

Dedicated to

Aquaculture Research & Development

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(Dr. Jesu Arockiaraj, highly acclaimed Eminent Scientist with Stanford University World Ranking in Top 2%. Has also received many Awards including Young Scientist Award by Government of India and Government of Tamilnadu)

Greetings!

As we embark on another fascinating journey into the dynamic world of aquaculture, I am pleased to welcome you to the latest edition of Auqafocus. It is an honor to serve as the Editor-in-Chief of this esteemed publication, and I am excited to bring you the latest advances, insights, and trends in the constantly evolving aquaculture sector.

Auqafocus evolves in tandem with the aquaculture landscape. To meet the demands of this vibrant field, we are continually enhancing and expanding our coverage. We aim to foster a community of knowledgeable professionals committed to the health of our water bodies and the sustainable production of aquaculture. We invite everyone to engage with us, share your perspectives, and join us on this exciting journey.

Aquaculture is a pivotal industry, essential for providing sustainable fish to the world's growing population. The challenges and opportunities within this sector are boundless, and Auqafocus is dedicated to being your trusted source for in-depth research and current information.

In this edition of Auqafocus, we are thrilled to present a diverse array of articles that delve into the transformative world of aquaculture. Highlighting the digitalization of farming, we explore how innovative technologies are revolutionizing aquaculture practices. We also address pressing issues such as the overuse of antibiotics and its impact on ecosystems, and we introduce promising natural remedies like neem for combating Enterocytozoon hepatopenaei (EHP) in shrimp farming. Furthermore, we feature insights from the latest research initiatives in Telangana state fisheries, showcasing regional advancements and their implications for global aquaculture.

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

Happy reading!
Dr. A. Jesu Arockiaraj
Editor-in-Chief, Auqafocus

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DIGITALIZING OF FISH FARMING & AQUACULTURE

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Introduction

Digitalization of fish farming is the evolving process by which today people are diversifying aquaculture models and businesses into new dimensions. It includes systems like intelligent water quality monitoring systems, innovative soil quality management systems, monitoring of weather forecasting, monitoring of fish quality, online training for the fish farmers, fresh fish delivery from farm to plate, Sensor-based feeding management technology, AI-based solar aeration technology, technology for pond management; deep sea fishing, etc. Digitalization of fish farming is now an integral part of AI and IoT technology, which are correlated with each other for diversifying Indian aquaculture, with a new face to boost this sector and provide a new dimension for economic growth.

IoT in Fisheries & Aquaculture

The Internet of Things (IoT) has revolutionized various industries, and fisheries and aquaculture are no exception. With the integration of AI and IoT technologies, these sectors have experienced a significant shift towards online and digitalized operations.

IoT devices such as sensors, cameras, and GPS trackers are being used to monitor water quality, track fish migration patterns, and detect potential issues in real time. AI algorithms analyze this data to provide valuable insights for fishery management. By leveraging these technologies, fishery operators can make informed decisions regarding stocking levels, feeding schedules, and disease prevention measures.

Similarly, IoT plays a crucial role in aquaculture in creating a connected ecosystem. Smart sensors embedded in fish tanks or ponds can monitor parameters like temperature, oxygen levels, pH balance, and feed consumption. This data is transmitted wirelessly to a centralized system where AI algorithms analyze it to optimize feeding regimes and detect anomalies or health issues among aquatic organisms.

Furthermore, IoT enables remote monitoring and control of fishery and aquaculture operations through mobile applications or web-based interfaces. This allows farmers or managers to access real-time data from anywhere. They can adjust environmental conditions or feeding schedules accordingly without physically being present on-site.

Overall, integrating AI and IoT in fisheries and aquaculture brings numerous benefits, including increased efficiency in resource management, improved productivity through optimized practices based on data-driven insights, and enhanced sustainability by minimizing environmental impact. As technology advances rapidly in this domain, the potential for further innovation is vast, and we can expect even more exciting developments that will shape the future of these industries.

Utilization of IoT-Based Solutions in Aquaculture & Fisheries

Digitalizing fish farming has become increasingly important in modern aquaculture development and growth. With technological advancements, several areas of fish farming can benefit from digitalization (Table 1).

This includes AI-based fingerling detection, AI-based farm management, Sensor based feeding management, IoT in fisheries and aquaculture, and many more.

Table 1: IOTs in various Aquaculture Systems

S.No.	Aquaculture System	Parameters checked	Microprocessors	References
1.	Aquaponics System	pH, Temp., Turbidity, NH_3, NO_3^{2-}	Arduino	Udanor *et al.* (2022)
2.	Hydroponics with Aquaculture sytem	pH, Temp., Humidity	Arduino	Tamana *et al.* (2021)
3.	Recirculating Aquaculture System	Temp. & Water-level	Raspberry Pi	Al-Hussaini etal. (2018)
4.	Biofloc Technology	pH, Temp., DO & TDS	Arduino UNO	Rashid *et al.* (2022)

I. Smart Water Quality Monitoring System
II. Smart Soil Quality Monitoring System
III. Smart Fish Sensory Evolution System
IV. Smart Weather & Climate Observation Station
V. IoT Based on Farm Management
VI. Artificial Intelligence for Fish Health and Body Metrics
VII. AI-Based Fingerling Detection
VIII. AI-Based Farm Management
IX. Sensor-Based Feeding Management
X. Online Training to the Fishers
XI. Online Fresh Fish Delivery (Farm to Plate)
XII. Online Booking for Entertainment
XIII. E-Commerce Platform
XIV. IoT Based Fish Transportation Devices

XV. IoT Fish Counting Device
XVI. IoT Based Solar Aeration System
XVII. IoT Based Fish Diagnostic System Through Image Analysing
XVIII. Online Platform for Consultancy Services, etc.

I. Smart Water Quality Monitoring System

The digital transformation of fish farming has brought about innovative solutions to enhance productivity and sustainability. This section explores various technologies and systems that are revolutionizing the industry. One crucial aspect is the implementation of smart water quality management systems. These systems leverage IoT sensors and data analytics to continuously monitor water parameters such as temperature, pH levels, dissolved oxygen, and nutrient concentrations. By maintaining optimal water conditions, fish health and growth can be maximized while minimizing the risk of diseases.

Water Pollution is a major threat to any aquaculture farm, as it affects health, economy, and biodiversity. Different methods of water quality monitoring and an efficient IoT-based method for water quality monitoring systems are used in Aquaculture (Varsha Lakshmikantha et al., 2021).

II. Smart Soil Quality Monitoring System

Similarly, Smart Soil quality study systems are vital in optimizing fish farm operations. These systems employ advanced sensors to measure soil characteristics like moisture content, nutrient levels, and salinity. By analyzing this data in real-time, farmers can make informed decisions regarding fertilization and irrigation practices to ensure optimal growth conditions for aquatic plants or crops. In 2050, the global population will exceed 9.5 billion people, increasing food demand. Increased production necessitated a significant expansion in the land and irrigation water resources. Adequate soil and water management strategies were essential for sustainable agriculture management practices (John Havlin, Ron Heiniger; Soil Fertility Management for Better Crop Production, 2020).

To combat soil and water pollution issues, smart soil or water pollutant study systems are utilized. These systems employ advanced monitoring techniques to detect contaminants in the water, such as heavy metals or chemical pollutants. By identifying potential sources of pollution promptly, appropriate measures can be taken to mitigate their impact on fish health and overall ecosystem sustainability.

III. Smart Fish Sensory Evolution System

Technological advancements have also led to the development of fish sensory evolution systems in recent years. These innovative tools enable farmers to better understand fish behaviour by monitoring their response to environmental stimuli such as light intensity or sound frequencies. This knowledge helps optimize feeding strategies and create a more natural habitat for aquatic species.

IV. Smart Weather & Climate Observation Station

Moreover, weather and climate observation stations with IoT devices provide real-time weather data for fish farm locations. This information aids farmers in making informed decisions related to feeding schedules, harvesting times, or implementing protective measures during extreme weather events. Lin et al. (2021) developed a system that integrates various sensors, including dissolved oxygen, pH, and water temperature in each water layer.

V. IoT - Based Farm Management

IoT-based farm management platforms integrate various aspects of aquaculture operations into a centralized system. These platforms allow farmers to remotely monitor critical parameters such as water quality or feed consumption rates through mobile applications or web interfaces. Such streamlined management processes significantly enhance operational efficiency while reducing manual labor requirements. The soil and water samples are monitored and analyzed using the soil fertility prediction system (Aarthi et al., 2023).

VI. Artificial Intelligence for Fish Health and Body Metrics

Artificial intelligence (AI) has also been found to be applicable in fish farming, particularly in fish health and body metrics analysis. AI algorithms can analyze data from various sources, such as underwater cameras or wearable devices, to assess fish behavior, and growth rates or detect early signs of diseases. This allows for timely interventions and improved overall fish health management.

VII. AI-Based Fingerling Detection

AI-based fingerling detection is a significant development in the industry. It utilizes artificial intelligence to accurately identify and count fingerlings, which are young fish used for stocking ponds or tanks. This technology helps streamline the process of monitoring and managing fish populations.

VIII. Sensor-Based Feeding Management

Sensor-based feeding management is another crucial aspect of digitalized fish farming. Sensors placed within the aquaculture system can monitor feed consumption by individual or groups of fish. This data helps optimize feeding strategies and reduce waste.

IX. Online Training for the Fish Farmer

Online training platforms have emerged to provide remote education and guidance to fish farmers. These platforms offer courses on best practices in aquaculture techniques, disease prevention measures, sustainable farming methods, etc., empowering farmers with the knowledge necessary for successful operations. There are many Online E platforms user friendly come up to help farmers 24 x 7, such as the E-fish Tutor app.

X. Online Fresh Fish Delivery System

Digitalization has also extended to consumer-facing aspects such as online fresh fish delivery services. Customers can now conveniently order freshly caught or farmed seafood directly from producers through online platforms or mobile applications.

XI. Online Booking for Entertainment

Furthermore, online booking services have made it easier for consumers to plan their visits to entertainment facilities associated with fisheries, such as fishing resorts or recreational fishing spots. These platforms allow customers to reserve their spots, check availability, and plan their fishing activities.

XII. E-Commerce Platform

In today's digitalized world, E-commerce platforms have become vital for various industries, including the fishery and aquaculture sectors. An E-commerce platform designed explicitly for fish allows fish farmers and suppliers to showcase their products online, reach a broader customer base, and streamline the buying process. With features like product listings, secure payment gateways, and order tracking systems, this platform enables seamless transactions between buyers and sellers in the fish industry.

XIII. IoT Based Fish Transportation

Transporting live fish from farms to markets or other destinations can be challenging. Howver, with IoT technology, fish transportation can be more efficient and reliable. IoT-based systems can monitor water quality, temperature, oxygen levels, and GPS tracking during transportation. This ensures that the fish are transported optimally with minimal stress or loss.

XIV. IoT Fish Counting Device for Fish Population Study

Accurate monitoring of fish populations is crucial for effective management in fisheries or aquaculture operations. IoT-based fish counting devices use advanced sensors and image recognition technology to automatically measure the number of fish in a tank or pond. This eliminates the need for manual counting methods and provides real-time data on population size for better decision-making.

The sonar imaging device has two cloud-based Artificial Intelligence (AI) functions that estimate the quantity and the distribution of the length and weight of fish in a crowded fish school. Because sonar images can be noisy and fish instances of an overcrowded fish school are often overlapped, machine learning technologies, such as Mask R-CNN, Gaussian mixture models, convolutional neural networks, and semantic segmentation networks were employed to address the difficulty in the analysis of fish in sonar images. Furthermore, the sonar and stereo RGB images were aligned in the 3D space, offering an additional AI function for fish annotation based on RGB images (Chang et al. 2022).

XV. IoT Based Solar Aeration System

Maintaining proper oxygen levels in ponds or tanks is essential for healthy aquatic life in fisheies or aquaculture setups. An IoT-based solar aeration system utilizes solar power to operate aerators that increase dissolved oxygen levels in water bodies where the electricity supply may be limited or unreliable. This sustainable solution ensures optimal conditions for fish growth while reducing energy costs.

XVI. IoT Based Fish Diagnostic System Through Image Analysing

Early detection of diseases is crucial in preventing outbreaks and minimizing losses in fisheries or aquaculture operations. An IoT-based diagnostic system uses image analysis techniques to identify signs of diseases or abnormalities in captured images of fish's external appearance. This system can provide quick and accurate diagnoses, allowing fish farmers to take timely actions to prevent the spread of diseases.

Verma et al. (2017) proposed a sensitive topic that is kidney stone detection. In this paper, the authors apply morphological operations and segmentation to determine ROI (region of interest) for the SVM classification technique. After applying this technique, they investigated the kidney stone images with some difficulties, such as the similarity of kidney stones and low image resolution (Ahmed et al. 2022).

XVII. Online Platform for Consulting Services

The fishery and aquaculture industry often requires expert guidance and consultancy services for various aspects such as farm management, breeding techniques, disease prevention, and market analysis. An online platform dedicated to consultancy services provides a convenient way for industry professionals to connect with experts in the field. Through this platform, users can access valuable insights, seek advice, and receive personalized recommendations to optimize their operations and improve overall productivity.

Major Constraints

It requires more variables than we can currently monitor to obtain the most complete picture of farm activity. Creating new probes to measure microbes, micropollutants, or other physicochemical properties makes this a technological challenge.

Another significant barrier to the IoT revolution in this industry is the capacity to transport a significant volume of data from the farm using the least amount of energy. By examining their behavior, activity, and potential diseases directly underwater, developing real-time monitoring using high-quality HD video feeds to enable deep image processing would create new prospects for livestock surveys. Additionally, it will be possible to scan the microenvironment, such as the weather or local activity, to stop poaching.

Conclusion

In conclusion, Digitalizing Fish Farming through various technologies such as AI-based fingerling detection, AI-based farm management, sensor-based feeding management, IoT integration, online training platforms, online fresh fish delivery services, and online booking for entertainment facilities brings numerous benefits to both farmers and consumers. It enhances efficiency, productivity, and sustainability and provides convenience in the industry with new job opportunities.

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Cresco

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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.

CRESCO ALGAE FORT

RS No. 6, Doddanpudi Village, Akiveedu Sub Division,
Kalla Mandal, West Godavari Dist,
Andhra Pradesh. PIN - 534 237.
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Mitigation of Enterocytozoon hepatopenaei (EHP) in shrimp Aquaculture through the application of neem leaf extract

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Abstract

The effects of *Enterocytozoon hepatopenaei* (EHP) infection in shrimp farming were investigated, and a sustainable intervention approach involving Neem aqueous extract (NAE) was proposed. Extended exposure to NAE demonstrated enhanced antioxidant defenses and immune responses, effectively mitigating the oxidative stress associated with EHP infection. Moreover, the application of NAE showed promise in reducing the proliferation of EHP spores within shrimp hepatopancreas, indicating its potential for combatting EHP infection in shrimp aquaculture.

Introduction

India is a prominent player in global aquaculture, particularly in shrimp production, ranking second worldwide and serving as the leading exporter of black tiger shrimp (*Penaeus monodon*) and whiteleg shrimp (*Litopenaeus vannamei*). Despite these achievements, the emergence of EHP, a microsporidian parasite, poses a substantial threat to shrimp farming in India and beyond. EHP affects shrimp growth, causing development retardation among individuals and hindering overall productivity. Clinical symptoms include growth retardation, lethargy, decreased feed intake, and soft shells. EHP does not generally lead to mass mortalities but increases vulnerability to other diseases and negatively impacts shrimp quality. EHP has been documented in numerous global shrimp farming regions, including India, where prevalence rates reach 50% in certain provinces like Shandong and Jiangsu, China. The disease has also been confirmed in *L. vannamei* populations in India.

Challenges in Controlling EHP

Detecting EHP infection poses a challenge due to its latent nature, lacking immediate mortality or discernible external manifestations. This delay in identification hinders timely intervention, enabling the parasite's unchecked dissemination. Currently, viable commercial treatments for EHP are unavailable, and potential interventions, like prebiotics and probiotics, necessitate further refinement and testing. EHP spores exhibit remarkable resistance to environmental variables, such as salinity fluctuations, disinfectants, and temperature changes, contributing to their prolonged persistence and elevating the risk of subsequent reinfection in aquaculture cycles. Shrimp that recover from EHP infection may harbor spores asymptomatically, serving as inconspicuous carriers and potential infection sources for healthy shrimp. The intricate life cycle of EHP, encompassing both intracellular and extracellular stages, complicates effectively targeting all phases through control measures.

Current EHP Controlling strategies

EHP-infected shrimp exhibit no visible symptoms, complicating timely treatment and facilitating the spread of the disease. Effective treatment methods for EHP are currently unavailable. To manage EHP, it is crucial to ensure that broodstock maturation and hatchery facilities are thoroughly cleaned and disinfected using sodium hydroxide solution (25 gms /L) followed by acidified chlorine (0.2 gms /L). Screening broodstock for EHP before admission to facilities is crucial. While PCR testing of post larvae (PL) is recommended to identify and prevent EHP transmission, this technique may not be accessible to all farmers, requiring expertise for its implementation. Disinfecting ponds with quicklime (CaO) and maintaining appropriate pH levels can help eliminate EHP spores between cultivation cycles. The thick-walled spores of EHP are challenging to inactivate, emphasizing the importance of stringent biosecurity measures and proper pond preparation to prevent EHP contamination in aquaculture ecosystems. Ongoing research on EHP strives to unravel its complete life cycle and host-pathogen interactions and formulate efficient control strategies. The existing knowledge gap delays the development of suitable and sustainable control methods against EHP infection. Additionally, researchers explore alternative avenues, such as leveraging natural compounds from plants to enhance shrimp resistance against EHP infection autonomously.

Neem as a Potential Treatment against EHP

Neem (*Azadirachta indica*) has been studied extensively for its potential bioactive properties due to limonoids, terpenoids, flavonoids, and saponins. These compounds have shown antifungal, antibacterial, anti-inflammatory, and antiviral activities. Investigation into using NAE against EHP spores demonstrates promise in boosting shrimp immunity and potentially mitigating EHP infections. NAE was prepared following Agbenin and Marley's procedure. Fresh neem leaves were sterilized, rinsed, dried, ground into a fine powder, soaked in distilled water, and filtered before storage at -4°C. The extract was concentrated and tested for toxicity. NAE toxicity was assessed using zebrafish larvae and shrimp post larvae (PL 10), with 5-25 mg/L concentrations for zebrafish and 20-100 mg/L for shrimp larvae. Toxicity analysis in adult shrimp included 30-55 mg/L concentrations. Adult shrimps were exposed to NAE at determined concentration of 40 mg/L for 15 days for therapeutic efficacy evaluation against EHP infection.

Scientific Approaches to Study EHP and Neem

To investigate the effectiveness of NAE against EHP, researchers utilize diagnostic tools such as enzymatic quantification from post-exposure of hepatopancreas samples (superoxide dismutase, catalase, prophenol oxidase, and nitric oxide levels) and staining techniques like Calcofluor-white (CFW) and Hematoxylin and Eosin (H&E) were used for spore detection and histological examination. PCR sensitivity tests were performed for EHP gene detection.

Results

NAE underwent preliminary screening in zebrafish larvae to assess its impact at varying concentrations. Zebrafish larvae exhibited high mortality at concentrations excluding five mg/L, with complete mortality observed within 24 hours. Notably, larvae tolerated the 5 mg/L dosage for 24 hours. Shrimp larvae exposed to higher concentrations (60-100 mg/L) also experienced significant mortality after 24 hours, with 20 and 40 mg/L groups demonstrating similar survival rates to the control after 36 hours. Adult shrimp were employed to confirm effects observed in larvae, and toxicity testing revealed that concentrations of 30-40 mg/L led to 100% survival, while higher concentrations (45-55 mg/L) resulted in mortality within 24 hours. The optimum NAE dosage for subsequent exposure studies was 40 mg/L based on concentration versus percentage lethality analysis.

Continuous exposure of shrimp to 40 mg/L NAE for 15 days, with water replacement every three days, revealed improved antioxidant activity. Analysis of immunological parameters in post-treatment shrimp demonstrated that NAE exposure stimulated antioxidant defense mechanisms, influencing non-enzymatic and enzymatic antioxidants. Superoxide dismutase activity significantly increased in NAE-treated shrimp infected with EHP, indicating a reduction in reactive oxygen species levels compared to EHP-infected shrimp. Catalase activity also increased in NAE-treated shrimp, reaching levels comparable to the control group. Nitric oxide activity, essential for immune responses, increased significantly in NAE-treated, EHP-infected shrimp, approaching control group levels. Prophenol oxidase activity, a vital component of the phenol oxidation pathway, increased dramatically after NAE administration, surpassing both control and EHP-infected groups.

Staining techniques, including Calcofluor-white (CFW), revealed fewer EHP spores in NAE-exposed shrimp compared to the model group. Histopathological examination of hepatopancreas sections exhibited fewer dark blue-dyed spores in NAE-exposed shrimp than EHP-infected shrimp, while no spores were observed in the control group. Polymerase chain reaction (PCR) sensitivity analysis confirmed the specificity of the EHP PCR method, with the targeted 358 bp band exclusively observed in DNA samples from EHP-infected shrimp. NAE exposure appeared to result in a lower level of EHP infection or a reduced quantity of EHP DNA in the analyzed samples. These findings suggest the potential efficacy of NAE as a treatment option for controlling EHP infection in shrimp.

Continuous exposure of shrimp to 40 mg/L NAE for 15 days, with water replacement every three days, revealed improved antioxidant defense via increased superoxide dismutase (SOD) and catalase (CAT) activity. NAE aided in neutralizing superoxide radicals, protecting against oxidative damage induced by EHP infection. Additionally, NAE normalized nitric oxide (NO) activity, potentially enhancing immune responses. Bioactive components in neem, such as triterpenoids and flavonoids, contribute to these effects. Histological examination of shrimp hepatopancreas indicated fewer EHP spores in NAE-exposed shrimp, supporting its role in EHP eradication. Calcofluor-white staining revealed reduced spores in NAE-exposed shrimp feces. Polymerase chain reaction (PCR) sensitivity testing suggested NAE may influence EHP infection or DNA quantity, suppressing EHP replication and proliferation. Identified compounds in Neem methanol extract (NME) possess antimicrobial, antioxidant, and anti-inflammatory attributes, potentially inhibiting EHP proliferation and mitigating associated inflammatory responses (Fig. 1). Further research is needed to validate the effectiveness of these compounds in the context of EHP infection in shrimp. Overall, NAE shows promise in enhancing antioxidant defense immune response and combating EHP in shrimp aquaculture.

Conclusion

NAE shows promise in enhancing antioxidant defense and immune response while combating EHP infection in shrimp aquaculture. Through various scientific approaches, NAE demonstrated significant potential in boosting shrimp immunity, reducing EHP spore development, and improving antioxidant activity.

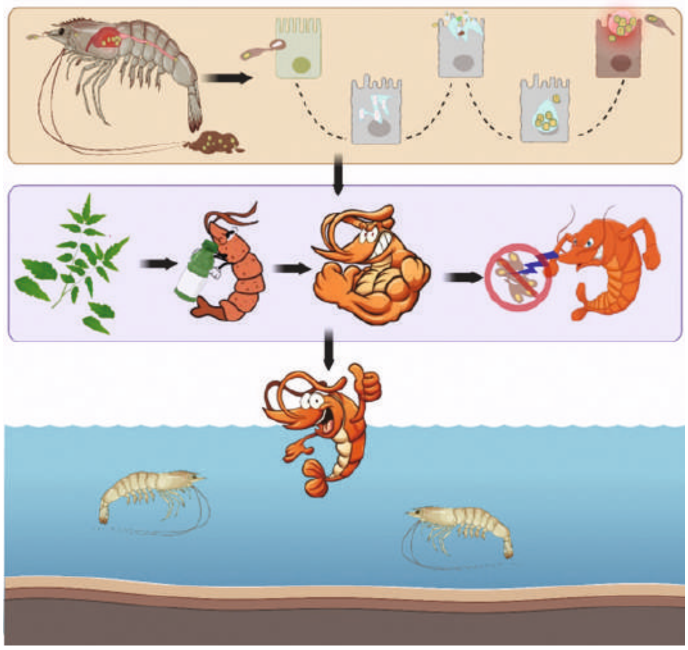

Fig. 1 Mechanism of EHP infection and NAE treatment therapy in the EHP infected shrimp.

Antibiotic Overuse in Aquaculture : Unveiling the Curse on Ecosystem Health

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Introduction

Recently, the escalating concern over antibiotic overuse in aquaculture has become a focal point, raising serious questions about its impact on the delicate equilibrium of ecosystem health. The backdrop of this issue lies in the pivotal role of aquaculture within the global food production landscape, where the growing demand for seafood has driven the industry to new heights. However, this success story is tainted by the increasing reliance on antibiotics to combat the challenges of intensive aquaculture practices. The use of antibiotics has surged due to factors such as overcrowded aquatic environments, stressful conditions, susceptibility to diseases, and the pursuit of high yields. Yet, the effects of this widespread antibiotic use extend far beyond the boundaries of aquaculture farms, infusing marine ecosystems and posing a considerable threat to their intricate balance. The intensification of antibiotic usage in aquaculture exacerbates ecological concerns and jeopardizes the health of the target species and non-target aquatic organisms. As antibiotic residues leach into water bodies, they contribute to the development of antibiotic-resistant bacteria, thus amplifying the global crisis of antimicrobial resistance. Consequently, addressing antibiotic overuse in aquaculture is not merely a matter of industry regulation; it emerges as an urgent imperative for safeguarding ecosystem health and preserving the delicate equilibrium of our oceans. The significance of this issue cannot be overstated, as unchecked antibiotic use not only jeopardizes the sustainability of aquaculture but also endangers the biodiversity and overall resilience of aquatic ecosystems.

This paper explores the multifaceted dimensions of antibiotic overuse in aquaculture, aiming to unravel its origins, consequences, and the imperative need for a paradigm shift towards more sustainable practices. By exploring the complex interplay between aquaculture practices and ecosystem health, this research sheds light on the intricate web of consequences that extend beyond the confines of fish farms. The paper will also scrutinize existing regulatory frameworks, assess their effectiveness, and propose actionable strategies to curtail antibiotic overuse while promoting a balanced and sustainable coexistence between aquaculture and its inhabitable ecosystems. Through this comprehensive examination, the paper aspires to contribute to the ongoing discourse on responsible aquaculture practices and environmental stewardship amid burgeoning global food demands.

Antibiotic Utilization in Aquaculture

Antibiotics are commonly used in aquaculture to treat and prevent bacterial infections in fish and other aquatic organisms. Oxytetracycline, a broad-spectrum antibiotic, is administered at a rate of 50-100 mg/kg body weight either orally through medicated feed or via immersion baths. Treatment duration may vary but is usually around 5-10 days. It is commonly used in aquaculture to treat various bacterial infections in fish, such as bacterial hemorrhagic septicemia and furunculosis. Florfenicol is administered orally via mediated feed at 10-20 mg/kg body weight effectively against a wide range of Gram-negative and some Gram-positive bacteria. Treatment duration may vary but is typically around 10 days. A fluoroquinolone antibiotic named enrofloxacin administered orally via mediated feed at 10-20 mg/kg is effective against many Gram-negative and some Gram-positive bacteria. Treatment duration may vary but is typically around 5-10 days. Trimethoprim, often combined with sulfonamides, is used in aquaculture to treat bacterial infections, particularly those caused by Gram-negative bacteria. They are administered orally via mediated feed at a rate of 100-200 mg/kg body weight. Treatment duration may vary but is typically around 7-10 days. A tetracycline antibiotic named Doxycycline administered orally via mediated feed at a rate of 10-20 mg/kg is used to treat bacterial infections in fish, particularly those caused by Gram-negative bacteria, by also being effective against some intracellular pathogens. Treatment duration may vary but is typically around 7-10 days. Amoxicillin is also used to treat bacterial infections and is administered orally via mediated feed at 10-20 mg/kg body weight. Treatment duration may vary but is typically around 7-10 days.

Aquaculture operations often use antibiotics to prevent and treat bacterial infections in fish populations. Overcrowded conditions, high stocking densities, and stressful environments can increase the susceptibility of fish to diseases, leading to a perceived need for antibiotic use. Economic factors, such as the desire to maximize production and profits, can drive the use of antibiotics in aquaculture. Many aquaculture producers, especially small-scale farmers, may have limited knowledge about the risks associated with antibiotic overuse and the importance of responsible antibiotic stewardship. Education and outreach efforts are needed to raise awareness about alternative disease management strategies and the potential consequences of antibiotic misuse. Pressure from supply chain actors, such as processors, retailers, and consumers, to meet demand for cheap and readily available seafood products can incentivize fish farmers to use antibiotics indiscriminately to maintain production levels and meet market demands.

Environmental consequences

Antibiotic residues in aquatic environments can promote the development and spread of antibiotic-resistant bacteria. Bacteria in the water, sediment, and biofilms may be exposed to sub-lethal concentrations of antibiotics, leading to the selection of resistant strains. Antibiotic-resistant genes can be transferred horizontally between bacteria in aquatic environments, including those in sediment and biofilms. This genetic exchange can contribute to the dissemination of antibiotic resistance within aquatic ecosystems. Antibiotic residues can alter the composition and function of microbial communities in aquatic ecosystems. This disruption can affect nutrient cycling, decomposition processes, and ecosystem stability (Figure 1). Some antibiotics can exhibit ecotoxic effects on aquatic organisms, even at low concentrations. These effects may include toxicity to fish, inhibition of algal growth, and disruption of aquatic food webs. Antibiotic residues in water systems can enter the food chain by consuming contaminated seafood or water. Prolonged exposure to low levels of antibiotics may contribute to the development of antibiotic resistance in human pathogens, posing risks to human health. Antibiotic residues in water systems can harm non-target organisms, including aquatic plants, invertebrates, and fish. Exposure to sub-lethal concentrations of antibiotics may disrupt physiological processes, impair growth and development, and increase susceptibility to diseases. Antibiotic use creates selective pressure on bacteria present in aquaculture settings. Bacteria susceptible to antibiotics are killed off, while those with genetic mutations or mechanisms that confer resistance to antibiotics survive and multiply. Bacteria can exchange genetic material through conjugation, transformation, and transduction. Antibiotic-resistant bacteria and resistance genes can spread beyond aquaculture facilities and potentially impact wild aquatic species.

Aquatic environments contaminated with antibiotic-resistant bacteria can serve as reservoirs for resistant pathogens that may harm human health. Consumption of contaminated seafood or recreational activities in polluted water can result in human exposure to antibiotic-resistant bacteria. The spread of antibiotic resistance in aquaculture environments can diminish the effectiveness of antibiotics used for both veterinary and human medicine. This can complicate the treatment of bacterial infections in both animals and humans and may lead to increased morbidity, mortality, and healthcare costs. When oxytetracycline enters aquatic ecosystems through discharge from aquaculture facilities or runoff from fish farms, it can persist in sediments and water bodies. This persistence can lead to the development of antibiotic-resistant bacteria in the environment, disrupting the natural balance of microbial communities. Florfenicol can accumulate in sediments and water bodies, persisting for extended periods. Sulfadiazine and trimethoprim are often used to treat bacterial infections in fish. These antibiotics can enter aquatic ecosystems through discharge from aquaculture facilities or effluent runoff. Enrofloxacin can enter aquatic ecosystems through discharge from fish farms or via runoff from surrounding agricultural areas.

Human health concerns

Antibiotic resistance transmission pathways pose significant human health concerns, as they contribute to the spread of antibiotic-resistant bacteria and compromise the effectiveness of antibiotics in treating infections. Environmental reservoirs within healthcare settings, such as sinks, drains, and medical devices, can harbor antibiotic-resistant bacteria and serve as transmission sources. Antibiotic-resistant bacteria can be transmitted to humans by consuming contaminated food, particularly meat, poultry, and seafood, from animals treated with antibiotics in agriculture and aquaculture (Figure 1). Inappropriate use of antibiotics in human medicine, agriculture, and veterinary medicine contributes to the selection pressure for antibiotic-resistant bacteria (Table 1). Non-compliance with prescribed antibiotic regimens or failure to complete the entire course of treatment can promote the survival and proliferation of antibiotic-resistant bacteria within the human host, facilitating transmission to others. The use of antibiotics in aquaculture can lead to the presence of antibiotic residues in seafood products.

Aquaculture operations may use various chemicals, such as disinfectants, pesticides, and antifungal agents, to maintain water quality and control diseases. Residues of these chemicals can accumulate in aquaculture products and may pose risks to human health if consumed excessively. Aquatic environments can be contaminated with heavy metals and POPs from industrial activities, agricultural runoff, and atmospheric deposition. Seafood products can be contaminated with bacteria, viruses, parasites, and other pathogens during production, processing, and handling. Consumption of contaminated seafood can lead to foodborne illnesses, such as bacterial infections, viral infections, and parasitic infections. Cross-contamination of seafood products with allergens, such as crustacean shellfish, fish, and mollusks, can occur during processing and handling.

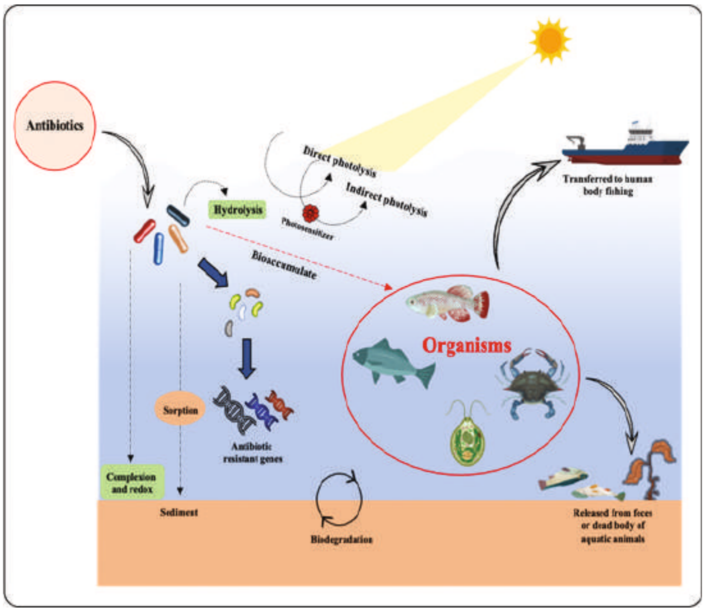
Table 1. Ecological and human health effects of antibiotics.

Individuals with allergies to seafood allergens may experience allergic reactions upon consuming contaminated products, even in trace amounts. Mislabeling and fraudulent practices in the seafood industry, such as species substitution and misrepresenting country of origin, can compromise the safety and authenticity of aquaculture products. Workers may be exposed to these chemicals through inhalation, dermal contact, or accidental ingestion, leading to acute or chronic health effects, such as respiratory irritation, skin rashes, or systemic toxicity. Aquaculture workers may be exposed to various biological hazards, including bacteria, viruses, parasites, and fungi, in water bodies and aquatic organisms. Contact with contaminated water or infected fish can lead to the transmission of infectious diseases, such as bacterial infections, viral diseases, and parasitic infections. Through repeated exposure, some aquaculture workers may develop allergic reactions or sensitivities to aquatic organisms, such as fish, shellfish, or algae. Allergic reactions can manifest as skin rashes, respiratory symptoms, or anaphylaxis.

Table 1. Ecological and human health effects of antibiotics.

S.No.	Antibiotic name	Target organisms		Residue compound	Antibiotic resistant genes	Human health risks
		Gram positive	Gram Negative			
1	Oxytetracycline	Staphylococcus, Streptococcus, Clostridium	E. coli, Salmonella, Vibrio	Oxytetracycline and 4-Epitetracycline	tet(A), tet(B), tet (C)	Gastrointestinal disorders
2	Florfenicol	Streptococcus spp., Staphylococcus spp.	Aeromonas spp., Edwardsiella spp.	Florfenicol amine	floR, fexA	Hepatotoxicity and nephrotoxicity
3	Enrofloxacin	Streptococcus, Staphylococcus	E. coli, Psuedomonas, Aeromonas	ciprofloxacin	qnr, aac(6')-Ib-cr, oqxAB	Gastrointestinal disturbances, hypersensitivity reactions
4	Sulfonamides	Streptococcus spp., Staphylococcus spp.	E. coli, Haemophilus	Sulfamethazine and Sulfamethoxazole	sul1, sul2, sul3, sul4, sul5, dfrA, dfrB	Allergic reactions, hemolytic anemia
5	Trimethoprim	Staphylococcus aureus, Streptococcus pneumoniae	E. coli, Klebsiella pneumoniae, Haemophilus influenzae	1,3,5-triazine derivatives	dfrA, dfrB	Headache, vomiting, kidney damage
6	Quinolones	Streptococcus pyogenes, Clostridium perfringens	Shigella spp. Pseudomonas aeruginosa, Klebsiella pneumoniae	Oxolinic acid	qnr, aac(6')-Ib-cr, qepA	Gastrointestinal upset and hypersensitivity reactions
7	Doxycycline	Staphylococcus aureus, Enterococcus	Haemophilus influenzae, Neisseria gonorrhoeae, Acinetobacter	Doxycycline hydrochloride	bla, qnr	Gastrointestinal disturbances and photosensitivity
8	Nitrofuranes	Streptococcus spp.	Aeromonas spp., Edwardsiella ictaluri, Flavobacterium spp.	Semicarbazide and 3-Amino-2-oxazolidinone	nfsA, nimA, nimB, nimC, nimD, nimE, fubA	Gastrointestinal disturbances, hypersensitivity reactions

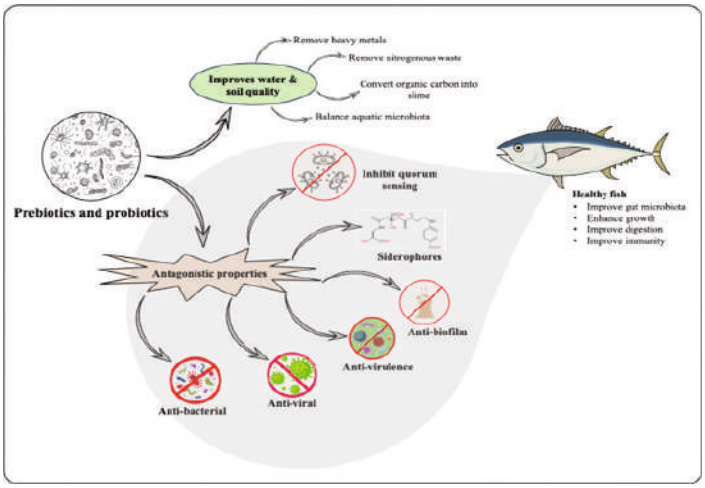
Figure 1. Effects of antibiotics on aquatic organisms.



Alternatives to antibiotics use

Probiotics and prebiotics offer promising alternatives to antibiotic use in aquaculture by promoting the growth of beneficial microorganisms in the gut microbiome of farmed fish, enhancing immune function, and reducing the risk of disease (Figure 2). Probiotics are live microorganisms that confer health benefits when administered in adequate amounts. In aquaculture, probiotics are typically administered orally or added to fish feed. *Lactobacillus* species are commonly used probiotics in aquaculture due to their ability to produce lactic acid and other antimicrobial compounds. *Bifidobacterium* species are another group of probiotics used in aquaculture. They contribute to gut health and immune function. *Bacillus* species are spore-forming bacteria that produce enzymes that aid in digestion and compete with pathogenic bacteria. Examples include *Bacillus subtilis* and *Bacillus licheniformis*. The yeast species *Saccharomyces cerevisiae* is used as a probiotic in aquaculture to improve nutrient utilization, enhance immune function, and reduce stress. It can also help mitigate the effects of toxic compounds in the gut. *Enterococcus* species are lactic acid bacteria that contribute to gut health and immune modulation in fish. They can inhibit the growth of pathogenic bacteria through competitive exclusion and the production of antimicrobial compounds.

Figure 2. Application of prebiotic and probiotics in aquaculture.



Probiotics and prebiotics can be administered through fish feed, water additives, or direct application to the aquaculture environment. Encapsulation techniques may be used to protect probiotic bacteria from harsh environmental conditions and ensure their survival until they reach the gut. Prebiotics can be incorporated into fish feed or provided as supplements to promote beneficial gut bacteria growth. Prebiotics are non-digestible fibers that serve food for beneficial gut microorganisms. They encourage the development and activity of probiotic bacteria, enhancing their beneficial effects. Fructooligosaccharides (FOS) are naturally occurring prebiotics in fruits, vegetables, and certain grains. They stimulate the growth of beneficial bacteria, such as *Lactobacillus* and *Bifidobacterium*, in the gut. Mannanoligosaccharides (MOS) are derived from yeast cell walls and have prebiotic properties. They help support gut health by binding to harmful bacteria and preventing their attachment to the intestinal lining. Galactooligosaccharides (GOS) are oligosaccharides composed of galactose molecules. They promote the growth of beneficial bacteria in the gut and help maintain a healthy microbial balance. Immunostimulants stimulate the immune system to enhance the host's ability to fight off infections and diseases.

In aquaculture, immunostimulants are used to boost the immune response of farmed fish and shellfish, thereby improving disease resistance and overall health by enhancing immune response, increasing resistance to pathogens, and activating immune cells. Immunostimulants may stimulate the production of immune factors, such as cytokines, interferons, and antimicrobial peptides. These play critical roles in orchestrating the immune response and combating infections by adaptive immunity priming and reduced reliance on antibiotics. Integrated Pest Management (IPM) in aquaculture involves using various strategies to control pests and diseases while minimizing dependence on antibiotics. Introducing natural predators, parasites, or pathogens that target pest species can help control their populations. Breeding programs to select disease-resistant strains of aquaculture species can help reduce susceptibility to common diseases, reducing the need for antibiotics. Providing a balanced diet with optimal levels of essential nutrients can improve aquaculture species' overall health and immune function, reducing their susceptibility to diseases.

Combining aquaculture with other farming activities, such as horticulture or livestock farming, in an integrated system can create ecological balances that naturally control pest populations, reducing the need for chemical interventions. Advanced diagnostic techniques such as PCR (Polymerase Chain Reaction) and ELISA (Enzyme-Linked Immunosorbent Assay) can help identify diseases early, allowing prompt intervention with targeted treatments rather than broad-spectrum antibiotics.

Future directions and conclusions

Future directions and conclusions regarding antibiotic use in aquaculture are heavily influenced by the need for sustainable and responsible practices in the industry. As outlined in integrated pest management (IPM) approaches, there will be increasing emphasis on developing and implementing alternative strategies to antibiotics in aquaculture. Collaboration between aquaculture producers, researchers, government agencies, and environmental organizations will be crucial in addressing antibiotic resistance and promoting sustainable aquaculture practices.

Growing consumer awareness of antibiotic use's environmental and health impacts in aquaculture will drive demand for sustainably produced seafood. There will be increased investment in research and development to discover new methods for disease prevention and control in aquaculture. International collaboration and cooperation will be essential given the global nature of aquaculture production and antibiotic resistance issues. Forums such as the Food and Agriculture Organization (FAO) of the United Nations and regional aquaculture organizations will facilitate information exchange and policy development on a global scale. Economic factors, including the cost-effectiveness of alternative strategies compared to antibiotics, will influence their adoption by aquaculture producers. In conclusion, the future of antibiotic use in aquaculture is moving towards greater sustainability, responsibility, and innovation. While antibiotics will likely continue to play a role in disease management in the short term, there is a clear trend toward reducing reliance on them in favor of alternative approaches that prioritize animal health, environmental protection, and public health. By embracing these principles and working collaboratively, the aquaculture industry can ensure a more resilient and sustainable future for seafood production.

A Brief Overview of Telangana State's Fishery Resources Prospect and Facilities

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Introduction

Telangana accounts for 3.5% of India's total geographical area and 2.9% of the population and ranks 12th in geographical area and population among the Indian States. The State is newly formed 29th in India and blessed with prosperous inland Fishery Resources state organizing in India at 3rd Rank. Total water spread area (WSA) 5.87 Lakh Ha; first Karnataka with 7.3 Lakh Ha; second Tamil Nadu with 6.96 Lakh Ha; and Total production in the state 2.2 in Lakh tons ranking in India 8th rank. The inland fishery resources consist of 5,062 km of rivers, 511 km of canals, 80 all types of reservoirs with a water spread area of 1.89 lakh ha, 4,612 department tanks with 2.4 lakh ha, 24,210 gramapanchayat tanks with 1.38 lakh ha and ponds 474 no's with water spread area of782 ha. The infrastructure includes 80 ice plants with a holding capacity of 750 metric tonnes and 8 cold storage with a holding capacity of 280 metric tonnes. The inland cooperatives of 3967 reportedly hada 3.1lakh registered fisher population out of 20 lakh fishermen. The infrastructure development in Telangana state is far from satisfactory, though the major fisheries development board is located in the state (Table 1 – 5).

Regarding the consumer profile, the Telangana local market is not yet up to the standard of consumer preference; the coverage should be for all households, with the primary focus being on families consuming carp and the sale of Fresh Carp. It is suggested that the focus be on the local markets; however, other markets couldbe tried out over a period of time.

A market yard can be established in a town where there are more than 5 MT of fish per week. The marketing yard is near the farm area and is based on the tank's area. If the tank is 20 acres, the yard area is 0.20 acres. The marketing place is near the town building construction as per NFDB guidelines.

The tanks registered at fisheries departments are accountable for yield, so state department officials need to register all the tanks. If that data can be provided through kiosk/internet, i.e., aquachoupal/ SMS to the concerned fisheries college team, it ensures productivity after analysis at all levels.

In marketingthese goods to achieve the desired qualification for exporters, he has to register at the district-level office based on his capacity in terms of property. He should have a minimum 10th standard qualification and be an active FCS member.

Telanganacomprises tank farming, so most of them are auctioned at the initial stage after stocking seed. Hence, in this connection, we need strong agreement from the fisheries community. They are responsible for their water, so auction players are only government.

Tendering process, mainly through e-tendering, is the best process with less documentation.

Exports of our state fishery goods need quality certification from the Fisheries College/Department fish quality assurance lab. However, data is filled through the state policies when the goods cross our state.

Marketing of the goods needs one place exit point. It can be possible through the check post of the district/Mandals while this process weighs Bridge certification has to verify that data can feed through an internet kiosk.

Table 1: Resources in Telangana

1	**Reservoirs**	No.	W.S.A. (in Ha.)	Nos. in Licensing system	Nos. in Lease system
	i) Large	8	140074	8	0
	ii) Medium	17	28090	10	7
	iii) Small	55	21671	8	47
	Total	80	189835	26	54
	Fish seed required (Advanced Fingerlings in Lakh)	942.505			
2	**Tanks**	Departmental		Gram Panchayath	
		No.	W.S.A. (in Ha.)	Nos. in Licensing system	Nos. in Lease system
	Perennial	628	53148	176	1235
	Long Seasonal	2195	114188	967	7225
	Short Seasonal	1789	73228	23067	129685
	Total	4612	240564	24210	138145
3	Fish seed required (Advanced Fingerlings in Lakh)	2563.79		496.05	
		No.		Area in Ha.	
4	Aqua culture ponds	474		781.30	
5	Rivers and canal	5062 Km and		511Km	
6	Fish seed farms	No.		Fish seed (fry) Production (in Lakhs)	
	Government	28		1101	
	Private	4		6300	
7	**Fishermen Cooperative Societies**	No.s		Membership	
	Fishermen Coop. Societies	3513		286844	
	Fisherwomen Coop. Societies	437		20420	
	Fishermen Marketing Coop. Societies	7		3307	
	District Fishermen Coop. Societies	10		2736	
	Total	3967		313307	
8	Fishermen Population	1904281			
9	Active fishermen	307234			
10	No. of Fish Markets (Sanctioned)	55			
11	No. of Community Halls (Sanctioned)	244			
	Fishermen Coop. Societies	3513		286844	
		Fish (in tons)		Prawn (in tons)	
12	Fish & Prawn production target 2016-17	345068		8495	

Table 2: Fish production target and achievements

Year	**Fish production**		**Prawn production**		**Total (in tons)**	
	Target	**Achmt.**	**Target**	**Achmt.**	**Target**	**Achmt.**
2011-12	193500	133587	4400	2206	197900	135793
2012-13	240000	214591	6320	5037	246320	219628
2013-14	260853	243037	6908	6596	267761	249633
2014-15	284400	260010	7330	8352	291730	268362
2015-16	312180	228185	7866	8567	320046	236752
2016-17 Upto Sept.,16	345068	66498	8495	1746	353563	68244

Table 3: Fish production target and achievements

S.No	Name of the District	Fish Seed rearing ponds		Culture Ponds		Total	
		No.of farmers	Area in Ha	No.of farmers	Area in Ha	No.of farmers	Area in Ha
1	Adilabad	2	0.00	3	5.00	5	5.00
2	Bhadradri	9	9.45	29	40.55	38	50.00
3	Hanamkonda	4	11.00	1	3.00	5	14.00
4	Hyderabad	0	0.00	0	0.00	0	0.00
5	Jagitial	16	49.94	2	6.10	18	56.04
6	Jangaon	11	23.97	3	3.00	14	26.97
7	J. Bhupalpally	4	6.37	47	57.08	51	63.45
8	J Gadwal	21	47.86	151	278.93	172	326.79
9	Kamareddy	2	3.28	15	14.76	17	18.04
10	Karimnagar	14	41.76	18	29.76	32	71.52
11	Khammam	248	226.32	0	0.00	248	226.32
12	KB Asifabad	5	8.80	4	6.00	9	14.80
13	Mahabubabad	10	10.00	54	68.00	64	78.00
14	Mahabubnagar	3	5.00	13	13.20	16	18.20
15	Mancheriyal	14	27.49	11	70.40	25	97.89
16	Medak	0	0.00	0	0.00	0	0.00
17	Medchal	0	0.00	1	1.00	1	1.00
18	Mulugu	4	17.30	41	83.59	45	100.89
19	Nagarkurnool	3	1.80	10	31.30	13	33.10
20	Nalgonda	94	53.45	418	382.32	512	435.77
21	Narayanapet	0	0.00	112	133.96	112	133.96
22	Nirmal	3	3.33	13	16.60	16	19.93
23	Nizamabad	23	119.05	18	34.59	41	153.64
24	Peddapalli	4	10.25	4	14.33	8	24.58
25	R Siricilla	14	26.93	5	0.00	19	26.93
26	Rangareddy	4	6.30	0	0.00	4	6.30
27	Sangareddy	0	0.00	9	13.57	9	13.57
28	Siddipet	0	0.00	5	6.34	5	6.34
29	Suryapet	59	107.46	47	56.01	106	163.47
30	Vikarabad	0	0.00	0	32.50	0	32.50
31	Wanaparthy	3	9.22	80	128.03	83	137.25
32	Warangal	7	41.52	2	2.00	9	43.52
33	Y.Bhongir	10	20.21	24	35.03	34	55.24
	TOTAL	**591**	**888.06**	**1140**	**1566.95**	**1731**	**2455.01**

Table 4: Year Wise Fish Seed Production Report

S.No	District	Fish Seed Farm	2015-16		2016-17		2017-18		2018-19	
			Target	Achive	Target	Achive	Target	Achive	Target	Achive
1	2	3	4	5	6	7	8	9	10	11
2	Adilabad	Satnala	37	16	37.00	20.20	39.00	0.00	16.00	0.00
3	Karimnagar	LMD	78	6.5	78.00	7.00	118.00	26.00	40.00	17.33
4		Kesavapatnam	55	0	55.00	0.00	55.00	0.00	18.00	0.00
5	Rajanna Siricilla	UMD	42	0	42.00	13.00	43.00	0.00	16.00	0.00
6	Siddipet	Sanigaram	13	0	13.00	0.00	13.00	0.00	11.00	0.00
7	Warangal (U)	Hanmakonda	14	3	14.00	6.00	16.00	0.00	10.00	0.00
8	Khammam	Wyra	62	52.5	62.00	43.00	65.00	18.00	18.00	3.68
9	Bhadradri Kothagudem	Kinnerasani	41	30.5	41.00	39.00	47.00	5.60	16.00	0.00
10	Nizamabad	Pochampad	138	21	138.00	42.00	211.00	15.00	40.00	26.84
11		Arsapally	13	0	13.00	9.00	16.00	0.00	4.00	0.00
12	Kamareddy	Nizamsagar	25	0	25.00	0.00	24.50	0.00	4.00	0.00
13	Medak	Medak	90	8	90.00	11.00	90.00	22.00	34.00	1.13
14	Sangareddy	Singoor	20	0	20.00	0.00	65.00	0.00	0.00	0.00
15		Sangareddy	38	12	38.00	8.00	20.00	6.50	30.00	9.67
16	Mahaboobnagar	Pillamarri	16	3.3	16.00	6.47	16.00	0.00	4.00	0.00
17		Jammichedu	18	5.9	18.00	11.80	21.00	0.00	0.00	0.00
18		Koilsagar	50	5.9	50.00	7.50	50.00	16.00	21.00	0.00
19	Nagarkurnool	Mucharlapally	12	0	12.00	0.00	12.00	0.00	13.00	0.00
20		Chandrasagar	26	6.1	26.00	8.40	26.00	6.00	16.00	0.00
21	Rangareddy	Medchal	13	4	13.00	0.00	16.00	0.00	0.00	0.00
22		Seriguda	11	6.5	11.00	3.00	16.00	0.00	10.00	0.00
23	Vikarabad	Nandivagu	40	18	40.00	6.00	39.00	0.00	13.00	0.00
24	Nalgonda	Dindi	21	0	21.00	0.00	21.00	0.00	13.00	0.00
25	Hyderabad	Rajendrangar	36	18	36.00	9.20	38.00	10.00	0.00	0.00
		Total	**909**	**217.2**	**909.00**	**250.57**	**1077.50**	**125.10**	**347.00**	**58.65**

Table 5: Year Wise Fish Seed Production Report

S.No	District	Fish Seed Farm	2015-16		2016-17		2017-18		2018-19	
			Target	Achive	Target	Achive	Target	Achive	Target	Achive
1	2	3	4	5	6	7	8	9	10	11
Leased out Farms										
1	Karimnagar	FFDA	21	2	21.00	10.00	0.00	2.00	16.00	2.94
2	Warangal (U)	Bheemaram	34	17.8	34.00	21.50	0.00	100.00	70.00	40.00
3	Nalgonda	Thummadam	29	6	29.00	8.00	0.00	0.00	110.00	70.00
4	Nirmal	Kadam	108	34	108.00	36.00	0.00	50.00	95.00	80.00
5	Wanapathy	Saralasagar	0	0	0.00	0.00	0.00	2.00	22.00	10.00
		Total	**192**	**59.8**	**192.00**	**75.50**	**0.00**	**154.00**	**313.00**	**202.94**

Inland Fisheries and Livelihoods in India

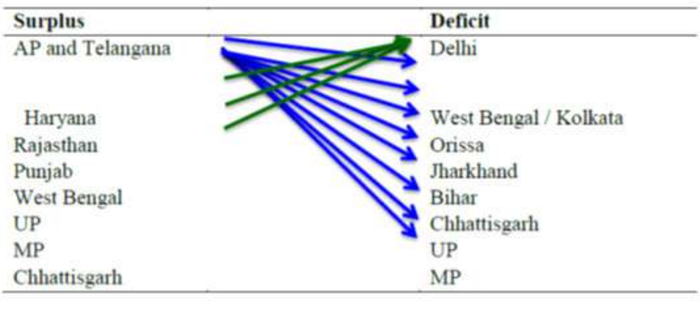
Inland fisheries in India comprise the production of fish from inland water bodies like streams, rivers, ponds, reservoirs, and lakes and also related activities like processing and marketing. It provides livelihood options to a large proportion of poor families in India. Traditionally, most of these families (belonging to the fishermen's caste) were associated with catching fish from these water bodies and selling it in local markets. Besides streams, rivers, and reservoirs, most of these water bodies are common property resources under the control of the Government.

Over the years, there has been a rise in demand for freshwater fish. This has led to a thrust on enhancing production through scientific cultivation practices. Increasingly, fish cultivation in such water bodies was viewed as a profitable, enterprising activity. Local elites started encroaching and taking control of these common property resources, mainly the ponds and tanks. Nevertheless, inland fishery has the potential to enhance the livelihood of a large proportion of poor families in India.

Freshwater Fish Market

The annual per capita availability of fish in the World is 19.1 kg. In the context of India, it is 3.2 kg. The yearly per capita consumption of fish is increasing every year. This is mainly due to the increase in the purchasing power of consumers and their preference for fish being a low-cost animal protein. Overall, there is a steady domestic demand for freshwater fish, i.e., mainly Carp and Murrel. Consumers generally prefer fresh fish. There is minimal processing of freshwater fish. The inland fish market is relatively informal in the country. Marketing channels are generally short. Producers' share in retail price is estimated to be more than fifty percent. The following Fig. 1details the overall surplus and deficit scenario of fish across :

Fig. 1. Domestic fresh Water Fish Market



Market Channels

Marketing channels relate to the demand and supply scenario across markets, and the consumer preference. The key marketing channel in the region includes harvesting of fish from water bodies and bulk sale in different markets, which depends on quantity of fish harvested. In case of higher quantity of harvest, fish is transported to wholesale markets. Irrespective of control of water bodies (Coop or Contractor) there is general preference to carry fish to distant wholesale markets. However, there are variants of this market channel, which has been explained in the earlier section of the report. At an all India level, fish from Andhra plays an important role in meeting the overall deficit in the country. AP supplies fish to metro markets like Kolkotta and Delhi; and deficit States like West Bengal, Orissa, Jharkhand, Bihar, UP, Chhatishgarh and MP. Fish supply from Punjab, Haryana and Rajasthan can be seen as local supply that meets the requirement in Delhi market. At all India level, States like MP, UP and Chhattisgarh presents a scenario of both surplus and deficit of fish. In recent years, in these States there is an increasing consumer preference to eat fish. This is due to rise in non vegetarian population, increase in purchasing power and fish (being low cost) as substitute to meat. The gap in fish supply is currently met by supply by AP and Telangana. Unlike other markets like Delhi where there is assured demand for AP and Telangana fish, the demand for fish in UP, MP and Chhattisgarh fluctuates. In case, there is low quantity of fish harvested, it is taken to local market. Interaction with market players in the project area and in distant markets revealed the key channels of marketing of fish. Local fish supply includes fish harvested from small & medium water bodies; and from large water bodies like reservoir. Fish catch coming from rivers and stream is very small proportion of supply. Fish from small & medium size local water bodies is generally sold in local towns, Jhansi and Gorakhpur market. Fish from large water bodies usually, harvested in large quantities gets sold in key markets like Jhansi, Gorakhpur and Lucknow. These water bodies are generally controlled by contractors, who are at times financed (for leasing cost, seed stocking) by big wholesale traders (Fig. 2).

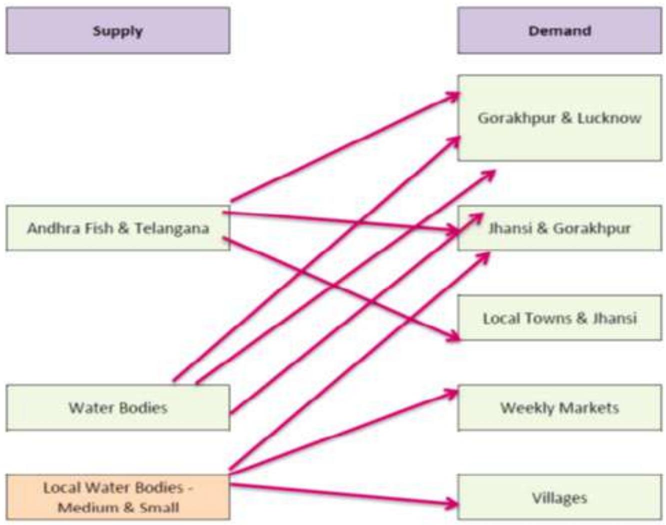
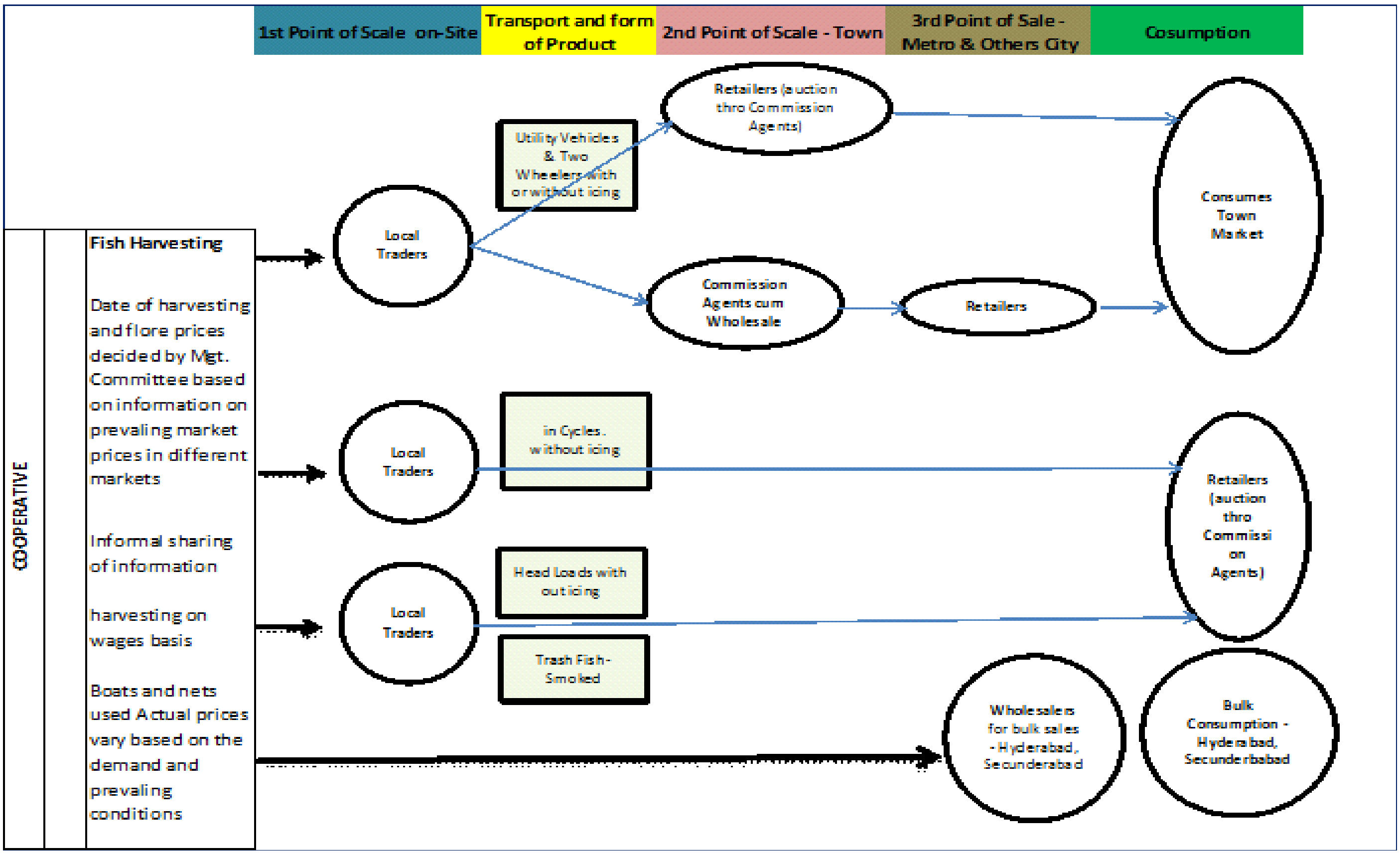


Fig. 2. Movement of Fish from Telangana to projected area at different Markets

Current Marketing Practices by Cooperatives

In most of the Cooperatives, initially, the key members try to collect information on prevailing price from different markets. The Managing Committee decides on floor price for sale of fish and the date of harvesting. The floor price is applicable to traders and retailers who would like buy fish from pond site. The actual price of sale varies, which depends on amount of fish harvested and participation of retailers and traders. The information gets disseminated informally. Fish is harvested on wage basis with use of boats and nets. In a year, most of the fish gets harvested in 2 to 4 lots. Fish is generally graded into two groups i.e. Carps and trash fishes. The following Fig. 3 details the mode of sale (in order of preference) of carps and related market channel:



	Local Trade Level	Wholesale Level	Retail Level	Consumers
Prices	Rs.75/Kg	Rs.85/Kg	RS. 100/Kg	Rs. 120/Kg
Margins at Levels		Rs.10/Kg	Rs.15/Kg	Rs.20/Kg

Fig. 3. Current practice by Cooperatives - Marketing of Fish - Markets, Channels, Players and Practices

Key members carry fish in bulk to the market in local towns and cities, where it is auctioned (facilitated by commission agent) or sold to commission agent cum wholesalers. Local retailers either participate in auction or buy fish from wholesalers.

Traders buy fish at pond site and sale through auction in key local markets. Fish from these local markets further goes for local retail sale.

Key members carry fish in bulk to distant market like Hyderabad and Secunderbad where it is auctioned or sold to wholesalers. Further the fish goes for retail sale in the area.

Local retailers (mainly male) buy fish at pond site and sale in weekly markets, regular retail markets in towns and vending (in cycle) in both urban and rural areas. A large proportion of retailers belong to fishermen community.

The trash fishes are sold to women vendors. The trash fishes are burnt/ smoked on floor (near the water body) to enhance the shelf life.

The women vendors' sale the smoke fishes in regular retail markets in towns or in weekly markets in rural areas. Most of the women vendors belong to fishermen caste. Besides this, certain quantity of fish goes for consumption at family level. There is incidence of poaching and poisoning of fish. At times, the local elites ask for fish as gift or at a subsidized price.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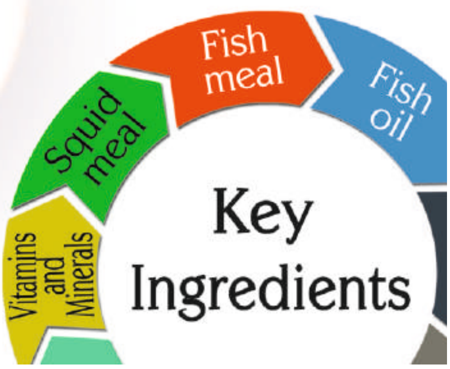

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