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Strengthening the domestic marketing

With its extensive coastline and abundant inland water resources, is a key player in the global fish market, exporting seafood to 129 nations, primarily the USA. According to the SOFIA 2024 report, India is the third-largest fish producer and the second-largest aquaculture producer globally, achieving a production of 17.545 million tonnes in the financial year 2022-23, which accounts for 8% of global output. However, the domestic fish market remains underdeveloped, hindering overall sector growth and affecting the livelihoods of millions of fishers and fish farmers. Addressing these challenges requires a strategic enhancement of domestic marketing channels. India's fisheries sector is severely hampered by inefficiencies in the supply chain. Fish are incredibly perishable and demand immediate handling and processing, yet the current infrastructure is grossly inadequate, resulting in massive waste. A significant portion of the catch is lost before reaching consumers due to the lack of cold storage facilities and a reliable transportation network. We must invest heavily in cold chain logistics and establish modern processing units near fishing hubs to enhance fish handling and drastically reduce post-harvest losses. Additionally, the fragmented and opaque marketing channels in this sector must be overhauled. Many fishermen and fish farmers are trapped in a cycle of exploitation by middlemen, which undermines their earnings. Strengthening direct marketing channels through fish cooperatives and producer organizations is essential. This will empower local fishermen and ensure that a larger share of profits reaches those directly involved in catching fish. Such measures are crucial for creating a fairer marketing framework and revitalizing the domestic fisheries market. Consumer awareness and preferences are vital for domestic fisheries marketing in India. Many regions face barriers to fish consumption due to taste preferences, dietary habits, and a lack of awareness about its health benefits. To address this, targeted marketing campaigns and educational programs should promote fish as a healthy and sustainable protein source, encouraging greater consumption and boosting domestic demand. Additionally, leveraging digital platforms presents a significant opportunity to transform fisheries marketing. Online marketplaces and e-commerce platforms can bridge the gap between fishermen and consumers, allowing for direct sales and reducing the dependency on traditional intermediaries. Digital tools can also be used for real-time tracking of catch quality, ensuring quality assurance, and gathering consumer feedback, which can further streamline the supply chain and enhance market efficiency. Government policies and support are also critical in fostering a vibrant domestic market for fisheries. Providing subsidies for infrastructure development, offering training programs for fishermen, and extending financial support for marketing innovations can drive growth in this sector. Furthermore, implementing stringent regulations to enforce fair trade practices and prevent exploitation can create a more equitable market environment. In conclusion, revitalizing domestic marketing in India's fisheries sector requires a multifaceted approach. By investing in infrastructure, improving marketing channels, promoting consumer awareness, leveraging digital technology, and supporting effective government policies, India can unlock the full potential of its fisheries sector. This would not only enhance the livelihoods of millions but also contribute to food security and economic growth. ◆◆◆

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Fisheries and Market Dynamics in India

Saurabh Bandyopadhyay

Fisheries in India have historically been overlooked in terms of research frameworks and data availability. The NSSO 68th round (2011-12) offered baseline insights into fish consumption patterns, but it lacked species-specific data and failed to establish connections between consumption patterns, market behavior, and policy implications. This oversight is particularly significant given the sector's critical role in food security, nutrition, and livelihoods. India is the second-largest fish producer globally, contributing 7.6% to global fish production and 1.2% to the country's Gross Value Added (GVA). Within the agricultural and allied sectors, fisheries account for 7.3% of GVA. The sector is a lifeline for millions, providing food, nutrition, and income. Following the Green and White Revolutions, India is undergoing a Blue Revolution, leveraging its fisheries potential to meet rising domestic and export demands while addressing food security and nutritional needs. Despite being the fastest-growing food-producing sector, fisheries remain one of the least researched areas in India, particularly from an economic perspective. Unlike key crops, fisheries often receive inadequate policy focus. Compounding this issue is the governance structure under India's 7th Schedule of the Constitution, where fisheries and aquaculture are State Subjects, while marine

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fisheries beyond territorial waters fall under the Union Government. This fragmented framework leads to inconsistent policies, hampering the sector's unified development.

Insights from the NCAER Study

To address these gaps, the National Council of Applied Economic Research (NCAER) conducted a comprehensive nationwide study in 2022-23 for the Ministry of Fisheries, Animal Husbandry, and Dairying. Covering 24 states and 12,600 households from rural and urban areas, the study estimated fish consumption demand and analyzed species-specific consumption patterns. Insights were drawn from fish-eating households, hotels, restaurants, and district officials.

Key findings revealed significant trends. In 2022, fish accounted for 16.8% of household food expenditure, up from 7.6% in 2011-12, with urban areas leading this increase. Future projections indicated that under a business-as-usual scenario, fish availability could reach 26 million tons by 2031. A moderately optimistic scenario (with average GDP growth rate over 6%) projects 30 million tons, while a highly optimistic scenario (with average GDP growth rate over 8%) estimates 35 million tons. However, nutritional inequalities persist, with disparities in fish demand and availability across states and income groups. These gaps necessitate targeted interventions to address logistical, infrastructural, and policy challenges.

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The study also identified factors

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influencing fish consumption patterns. A positive link exists between education levels and fish consumption, underscoring the importance of knowledge in shaping healthier food choices. Doorstep delivery emerged as the most influential factor driving fish consumption, followed by the availability of diverse fish varieties. Nutritional awareness, especially post-COVID, significantly boosts fish consumption, as households increasingly recognize its health benefits. Urban households consume more fish compared to their rural counterparts, reflecting differences in accessibility and preferences. Additionally, a negative relationship was observed between health expenditure and fish consumption, suggesting that households consuming more fish tend to spend less on healthcare, likely due to its positive impact on health.

Role of Consumer Behavior and Mass Fish Markets

Consumer behavior analysis, using a binary logistic model, highlighted several drivers and constraints. High fish prices restrict consumption, especially among low and occasional fish-eating households. Preferences for alternatives like chicken and mutton further limit fish consumption in some regions. Market-related factors, such as hygiene, fish odor, and bones, also play a role in shaping preferences. However, convenience factors like doorstep delivery and the availability of ready-to-cook or ready-to-eat fish products significantly enhance consumption. Mass fish markets have emerged as pivotal solutions for addressing demand-supply challenges. These markets, equipped with robust infrastructure such as cold chains and quality control systems, ensure the availability of fresh, hygienic fish at affordable prices.

They play a critical role in stabilizing prices, enhancing supply chain efficiency, and improving access to diverse fish varieties. Additionally, mass fish markets create employment opportunities across the value chain, from production to retail, while fostering cultural acceptance of fish consumption in non-traditional regions.

Recommendations for Boosting Fish Consumption

To enhance fish consumption and address existing disparities, a multi-pronged strategy is essential. First, significant investment in infrastructure development is needed, including reliable transportation systems, cold storage facilities, and hygienic fish handling practices. Establishing regional mass fish markets with robust supply chains can play a transformative role in ensuring affordability, accessibility, and availability of diverse fish varieties.

Second, mass awareness campaigns

should be launched to promote the nutritional and health benefits of fish consumption, particularly targeting non-traditional fish-eating regions. These campaigns should highlight the role of fish in improving health outcomes while encouraging cultural acceptance of fish in various diets.

Third, the availability of convenient fish products must be prioritized. Ready-to-cook and ready-to-eat options, along with boneless and attractively packaged fish products, can address consumer concerns regarding preparation and consumption while making fish more appealing to a broader audience.

Fourth, coordinated policy efforts between the Central and State Governments are crucial to overcoming fragmented governance and ensuring a unified approach to developing the fisheries sector. This involves creating a supportive regulatory environment and fostering collaboration to address logistical and operational bottlenecks. Finally, mass fish markets should be developed as critical hubs to connect producers and consumers, stabilize prices, and enhance market efficiency. These markets should focus on ensuring the availability of fresh and hygienic fish, promoting quality control, and catering to the diverse preferences of consumers, thus supporting the overall growth and accessibility of the sector.

Concluding Reflections

The fisheries sector is poised for transformative growth, driven by rising consumer demand, strategic investments, and infrastructure enhancements. Mass fish markets, combined with initiatives to raise awareness and improve product convenience, have the potential to revolutionize fish consumption patterns. These measures will not only address supply chain inefficiencies but also reduce nutritional inequalities, improve public health outcomes, and uplift millions of livelihoods.

With coordinated efforts, the fisheries sector can become a cornerstone of India's economy, ensuring food security, boosting nutrition, and meeting the rising domestic and export demands. By leveraging consumer behavior insights, fostering infrastructural innovation, and addressing policy fragmentation, the sector can sustain its momentum and unlock its vast potential for long-term growth. ■■■

The author is Senior Fellow at NCAER. (Views expressed are personal. References can be availed on request.)

Genetic resources of coldwater fisheries in india

Many authors have identified 17 members of the snow trout (locally known as Asela, Sela or Rasella in Uttarakhand, Gulgali in Himanchal, and Koushargad in Kashmir Himalayas) out of the approximately 258 cold water fish species (both native and exotic) reported from Indian uplands (Talwar & Jhingran, 1991; Tilak, 1987 and Sunder et al., 1999).

Yumnam Rameshori*1
Pramod Kumar Pandey*2

Introduction

In the context of fisheries, Coldwater fisheries refer to fishery systems that focus on species that thrive in cooler water temperatures, generally below 20°C (68°F) but the range can slightly vary. These fisheries typically include species like salmon, trout, and grayling, which are adapted to live in cold, oxygen-rich environments. Coldwater aquatic habitat includes rivers, streams, lakes, and ponds situated in mountainous or elevated areas. These ecosystems support a unique assemblage of fish species that have adapted to the specific conditions of low temperatures, high oxygen levels, and often turbulent waters.

India's varied climatic conditions, ranging from tropical to temperate, create an exceptional environment for a diverse array of aquatic species. Coldwater fisheries are an essential component of India's aquatic resources, particularly in the northern Himalayan region. The Himalayas, a mountain range that spans 2,500 kilometers from west to east, are flanked by the Hindu Kush and Karakoram mountains, along with the high Plateau of Tibet. This majestic range is divided into four parallel belts: the Siwaliks, the Lesser Himalaya, the Greater Himalaya, and the Trans-Himalaya. The region is drained by 19 major rivers, with the Indus and Brahmaputra being the longest. The deepening of valleys and the rise of the Himalayas has led to the development of extensive river systems. Among the largest rivers in the world, the Indus, Ganga, and Brahmaputra have a combined mean annual discharge of 209,691.6 million cubic meters. The Ganga originates from five source rivers: the Bhagirathi, Mandakini, Alaknanda, Dhauliganga, and Pindar. The Brahmaputra, known

Coldwater fisheries refer to fishery systems that focus on species that thrive in cooler water temperatures, generally below 20°C (68°F).

as Yarlung Zangbo Jiang (Tsangpo) in Tibet, enters India as the Dihang in Arunachal Pradesh and is known for causing significant flooding during the southwest monsoon season. In India, coldwater fisheries are primarily located in the northern states, particularly in the Himalayan regions of Jammu and Kashmir, Himachal Pradesh, Uttarakhand and northeastern Indian States. Cold water fishery resources in southern India are relatively scarce compared to other regions, mainly because of the warmer climate. However, specific areas, especially in the Western Ghats and at higher altitudes, offer favourable conditions for cold water fish species. This sector includes various species, such as native trout, snow trout, and different types of carp and hill stream fish, all of which are essential for ecological balance and economic well-being. These areas are characterized by their alpine and subalpine ecosystems, which create the ideal conditions for coldwater fish species to thrive. Therefore, the habitat characteristics of coldwater environments are distinctly different from those of warmwater systems. This cooler environment supports a range of biological processes that are critical for fish survival and reproduction. Understanding the dynamics of coldwater fisheries is vital not only for biodiversity conservation but also for the livelihoods of local communities dependent on these resources.

The Himalayas are home to a diverse range of coldwater fish species, each exhibiting unique adaptations that enable them to thrive in these challenging environments. Brown Trout (Salmo trutta) and Rainbow Trout (Oncorhynchus mykiss) are among the most recognized coldwater species. Introduced into Indian waters in the early 20th century, these fish have become popular both ecologically and economically. They are well-adapted to cold, clear streams and rivers, and their presence is often seen as an indicator of a healthy aquatic ecosystem. The Mahseer is a prized game fish known for its size and strength. Various species of Mahseer inhabit the coldwater streams of the Himalayas and are culturally significant in local fishing traditions. They are sought after not only for their sporting value but also for their culinary qualities. Commonly referred to as snow trout, species of the genus Schizothorax are endemic to the Himalayan region. These fish have adapted to coldwater habitats, displaying unique features such as flattened bodies and specialized gill structures that enable them to thrive in oxygen-rich waters. Garra fish, particularly Garra gotyla and Garra rufa, are also prominent in coldwater systems. They are often found in fast-flowing streams and are recognized for their feeding habits, which include grazing on algae and detritus, thus playing a vital role in the ecosystem. The genus Barilius includes small fish that inhabit coldwater streams and rivers. They are an important food source for larger predatory fish and contribute to the overall biodiversity of coldwater habitats. Small coldwater fishes like the Nemachilids, Botiid Loaches, Psilorhynchids and some Glyptosternoids exhibiting distinctive patterns and adaptations to hill stream environments have significant potential in the ornamental fisheries sector. These species not only enhance the visual appeal of aquariums but also bring unique ecological characteristics that can enrich aquaristic experiences. The potential of these small coldwater fishes in ornamental fisheries highlights the importance of sustainable harvesting and conservation efforts.

Coldwater fisheries are not only vital for biodiversity but also have significant economic implications. They provide livelihoods for many communities engaged in fishing and aquaculture. The growing interest in recreational fishing, particularly in trout and Mahseer, has also contributed to local economies through eco-tourism. Sustainable practices in coldwater fisheries are essential to balance economic benefits with ecological preservation. The unique habitats of the Himalayas foster rich biodiversity, but they are also vulnerable to threats such as climate change, pollution, and habitat degradation. Rising temperatures can alter water quality and disrupt fish populations, while human activities such as dam construction and urban development can significantly impact these fragile ecosystems. Sustainable

It may be noted that less than 2.5% of the total water reserves is fresh water and mostly locked in ices in cold and temperate regions of the world. The Himalayan region are usually cold occupying 16.2% of total geographical area of India and 40 % of total utilizable waters are from Himalayas (Singh & Yumnam, 2023).

management strategies are crucial to preserve coldwater fisheries and the biodiversity they support. Coldwater fisheries in India, particularly in the Himalayan region, are a treasure trove of biodiversity, cultural significance, and economic potential. Understanding the definition of coldwater habitats and the species that inhabit them is critical for promoting conservation and sustainable fishing practices. As interest in these unique ecosystems grows, it is essential to implement effective management strategies to ensure their preservation for future generations while supporting the communities that depend on them. Through careful stewardship, the coldwater fisheries of the Himalayas can continue to thrive, maintaining their ecological integrity and providing benefits to both people and nature.

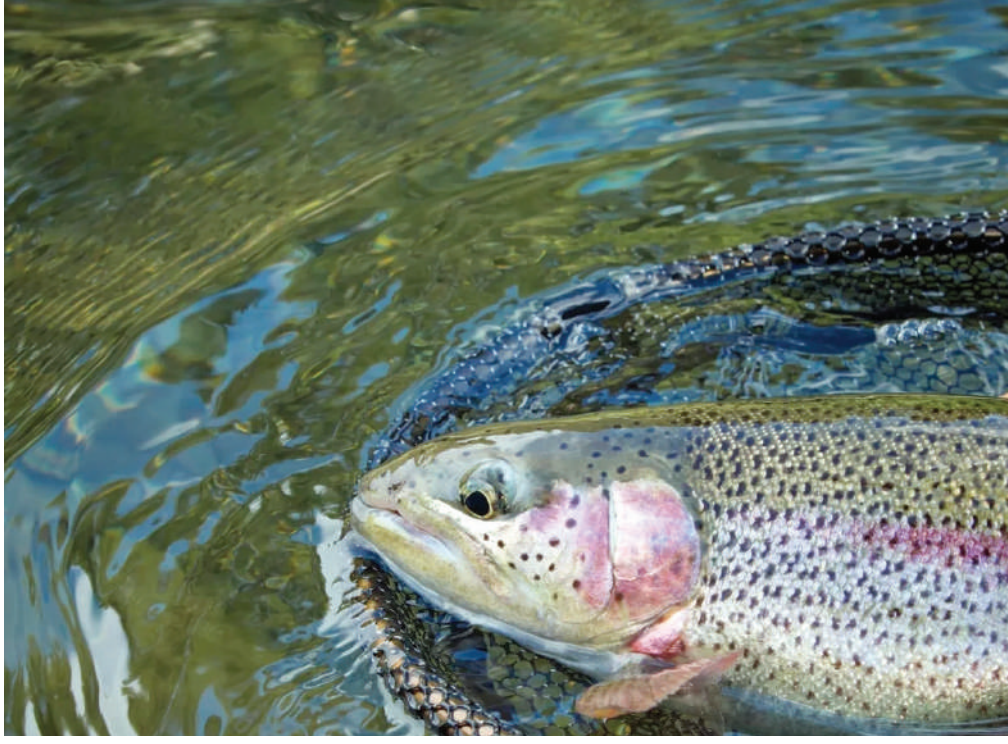
Genetic Resource of Coldwater fisheries in India

The coldwater fisheries harbour 258 species belonging to 21 families and 76 genera. Out of these, the maximum of 255 species are recorded from North-East Himalaya, 203 from the west and central Himalaya and 91 from the Deccan plateau. The commercially important Indian coldwater species are Tor tor, T. putiora, T. mosal, T. progeneius, T. khudree, T. mussullah, T. malabaricus, Naziritor chelynoides, Neolissochilus wynaadensis, N. hexagonolepis, Schizothoraichthys progastus, S. esocinus, Schizothorax richardsonii, S. plagiostomus, S. curvifrons, S. micropogon, S. kumaonensis, Opsarius bendelisis,

O. shacra, Barilius. vagra, Raiamas bola, Bangana dero, Labeo dyocheilus, Tariqilabeo periyarensis, Semiplotus semiplotus, Osteobrama belangeri, Garra lamta, Garra gotyla, Glyptothorax pectinopterus, G. brevipinnis, G. stoliczkae, Chagunius chagunio, Labeo dero, L. dyochilus and Lepidopygopsis typus. In addition to commercially important species, smaller indigenous fish such as the species under the genera Diptychus, Puntius, Devario, Psilorhynchus, Schistura, Mystus, Batasio, and Badis also inhabit the coldwater ecosystem. These species are significant not only ecologically but also in the ornamental fish industry. (Sehgal, 1999; Sunder et al., 1999; Mahanta et al., 2011; Jena & Gopalakrishnan, 2012; Sehgal, 2012).

Distribution

The distribution of fish species in Himalayan streams is profoundly influenced by a combination of ecological, hydrological, and geographical factors. The unique topography of the Himalayas creates diverse habitats, from fast-flowing rivers to tranquil pools, each supporting different fish communities. Altitude plays a crucial role; as elevation increases, water temperature typically decreases, which can limit the distribution of certain species. Additionally, varying levels of oxygenation and water chemistry across different altitudes further shape fish populations. The presence of natural barriers, such as waterfalls and rapids, can also restrict the movement of fish, leading to isolated populations and unique species adaptations. Climate and seasonal changes are other significant factors affecting fish distribution in these streams. The monsoon season brings heavy rainfall, altering stream flow and water levels, which can impact breeding and feeding habitats. Species that are sensitive to environmental fluctuations may be displaced or experience population declines during extreme weather events. Furthermore, the distribution of fish species in the Himalayan streams is influenced by factors such as flow rate, substrate composition, water temperature, and food availability. Sehgal (1988) identified several zones in the turbulent streams based on the dominant fish species and hydrographical features:



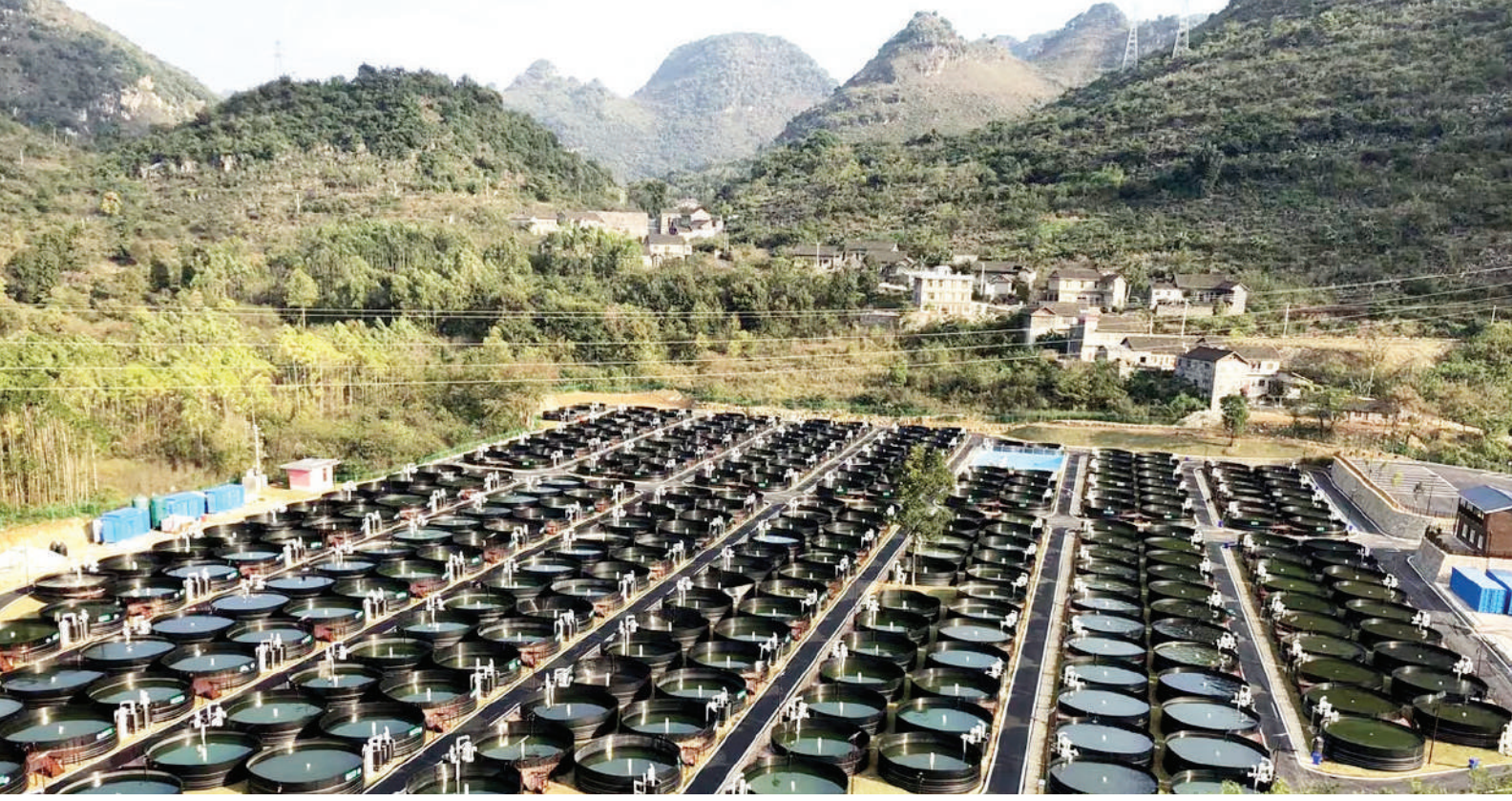
In December and January, when temperatures in the Lesser and Greater Himalayan streams are close to zero, schizothoracines and brown trout continue to be active. In the Lesser Himalaya, dryness and hailstorms can create unfavourable conditions that kill fish. The eastern Himalaya, drained by the Brahmaputra, has a higher coldwater fish diversity than the western Himalayan drainage.

i. **Headwater Zone:** This area is inhabited by rheophilic species, including loaches and catfish like Nemacheilus gracilis, N. stoliczkae, and Glyptosternum reticulatum.

ii. **Large Stream Zone:** Formed by the confluence of headwater streams, this zone is home to Diptychus maculatus and various Nemacheilus species. In the upper reaches of the most turbulent sections, rheophilic snow trout species such as Schizothoraichthys esocinus, S. progastus, Schizothorax richardsonii, and Schizopygopsis stoliczkae can be found. The intermediate reaches are frequented by Schizothorax longipinnis, S. planifrons, and S. micropogon. The slower-moving sections are occupied by Garra gotyla, Crossocheilus diplochilus, Labeo dero, and L. dyocheilus.

iii. **Slow-Moving Meandering Zone:** This zone supports a diverse array of cold or eurythermal species, including Barilius spp., Tor spp., catfish, homalopterid fish (Homaloptera spp.), and snakeheads (Channa spp.).

The morphological adaptations of fish species to survive in turbulent waters are intimately linked to their distribution in Himalayan streams.



Well-developed pectoral and pelvic fins allow for fast manoeuvring in strong currents like in Glyptothorax, Creteuchiloglanis, Parachiloglanis Myersglanis, Pseudecheneis while streamlined bodies reduce drag in many species, such as Schizothorax, Crossocheilus and Garra. Certain fish have unique characteristics that enable them to stick to rough surfaces and withstand displacement, such as sucker-like jaws as in Garra, Crossocheilus, Glyptosternoids. These structural characteristics determine their dispersal patterns along different stream gradients in addition to improving their survival in hostile situations. Furthermore, Himalayan fish inhabit distinct ecological niches in these streams due to the existence of particular morphological features. In the swiftest currents, where competition is intense and food supplies may be plentiful, fish with larger, more muscular bodies typically flourish. In contrast, species that have adapted to live in slower-moving waters could be found in pools and eddies, where they can take advantage of various habitats and food supplies. The complicated link between anatomical adaptations and environmental variables is shown by the mosaic of fish distribution created by this specialisation across the varied aquatic habitats of the Himalayas. Menon (1962) linked the anatomical traits [redacted] fish to live in torrential streams to their distribution. He identified six major groups of fish: (a) Labeo, Tor, Barilius, and Puntius, which live in shallow, clear, cold water in the foothills without any noticeable changes to the current; (b) Schizothoracines and the introduced trout, which live in bottom water layers in deep fast current and have strong, muscular cylindrical bodies; (c) Crossocheilus spp, which hides among pebbles and stones to fend off the strong current; (d) loaches Nemacheilus, Botia, and Amblyceps, which have special attachment devices; (e) fish with adhesive organs on their ventral surface that allow them to attach to bare rock surfaces in lower current, such as Garra, Glyptothorax, and Glyptosternum; and (f) fish with limpet-shaped bodies and mouths, gills, and fins that are highly adapted to their environment, such as Balitora.

One important limiting element that affects both local and global species dispersion is water temperature. Reproductive cycles, metabolic rates, and general survival are all impacted. For growth and reproduction, many fish have certain ideal temperature ranges; departures from these ranges can lead to stress, decreased fertility, and higher mortality rates. Temperature also affects the solubility of oxygen, which is necessary for aerobic organisms. Sensitive species may be harmed by hypoxic circumstances caused by a drop in oxygen levels in warmer seas. Since organisms adapt to flourish in particular thermal ranges, particularly in a single water system, temperature ultimately shapes species dispersion throughout a variety of environments. For example, tropical species are generally not found in colder waters, while polar species are adapted to survive in low temperatures. Also, the upper tolerance of cold stenothermic species, including alien brown trout and endemic schizothoracines (Schizothoraichthys esocinus and Diptychus maculatus), is around 20°C. Greater tolerance allows carp, mahseer, and lesser baril to withstand water temperatures above 25°C. In December and January, when temperatures in the Lesser and Greater Himalayan streams are close to zero, schizothoracines and brown trout continue to be active. In the Lesser Himalaya, dryness and hailstorms can create unfavourable conditions that kill fish. The eastern Himalaya, drained by the Brahmaputra, has a higher coldwater fish diversity than the western Himalayan drainage.

Coldwater Fishery

The Himalayan rivers have two types of fishing: subsistence and sport/recreational, with commercial fishing being small-scale due to low biological productivity. Subsistence and commercial fisheries exploit

carps, lesser barils, schizothoracines, garrids, and sisorids, while other genera are small-sized and of low economic value. The exotic brown trout, Salmo trutta, has become entrenched in certain regions. In the British era, to satisfy the demand for recreational fishing, coldwater aquaculture in the Indian Himalayas entails introducing common carp and exotic trout (Sehgal, 1989). The sports or recreational fishery in Himalayan waters is mainly based on Tor putitora, called golden mahseer, other species of mahseers and trouts. Valuable mahseer, Mahseer, a rare India and exotic trouts available in coldwater regions are highly demanded among the anglers.

However, coldwater resources were not fully explored for fish diversity due to challenges in accessing upper river stretches and morphological plasticity, leading to erroneous species delimitation. Moreover, fish diversity is driven by genetic diversity which is crucial for biological existence, speciation, population structuring, and sustainable management of coldwater fishery resources. Genetic diversity plays a role in ecosystem resilience, influencing food web dynamics and interactions with other species. Fish over generations adapt to ecosystems, resulting in fixed alleles and variation in frequency across distribution, leading to genetic structuring of fish populations.

It may be noted that less than

The coldwater fisheries harbour 258 species belonging to 21 families and 76 genera. Out of these, the maximum of 255 species are recorded from North-East Himalaya, 203 from the west and central Himalaya and 91 from the Deccan plateau.

2.5% of the total water reserves is fresh water and mostly locked in ices in cold and temperate regions of the world. The Himalayan region are usually cold occupying 16.2% of total geographical area of India and 40 % of total utilizable waters are from Himalayas (Singh & Yumnam, 2023). This provides an opportunity for cold-water aquaculture. There is enormous potential to increase in future due to Himalayas. In the India, cold water aquaculture is picking up recently. Cold water aquaculture has gained increasing attention in recent years, particularly in regions with suitable climatic conditions, such as the Himalayan states of India. This sector focuses on farming fish species that thrive in cooler temperatures, primarily including trout, Mahseer, and certain indigenous species like snow trout (Schizothorax sp.). Additionally, there are several endemic and locally available species too. Many authors have identified 17 members of the snow trout (locally known as Asela, Sela or Rasella in Uttarakhand, Gulgali in Himanchal, and Koushargad in Kashmir Himalayas) out of the approximately 258 cold water fish species (both native and exotic) reported from Indian uplands (Talwar & Jhingran, 1991; Tilak, 1987 and Sunder et al., 1999). Species of the genus Schizothorax, which includes the species niger, esocinus, nasus, progastus, labiatus, richardsonii and kumaonensis; and one each of the following genera: Diptychus (maculatus), Lepidopygopsis (typus), Ptychobarbus (conirostris), and Schizopygopsis (stolickai). Lepidopygopisis typus is the only species found in Kerala's Periyar Lake (Western Ghats). The

most prevalent and extensive is Schizothorax richardsonii. These species, aside from the commercially farmed fish, have significant potential in the coldwater fishery sector.

Cold water aquaculture has seen significant growth due to rising demand for high-value fish species, particularly trout. With advancements in breeding techniques, disease management, and feed formulation, aquaculture practices have become more efficient. Many fish farms now utilize recirculating aquaculture systems (RAS) and other innovative technologies to optimize production and maintain water quality. Despite its growth, cold water aquaculture faces several challenges. Fluctuating temperatures because of climate change can affect fish growth and health. Dependence on natural water bodies may lead to conflicts with other water users and can be affected by seasonal changes. As farming intensifies, the risk of diseases can increase, necessitating effective management strategies. While demand is growing, access to markets and supply chain infrastructure can be limited, especially in remote areas. The future of cold water aquaculture looks promising, driven by increasing consumer demand for sustainable and locally sourced seafood. Research into selective breeding and improved aquaculture techniques continues to enhance productivity and sustainability. Additionally, efforts to promote integrated farming practices, where fish farming is combined with agriculture, can improve overall economic viability for farmers.

Threats

Notwithstanding the species richness, invasive species, climate change, changing water flow, habitat loss, and overexploitation pose risks to coldwater species. Anthropogenic intervention and climate change are posing such severe risks to the biodiversity of aquatic ecosystems and ecosystem stability that addressing this issue calls for a number of solutions and objectives (Jena & Gopalakrishnan, 2012; Singh et al. 2014). The diversification of fish is essential to ecosystems, yet each species is vulnerable to many threats, such as habitat modification, resource depletion, and loss of germplasm as a result of overfishing, siltation, water discharge, and climate change. The following are the main risks to the diversity of coldwater fish:

- Climate change has a significant impact on coldwater fisheries, mainly through rising water temperatures and changing precipitation patterns. Increased greenhouse gas emissions such as carbon dioxide, methane, nitrous oxide, and fluorocarbons warm the Earth's surface, leading to glacier shrinkage, turbid water influx in snow-fed rivers, excessive freshwater discharge into the sea, rising sea temperatures, and gradual sea level rise. As temperatures rises, many coldwater fish species, including salmon and trout, experience reduced habitat availability since they prefer cooler waters. For instance, salmon rely on specific temperature ranges for spawning; warmer waters can disrupt their reproductive cycles and increase mortality rates. Additionally, altered precipitation affects stream flow, leading to lower water levels during critical periods and further stressing these species. In the cold Himalayan region, decreased snowpack and earlier snowmelt have already been linked to declining populations of coldwater fish. These changes threaten biodiversity and disrupt local fishing economies that depend on these species.
- The distribution, abundance, and ecological structure of coldwater fish species are all also impacted by climate fluctuation. Changes in temperature, precipitation, and seasonal cycles can disrupt the delicate environmental conditions that coldwater species depend on for breeding and growth. For example, increased water temperatures can lead to reduced oxygen levels, stressing fish populations and limiting their distribution. Additionally, fluctuations in water flow can affect spawning sites and food availability, further impacting population sizes. These stressors can result in population bottlenecks, where only a small number of individuals contribute to the next generation, reducing genetic variation. As genetic diversity declines, the ability of coldwater fishes to adapt to changing environmental conditions diminishes, making them more vulnerable to diseases and other ecological pressures. The degree of change and the sensitivity of species or ecosystems determine the effect on fish. The most vulnerable to the effects

India's varied climatic conditions, ranging from tropical to temperate, create an exceptional environment for a diverse array of aquatic species. Coldwater fisheries are an essential component of India's aquatic resources, particularly in the northern Himalayan region.

of global warming are coldwater fishes, especially those found in temperate climates. According to ecological models, temperature warming will cause temperate fish species to decline significantly. Effective conservation strategies must account for climate variability to help preserve the genetic diversity and resilience of coldwater fish populations.

- Floods, environmental changes, and extreme climatic events significantly impact coldwater fish diversity, making their management and conservation critical in the face of increasing climate variability. These events can alter habitats, disrupt breeding patterns, and affect water quality, threatening the survival of sensitive species such as trout and mahseer. For effective conservation, it is essential to develop adaptive management strategies that account for these unpredictable changes. This includes monitoring ecosystems to assess vulnerabilities and implementing habitat restoration projects to enhance resilience against flooding and other extreme events. Furthermore, raising awareness among local communities about the effects of climate change on aquatic ecosystems can foster collective action towards conservation efforts. By integrating adaptive practices into coldwater fishery management, we can better safeguard fish diversity and maintain the ecological integrity of these vital freshwater systems.
- Over-exploitation of coldwater fish species is a significant factor contributing to the decline in genetic diversity and relative species abundance. Intensive fishing practices, whether for commercial purposes or recreational angling, often target specific species, leading to unsustainable harvest levels.

This relentless pressure can diminish population sizes and reduce the genetic pool, making fish populations more susceptible to diseases and environmental changes. Additionally, as certain species are depleted, the overall balance of the ecosystem is disrupted, affecting the interactions between species and their habitats. The loss of genetic diversity not only hampers the resilience of fish populations but also threatens the ecological integrity of coldwater systems. The National Commission on Agriculture reported a decline in the mahseer fishery due to indiscriminate fishing of brooders and juvenile fishes and adverse effects of river valley projects (Singh, 2012). The stress on the mahseer population is not only due to overexploitation for table value but also to the rise in developmental activities, particularly hydroelectric-cum-irrigation projects. Despite this, the use of rugged methods like dynamite, bleaching powder, pesticides, and damming continues, leading to mass mortality and adversely affecting recruitment rates. To counteract these effects, implementing sustainable fishing practices, such as regulated catch limits and seasonal closures, is crucial for preserving both genetic diversity and the health of coldwater fish populations.

- Coldwater fish genetic diversity is seriously threatened by the introduction of exotic species. When non-native species are introduced into these ecosystems, they can compete with indigenous species for resources such as food and habitat, often leading to declines in native populations. In some cases, exotic fish can also interbreed with local species, resulting in hybridization that dilutes the genetic integrity of native populations. This genetic mixing can reduce the adaptive capacity of coldwater fishes, making them less resilient to environmental changes and disease. Additionally, exotic species may bring new pathogens or parasites that can further harm indigenous fish populations.
- Habitat loss is a significant threat to coldwater fisheries, severely impacting the health and sustainability of aquatic ecosystems. This loss occurs due to various factors, including climate change, urbanization, agricultural expansion, and infrastructure development, which collectively degrade or eliminate critical habitats. As water temperatures rise and natural flow patterns are altered, the delicate balance required for coldwater fish species to thrive is disrupted.
- Flow modification due to the construction of dams poses a significant threat to cold water fisheries, disrupting the natural hydrological patterns essential for the survival of many aquatic species. Dams alter river flow, creating stagnant water bodies that can lead to increased water temperatures and reduced oxygen levels, conditions unsuitable for cold water fish such as trout and mahseer. Additionally, these modifications obstruct migratory pathways, preventing fish from accessing critical spawning and feeding habitats upstream. The altered flow regime can also affect sediment transport and nutrient distribution, further degrading the ecological health of affected waterways. As a result, the balance of these sensitive ecosystems is disrupted, leading to declines in fish populations and biodiversity.

Recommendations for Sustainable Cold-water Fishery Management

- **Integrated Management Practices:** Implementing holistic strategies that consider entire aquatic ecosystems. Monitoring fish populations, habitat conditions, and water quality will support informed decisions on fishing quotas and seasons.
- **Community-Based Management:** Empowering local stakeholders to take part in conservation efforts, fostering a sense of ownership and responsibility.
- **Education and Awareness:** Promoting programs that highlight the importance of biodiversity and sustainable practices, encouraging responsible fishing and habitat preservation.
- **Sustainable Aquaculture:** Developing eco-friendly fish farming systems, such as recirculating aquaculture systems (RAS), raceways, etc. to reduce pressure on wild stocks while meeting market demand for high-value species like trout and Mahseer.
- **Habitat Restoration:** Restoring degraded aquatic environments and improving riparian zones to support healthy ecosystems for wild and farmed fish.
- **Collaborative Policy Development:** Engaging government bodies, NGOs, and local communities in formulating policies that support sustainable utilization and conservation of coldwater fishery **Resources.**

By adopting these strategies, we can balance ecological health with economic development, ensuring the long-term viability of coldwater fisheries for future generations. ■■■

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(Views expressed are personal. References can be availed on request.)

Nanoparticles
An innovative tool for aquaculture sustainability

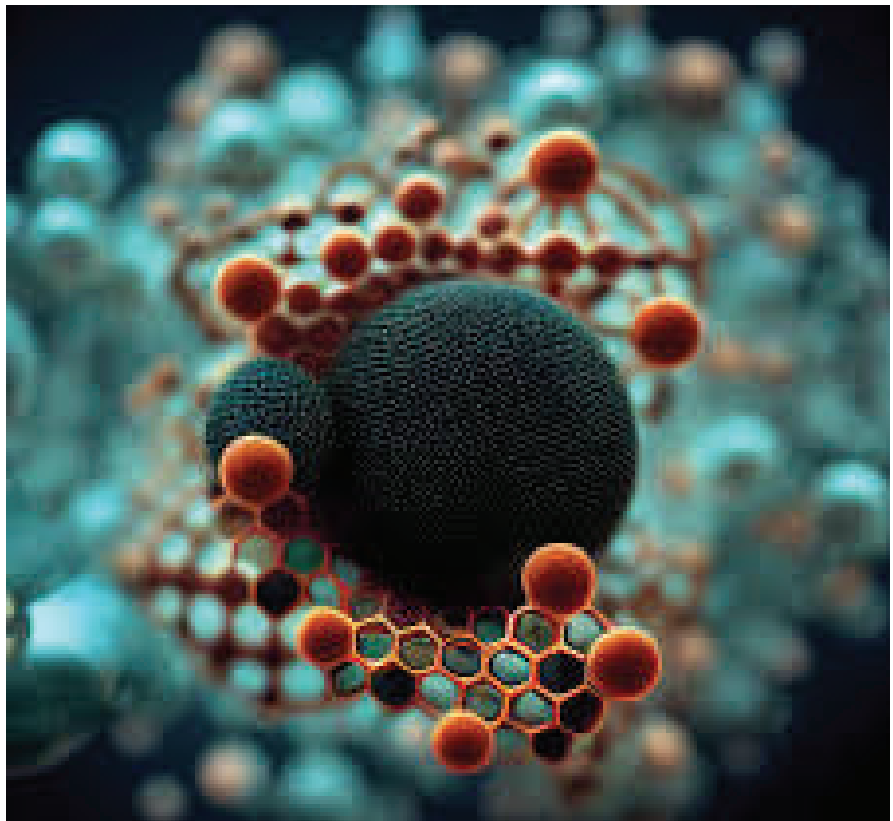
Neha Sanwal*,
Avdhesh Kumar, Akansha Khati
Ranjeet Singh

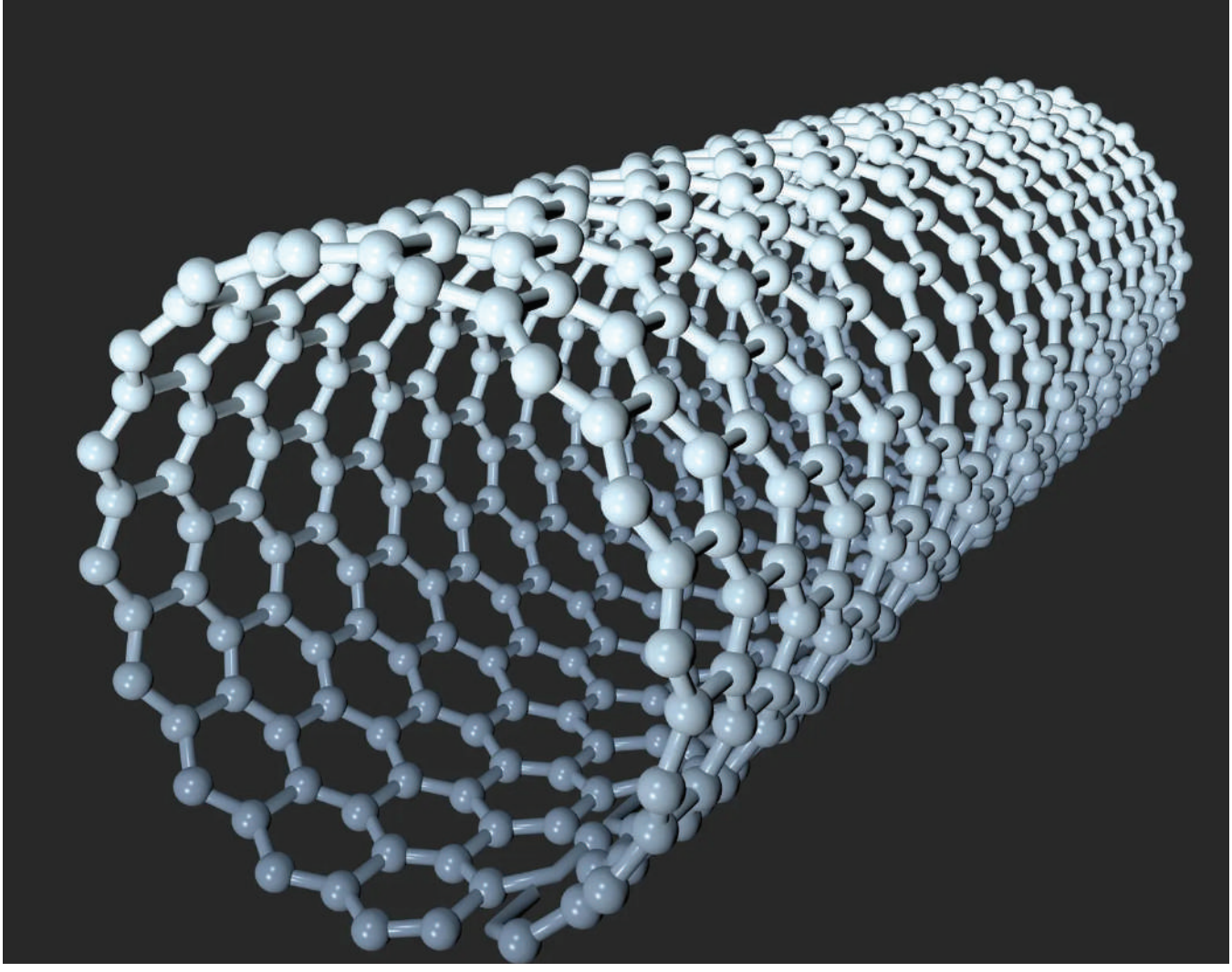
"Nano" is a Greek word synonymous to dwarf meaning extremely small. Nanoparticles are cluster of atoms in the size range of 1-100nm.A potent tool for advancing sustainable aquaculture is nanoparticles.

The aquaculture sector is undergoing a revolutionary change as a result of the incorporation of nanotechnology in response to the growing worldwide difficulties in food security and the rising need for sustainable protein sources. Nanomaterials are utilised to promote disease prevention, maximise fish development and health and increase the nutritional value and digestibility of aquafeed. Drug delivery methods and vaccinations based on nanoparticles reduce the need for antibiotics and real-time water quality monitoring is possible using nano-sensors. Additionally, the design of infrastructure has been transformed by nanotechnology, which has helped create intelligent, self-regulating aquaculture systems.

Introduction

"Nano" is a Greek word synonymous to dwarf meaning extremely small.Nanoparticles are cluster of atoms in the size range of 1-100nm.A potent tool for advancing sustainable aquaculture is nanoparticles. Their distinctive qualities—such as their large surface area, adjustable size and reactivity—make them excellent for raising feed efficiency, fish health and water quality. Fish feed supplemented with nanoparticles offers a viable substitute tactic for advancing sustainable aquaculture. Nanomaterials are utilised to promote disease prevention, maximise fish development and health and increase the nutritional value and digestibility of aquafeed. Drug delivery methods and vaccinations based on





nanoparticles lessen the need for antibiotics and real-time water quality monitoring is possible using nano sensors. Additionally, the design of infrastructure has been transformed by nanotechnology, which has helped create intelligent and self-regulating aquaculture systems.

Role in aquaculture

Direct uses

Feed enhancers

Chitosan nanoparticles : For nutrients that readily break down when exposed to water, chitosan nanoparticles can be utilised as an encapsulating agent (Chatterjee and Judeh, 2016).

Selenium nanoparticles: In crucian carp (Carassius auratus gibelio) fed supplemented diets, the ultimate weight, blood plasma and muscle protein content all rose with the addition of Senanoparticles (Zhou et al., 2009).

Zinc nanoparticles: In their 2015 study, Faiz et al. examined ZnO nanoparticles as a dietary zinc source that shown enhanced development and immunological response in grass carp (Ctenopharyngodonidella).

Iron nanoparticles: Young carp and sturgeon given iron nanoparticles were shown to grow more quickly (30% and 24%, respectively) (ETC, Action Group on Erosion, Technology and Concentration, 2003).

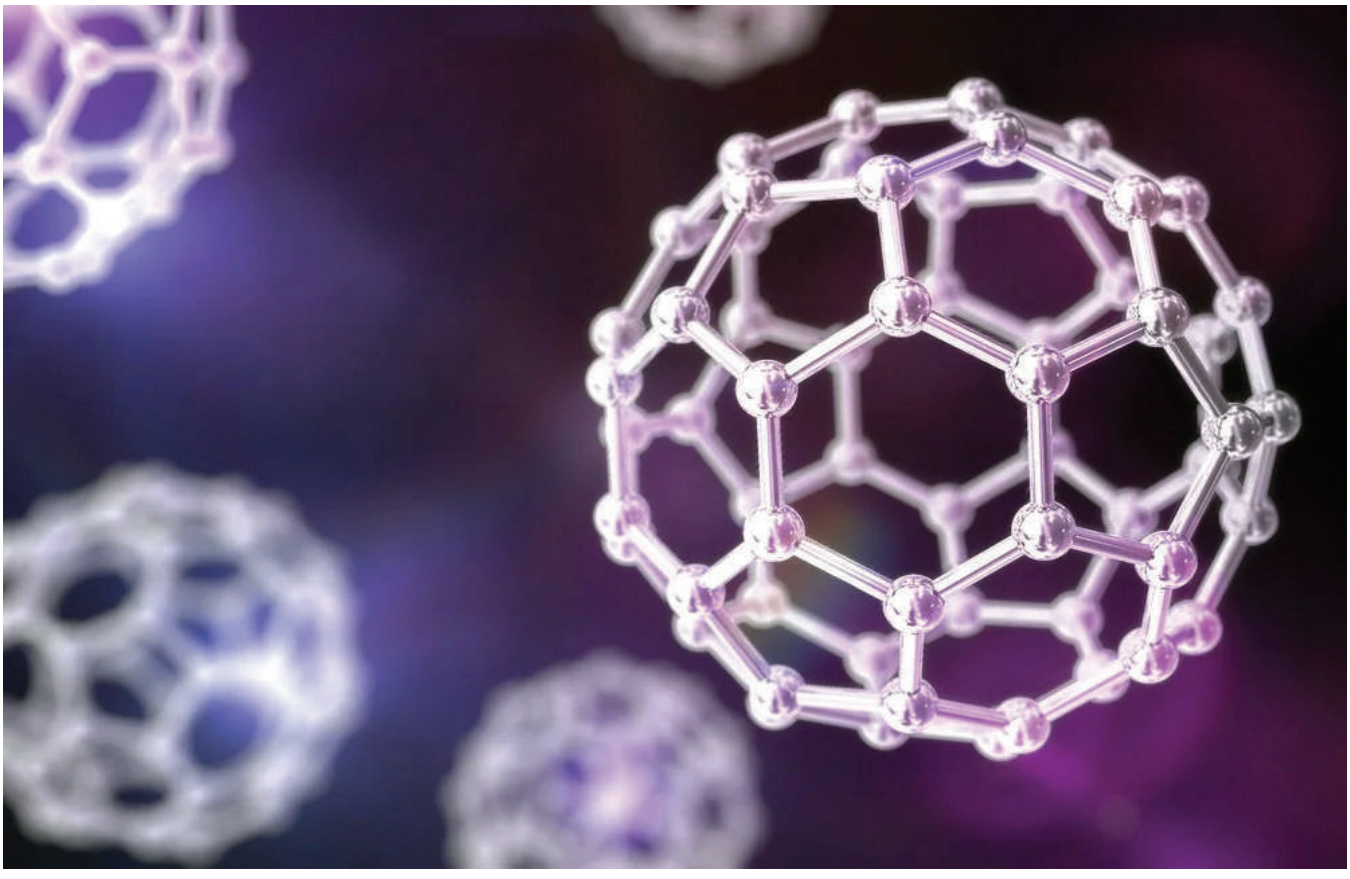
Nanomaterials are utilised to promote disease prevention, maximise fish development and health and increase the nutritional value and digestibility of aquafeed. Drug delivery methods and vaccinations based on nanoparticles lessen the need for antibiotics and real-time water quality monitoring is possible using nano sensors

Aqua cultured species health

Silver nanoparticles (Ag): Cell membrane breakdown and cell death result from binding onto bacterial cell membrane proteins (Huang et al., 2011).

Chitosan-Ag nanocomposites: The antibacterial activity of Chitosan-Ag nanocompositesagainst the fish disease Aeromonas salmonicida was examined by Dananjaya et al. (2016).

Silica-based nanoparticles: Because of its porous nature and capacity to assimilate huge dosages, it can be utilised for the administration of drugs, medicines, or other therapies



Numerous nanoparticles tend to collect in different organs inside a host and are not biodegradable. Certain nanoparticles, such silicon dioxide, cobalt and nickel, can cause cancer. Human lung cells are poisoned by zinc oxide nanoparticles.

(Strømme et al., 2009).

Fish breeding-

In female Cyprinus carpio fish, chitosan nano-conjugated hormone nanoparticles demonstrated efficient delivery and increased reproductive production (Rather et al., 2013).

Drug delivery

Drug stability, delivery specificity, little or no adverse effects, safety, biocompatibility and biodegradability are all essential characteristics of an optimal drug delivery system. They are used as drug delivery methods because they are small, able to transcend biological boundaries and high reactivity with other conjugates and compounds due to the surface area to volume ratio.

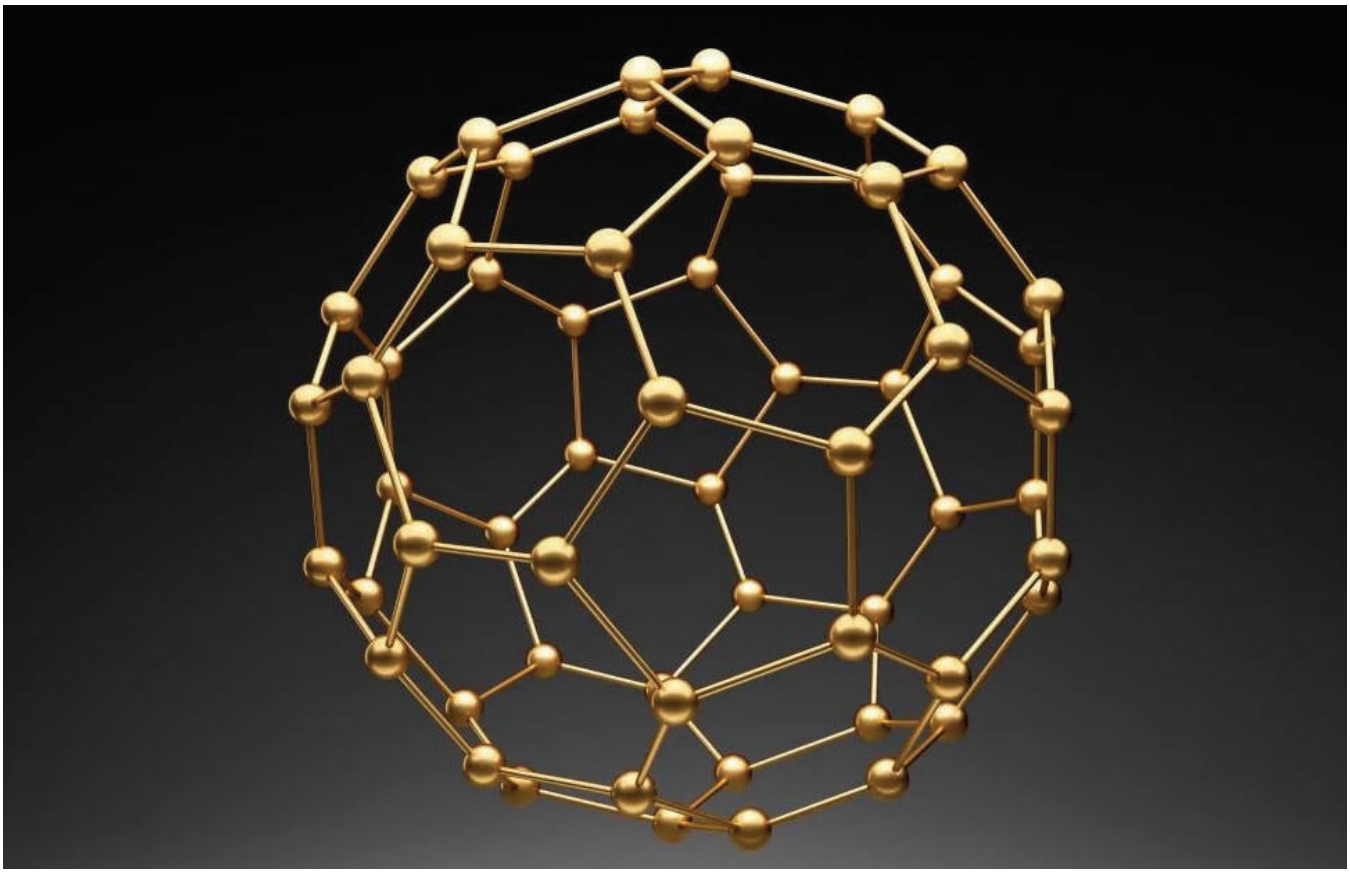
Fish nano-vaccines

For the preparation of fish nano-vaccines appropriate vaccination antigen is prepared and then intended nanoparticle is prepared. Antigen encapsulation or adsorption is done using nanoparticles. The evaluation of the polydispersity index, zeta potential and encapsulation effectiveness is performed.

Indirect uses

Water Treatment in Aquaculture

According to Rather et al. (2011), Nanoparticles based antifoulings such as CuO nanoparticles, ZnO nanoparticles and Si nanoparticles seem to be promising options because of their high surface-to-volume ratio, which



effectively blocks fouling agents.

Tagging & Nano Barcoding

Radio frequency ID (Rfid)- It contain chip with a radio circuit that includes a nanoscale part having integrated identifying code. These tags have the capacity to store additional data, can be remotely scanned. These tags may be used to track fish and to keep an eye on their eating habits, swimming patterns and metabolism.

Nanobarcode- An information-encoding approach is provided by changes in the metallic stripes of a monitoring device that include nanoparticles.

Disease diagnosis

A. salmonicidaantibody-gold nanoparticles conjugated for immune diagnosis of furunculosis in fish tissue was the first study to use AuNPs for fish pathogen detection.

Packaging

The impact of chitosan and chitosan NPs on silver carp (Hypophthalmicthys molitrix) fillets kept at 4 °C was investigated by Ramezani et al. (2015).

Routes of entry, uptake and bioavailability into living systems

In terrestrial organisms, the uptake is by inhalation or by ingestion. Among aquatic organisms there is direct passage across gills or by external surface epithelia.

Nano Risk

Numerous nanoparticles tend to collect in different organs inside a host and are not biodegradable. Certain nanoparticles have a high potential for spontaneous combustion.

Compared to bigger particles, nanoparticles may penetrate the body and its important organsmore readily. Certain nanoparticles, such silicon dioxide, cobalt and nickel, can cause cancer. Human lung cells are poisoned by zinc oxide nanoparticles.

Conclusion

Health care and quality of life will be enhanced by nanotechnology. It will raise our level of living and contribute to the society's continued economic growth. The majority of the scientific community is ignorant of the possibilities of nanotechnology, which is yet not widely used. For the greatest advantage, it is essential to encourage companies to concentrate on developing future products that make use of these technologies. ■■■

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(Views expressed are personal. References can be availed on request.)

ICAR-CMFRI, Chennai, observed Kisan divas in fisheries and improving livelihood of fishers

ICAR- CMFRI, Madras Regional Station at Senjiamman Nagar, Pazhaverkadu coastal fishing village, Ponneri Taluk, Tiruvallur District of Tamil Nadu celebrated kisan Divas on 20th December with the agenda to popularize the cutting-edge technologies of ICAR-CMFRI that will improve the livelihood of fisher folks.

The beneficiaries of Pazhaverkadu Senjiamman Nagar ST Meenavar kooturavu Sangam along with the staff members had a detailed discussion on sea cage cultures being undertaken. The team further briefed the beneficiaries on the way forward regarding installation of large diameter circular cages, increased stocking density, modifications of feeding pattern, monitoring of fish health parameters towards achieving maximum harvest and returns in the form of revenue generation.

The beneficiaries in their feedback appreciated the efforts taken by CMFRI for the recent record breaking bumper harvest and huge revenue generated. The fisher women further highlighted that apart from their day to day marketing activities, they also could involve in the activities of cage culture programme. The beneficiaries also assured for maximum participation and cooperation towards the aim of ICAR-CMFRI in doubling the farmer's income.

(Source: https://cmfri.org.in/)

India voiced at WTO for strong subsidy rules in High Sea Fishing

India voiced during meetings of negotiating group on rules (fisheries subsidies), WTO, Geneva, in regards with high fishing activities, for strict rules and regulations on the subsidies granted by countries which are engaged . India submitted its document at World Trade organization which highlight the star disparity, the documents the document noted that the WTO provides a modest dollar 35% annually compared to subsidies as high see as dollars 76000 per fisher per year in European Nations. India put forward its views that historical subsidious should also take permission of the committee on fisheries subsidy subsidies for grant of subsidies in future. "India has pitched for strong disciplines for historical fisheries subsidisers which are engaged in distant water fishing (200 nautical miles from sea shore) and has asked for a moratorium on subsidies at the present level for 25 years," the official said. The pointers regarding the subsidies are also supported by the countries like Indonesia and other developing countries the officials added," the official added. "Blaming India for stalling the decision at the GC (General Council) is merely an excuse and a tactic to push for weak disciplines, allowing business as usual to continue," the official said adding WTO members engaged in distant water fishing should stop providing any kind of subsidies for 25 years as they provide significantly higher support measures and are indiscriminately exploiting the fisheries resources. In its document India has also raised a concern for adopting up per capita distribution of subsidies criteria to address concern over fishing and capacity under the WTO framework.

The document - Designing Disciplines for the Overcapacity and Overfishing Pillar: A case for intensity-based subsidies approach - was submitted by India and it would come up for discussion in the General Council meeting of the WTO at Geneva on December 16-17. The issue is being negotiated at the WTO as the member countries are discussing reaching an agreement on disciplining subsidies that lead to overfishing and overcapacity.

(Source: https://www.millenniumpost.in/)

Industry Experts Forecast Positive Outlook for Domestic Shrimp Market at Shrimp Retail 2024 Conference

Emphasizing the need to boost the domestic market for the sustainable growth of the shrimp industry, speakers and experts shared their thoughts on the collective efforts required from stakeholders during the two-day Shrimp Retail 2024 conference, held on December 5-6, 2024, in New Delhi.

The conference was inaugurated by Shri Sukanta Kumar Panigrahi, Hon'ble Member of Parliament, Lok Sabha, and Member of the Standing Committee on Agriculture, Fisheries, Animal Husbandry & Dairying, Food Processing & Cooperative, Government of India. Speaking at the inaugural session, Dr. Kuldeep K. Lal, Director of ICAR-CIBA, highlighted the central institute's efforts toward the genetic improvement of Indian white shrimp and the promotion of intensive shrimp farming technologies for sustainable sectoral growth. Delivering the keynote address, Dr. Joykrushna Jena, DDG-Fisheries Science, ICAR, emphasized the importance of infrastructure development for local markets and ensuring the availability of fish and shrimp at affordable prices. In his opening address, Ramakantha Akula, CEO of The Waterbase Ltd., urged stakeholders to work concertedly to promote shrimp consumption within the country. Highlighting the immense potential of the domestic market, he suggested that companies focus on promoting value-added shrimp products through caterers and quick-service restaurants (QSRs). He also stressed the importance of engaging PR agencies and health experts to raise awareness about the health benefits of shrimp and dispel myths surrounding shrimp consumption.

During a panel discussion on forging partnerships to develop the domestic market, key players in the shrimp value chain discussed leveraging existing collaborative relationships between producers and consumers. The panelists included Dr. Victor Suresh, Former President of SAP; Anshuman Chand, Director of Alpha Marine Ltd.; Gulrez Alam, Managing Director of NFB Agro and Foods & Secretary of the Shrimp Feed Manufacturers Association; Dr. Kaushik

Jingham, Director of Avighna Associates Private Ltd.; and Amit Sharma, Chief Business Officer of Indicold. The speakers pointed out the lack of reliable market information and data on the domestic shrimp market, which poses a significant challenge in devising efficient strategies for market development. Additionally, they highlighted the potential of using the existing cold chain network to expand the domestic shrimp market.

On the second day of the conference, Dr. Saurabh Bandyopadhyay, Project Leader at NCAER, discussed current and future trends in India's fish and shrimp market. He also presented findings from a study titled Fisheries Demand and Future Prospects in India.

Delving into consumer behavior in the era of burgeoning online retail and quick commerce, industry insiders, including Shipra Gupta, Managing Director of Aqua Start United Industries; B.G. Vishal, Vice President of Sales & Procurement at Captain Fresh; Aniruddha Basu, Business Head (North, South, and East Regions) at FreshtoHome; and Shailendra Singh, Corporate Chef at Pride Hotels and Resorts, spoke about the technological transformations influencing consumer behavior and preferences. They discussed how emerging technologies could be leveraged to further promote the domestic shrimp market.

During a panel discussion on 'Supply Chain Challenges and Solutions,' speakers highlighted the importance of strengthening the supply chain from farm to fork for the development of the domestic market. K. Jeevanandam, National Category Head (Egg, Fish & Meat) at Big Basket, presented his perspectives on the supply chain issues in the domestic market. Other panelists, including Dr. Saurabh Shekhar, Managing Director of Nutreco South Asia; Dr. Pramod Kumar Prabhakar, Assistant Professor at NIFTEM; and Pradip R. Navik, Director of Zeal Aqua Ltd., discussed the challenges faced by shrimp producers and emphasized the need for innovative solutions.

The conference also delved into the rising demand for fish and shrimp in the Delhi-NCR market. Local traders, hoteliers, and professionals shared insights into market trends in the region. Speakers included Sanket Poonia, Managing Director of Dr. Attar Feed and Frozen Foods; Chef Sandeep Supkar, Director of Food and Beverage at Five Iron Golf, Greater Noida; Aman Anand, a trader from Chandigarh; and Chef Bhart Kemani, Owner of Nutmeg Catering and Executive Committee Member of the Indian Culinary Forum.

Dr. P.E. Cheran, a Senior Consultant in Shrimp Farming, provided an overview of the current scenario for shrimp farmers and production trends. Additionally, Dr. Akshaya Panigrahi and Dr. K.P.S. Kumaraguru Vasagam, Principal Scientists at ICAR-CIBA, presented a brief video highlighting the technological innovations and initiatives undertaken by CIBA in the shrimp farming sector.

Concluding the conference, Pravash Pradhan, Convener of Shrimp Retail 2024, stressed the importance of developing a B2B networking platform for the shrimp industry. He emphasized that the country's young population, increasing consumption of animal protein, and rising per capita income present immense potential for the domestic shrimp market. He expressed optimism that the industry would achieve sustainable growth if the domestic market were fully developed.

ICAR-CIFT conducted skill development programme on value addition of Cage-Farmed Fish

ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), Kochi, conducted a three-day Skill Development Programme on "Hygienic Handling, Packaging and Value Addition of Fish on date 16, 17, 18 December under the Tribal Sub-Plan (TSP) initiative.

The programme aims to empower tribal fishermen from Nandurbar, Maharashtra; including the Bhil and Pavara tribes residing near the Narmada Reservoir, who are engaged in cage farming of Pangasius spp.

The program covers the theoretical knowledge and practical skills in hygienic fish handling, pre-processing techniques, and the preparation of value-added fish products, specifically from cage-farmed. This program also taught about utilizing fish waste for byproducts, modern packaging methods, and compliance with FSSAI standards for fish products to the participants.

Dr. George Ninan, Director of ICAR-CIFT, during his inaugural speech emphasized on the need to equip fishers with modern techniques to enhance fish quality and ensures sustainable livelihoods. Mr. K.G. Padvi, Assistant Commissioner of Fisheries (T), Nandurbar, highlighted the importance of such training programs in improving the skills of tribal fishing communities.

(Source: https://www.cift.res.in/skill-development-programme-on-value-addition)

Over 30 countries gathered for 2-days conference organized by (GFCM)

General Fisheries Commission for the Mediterranean (GFCM) of the Food and Agriculture Organization of the United Nations (FAO) and the Government of Greece, with the financial support of the European Union, organized largest regional aquaculture conference, titled "Shaping the future of sustainable aquaculture in the Mediterranean and the Black Sea" in Heraklion, Greece.

The conference provided a forum to review the progress achieved since the inaugural regional conference held ten years ago in Bari, Italy, and discuss how to embrace innovation and sustainability, boost resilience and unlock the full potential of aquaculture in the region, in pursuit of the objectives of the GFCM 2030 Strategy and beyond.

Aquaculture is becoming increasingly vital for food security, employment and economic development in the Mediterranean and Black Sea region. Over the past decade, the sector has witnessed remarkable growth, with marine and brackish water aquaculture production soaring by 91.3 percent and revenues climbing by 74.5 percent.

High-level decision-makers and stakeholders, including aquaculture experts and representatives from research and academia, international, intergovernmental and non-governmental organizations, producers and aquaculture farmer associations from across the region and beyond, shared ideas and experiences through a series of keynote speeches, panels and side events. Participants also included small-scale farmers, as well as the newly created Network of Women in Aquaculture, born out of a GFCM initiative to empower women in the sector.

During the event, participants reviewed the impressive progress made by the sector in the last decade, including the many national and regional advances made towards enhancing the sustainability of the sector, such as the development of national aquaculture strategies and the increased engagement of farmer associations

"The strong representation of the regional aquaculture community at the conference is an important step towards the sustainable development of the sector. Our approach, at the GFCM, encompasses all dimensions of sustainability, from governance and social aspects to environmental stewardship and economic growth. Our countries have a shared vision for the future, deeply rooted in their common goals and aspirations, but also aligned with the realities aquaculture farmers face every day," said Miguel Bernal, Executive Secretary, GFCM.

As countries in the region discuss the conclusions of the conference, it is expected that these outcomes will guide the GFCM and its members in defining new national and regional strategic actions for the sustainable development of aquaculture, including in the context of the 2025 United Nations Ocean Conference and the next MedFish4Ever Declaration.

(Source: https://www.fao.org/gfcm/news/detail/en/c/1729069/)

ICAR-CIBA : Pioneering Support for Sustainable Shrimp Farming in India

Dr. Akshaya Panigrahi
Principal Scientist, ICAR-CIBA

CIBA drives innovations in seed quality, genetic improvement, cost effective premium feed development, disease management, and sustainable farming practices.

India is one of the global leaders in shrimp farming, producing over 1 million tons annually, with frozen shrimp exports contributing 40.19% of the country's total export quantity and 66.12% of total earnings in US dollars. The shrimp industry is a major driver of economic growth and rural employment, directly or indirectly supporting around 1.2 million people across various stages of the supply chain. As the global population continues to grow, the need for nutrient-rich, sustainable food sources is expected to surge, positioning aquaculture, particularly shrimp farming, as a key contributor to future food security.

Despite its prominence, the Indian shrimp farming sector faces significant challenges. Rising costs of inputs such as feed, seed, energy, and manpower, coupled with disease outbreaks, climate variability, market volatility, and inadequate cold chain infrastructure, present ongoing obstacles. However, the sector also holds immense potential. India's tropical climate, advanced farming technologies, skilled workforce, and vast saline lands—1.2 million hectares of coastal land and 900 million hectares of inland saline soils, of which only 12% is currently utilized—offer a strong foundation for sustainable growth. Additionally, the availability of diverse agricultural and allied industry by-products provides ample resources for feed production.

ICAR-CIBA (Central Institute of Brackishwater Aquaculture) plays a pivotal role in overcoming these challenges and unlocking the potential of shrimp farming in India. As a premier research and development institution, CIBA drives innovations in seed quality, genetic improvement, cost effective premium feed development, disease management, and sustainable farming practices. The institute supports stringent certification and

India is one of the global leaders in shrimp farming, producing over 1 million tons annually, with frozen shrimp exports contributing 40.19% of the country's total export quantity and 66.12% of total earnings in US dollars

monitoring systems to ensure the supply of healthy, disease-free shrimp seeds, including native species like Penaeus indicus. Its work in selective breeding program of desi shrimp, P. indicus aims to develop shrimp breeds that are resilient, fast-growing, and resource-efficient.

CIBA is also at the forefront of promoting sustainable farming practices, such as IoT driven precision farming systems, which optimize water, feed, and energy use. The adoption of biofloc technology and partial water recirculation techniques further minimizes environmental impact while enhancing nutrient utilization. These efforts align with the global demand for eco-friendly and climate-smart aquaculture systems. Team of scientists from CIBA along with director had participated in the 3rd edition of Shrimp retail, 2024. Also, the institute have displayed all its technologies and products through one exhibition put during the conference. Director of the institute Dr Kuldeep Lal touch upon all what is required for increasing the consumption through emphasis on domestic marketing. He also spoke about the insurance scheme which ICAR-CIBA technically supported and developed exclusively for shrimp farmers and its unique features which made it possible for many insurances company to successfully lunch as a product.

Dr A Panigrahi, Principal Scientist have covered all aspects of technological innovations which is defining the future trends in shrimp farming. He also elaborated our roadmap to ensure quality production. The institute also focuses on strengthening biosecurity measures, expanding diagnostic lab networks, and enhancing disease surveillance to reduce the risks posed by outbreaks. Dr Kumaraguru Vasagam talked about super intensive shrimp farming which the institute have successfully demonstrated recently and interest it generated among the stakeholders.

Furthermore, CIBA contributes to the establishment of local feed mills to ensure cost-effective, high-quality feed production using alternative ingredients such as insect meals, seaweed, algal meals, and agricultural by-products. The institute also advocates for financial support mechanisms, insurance schemes, and subsidies, to empower small and medium-scale farmers to adopt modern, sustainable farming practices. Through its multifaceted initiatives, ICAR-CIBA not only addresses the immediate challenges faced by the shrimp farming industry but also ensures its long-term sustainability and global competitiveness. By enabling India to harness its natural advantages and technological expertise, CIBA continues to strengthen the nation's position as a leading contributor to the global seafood industry.

New Age Seafood Brands

Using Digital Technology to Revolutionize Consumer Experience

BG Vishal
Vice President, Sales & Procurement—Shrimp, Captain Fresh

India is one of the world's largest producers of farmed shrimp, particularly species like Penaeus monodon (Black Tiger shrimp) and Litopenaeus vannamei (White leg shrimp).

India is a significant player in the global shrimp market, not just as a top exporter but also with a growing domestic retail sector. The Indian shrimp

dobe Stock | #1158066750

industry has seen a remarkable transformation over the past few decades, with advancements in aquaculture and improvements in supply chain logistics.

1. Market Overview

India's shrimp retail market has opportunity to expand rapidly, driven by rising disposable incomes, urbanization, and increasing consumer awareness of healthy eating. Shrimp, being a rich source of protein, can become a staple in many non-veg consuming Indian households.

2. Indian consumers

a. Rising middle class is driving purchase power
b. Higher tendencies to experiment with global cuisines
c. Looks for value, affordability and relevance
d. Indian consumer wants Indian variety.
e. Focus towards staying healthy

3. Production and Supply Chain

India is one of the world's largest producers of farmed shrimp, particularly species like Penaeus monodon (Black Tiger shrimp) and Litopenaeus vannamei (White leg shrimp). The country's coastal state's Andhra Pradesh, Tamil Nadu, and Odisha are major hubs for shrimp farming. Advanced farming techniques and natural resource availability ensure a consistent supply of high-quality shrimp.

4. Retail Channels

Shrimp reaches consumers through various channels, including:

- **Supermarkets and Hypermarkets:** Modern retail outlets offer a variety of fresh and frozen shrimp products.
- **Online Platforms:** E-commerce has made shrimp accessible to a broader audience, with many online platforms offering door-to-door delivery.

- **Local Markets:** Traditional fish markets continue to be a popular choice for many consumers, providing fresh, locally sourced shrimp.

5. Consumer Expectations in Digital Age

a. Demand for traceability - wants to know where their food comes from, ensuring sustainability and quality
b. Convenience - Digital platforms analyze consumer preference to offer tailored seafood options, enhancing the purchase experience
c. Quality Assurance - Mobile apps enable easy access to seafood products allowing consumers to shop effortlessly
d. Personalized Recommendations - Through online marketplaces expects customize suggestions based on past purchases
e. Product Information - Access to nutritional information and source

6. Challenges and Opportunities

- Supply Chain Management: Ensuring the freshness of shrimp throughout the supply chain
- Regulatory Compliance: Meeting food safety standards
- Market Competition: Competing with other sources of protein like chicken and fish
- Educating Consumer: the transformation from Fresh to Frozen, marketing strategies focusing on health benefits can propel the industry forward

7. Future Prospects

With continued government support and private investment, the sector is poised for significant growth. The focus will likely to shift towards more value-added products and tapping into new consumer segments.

(Views expressed are personal. References can be availed on request.)

Changing landscape of the shrimp domestic market: way forward

Ramakanth Akula
CEO, The Waterbase Ltd.

Introduction

Over the past decade, the fisheries sector has made impressive advancements towards sustainable economic growth through concerted and collaborative efforts by the government and private sector. The government now targets

- Additional fish production of 7 Million ton
- Double fisheries exports to Rs 1,00,000 Crores
- Generate 55 lakh employment opportunities for socio-economic development.

This is possible only with collaboration and by adoption of sustainable aquacultural practices, according top priority to food safety, quality and process modernizations. The Government should continue its consultative approach in policy making, should take necessary steps to boost domestic consumption and exports.

Shrimp sector is going through challenging times. Weak shrimp demand, combined with persistently strong supply, created price levels even lower than the lowest. Production costs remained elevated due to high input prices and other costs. Shrimp prices are volatile but below cost for most producers

Global Demand and supply of Shrimp

2024 seem to be more challenging than expected for the shrimp and fisheries market. Global shrimp prices fell to new lows in the H1 of 2024, largely due to a widespread economic slowdown that has seen market demand drop below supply. Demand for shrimp in all the three regions Viz US, China and EU remained soft in the last 3 quarters of

2024. Supply and demand conditions have become severely imbalanced in China as Chinese farms report good harvests. Prices are at decadal low. Weak consumer demand, inflationary trends and a clogged supply chain impacted Shrimp sales in US

Global Outlook for 2025

We can't expect any strengthening of shrimp prices in 2025 unless the production moderates. Any increase in supply from Ecuador, India or Vietnam can again lead to oversupply and we may not see the much-needed price recovery. Furthermore, Persistent macroeconomic challenges in China are poised to soften import demand in H1 2025. Demand in the US could improve considering the low level of inventories, albeit from a subdued baseline, a gradual recovery anticipated only next year.

Indian Aquaculture is at crossroads

- Non remunerative Farm gate prices, rising production costs , lower production efficiencies
- Inclement weather, repeated disease outbreaks (Vibrio, WSSV, EHP, White gut) impacting production

- Excess capacities in the sector leading to lower margins
- Farmed fish in India has no market abroad
- Untapped Domestic market for shrimp, low per capita seafood consumption
- No major innovations or Technology adoption in Aqua farming for over a decade

4Ds to Sustain the Growth Momentum

Drive Domestic consumption

It is critical to have a strong domestic market to insulate ourselves from the vagaries of International prices and Demand

Diversify Species

Depending on same species may be too risky. Genetic improvements, Adoption of other species like will bode well for the country

Disease Mgt & Diagnostics

Disease management and Diagnostics will be key to boost output and thereby farmer profitability

Defend Cost structure

Increase productivity through adoption of technology, optimising production costs, and thereby building efficiencies

Shrimp consumption Past to Present

Past Situation	Present Situation
Consumption largely confined to coastal areas	Cold Chain is catching up
Sales mainly through Wet markets, largely unorganized	Quick commerce is playing a pivotal role
Affordability?	Discerning consumers insisting in quality products
Export Surplus, rejects find their way to the domestic market	Shrimp is no more prohibitively expensive
One or two product forms	Latent Demand for Value added products
Non-existent Cold chain Hesitancy towards Frozen	Per capita consumption is growing exponentially on a lower base

Why should we drive Domestic Demand for Shrimp?

Factors that aid in the growth of domestic consumption

1. Availability

- ❏ Limited availability, confined to areas closer to production centers
- ❏ Cold chain is not developed enough across all the cities, GOI 's thrust visible need more
- ❏ Preference for fresh over frozen
- ❏ Quick commerce, online players are expanding their footprint but still the focus is on Tier 1 cities
- ❏ Right quantity, right product, right price, right quality always an issue

2. Affordability

- ❏ Cheaper proteins are now consumed significantly by the middleclass. Low prices will have a favorable impact by bridging the gap between other meats and Shrimp.
- ❏ In India, food represents 41% of total household spending, a much larger share of the total spending when compared to other countries. But things are changing for better. We are fifth largest and the fastest growing economy
- ❏ Continued economic growth will help people moving up the value chain. Indian Middle class will reach around 700 Million by 20230, this would augur well for Shrimp consumption.

GDP per capita v. percentage of household spending on food

MARKET	GDP per capita in USD (2023)	% of household spending on food
US	80,034	12.8%
EUROPE*	39,940	14.3%
CHINA	13,721	30.5%
INDIA	2,601	41%

*EU data

Sources GDP per capita: International Monetary Fund (IMF) | GSFF report The future is

Household Spending: U.S. Bureau of Labor Statistics; National Bureau of Statistics of China; Kantar; Eurostat

3. Awareness

Shrimp contain a relatively large amount of protein per 100 g. The amino acids in the protein in shrimp are important for various vital body functions, such as muscle growth, tissue regeneration, immune function, energy making, and blood sugar regulation. Shrimp is a lean protein source, especially when compared to other sources of animal protein such as pork, beef, and chicken.

Shrimp nutritional values compared to other proteins (per 100 g)

	Shrimp	Beef (ground)	Chicken (wing)	Pork (chop)
Energy (kcal)	99	209	161	196
Fat (g)	0.3	14.6	7.1	13.5
Carbohydrates	0.2	0.8	0.0	0.1
Protein	24	19.1	24.3	19

FAT The fat in shrimp is composed of unsaturated omega-3 fatty acids. These are the so-called "healthy fats" (as opposed to the unhealthy saturated fats and trans fats). Most fats from animal sources are saturated fats, whereas most fats in vegetables and fish are unsaturated.

FIBER Most dietary fiber is found in plant-based ingredients such as vegetables, fruit, nuts, etc. Meat and fish don't usually contain fiber. However, shrimp do contain a small amount of fiber in the form of chitin in the shells (if they're eaten).

VITAMINS Shrimp contain several essential vitamins:
- Vitamin D for bone health and immune function
- Vitamin B12 for red blood cell production
- Vitamin E for antioxidant properties

MINERALS AND TRACE ELEMENTS Shrimp contain several minerals and trace elements:
- Iron for oxygen transport and energy production
- Selenium for immune function and antioxidant defense
- Zinc for metabolism and wound healing

THE US In the United States, there's a clear trend to eat more healthily. Half of consumers call healthy eating a top priority. For most of them, this means cutting back on sugar, salt, and fat. About 37% of US consumers report that they've cut back on red meat. Again, the COVID-19 pandemic has also contributed to the desire to eat more healthily.

4. Attractiveness or Acceptability

- ❏ Delicacy
- ❏ It is versatile and can be adapted to various culinary styles
- ❏ Minimum cooking time, little or no preparedness
- ❏ Scores high on Sustainability too

Advisory support for consuming healthy foods

Relevance of health and nutrition in key markets

In China, economic growth, urbanization, and rising incomes have caused major changes in dietary habits: diets contain more salt, fat, and sugar than ever before. This has had a major effect on the health of the population: obesity, cardiovascular disease, and diabetes are on the rise. In response to this development, the Chinese government has issued the "Healthy China 2030" Planning Outline and the Chinese National Nutrition Plan (2017-2030).

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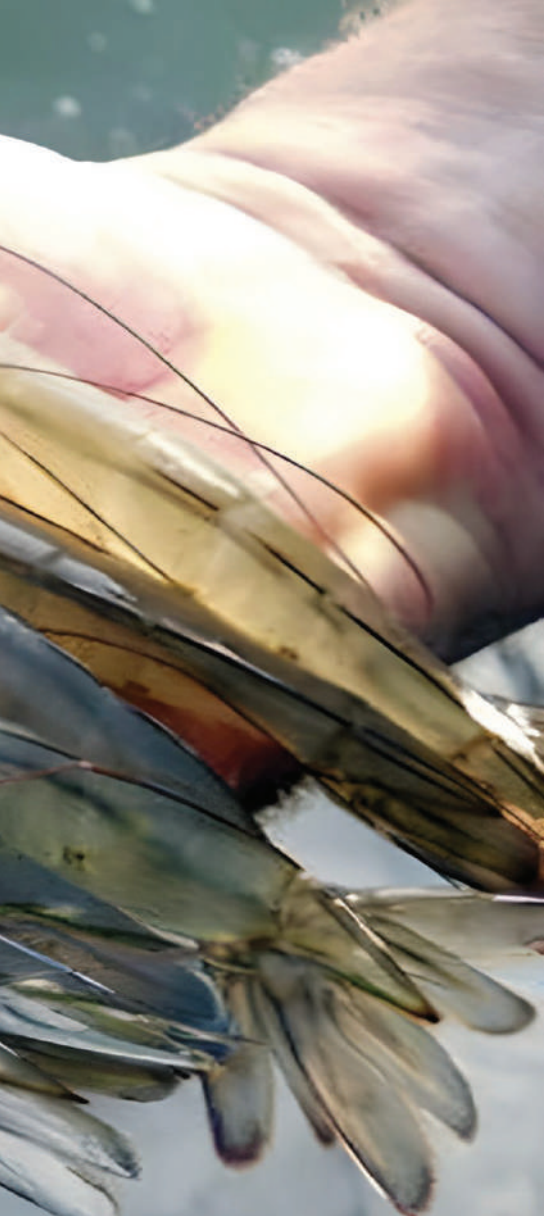
EUROPE In European markets, similar trends can be observed. For example, 62% of French respondents report having reduced their consumption of processed foods, and more than half of them have reduced their intake of sugar, fat, salt, and red meat. The German market shows similar data



American Heart Association recommends shrimp consumption as shrimp is a lean protein source containing unsaturated omega-3 fatty acids, it's good for the heart. In its Science Advisory of 2018, the American Heart Association recommends the inclusion of 1-2 seafood meals per week to reduce the risk of various types of heart problems (congestive heart failure, coronary heart disease, ischemic stroke, and sudden cardiac death). USFDA has regarded shrimp as the top 5 foods that are safe for all.

Health

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BRAIN HEALTH Omega-3 fatty acids play a role in cognitive function. The choline content in shrimp can aid brain development and brain function. What's more, shrimp contain astaxanthin, an antioxidant that is linked by several studies to the reduction of oxidative stress, and the ensuing neurodegenerative effects.

IMMUNE FUNCTION Vitamins D and E found in shrimp, as well as the elements selenium and zinc, aid the body's immune function, helping it to combat infections.

Way forward:

1. Concerted efforts are required from all stakeholders to promote shrimp consumption in the country. A body like NECC should be formed to promote domestic consumption.
2. Affordable prices will be key
3. In large cities, participate in all food festivals and make consumers try shrimps
4. Huge opportunity exists for Value added through Caterers and QSRs
5. Get an endorsement from necessary health authorities to include shrimp in diet
6. Bust the myths –Engage IMA and ICMR to put to rest all concerns about eating shrimp
7. Use PR extensively to create awareness among Indians on the nutritional value of shrimp
8. Promote consumption through recipes' how to Cook shrimp'

Domestic market is not an alternative place to sell surplus, it is going to be a big market in the future, exporters should accord top priority and supply good quality products at right time and right price.

Changing environment Impact on growth of finfish

Ishita Mehta

Nearly one-third of all freshwater fish are threatened with extinction, and 16 species went extinct in 2020 alone

Finfish holds the diverse variety of organism which can be found from muddy water to clean water, saline water to freshwater, surface water to demersal water areas etc. This mega diversity is very sensitive towards the change occurring in their surroundings. This comprehensive article throws the light upon the impact on the fishes due to the change of environment because of human interference. Before predicting the extent of the impact occurs in fish development and growth due to change in environment, one should have the better understanding of the impact which will happen. With the time the deterioration of the aquatic environment is adversely affecting the fish development and growth.

Pisces is the largest class of chordate phylum containing 36,272 finfish species, is greatly affected by the all the phenomenon occurred because of gradual change in the ecosystem. Scientist had reported change in their feeding behavior, breeding, physiological functioning, nutritive values, habitat and so on.

Introduction:

With the increase in human population, pollution and many anthropogenic activities, our earth environment is changing gradually which is causing a huge impact on earth's biodiversity. This not only affecting the terrestrial organism but also has a great impact on the aquatic organisms.

Pisces is the largest class of chordate phylum containing 36,272 finfish species, is greatly affected by the all the phenomenon occurred because of gradual change in the ecosystem. Scientist had reported change in their feeding behavior, breeding, physiological functioning, nutritive values, habitat and so on.

Habitat loss of finfish

Habitat is an ecological asset for the growth and production of the finfish. A clean and nutrient available habitat can lead to the growth of the disease free and stress free healthy fishes, larvae, spawns etc. The change in environment due to anthropogenic activities like pollution, dam building, erosive activities etc. is the major reasons behind the excessive degradation of the habitat of fishes. Habitat loss has now become one of the major concerning issues as it is ultimately leading towards the extinction of sensitive species of the fishes. Nearly one-third of all freshwater fish are threatened with extinction, and 16 species went extinct in 2020 alone.

Impact on feeding behavior

It is studied that increase in the toxicants (pollutants) in water can result in the reduced appetite of the fishes than the clean water. The fishes when exposed to polluted water, it shows less voracious behavior and become full in less time, which ultimately result in deterioration in their health and essential nutrients in their body.

Alternation of temperature also plays a major role in the change of feeding behavior in the fishes. It is studied that metabolic processes increase 2 to 3-fold with a 10°C increase in environmental temperature. Increases of fish somatic growth rate were caused by the temperature variation directly, including water and air temperature induced by climate change.

Hormonal imbalance

Developments in fishes are regulated by hormones and are thus sensitive to changes in temperature and environmental endocrine disruption. Hormones are released is directly related to the environmental change occurring in the water. As the fishes are exposed to any stressful condition like decrease in do level, increase of ph, increase of turbidity etc. it start releasing hormones. Excessive or mild release of hormones can result in hormonal imbalance. Hormonal imbalance can lead to the reduced fertility, smaller eggs, and delayed age of maturity.

Bioaccumulation in fishes

With the rise in temperature the solubility of water increases so as the dissolution of toxic elements which is released in water. In the fish bioaccumulation process occurs in two ways first aqueous uptake of water-borne chemicals and second is the dietary intake by ingestion of contaminated food particles. Bioaccumulation can lead to various health issues and increase of toxicants inside fish body and sometimes it leads to massive death of fishes.

Impact on the breeding of fishes

Most of the fishes breed during the month of June to august (rainy season). It has been noticed that the duration of breeding (number of days) increases with the increase in the number of rainy days. But due to the global warming the time of breeding is significantly varying and the seasons are varying.

Temperature variation can hamper the breeding of fishes in many ways like it can fluctuates the timing of spawning, it can retard the growth and development of gonads, it can lead to late maturity of the brooders, it can affect the quality and quantity of the gametes released or affect the development of the embryo.

Causing morphological and physiological deformities

A polluted and toxic aquatic environment can cause various morphological and physiological problems in the fishes. Some of these problems which is reported by researchers are Scale disorientation • Split fins • Fin deformity • Opercular deformity • Hyperplasia of the surface of the mouth • Protruding mouth or nose part depression • Gill deformity • Jaw deformity • Eye deformity • Muscle atrophy • Skeleton deformity • Outward protrusion of the lower lip • Tumors and other swellings.

Pisces is the largest class of chordate phylum containing 36,272 finfish species, is greatly affected by the all the phenomenon occurred because of gradual change in the ecosystem

Impact on fish eggs, spawns, fry and fingerlings.

Usually it has been noticed that fish eggs are more resistant than the adult fishes bust extreme change in the surrounding like increase of temperature, acidity, ph alkalinity, turbidity , reduced DO have leads to the high mortality rate. For example when the ph of water is less than 4 then the eggs collapsed. And ph more than 9 can cause endosmosis in eggs leads to swelling of eggs.

Conclusion

Inclusion of much toxic substance in water can lead to the change in the environment of aquatic system.

This attenuated the growth, feeding behavior, breeding ground, development of the fishes. This will lead to the under development and mortality of the fishes. To produce healthy fishes it is necessary to provide them with the optimum water quality where they can flourish fully.

(Views expressed are personal. References can be availed on request.)

Fisheries Awards Distributed in World Fisheries Day

Best Marine State	Kerela
Best Inland State	Telengana
Best Himalayan and Northeastern State	Uttarakhand
Jammu & Kashmir	Best Union Territory
Best Marine District award	Kollam, Kerala
Best Inland District	Kanker in Chhattisgarh
Best Himalayan and Northeastern District	Darrang in Assam
Best District in a Union Territory	Kulgam in Jammu & Kashmir
Best Marine Fish Farmer	Shri Ravi Kharvi from Karnataka
Best Inland Fish Farmer	Shri Shiv Prasad Sahani from Bihar
The Best Marine Fisheries Cooperative/FFPO	Mandovi Fishermen Marketing Cooperative Society, Goa
the Best Inland Fisheries Cooperative/FFPO	Srijoni Min Unnayan Samabai Samiti Ltd.
Best Enterprise in the sector	Anmol Feed Pvt. Ltd, West Bengal

Padma Shri from a Village Pond

Shri. Bata Krushna Sahoo

Shri. Bata Krushna Sahoo, hail from Sarakana Village, Khurda District, Odisha; is the first NFDB-NFFBB Network hatchery owner. He started his practices in 1986, by taking Village panchayat pond of area around 12,000 m2 (0.3 acre) on lease at a cost of Rs.12,000/- for 3 years and ventured into fish culture for the first time. He stocked about 4000 yearlings of 40- 80 gm size each in that pond. He used to fed them with a mixture of wheat flour, rice bran and ground nut oilcake (GNOC) procured from market in consultation with the ICAR-CIFA Scientists. Within a year, he sold his first harvest of fish around 1.3 to 1.4 tonnes weighing 600-800 gm each in local market. Later, he invested Rs. 13,000/- towards input cost in addition to lease amount and gained a good profit of Rs. 12,000/ within a year. As he used to purchase seeds from the vendor, so he faced severe mortality in the pond due to poor seed quality and long distance transportation. To tackle this problem, in 1988, Shri. Sahoo decided to produce good quality carp spawn at his pond site adopting Hapa breeding method and started induced breeding of Common Carp using

Pituitary hormone with the technical support of KVK, Khurda Scientist. In the first batch, around 4 lakh spawn was produced and stocked in the pond for further rearing up to 60 days. He managed the early stages efficiently with proper feeding and sold early fingerlings to fish farmers and earned Rs. 8,000/- in 2 months. He realized that the fish seed production in small ponds was more profitable than fish farming with revenue of Rs. 25,000/- earned in 8-10 months from grow out pond. Later on, Shri. Sahoo adopted the scientific method of packaging for IMC breeding, spawn and fry production and brood fish maintenance. He constructed the Chinese carp hatcheries at two sites, 150 to 200 m distance apart. He produced spawn, fry and advanced fry of Indian major carps, exotic carps, minor carps and gold fishes. About 160-200 million healthy spawn and five million carp fries are produced at those hatcheries every season. In the year 2017, he procured brooders of Jayanti Rohu and Improved Catla from National Fish Farmers Brood Bank and since then he has been producing improved variety seed.

10th July 2018, on the occasion of National fish farmer's day he became the first hatchery owner who signed the MoU with NFFBB as Network hatchery owner. After the tie-up with NFDB-NFFBB, he has progressed and prospered socio-economically. ICAR-CIFA demonstrated various technologies at his farm including NFDB funded CIFA-CIFA BROODTM diet. He achieved success in early maturation (within 48 days) and early breeding in the month of April after the brood fishes were fed with CIFA BROODTM, same is being adopted by NFDB-NFFBB. In the year 2020, Shri. Bata Krushna Sahoo was conferred with the 4th highest Civilian award, "Padma Shri" in the discipline of Animal Husbandry by Govt. of India for his stupendous achievement in Fish culture and adopting the technologies developed by Research institutes like ICAR-CIFA. He has been producing around 40-50 million Spawn of improved variety which has given his hatchery an edge to scale up his seed business. According to Shri. Sahoo, by taking due care of ponds through good quality seed stocking, regular and proper feeding and maintaining water quality would definitely bring a minimum profit of Rs.2 lakhs per acre, whereas the paddy could give only Rs. 20,000 per acre. He also informed that with good quality seed from quality brood fish of improved variety, two crops (5 months each) could be taken up if the yearlings are stocked and maintained in a small rearing pond.

Shri. B.K Sahoo is an inspiration to hundreds of young entrepreneurs in India who are willing to establish and operate carp hatcheries, as the availability of good quality fish seed in adequate quantity will lead to the success and progress of grow-out fish culture in days to come.

Fish Mappas

Fish mappas is a famous dish of fish curry from backwater of kerela, it is the representation of this region. Kerala style fish mappas or meen mappas is a Syrian Christian delicacy, also known as Kottayam style Meen Mappas. Fishes like pomfret, seer fish, butter fish (moda), pearl spot fish (karimeen fish) is most suitable for this curry.

Ingredients:

- 1 Whole fish
- 1cup coconut milk
- 1tsp chilli powder
- 1tsp coriander powde
- ¼ tsp turmeric
- Chopped ginger-garlic
- 2-3 shallots or onions
- 2 green chillies
- 2 medium tomatoes
- 2-3 tamarind sticks
- Curry leaves
- Mustard seeds, fenugreek seeds(methi)
- Kokum

Method:

- Heat oil in pan
- Add mustard seeds, fenugreek seeds, curry leaves,slit green chillies and sliced onion. Saute till onions turn brown
- Now add coriander, mustard powder, chopped tomato , kokum fruits, big cubes of any sea fish and fish stock.
- Cover and cook for 5minutes
- Now remove cover and reduce to a semi dry consistency
- Add coconut milk and let simmer for 2 minutes taking care not to let the milk come to a boil
- Temper with coconut oil, ginger julinnes, chopped garlic, curry leaves and chopped shallots.


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