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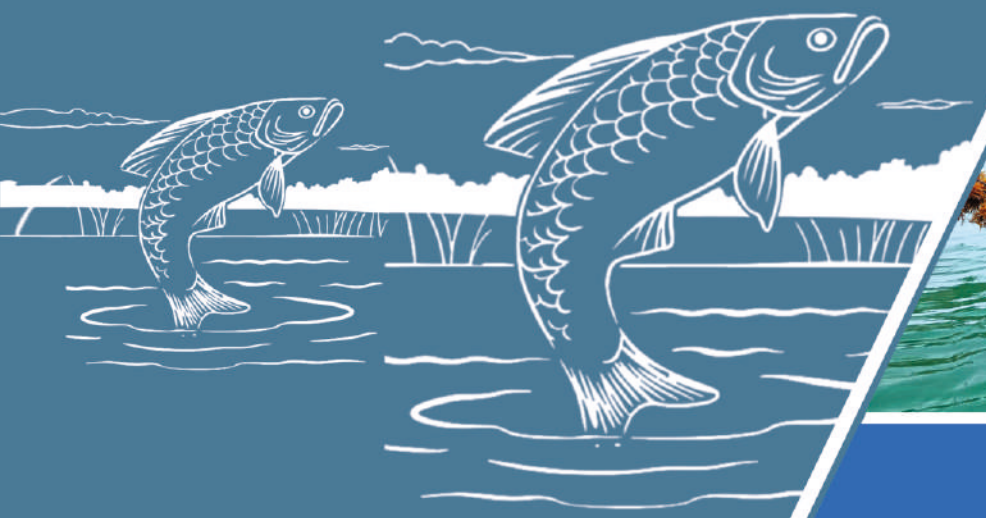

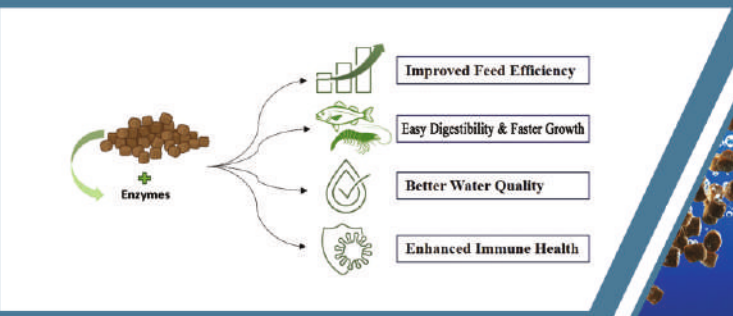

Enzymes in Aquaculture Feed

AQUAFOCUS

Dedicated to

Aquaculture Research & Development

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FAITT

As we present this latest edition of **Aquafocus Magazine**, we are excited to explore the transformative innovations and research breakthroughs that are redefining the aquaculture industry. This issue is a testament to the relentless efforts of scientists, farmers, and industry leaders working toward sustainable and profitable seafood production.

One of the key highlights of this edition is the **growing role of nutritional programming in aquaculture**, a revolutionary approach that optimizes fish metabolism, enhances feed utilization, and ensures long-term sustainability in farming practices. The integration of **enzymes in aquafeeds** is another groundbreaking topic, revealing how precision nutrition is improving feed conversion ratios and reducing waste, ultimately benefiting both farmers and the ecosystem.

Furthermore, we feature **in-depth case studies and real-world success stories**, such as the inspiring journey of young entrepreneurs in Haryana who, with FAITT's support, are revolutionizing shrimp farming through innovation and strategic interventions.

At **FAITT Magazine**, our mission remains steadfast to empower aquaculture professionals with knowledge, insights, and practical solutions that drive growth, sustainability, and excellence. We invite you to immerse yourself in this edition and join us in shaping the future of aquaculture.

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

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Wolffia globosa in Aquafeeds for Profitable and Eco-friendly Sustainable Aquaculture

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Abstract

Aquaculture is a fast-growing sector that produces high-quality fish. Finding reasonably priced feed is necessary for aquaculture operations to be sustainable and generate high marginal profits. Health and growth of cultured fish species are impacted by nutritious aquafeeds. Cost-effective feed must be available in order to make money. High digestibility, acceptable palatability, great amino acid content, and lack of non-nutritional components are just a few of the critical requirements that protein sources used in aquafeeds must satisfy. Wolffia globosa, which can boost fish profitability when added to diets in a well-processed state, is highlighted in this article. Aquaculture can be sustainably produced by wolffia by the conversion of ambient ($CO_{2)}$ and nitrogen (N_2). In addition to crude protein, wolffia meal offers high concentrations of essential amino acids, vitamins, and minerals for the growth and development of many farmed fish. It can also lead to reduced feed costs and less environmental impact than traditional fishmeal production in aquaculture. The article emphasises that integrating well-processed wolffia meal to fish diets can boost profitability. Environmental benefits of wolffia in aquafeed has the ability to sustainably transform atmospheric carbon dioxide (CO_2) and nitrogen (N_2) into aquaculture. The significant quantities of crude protein, vital amino acids, vitamins, and minerals found in wolffia meal aid in the growth and development of several farmed fish. It can also minimise aquaculture feed costs and reduce the environmental effects of producing fishmeal the conventional way.

Keywords: *Wolffia globosa*, Aquafeeds, Farmed Fish, Sustainable Aquaculture

Introduction

High-quality animal protein is produced by the rapidly expanding aquaculture sector. However, the availability of inexpensive feed is a prerequisite for sustainability in aquaculture development with high marginal profit. Fish species raised in tanks benefit from nutritious aquafeeds in terms of growth and health. Fish species raised in tanks benefit from nutritious aquafeeds in terms of growth and health. Excellent amino acid content, high digestibility, acceptable palatability, and the lack of non-nutritional components are just a few of the critical requirements that protein sources used in aquafeeds must satisfy. The main protein source in aquafeeds has been fishmeal since it contains essential amino acids (EAAs), minerals, vitamins (B12, biotin, and choline), omega (n-3) fatty acids, and vitamins A, D, and E. But if fishmeal is the only protein source, wild fish populations are negatively impacted. Furthermore, one of the primary barriers to aquaculture's growth is the escalating cost of fishmeal. Generally speaking, feed costs account for half of all aquaculture operating costs, with protein sources making up the majority of these costs. Duckweed, a rare and valuable plant, thrives in well-controlled environments. Wolffia, the smallest duckweed, has reduced morphology and core pathways, making it a potential synthetic plant biology chassis. Its minimal gene set and relaxed time-of-day gating make it ideal for bottom-up and top-down genome engineering. Wolffia's aquatic nature allows for precise manipulation and speed for experiments, enabling detailed description of cellular function and synthetic plant construction.

Recently, there has been a lot of interest in plant-based proteins as potential substitutes for animal proteins. Future food issues and low protein intake can be addressed by using plant-based proteins, which are more environmentally friendly and more productive to manufacture than animal proteins. Aquafeed formulas are now using plant-based proteins including soybean meal, wheat gluten meal, and cottonseed meal in place of expensive and non-renewable fishmeal. Although aquatic weeds, like wolffia, can be used as ingredients in fish diets, they are often regarded as waste. Wolffia may be produced on a farm in a short amount of time and at a minimal cost in a controlled setting. In the process of photosynthesis, it can fix atmospheric nitrogen and carbon dioxide to produce

ammonia and carbohydrates. In order to reduce production costs and improve crop yield and quality, can be used in place of nitrogenous fertilisers. Wolffia reduces the rate of evaporation in irrigated rice fields and can be fed to ducks, chickens, pigs, cattle, buffalo, fish, prawns, snails and crabs.

Morphology

Wolffia globosa, also referred to as "water lentils," is a member of the Lemnaceae family's Wolffoideae subfamily. Its biological characteristics are similar to those of its Lemnoideae relatives in that it is the smallest flowering plant, grows at the fastest rate in the plant kingdom, and does not have a pseudo root system. It has become a viable option for sustainable food production because of its quick growth rate, high protein content, and nutritional value, especially in areas with difficult agricultural conditions. The tiniest higher plant is called Wolffia globosa, and it differs completely from other higher plants in terms of morphology. It just possesses a frond that is unrelated to any of the three main organs, instead of the conventional morphology of roots, stems, and leaves. The fastest growing plant on Earth is called Wolffia globosa, and it has no roots. In four months, if given unlimited access to CO_2 and nutrients, it might yield 1030 plants.

Techniques for Wolffia Culture

Wolffia may be grown in (i) pits, (ii) containers, or (iii) ponds, (iv) cement tanks however, the area and the size of an Azolla culture unit depends on the quantity to be harvested and the availability of space. Small, marginal, landless, and resource-poor farmers are able to use the culture technology due to its cheap investment requirements. The procedures for wolffia culture in pits and cement tanks are as follows:

The College of Fisheries at Central Agricultural University (Imphal), Lembucherra, Tripura, India, kept twenty-day-old *L. rohita* fry in six outdoor cement tanks of 20 m3 (4 m × 5 m × 1 m), with a stocking density of 30 fry/m^2. Three tanks were given a random application of prepared feed and live wolffia each. Before the tanks were filled with animals, a 6–8 cm soil layer was provided. The tanks were filled with ground water after being thoroughly cleaned, dried, and treated with lime (500 g of Ca $(OH)_2$ each tank) at a rate of 250 kg/ha. The tanks were also well-exposed to sunlight. Tanks were fertilised with slurry made from cow dung and mustard oil cake that had been steeped in water for 24 hours before application, following a week of water filling via pumping. Healthy plankton populations were developed before *L. rohita* were stocked. The formulated feed and live Wolffia were fed in two equal feedings at 9:00 and 16:00 hours each day, at a rate of 8%–10% (dry matter basis) of the daily feed ration. An equal amount of nitrogen was added to the formulated feed and live Wolffia.

Fig 1. Steps of Wolffia culture in cemented tank, Resource : COF, CAU, Tripura

Everyday, right before feeding, live wolffia was gathered from the farm. Wet feed was used for live wolffia, while dry feed was used for formulated feed. Consequently, taking into account 95% of the moisture content of live Wolffia, the amount of isonitrogenous live Wolffia needed for the prepared feed ration was computed. To track growth and modify the feed ration, fish samples were taken every two weeks.

Conditions of Wolffia Culture

In order to properly flourish, wolffia needs at least 13 centimetres of water and sunlight under conditions of partial shade. The optimal temperature range for wolffia growth is 25–35° C. It needs water with a pH between 5 and 7.3 and a relative humidity between 80 and 90%. Locations that receive sufficient but not direct sunlight should be chosen. Supplementing with nutrition is necessary, particularly with micronutrients.

Fig. 2 Feeding of fresh Wolffia in aquaculture pond

Nutrient Profiling

The wolffia species, which are traditionally consumed by humans in Asian nations, have been studied as potential food sources. The genetic background and cultivation circumstances determined the amount of macro and micro components. There was a range of 20–30% total protein content, 10-15% starch and fat content, and 25% fibre content. There was a high content of essential amino acids and polyunsaturated fatty acids (over 60% of total fat). Wolffia microscopica's quick growth and large production make it a promising candidate for practical human nutrition. As a percentage of dry weight, the W. globosa has the following contents: 45.54% protein, 5.33% fat, 9.98% crude fibre, 20.43% ash, and 19.21% nitrogen free extract. Additionally, it contains 15.1% w/w of 15 different types of amino acids. Total phenolics, flavonoids, and chlorophylls were found to include 55.28 ± 1.35 (ìg GAE/g dry weight), 159.84 ± 6.65 (ìg catechin equivalent [QE]/g dry weight), and 22.91 ± 0.15 (mg/g dry weight), triacylglyceride level

Fig. 3 Effects of Wolffia feed on cultured pengba fish (*Osteobrama belangeri*)

varied between 0.02% and 0.15% on a dry weight basis, respectively.

Application of wolffia in Aquaculture

The use of two macrophytes (Lemna and Wolffia) in their quality as a biofilter in RAS resulted in a significant increase in dissolved oxygen and decrease in total dissolved solids, ammonia, nitrite, orthophosphate, and total phosphorus in the water. Additionally increase in the growth of the fingerlings of cultivated carp.

Wolffia sp. capacity for managing wastewater produced by climbing perch cultures. The outcomes demonstrated that Wolffia sp. biomass may be used to control pH and dissolved oxygen levels appropriate for freshwater fish culture, as well as efficiently lower wastewater's levels of ammonia, total suspended particles, total nitrogen, and total phosphorus. Duckweeds are known to extract all dissolved inorganic nitrogen (49–95%) from municipal wastewater, 43–55%) from swine wastewater as secondary effluent, and 46–62% from anaerobic digestion effluent. As a result, Wolffia sp. may yield useful nutrients for use in other sectors when utilised in wastewater treatment. It is noteworthy that duckweeds (Lemnaceae), such as wolffia globosa, are capable of effectively removing nitrogen, specifically NH4+, NO3-, and phosphorus from wastewater and aquaculture effluents and provide extremely valuable natural resources rich in starch, antioxidants, phenols, flavonoids, and carotenoids. Consequently, wolffia was used as a source of protein and carotenoid for ornamental fish and as an efficient live feed for Labeo rohita. Duckweeds are also

helpful in the production of animal feed, biofuel, bioethanol, bioplastics, medicinal and cosmetic products.

Effects of the wolffia in the Diet of Fish and livestock

In India, aquaculture is dominated by three giant carp species: *Labeo rohita*, *Catla catla*, and *Cirrhinus mrigala*. These species account for 87% of the country's freshwater productivity. Fish that are raised in clay ponds are fed low-nutrient sources. For seed growth and rearing, live wolffia globosa could be utilised in place of extra feed. Live wolffia globosa may entirely substitute other feed inputs, like silver barb (*Barbonymous gonionotus*), rohu, pengba (*Osteobrama belangeri*), and Amur common carp (*Cyprinus carpio*), in seed growing and carp growth. Frequently growing aquatic plants called duckweed are high in protein, low in fibre, and contain compounds that are bioactive. Wolffia, the tiniest blooming plant, grows well in polyculture systems and can be eaten raw. Carassius auratus, an experimental goldfish, was fed simulated meal including wolffia to boost its colour and nutritional content. It has been demonstrated that recirculating aquaculture systems with duckweeds (Lemna and Wolffia) boost common carp development while lowering ammonia, nitrite, total dissolved solids, and orthophosphate levels. Wolffia has been the subject of numerous investigations. Duckweed Wolffia (*Wolfia arrhiza*) was utilised as a substitute feed source for a range of fish, including Tilapia (*Oreochromis niloticus*) fry. *W. arrhiza* (L.) appears to improve the meat and organoleptic quality of several test fish species when grown in an intense polyculture system. Utilised as an alternative to soybean flour for grill chicken feed ingredients. Wolffia globosa have shown that it has potential for use as both a clean food source for humans and as a feed source for aquaculture and animal husbandry.

Fig. 4 Utilising wolffia in agriculture, livestock and fisheries

Wolffia used as human food

Duckweed is also consumed as food by people in a variety of countries. Wolffia globosa, for instance, is a rootless duckweed that is sold in traditional markets in Thailand under the names khai nam, kai-pum, or kai nhae, which mean "water eggs." Therefore, it can be concluded that Wolffia globosa protein is suitable to be counted as a nutritious alternative plant-based protein and to be used as a raw material for the production of novel functional ingredients.

Wolffia used as Bioactive compound

In particular, the nutritional value and bioactive components of incubating duckweed in various production methods such as different containers and light intensities have not been investigated when comparing it to commercial products. These results about the best aquaculture conditions to produce high nutritional value and bioactive chemicals like flavonoids, chlorophyll, and total phenolics would be helpful to the scientific community. In order to increase the nutritive value of the plant, this study looked at the best aquaculture conditions and drying parameters for duckweed while also considering its nutritional value and bioactive components. Duckweed is also useful in the manufacturing of biofuel, bioethanol, and animal feed, it is also useful in the creation of bioplastics, medications, and cosmetics.

Challenges for wolffia Use in Aquafeed

Plant cells contain high concentrations of carbohydrates and fibre. Carnivorous fish species usually cannot digest diets high in fibre because they do not have the enzymes to break down cell walls. Moreover, anti-nutritional factors (ANFs) such phenolic compounds, protease inhibitors, phytates, lectins, and oligosaccharides are present in large proportions in plant-based protein sources; these should be neutralised before adding them to aquafeed. Fish disease resistance may be adversely affected by the presence of ANFs in soybeans, for instance, which may stimulate cytosolic enzyme activity and an inflammatory response. Many plant-based materials can be utilised in aquaculture feed by lowering their ANFs, even if plant-based ANFs negatively impact farmed fish's nutritional metabolism and health.

Fig. 5 Utilising wolffia in high- value plant protein – based products

ANF Reduction Techniques for wolffia

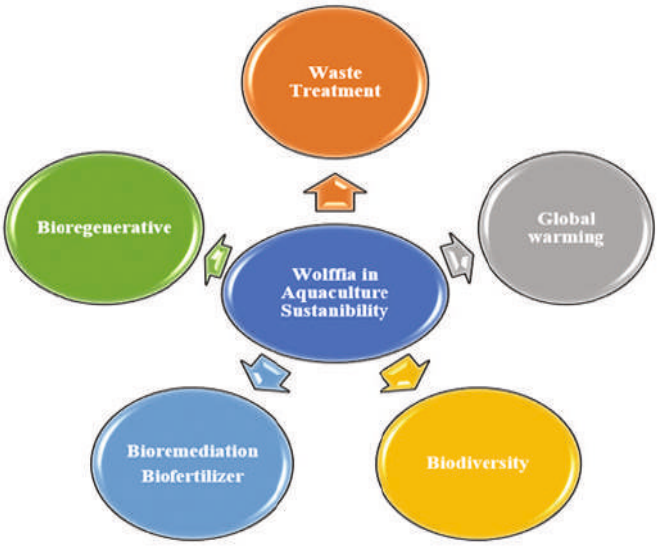
Two distinct approaches exist for reducing the amino acid content of plant-based feed ingredients: thermal processing and chemical processing. Thermal treatments improve the availability of nutrients and the digestion of fish by changing the chemical structure of the meal. These dangerous materials become inert when heated processes including baking, toasting, steaming, and extrusion are used. For example, boiling can reduce the amount of trypsin inhibitors, which prevent soybean proteins from being digested, and extrusion can denature lectins, which restrict the absorption of carbs. ANFs are also rendered inactive by specific chemical treatments. For example, phytotase can hydrolyse indigestible phytate. Meals high in wolffia have the potential to lower the body's levels of dangerous ANFs.

Environmental Benefit of wolffia in Aquafeed

In a sustainable manner, wolffia can transform atmospheric CO_2 and nitrogen (N_2) into aquaculture. A high concentration of vital amino acids, vitamins, minerals, and crude protein may be found in wolffia meal, which helps many farmed fish thrive and flourish. Wolffia globosa can be used as a phytoremediator to remove cadmium levels. It can help minimise feed costs in aquaculture and lessen the environmental effects of producing fishmeal the conventional way. Organic carbon and nitrogen into the soil during their breakdown, these substances have the ability to improve its chemical composition. The application of wolffia in biofertilizer, animal feed, pharmaceuticals, water purification, biogas generation, mosquito control, potential for reducing the carbon footprint and ammonia reduction can significantly mitigate the effects of global warming.

Conclusion

Duckweed, or Wolffia globosa consequently be a rich source of protein as an alternative natural feed for aquaculture, animal husbandry, or humans. Wolffia globosa, the duckweed, grows well both indoors and outdoors. In comparison to indoor settings, the ability to grow (specific growth rate, daily growth rate, and daily productivity) was higher outside. The potential of wolffia meal to boost aquaculture profitability in a sustainable manner is highlighted in this article. The large amounts of crude protein, vital amino acids, vitamins, and minerals found in wolffia meal aid in the growth and development of several farmed fish. It can also minimise aquaculture feed costs and lessen the environmental effects of producing fishmeal the conventional way. To attain good growth performance and survival in aquaculture, wolffia meal must first minimise ANFs. Moreover, it has a high percentage of unsaturated fatty acids (FAs), which are thought to be healthier than saturated FAs and have antioxidant qualities. It possesses greater concentrations of total phenolics and flavonoids than conventional crops, which could make it a rich source of antioxidants. Ultimately, Wolffia globosa low amounts of antinutritional factors were readily absorbed. These findings imply that nutrients are readily absorbed by the body and point to a possible food supply.



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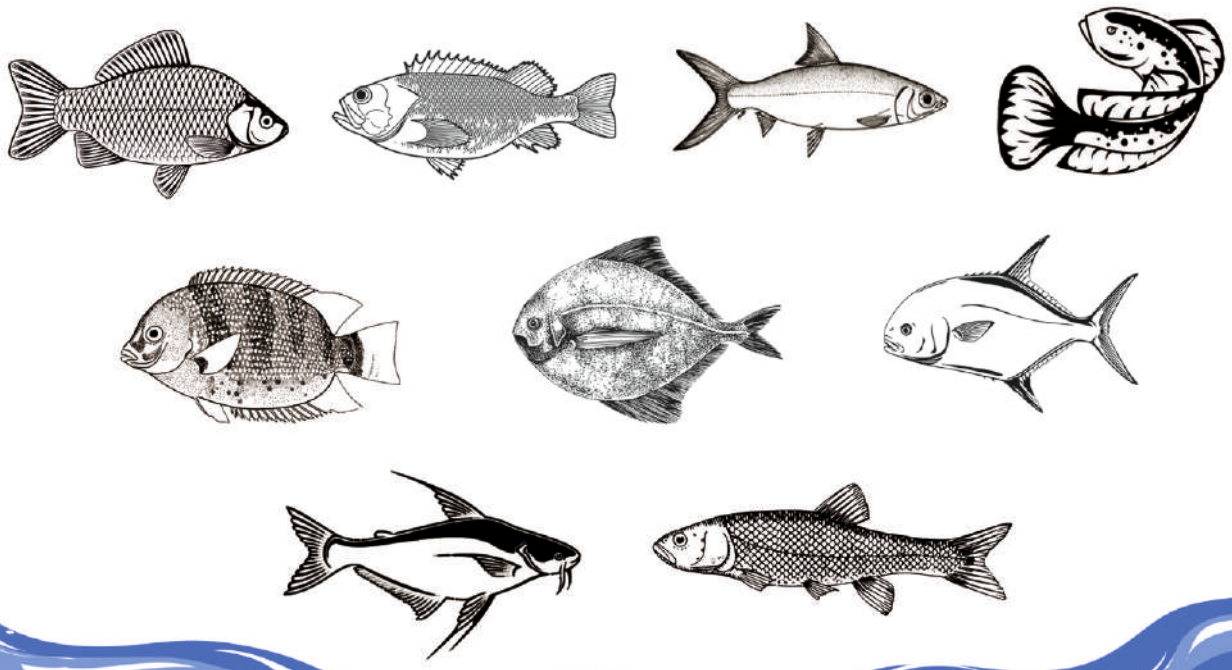

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Nutritional Programming in Fishes

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Abstract

The time has arrived to rethink and rewrite the inherent practices of feeding fishes. Since feed cost around 60-80% of the total expenses in aquaculture and that the feed ingredients are more fish meal based, it is quintessential to reform the practices more sustainably so as to reduce the cost and dependence over marine sources as well as to ease the fish in feeding its food. Moreover it is also important to understand the requirements rather than merely feeding the fish with our preferred choices and for this to happen, there is a need to understand the physiology and feed preferences of each species and also its habit and habitat where it perpetuates and resonates. Hence is the significance of nutritional programming which helps in promoting sustainable feeding strategies as it makes an association between early nutritional environment with growth, metabolism and development. Nutritional programming establishes conducive environment for the juveniles of fish to respond to exceptional nutrient rich feed like plant based feed fed to them so that they get easily acclimatized to such components in its later life without showcasing difficulty in intake and absorption, assimilating those better than the non-programmed fishes. Such better assimilation will improve feed utilization leading to less wastage and maximum feed conversion. The program intervenes the metabolic and immunological processes of fish so that it can respond better to similar diet later in its life. This will help in replacing the fish protein source by plant based protein with its proper utilization and with no compromise made over fish's meat quality. In addition, programmed nutrition also can evade the chances of health issues and can ensure good health to the new born as well, if the parent's feed is accurately programmed. Therefore the technique previously popular in mammals has to be employed in fishes too to suffice the aquaculture production and requirements of the world as this technique is capable of becoming a key tool in the industry's forward journey.

Keywords

Metabolism, Assimilation, Immunology, Nutrigenomics, Nutrigenetics, Precision Nutrition

Introduction

The possibility of metabolic programming emerged since the past 20 years (Lucas et al., 1998). Nutritional programming is an issue which has to be explored to understand the underlying mechanism as of how it modulated fish metabolism (Geurden et al., 2014). The environmental stimuli given at juvenile stage on a long term basis through this programming links with the epigenetics of the fish and gets transmitted from one generation to another generation (Gavery et al., 2017).Undoubtedly, to understand the vital communication of food components with the genes, there is a need to bring forth a substantial research into the "omics" of nutrition too (Trujillo et al., 2006).

Nutritional programming essentially aims at reframing the feeding strategies of fish to a more sustainable pattern for promoting plant based feed as the world is facing difficulty in obtaining animal based feed sources (Francis et al., 2001) without negatively influencing fish's growth, reproductive performance and its meat quality through evaluating its real metabolic phenomena and by regulating its nutrient intake and assimilation pattern (Panserat et al., 2019). The wild catch is depleting due to mismanaged fishing and therefore the stock is highly vulnerable. Hence it's advisable not to further utilize these for fish feed as this may pave way for ecosystem imbalance ultimately (Hua, K., & Bureau, D. P., 2012).

To shift to sustainable feed ingredients, plant based ingredients were incorporated previously itself into the fish feed but then the industry faced repercussions as the fishes didn't respond duly. The plant sources didn't have essential fatty acids for fishes and moreover the marine fishes could not synthesize these. Simultaneously, the plant ingredients were loaded with carbohydrates and the carnivorous fishes

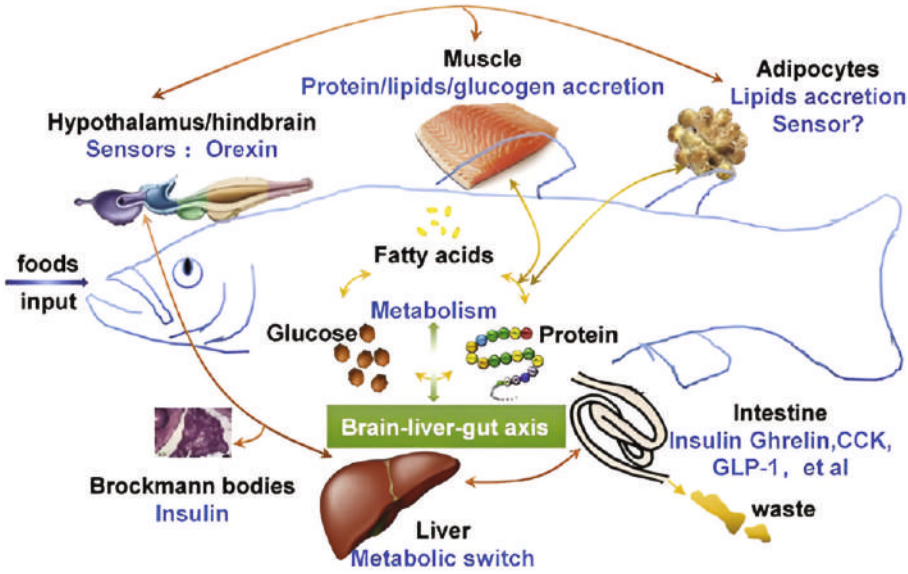

Figure 1: Intra-tissue communication of fish metabolism (Source: Zhang, Y., Lu, R., Qin, C., & Nie, G. (2020). Precision nutritional regulation and aquaculture. *Aquaculture reports*, *18*, 100496 [24].)

poorly metabolized carbohydrates (Conceicao et al., 2007), thus restricting all together the carbohydrates in fish feed (Hua, K., & Bureau, D. P., 2012). Hence is the importance of nutritional programming which turned out as a fruitful outcome out of the search for mechanisms to maximize the capacity of fish to utilize alternate energy sources (Conceicao et al., 2010).

The various positive outcomes of nutritional programming in fish has been reflected through its growth and sustenance pattern, body and brain development, and nutrient metabolism, mediated via reframed metabolic pathways and regulation of gene expression at its epigenetic level during a crucial phase of its life when they show high plasticity and flexibility in development (Hou, Z., & Fuiman, L.A., 2020). Best results came out from experiments with European sea bass, Long snout sea bream Atlantic salmon, Rainbow trout, Nile tilapia and many more.

Along with this boon has developed the concept of precision nutrition which aims to provide accurate nutrition to the fish, depending upon the species, developmental stage and breeding environment so as to decrease environmental perturbations and to enhance profits. Improvisation of feed-processing techniques and development of specific feed combination will serve the purpose of precision nutrition by acting as a key tool. This exemplifies that through successful nutritional programming, precision nutrition will itself get promoted and popularised (Zhang et al., 2020).

Methodology

The desired fish species is selected and the experimental plan is developed to expose it to programmed diet.

The initial phase in nutritional programming involves nutritional conditioning to larvae. The second phase is to repeat the same conditioning with the juveniles. The feed formulation and microinjection or dietary incorporation follows. Microinjection is essentially proved as an effective tool to alter nutritional composition of yolk (Rocha, F.S., 2015). Further as per each experimental design and its time frame, the fishes are randomly selected and analyzed- blood metabolite analysis, mRNA quantification, chemical composition analysis, gene expression assays or enzymatic assays are performed accordingly closely ensued by data analysis for final observations and results.

The Exemplary

The success stories of nutritional programming of few among the various fishes tested with, are as given below. Metabolic programming by dietary carbohydrate in European sea bass larvae with 34% of starch in feed as a stimulus brought positive results. The outcome of the experiment howsoever also suggested that the larval conditioning may fade over time and hence it is appropriate to give nutritional stress pulses regularly during the first months of life to fish for consistent results (Zambonino-Infante et al., 2019).

Studies in *Hippocampus reidi* (long snout sea bream) revealed that nutritionally programmed parents produce better offspring (Otero-Ferrer et al., 2016).

Atlantic salmon responded positively to programmed diet when fed 3 months prior with plant based feed. Later the fish exhibited great assimilability with the feed reflecting in its growth, feed retention and feeding efficiency. A study revealed 24% higher growth rate with vegetable based feed in its early development phase as against marine based diet. Nutritional intervention improved carbohydrate, protein and lipid metabolism by 28%, signaling by 15% and immune, endocrine and translation by 7% (Vera et al., 2017). Further it induced an up-regulation in genes involved in phosphorylation, pyruvate metabolism, TCA cycle, glycolysis and fatty acid metabolism in liver (Vera et al., 2017).

In rainbow trout, nutritional programming with sustainable feed affected the routes of sense recognition, synaptic communication, cognitive activities of the body and the activities neuroendocrine peptides in the brain. As of liver, the pathways associated with xenobiotic metabolism, proteolysis and cytoskeletal cell cycle control are affected (Balasubramanian et al., 2016).

For Nile tilapia, 2M microinjection of glucose into its yolk reserve during its juvenile stage had several positive effects on its adult like, efficient use of glucose with protein-sparing effects, inducting lipogenesis and decreasing amino acid catabolism, leading to its improved growth performance (Kumkhong S., 2020).

The scientists at University of Texas through their study revealed that the fish red drum gets its DHA which

properly programmed nutrition is provided, the benefits are innumerable, ranging from cost effectiveness to high survival rate and best growth and reproductive performances (Fuiman, L. A, & Perez, K.O., 2015).

As of zebra fish adult programmed with carbohydrates, it says that the time slot from culture to weaning is an important period for potential modification of its long-term physiological functions and that it is possible to permanently alter its carbohydrate digestion, transport and metabolism through early nutritional programming in this time frame (Fang et al., 2014).

While, the zebra fish when fed with plant protein, the programmed fish group expressed improved middle intestinal lining area with highest villus length to width ratio pointing towards the mechanism behind improved feed

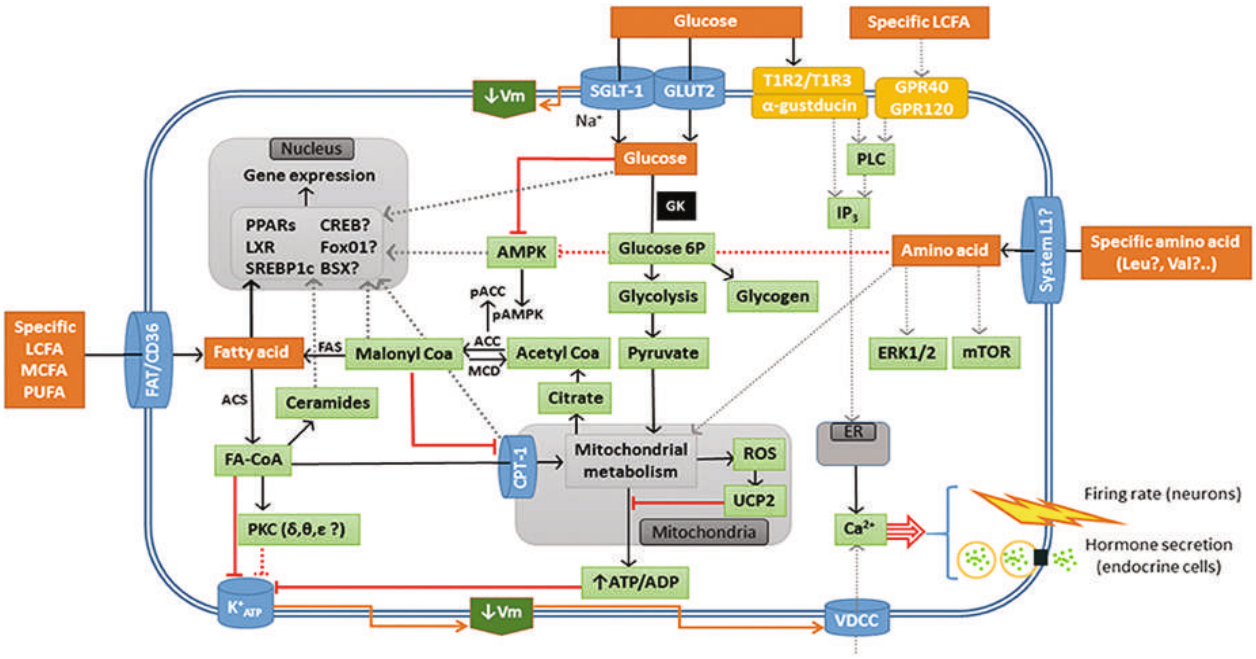

Figure 2 : **Schematic drawing with a model of different sensing systems for glucose, fatty acid, and amino acid in sensor cells in fish** (Source: Conde-Sieira, M., & Soengas, J. L. (2017). Nutrient sensing systems in fish: impact on food intake regulation and energy homeostasis. *Frontiers in neuroscience*, *10*, 603 [4].)

is contained in its yolk for its offspring's proper development comes from the its food source- shrimp and crab. Decline in these food resources due to damaged ecosystem is therefore likely to impact the young one's survival. Hence they reported the significance of metabolic programming here for the declining fish populations to recover as one of the important conservation strategies amongst the other strategies. Several countries release millions of young ones into the natural water bodies to replenish the natural fish stock by hatchery production and rearing. In this step if

assimilation as endocrine and morphological adaptation of the digestive system culminating in improved growth performance (Kwasek et al.,2020).

Another case is with the same zebra fish as a model organism instead. It is fed nutritionally programmed feed to increase its experimental vigor and vitality for its nutrigenomics and nutrigenetics study and also for analyzing the effect of variation at genetic level on dietary response and the role of nutrients and bioactive food

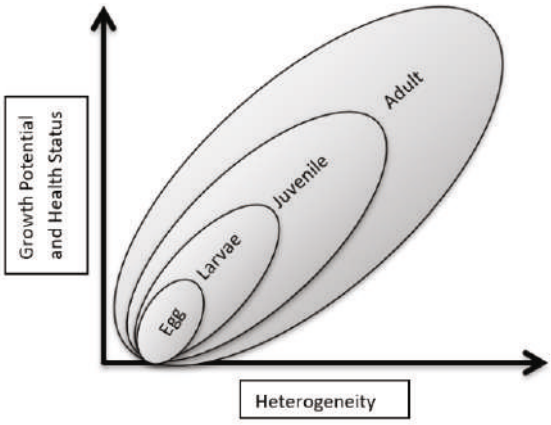

Figure 3 : Graph expressing the relationship of fish's growth potential and health status with heterogeneity through its various life stages

components in gene expression respectively (Fenech et al.,2011), ultimately enhancing its value and efficacy as a model organism. The zebra fish community will benefit from an increased understanding of the nutritional needs of zebra fish (Williams, M.B. & Watts, S.A., 2019). Hence similar studies are the need of the hour and especially concerning such models.

Prospects of Nutritional programming

The environmental factors confronted during early developmental stages, the differences in each fish's physiology and survival strategies, nutritional intervention type and time of developmental windows affects the process of nutritional or metabolic programming.

Nutritional programming in fact invokes a permanent functional change in the fish's physiology by affecting its crucial organs development accordingly and adaptively tunes its body to the changed trophic condition and environment which it may likely encounter in its future too.

Several studies are happening across the globe in testing the sustainable feed (plant-based) served to fish with minor inclusion of animal based components. Successful results have come up while testing with different species under different conditions and that an universal strategy is yet to come out.

In fact the outcome of this research will influence and impact academia, feed industry and the consumers. New feed formulation will pop-up to feed the programmed fish to better utilize its food thereby cutting feed cost as the sustainable feed has replaced the costly marine ingredients, with best flesh quality ensured anyhow. Further with programmed fish, its health and well-being is guaranteed on a better scale benefitting the industry as a whole from losses. Nutritional programming which incorporated plant protein is also said to alter the gut epithelial lining, subsequently increasing fish's resistivity to negative side effects of plant protein, improving its ability to cope with these alternative raw materials and better assimilate them in later life. With the processing sector, the improved meat quality is a boon.

Epigenetic mechanisms such as genomic imprinting may affect programming. These epigenetic modification is stimulated by environmental changes occurring in both somatic and germ cell lineage during development. Nutritional changes made at earlier stage in fact modify cell-specific DNA methylation patterns and these altered DNA methylation patterns in specific cells are transmitted to the daughter cells by replication too, whereby the initial modifications are immortalized (Patel, M.S., & Srinivasan, M, 2002).

But however certain research like with respect to the case of European sea bass, still there is a need to instill the programming effects in the fish till its adulthood and for this the possible biological mechanisms to imprint the stimulus includes: adaptive gene expression changes, preferential clonal selection of adapted cells in programmed tissues and programmed differential proliferation of tissue cell types.

Way Forward

With all these benefits, it is understood that nutritional programming has a huge future ahead in the aquaculture sector. Necessary scientific and technical intervention will lead forward. Understanding fish nutritional requirements and those factors influencing these with appropriate management strategies will help in building a robust and sustainable fisheries sector. However, practical implication with due awareness creation among farmers and other stakeholders is essential to succeed ultimately.

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CRESCO Objectives

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CRESCO and MICROALGAE Production

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

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Seaweeds in Aquaculture Applications : Benefits to Aqua Farmers and Feed & Nutrition Management

Ashok Kumar Banoth

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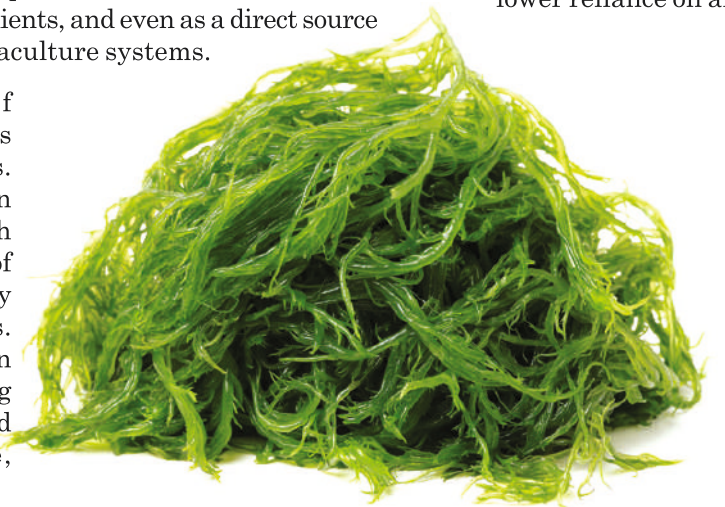
Seaweeds have gained increasing attention in the aquaculture industry due to their versatile applications and significant benefits in feed and nutrition management. As the demand for sustainable aquaculture practices grows, seaweeds present an environmentally friendly and cost-effective alternative to traditional feed ingredients and nutritional supplements.

Aquaculture Applications of Seaweeds

In aquaculture, seaweeds are used in various forms, including whole algae, dried algae, and algae-derived products, to enhance the production of farmed fish and shellfish. Seaweed-based products are utilized as feed additives, functional ingredients, and even as a direct source of nutrition in certain aquaculture systems.



The integration of seaweeds in aquaculture has several practical benefits. For example, seaweeds can be incorporated into fish feeds as a natural source of proteins, essential fatty acids, and carbohydrates. They are also rich in micronutrients, including vitamins (A, C, D, E, K) and minerals (iodine, magnesium, calcium, potassium), which are vital for the growth and health of aquatic organisms.

Benefits to Aqua Farmers

1. **Cost-Effectiveness** : By supplementing or replacing traditional feed components such as fishmeal and soy with seaweed, aquaculture farmers can reduce feed costs. This can be especially significant in regions where fishmeal prices fluctuate, as seaweeds offer a more stable and sustainable alternative.
2. **Sustainability**: Seaweed farming is a highly sustainable practice. Seaweeds absorb excess nutrients from the water, such as nitrogen and phosphorus, reducing the risk of eutrophication (nutrient overload) in aquaculture ponds. This makes seaweed farming an environmentally friendly activity that complements sustainable aquaculture practices.
3. **Improved Health and Disease Resistance**: The natural bioactive compounds found in seaweeds, such as antioxidants and antimicrobial properties, can boost the immune system of farmed species. This contributes to healthier stocks, reduced disease outbreaks, and lower reliance on antibiotics and chemicals.
4. **Enhanced Growth and Feed Conversion**: Studies have shown that the inclusion of seaweed in fish feed can improve growth rates and feed conversion efficiency. Seaweed's rich composition of amino acids, peptides, and polysaccharides enhances digestion and nutrient absorption, which ultimately leads to faster growth and healthier aquaculture species.

Role in Feed and Nutrition Management

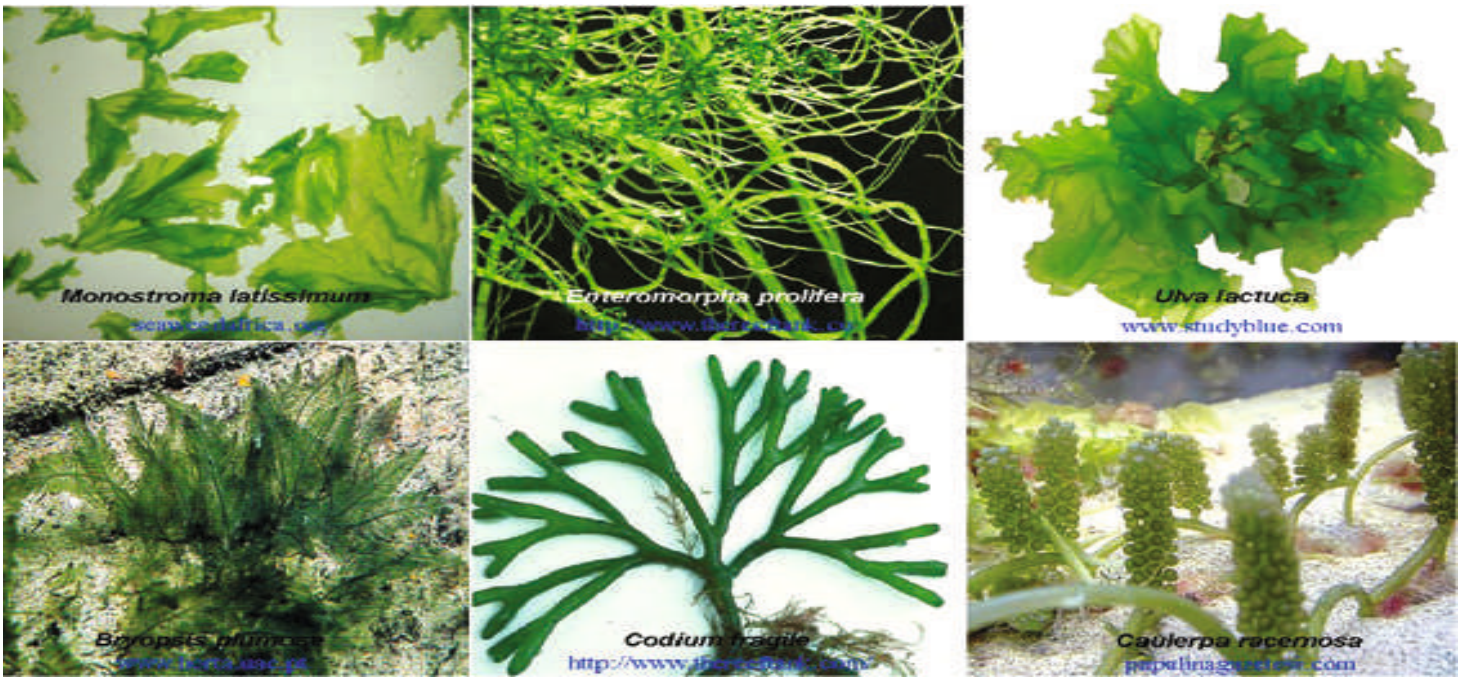
Seaweed-based feeds are gaining popularity as they provide a more balanced nutritional profile compared to conventional plant-based feeds. The proteins in seaweed contain a wide range of essential amino acids, offering a valuable alternative to plant proteins that often lack certain key amino acids. Additionally, the high fiber content of seaweeds aids in promoting better gut health in farmed fish and shrimp.

Seaweeds also have a positive impact on the gut microbiota of aquaculture species. The prebiotic properties of certain seaweeds stimulate the growth of beneficial bacteria in the digestive system, which improves overall gut health and enhances nutrient absorption. This is especially important in aquaculture systems where digestive efficiency directly affects feed utilization and growth rates.

Furthermore, seaweed-derived ingredients such as alginate, carrageenan, and agar are commonly used in formulating feed pellets due to their gelling, binding, and stabilizing properties. These ingredients not only improve the physical properties of the feed but also help in the controlled release of nutrients, ensuring optimal nutrient availability to the farmed species.

Conclusion

Incorporating seaweeds into aquaculture practices offers numerous benefits for both aquaculture farmers and the health of aquatic species. By promoting sustainable farming practices, improving feed efficiency, and enhancing the health and growth of farmed organisms, seaweeds present a promising solution for the future of aquaculture. As the industry continues to seek more sustainable and nutritious feed options, seaweeds will undoubtedly play an increasingly significant role in shaping the future of aquaculture.



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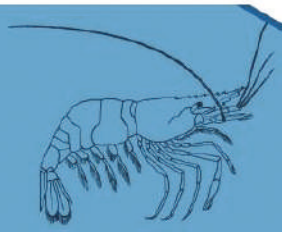

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FAITT and CRESCO : Pioneering Micro Algae Technology for a Revolutionizing Aquaculture

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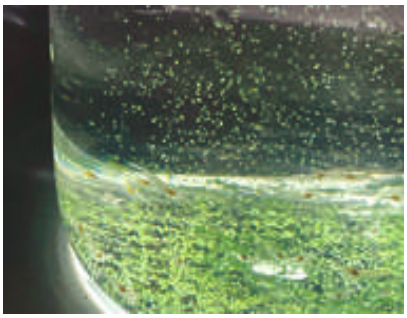
What is MAT?

Micro Algae Technology (MAT) is an encapsulated microalgae-based functional feed designed for shrimp and fish larvae. This innovative feed combines a mixture of beneficial microalgae, encapsulated using advanced technology to ensure a high concentration of vital nutrients such as protein, amino acids, vitamins, pigments, and bioactive compounds.



Features of MAT :

Microencapsulated Algae Composition: MAT Pro consists of high-quality microalgae, including *Chlorella, Spirulina, Isochrysis, Nannochloropsis, Chaetoceros,* and *Thalassiosira.*

Advanced Microalgae Technology : Developed using pioneering micro-encapsulation techniques to achieve specific particle sizes, making it ideal for shrimp hatchery and nursery feeding programs.

Nutrient-Rich Formula: MAT Pro is a superfood for shrimp, containing:

60% protein
8% fat
Essential amino acids
Minerals and vitamins
Fatty acids
Pigments, including phycocyanin, which offers antioxidant, anti-inflammatory, and hepatoprotective properties.

Benefits of MAT :

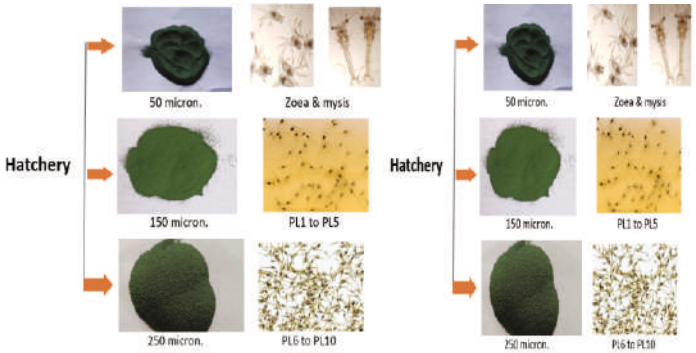
Serves as a functional feed

Acts as a natural superfood for shrimp

Provides essential amino acids, vitamins and minerals
Offers antioxidant and hepatoprotective properties

Feed Sizes :

Product Size : Various sizes available
(Images to be included)



Usage and Dosage :

Recommended inclusion : **10% to 20% of every meal** or **one complete meal per day**

Dosage may vary depending on hatchery requirements and climate conditions.

This advanced feed solution is designed to optimize shrimp and fish larvae growth, ensuring enhanced health and performance.

Success Story of MAT Technology in Shrimp Farming

Farmer Profile :

Mr. Subbaraju Gadirajun, a corporate farmer, has been engaged in large-scale shrimp farming for the past 25 years in Keswararam Village, West Godavari, Andhra Pradesh. He owns and operates a 120-acre shrimp farm, which is divided into four blocks, maintaining high levels of hygiene and biosecurity. Mr. Subbaraju is an innovative farmer who actively conducts research and development on his farm to enhance productivity and sustainability.

Adoption of MAT Technology :

FAITT, an NGO dedicated to supporting farmers through technology transfer, developed a novel Micro Algae Technology (MAT) using Spirulina-based products. The Spirulina is processed into a dry powder, which is then mixed with commercial shrimp feed to improve growth, coloration, and immunity.

Initially, many farmers were hesitant to adopt this new technology, as only 2.5% of farmers typically fall into the early innovator category. However, as a progressive farmer, Mr. Subbaraju quickly embraced this innovation. He conducted a trial in one crop cycle over 10 acres of land, incorporating Spirulina powder into shrimp feed.

Observations and Results :

After experiencing positive results, Mr. Subbaraju recommended that the technology be developed into small feed pellets to enhance ease of application. FAITT subsequently developed the MAT pelletized feed, which was then introduced into Mr. Subbaraju's entire 120-acre farm. He incorporated MAT feed as 10% of the first meal of the day and observed the following benefits after two months:

1. Increased Growth Rate: The shrimp exhibited a weight increase of 1.5 grams extra per shrimp compared to traditional feeding methods.
2. Enhanced Immunity: The shrimp showed improved disease resistance, and no disease outbreaks were recorded in the farm.
3. Improved Feed Intake: The MAT technology enhanced feed attraction, leading to better feeding efficiency.
4. Better Pigmentation: During check tray observations, shrimp gut color changed to green, and pigmentation improved, resulting in visually healthier shrimp.

Conclusion :

Mr. Subbaraju's successful implementation of FAITT's MAT technology demonstrates its effectiveness in enhancing shrimp growth, immunity, and overall farm productivity. His results serve as a model for other farmers looking to adopt innovative and sustainable shrimp farming practices. The MAT feed technology can be effectively used after 35 days of crop initiation to achieve superior results.

This success story highlights the potential of Spirulina-based feed technology in revolutionizing the shrimp farming industry, ensuring higher yields, disease resistance, and economic sustainability for farmers in Andhra Pradesh and beyond.

The Health Benefits of Seafood

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Seafood plays a significant role in the diet, economy, and culture of India, with its importance growing in recent years. India is one of the largest producers and exporters of seafood, and its coastal regions contribute a lot to the country's seafood production. Let's break down the various aspects of seafood awareness, products, promotions, and its advantages to humans in India :

1. Seafood Awareness in India:

Nutritional Benefits: Seafood is rich in proteins, omega-3 fatty acids, vitamins (like Vitamin D and B12), and minerals such as iodine and selenium. Awareness about these health benefits is increasing, particularly for cardiovascular health, brain function, and overall well-being.

Sustainability: There's growing awareness about sustainable fishing practices, the depletion of fish stocks, and the environmental impact of overfishing. Efforts are being made to educate consumers about sustainable seafood choices to protect marine biodiversity and ecosystems.

Health and Safety: Ensuring seafood is sourced from hygienic, trusted suppliers is crucial for consumer safety. There are campaigns aimed at educating people on the importance of buying seafood from certified vendors to avoid contamination (e.g., heavy metals, pollutants).

2. Seafood Products in India:

India offers a wide variety of seafood products, many of which are region-specific. Some common seafood products include :

Fish: Popular fish varieties like pomfret, mackerel (bangda), tuna, sardines, and grouper are consumed across the country.

Shellfish: Prawns (especially the white and black tiger prawns), crabs, lobsters, and mollusks such as clams and oysters are widely enjoyed.

Processed Seafood Products: The Indian seafood market also includes processed seafood like frozen fish, dried fish, smoked fish, and canned seafood. These products are particularly popular for exports.

Frozen Seafood: Frozen seafood has become popular due to its convenience, longer shelf life, and the ability to maintain the nutritional quality of seafood.

3. Seafood Promotions in India:

There have been various promotional efforts aimed at increasing seafood consumption in India:

Government Initiatives: The Indian government promotes seafood consumption through campaigns to highlight its nutritional benefits. These include local programs that focus on promoting fish farming and aquaculture to increase local availability and affordability.

Industry Events and Fairs: Seafood festivals, expos, and food fairs are organized regularly to raise awareness about the variety and benefits of seafood. These events often include cooking demonstrations and tastings.

Private Sector Initiatives: Major seafood brands and retailers run promotional campaigns through advertisements, social media, and partnerships with chefs and food influencers. These promotions often focus on highlighting the health benefits, quality, and freshness of Indian seafood.

4. Advantages to Humans:

Rich Source of Nutrients: As mentioned earlier, seafood is an excellent source of high-quality protein, essential fatty acids, and micronutrients. It contributes to overall good health, supports the immune system, and helps in maintaining muscle mass.

Cognitive and Mental Health: Omega-3 fatty acids, found abundantly in fish like salmon and mackerel, are known for their positive impact on brain health, improving memory, and reducing the risk of mental health issues such as depression and anxiety.

Heart Health: Regular consumption of seafood is linked to a lower risk of heart disease due to the heart-healthy omega-3 fatty acids, which help in reducing inflammation, lowering cholesterol levels, and improving circulation.

Weight Management : Seafood is a great option for weight management because it is rich in protein but relatively low in calories. It helps in building lean muscle mass and keeping you full for longer.

Bone Health: Some seafood varieties like sardines and salmon are rich in vitamin D and calcium, essential for maintaining strong bones and preventing conditions like osteoporosis.

Challenges and Opportunities:

Sustainability Issues: One of the biggest challenges for India's seafood industry is overfishing and the depletion of marine resources. The growing demand for seafood necessitates the need for responsible and sustainable fishing practices to preserve marine biodiversity.

Aquaculture Development: The growth of aquaculture (fish farming) offers opportunities for India to meet the rising demand for seafood. This can be a more sustainable option if managed responsibly.

Export Potential: India has significant potential to boost its seafood exports, particularly to countries in Europe, the Middle East, and Southeast Asia, where seafood consumption is high. Ensuring quality standards, certifications, and improving logistics infrastructure can help tap into this opportunity.

In conclusion, the promotion of seafood awareness, the development of diverse seafood products, and the health benefits associated with consuming seafood make it an important part of India's dietary habits and economic growth. However, there needs to be a balanced focus on sustainability to ensure long-term availability of seafood resources.


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World Seafood Congress in India for the first time!

Dr. Ian Goulding, PhD,
President
International Association of
Fish Inspectors (IAFI)

On behalf of IAFI, the International Association of Fish Inspectors, it gives me great pleasure to announce that the World Seafood Congress 2025 will be held at the Chennai Trade Centre, Chennai India on 22-24 September 2025. IAFI is recognised by the UN Social and Economic Affairs Committee as representing stakeholders in the global supply chain for aquatic food and feed products, of both plant and animal origin.

In promoting the World Seafood Congress, IAFI aims to bring together parties engaged in fish technology and safety from government, the fish and seafood harvesting, processing and marketing industries, academia, public and private organizations and other diverse disciplines. The Congress provides all of these actors with a great opportunity to exchange information, ideas and methodologies, and to interact with fellow professionals across all parts of the supply chain and to foster understanding and strengthen collaboration.

The World Seafood Congress has its roots in the FAO Technical Conference on Fish Inspection and Quality Control, held in Halifax, Canada in 1969. The historical city of Chennai joins a long list of distinguished hosts including Halifax, Canada (1999), Vancouver, Canada (2001), The Hague, Netherlands (2003), Sydney, Australia (2005), Dublin, Ireland (2007), Agadir, Morocco (2009), Washington DC (2011), Newfoundland, Canada (2013), Grimsby, UK (2015), Reykjavik, Iceland (2017), Penang, Malaysia (2019) and Peniche, Portugal 2023. We are delighted to bring the Congress for the first time to the sub-continent, with its vibrant, dynamic and globally integrated seafood sector.

Whilst IAFI has its roots in fish quality control, and particularly in the safety of fishery and aquaculture products, our remit has expanded considerably, as globalisation of our food supply has brought additional issues of sustainability and equity to the fore. IAFI has always placed a high priority in ensuring that the seafood supply chain delivers products in a way that ensures that all participants, and especially those in developing countries receive, a fair share of the benefits of the global seafood trade, and that the environmental impacts of our business activities do not undermine the livelihoods of future generations. To this end, we look forward once again to the participation of our UN and bilateral development partners, for whom production and distribution of fisheries and aquaculture products forms a core part of their blue economy strategies.

We will be honoured if you can join us at WSC2025 Chennai, along with producers, processors and distributors of aquatic products from all around the world, as well as trade associations, government agencies, competent authorities, NGOs, vocational training and educational and the R&D institutions. As well as an exciting and stimulating line-up of top presenters setting out the latest trends, challenges and developments in the global seafood trade, we are pleased that the Congress will also include Regional Developing Country Workshops with UN participation (21 September), a concurrent trade exhibition showcasing some of the latest products and technologies in seafood processing and distribution, a poster competition, industry visits (25 September) and a full programme of social and networking activities. Don't miss WSC2025 in Chennai.

Hope to see you there!

World Seafood Congress

Every two years, the World Seafood Congress (WSC) gathers global seafood industry leaders, showcasing the latest advancements and addressing key issues like sustainability and ocean health. Organised by the International Association of Fish Inspectors (IAFI), an international NGO recognised by the United Nations, WSC is an event that provides insights to new standards for the industry, fostering collaboration and innovation.

13th World Seafood Congress

India will host the World Seafood Congress for the first time, and will be held in Chennai, an important global seafood hub. This, the 13th Congress, marks a significant milestone and highlights the nation's growing influence as a major player in the global seafood sector.

As the world's second-largest producer of seafood, India holds a critical role in developing, advancing and demonstrating sustainable practices, enhancing market access, and fostering innovation in seafood production and trade. Hosting the World Seafood Congress in India offers a unique opportunity to bring together global leaders, policymakers, scientists, and industry experts to address key challenges and opportunities within the seafood industry, particularly in the areas of sustainability, ethics, innovation, and food safety.

The World Seafood Congress 2025 will provide a platform for in-depth discussions on the future of the seafood sector and foster awareness and promote best practices in processing and distribution technologies, the science of fish quality control, inspection methodologies, sustainability and ethics in trade.

Why attend?

Join global industry leaders at the World Seafood Congress 2025

- Connect with top professionals and experts from around the world.
- Discover cutting-edge technologies and best practices shaping the future of seafood.
- Learn how to implement sustainable practices and stay ahead of regulatory changes.
- Explore new business prospects in India, a rapidly growing seafood market.
- Participate in discussions that will define the global seafood industry.
- Be part of the conversation. Shape the future of seafood.

WORLD SEAFOOD CONGRESS 2025

- 3-day Conference
- 3 Day Trade Fair
- Pre Conferences
- Abstract Presentation
- Site Visits
- Workshops

Abstract Submission is now open.

Venue

Chennai Trade Centre

Chennai, a thriving port city on India's southeastern coast, is strategically located to provide unparalleled access to global seafood markets and international logistics networks, making it an ideal venue for a congress of this stature. With its world-class infrastructure, including excellent connectivity by air, road, and rail, and a wide range of accommodation options—offering thousands of hotel rooms to suit every need—Chennai ensures a seamless experience for all delegates.

Beyond its logistical advantages, Chennai boasts a rich cultural heritage, vibrant cuisine, and a warm, welcoming atmosphere, adding a unique local charm to your congress experience. Whether it's business or leisure, Chennai offers an enriching backdrop for this international gathering.

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Advancing Sustainable Aquaculture : Enzymatic Floating Fish Feed through FAITT Interventions in West Bengal

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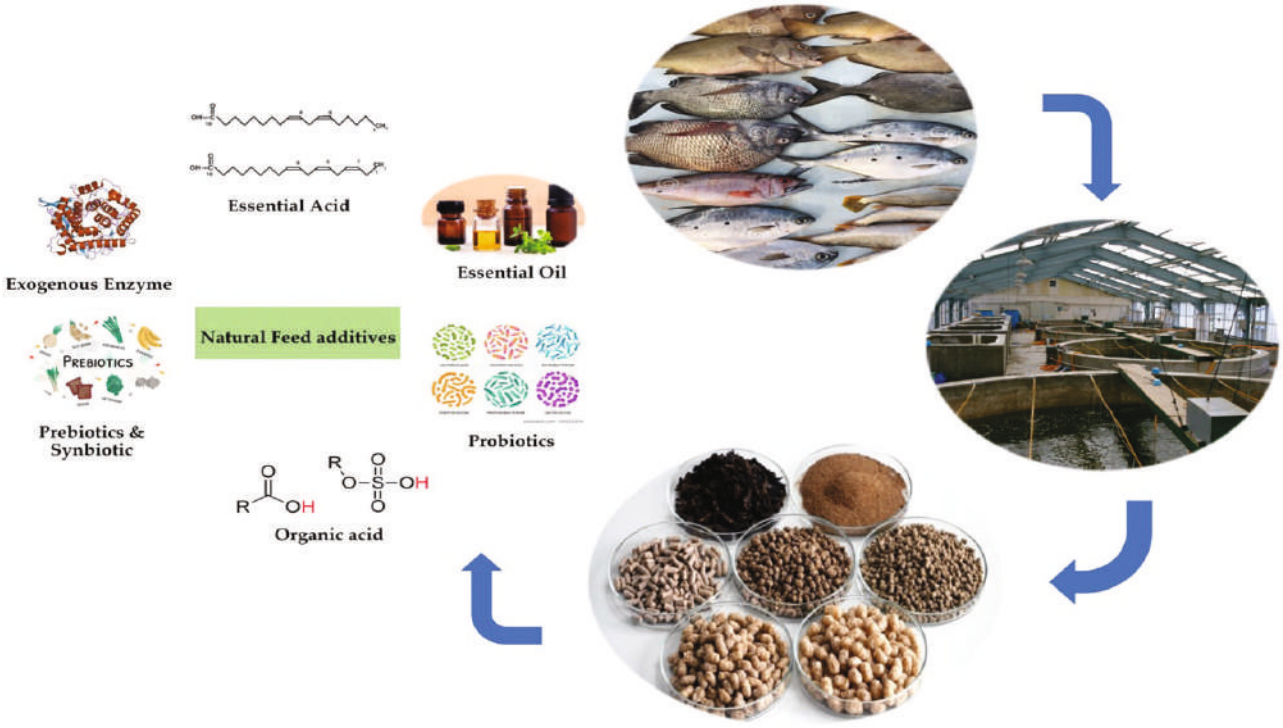
Introduction

Animal feed is a complex food product composed predominantly of raw agricultural ingredients such as forage like hay and alfalfa and partially refined ingredients like soy bean meal, cracked corn kernels and wheat middling. The relative quantities of these ingredients vary with location, season, species being fed and the cost of the ingredient. Animals are not capable of digesting all the plant matter they consume due to a number of factors; low levels of some digestive enzymes, short residence time of the food in the digestive system or the lack of specific enzymes. The purpose of adding enzymes to feed is to improve the utilization of the feed, increasing the amount of nutrients available to the animals which improves their health, lowers feed cost for the farmers and reduces farm waste volume. The benefit to the consumer has been lower prices for meat in the supermarket and restaurants relative to 50 years ago.

According to a report by Food and Agriculture organization (FAO), global population is expected to grow and reach 9 billion by 2050 and one critical challenge of growing population is the supply of food and protein source. Fishes are known to be one of the most energy efficient protein sources with average food conversion ratio (FCR) ranging from 1.2 to 2.0, having high protein (18 to 20g per 100g of serving) and low calorific value (96 to 208 calories per 100g of serving). For a growing population, it is important that feed given to farmed fish remains sustainable. Enzymes will help in using economical raw materials, increase performance, and decrease anti-nutritional factors.



Raw Materials in Fish Feed

Most of the raw materials used in fish feed industry are plant based; corn, corn gluten meal, rice bran, wheat bran, sunflower seed meal, groundnut meal, cottonseed meal, linseed meal, copra meal and DORB (de-oiled rice bran). All these raw materials have high fibre, which are the undigested part of the feed, not digested by the innate enzymes naturally found in the fish gut. The non-digestible fibre includes high levels of non-starch polysaccharides made of cellulose, hemicellulose and lignin. There are many evidences that have reported increase in the viscosity of digested feed due to the presence of non-starch polysaccharides, which leads to decrease in the available nutrients in the feed.

Application of Enzymes in Animal Feed Industry

The application of enzymes as feed additive has a history of twenty years. In feed industry, enzymes are used to enhance nutrient digestibility, focusing on removing the anti-nutritive effects of non-starch polysaccharides (NSP). Besides, phytase is not only used to increase the utilisation of phytate P, but also to alleviate environmental burdens by reducing P excretion in the excreta. Enzymes can also be used to noncereal grain components of the diet. These vegetable protein sources are often high in NSP, which are poorly characterised in regard to their molecular structures. The enzyme industry today is constantly searching for new areas of application. Some recent data demonstrate the role of glycanases (carbohydrates degrading enzymes) as an alternative to in-feed antibiotics.

Innate Enzymes in Fishes

The most common enzymes reported in carps are given

Lipase——àAmylase

Trypsin——à Maltase

Chymotrypsin——à Cellulase- exogenous (microbial)

Most feed ingredients of plant origin also contain anti-nutritional factors such as protease inhibitors (Kunitz trypsin inhibitors, Bowman-Brik Inhibitors), lectins, saponins and phytic acids. Unlike etherate-nutritional factors, phytic acid is not degraded by heat treatment during pelleting. Phytic acid is known to interfere in absorption of minerals like calcium, magnesium and potassium; having an adverse effect on the growth and development of fishes.

Exogenous Enzyme Supplementation

Supplementation of exogenous NSPases (non-starch polysaccharides degrading enzymes) and phytases is known to improve digestion of natural and supplemented feed, thereby improving the feed efficiency and performance.

Addition of NSPases and phytases is a smart solution for improving the profitability in aquaculture. It not only helps in the digestion of high fibre containing raw materials but also helps in reducing the usage of minerals like MCP and DCP (mono and dicalcium phosphate). Foundation for Aquaculture Innovation and Technology Transfer (FAITT) research team has formulated an enzyme product with the combination of NSPases and phytase based on the raw materials used in fish feed and the feeding behaviour and study performances.

Bhojan Enzyme Floating Feed (Bhojan E Feed) is a multi-substrate enzyme powder (from the reputed company commercial Multi Enzyme purchased and used for this study) containing NSP (Non-Starch Polysaccharide) enzymes and phytase developed to improve the nutrient quality of fish feed. Application of the product is at farm level, where it is mixed with the feed right before consumption by the animals.

This paper summarizes the application and benefits of Bojan enzyme Feed through digestibility and growth trials conducted at FAITT Research Laboratory and subsequent commercial trials done in, Andhra Pradesh, India, and its application in fish farm .

IN VIVO GROWTH STUDIES

Two in vivo trials were conducted in commercial farms at Radhamani and Nimthori near Tamluk West Bengal to demonstrate the benefits of Bhojan Enzyme Floating Feed (Bhojan E Feed). The farms had a mixed culture of Indian major carps Rohu and Catla. Bhojan Enzyme Floating Feed (Bhojan E Feed) was fed in treatment pond and fishes were fed with feed without product supplementation and control Pond other commercially available floating feed The fish were fed once in a day for a period of 90 days. The effect of enzyme supplementation on weight gain was recorded by netting approximately 100 fish, thrice from sides of the pond and the average weight was calculated and recorded once in 30 days.

Farm trial I

The details of the farm trial I is given in the table 1

Table 1. Farm trial I details

Trial I	Control	Treatment
Area of culture	30 acres	10 acres
Stocking density	Rohu- 55,000 & Catla- 2000	Rohu- 25,000 & Catla- 3000
Diet	Commercial fish feed without supplementation of enzymes	Bhojan Enzyme Floating Feed (Bhojan E Feed)

Results

Commercial trial I showed increase in weight gain in treated group than control groups (Fig. 1). At the end of the trial, the treatment group having Rohu weighed 50g more and Catla weighed 40g more than the control group.

Farm trial II

The details of the farm trial II are given in the table 2.

Table 2. Farm trial II details

Trial II	Control	Treatment
Area of culture	20 acres	10 acres
Stocking density	Rohu- 35,000 & Catla- 2000	Rohu- 25,000 & Catla- 3000
Diet	Commercial fish feed without supplementation of enzymes	Bhojan Enzyme Floating Feed (Bhojan E Feed)

Results

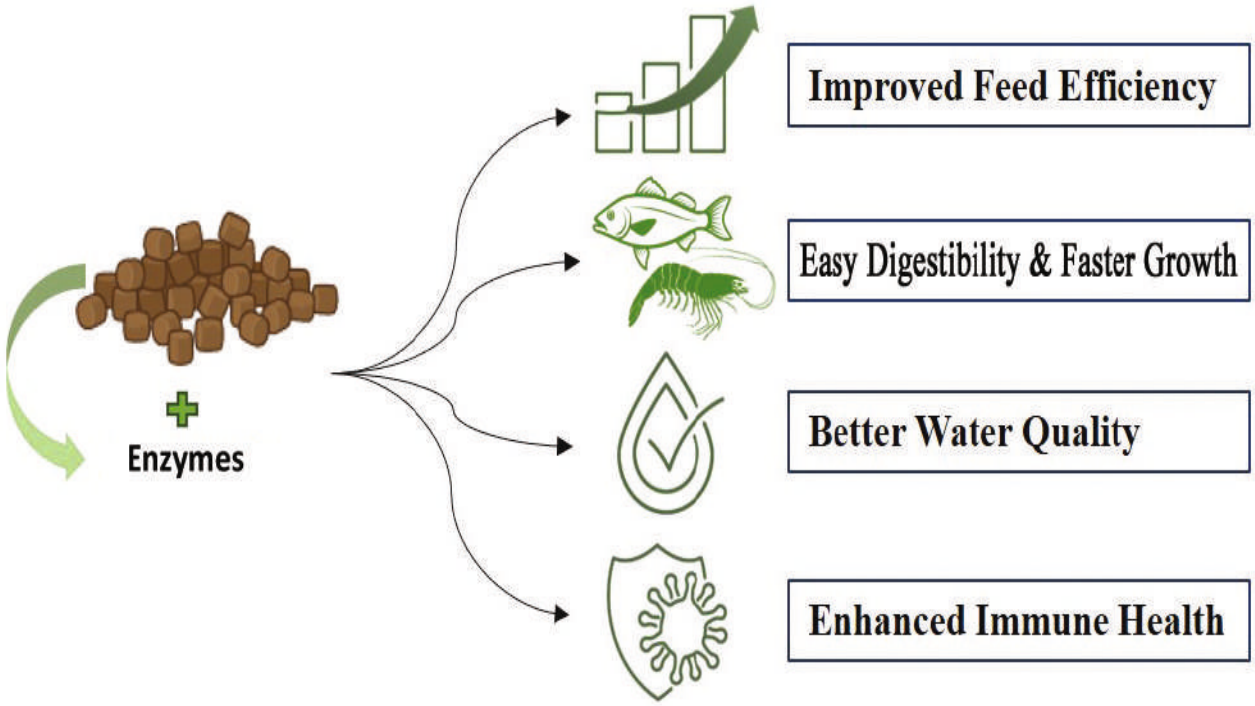
Trial II, control group of Catla were 20 grams less than the treatment group, and the same group gained 190 grams more than control group at the end of the trial (Fig. 2). similarly, Rohu in treatment ponds gained 30 grams more than the control group at the end of the trial.

Skin Pigmentation

In both the above trials better utilization of phytoplankton and algae resulted in enhanced carotenoid bioavailability. Supplementation of Bhojan Enzyme Floating Feed (Bhojan E Feed) showed an increase the pigmentation of carps. This was observed by visual examination during the trials and was consistently reported by farmers.

CONCLUSION

Post pellet application of enzymes application for fish feed is an attractive way of solving the indigestibility of high fibre containing feed raw materials. Not only does it improve the fish performance, but also decreases the eutrophication of pond water caused due to release of undigested feed and phosphorus, thus helping the farmers in maintaining water quality and animal health. This study further to prove the bioavailability of Enzyme percentage in feed and the percentage of loss while manufacturing feeds (due to steam and cooking process) similarly, to standardize the inclusion ratios of per ton in feed productions.



Benefits of Enzymatic Feed

Moyna Aqua Expo Review : Driving Innovation and Sustainability in the Aquaculture Industry

Moyna Aquaculture expos offered a significant platform for stakeholders in the aquaculture industry to come together, share knowledge, and explore new technologies, trends, and sustainable practices that shape the future of the industry. As the global demand for seafood continues to rise, and sustainability becomes increasingly critical, these expos play a pivotal role in connecting industry professionals and fostering innovation.

Key Focus Areas of Moyna Aqua Expo:

Moyna Aqua Expo provided a space for diverse players in the industry, including fish farmers, suppliers, technology providers, researchers, and government representatives, to engage with the latest developments. The following key areas are typically highlighted in this event.

Sustainable Practices: With the growing emphasis on environmental responsibility, Moyna Aqua Expo showcase sustainable aquaculture techniques. These include eco-friendly feed, water management systems, waste reduction technologies, and alternative farming methods. Companies present their innovations that minimize the ecological footprint of fish farming while ensuring long-term viability.

Aquaculture Technologies : The integration of cutting-edge technologies is transforming the aquaculture industry. Expos offer insights into innovations such as smart farming systems, automated feeding systems, water quality monitoring, and AI-based data analysis. These technologies enhance efficiency, optimize production, and improve fish health and welfare.

Aquaculture Genetics and Breeding : Advances in genetic research and breeding programs are essential for producing healthier, more resilient fish. Expos provide a platform for sharing the latest breakthroughs in fish genetics, breeding techniques, and innovations that contribute to higher yield and disease resistance.

Health and Disease Management : Disease management is a critical aspect of successful aquaculture. At expos, experts present the latest methods and solutions for controlling and preventing diseases in farmed fish, such as vaccines, biosecurity measures, and diagnostic tools.

Supply Chain and Market Trends : Moyna Aqua expo also serve as a hub for discussions on the seafood supply chain, market trends, and export opportunities. This helps businesses connect with buyers, distributors, and retailers to expand market reach and enhance the value chain.

Benefits of Participants in Moyna Aqua Expo:

Networking Opportunities : Expos offer valuable opportunities to connect with potential partners, investors, and suppliers. Attendees can expand their business networks, establish new collaborations, and forge relationships that can lead to fruitful business opportunities.

Knowledge Sharing and Education : Participating in seminars, panel discussions, and workshops allows attendees to gain insights from industry experts, researchers, and thought leaders. These discussions provide a deeper understanding of industry challenges, emerging trends, and innovative solutions.

Exposure to New Markets: For businesses looking to expand internationally, aquaculture expos provide exposure to global markets. Companies can engage with international buyers and partners, explore export possibilities, and identify new market opportunities.

Showcasing Innovations : For exhibitors, expos are a perfect platform to showcase their products, services, and innovations to a targeted audience. It allows companies to demonstrate the effectiveness of their solutions in a competitive marketplace, enhancing brand visibility and credibility.

Conclusion :

Moyna Aqua Expo are a vital part of the industry's growth, driving innovation, sustainability, and collaboration across the sector. By participating, companies, professionals, and stakeholders gain access to the latest technologies, trends, and best practices that shape the future of aquaculture. These events not only provide a platform for business expansion but also foster the exchange of knowledge and the development of sustainable solutions that ensure the long-term success of the global aquaculture industry.

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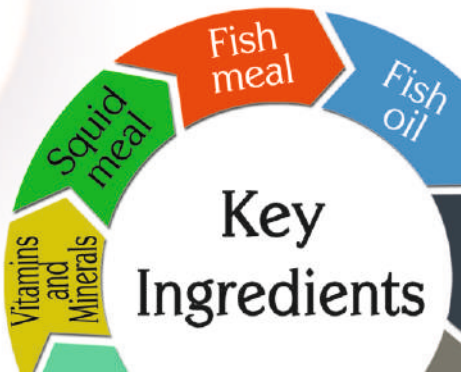

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