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Spirulina a Blue Green Algae as Growth Enhancer in Fishes

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Review Article

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ABSTRACT

Spirulina a blue green algae has several benefits of using in aquaculture. Compound feeds are in desperate need of fish meal and fish oil substitutes because of the growing costs and the desire to support sustainable fisheries. In fish feed, spirulina, a filamentous blue green microalga, might take the place of more costly animal proteins. Spirulina's protein concentration (58 percent) is higher than that of other regularly utilized plant sources, making it an excellent source of protein. As a result, it may be utilized in fish feed as an alternate protein source. For most fish feed, spirulina is used as a supplement to fish meals and as an alternative to a fish meal. Spirulina has been studied as a fish feed for various fish species.

Keywords: Spirulina; Growth promoter; Fish feed; Nutrition; Algae

INTRODUCTION

Aquatic items are becoming more sought after across the world. Even though the seas span over seventy percent of the planet's surface, fourteen of the world's largest fishing regions are overfished. As a result of natural yield limits and the scarcity of appropriate aquaculture sites, traditional methods like aquaculture (the growing of fish and seaweed) can only go so far in meeting consumer demand and relieving pressure on wild fish populations [1]. Aquaculture is the cultivation of aquatic creatures, such as fish, mollusks, crustaceans, and aquatic plants, under regulated conditions. Cultural practices imply involvement in the raising process to improve output, including regular stocking, food provision, predator protection, etc. Aquaculture is similar to the cattle and poultry sectors in that it involves raising animals in captivity, butchering them, and then selling the meat. When used in the aquaculture of coastal regions, in particular, biotechnology may have a significant impact [2].

To put it another way, aquatic biotechnology is the application of science and engineering to the direct and indirect utilization of aquatic organisms in their natural and modified states. "Fish health and brood stock optimization are also part of this, as is aquatic bioprocessing (the extraction of useful substances from marine organisms) and aquatic bioremediation (use of microorganisms to degrade toxic chemicals in the aquatic environment)." Aquaculture biotechnology offers immediate potential, while marine medicines, aquatic bioinformatics, and aquatic biosensors provide long term prospects. When used in aquaculture, biotechnology may aid in boosting an organism's capacity to thrive in various environmental circumstances, such as warm or cold water. In addition, contemporary biotechnology methods are used to generate vaccinations against disease agents and parasites that typically harm marine creatures against species and serotype specific vaccines [3-7].

Foods rich in vital amino acids, minerals, and vitamins like fish are necessary for human nutrition. Aquaculture accounts for 56.44 percent of overall fish output in Bangladesh and provides 60 percent of the country's daily protein intake from fish [8].

On the other hand, the quality of aquaculture feed ingredients is a significant issue. It is necessary to have high quality feeds created from a sustainable supply of components available for aquaculture. Because of its high protein content and excellent amino acid balance, F.M. has historically been the principal protein component in aqua diets. Because of its high nutritional value, it is difficult to substitute for other sources of these nutrients. Sea fish populations are dwindling, making it challenging to get F.M. sustainably from wild fisheries. The future supply of F.M. for aqua feeds is no more certain. Modern aquaculture has been severely hampered by the high cost, rising demand, low quality, and difficulty obtaining F.M. due to these factors and others. Much effort has been put into finding new sources of protein for farmed fish that are both animal and plant based [9-15].

Fish has a significant role in human nutrition as a source of dietary animal protein. "Fishery products are a good source of protein because they contain all the essential amino acids (methionine, cystine, threonine, tryptophan, arginine, isoleucine, valeucine, histidine and phenylalanine) and minerals (iodine, phosphorus, potassium, iron and vitamin A and D in desirable concentrations) as well as a wide range of vitamins and minerals." Low carbohydrate and unsaturated fat, particularly Omega 3s, make this a valuable source of protein for those on a healthy diet. Aquaculture accounts for 56.44 percent of Bangladesh's total fish output, inland open water provides 28 percent, and marine waters contribute 16 percent of overall production. In terms of aquaculture output, Bangladesh ranks fourth in the world, according to FAO figures from 2017. "Fish output from aquaculture has grown at an average annual rate of 8.8% over the previous three decades, making it one of the fastest growing animal food industries". Seed and feed are the critical constraints in aquaculture. In intensive and semi-intensive aquaculture systems, fish feed accounts for 60 percent–70 percent of operating costs. "Fish meal is considered the greatest source of dietary protein due to its high digestibility and perfect balance of key amino acids and fatty acids." Due to aquaculture's fast expansion, demand for F.M. is predicted to continue to rise, which will result in an even higher price. Wild caught fish may not be sustainable for F.M. production [16]. Novel protein sources such as cheaper plant or animal origin proteins must be used in aqua feed production to achieve sustainable aquaculture. The alga may also be used to enhance meat's color, taste, and quality as an alternative protein source. "Because of its high protein, vitamin, essential amino acid, mineral, essential fatty acid, and antioxidant pigment content, spirulina is one of the most often utilized microalgae in aquatic animal diets."

Due to an ever growing global population, food security has been a significant concern in recent years. By 2020, the globe will need an extra 23 million metric tons of aquatic food to meet current per capita consumption levels as the global population grows. Aquaculture will have to provide an increased supply. Because traditional agriculture cannot provide enough food to sustain the world's growing population, researchers must look for new, alternative, and unconventional food sources. Aquaculture's increased practice may be a solution for producing more fish to fulfill the protein needs of the world's vast populace. In order to do so, we must increase fish production while decreasing feed costs. According to some research, adding more plant protein to fish diets may lower the price of F.M. and feeds. As a result, using spirulina in fish feed is beneficial [17].

In aqua feeds, spirulina has been utilized as a protein and vitamin supplement for fish, shrimp, and poultry and a complementing nutritional element. This micro alga is used in China to replace imported feed to boost shrimp growth, immunity, and viability. It is not widely utilized in fish farms in Bangladesh. Hence it is not produced commercially as a fish feed component there. "Spirulina, on the other hand, looks to have much promise for growth, particularly as a small scale crop for nutritional betterment, economic development, and environmental mitigation." According to FAO fisheries data, this commodity is becoming more critical. Production of Spirulina in China increased from 19 080 tons in 2003 to 41 570 tons in 2004, with a value of between $7.6 million and USD 16.6 million.

On the other hand, the rest of the globe seems to be producing nothing. Spirulina's advantages have been well publicized, but it has not gotten the attention it deserves. In order to get the most out of these algae, it should be exploited more effectively, and spirulina should be grown commercially. So Bangladesh can produce its fish and supply its domestic animal protein needs [18].

Nutritional requirements of fish

Aquaculture, where feed accounts for around half or more of the variable production costs, relies heavily on high quality nutrition to provide a healthy, high quality product at an affordable price. Fish nutrient needs are given as the minimal dietary amounts required ensuring the maximal performance of fish under experimental situations when fed diets commonly produced from semi-purified components [19]. Fish rely on various elements to determine their nutritional needs, including species, growth stage, eating habits, water chemistry and biology, and the availability of natural food. In order to meet the development and energy needs of the fish, a vitamin-mineral premix and oilcake, fishmeal, and animal meal (protein sources) are advised for semi-intensive culture techniques, as are rice bran, wheat bran, and maize (carbohydrate sources).

Spirulina as feed ingredients

Spirulina is a genus of roughly 15 species of filamentous, multicellular, blue green microalgae. It is divided into two subgenera, *Arthrospira* and spirulina. "*Arthrospira platensis* is the most common and commonly accessible spirulina species, and most published research and public health decisions are based on this particular species." It is easy to find spirulina microalgae across the globe. For both terrestrial and aquatic species, it is regarded as one of the most concentrated natural sources of nourishment. Up to 70 percent in dry weight, spirulina has a high protein and fat content. Because of its high concentration of antioxidants and other nutrients (particularly vitamin A and B_{12}), it is becoming more popular as an ingredient in the food. As a result, spirulina has the potential to be an outstanding source of nutrients as well as a significant energy source in animal feed. According to Qureshi, et al. spirulina may be fed to animals and used as a dietary supplement for people [20].

Low cost culture media makes growing spirulina in a lab simple and inexpensive. It is easy to cultivate, harvest, and prepare and contains a high concentration of macro and micronutrients, making it an excellent food source. As a result of its incredible nutritional value, it has grown commercially for more than a decade in nations throughout the globe. This includes protein, amino acids, vitamins, minerals, vital fatty acids, and beta carotene.

The benefits of spirulina feeding

- Fish will develop faster and more uniformly if fed spirulina. Spirulina has no indigestible components. Therefore it aids digestion and increases nutrient absorption.
- A clogged intestine may cause a person to have a large belly, leading to other health problems.
- Spirulina increases the synthesis of enzymes that break down fats and turn them into energy for the fish when lipids are absorbed.
- Spirulina contains carotene pigments that enhance the colors of your fish, making it a good choice for aquariums.

Commercial spirulina production is necessary to fulfill consumer demand. Paddle wheels are used to churn the water in open channel ponds. Spirulina farms may be found worldwide, although most are in the United States, Thailand, China, India, and Pakistan. Humans gain from the long-term health advantages of feeding spirulina to fish.

As a result, spirulina is grown commercially to suit consumer demand. Open channel ponds with paddle wheels churn the water to accomplish this. Spirulina farms may be found worldwide, although most are in the United States, Thailand, India, China, and Pakistan, respectively. Feeding spirulina to fish has long term advantages for humans, with millions worldwide taking spirulina pills to boost their immune systems. There is even continuing study indicating Spirulina may be able to regulate malignant cells in the body.

New concept on growth enhancement

Aquaculture operators need technology that speeds up growth since farmed fish take a long time to reach marketable size compared to other protein sources, such as chicken. Even though these approaches have not yet been deployed commercially, growth augmentation is now conceivable. One example is the microinjection of genes for growth hormone into fertilized eggs, which has been shown to accelerate development by 30%-60%. Selfish culture may benefit from this technology as well as change manufacturing. Rapid abalone growth may offer new avenues for cultivating this slow growing mollusk once it has been introduced to the gene for growth hormone. A marker gene for giant prawns has just been successfully introduced, proving the viability of gene transfer in crustaceans and opening the door to research involving gene induced commercially relevant features.

LITERATURE REVIEW

As the world's appetite for fish and fishery products grows, so does aquaculture, a significant food business. There were 178.5 million tons of fish produced worldwide in 2018, with aquaculture contributing a 45.99 percent share of 82.1 million tons (mt). Inland fisheries, fueled by freshwater aquaculture, are now contributing a larger share of the country's overall fish output, which is expected to reach 14.18 MMT in 2019-2020. More than 88% of the fish farming in the United States is raised in freshwater aquaculture, which has grown from about 1.9 million metric tons in 2000-2001 to 6.2 million metric tons last year.

The aquaculture sector is also working hard to fulfill the rising demand for fish to combat world hunger and promote global food and nutritional security is a good example. With the development of more intensive aquaculture methods, the significance of nutrition in determining not just production costs but also fish growth, health, and waste generation has become increasingly important. 60 percent to 70 percent of operating expenses in intensive and semi-intensive methods of fish farming are accounted for by fish feed. Plant sources more cost effective than fish feed may be a potential option to be included in the formulated meal. Aquaculture's long term viability in terms of environmental, social, and economic rewards will be significantly enhanced by the prudent use of these natural resources.

Need for alternative feed supplements

Aquaculture's fast expansion has increased feed component prices due to increased demand for additional feed. More than 60% of the entire cost of a commercial aquaculture operation is spent on fish feed, making it a significant variable expense for fish farming businesses. Protein is the most costly component of formulated feed, and fish meal and de oiled cakes are the primary sources of protein in aquatic feed. Fish meal replacement by plant protein sources is of tremendous interest owing to high costs, poor quality, and restricted availability. Plant based feed components are needed by fish farmers worldwide since they are less expensive and easier to get Bhosale, et al. On the other hand, the introduction of animal protein may lead to long term contamination issues.

Additionally, various anabolic and hormone related drugs, anti-bacterials, and synthetic growth accelerators are routinely used in shrimp farming. “Due to the serious consequences such as bacterial drug resistance, disruption of animal intestinal micro ecological balance and the presence of antibiotic residues in resulting fish/shrimp products, several countries have restricted antibiotic use to combat the disease problem in aquaculture over the last decade”. Efforts are being made to find some effective pro environmental alternatives. Fish and fishery products are less popular because of the adverse effects of artificial feed additives on human health. When it comes to making aquaculture more environmentally friendly and economically feasible, most fish farmers today choose to use herbal or plant-based solutions instead of chemical growth enhancers. Fish feed might benefit from using plant resources to promote desirable qualities such as growth promotion, hunger stimulation, gonadal maturation, and immune stimulant capabilities, as well as anti-stress and antibacterial properties, as shown by numerous research.

Growth promotion

Energy and protein may be found in the waste from the preparation of vegetables and fruits. Extracts/meals made from herbs, barks, leaves, peels, and fruit and plant debris seeds have been claimed to boost animal performance by increasing digestive secretions. “The plant products are deemed safe to use in the food business and as perfect growth promoters in animal diets since they do not contain any residues” Larvae of African catfish *Clarias gariepinus* were given lettuce and neem seed meal (1:1), which resulted in equivalent growth to those fed live *Artemia*, showing that these non-edible portions might be used as feed supplements. A 15 percent addition of sweet potato peels to the diet of tilapia (*Oreochromis niloticus*) increased the development, feed utilization, and biochemical reaction of the fish, as well as economic advantages in the form of lower production costs. “Protein digestion, feed conversion ratio, specific growth rate, and weight increase were all improved when papaya leaf meal was added to the diet of *Penaeus monodon* postlarvae Penaflorida.” A papaya leaf (2.5 percent) mixed diet administered to *Cyprinus carpio* fingerlings demonstrated increased growth performance. Fingerlings of common carp grew better when they were fed dried pea pods in powdered form at 20%, according to Tewari, et al. The effectiveness of sun dried duckweed (Lemna minor) in the diet of carps, including Rohu, Labeo rohita, and common carp, under a semi-intensive culture system, was evaluated by Kaur, et al. They found that fish grew better when 10% of their diet included the plant. Lemna minor meal at 15% was recommended by Mavani and Vyas for Catla catla fry to increase growth, survival, and cost benefit ratio. “Duckweed meal may substitute fishmeal up to 50% without impacting growth or nutrient consumption, according to a study by Srirangam that looked at the effects on *Ctenopharyngodon Idella* (grass carp) growth of partial replacement of fish meal with duckweed (L. minor) and soybean meal.” Researchers have found that feeding carps, such as L. rohita (20.60 percent), *Cirrhinus mrigala* (26.80 percent), and *Cyprinus* carpio (70 percent) with diets that contain 20 percent sundried *Spirodela* can increase weight gain by as much as 50% while also saving up to 50% on feed costs by replacing animal protein supplements with *Spirodela*. In addition to *Azolla*, aquatic macrophytes such as

Azolla might be fed to fish as food. *Azolla* supplementation has been shown to improve fish development and decrease feeding costs. Feeding tilapia on *Azolla*, an aquatic fern, is effective. According to Abou, et al., the addition of *Azolla* in fish feed enhanced growth performance, feed utilization, and survivorship in Nile tilapia fry, and these findings were recorded with an increase in dietary inclusion of *Azolla* up to a specific level. The development and survival of herbivorous fish, particularly Rohu fingerlings, have been studied by supplying *Azolla* species as a component of fish meal partly or totally. An *Azolla* supplemented diet improved the development of fingerlings of L. rohita, according to Kumari and colleagues in 2017. For Tilapia species, Mosha recommended including *Azolla* at a level of 10 percent -45 percent in the diet, while for cyprinids, the inclusion level should be 10 percent -50 percent. "There is ample natural untapped resource for less costly fish feed and greater fish output to improve farmer's income, as revealed by Jafar, et al., in their study on the influence of molasses fermented water hyacinth feed on growth and body composition of common carp the use of medicinal plants or herbs, such as herbs, for immunostimulation to improve fishes resistance to sickness is not the only benefit. These herbs such ashwagandha, aloe vera, ginger, garlic, turmeric, and tulsi have been studied extensively to see how they affect fish growth, survival, and meat quality". In this article, a few recent researches are discussed. According to Datta and coworkers, Asian striped catfish P. hypophthalmus may be fed with 1 percent ginger powder to increase growth, survival, FCR, and SGR by modifying the feed the hematological parameters. "At inclusion levels of 1-3 percent, Aloe Vera Powder (AVP) supplementation improved fish survival and increased fish growth (net weight gain, specific growth rate, and feed conversion ratio) and meat quality considerably (P0.05)". An Indian Major Carp, L. rohita fingerlings, were fed garlic powder as a feed additive, and its growth, meat quality, and fish production were increased by 2% supplementation and their revenue. Further research on the effects of garlic supplemented diet on common carp growth and survival was conducted by Farwah, et al.

DISCUSSION

According to Srivastava, et al, amla supplemented diets improved the development and quality of fingerlings of L. rohita (Ham.) by 3 percent in terms of growth enhancement and improvement in flesh quality. "Additives of 2 percent ashwagandha root powder in the grow out diet of L. rohita may increase growth performance and meat quality, according to Srivastava, et al."

Immuno stimulation

Regarding fish farming, disease outbreaks are a significant concern because of aquaculture's rapid growth and the potential for enormous financial losses due to lower fish output. Immunologists have shown much interest in manipulating the host's immune response to battle infectious illnesses. Immunomodulation affects the host's defensive systems by stimulating or suppressing different cellular, humoral, and non-specific markers. "Due to the existence of major active components such as phenolics, flavonoids, alkaloids, pigments, steroids, and others, natural plant products play an important role in aquaculture as an immunostimulating agent with antistress and anti-microbial effects." Using garlic peels in the diet by Thanikachalam, et al. improved the hematological parameters of African catfish, Clarias gariepinus fingerlings and made the fish more resistant to infection with *Aeromonas hydrophila*. *Astragalus* sp. stem and root extracts from Chinese herbs were also shown to enhance several cellular and humoral immune responses in the common carp, *C Carpio*. "The goldfish *Carassius aureus* immune system and microbial infection were both enhanced by the herbal immunostimulants *E. officinalis* (Amla), *Cynodon dactylon*, and *Adathoda vasica*." Immunostimulatory effects in *Oreochromis mossambicus* against A. *hydrophila* infection were enhanced by dietary consumption of *Basel* (Tulsi) O. sanctum by increasing antibody response and disease resistance. It has been shown that feeding fish Neem leaf powder improves their non-specific immunity, as studied by Kaur and colleagues. This study found phagocytic activity was more significant in *C. Carpio* given the powder than in controls. Lates calcarifer, an Asian seabass, was similarly shown to have the highest antibody titer and phagocytic activity when challenged with *Vibrio harveyi* by Talpura and Ikhwaniddin. "Turmeric powder is a potential immunostimulant for increasing the growth performance of common carp and innate immunity against *Aeromonas* at 2.0 g/kg diet, according to Abdel-Tawwab and Abbass."

CONCLUSION

In order to provide a product that is nutritious, delicious, and excellent in quality, fish and crustacean diets must consider each species' unique needs. It is also necessary to evaluate the availability of raw resources and the means of sustaining them in their absence. Fisheries and aquaculture operations by providing the necessary elements. It is now well accepted that dietary techniques are vital in treating aquatic animal diseases. The usefulness of specific Amino Acids (A.A.s) as nutraceuticals for farmed fish has recently been highlighted in several studies, with a particular focus on immune feeding techniques. Fish leukocytes rely heavily on glutamine as a source of energy. Glutamine is transformed into alpha ketoglutarate, which powers the Krebs cycle and provides extra energy to maintain immune function during immunological activation at a cellular level. Arginine's significance in regulating the immune system, cell proliferation, and neuro endocrine systems has been shown in both *in vitro* and *in vivo* research. However, its practical health consequences in farmed fish are still controversial.

Additionally, arginine is an essential source of the bactericidal agent nitric oxide. Again, it serves as a starting point for polyamine biosynthesis by transforming into ornithine, an important catalyzer during cell proliferation. To help indole amine 2,3-dioxygenase in leukocytes, another amino acid, tryptophan, is engaged in immunological tolerance processes *via* its metabolites. The role of tryptophan in the stimulation of dendritic cells has also been shown. The number of leukocytes and an improved humoral immune response were reported in fish fed diets supplemented with methionine. As an amino propyl donor during polyamine turnover, S-Adenosylmethionine may alter gene expression patterns. Providing cysteine for glutathione formation, methionine may potentially affect antioxidant capacity indirectly. The mechanisms by which A.A. exerts its immunomodulatory effects have been the subject of few investigations.

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