Spirulina Platensis - Its Potent Role in Aquaculture

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Abstract

Spirulina is a blue green algae which has drawn world wide attention due to its nutritional profile rich in 70% protein, minerals,vitamins, aminoacids and phycocyanin.The prospects of Spirulina are very bright in the feed applications in aquaculture practices.It is widely used in aquaculture and can promote the growth of cultured species, improve health provide disease resistance, and increase the survival rate of larvae in aquaculture. The aquafeed supplemented with Spirulina is potentiated with many ingredients in highly balanced nutritious form which are used for enhancing the digestive mechanisms in animals used in aquaculture .

***Key words** : Spirulina, aquaculture, cynobacteria*

Introduction –

Spirulina platensis (SP) is a cyanobacterium, used in many countries as nutritional supplement for human and animal consumption, labelled as a powerful food, rich in proteins, carbohydrates, polyunsaturated fatty acids, terols, minerals and vitamins. **(Piñero *et al.,* 2001; Chamorro *et al.,* 2002; Sarma and Jha 2010, Jha *et al.,* 2012).** It is a natural feed supplement and used to increase fish growth in various aquaculture practices. *Spirulina platensis* has been studied by various workers. It has gained considerable attention due to its dietary composition used in many countries of Asia as a protein supplement and popular health food. It has been used as Aquafeed and as a complementary dietary ingredient of feed for fish and shrimp due its protein and vitamin source. Many countries like China and Japan is using this micro-alga as a partial substitute of imported forage to promote the growth, immunity and viability of shrimp. It has a unique quality to detoxify chelate toxic minerals, and this characteristic is not yet noticed in any other microalgae (**Maeda and Sakaguchi, 1990; Okamura and Aoyama, 1994)** *Spirulina platensis* provides phycocyanin, a source of biliverdin which is among the most potent of all intra-cellular antioxidants. This paper focuses on properties , benefits and applications of *Spirulina* in aquaculture. In the 16 century, Spanish invaders conquered Mexico and they discovered that the Aztecs living in the Valley of Mexico in the capital Tenochtitlan were collecting a "new food" from the lake **(Sasson, 1997).** Spanish chroniclers described fishermen with fine nets collecting this blue coloured "techuitlatl" from the lagoons and making a blue-green cake from it. The only remnant today, Lake Texcoco, still has a living algae *spirulina* population. The Kanembu population living along the shores of Lake Chad collects the wet algae in clay pots, then semi-dried algae is then cut into small squares and taken to the villages, where the drying is completed on mats in the sun (**Abdulqade *et al,* 2000**). Dihé is crumbled and mixed with a sauce of tomatoes and peppers, and poured over millet, beans, fish or meat and is eaten by the Kanembu in 70 percent of their meals .Pregnant women eat dihé cakes directly because they believe its dark colour will screen their unborn baby from the eyes of sorcerers **(Ciferri, 1983).**

Review of literature :

Morist *et al.,* 2001 observed recovery and treatment of *Spirulina platensis* cells cultured in a continuous photobioreactor to be used as food. **Lu *et al*., 2002** studied acceptability of raw *Spirulina platensis* by larval tilapia, *Oreochromis niloticus* where as **Chamorro *et al.*, 2002** gave an account of update on the pharmacology of *Spirulina* (*Arthrospir*a), an unconventional food. **Lu and Takeuchi, 2004** observed Spawning and egg quality of tilapia, *Oreochromis niloticus* feed solely on raw *Spirulina* throughout three generations. **Jeyaprakash**

and Chinnaswamy, 2005 observed effect of *spirulina* and Liv-52 on Cadmium induced toxicity in albino rats.**Habib *et al.*, 2008** gave a review on culture, production and use of *Spirulina* as food for humans and feeds for domestic animals and fish. **James *et al.*, 2010**. Studied effect of dietary supplementation of *spirulina* on growth and phosphatase activity in Copper-exposed Carp (*Labeo rohita*). **Ungsethaphand *et al.*, 2010** studied effect of feeding *Spirulina platensis* on growth and carcass composition of hybrid red tilapia (*Oreochromis mossambicus* × *O. niloticus). Mykiss.***Moe 2011** observed effect of diet Containing *Spirulina platensis* on the growth and haematology of Nile Tilapia, *Oreochromis niloticus* (Linnaeus, 1758). **Jha., Sharma, and Qureshi, 2012** observed effect of different percentages of *Spirulina platensis* and *Tagetes erecta* on the growth, whole body composition and total carotenoid content in *Barilius bendelisis.* **Teimouri., Amirkolaie and Yeganeh, 2013** gave an account of effect of *Spirulina platensis* meal as a feed supplement on growth performance and pigmentation of Rainbow trout (*Oncorhynchus)* **Bangeppagari *et al.*,2014** studied therapeutic efficiency of *Spirulina* against Cadmium chloride exposed histoarchitectural changes in liver of fresh water cat fish , *Clarias batrachus* .**Bilal *et al.*, 2014** studied protective effects of dietary *Spirulina* against Cadmium chloride exposed histoarchitectural changes in liver of fresh water catfish, *Clarias batrachus.*, **Alberto *et al.*, 2017** studied antioxidant and anti bacterial activities of microalgal *Spirulina*.

General Characteristics of *Spirulina* -

Spirulina is symbiotic, multicellular and filamentous blue-green microalgae with symbiotic bacteria that fix nitrogen from air, can be rod- or disk-shaped having photosynthetic pigment , known as phycocyanin, which is blue in colour. These bacteria also contain chlorophyll a and carotenoids. The presence of gas-filled vacuoles in the cells, together with the helical shape of the filaments, result in floating mats. *Spirulina sp*. has been used as food for centuries by different populations and only rediscovered in recent years. Once classified as the ¯blue-green algae'', it does not strictly speaking belong to the algae, even though for convenience it continues to be referred to in that way. It grows naturally in the alkaline waters of lakes in warm regions. Measuring about 0.1mm across, it generally takes the form of tiny green filaments coiled in spirals of varying tightness and number, depending on the strain. P. J. Turpin (1827) isolated *Spirulina* from a fresh water sample. In 1852, Stizenberger gave this new genus the name *Arthrospira* based on the septa presence, helical form and multicellular structure. Because of the common helical morphology, reunified the members of the two genera under the designation *Spirulina* without considering the septum, only morphological similarity. In 1989, these microorganisms were separately

classified into two genera *Spirulina* and Arthrospira; this classification is currently followed. According to the classification in Bergey's Manual of Determinative Bacteriology, *Spirulina* belongs to the oxygenic photosynthetic bacteria that cover the groups Cyanobacteria and Prochlorales, which by phylogeny, are related to the sequence of the rRNA (ribosomal ribonucleic acid) sub-unit 16s. As a function of the sequence data of this sub-unit and the rRNA sub-unit 5s, these prokaryotes are classified within the Eubacteria group. The dried cells of microorganisms such as bacteria, fungi, yeasts and algae that are grown in large scale culture systems as proteins, for human or animal consumption are collectively known as single cell protein and are characterized by; fast growth rate; high protein content (43-85%) compared to field crops They require less water and land and independent of climate; grow on wastewater; can be genetically modified for desirable characters such as amino acid composition and temperature tolerance.

Composition of *Spirulina* -

Spirulina contains unusually high amounts of protein, between 55 and 70 percent by dry weight, depending upon the source (**Phang *et al.,* 2000).** It is a complete protein, containing all essential amino acids. It is rich in polyunsaturated fatty acids (PUFAs), 1.5–2.0 percent of 5–6 percent total lipid. In particular *Spirulina* is rich in ã-linolenic acid (36 percent of total PUFAs), and also provides ã-linolenic acid (ALA), linoleic acid (LA, 36 percent of total), stearidonic acid (SDA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) and arachidonic acid (AA). It contains vitamin B1 (thiamine), B2 (riboflavin), B3 (nicotinamide), B6 (pyridoxine), B9 (folic acid), B12 (cyanocobalamin), vitamin C, vitamin D and vitamin E, rich source of minerals like potassium, and also contains calcium, chromium, copper, iron, magnesium, manganese, phosphorus, selenium, sodium and zinc. *Spirulina* contains many photosynthetic pigments including chlorophyll a, xanthophyll, beta-carotene, echinenone, myxoxanthophyll, zeaxanthin, canthaxanthin, diatoxanthin, 3-hydroxyechinenone, beta-cryptoxanthin, oscillaxanthin, plus the phycobiliproteins c-phycocyanin and allophycocyanin. Some researchers found that polyunsaturated fatty acids (PUFAs) could represent 25 to 60 percent of total fatty acids in *Spirulina* . The important fatty acids like linoleic acid and linolenic acid are also present: up to 1.0 g/100 g of dry biomass of *Spirulina.* The predominant fatty acids are palmitic acid (44.6–54.1 percent), oleic acid (1–15.5 percent), linoleic acid (10.8–30.7 percent) and ã-linolenic acid around 8.0–31.7 percent. Gamma-linolenic acid (GLA) is an essential fatty acid rarely available in ingredients or diet. The â-carotene and B-group vitamin, vitamin E, iron, potassium and chlorophyll available in the *Spirulina* can promote the metabolism of carbohydrate, fats, protein, alcohol, and the reproduction of skin, muscle and mucosa.

Chelating Properties -

Spirulina has a unique quality to detoxify and chelate characteristic , not yet confirmed in any other microalgae **(Maeda and Sakaguchi, 1990; Okamura and Aoyama, 1994).** It can be used to detoxify arsenic from heavy metals (minerals) from water, food and environment. Beijing University has extracted bioactive molecules from *Spirulina* which could neutralize or detoxify the toxic and poisonous effect of heavy metals, and which showed anti-tumor activity. Several institutions and research organization in China are focusing on biomolecules which show anti-tumor, anti-age and anti-radiation properties **(Liu, Guo and Ruan, 1991; Li and Qi, 1997).**

***Spirulina a*nd its Application in Aquaculture –** *Spirulina is* a excellent feed for aquaculture and is used in dried form as a supplementary feed for various aquaculture practices . *S. platensis* meal is available at a commercial scale; thus its use in feeds for aquaculture is possible (**Jaime-Ceballos *et al* 2006)** .Many studies have been conducted by various workers from time to time. *Cyprinus carpio, Tilapia nilotica* and *Penaeus monodon* have shown significant improvement in their body colour when provided with a feed of *Spirulina*. Superior growth rate was achieved in *Ictiobus cyprinellus*, *Tilapia aurea*, Silver Carp, Common and Grass Carp, upon addition of 10% *Spirulina* in their basal diet .*Spirulina* have already been tested as a substitute protein source for *Cyprinus carpio*, where equal or even higher growth rates were obtained by diets containing 25% algae meal, replacing 80% of the dietary fishmeal (**Sandbank and Hepher 1978)** .*Caranx delicatissimus* when fed with a *Spirulina* supplemented diet showed a marked development in colour, texture and taste .Several studies have been conducted using dried *Spirulina* as a supplement diets of crustaceans. Addition of *Spirulina* in the diet of giant freshwater prawn (*Macrobrachium rosenbergii*) significantly improved growth, survival and feed utilization regardless of supplementation level in range of 5-20% (**Nakagawa Gomez-Diaz 1995)** .Partial replacement of fish meal with *S. platensis* has also been evaluated in juvenile Pacific white shrimp, *Litopenaeus vannamei*, with better result (**Hanel *et al* 2007).**It was studied as a feed supplement also for the giant freshwater prawn *(Macrobrachium rosenbergii*), and is known to significantly improve growth, survival, and feed utilization. The supplementation range was 5–20 percent and results were similar at any of the ranges added to the feed **(Nakagawa and Gomez-Diaz, 1975).** *Spirulina*-containing feed was found to reduce the cultivation time and mortality, and increase shell thickness of scallop. The survival rate of abalone *(Haliotis midae*) was improved by 37.4 percent. Feeding on *Spirulina* helped to improve disease resistance of high value fish resulting in an improvement in their survival rate from 15 to 30 percent. Abalone

(Haliotis midae) shows good growth when fed a diet containing *Spirulina* meal **(Britz, 1996).**

The reproductive performance of Nile tilapia *(Oreochromis niloticus*) was tested using freshly harvested *Spirulina platensis* in comparison with control parent fish and progeny fed on commercial diets **(Lu and Takeuchi, 2004)**. Mozambique tilapia *(Oreochromis mossambicus*) was cultivated in artificial ponds with relatively high stocking density and fed with a mixture of solar-dried *Spirulina* that had been cultivated and processed using low-cost technology and added to groundnut cake. The resulting average food conversion ratio was lower than that observed using control fish fed with the usual fishmeal-based ration. Furthermore, the yield of tilapia fed on *Spirulina* mixed with groundnut cake was 4–5 higher than that of fish fed on groundnut cake alone **(Vonshak,1997**). China is using *Spirulina* as a partial substitute of imported feed to promote the growth, immunity and viability of prawns *such as Penaeus monodon. Spirulina*-containing feed was found to reduce the cultivation time and mortality, and increase shell thickness of scallop. The survival rate of abalone *(Haliotis midae)* was improved by 37.4 percent. Feeding on *Spirulina* helped to improve disease resistance of high value fish resulting in an improvement in their survival rate from 15 to 30 percent **(Habib *et al* 2008). (Ghaeni 2010**) has been used *Spirulina* as a supplement in green tiger prawn larvae diet Also effect of *Spirulina platensis* meal has been evaluated as feed additive on growth and survival of *Litopenaeus schmitti* shrimp larva (**Jaime-Ceballos**, ***et al*** **2006).**

Conclusion

Spirulina platensis can be used as a partial supplement or complete replacement for protein in aquafeed. As it promotes the growth , health , survival, production disease resistance and immunity in aquaculture. As natural source feed, it plays an important role in aquaculture, especially in the aquatic farming the results are quite wonderful. *Spirulina* is a cheaper feed ingredient than others of animal origin. Many countries world wide are using *Spirulina* as a partial substitute of imported feed to promote the growth, immunity and viability in aquafeeds. It grows in water and can be harvested and processed easily and has very high macro- and micro-nutrient contents.

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