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A Review on Spirulina (Arthrospira Platensis) Super Food for Future

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Abstract: *The blue-green algae spirulina, also known as arthrospira, sprang to fame after NASA employed it effectively as a food supplement for astronauts on space missions. About 60% of the protein in spirulina comes from 12 different vitamins and at least 8 minerals. As a result, spirulina is a super food and offersa wide range of advantages. It has the capacity to regulate immunological processes and demonstrates anti-inflammatory characteristics by preventing mast cells from releasing histamine. Several randomised controlled trials and systematic reviews have been conducted to examine the effectiveness and potential clinical uses of spirulina in the treatment of various diseases. The results of these studies suggest that this alga may improve a number of symptoms and may even have anticancer, antiviral, and antiallergic properties. potential and current clinical applications.*

Keywords: Spirulina Arthrospira platensis, Nutritional use, Dietary supplement, Super Food

I. INTRODUCTION

Spirulina are multicellular and filamentous blue-green algae that has gained considerable popularity in the health food industry and increasingly as a protein and vitamin supplement to aquaculture diets. It grows in water, can be harvested and processed easily and has very high macro- and micro-nutrient contents. It has long been used as a dietary supplement by people living close to the alkalinelakes where it is naturally found – for instance those living adjacent to Lake Chad in the Kanem region have very low levels of malnutrition, despite livingon a spartan millet-base diet. This traditional food, known as dihé, was rediscovered in Chad by a European scientific mission, and is now widely cultured throughout the world. In many countries of Africa, it is still used as human food as a major source of protein and is collected from natural water, dried and eaten. It has gained considerable popularity in the human health food industry and in many countries of Asia it is used as protein supplement and as health food.

Spirulina has been used as a complementary dietary ingredient of feed for fish, shrimp and poultry, and increasingly as a protein and vitamin supplement to aqua feeds. China is using this micro-alga as a partial substitute of imported forage to promote the growth, immunity and viability of shrimp. There has also been comprehensive research on the use of spirulina as aquaculture feed additives in Japan. During the sixtieth session of the United Nations General Assembly, a revised draft resolution on the "Use of spirulina to combat hunger and malnutrition and help achieve sustainable development" was submitted by Burundi, Cameroon, Dominican Republic, Nicaragua and Paraguay. As a followup of this resolution, FAO was requested to prepare a draft position paper on spirulina so as to have a clearer understanding on its use and to convey FAO's position on this. The primary objective of this review is therefore to assess and evaluate the existing knowledge on the culture, production and use of spirulina for both human consumption and animal feeds.

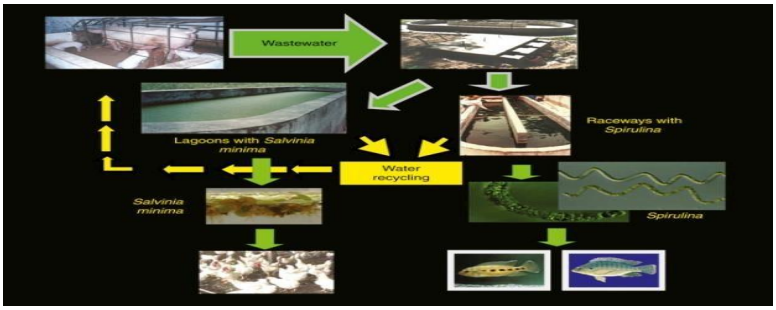

Fig1- spirulina cycle

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Fig2- spirulina production

Spirulina Arthrospira platensis is a unicellular micro algae which grows in fresh water, in Salt water, as well as in brackish bodies of water. It also grow in a highly alkaline environment of pH 10-12. Such a conditions currently exist in certain lakes in sub Saharan Africa and Formerly in Mexico and Central America.

CLASSIFICATION OF SPIRULINA:

Fig 3: classification of spirulina

TAXONOMY OF SPIRULINA:

The common name, spirulina, refers to the dried biomass of Arthrospira platensis, which belongs to the oxygenic photosynthetic bacteria that cover the groups Cyanobacteria and Prochlorales. These photosynthetic organisms were first considered to be algae, a very large and diverse group of eukaryotic organisms, until 1962 when they were reclassified as prokaryotes and named Cyanobacteria. Scientifically, quite a distinction exists between the Spirulina and Arthrospira genera. Stizen berger, in 1852, gave the name Arthrospira based on the presence of septa, its helical form, and its multicellular structure, and Gomont, in 1892, confirmed the aseptate form of the genus Spirulina.

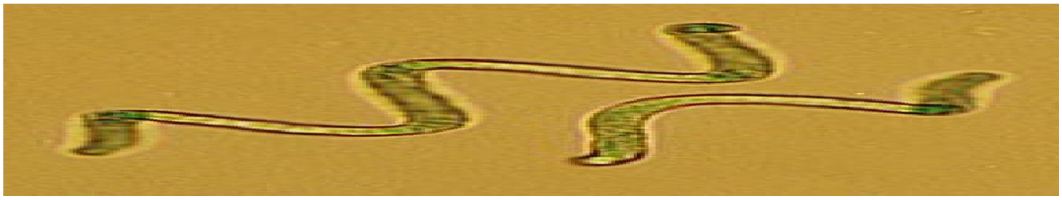

Fig 4: Taxonomy of Spirulina

MORPHOLOGY OF SPIRULINA:

Spirulina is a multicellular, filamentous, blue-green symbiotic microalga that works with symbiotic bacteria to fix nitrogen from the atmosphere. Spirulina can be formed like a rod or a disc. The blue pigment phycocyanin serves as theirprincipal photosynthetic pigment. Additionally, these bacteria include carotenoids and chlorophyll a. Some of them have the phycoerythrin pigment, which gives the bacteria a red or pink colour. Spirulina are autotrophic because they

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photosynthesize. Spirulina divides through binary fission. Only a liquid environment or culture medium can sustain the trichomes' helical form, which is distinctive to the genus. The helical structure of the filaments and the presence of gas-filled vacuoles in the cells cause floating mats. The trichomes are 3 to 50 m wide and 50 to 500 m long.

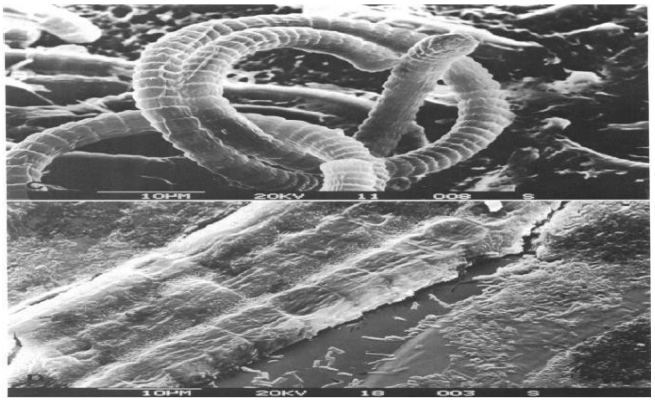

Fig 5: Morphology of Spirulina

HISTORY:

German algal scientist Dr. Darwin made the discovery of the spiral-shaped algae and gave it the name spirulina. The cyanobacteria class was discovered by uncited Mexicans in the 16th century, and the seaweed spirulina, a blue-green algal biomass, has been consumed regularly ever since

Fig 5: Aztecs harvesting Spirulina for Food.

Since it was harvested from Lake Texcoco and sold as cakes, spirulina is known to have been an important food source for the Aztecs in 16th-century Mexico. This information comes from one of Cortés' soldiers. Tecuitlatl, which translates as the stone's feces, was the Aztec name for it. French researchers discovered an abundance of spirulina at the lake in the 1960s, but there is no evidence that it was used there as a staple food source after the 16th century. Early in the 1970s, a large-scale Spirulina production facility was built, garnering interest on a global scale.

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GLOBAL SPIRULINA MARKET:

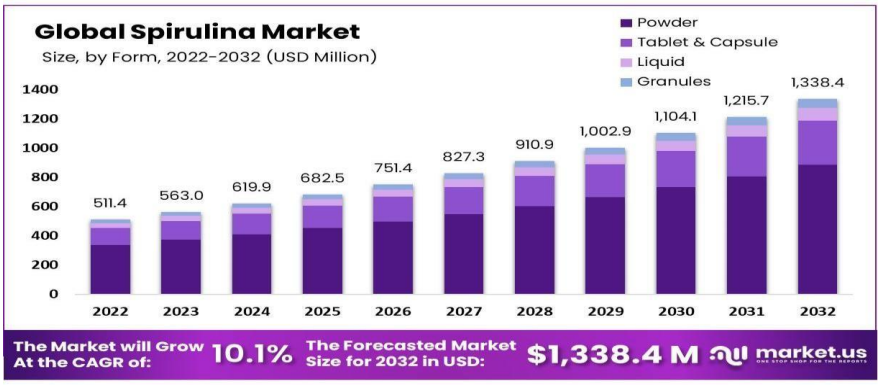

Fig 6- Global spirulina market

COMPOSITION:
Total calories (kcal) 333
KcalTotal fat (g) 5 g
Protine (g) 67g
Total Carbohydrate (g) 16 g
Fiber (g) 7g
Moisture (g) 5g

VITAMINS PRESENT IN SPIRULINA:
Vitamin (A) (IU) 375,000 (IU)
Vitamin B12 (ug) 300 ug
Calcium (mg) 333 mg
Iron (mg) 217mg
Total carotenoids (mg) 500mg

BIOCHEMICAL COMPOSITION:

Protein:

Spirulina contains surprisingly high measures of protein, somewhere in the range of 55 and 70 percent by dry weight, contingent on the source. It is a finished protein, containing all fundamental amino acids, however with diminished measures of methionine, cystine, and lysine, when contrasted with standard proteins like that from meat, eggs, or milk; it is, nonetheless, better than all standard plant protein, for example, that from meat, eggs, or milk, it is, Notwithstanding, better than all standard plant protein, like that fromvegetables.

Vitamins:

Spirulina contains vitamin B1 (thiamine), B2 (riboflavin), B3 (nicotinamide), B6 (pyridoxine), B9 (folic corrosive), B12 (cyanocobalamin), L-ascorbic acid, vitamin D and vitamin E.

Minerals:

Spirulina is a rich wellspring of potassium, and furthermore contains calcium, chromium, copper, iron, magnesium, manganese, phosphorus, selenium, sodiumand zinc.

Essential unsaturated fats:

Spirulina has a high measure of polyunsaturated unsaturated fats (PUFAs), 1.5-2.0 percent of 5-6 percent absolute lipid. Specifically spirulina is rich in γ- linolenic corrosive (36% of absolute PUFAs), and additionally gives γ-linolenic corrosive (ALA), linoleic corrosive (LA, 36% of aggregate), stearidonic corrosive (SDA), eicosapentaenoic corrosive (EPA), docosahexaenoic corrosive(DHA) and arachidonic corrosive (AA).

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Photosynthetic pigments: Spirulina contains many colors including chlorophyll a, xanthophyll, beta-carotene, echinenone, myxoxanthophyll, zeaxanthin, canthaxanthin, diatoxanthin, hydroxyechinenone, beta- cryptoxanthin, oscillaxanthin, in addition to the phycobiliproteins cphycocyaninand allophycocyanin.

NUTRIENT LEVEL:

Basic nutrients such as amino acids, essential fatty acids, vitamins and minerals,Spirulina supplies many phytonutrients that are lacking in most of our diets. Spirulina supplies common nutrients at high levels; comparing Spirulina with other foods shows it unusual nutrient profile.

Nutritional content	Per 100 g
Energy	332 kcal
Fat	0.8 g
Carbohydrate	12.8 g
Protein	65.3 g
Fiber	6.4 g
Salt	3 g
Vitamin A	1200 µg
Riboflavin (B2)	0.3 mg
Vitamin B6	0.7 mg
Magnesium	2.59 mg
Iron	53.2 mg
Chromium	22 µg

Fig 7: Nutrient levels of spirulina.

UNITED NATIONS AND NASA INTEREST:

Spirulina or Arthrospira is a blue-green alga that became well known after it was effectively utilized by NASA as a dietary enhancement for space travelers on space missions. Why NASA Supports Spirulina As Space Food? Give it an idea that there is a centuries-old Super-food that has as of late been recognized as a fantastic decision of being considered as space food! Spirulina basically upholds generally speaking great wellbeing, and is an incredibly protected supplement to be consumed by individuals of practically all age gatherings and different backgrounds.

SPIRULINA FARMING CONDITIONS FOR GROWTH:

Spirulina must be grown at a minimum temperature of 20°C, although it can also thrive at temperatures as high as 37°C. Spirulina may grow without soil if itis grown in water. For spirulina to thrive, it needs chemicals and minerals, and the pH of the growth medium should be between 8 and 11. Spirulina is often grown in a container or an artificial pool. Spirulina requires shade during its early growing stages, thus it is given a temporary cover. Spirulina grows more slowly when there is less sunlight and less concentration in the solution. Shallow water is ideal for cultivating spirulina in lakes or other containers. Rainis thought to dilute the culture and change the pH; dust and sand tangle in the spirulina and make it heavy, causing it to sink to the bottom; flies and insects should be avoided; and direct sunlight at the beginning of growth must be avoided. The foregoing issues might all be resolved by a green house setup since spirulina reduces evaporation and cross-contamination farming. The temperature rises as a result, and cultivation of microalgae

MEDIUM OF GROWTH FOR SPIRULINA FARMING:

Spirulina is grown in a culture media that is composed of water and nutrients. Since Spirulina doesn't have any competitors at the pH level maintained in the pond, any type of water can be used, including brackish water, rainwater, fresh drinking water, etc. At this pH level, neither parasites nor germs can survive in the medium. Heavy metals should not be present in the water used to grow spirulina because if they are, the spirulina will absorb them. The fertilizers required for spirulina farming are: Sodium bicarbonate • Citric acid • Urea • Potassium nitrate • Sodium chloride • Potassium dehydrogenate phosphate • Iron sulfate • Magnesium sulfate Large scale cultivation needs calcium in the form of lime, gypsum or calcium chloride.

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Spirulina Cultivation and Production:

Natural Habitat:

Spirulina is one among many algal species found growing in natural freshwaters. They are also found in natural habitats such as soil marshes, seawater, and brackish waters where alkaline waters exist. They thrive well in highly alkaline waters with a high level of solar radiation where no other microorganisms can grow. They can also tolerate low temperatures 15° C during nights and 40° C for a few hours in the daytime. In the natural habitats, their growth cycles depend on the limited supply of nutrients. When new nutrients from the rivers or from pollution reach the water bodies, the algae rapidly grows and increase its population to the maximum density. When nutrients get exhausted the Spirulina dies off reaching the bottom and gets decomposed releasing nutrients into the water. A new Spirulina cycle begins when more nutrients flow into the lake.

Commercial and Mass Cultivation:

Japan in the early 1960's started large-scale culture cultivation of microalgae of chlorella followed by Spirulina in the early 1970's. Today, there are more than 22 countries that cultivate Spirulina commercially on a large-scale.

Ponds:

Commercial cultivation is usually carried out in shallow artificial ponds equipped with mechanical paddle wheels for stirring the culture. The cultivationis carried out in two ways. 1. Concrete ponds and 2. Pits lined with PVC or other plastic sheets. Concrete ponds can last for very long mass cultivation, but it is very expensive. The cost of production in the early years will be high. Low-cost clay sealing and durable plastic sheets will not last long, but incur investment at regular periods when the materials start to wear and tear. Concreteponds will be more cost-effective in the Spirulina business over the years while low-investment structures will be more expensive in the business over the years. Ponds can be of any size and shape depending on the physical land dimensions. Construction of single or multiple ponds can be done with each pond size of 50 m long, 2-3 m wide, and with 20 to 30 cm depth are ideal pond conditions. Length of the ponds can be of any length depending on the land availability. Covering of each pond with transparent polythene covers will help increase the temperature, decrease water evaporation, and helps reduce chances of contamination.

Mixing Devices:

There are two ways of mixing the culture evenly and they are manual mixing the culture and mixing the culture mechanically. Hand tools, such as long sticks,or broomsticks, or any convenient devices can be used. Commonly used mechanical devices are paddle wheels, these are installed for stirring the culture. Stirring the culture helps all the Spirulina organisms reaching to the top thatthey can take carbon dioxide and solar energy for photosynthesis. Paddle wheels are installed according to the size of the ponds. A large paddle wheel of diameter about two meters should rotate at 10 rpm speed. A small paddle wheel of diameter up to 0.7 meters can rotate at 25 rpm speed for proper culture stirring.

Spirulina Cultivation Process:

Cultivation can be started after water is fed into each concrete pond at a required height and after paddle wheels are installed. The water has to have the right pH value and alkaline by adding required salts at the required rate. Once the water has a standard micronutrient composition, the pond is ready forSpirulina seeding. Ideally, for uniform growth and for uniform harvesting, 30 grams of dry Spirulina is added for every 10 liters of water. A concentrated live Spirulina culture can also be used as seeding the pond. In commercial farms, one pond is exclusively kept for rearing Spirulina as seed. This will reduce the regular purchase and the farm becomes self-sustain and also can sell live Spirulina seed to other farmers. The algae bacterium starts to double in biomass within three to five days. The alga thrives growing by consuming the nutrientsin the culture medium. Farmers have to continually check the nutrient content value and adding fresh water at regular periods for good production and for top yields. Farmers should be alert to control environmental conditions as this prevents the culture medium from contamination. Cultures grow rapidly as well as perish rapidly when Spirulina cultures are not taken care of properly. The matured Spirulina changes from light to dark green in color. The concentration of algae and color of the algae is the deciding factor for when Spirulina should be harvested. The other way is by using Secchi desk to measure and it should bearound 0.5 grams per liter of culture medium.

The water level in the pond should be maintained at 20 to 30 cm (25 cm is ideal water level height). As most of the ponds are open the evaporation of water will affect the cultivation. Especially during summer, on an average thrice in a

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month, fresh water is released into the ponds to maintain consistent (25 cm) water level height throughout the cultivation.

Harvesting and processing:

Spirulina harvesting, processing and packing has eight principleStages :

Filtration and cleaning : A nylon filter at the entrance of the water pond isneeded;

Pre-concentration: To obtain algal biomass which is washed to reduce saltscontent;

Concentration: To remove the highest possible amount of interstitial water(located among the filaments);

Neutralization: To neutralize the biomass with the addition of acid solution;

Disintegration: To break down trichomes by a grinder;

Dehydration by spray-drying: This operation has great economic importancesince it involves about 20–30 percent of the production cost;

Packing: It is usually in sealed plastic bags to avoid hygroscopic action on thedry spirulina; and

Storage: Stored in fresh, dry, unlit, pest-free and hygienic storerooms toprevent spirulina pigments from deteriorating

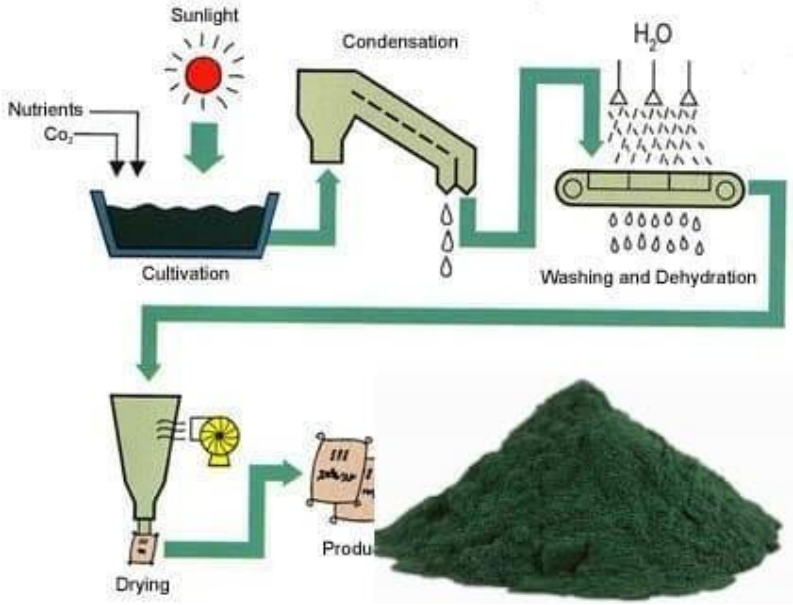

Fig 8: Process of spirulina production

USES OF SPIRULINA:

Rich in many nutrient : A single tablespoon (tbsp.), or 7 g, of dried spirulina powder contains: ● Protein: 4 g ● Thiamin: 14% of the Daily Value ● Riboflavin: 20% of the DV ● Niacin: 6% of the DV ● Copper: 47% of the DV Iron: 11% of the DV.

Spirulina have anti-cancer properties: decrease the volume of cancer cells in the body by activating a group of immune cells. An earlier human clinical study also has shown that spirulina is effective in the prevention of oral cancer.

It support blood sugar control.

Spirulina used to improve muscle strength. Spirulina, its high total protein content (it contains the 8 amino acids necessary for the formation of a complete protein) and increase muscle strength.

Effective against anemia.

powerful antioxidant and anti-inflammatory properties.

Enhance the energy.

Improve body functions

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SIDE-EFFECTS OF SPIRULINA:

Some minor side effects of spirulina Arthrospira may include following
nausea
insomnia
headaches

II. CONCLUSION

Spirulina is highly nutritious and shows great diversity and higher concentrations of nutrients compared to other food sources. The present review concludes that the Spirulina is used as a potential health food in human diet and used in food industry. It is a super food and a best dietary source for the malnutrition. It lowers celesten, suppresses fatty accumulation in the liver, prevents tumor formation, enhances the immune system and protects kidneys. S. platensis are known to contain an excellent source of minerals, especially calcium and potassium, proteins, carbohydrates, essential fatty acids, vitamins, minerals, carotenes, chlorophyll a and phycocyanin. Therefore Spirulina could be used as medicine for diseases as well as daily nutrient source.

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