

# Dietary Spirulina in Pharmaceutical and Nutraceutical Applications

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**Abstract:** *The importance of spirulina has been developed and used by mankind as food, drug since ages due to its biological value. Spirulina is an incredibly rich source of proteins and vitamins that its efficiency fights against through deficiencies all over the developing countries. It has emerging as an medical food with the discovery and validation of health benefits ranging to eradicate health problems now-a-days. spirulina, a nutrient-rich algae are being used around the world to help and treat illness and are being seriously discussed as a sustainable source of food with the potential to end world hunger. Spirulina is deemed safe for human consumption evident by its long history of food use and contemporary scientific findings. Advances in effective cultivation techniques will help in pharmaceutical and in therapeutic applications as antioxidant, antiinflammation, antidiabetic and also as anticanceric agent to treat. Being consumed since centuries, spirulina has well established itself as a super food, an excellent weapon against an array of nutritional deficiencies. In recent years, spirulina has garnered enormous attention from research fraternity as well as industries as a thriving source of nutraceutical and pharmaceuticals. Moreover, there is a plethora of unexploited novel compounds and biological activities in this algae, worth-exploring. Innovative formulations are required to fortify conventional foods with spirulina. An attempt has been carried out to assess the effect of dietary spirulina as pharmaceutical and nutraceutical product in management of diabetes. The study is in progress.*

**Keywords:** spirulina, health benefits, pharmaceutical and nutraceutical application, food industry.

## 1. Introduction

Pharmaceuticals and Nutraceutical are nutrients from food or food products that not only supplement the diet but also facilitate the prevention or treatment of a disease and/or disorder. There are over 470 nutraceutical and functional food products commercially available with researched health benefits. An increased global interest has arisen in these substances due to their documented role in health enhancement. The health seeking consumer trend has intensified the use of products aimed at promoting health as well as treating potential fatal ailments (i.e. heart disease, cancer, Parkinson's disease etc.). The current estimated global market size for nutraceuticals products is 30 to 60 billion dollars, primarily in the United States, Japan, and Europe, with a potential short-term growth market demand of over 197 billion dollars. With the increase in demand for nutraceuticals and food supplements, organisms that can rapidly produce nutritional compounds are desired. Spirulina is fast emerging as a whole answer to the varied demands due to its impressive nutrient composition which can be used for therapeutic uses. The United Nations world food conference declared spirulina as "the best for tomorrow", and it is gaining popularity in recent years. The spirulina ability as a potent anti-viral, anti-cancer, hypocholesterolemic and health improvement agent is gaining attention as a nutraceutical and a source of potential pharmaceutical.

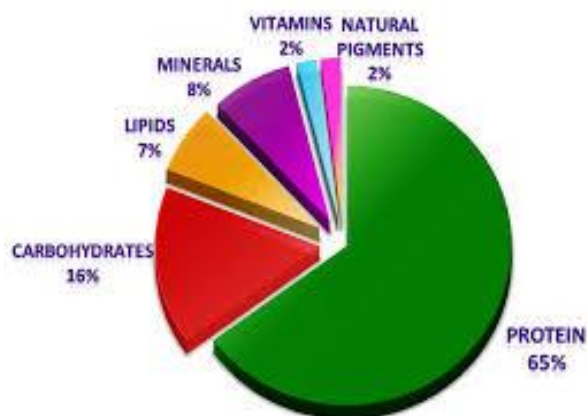
Human evidence suggests that spirulina can improve lipid and glucose metabolism, while also reducing liver fat and protecting the heart. Animal studies are very promising as well, as spirulina has been shown to be of similar potency as commonly used reference drugs, when it comes to neurological disorders. These effects also extend to arthritis and immunology. Many people promote Spirulina as a

treatment for a range of metabolism and heart health issues, including weight loss, diabetes and high cholesterol, according to the National Institutes of Health (NIH). People may also recommend Spirulina as an aid for various mental and emotional disorders, including anxiety, stress, depression and attention deficit-hyperactivity disorder (ADHD). Spirulina is said to help a range of eclectic health problems, including premenstrual symptoms and amyotrophic lateral sclerosis (Lou Gehrig's disease), according to the NIH. A combination of zinc and Spirulina may help the body clear arsenic in people whose drinking water has unusually high levels; according to the NIH. Medical studies are currently under way to determine Spirulina's effect on viral infections, swelling, wound healing and the immune system in general, according to the NIH.

## 2. Composition of Spirulina

Spirulina platensis is a microalgae with appropriate composition to be used as a food supplement. It is commonly used by humans and animals as protein source. Several studies such as palatability, lack of toxicity and easy digestion, antioxidant actions, hypocholesterolemic, anticancer, immunostimulant, anti-inflammatory, antiviral, among others have been conducted to verify the possible benefits of spirulina and some properties have been verified (Rodriguez-Hernández et al., 2001; Derne et al., 2006; Colla et al., 2007). Spirulina contains practically all the components that would be found in the ideal whole food: a considerable proportion of proteins, vitamins, mineral salts, carbohydrates, pigments, trace elements, and essential fatty acids. Spirulina is particularly rich in plant protein, which makes up of its weight. This is truly extraordinary, especially since the best sources of plant protein only offer half of these amounts. Soya flour, for instance, only contains

35protein. Spirulina provides complete proteins because it contains the full range of essential amino acids (47% of total protein weight). Vitamins are naturally found in Spirulina that means  $\beta$ -carotene: 212 mg. The bioavailability of Spirulina's carotenoids has been demonstrated in a number of clinical studies. It is also exceptionally rich in vitamin B12. This vitamin is, by far, the most difficult to get from a vegetarian diet because no fruit, vegetable, grain, or legume contains it. Spirulina has 4 times as much vitamin B12 than raw liver, which was long thought to be the best source of this nutrient. Spirulina also contains levels of vitamin E comparable to those found in wheat germ, which is recognized as an excellent source of vitamin E. The main antioxidant vitamins contained in Spirulina are  $\beta$ -carotene, other carotenoids, and vitamin E. They protect our cells against aggression caused by free radicals (anti-ageing effect). It is also rich in iron, magnesium, calcium, and phosphorus.



**Figure 1: Composition of spirulina**

### 3. Pharmaceutical Applications of Spirulina

Spirulina is an incredibly rich source of proteins that could efficiently fight against food deficiency in developing countries. Various applications of spirulina are as follows.

#### **Spirulina as Anti-inflammatory and Antiarthritic effect**

The anti-inflammatory effect of spirulina was studied in zymosan-induced arthritis in mice. After 8 days of administration, the abnormal level of  $\beta$ -glucuronidase in synovial fluid was measured to have fallen down. The effect of polysaccharide extract from spirulina was assessed on corneal neovascularization both in vivo and in vitro. The results suggested that the polysaccharide may be effective in the therapy of corneal opacities involving neovascularization and inflammation.

#### **Spirulina as Antihyperlipemic**

The effect of oral administration of spirulina maxima was evaluated on serum lipids and blood pressure. When consumed at a dose of 4.5 g/day for 6 weeks, a pronounced hypolipemic effect was observed. Further, the potency of Spirulina platensis in diet at a dose of 0.5 g/day, in treating high fat diet-induced hypercholesterolemia in rabbits was evaluated. Results showed that levels of serum cholesterol decreased in the spirulina-fed rabbits and high density lipoprotein content measured higher than control.

#### **Spirulina as Anti-diabetic**

The protective effects of spirulina fusiformis extract against rosiglitazone induced osteoporosis was assessed in insulin resistant rats. After 45 days, the integrity of the bone surface as well as the bone strength improved. The bone restoration was assumed to be due to the high content of calcium and phosphorus in spirulina. The chromium and linoleic acid content was held responsible for decline in the fasting serum glucose, HDL, LDL and triglycerides levels.

#### **Spirulina as Anticancer effects**

The use of spirulina as complementary and alternative medicine (CAM) by breast cancer survivors in Malay was reported. The functionalization of selenium nano particles with spirulina polysaccharides could be successfully carried out. As a surface decorator, the polysaccharide enhanced the cellular uptake of the assembly and resultant cytotoxicity towards several human cancers. The chemotherapeutic potency of the assembly towards human melanoma A375 cells was mediated through apoptosis.

#### **Spirulina as Antianaemic and Antileucopenic:**

The effect of spirulina platensis in alleviating toxic impacts of heavy metal-adulterated diet was investigated. The results suggested that the algal supplementation may be useful in treatment of leukaemia and anaemia caused by lead and cadmium. Based on experimental outcome, it was inferred that 12 week supplementation of spirulina may ameliorate anaemia in senior citizens.

### 4. Conclusion

Being consumed since centuries, spirulina has well established itself as a super food, an excellent weapon against an array of nutritional deficiencies. In recent years, spirulina has garnered enormous attention from research fraternity as well as industries as a thriving source of nutraceuticals and pharmaceuticals. Innovative formulations are required to fortify conventional foods with spirulina and more scientific, clinical and toxicological research has to be carried out for extensive usage of spirulina in food and pharma industry.

### References

- [1] Annapurna V, Shah N, Bhaskaran P, Bamji SM, Reddy V. Bioavailability of spirulina carotenes in preschool children. *J Clin Biochem Nutr* 1991;10:145-151
- [2] Babu M et al. Evaluation of chemoprevention of oral cancer with Spirulina fusiformis. *Nutr Cancer* 1995; 24:197-202.
- [3] Colla, L.M., Muccillo-Baisch, A.L. and Costa, J.A.V. (2009) *Spirulina platensis* effects on the levels of total cholesterol, HDL and triacylglycerols in rabbits fed with a hypercholesterolemic diet. *Brazilian Archives of Biology and Technology*, 51: 405-411.
- [4] Devi MA, Venkataraman LV. Hypocholesterolemic effect of blue-green algae spirulina on albino rats. *Nutr Rep Int* 1983;28:519-530.
- [5] Gustafson K et al. AIDS antiviral sulfolipids from cyanobacteria (blue-green algae). *J Natl Cancer Inst* 1989;81:1254.

- [6] Hayashi T, Hayashi K et al. Calcium spirulan, an inhibitor of enveloped virus replication, from a bluegreen alga *Spirulina platensis*. J Nat Prod 1996; 59:83-87.
- [7] Kapoor R, Mehta U. Effect of supplementation of blue green algae on outcome of pregnancy of rats. Plants Food Hum Nutr 1993; 43:131-148.
- [8] Mageshwari U, Joseph S and Minitha S. Pattern of cardiovascular complications among diabetics. Ind J NutrDietet. 2004; 41: 507.
- [9] Nakaya N, Homma Y, Goto Y. Cholesterol lowering effect of spirulina. Nutr Rep Int 1988; 37:1329-1337.
- [10] RODRIGUEZ-HERNANDEZ, A.; BLÉ-CASTILLO, J.L.; JUÁREZ-OROPEZA, M.A. et al. Spirulina maxima prevents fatty liver formation in CD-1 male and female mice with experimental diabetes. Life Sciences, v.69, n.9, p.1029-37, 2001.
- [11] Schwartz J, Shklar G et al. Prevention of experimental oral cancer by extracts of Spirulina – Duraliella algae. Nutr Cancer 1988;11:127-134.
- [12] Simsek, N., Karadeniz, A., Kalkan, Y., Keles, O.N. and Unal, B. (2009) *Spirulina platensis* feeding inhibited the anemia- and leucopenia-induced lead and cadmium in rats. Journal of Hazardous Materials, 164:1304-1309.
- [13] Torres-Duran, P.V., Ferreira-Hermosillo, A. and Juarez-Oropeza, M.A. (2007) Antihyperlipemic and antihypertensive effects of *Spirulina maxima* in an open sample of mexican population.
- [14] Venkataraman LV. Spirulina: global reach of a health care product. Souvenir, IFCON ,98, 4th International Food Convention, 1998; 175.
- [15] Lauren cox, Live science contributor, Spirulina : Nutrition facts and health benefits, November 21, 2014.