

Review

SPIRULINA : NUTRITIONAL AND THERAPEUTIC REVIEW

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Introduction

The current environmental conditions deteriorations, mental and physical stress, changes in the diet have been serious risk factors for the humans, increased the death rate and civilization diseases. These are the obvious reasons why new progressive trends are being extensively developed in modern medicine, pharmacology and biotechnology and more effective harmless medicaments are being sought for to treat and prevent various diseases. One of the trends in biotechnology is associated with Blue green microalgae *Spirulina platensis* which have been widely employed as food and feed additives in agriculture, food industry, pharmaceuticals, perfume making, medicine and science [1].

Spirulina is the most cultivated microalga worldwide – over 30% of the world microalgal biomass production is from *Spirulina* [2]. *Spirulina* are unicellular 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 has long been used as a dietary supplement by people living close to the alkaline lakes where it is naturally found. *Spirulina* has been used as a complementary dietary ingredient of feed for fish, shrimp and poultry. Among the various species of *Spirulina*, the blue green alga *Spirulina platensis* has drawn more attention because it shows a high nutritional content characterized by a 70% protein content and by the presence of minerals, vitamins, amino acids, essential fatty acids etc. [3].

Spirulina platensis is naturally found in tropical regions, thriving in alkaline lakes with a pH of 11 and high concentrations of NaCl and bicarbonates. These challenging conditions, which are limiting for other microorganisms, create an environment conducive to cultivating microalgae in open reactors [4]. Within Cyanobacteria, the light-harvesting pigments encompass chlorophyll-a, carotenoids, and phycobiliproteins. These phycobiliproteins are proteins containing linear tetrapyrrole prosthetic groups, classified based on their structures into phycocyanin, phycoerythrin, and allophycocyanin [5].

Nutritive value of spirulina

Spirulina is a blue-green algae that is often touted as a highly nutritious superfood due to its rich nutrient profile. It is consumed as a dietary supplement in various forms, such as powders or capsules. Here's an overview of the potential nutritive value of spirulina:

1. Protein: *Spirulina* is known for its high protein content, and it is considered a complete protein source, meaning it contains all essential amino acids. The

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protein content can range from 50% to 70% of its dry weight, making it an excellent source of plant-based protein.

2. **Vitamins:** Spirulina is a good source of various vitamins, including B vitamins (such as B1, B2, B3, B6, and B12), vitamin K, and vitamin E. It's particularly noteworthy for its vitamin B12 content, as this vitamin is generally lacking in plant-based foods and is more commonly found in animal products.
3. **Minerals:** Spirulina contains several essential minerals, including iron, calcium, magnesium, potassium, and zinc. These minerals are important for various bodily functions, including bone health, immune support, and energy metabolism.
4. **Carotenoids:** Spirulina contains various carotenoids, including beta-carotene, zeaxanthin, and lutein. These compounds are known for their antioxidant properties and their potential to support eye health and overall immunity.
5. **Chlorophyll:** The green color of spirulina comes from chlorophyll, a pigment involved in photosynthesis. Chlorophyll is believed to have antioxidant and detoxifying properties.
6. **Fatty Acids:** Spirulina contains a small amount of healthy omega-3 and omega-6 fatty acids. These are important for heart and brain health.
7. **Phycocyanin:** This is a unique pigment found in spirulina that gives it a blue-green color. Phycocyanin has antioxidant and anti-inflammatory properties and may have potential health benefits.
8. **Digestibility:** Spirulina is relatively easy to digest, and its nutrients are generally considered bioavailable, which means they can be easily absorbed by the body.

Spirulina maxima, an alga abundant in organic nitrogenous components, which is used as a food source in the Chad Republic, Africa. They analyzed the amino acid composition, vitamin content, and nutritional value of a strain of this alga cultivated in an open-air pilot production unit. The results revealed that it consisted of 62 percent protein with excellent digestibility. Moreover, it contained essential vitamins such as β -carotene, β 1, β 2, β 6, β 12, and C [6].

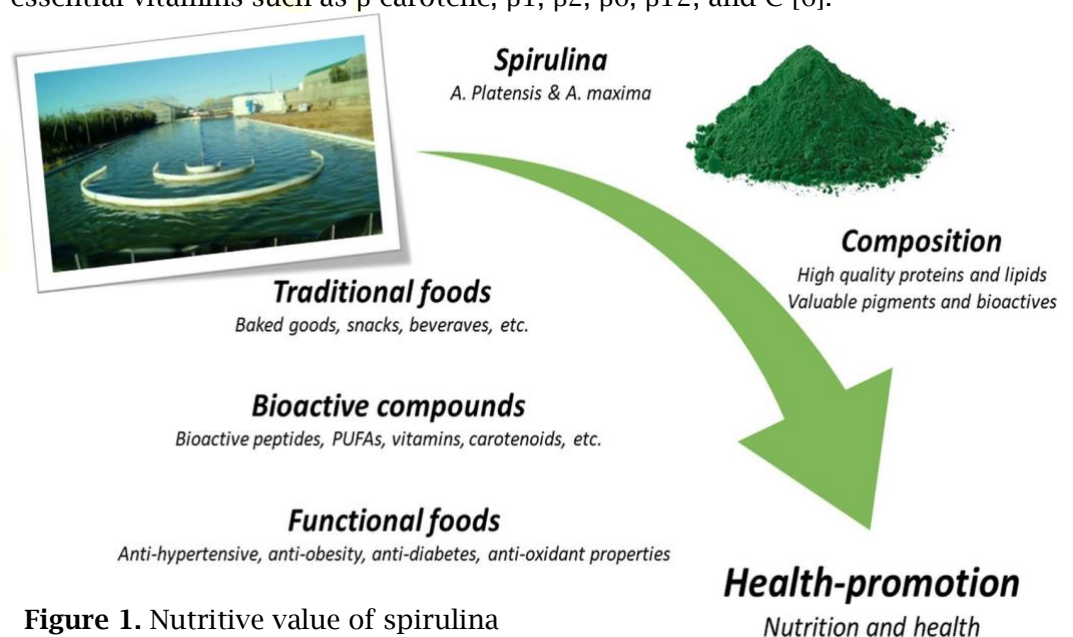


Figure 1. Nutritive value of spirulina

Nutritional profile of *Spirulina* powder.

Composition*	Per 100 g	Composition*	Per 100 g
1. Macronutrients		Vitamin B2, mg	3.7
Calories, kcal	290	Vitamin B3, mg	12.8
Water, g	4.7	Vitamin B6, mg	0.4
Total lipids, g	7.7	Vitamin E, mg	5.0
Total protein, g	57.5	4. Amino acids	
Carbohydrates, g	23.9	Tryptophan, g	0.93
Ash, g	6.2	Threonine, g	2.97
2. Minerals		Isoleucine, g	3.21
Calcium, mg	Vitamin C, mg	Leucine, g	4.95
Iron, mg	28.5	Lysine, g	3.02
Magnesium, mg	195.0	Methionine, g	1.15
Phosphorous, mg	118.0	Cysteine, g	0.66
Potassium, g	1.4	Phenylalanine, g	2.77
Sodium, g	1.0	Tyrosine, g	2.58
Zinc, mg	2.0	Valine, g	3.51
Copper, mg	6.1	Arginine, g	4.15
Manganese, mg	1.9	Histidine, g	1.08
Selenium, µg	7.2	Alanine, g	4.51
3. Vitamins		Aspartic acid, g	5.79
Vitamin A, IU	570	Glutamic acid, g	8.39
Vitamin K, µg	25.5	Glycine, g	3.09
Vitamin B1, mg	2.4	Proline, g	2.38
		Serine, g	2.99

Data accessed from the U.S. Department of Agriculture Food Data Central database available at <https://fdc.nal.usda.gov/>. Data accessed on March 2020-FDC ID:170495.

Medicinal uses of *spirulina platensis*

Studies indicates that the consumption of *Spirulina* over a span of 4 weeks results in a significant 4.5% reduction in serum cholesterol levels in human [7]. Additionally, it has been noted to contribute to a considerable reduction in body weight. A noteworthy effect of *Spirulina* extract consumption is its ability to stimulate the production of tumor necrosis factor within macrophages, suggesting a potential mechanism for promoting tumor regression [8].

An extract called Calcium-*Spirulina* (Ca-SP), derived from *Spirulina*, has shown antiviral activity against HIV, Herpes Simplex Virus, Human Cytomegalovirus, Influenza A Virus, Mumps Virus, and Measles Virus. *Spirulina maxima* extract has antimicrobial effects against *Bacillus subtilis*, *Streptococcus aureus*, *Saccharomyces cerevisiae*, and *Candida albicans*. *Spirulina* offers diverse benefits, including reducing hepatic damage, inflammation, cellular degeneration, and anaphylactic reactions. It contains vital elements like vitamin A, iron, vitamin B12, and γ -linolenic acid with applications ranging from eye disease prevention to eczema therapy. *Spirulina* is also used for alleviating premenstrual syndrome, immune system stimulation, animal cell growth, and residual water treatment [9 & 10].

Health Benefits of Spirulina

Nutrient-Rich Complete Protein

Spirulina is considered a complete protein source, containing all essential amino acids required by the human body. This makes it a valuable dietary supplement for individuals, including vegetarians and vegans, looking to meet their protein needs [11].

Antioxidant and Anti-Inflammatory Properties

Spirulina boasts a wealth of antioxidants, including phycocyanin and carotenoids, that play a pivotal role in counteracting oxidative stress and mitigating inflammation within the body.

Immune System Support

To conclude, the immunomodulatory effects of Spirulina hold the potential to enhance the body's immune defenses against infections and illnesses.

Potential Cardiovascular Benefits

Spirulina's lipid-lowering and antihypertensive effects have been investigated, suggesting its potential in supporting cardiovascular health. It may help in reducing cholesterol levels and managing blood pressure.

Conclusion

Spirulina emerges as a nutrient-rich powerhouse, replete with an extensive array of health benefits. Brimming with indispensable amino acids, vitamins such as β -carotene, and an assortment of vital minerals, it assumes a pivotal role as an invaluable dietary supplement. Noteworthy for its antiviral and antimicrobial attributes, coupled with its immune-enhancing prowess, Spirulina shines as a potential shield against various diseases. The presence of potent antioxidants within Spirulina equips it to combat oxidative stress and quell inflammation, thereby making notable contributions to overall well-being. Additionally, its capacity to lower lipid levels and exhibit antihypertensive traits imparts commendable cardiovascular advantages, making it an ally in the regulation of cholesterol levels and blood pressure. In essence, the remarkable nutritional composition and therapeutic potential of Spirulina position it as a versatile and indispensable resource for elevating nutritional intake and providing comprehensive holistic support for overall health.

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