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Review Article

A Review on Nutritional and Protective Role of *Spirulina Platensis*

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ABSTRACT

Spirulina is the first photosynthesizing procaryotes, called cyanobacteria or blue-green algae, which is used as a source of potential food supplement and pharmaceutical values. Therefore, the present review summarized that S. protects is used as a food supplement and has antioxidant and anti-inflammation activities, free radical-scavenging activity, peroxidation effects and metalloprotection roles.

Keywords: Nutrition; Protective; *Spirulina plantesis*

BACKGROUND

Spirulina is the first photosynthesizing procaryotes, called cyanobacteria or blue-green algae, used light energy to break apart the abundant carbon dioxide and water molecules into carbon food compounds, releasing free oxygen [1]. It has been used as a source of potential food supplement and pharmaceutical values which is constituted of high proteins, vitamins, essential amino acids, minerals, various essential fatty acids and phytochemicals [2]. It is called a superfood because its nutrients and phytonutrients profile is more potent than any other food, plant, grain or herb [1]. Each cell of Spirulina species has a diameter of 5 to 10 µm, with a helical and filamentous form and 5 to 6 turns. It is characterized by helical diameter of 50 µm to 60 µm and 200 µm to 300 µm long [3].

The United Nations Organization (UNO) has recommended Spirulina as the ideal food for mankind and the World Health Organization (WHO) has also declared Spirulina as a safe food with excellent nutritional value [4]. Recently, great attention and extensive studies have been devoted to evaluate its therapeutic benefits on an array of diseases including hypercholesterolemia, hyperglycerolemia, cardiovascular diseases, inflammatory diseases, cancer, viral infections, hypolipidemic, antioxidant, and anti-inflammatory activities [5].

TAXONOMY OF *SPIRULINA PLANTESIS*

The genus Spirulina was established by Turpin for Spirulina oscillarioides in 1827 [6]. It is belongs to the kingdom Monera and division Cyanophyta whichis a genus of the phylum Cyanobacteria ("Cyano" from the Greek meaning blue). Nowadays, there are more than 39 species of Spirulina in which S. platensis, S. fusiformis and S. maxima are the most investigated because of their high nutritional and pharmacological values. *S. plantesis* species is the most commonly available and widely used in different fields specially food industry and medicine [3].

Domain	**Bacteria**
Kingdom	Archaeplastida
Division	Cyanobacteria
Class	Cyanophyceae
Order	Oscillatoriales
Family	Pseudanabaenaceae
Subfamily	Spirulinoideae
Genus	Spirulina
Species	*Spirulina plantesis*

Table 1: Domain and bacteria.

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PHYTOCHEMICAL CHARACTERISTICS OF *SPIRULINA PLANTESIS*

Phytochemicals are the secondary metabolite which possesses many bioactivities such as antioxidant, anticancer, anti-inflammation, antimicrobial, antiviral, immunohancing. *S. plantesis* contains active phytochemicals possessing prophylactic and therapeutic properties, without exerting any toxicity or adverse effects. Some of thecompound includes phycocyanin, beta-carotene, alpha-tocopherol, phenol, fatty acids compounds and a recently isolated complex, Calcium Spirulan [7]. Phycocyanin has been reported as a significant phytochemical which protects liver, kidney, and other organs [8]. Carotenoid of Spirulina contains Alpha-carotene, beta-carotene, xanthophylis, cryptoxanthin, echinenone, zeaxanthin and lutein [9].

Phycobiliproteins are accessory photosynthetic pigments that participate in an extremely efficient energy transfer chain in photosynthesis [10]. Phycocyanin is one of the three main groups of phycobiliprotein (phycocyanins, allophycocyanins and phycoerythrins). According to [1], phycocyanin evolved a billion years before chlorophyll and may be the precursor to chlorophyll and hemoglobin. It has both magnesium and iron in its molecular formation, and therefore, phycocyanin may be the origin of life common to both plants and animals.

The chemical structure of the bilinchromophores in phycocyanin is very similar to bilirubin, a heme breakdown product (Figure 1). It is composed of two dissimilar a and b protein subunits of 17,000 and 19,500 Da, respectively, with one bilinchromophore attached to the subunit (a 84) and two to the b subunit (b 84, b 155). Phycocyanin exists as a complex interacting mixture of trimer, hexamer, and decamer aggregates.

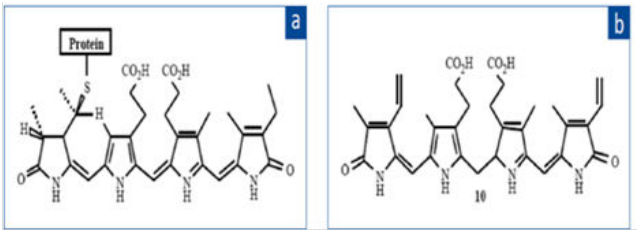

Figure 1: Chemical structure of phycocyaninbilin chromophore (open-chain tetrapyrrol) (a) and bilirubin (b).

Nutritional use

S. plantesis has found wide applications in the areas of agriculture, food, pharmaceuticals, perfumeries, medicine and science. Nowadays, this organism is used as a food supplement and is marketed in the form of pills, capsules and powder or incorporated into various types of food like cakes, biscuits, noodles and health drinks, etc. Various countries are developing strategic programs for the production and use of *S. plantesis*. In China, the *S. plantesis* industry is developing rapidly with several factories producing hundreds of tons of *S. plantesis* in the form of dried powder that is used as food, fodder and medicine [8].

S. plantesis has been orally consumed for thousands of years by humans among the Mexican, African, and Asian societies and also is a popular food and nutritional supplement in Japan and the United States. Among several occurring species of Spirulina, the most commonly used in nutritional supplements are *S. platensis*.

PROTECTIVE ROLES

Antioxidant and anti-Inflammation activities

The antioxidant and anti-inflammatory properties of phycocyanin were first reported and confirmed by numerous studies thereafter. *S. plantesis* contains several active ingredients, notably it is the richest natural sources of β-carotene and phycocyanin that have potent antioxidant and antiinflammatory activities [4].

Free radical-scavenging activity

Free radicals are chemical species with a single unpaired electron, which is highly reactive. The majority of free radicals that damage biological systems are oxygen radicals and other (Reactive Oxygen Species) ROS, which are by-products formed in the cells of aerobic organisms such as alkoxyl, hydroxyl, peroxyl, and superoxides. Under normal circumstances the natural antioxidant defense systems detoxify the superoxide anion by the mitochondrial manganese (Mn) superoxide dismutase. Spirulina extracts contain abundantantioxidant such as carotenoids, sulfolipids, glycolipids, phycocyanin, superoxide dismutase, RNA and DNA which have the capable of joining with free radical and rendering it harmless. Phycocyanin is the most scavengers of these free radicals because of its open chain tetraphyllores structure.

DISCUSSION

Peroxidation effects

Lipid peroxidation is mediated by ROS, which are responsible for the destruction and damage of cell membranes. These ROS include hydroxyl radicals, lipid oxyl or peroxyl radicals, as well as singlet oxygen and peroxinitrite that are formed from nitrogen oxide (NO). All of these groups of atoms are frequently by-products of oxygen metabolism. Phycocyanin scavenges free radicals because its open chain tetrapyrroles structure. In addition, it also inhibits liver microsomal lipid peroxidation that is induced by Fe^{+2}-ascorbic acid.

Immune system

Phycocyanin has shown enhancement of proliferation and differentiation of bone marrow hematopoietic cells thereby increasing the levels of various cytokines like IL-1ß, IFN-g, GMCSF and IL-3. It has also been shown to increase the expression of essential enzymes and biochemicals related to the balanced function of liver and kidney, includes, Cytochrome P-450 (CYP), Superoxide Dismutase (SOD), Catalase (CAT), Alanine transaminase (ALT), and Aspartate transaminase (AST). This further leads to the detoxification.

Metalloprotection roles

S. plantesis possesses the metalloprotective effects of heavy metals, such as Cd, lead, mercury, and arsenic. These heavy metals can impact the cellular growth, diminish cellular

productivity, and induce toxicity in cells, ultimately leading to cellular death. In addition, heavy metal decreases DNA synthesis. *S. plantesis* increase the DNA synthesis and repair and remove the heavy metals through several mechanisms, such as adsorption, enzymatic synthesis, or through the production of extracellular polymers.

CONCLUSION

The present paper provided that the *S. plantesis* has nutritional value in most of developing countries. This review also validates the hypothesis of protective role of *S. plantesis* on the human tissues like in the liver and kidney.

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