ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 8, Issue, 9, pp. 19825-19827, September, 2017

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Review Article

SPIRULINA -A REVIEW ON NUTRITIONAL PERSPECTIVE

Radha Palaniswamy* and Chandra Veluchamy

Department of Biotechnology, Dr. NGP Arts and Science College, Coimbatore, Tamil Nadu, India

DOI: http://dx.doi.org/10.24327/ijrsr.2017.0809.0767

ARTICLE INFO

Article History:

Received 17th June, 2017
Received in revised form 12th July, 2017
Accepted 04th August, 2017
Published online 28th September, 2017

Key Words:

Spirulina, nutritive values, nutraceuticals, proteins, antioxidants.

ABSTRACT

Spirulina is free-floating filamentous micro algae growing in alkaline water bodies. With its high nutritional value, it has been consumed as food for centuries in various parts of the world. It is now widely used as nutraceutical food supplement worldwide. *Spirulina platensis* has gained popularity as the food of the universe. Various researches have proved it to be a potent source of nutrient. Spirulina's nutritional qualities are truly-one-of-a-kind. The following paper has focused on the different biomolecules which are present in spirulina namely, proteins, carbohydrates, lipids, vitamins, minerals, nucleic acids, antioxidants, pigments and enzymes.

INTRODUCTION

Global demand for nutritional food apart from traditional and nutritional values is to use the food for functional values too. One such food is blue green algae, spirulina which has been a part of human diet since thousands of years as per archeological evidences. Apart from the basic needs, foods are consumed for the role of bioactive components in the body due to the presence of various phytochemicals present in them. The foods which play a role as nutraceuticals is called as functional foods [1]. Widespread approach of the world to comprehend the use of Spirulina platensis (*S. platensis*) from a basic algal component to a potential nutritional food was made possible by the cooperation of several organization, research institutes and industries which joined hands to identify, study, prove, and launch ready to consume product [2].

Spirulina (*Arthrospira platensis*) is a ubiquitous spiral-shaped blue-green microalgae, commonly found in seawater and brackish water. Among the various species, *S.platensis* and *S. maxima* are the only two used as food. The blue-green colour is due to the presence of various types of photosynthetic pigments like chlorophyll, carotenoids, phycocyanin and phycoerythrin [3].

Proteins: In the urge to develop potential, effective protein sources for preventing malnutrition, attention has been turned to microalgae. Single cell protein, i.e., crude or refined sources of protein that originates from microorganisms represent a great offer to many industries, including the feed, food and nutritional ones [4]. Spirulina has an exceptionally high protein content of which 90% is digestible. Spirulina contains all the essential amino acids in fairly high amounts, but the amount of the sulphur amino acids is low. The biological value of algae protein varies according to the algae species. Based on limited scientific evidence available, spirulina might be a promising source of protein for human nutrition especially in the situation of protein deficiency or malnutrition [5]

Digestibility: *S.platensis* has no cellulose in its cell walls, composed of soft mucopolysaccharides which makes it easily digested and assimilated (85 to 95% digestible). This easy digestibility is especially important for people suffering from intestinal malabsorption or older people. They find spirulina's protein easy to digest[6]. It is effective for victims of malnutrition diseases like kwashiorkor, where the ability of intestinal absorption has been damaged. For malnourished children, it is more effective than milk powders since lactic acid in milk is difficult to digest and absorb [7].

Carbohydrates: Approximately 20% of the nutrient of *S. platensis* is made of carbohydrates. The content of carbohydrates depend on the growth medium of the algae, the richer the medium the greater the content, nevertheless, maximum content reported is 20% [8]. The majority are complex

Corresponding author:* **Radha Palaniswamy
Department of Biotechnology, Dr. NGP Arts and Science College, Coimbatore, Tamil Nadu, India

carbohydrates like rhamnose, xylose, galactose and glycogen. Simple carbohydrates like glucose, fructose and sucrose are present in small quantities. From the nutrient standpoint, mesoinositol phosphate (a carbohydrate) which is an excellent source of organic phosphorus and inositol occurs in higher volumes. This inositol content is about eight times that of beef and several hundred times that of the vegetables with the highest levels. Spirulina's polysaccharides are believed to have a stimulating effect on DNA repair mechanisms, which might explain the radio-protective effect mentioned several times in relation to spirulina. Certain polysaccharides are also thought to have immune-stimulating and immune-regulating properties[9].

Lipids: Human requirement for fatty acids is said to be 1-2% for adults and 3-4% for children which can be achieved from *S.platensis*. It is considered one of the best known source of gamma-linolenic acid, after human milk and vegetable oils (evening primrose, borage, blackcurrant seed and particularly hemp oil) [10]. Other fatty acids which are present are linoleic acid (18:2 omega-6), high proportion of palmitic acid (16:0), which forms more than 60% of lipids in *Spirulina maxima*, but only about 25% in *S. platensis*. The importance of these fatty acids lie in their biochemical evolution: they are theprecursors of the prostaglandins, leukotrienes and thromboxanes that serve as chemical lmediators of inflammatory and immune reactions [11].

Vitamins: Vitamin B12 is the largest and most complex; it represents all of the biologically active cobalamins. The fact that Spirulina has an exceptionally high content of vitamin B12 -as other sea weed do-is of great importance because such vitamin is only in animal origin foods. Thus this alga might be considered as a good source for vegans [12]. It is also a good source of beta-carotene, containing about 700-1700 mg/kg, which once absorbed will be biotransformed into vitamin A. Human requirements of vitamin A are of approximately 1 mg/day; hence 1-2 g of algae will be enough to assure this need [13]. Spirulina is an abundant source of vitamin B1 (thiamine), B2 (riboflavin), B3 (nicotinamide), B6 (pyridoxine), B9 (folic acid), B12 (cyanocobalamin), vitamin C, vitamin D and vitamin E [14].

Minerals*:* Calcium and phosphorous contents are comparable to those of the milk due to the best availability. The relative proportion(Ca:P) of these micronutrients is compatible with the preservation of bone health since it reduces decalcification risk. Moreover, as it was previously stated, the cyanobacteria of interest is an oxalate-free plant food, thus -as with iron- it provides calcium with high availability and improves its absorption[15]. *S. platensis* does not have pericardium like cereals, hence it does not present phytates/oxalates that chelate iron and lower its absorption like that of spinach[16]. Studies show iron in spirulina is 60% better absorbed than iron supplements such as iron sulfate and minerals, including calcium, iron, magnesium, manganese, potassium, zinc, and selenium [17].

Nucleic acids*:* It is made up of DNA and RNA. Nucleic acids' catabolism yields uric acid, since purines -adenine and guanine-are being degraded. High levels of uric acid are correlated to the development of gout, kidney stones and, more recently, cardiovascular disease [18]. *Spirulina*'s content of nucleic acids is about 4-6% of its dry weight; this values are - for much-lower than that of other single-cell protein sources (e.g., yeast contains about 20% of its dry matter) and other microalgae like Chlorella [19]. The World Health Organization recommends that the daily total nucleic acid consumption should not exceed 4 g; to get such quantity from the blue-green algae, one would have to consume up to 80 g [20].

Antioxidants: Algae like other life forms contain antioxidant organic compounds and enzymes that inhibit the oxidative damage, which results primarily from reduced states of oxygen. This leads to the production of reactive oxygen species like superoxide radical anion, hydrogen peroxide, the hydroxyl free radical, and singlet oxygen [21]. The foremost enzymes that restrict oxidative damage are superoxide and catalase which are present in the algae along with polyphenols which act as good antioxidants [22]. Some of the other antioxidants include water-soluble ascorbate (vitamin C) and the lipid-soluble α-tocopherol (vitamin E) and carotenoids such as astaxanthin [21]. Other species found are glutathione peroxidase. Mycosporine-like amino acids, mainly considered as UV screening compounds, are also antioxidants that act as scavengers and quenchers of reactive oxygen species in algae [23].

Pigments: The blue-colored pigment phycocyanin has been reported to have significant antioxidant, anti-inflammatory, hepatoprotective and broad-spectrum radical scavenging properties. This pigment can be easily extracted out from the cell and can be incorporated into food products. Pure phycocyanin can have higher therapeutic value for treatment of various disorders. Besides, being a natural compound it is least toxic. Studies show that phycocyanin stimulates production of white blood cells and red blood cells [24]. Carotenoids are the second most important group of pigments found in algae. They play a role as lipophylic antioxidants and they are thought to be responsible for the therapeutic property of carotene as anticancer agent [25].

Enzymes: Spirulina can also be exploited for the production of various enzymes, especially antioxidant enzymes. It has a very high amount of the superoxide dismutase enzyme, which is an important free radical scavenging enzyme. This enzyme can be used therapeutically for the treatment of various diseases related to oxidative stress or as a component in anti-wrinkle skin lotions and face masks as aging is believed to a consequence of oxidative stress [26].

Food usage: Among the varied products in which dried, flaked, or powdered Spirulina is now incorporated are: baked desserts, beer, breakfast cereals, confectionary, corn chips, crackers, doughnuts, food bars, frozen desserts, juice smoothies, muffins, pasta, popcorn, salad dressing, snack foods, and soups. Several cookbooks dedicated to Spirulina have been published [27].

CONCLUSION

Spirulina - a wonder food supplement with low or negligible side effects. The highly diverse nutritive nature of spirulina together with its antioxidant and protective health benefits have been utilized in various health related problems. The potential health benefits of spirulina must be adequately recognized and implemented thus making full use of this nature's gift. As it is easily cultivated in most regions of the world it can be made

easily available at economical prices for access to all classes of population.

References

1. Wells, M L., Potin, P., Craigie, J S., Raven, J A., Merchant, S S., Helliwell, K E., Smith, A G., Camire, M E and Brawley, S H. (2016): Algae as nutritional and functional food sources: revisiting our understanding. *J Appl Phycol.*, (29) 2: 949-982.
2. Mohan, A., Misra, N., Srivastav, D., Umapathy, D., and Kumar, S. (2014): Spirulina-The Nature's Wonder: A Review. *Sch J App Med Sci.*, (2) 4: 1334-1339.
3. Belay, A.(2002): The Journal of the American Nutraceutical Association. The Potential Application of *Spirulina* (*Arthrospira*) as a Nutritional and Therapeutic Supplement in Health Management. *J Med Nutr Nutraceut*., (5) 2: 27-48.
4. Olaizola, M. (2003): Commercial development on microalgal biotechnology: from the test tube to marketplace. *Biomolec Eng*., (20): 459-66.
5. Tang, G and Suter, P M. (2011): Vitamin A, Nutrition, and Health Values of Algae: Spirulina,Chlorella, and Dunaliella. *J Pharm Nutr Sci*., (1) 2: 111-118.
6. Sharoba, A M. (2014): Nutritional value of Spirulina and its use in the preparation ofsome complementary baby food formule. *J Agroaliment Proc Technol*, (20) 4: 330-350.
7. Parry, E.I.D. (2014): Limited.*Spirulina for Children.* Parry Nutraceuticals Division. DareHouse, 4th Floor, # 234, N.S.C. Bose Road, Parrys Corner, Chennai - 600001, India.
8. Salla, A C., Holz, L C., Briao, V B., Bertolin , T E., Colla, L M., Alberto, J and Costa V. (2016): Increase in the carbohydrate content of the microalgae *Spirulina* in culture by nutrient starvation and the addition of residues of whey protein concentrate. *Biores Technol*., (209): 133-141.
9. Hug, C. and Weid, D. (2011): Spirulina in the fight against malnutrition assessment and prospects. Antenna Technologies., 1-28.
10. Ciferri O. (1983): *Spirulina*, the Edible Microorganism. *Microbiol Rev*., (47): 551-578.
11. Deng, R and Chow, T J. (2010):Hypolipidemic, Antioxidant and Anti-inflammatory Activities of Microalgae *Spirulina*. *Cardiovasc. Ther*., (28) 4: 33-45.
12. Cases, J., Vacchina, V., Napolitano, A., Caporiccio, B., Besançon, P., Lobinski, P. and Rouanet, J. M. (2001): Selenium from selenium-rich Spirulina is less bioavailable than selenium from sodium selenite and selenomethionine in selenium-deficient rats. *J Nutr*., (131): 2343-2350.
13. Oren, A. and Cimerman, G. N. (2007): Mycosporines and mycosporine like amino acids:UV protectant or multipurpose secondary metabolites. *FEMS Microbiol Lett.*, (269) 1: 1-10.
14. Alvarenga, R R., Rodrigues, P B., Cantarelli, V S., Zangeronimo, M G., Silva, J W., Silva, L R., Santos, L. M. and Pereira, L. J. (2011) : Energy values and chemical composition of spirulina (*Spirulina platensis*) evaluated with broilers. *R Bras Zootec*., (40) 5: 992-996.
15. Kulshreshtha, A., Zacharia, A. and Jarouliya, U. (2008): *Spirulina* inhealth care management. *Curr Pharm Biotech*., (9): 400-405.
16. Becker, E. W. (2007): Microalgae as a source of protein. *Biotechnol Adv*., (25) 2: 207-210.
17. Ghaeni, M. and Roomiani, L. (2016): Review for Application and Medicine Effects of *Spirulina platensis* Microalgae. *J Adv Agri Technol*., (3) 2: 114-117.
18. Johnson, R.J., Kang, D.H. and Feig, D. (2003): Is there a pathogenic role for uric acid in hypertension and cardiovascular and renal disease?. *Hypertension*., (41) : 1183-90.
19. Narasimha, D. L. R., Ventakaraman, G. S., Suyrnder, K., Duggal and Eggum, B O. (1982): Nutrional quality of the blue green alga Spirulina platensis geitler. *J Sci Food and Agri.*, (33) 5: 456-460.
20. Salmean, G. G., Castillo, L. F. and Cevallos, G. C. (2015): Nutritional and toxicological aspects of Spirulina (Arthrospira). *Nutr Hosp*., (32) 1: 34-40.
21. Halliwell, B. and Gutteridge, J.M.C. (2007): Free radicals in biology and medicine, 4th edn. Clarendon, Oxford.
22. Hwang, H., Chen, T., Nines, R.G., Shin, H.C. and Stoner, G.D. (2006): Photochemoprevention of UVB-induced skin carcinogenesis in SKH-1 mice by brown algae polyphenols. *Int J Cancer*., (119): 2742-2749.
23. Cornish, L. and Garbary, D.L. (2010): Antioxidant from macroalgae"potential applications in human health and nutrition. *Algae*., (25) 4:155-171.
24. Desai, K. and Sivakami, S. (2004): Spirulina - The Wonder Food of the 21st Century. *APBN*., (8): 1298-1302.
25. Gireesh, T., Nair, P.P. and Sudhakaran, P.R. (2004): Studies on the bioavailability of provitamin A carotenoide, beta-carotene,using human exfoliated colonic epithelial cells. *Br J Nutr*., (92) 2: 241-5.
26. Khan, Z., Bhadouria, P. and Bisen, P.S. (2005): Nutritional and therapeutic potential of *Spirulina*. *Curr Pharm Biotech*., (6): 373-379.
27. Small, E. (2012): Spirulina -food for the universe. *Biodiversity*., (12) 4: 255-265.

How to cite this article:

Radha Palaniswamy and Chandra Veluchamy.2017, Spirulina -A Review On Nutritional Perspective. *Int J Recent Sci Res.* 8(9), pp. 19825-19827. DOI: http://dx.doi.org/10.24327/ijrsr.2017.0809.0767

****