IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 3, Issue 2, January 2023
Impact Factor: 7.301

Utility of Spirulina as Immunity Booster Agent

Dr. Babita Yadav
Associate Professor, Botany Department
Nehru College Chhibramau Kannauj, Chhibramau, Uttar Pradesh, India

Abstract: *Spirulina is a single-cell protein that is high in important minerals and vitamins and can be used to make functional foods. Spirulina is a single-cell protein that contains all of the essential amino acids.It contains important minerals and vitamins and can be used to make functional cuisine. Indeed, one of the most serious issues in the food business is the use of manufactured food additives, which raise the chance of cancer.As a result, attempts are currently being made around the globe to isolate new and safe antioxidants from natural sources.Among these, cyanobacterial natural products are a significant source of novel drug molecules. Natural bioactive products have therapeutic value in and of themselves, but they are also used as building blocks to make synthetic analogues. Spirulina contains protein (70-55%), carbs (25-25%), important fatty acids (18%), vitamins, minerals, and colours such as carotene, chlorophyll A, and phycocyanin. Clearly, the advent of important cyanobacterial properties Spirulina can serve as an appropriate replacement for many antimicrobial substances and synthetic antioxidants that not only pose no danger to the consumer but can also enhance consumer health. Spirulina's nutritional value, bioactive characteristics, and immunological uses have all been addressed in this study. According to current study, spirulina supplements have been recognised by worldwide certification as a safe nutritious and dietary addition.*

Keywords: Antioxidants; Food additives; Spirulina

I. INTRODUCTION

Spirulina is a genus of cyanobacteria that has developed the capacity to use carbon dioxide dissolved in saltwater as a nutritional supply for reproduction. (Ali & Saleh, 2012). Spirulina is a genus of filamentous cyanobacteria of the Oscillatoriaceae family, distinguished by straight-shaped strands of cells surrounded in a thin sheath. (Fig. 1). It is a photosynthetic cyanophyte that develops rapidly in bright sunlight, high temperatures, and alkaline environments. Spirulina are filamentous cyanobacteria that have gained widespread acceptance in the health food sector and as a protein and vitamin supplement to aquaculture diets. It thrives in both saline and fresh water, is readily collected and processed, and has high levels of macro- and micronutrients (Costa et al., 2019; Rosario & Josephine, 2015; Soni, Sudhakar, & Rana, 2017; Wan, Wu, &Kua, 2016). Spirulina may be grown in a variety of methods, the most well-known of which being photobioreactors and raceways. Raceways are usually rectangular with rounded corners, need a lot of ground space, and are weather and season dependant. Photobioreactors are closed culture methods that keep Spirulina strains safe from contamination. In these systems, cultivation factors including as pH, temperature, and light may be readily adjusted. (Wan et al., 2016).It has long been used as a nutritional supplement by individuals who live near lakes where it grows naturally. (Ali & Saleh, 2012). Dihé, for example, is an obsolete dish that is cultured globally. After drying, Dihé obtained from alkaline water is still utilised as the primary source of edible protein in many African nations. It has spread as a protein supplement in several Asian nations and is now manufactured industrially for human consumption. Pregnant ladies have a common misconception that eating dihé cakes can protect their unborn child from the gaze of magicians.

Spirulina is also used topically as a poultice to treat some disorders. (Soni et al., 2017). The local selling value of the dihé gathered annually from Lake Kossorom in Chad exceeds $100,000, indicating a significant influence on the region's economy (Wan et al., 2016). Furthermore, the European Space Agency and the National Aeronautics and Space Administration have recommended Spirulina for nutritional supplements during long-term space travel. Since then, various animal and human clinical trials have been conducted to establish its usefulness as a supplement. Spirulina is a low-cost dietary supplement that has been shown to have no significant adverse effects. Spirulina is used as a sustaining food concentration since it is high in protein (60-70%), vitamins (4%), vital fatty acids, and anti-oxidants

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 3, Issue 2, January 2023
Impact Factor: 7.301

(Santos, Freitas, Moreira, Zanfonato, and Costa, 2016).Spirulina is a good source of fatty acids like linoleic acid and linolenic acid, phycobiliproteins like phycocyanin and allophycocyanin, amino acids like leucine [10.9% of total amino acids], valine and isoleucine, and minerals like iron. Spirulina administration has been favourably received by groups of malnourished children and adults. Treatment of victims of the Chernobyl nuclear accident, particularly youngsters whose bone marrow had been affected by radiation exposure, helped to maintain the immune system. Toxicological studies on all Spirulina species have revealed no hazardous effects on the kidney, liver, reproductive system, or body physiology during or after acute or chronic dosages.Spirulina lacks cellulose cell walls and hence does not require chemical or physical procedures to become absorbable (Soni et al., 2017).

Spirulina as a wonderful future food source

Spirulina has the amazing capacity to be employed in the preparation of concentrated high-quality meals. The diet and Agriculture Organization (FAO) of the United Nations has designated Spirulina as a great diet and nutritional supplement for the twenty-first century. Food processors are concerned about the authentication of food supplies since the purity of food ingredients is undoubtedly vulnerable to abuse by unscrupulous vendors.

Spirulina has been utilised as a nutritional supplement for fish, shrimp, and poultry, and more recently as a protein and vitamin supplement to aqua diets. China is ingesting microalgae as a partial alternative for imported fodder in order to stimulate shrimp growth, immunity, and viability. In Japan, much study has been conducted on the utilisation of Spirulina as aquaculture feed additives (Santos et al., 2016). Spirulina is high in minerals and vitamins.

It contains all of the necessary amino acids, beta carotene, gamma linolenic acid, vitamin B, trace elements, and other nutrients. It has 18% more calcium than milk, 5100% more iron than spinach, 670% more protein than tofu, and 3100% more beta carotene than carrots. Spirulina has stronger antioxidant and anti-inflammatory properties than five other fruits and vegetables. Spirulina contains 60 times more phytonutrients than spinach, 31 times more than blueberries, and 700 times more than apples (Wu et al., 2016).

Spirulina as protein malnutrition

Numerous investigations on the chemical structure of biomass have been conducted. S. platensis and S. maxima have a very high protein content. like a high protein content in Spirulina is unusual even in the microbial world, being surpassed only by some bacteria like as Cellulomonas has been shown to contain protein levels that exceed 80% of its dry weight. (Kameshwari, Selvaraj, & Sundaramoorthy, 2020).However, those bacteria's high protein concentration is coupled with high nucleic acid content, which is medically undesirable. Additional nucleic acids generate uric acid accumulation due to purine degradation, which can lead to pathological conditions like gout. The content of nucleic acid in Spirulina is always less than 5% of the dry weight and so beneficial. Spirulina research undertaken by the World Health Organization (WHO) and experts in the United States, France, West Germany, Mexico, Vietnam, and Japan revealed that it has a unique combination of nutrients that no other plant source can give. (Lupatini, Colla, Canan, &Colla, 2017). Spirulina's NPU value is comparable to that of other vegetarian sources with comparable amino acid content, biological value, and digestibility.

Spirulina protein has an impressive amino acid profile. With the exception of cysteine and lysine, which are somewhat lower than the standard protein (FAO), all of the other necessary amino acids are present in sufficient amounts. (Aiello et al., 2019). The potential utility of Spirulina as a protein source for human consumption has long been recognised. Spirulina research undertaken by the World Health Organization (WHO) and experts in the United States, France, West Germany, Mexico, Vietnam, and Japan revealed that it has a unique combination of nutrients that no other plant source can give. (Lupatini, Colla, Canan, &Colla, 2017). Spirulina's NPU value is comparable to that of other vegetarian sources with comparable amino acid content, biological value, and digestibility.Spirulina protein has an impressive amino acid profile. With the exception of cysteine and lysine, which are somewhat lower than the standard protein (FAO), all of the other necessary amino acids are present in sufficient amounts. (Aiello et al., 2019). The potential utility of Spirulina as a protein source for human consumption has long been recognised.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 3, Issue 2, January 2023
Impact Factor: 7.301

Carbohydrates and Fatty acids of *Spirulina*

As cellulose is absent in Spirulina, its carbohydrates are easily absorbed. Furthermore, the lack of free sugars makes it a great nutritional supplement for diabetes, obesity, and other similar disorders (Braga, Mastrantonio, Costa, &Morais, 2018). Another advantage of spirulina is its lipid makeup, which is cholesterol-free and high in poly-unsaturated essential fatty acids, making it excellent for disorders such as atherosclerosis, obesity, and high blood pressure. Spirulina also contains myristic acid (0.23%), palmitic acid (46.07), palmitoleic acid (1.26), oleic acid (5.26), and gamma linolenic acid (17.43%), which may have medicinal consequences (T.-T. Li et al., 2019). Spirulina has been discovered to have lipid-lowering properties since 1981.Later that year, Iwata et al. (1990) reviewed the preclinical study on Wistar rats that had been artificially created with hyperlipidemia by feeding them a high-fructose diet. For four weeks, the groups were either on a high-fructose diet alone or on a high-fructose diet with Spirulina at 5%, 10%, and 15% concentrations. The results revealed a considerable improvement in the lipid profile with increased activity of lipoprotein lipase (LPL), although there was no significant difference in lipid levels or LPL between the 5%, 10%, or 15% Spirulina concentration groups. Furthermore, they discovered that when 5% spirulina was administered, hepatic triacylglycerols reduced (Iwata, Inayama, & Kato, 1990). Spirulina intake over eight weeks boosted HDL-C and decreased LDL-C, TG, and TC levels when fed a high-fat diet, similar to prior research. Furthermore, Spirulina ingestion may help to dramatically normalise hepatic steatosis by improving liver function tests such as transaminases, free fatty acids, and total lipid profile. This success was attributed to the activation of the AMP-activated protein kinase signalling pathway, which downregulates the expression of lipid synthesising genes, specifically sterol regulatory element-binding transcription factor-1c, 3-hydroxy-3-methyl glutaryl coenzyme A reductase, and acetyl CoA carboxylase, ultimately lowering TG levels and successfully inhibiting fatty acid synthesis. (T.-T. Li et al., 2018).

Vitamins and minerals of *Spirulina*

Spirulina has a potent combination of vitamins, including A, Bl, B2, B6, B12, E, and H. It provides 21% of the Recommended Dietary Allowance (RDA) for thiamin and riboflavin. (Nowruzi, Haghighat, Fahimi, &Mohammadi, 2018). It has a ß-carotene level that is 20 times that of carrots. Its folic acid and vitamin B12 levels make it an effective anaemia treatment. Spirulina's mineral composition is also appealing. It has 12 times more iron than any other food and is also abundant in magnesium, potassium, and other trace minerals. Spirulina, which is high in calcium and iron, is beneficial to blood regeneration and the proper functioning of teeth and bones.Complete research conducted by UNIDO; Central Food Technological Research Institute, Mysore; and numerous international agencies have clearly established the nutritional value of Spirulina (Grosshagauer, Kraemer, & Somoza, 2020).

Spirulina contains important minerals and trace elements incorporated from its growing media into chelated, easily absorbed forms, such as potassium, a key mineral that regulates electrolyte balance in the body.Iron deficiency is more frequent in women throughout their reproductive years. Iron is poorly absorbed in several dietary supplements; however, iron is better absorbed in Spirulina than in ferrous sulphate and other supplements. As a result, it might be a good supply of iron for anaemic pregnant women.

Probiotic property of *Spirulina*

Spirulina functions as a useful food, preserving healthy gut bacteria. A meal addition of 5% Spirulina to rats for 100 days resulted in 32.7% more Lactobacillus and 32.7% more vitamin B1. Furthermore, Spirulina platensis extracellular products significantly increased the growth of lactic acid bacteria such as Lactococcuslactis, Streptococcus thermophilus, Lactobacillus casei, Lactobacillus acidophilus, and Lactobacillus bulgaricus (Golmakani, Soleimanian-Zad, Alavi, Nazari, and Eskandari, 2019).

II. IMMUNOLOGICAL APPLICATIONS

Spirulina became well recognised by NASA as a dietary supplement for astronauts on space expedition, it inhibited the release of histamine by mast cells, and Spirulina may enlarge several anti-allergic symptoms. Chronic tiredness is unaffected by spirulina. Spirulina extract combined with zinc may be beneficial in the treatment of chronic arsenic poisoning with melanosis and keratosis.The first human feeding trial demonstrated Spirulina's anti-allergic rhinitis properties. Spirulina aids in the prevention of certain nutritional deficiencies (Ghattas, Dawoud, Mahrous, &Elgabry,

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 3, Issue 2, January 2023
Impact Factor: 7.301

2019). It aids in the prevention of cancer, infectious disorders, cellular aging, and decreased immune system effectiveness, as well as playing an important part in the functioning of the medulla. Spirulina extract has a protective effect against apoptotic cell death caused by free radicals.

Spirulina was a more effective inhibitor than Chlorella. After 12 hours of treatment, annexin-V staining revealed that Spirulina extract induced apoptosis in hepatic stellate cells (HSC). Furthermore, Spirulina extract caused a cell cycle arrest of HSC during the G2/M phase.Spirulina platensis boosts the immune response by boosting macrophage functions, IL - I production, phagocytosis, and, most notably, primary response. (Chia et al., 2019).

Global *Spirulina* Market

Spirulina is promoted and consumed in a variety of nations, including Belgium, Egypt, the United States, Germany, Ireland, Argentina, the Philippines, India, Brazil, Chile, Spain, France, Canada, Africa, and others where public administration and associations have permitted human use. Cyanotech (USA), Hainan DIC Microalgae Co., Ltd (China), Earthrise Farms (USA), MarugappaChettir Research Center (India), Genix (Cuba), and Solarium Biotechnology (Chile) are some of the most well-known global Spirulina producing firms. (Costa et al., 2019).

III. FUTURE RESEARCH AND PERSPECTIVE VIEWS

Although more research is needed, biodiesel and nutraceutical production from Spirulina strains can achieve commercial success through the development of advanced culture techniques that mimic natural conditions and have enormous potential to improve activities such as fast growth and high lipid-secreting ability. In reality, many strains of Spirulina have now been found, isolated, cultivated, and characterised using molecular methods, biochemical, nutraceutical, and isolation techniques, with the isolation stage serving as the starting point for diverse biotechnological applications.Moreover Spirulina strains might be exploited to create new therapies against newer viruses like coronavirus. (SARS-CoV-2).However, further study is needed to focus on the successful axenic cultivation of Spirulina in order to ease their utilisation for bioactive components.

Current and future directions in Spirulina strain research include integrated multi-omics analysis for detecting biosynthetic gene clusters, biosynthetic pathways, and metabolic engineering for increased target chemical synthesis. Metabolomics study of field-collected materials utilising tools such as LC-TOF-ESI-MS/MS, HR-ESI-MS, MALDI-TOF-MS, and others aids in the de-replication of known chemicals and the search for new molecules.

IV. CONCLUSION

According to the findings of this research, Spirulina is employed as a possible health food in human diets and in the food business. It is a superfood and an excellent dietary source for malnutrition. It reduces cholesterol, inhibits fatty buildup in the liver, prevents tumour growth, boosts the immune system, and protects the kidneys. S. platensis is recognised to be high in minerals, particularly calcium and potassium, as well as proteins, carbohydrates, essential fatty acids, vitamins, minerals, carotenes, chlorophyll a, and phycocyanin. As a result, Spirulina might be utilised as both a treatment and a daily food source.

REFERENCES

[1]. Aiello, G., Li, Y., Boschin, G., Bollati, C., Arnoldi, A., &Lammi, C. (2019). Chemical and biologicalcharacterization of spirulina protein hydrolysates: Focus on ACE and DPP-IV activitiesmodulation. Journal of Functional Foods, 63, 103592.

[2]. Ali, S. K., & Saleh, A. M. (2012). Spirulina - An overview. International Journal of Pharmacy andPharmaceutical Sciences.

[3]. Braga, V. da S., Mastrantonio, D. J. da S., Costa, J. A. V., &Morais, M. G. de. (2018). Cultivationstrategy to stimulate high carbohydrate content in Spirulina biomass. BioresourceTechnology, 269, 221–226.

[4]. Chia, S. R., Chew, K. W., Show, P. L., Xia, A., Ho, S.-H., & Lim, J. W. (2019). Spirulina platensisbased biorefinery for the production of value-added products for food and pharmaceuticalapplications. Bioresource Technology, 289, 121727.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 3, Issue 2, January 2023
Impact Factor: 7.301

[5]. Costa, J. A. V., Freitas, B. C. B., Rosa, G. M., Moraes, L., Morais, M. G., & Mitchell, B. G. (2019).Operational and economic aspects of Spirulina-based biorefinery. BioresourceTechnology, 292, 121946.

[6]. Ghattas, T. A., Dawoud, E. N., Mahrous, A. F., &Elgabry, E. A. (2019). Effect of Spirulina platensissupplementation on growth, some biochemical and immunological parameters in sucklingcalves. Egyptian Veterinary Medical Association, 79, 443–460.

[7]. Golmakani, M.-T., Soleimanian-Zad, S., Alavi, N., Nazari, E., &Eskandari, M. H. (2019). Effect ofSpirulina (Arthrospira platensis) powder on probiotic bacteriologically acidified feta-typecheese. Journal of Applied Phycology, 31(2), 1085–1094.

[8]. Grosshagauer, S., Kraemer, K., & Somoza, V. (2020). The True Value of Spirulina. Journal ofAgricultural and Food Chemistry, 68(14), 4109–4115.

[9]. Iwata, K., Inayama, T., & Kato, T. (1990). Effects of Spirulina platensis on plasma lipoprotein lipaseactivity in fructose-induced hyperlipidemic rats. Journal of Nutritional Science andVitaminology, 36(2), 165–171.

[10]. Kameshwari, V., Selvaraj, S., &Sundaramoorthy, S. (2020). Single Cell Protein Spirulina-A NutrientTreasure. Research Journal of Pharmacology and Pharmacodynamics, 12(2), 49.

[11]. Li, B., Zhang, X., Gao, M., & Chu, X. (2005). Effects of CD59 on antitumoral activities of phycocyaninfrom Spirulina platensis. Biomedicine & Pharmacotherapy, 59(10), 551–560.

[12]. Li, T.-T., Liu, Y.-Y., Wan, X.-Z., Huang, Z.-R., Liu, B., & Zhao, C. (2018). Regulatory Efficacy of thePolyunsaturated Fatty Acids from Microalgae Spirulina platensis on Lipid Metabolism andGut Microbiota in High-Fat Diet Rats. International Journal of Molecular Sciences, 19(10),3075.

[13]. Li, T.-T., Tong, A.-J., Liu, Y.-Y., Huang, Z.-R., Wan, X.-Z., Pan, Y.-Y., … Zhao, C. (2019).Polyunsaturated fatty acids from microalgae Spirulina platensis modulates lipidmetabolism disorders and gut microbiota in high-fat diet rats. Food and ChemicalToxicology, 131, 110558.

[14]. Liu, Y., Xu, L., Cheng, N., Lin, L., & Zhang, C. (2000). Inhibitory effect of phycocyanin from Spirulinaplatensis on the growth of human leukemia K562 cells. Journal of Applied Phycology.

[15]. Lupatini, A. L., Colla, L. M., Canan, C., &Colla, E. (2017). Potential application of microalga Spirulinaplatensis as a protein source. Journal of the Science of Food and Agriculture, 97(3), 724–732.

[16]. Mani, U., Sadliwala, A., Iyer, U., & Parikh, P. (2000). The Effect of Spirulina Supplementation onBlood Haemoglobin Levels of Anaemic Adult Girls. Journal of Food Science andTechnology.

[17]. Nowruzi, B., Haghighat, S., Fahimi, H., &Mohammadi, E. (2018). Nostoc cyanobacteria species: anew and rich source of novel bioactive compounds with pharmaceutical potential. Journalof Pharmaceutical Health Services Research, 9(1), 5–12.

[18]. Santos, T. D., Freitas, B. C. B. de, Moreira, J. B., Zanfonato, K., & Costa, J. A. V. (2016).Development of powdered food with the addition of Spirulina for food supplementation ofthe elderly population. Innovative Food Science & Emerging Technologies, 37, 216–220.

[19]. Soni, R. A., Sudhakar, K., & Rana, R. S. (2017). Spirulina – From growth to nutritional product: Areview. Trends in Food Science & Technology, 69, 157–171.

[20]. Wan, D., Wu, Q., &Kuča, K. (2016). Spirulina. In Nutraceuticals (pp. 569–583). Cambridge, MA, USA: Academic Press.

[21]. Wu, H.-L., Wang, G.-H., Xiang, W.-Z., Li, T., & He, H. (2016). Stability and Antioxidant Activity ofFood-Grade Phycocyanin Isolated from Spirulina platensis. International Journal of FoodProperties, 19(10), 2349–2362.

[22]. Wu, Q., Liu, L., Miron, A., Klímová, B., Wan, D., &Kuča, K. (2016). The antioxidant, immunomodulatory, and anti-inflammatory activities of Spirulina: an overview. Archives ofToxicology, 90(8), 1817–1840.