

**A REVIEW ON SPIRULINA PLATENSIS AS AN IMMUNITY BOOSTER FOR THE
PRESENT SITUATION**

Praveena B.*, Yashas M., Harish B., Harshavardhana R., and Yamuna M.

Department of Chemistry, M.E.S. College of Arts, Commerce and Science, Bangalore-560003.

*Corresponding Author: Praveena B.

Department of Chemistry, M.E.S. College of Arts, Commerce and Science, Bangalore-560003.

Article Received on 30/04/2020

Article Revised on 20/05/2020

Article Accepted on 10/06/2020

ABSTRACT

The Immune system refers to a collection of cells, chemicals and processes that protects our body from foreign antigens like viruses, bacteria, cancer cells etc. The primary functions of immune system are to defend against pathogens, which are disease causing organisms. In present world, antigens show more resistive power to antibodies which results in causing many diseases. In this review, we focus on the work of spirulina platensis which is a unicellular alga, as an immunity booster. Traditionally *Spirulina* is used as a food supplement with a potential strengthening of immune system. Also, it is inevitable to find such immune booster to stay away from diseases, as *Spirulina platensis* is rich in protein, vitamin, mineral and carotenoids, it acts as an immunity booster.

KEYWORDS: - Antigens, Antibodies, Immune system, Immunity booster, *Spirulina platensis*.**INTRODUCTION OF SPIRULINA PLATENSIS**

Cyanobacteria is a primitive group of gram negative, ubiquitous in nature, oxygenic photoautotrophic prokaryotes which have wide distribution ranging from hot springs to Arctic and Antarctic regions and are important biomass producers in both aquatic and terrestrial ecosystems. They are the valuable sources of natural products of medicinal and industrial importance (B.Praveena *et al.*, 2015).^[1] *Spirulina* is a blue green algae that become popular when it is used by NASA as dietary supplement for astronauts, since *Spirulina* contains 70% of protein, also contain vitamins especially B12 and carotenoids (P.D.Karkos *et al.*, 2008).^[2,3] *Arthrospira platensis* also commonly called as *Spirulina platensis* is a microscopic, filamentous, unicellular prokaryote which is found in fresh water, marshes and sea water (Akbarizadeh, M *et al.*, 2020).^[4] Unlike many other cyanobacteria which are proven to be toxic, no such property has been attributed to *Arthrospira*. *Spirulina* is rich in macronutrients and micronutrients. *Spirulina* have been used for food for thousands of years. P.J.Turpin in the year 1827 isolated *Spirulina* from fresh water sample. *Spirulina* is naturally found in tropical regions inhabiting alkaline lakes (pH 11) with high concentration of NaCl and Bicarbonates (P.Saranraj *et al.*, 2014)^[5,6], (Shabana Kouser Ali *et al.*, 2012). *Spirulina* has attracted people and scientists from all over the world due to its unique properties. *Spirulina* is found to have many applications in the field of agriculture, pharmaceuticals, perfumeries, medicine and science. It

acts as a booster for immune system since spirulina contain chlorophyll and also it helps to flush out toxins from the blood (Radha Palaniswamy *et al.*, 2018).^[7] *Spirulina* helps in improving the immunity power and increases resistance to viral infection. *Spirulina* helps in building the component of the mucosal and systemic immune system as it activates the cells of innate immune system. Some of the pre-clinical animal studies have shown good immune stimulatory effects in a variety of species. In humans, mammals, chicken and fish *Spirulina* produces an immune stimulating effect by enhancing the resistance to infections, the capacity of influencing haemopoieses, and stimulating the production of antibodies and cytokines. Sulfolipids derived from *Spirulina* have also proved effective against HIV. Extracts from *Spirulina* biomass have also been found active against herpes virus, cytomegalovirus, influenza virus, etc. *Spirulina* extracts have also been shown capable of inhibiting carcinogenesis (Arpita Mohan *et al.*, 2014).^[8] *Spirulina* is a rich source of phycocyanin, carotenoids, Bili proteins, phenolic acids, iodine, and vitamin. More over the high active ingredient of C-phycocyanin in *Spirulina* makes it exhibit activities such as an antioxidant, anti-inflammatory activity, it shows immunomodulatory activities and bio modulating properties (Liu Q *et al.*, 2016), (Nege A S *et al.*, 2020), (Abdulmumin A Nuhu, 2013).^[9,10,11]

Health benefits of *Spirulina*

Malnutrition is one of the conditions of deficiency in nutrients. This is observed mostly in the children. Almost half of the children below three years are suffering with malnutrition. To fight against malnutrition *Spirulina*, a green superfood packed with nutrients is taken as an option. The composition of *Spirulina* includes high Proteins 60-70%, Carbohydrates- 19 to 20%, Lipids upto 14% of dry weight (ORIO CIFERRI 1983). Daily consumption of *S. platensis* coupled with nutritional counselling significantly was found in reducing nutrient deficiency and also increase in immunity. It is also strongly associated with significant reduction of the viral load and increase the CD4 cell count and six month follow up of HIV-infected, ART-naïve in early stages of disease significantly delayed the time to HIV disease progression (Njom, A. N *et al.*, 2016), (Marthe-Elise Ngo-Matip *et al.*, 2014).^[12,13]

Spirulina has a peculiar property and it is a boon to immune system. In addition to antioxidant, anti-inflammatory activity, it shows immunomodulatory activities and bio modulating properties. Many studies have proved that *Spirulina* possesses immune enhancing properties. And also this algae improves immunological resistance in subjects with various types of cancer, AIDS, and other viral disease (Khan Z *et al.*, 2005).^[14]

The important health benefits of *Spirulina* are

- Radioprotection
- Protection of kidneys and liver
- Improvement of blood quality and prevention of anaemia
- Benefits for diabetes
- Prevention of liver and renal toxicity
- Immune protection
- Relief in allergic reaction
- Removal of heavy metals from the body
- Reduction of blood pressure (Arpita Mohan *et al.*, 2014).^[8]

Immunity

Immunity is nothing but it is a strength of an organism to defend against the infection. The immune system protects us from invading pathogenic foreign microorganisms (viruses, bacteria, fungi and other parasites) into the body. It is a defence mechanism exerted by the body to recognise non- self or foreign matter. Immune defence or immunity of the body operates in two different ways, which are interdependent to some extent.

1. Innate immunity
2. Adaptive immunity

Innate immunity provides the immediate defence against the pathogenic organisms in general. It is not specific to

any organisms and provides the first line of defence against any infection. It is said to be non-specific and is not specific to a particular pathogen. It is a rapid response which occurs within minutes; It has no memory and does not confer long-lasting immunity to the host. It has 4 main components and is found in all classes of plant and animal life. Unlike innate immunity which is non-specific adaptive immunity is This provides a specific immune response directed at an invading pathogen. Following exposure to a foreign organism there is an initial EFFECTOR RESPONSE that eliminates or neutralizes a pathogen. Later re-exposure to the same foreign organism induces a MEMORY RESPONSE with a more rapid immune reaction that eliminates the pathogen and prevents disease. This response is found only in vertebrates.

How *Spirulina* increases immunity in the body

Spirulina platensis extract has many usages in medical field, it also has the properties of *in vitro* antiviral and anti-AIDS activities, anti-inflammatory, anti-microbial, Immunomodulatory properties. It is also effective in reducing hyperlipidaemia, diabetes, and high blood pressure in man and animals, antitumor and antiviral effects against Herpes simplex.

In Human Beings

In HIV patients: In HIV the supplementation with *S. platensis* during 6 months and after 6 months of treatment resulted in an increase in CD4 count and haemoglobin level and also a decrease in viral load (Ngo-Matip *et al.*, 2015).^[13] In test conducted more than 50% of the patients who were treated with *Spirulina platensis* showed the significant regressions of opportunistic disease. This is because of presence of a large amount of macro and micronutrient identified in *Spirulina platensis* which can improve the immune system or prevent these opportunistic diseases. Also, intake of *S. platensis* even in small amounts it can build up both humoral, cellular arms of the immune system and also enhances the body's ability to generate new blood cells. The result showed that the spirulina platensis extract acts by avoiding the virus to attach and penetrate to the cell membrane to infect the cell. The calcium-spirulant (Ca-SP) and sodium-spirulant (Na-SP) found in the *S. platensis* extract interfered with replication of viruses including HIV-1, also increases the activation of macrophages, T- and NK cell activities. Polysaccharides, phycocyanin, glycol-lipids and Sulfolipids identified in *S. platensis* extract increase the immunity by enhancing bone marrow reproduction, growth of thymus and spleen and bio-synthesis of serum protein. Presence of phenolic acids, tocopherols and β -carotene and other antioxidant molecules in *S. platensis* extract exhibited the antioxidant protection with many benefits both *in vitro* and *in vivo*.

In animals**In mice**

Feeding spirulina to fish and poultry results in increased disease resistance and in improved survival and growth rates, which may be a result from an improvement of immune functions. Also, the suppression of delayed hypersensitivity by toluene-2, 4-diisocyanate in mice fed *Spirulina* in chow. The antitumor effect of *Spirulina* in hamsters through stimulation of the immune response, involving T-cell activation. The test that was conducted on mice showed that simultaneous treatment with antigen and *Spirulina platensis* extract may enhance IgA production through a stimulation of the intestinal immune system. Thus, obtained secretory IgA antibodies, the predominant isotype in most secretory tissues or mucosal surfaces, exhibit various biological properties such as agglutination of microorganisms; neutralization of bacterial enzymes, toxins, and viruses (O Hayashi *et al.*, 1994).^[15]

In fishes

The result of the test conducted on parrot fish showed that it showed improvement of fish growth by replacing 5% FM protein with *Spirulina*. Growth enhancement effect of *Spirulina* is due to its role in nutrient digestibility and its high contents of several nutrients, such as vitamins and minerals. According to enhancement of the dietary antioxidant capacity by *Spirulina platensis*, its inclusion in diets would protect fish from tissue damage by inhibition of the formations of reactive oxygen derivatives (S.S.Kim *et al.*, 2013).^[16]

Spirulina platensis has been recognized as a potential immunostimulant and also it augments components of mucosal and systemic immune system through the activation of non-specific immune system. The aqueous extract of *Spirulina platensis* showed the influence on the immune system by enhancement of phagocytic activity and the stimulation of NK cells.

Peritoneal phagocytes from fish fed *Spirulina platensis* showed enhanced phagocytosis against zymosan and an increased chemotaxis to *E. ictaluri* exoantigen. (Patria L Duncan *et al.*, 1996).^[17] There was significant increase in growth performance factors and also increase in survival rates in fish consumed with spirulina supplement, also there was significant increase in hematocrit, nitroblue tetrazolium and lysozyme activity. (Mai D Ibrahim *et al.*, 2013).^[18]

The polysaccharides and other components present in algae can be utilized for the development of the antiviral agents against the novel coronavirus, COVID-19. The sulfated polysaccharides present in algae have the high potential to act against viral infections. As these algae is proven to have anti-viral properties it can be suggested

for the discover of vaccine against corona. As there is a problem of time consuming for clinical trials, commercially available of vaccine it can be suggested to consume spirulina orally as a preventive measure in form of capsules, chikkis, candies as it is termed as Superfood with high nutritious values which will improve the immunity. This may result in the increase in the immunity of patients and result in the improvement of patient's health.^[19]

Future prospective

Arthrospira platensis is a blue green algae has a potential activity against enveloped RNA virus, hence it may be used against the novel corona virus as a preventing measure. As *Spirulina* is termed as a superfood it can be used as a preventive measure to increase the immunity and control the disease to some extent as it is said Prevention is better than cure.

REFERENCES

1. Praveena, B., Jyothsna, P., Murthy, S.D.S. (2015). Review on UV-B radiation impact on cyanobacteria and possible protection mechanisms In: "Microbes and sustainable Agriculture: Prospects and Challenges" (Kaushal Chowdary and Dolly Watal Dhar, eds) pp-153-168, Nova Science Publishers, USA.
2. Karkos, P.D., Leong, S. C., Karkos, C, D., Sivaji, N., and Assimakopoulos, D.A. (2011). Spirulina in clinical practice: evidence-based human applications. Evidence-based complementary and alternative medicine, 2011; 1-4.
3. Ciferri, O. (1983). Spirulina, the edible microorganism. *Microbiological reviews*, 47(4): 551.
4. Akbarizare, M., Ofoghi, H., Hadizadeh, M., and Moazami, N. (2020). *In vitro* assessment of the cytotoxic effects of secondary metabolites from *Spirulina platensis* on hepatocellular carcinoma. *Egyptian Liver Journal*, 10(1): 1-8.
5. Saranraj, P., and Sivasakthi, S. (2014). Spirulina platensis—food for future: a review. *Asian Journal of Pharmaceutical Science and Technology*, 4(1): 26-33.
6. Ali, S. K., and Saleh, A. M. (2012). Spirulina-an overview. *International journal of Pharmacy and Pharmaceutical sciences*, 4(3): 9-15.
7. Radha Palaniswamy* and Chandra Veluchamy,(2018). THERAPEUTIC USES OF SPIRULINA: A REVIEW. *International Journal of Current Innovation Research*, 4(1 A): 975-979.
8. Mohan, A., Misra, N., Srivastav, D., Umopathy, D., and Kumar, S. (2014). *Spirulina*, the nature's wonder: A review. *Lipids*, 5: 5-10.
9. Liu, Q., Huang, Y., Zhang, R., Cai, T., and Cai, Y. (2016). Medical application of *Spirulina platensis* derived C-phycocyanin. Evidence-based

- complementary and alternative medicine, 2016; 1-14.
10. Nege, A. S., Masithah, E. D., & Khotib, J. (2020). Trends in the Uses of Spirulina Microalga: A mini-review. *Jurnal Ilmiah Perikanan dan Kelautan*, 12(1): 149-166.
 11. Nuhu, A. A. (2013). Spirulina (Arthrospira): an important source of nutritional and medicinal compounds. *Journal of Marine biology*, 2013; 1-8.
 12. Njom, A. N., Nguwoh, P. S., Ngounouh, C. T., Tchidjou, H. K., Pieme, C. A., Otélé, J. M., ... & Fokam, J. (2016). HIV-Infected or-Exposed Children Exhibit Lower Immunogenicity to Hepatitis B Vaccine in Yaoundé, Cameroon: An Appeal for Revised Policies in Tropical Settings?. *PloS one*, 11(9): e0161714-e0161714.
 13. Ngo-Matip, M. E., Pieme, C.A., Azabji-kenfack, M., Moukette, B. M., Korosky, E., Stefanini, P., and Mbofung, C.M. (2015). Impact of daily supplementation of spirulina platensis on the immune system of the naïve HIV-1 patients in Camereroon: a 12 months single blind, randomized, multicenter trial. *Nutrition Journal*, 14(1): 70.
 14. Khan, Z., Bhadouria, P., and Bisen, P.S. (2005). Nutritional and therapeutic potential of *Spirulina*, *Current pharmaceutical biotechnology*, 6(5): 373-379.
 15. Hayashi, O., Katoh, T., and Okuwaki, Y. (1994). Enhancement of antibody production in mice by dietary *Spirulina platensis*, *Journal of Nutritional Science and Vitaminology*, 40(5): 431-441.
 16. Kim, S. S., Rahimnejad, S., Kim, K. W., and Lee, K. J. (2013). Partial replacement of fish meal with *Spirulina Pacifica* in diets for parrot fish (*Oplegnathus fasciatus*). *Turkish Journal of Fisheries and Aquatic Sciences*, 13(2), 197-204.
 17. Duncan, P.L., and Klesius, P.H. (1996). Effects of feeding Spirulina on specific and nonspecific immune responses of channel catfish, *Journal of Aquatic Animal Health*, 8(4): 308-313.
 18. Ibrahim, M.D., and Ibrahim, M.A. (2014). The potential effects of spirulina platensis (*Arthrospira platensis*) on tissue protection of Nile tilapia (*Oreochromis niloticus*) through estimation of P53 level, *Journal of advanced research*, 5(1): 133-136.
 19. Elaya Perumal, U., and Sundararaj, R. (2020) Algae: A Potential Source to Prevent and Cure the Novel Coronavirus—A review, *International Journal on Emerging Technologies*, 11(2): 479-483.