

SPIRULINA AS A SOURCE OF BIOACTIVE COMPOUNDS IN THE FOOD AND HEALTH SECTOR

Abstract

The purpose of the present study is to summarise the mechanisms of action of *Spirulina*, phytochemical, food safety, nanofiber scaffolds, PHB, highlight the potential effects of this alga on humans, and address current and potential future clinical applications, based primarily on *in vivo* studies and a few carefully designed *in vitro* studies, as well as the highest levels of evidence currently available in the literature. The objective of this study is to examine the antioxidant activity of new commercial products containing fresh *Spirulina* and the factors influencing it. Antioxidant activity varies depending on the combination of elements in the meal, according to several studies. government organisations growing *Spirulina* to reduce the cost of purchasing it from private businesses and supplying it as food to anganwadis and ashrams so that it can gradually eradicate the problem of malnutrition in India. The synergy coefficient was used to identify and express synergistic, antagonistic, and additive interactions between samples in order to gradually alleviate the issue of malnutrition in India and other nations. In the present review the bioactive composition of *Spirulina* and potential for different applications in functional foods are covered.

Keywords: Phytochemical, Food safety, Nanofiber scaffolds, PHB

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I. INTRODUCTION

Spirulina are multicellular and filamentous blue-green microalgae belonging to two separate genera *Spirulina* and *Arthrospira* and consists of about 15 species. Of these, *Arthrospira platensis* is the most common and widely available *Spirulina* and most of the published research and public health decision refers to this specific species. *Spirulina* is natural food belongs to plantae kingdom which consists of different phytochemicals. (Balakrishnan *et al.*, 2009 and Dawes, 1998). This phytochemicals are biologically significant and plays a vital role in medicinal applications. Many studies revealed that phytochemicals from *Spirulina* used in cancer, tuberculosis, inflammation and many other blood related diseases (Shyamala *et al.*, 2013). The bioactive compound includes proteins, carbohydrates, phenolic compounds, vitamins, and minerals. The production of bioactive compound is depends on environmental conditions such as temperature, pH, nutrients, metal ions and other chemicals (Wijesekara I. *et al.*, 2011). These phytochemicals play an important role in the treatment of many chronic diseases. There are two main methods for the analysis of phytochemical screening such as qualitative and quantitative analysis. The qualitative tests are used to identify the constituents. (Wijesekara *et al.*, 2011). *Spirulina* is marketed and consumed in several countries, including, U.S.A, Thailand, Taiwan, Vietnam, China, India and Cuba (Shanmugam M *et al.*, 2000).

II. FIELD OF APPLICATION

Asia has used *Spirulina* for more than a millennium. It has been marketed as a food supplement due to the high-quality protein and additional beneficial components (Ali and Saleh, 2012, Borowitzka, 2013, Priyadarshani and Rath, 2012). *Spirulina* has recently gained popularity as a non-toxic, non-carcinogenic natural blue colourant for use in food and cosmetics (Pandey *et al.*, 2013). In the US, the FDA has designated *Spirulina* extract as a colour additive exempt from certification and authorised its use in ready-to eat cereals (apart from extruded cereals), frostings, ice cream and frozen desserts, dessert coatings and toppings, beverage mixes and powders, yoghurts, custards, puddings, cottage cheese, gelatin, and breadcrumbs. *Spirulina* is a suitable dye for dairy goods, ice cream, and sweets including chewing gum, coatings, chocolate, sugar embellishments, and candies. The shelf life of the finished goods is increased during processing and storage by low temperatures and light exclusion. The colourant is unsuitable for commercial use for watery food items with pH values below 4.5 and alcohol contents above 20%. (Newsome *et al.*, 2014). Additionally, *Spirulina* is utilised as an antioxidant, thickening, and water binding agent, especially in face, skin, and hair care products, as well as a pigment in cosmetics including lip Sticks, eyeliners, and eye shadows. (Priyadarshani and Rath, 2012). Numerous toxicological investigations have validated the safety of *Spirulina*. *Spirulina* is currently one of the items on the US Food and Drug Administration's list of item classified as Generally Recognised as Safe (GRAS). (Tarantino LM.2003.) (Belay A. 2003.) *Spirulina* biomass demonstrates antiallergenic, antibacterial, antifungal, anti-inflammatory antioxidant, and immunomodulating effects in addition to stimulating vital biological processes (Khan *et al.*, 2005). As a result, the biomass of *Spirulina* LEB 18 added to scaffolds promotes cell proliferation and tissue regeneration (Morais *et al.*, 2010. Qureshi MA *et al.*, 1995).

III. EXPECTED OUTCOMES

With the efforts of researchers and the government, the potential of *Spirulina* must be noticed and brought into use for solving various problems like malnutrition on national and international levels.

Spirulina proves to be an excellent source of micro nutrients like iron iodine, vitamin a foliate zinc, vitamin B1 vitamin B2 and vitamin B3 as all these micronutrients happen to be very effective in recovery from malnutrition. Eradication of malnutrition in Maharashtra gradually with the help of *Spirulina* supplements manufactured by the government.

- Use of *Spirulina* ruminants or expired supplements as a natural fertilizer to crops and other agricultural produce.
- Use of cheaper spiral in a based supplements produced by government for people suffering from anaemia diabetes cholesterol and blood pressure related issues as it aids them very well.
- Eradication of malnutrition in Maharashtra gradually with the help of *Spirulina* supplements manufactured by the government.
- Approximately 3000 tons dry weight is currently produced annually in the United States, Thailand, India, Taiwan, China, Pakistan, and Burma (Raja et al., 2007)

IV. SCOPE APPROACH

The *Spirulina* Market is expected to reach \$1.1 billion by 2030, at a CAGR of 9.4% from 2023 to 2030, while in terms of volume, the market is expected to reach 102,381.3 tons by 2030, at a CAGR of 8% from 2023 to 2030

V. USE OF SPIRULINA FOOD INDUSTRY

Spirulina are multicellular 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.

Earthrise farm was the first *Spirulina* farm in North America, established in 1976, and today is the largest *Spirulina* farm in the world. With over 40 years of experience and a 108-acre site, Earthrise has continued to produce high quality and safe *Spirulina* for consumers around the world. (WWW.Earthrise)

VI. BENEFITS TO THE SOCIETY

Like other blue-green algae, *Spirulina* is susceptible to contamination from poisonous compounds known as microcystins. Additionally, it can take up heavy metals from the water in which it is grown. For these reasons, it's crucial to purchase *Spirulina* from a reputable company.

Spirulina may strengthen the immune system, assist in preventing allergic reactions, and have antiviral and anticancer characteristics, according to test tube and animal research. However, there is no evidence that *Spirulina* offers these or any other advantages to humans. More study is required.

Nanofiber scaffolds offer tissue engineering potential by replicating extracellular matrix structure and function. Electrospun scaffolds have high surface area, porosity, nutrient diffusion, and promote angiogenesis/vascularization during regeneration. (Ramier J, 2014)

Nanofiber scaffolds can be replaced with *Spirulina* biopolymers, which are biodegradable and compatible with cells and tissues. *Spirulina* biomass can be added to polymer solutions without extreme temperatures or pH, allowing internal components like proteins, fatty acids, and biopolymers to stimulate cells or tissues.

Polyhydroxyalkanoates (PHAs), including polyhydroxybutyrate (PHB), can be extracted from microorganisms like *Spirulina* and used as a toxic biocompatible scaffold for human tissue and organ culture. PHB degrades into a harmless compound, indicating its biocompatibility with cultured cells and tissues. *Spirulina* biopolymer nanofiber scaffolds have lower rejection risks and advantageous bioactive compounds (Sudesh K, et al 2000” and Jau M *et al.*, 2005).

VII. FUTURE SCOPE

Commercial and mass cultivation: In the early 1960s, Japan began a large-scale culture production programme for the microalgae *Chlorella* and *Spirulina*. More than 22 nations currently engage in extensive commercial *Spirulina* cultivation.

VIII. CONCLUSION

Already, *Spirulina* is a well acknowledged and well-liked nutritional supplement. The requirement for studies to support its health advantages is minimal. This is supported by information on its nutritional worth, which makes *Spirulina* a superior option when creating diets and addressing malnutrition.

Preclinical research employing animal models is still being done to assess the bioactive potential of *Spirulina*. However, these researches appear to support the existence of *Spirulina's* potent antioxidant, anticancer, and antiviral activities as well as its ability to prevent diabetes, obesity, and allergic inflammation. Additionally, it has excellent hypoglycaemic, hypocholesterolaemia, and immunomodulatory potential.

The potential of *Spirulina* as a therapeutic food is drawing more attention due to consistent results on its bioactivities. The use of nutraceuticals in the treatment of hypercholesterolemia, hyperglycaemia, cardiovascular disease, and cancer should be quite beneficial. Studying the phytochemical composition, nutritional and biological effects allows the development of new scientific research.

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