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SPIRULINA SUPPLEMENTATION: A THEMATIC REVIEW OF HEALTH BENEFITS DOSAGE AND CLINICAL IMPLICATION

Dr. S. Senthil Kumaran[1*], Dr. R. Giridharan[2]

[1] Assistant Professor, General & Adapted Physical Education and Yoga (GAPEY), Ramakrishna Mission Vivekananda Educational & Research Institute (Deemed University), Coimbatore, Tamil Nadu.*

[2] Associate Professor and Head, General & Adapted Physical Education and Yoga (GAPEY), Ramakrishna Mission Vivekananda Educational & Research Institute (Deemed University), Coimbatore, Tamil Nadu.

ABSTRACT

Spirulina is a microscopic blue-green algae (cyanobacteria), has gained global recognition as a potent dietary supplement owing to its exceptional nutritional profile. Rich in high-quality protein, essential amino acids, vitamins (especially B-complex and vitamin A), minerals (such as iron, calcium and magnesium), essential fatty acids and powerful antioxidants like phycocyanin, spirulina is increasingly used in both preventive health and complementary medicine. This thematic review synthesizes findings from multiple peer-reviewed studies to present a comprehensive overview of spirulina's health benefits and physiological effects. Specifically, it examines spirulina's role in enhancing immune function, reducing oxidative stress and inflammation, supporting cardiovascular health through lipid profile modulation and improving glycemic control in individuals with metabolic disorders. The review also explores its potential in alleviating allergy symptoms, enhancing physical performance and contributing to malnutrition recovery programs. In addition, the paper discusses recommended dosage ranges for general wellness and therapeutic use, identifies groups who should exercise caution, and highlights the importance of product quality and safety testing. While current research underscores spirulina's potential as a valuable functional food, evidence suggests that its benefits are most effective when consumed in appropriate doses and sourced from reputable suppliers. By consolidating available scientific knowledge, this paper aims to guide healthcare professionals, nutritionists and health-conscious individuals toward the informed and safe use of spirulina supplementation in various contexts.

INTRODUCTION

Spirulina (Arthrospira platensis) is a microscopic, spiral-shaped blue-green algae traditionally used as a food source. In recent decades, it has gained global attention as a functional food and dietary supplement due to its dense nutritional profile and wide-ranging health effects. Spirulina is naturally rich in protein, essential amino acids, vitamins, minerals and biologically active compounds such as phycocyanin and gamma-linolenic acid.

This review presents a thematic overview of spirulina supplementation based on recent research. It explores its nutritional profile, therapeutic potential, recommended intake levels and any safety considerations.

Nutritional Profile of Spirulina

Spirulina is widely regarded as one of the most nutrient-dense natural substances known to science. This blue-green microalgae is exceptionally rich in high-quality protein, comprising approximately 60–70% of its dry weight. Unlike many plant-based sources, spirulina provides all essential amino acids, making it a complete protein suitable for vegetarians and vegans. This high protein content, combined with its easy digestibility, makes spirulina a valuable supplement for individuals with increased protein needs, such as athletes, growing children or those recovering from illness.

In addition to proteins, spirulina offers a diverse range of vitamins essential for metabolic functions and cellular health. It is particularly abundant in B-complex vitamins, including thiamine (B1), riboflavin (B2) and niacin (B3), which are vital for energy production, nervous system function, and red blood cell formation. It also contains significant levels of provitamin A (in the form of beta-carotene), which supports eye health and immunity and vitamin E, a known antioxidant that helps protect cell membranes from oxidative damage.

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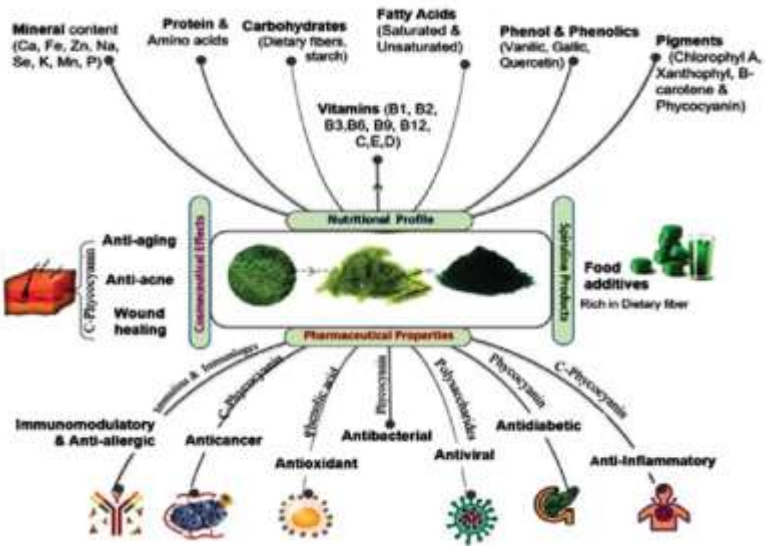
The mineral content of spirulina is equally impressive. It is a natural source of iron, which is crucial for oxygen transport and anemia prevention, as well as calcium and magnesium, which support bone strength and neuromuscular function. Potassium an essential electrolyte, contributes to heart health and fluid balance. Spirulina also contains trace elements such as zinc, selenium, and manganese, which are involved in immune regulation and antioxidant enzyme function.

Another remarkable feature of spirulina is its lipid profile. Though low in fat, it includes a rare and beneficial omega-6 fatty acid known as gamma-linolenic acid (GLA). GLA possesses potent anti-inflammatory properties and has been linked to improved skin health, hormone balance and cardiovascular function.



Furthermore, spirulina is rich in bioactive pigments with antioxidant properties, including phycocyanin, which gives spirulina its characteristic blue-green color. Phycocyanin has been extensively studied for its free radical-scavenging activity and anti-inflammatory effects. Other important antioxidants in spirulina include chlorophyll, which supports detoxification, and carotenoids such as beta-carotene and zeaxanthin, which play a role in eye and skin health.

Spirulina offers a comprehensive array of macronutrients and micronutrients in a highly bioavailable form. Its unique combination of protein, vitamins, minerals, essential fatty acids, and antioxidants makes it an ideal candidate for addressing nutritional deficiencies and promoting overall health in both clinical and non-clinical populations.

Health Benefits of Spirulina Supplementation

Spirulina supplementation has been associated with a wide range of health benefits, many of which are supported by both experimental and clinical studies. One of its most notable effects is immune system modulation. Spirulina has been shown to stimulate the production and activity of immune cells such as natural killer cells, T lymphocytes and macrophages, thereby enhancing the body's ability to fight infections and control inflammation. This immunostimulatory effect also includes the increased production of antibodies, contributing to improved adaptive immunity **(Karkos et al., 2011).** Such properties make spirulina a potentially valuable supplement in both preventive health and immune-compromised conditions.

Another major benefit of spirulina is its antioxidant and anti-inflammatory activity, primarily attributed to its key bioactive compound, phycocyanin. This blue pigment is a powerful scavenger of free radicals, helping to neutralize oxidative stress, which is a major contributing factor in chronic diseases such as cancer, diabetes and neurodegenerative disorders. In addition to protecting cellular structures from oxidative damage, phycocyanin also inhibits the expression of inflammatory cytokines, thereby reducing systemic inflammation **(Kumar et al., 2008).**

Spirulina also offers significant cardiovascular benefits. Several studies have demonstrated that regular supplementation can lower low-density lipoprotein (LDL) cholesterol, total cholesterol and triglyceride levels, while simultaneously increasing high-density lipoprotein (HDL) cholesterol. These lipid-modifying effects suggest a cardioprotective role, particularly in individuals with hyperlipidemia or metabolic syndrome. Moreover, spirulina may help reduce blood pressure and improve arterial function, further enhancing its value in heart health management **(Torres-Duran et al., 2007).**

In terms of blood sugar regulation, spirulina has shown promise in individuals with type 2 diabetes. Clinical trials report reductions in fasting blood glucose levels and improvements in insulin sensitivity after spirulina supplementation, likely due to its influence on pancreatic beta-cell function and its antioxidant properties **(Parikh et al., 2001).** These effects position spirulina as a supportive dietary intervention for managing glycemic control in diabetic and prediabetic individuals.

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Spirulina also appears to provide relief from allergic reactions, particularly allergic rhinitis. Research has indicated that it can significantly reduce symptoms such as nasal congestion, sneezing and itching. These effects are believed to be mediated by its ability to modulate immune responses and reduce histamine release, offering a natural alternative to conventional antihistamines in the management of seasonal or chronic allergies **(Cingi et al., 2008).**

Spirulina may contribute to enhanced physical performance, especially in athletic populations. Supplementation has been associated with increased endurance, reduced exercise-induced oxidative stress and quicker muscle recovery. These benefits are primarily due to spirulina's high antioxidant content, which helps combat exercise-related oxidative damage as well as its rich nutrient profile, which supports energy metabolism and reduces fatigue **(Kalafati et al., 2010).** Together, these findings highlight spirulina's potential as a functional supplement for both general health and specific therapeutic applications.

Recommended Dosage

The appropriate dosage of spirulina supplementation can vary significantly depending on the intended purpose, individual health status, and physiological response. For general health maintenance and nutritional support, a daily intake of **1 to 3 grams** is commonly recommended. This dosage is generally sufficient to provide essential nutrients such as protein, vitamins, and antioxidants, contributing to improved energy levels, immune function and overall well-being. For individuals seeking therapeutic benefits, such as lowering blood cholesterol, improving blood sugar control or supporting cardiovascular health, higher doses in the range of **5 to 8 grams** per day may be more effective. Clinical studies have used such dosages to achieve measurable health outcomes, particularly in cases of hyperlipidemia and type 2 diabetes.

In the context of athletic performance and physical endurance, spirulina is often taken in moderate-to-high doses, typically between **4 and 6 grams** daily. At these levels, spirulina may help reduce exercise-induced oxidative stress, enhance recovery and support muscle function due to its rich nutrient and antioxidant content. Regardless of the purpose, it is crucial to begin supplementation with a lower dose and gradually increase it to allow the body to adjust and to monitor for any adverse reactions.

Spirulina is available in tablet, capsule or powdered form, making it flexible and convenient for various users. It is generally recommended to take spirulina with meals, which may improve nutrient absorption and reduce the risk of gastrointestinal discomfort. While spirulina is considered safe for most people, its dosage should ideally be tailored to individual needs and health conditions. Consultation with a healthcare professional is advised, especially for individuals with pre-existing medical conditions, those taking medications or those considering high doses for therapeutic use. Additionally, it is essential to ensure that the spirulina product is sourced from reputable suppliers as contamination with heavy metals or toxins can pose health risks.

Safety and Precautions

Spirulina is considered safe for most people when used in appropriate doses. However:

- Some may experience mild side effects like nausea, bloating or headaches
- People with phenylketonuria (PKU) or autoimmune diseases should avoid spirulina unless advised by a doctor.
- Contamination is a concern; always choose high-quality, lab-tested spirulina to avoid toxins like microcystins or heavy metals
- Pregnant or lactating women should consult a physician before use.

CONCLUSION

Spirulina is a highly nutritious and versatile natural supplement that offers a range of scientifically supported health benefits. Its rich content of protein, essential vitamins, minerals and antioxidants makes it particularly valuable for enhancing immune function, reducing oxidative stress, supporting cardiovascular health and regulating blood sugar levels. When taken in appropriate doses, spirulina is generally well tolerated and can be a safe and effective addition to one's daily nutritional routine. As ongoing research continues to explore its full therapeutic potential, spirulina's role in preventive and integrative health practices is becoming increasingly recognized. However, to maximize its benefits, users should pay careful attention to dosing guidelines and ensure they choose high-quality, contaminant-free products. Overall, spirulina represents a promising natural aid for promoting general wellness and addressing specific health conditions in a holistic manner.

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