Use of nutraceuticals in the management of obesity and other chronic diseases

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Abstract

Obesity is a chronic, multifactorial disease that represents a global public health problem and is associated with the development of metabolic disorders such as type 2 diabetes mellitus, arterial hypertension, and dyslipidemia. In this context, nutraceuticals have emerged as a complementary therapeutic alternative due to their bioactive properties.

The present study corresponds to a narrative review of the scientific literature, conducted through a search in databases such as PubMed, SciELO, and Elsevier. Articles published between 2015 and 2025, in both English and Spanish, were included. Clinical trials, systematic reviews, and meta-analyses related to the use of nutraceuticals in the management of obesity and chronic diseases were considered. Duplicate studies, articles without full-text access, and those not related to the objective of the study were excluded. Article selection was carried out through title, abstract, and full-text review.

Various nutraceuticals were analyzed, highlighting Spirulina (Arthrospira platensis), a microalga rich in proteins, antioxidants, and micronutrients, which has shown positive effects in reducing body weight, improving lipid profile, and decreasing inflammation. The reviewed evidence suggests that nutraceuticals may contribute to the comprehensive management of obesity, particularly as adjunctive therapy.

In conclusion, although the effects may vary, the use of nutraceuticals represents a promising strategy; however, further evidence is required to establish standardized clinical recommendations.

Keywords: Nutraceuticals; Spirulina; Obesity; Hypertension; Dyslipidemia.

Introduction

Obesity is a chronic and multifactorial disease characterized by an excess of body fat that compromises an individual's health and increases the risk of developing cardiometabolic diseases such as diabetes mellitus, arterial hypertension, and simple or mixed dyslipidemia (1).

Over recent decades, the prevalence of obesity has increased significantly, doubling between 1990 and 2022. According to the World Health Organization (WHO), in 2022 approximately 2.5 billion adults were overweight and 890 million were obese, representing nearly 16% of the global population (2).

Diet plays a fundamental role in the functioning of the body and in maintaining homeostasis. Its primary purpose is to meet the nutritional requirements necessary to preserve physiological balance, as well as physical and mental well-being. However, the evolution of modern lifestyles has promoted the homogenization of dietary patterns and an increased consumption of ultra-processed foods, contributing to the rise of non-communicable diseases and constituting a major public health problem (3).

In this context, the concept of functional food emerges, defined by the Center for Functional Foods in the United States as natural or processed foods containing biologically active compounds capable of providing clinically proven health benefits through specific biomarkers associated with the prevention, management, or treatment of chronic diseases and their symptoms (4).

The term nutraceutical, introduced in the 1990s by Dr. Stephen De Felice, derives from the combination of the words "nutrition" and "pharmaceutical." This concept refers to bioactive compounds derived from natural sources—such as plants, algae, herbs, and functional foods—that contribute to health promotion, disease prevention, and therapeutic support in various conditions (5,6).

Nutraceuticals may provide multiple benefits by modulating metabolic processes, improving nutrient absorption, and reducing chronic inflammatory states. These properties make them an attractive complementary alternative in the management of obesity and other chronic diseases (6).

Various nutraceutical compounds have demonstrated the ability to regulate appetite, increase thermogenesis, reduce fat absorption, and improve lipid profiles, thereby promoting weight loss and improving metabolic parameters in individuals with obesity (7).

In this context, the present review analyzes the available scientific evidence on the efficacy of different nutraceuticals in the treatment of obesity, with the aim of evaluating whether dietary and nutritional interventions supported by their use can modify the pathophysiological processes involved in the development of this disease (8).

Methodology

A narrative review of the scientific literature was conducted to analyze the available evidence on the use of nutraceuticals in the management of obesity and other chronic diseases.

The literature search was performed in electronic databases such as PubMed, SciELO, and Elsevier. Articles published between 2015 and 2025 in English and Spanish were included.

Search terms included: "nutraceuticals," "obesity," ***Spirulina***, ***Camellia sinensis***, ***Nigella sativa***, "glucomannan," "polyphenols," and "metabolic diseases," along with their English equivalents. These terms were combined using Boolean operators (AND, OR).

Inclusion criteria comprised studies in humans and animal models, clinical trials, systematic reviews, and meta-analyses related to the use of nutraceuticals in the treatment of obesity or chronic diseases. Exclusion criteria included duplicate articles, studies without full-text access, and those not directly related to the study objective. Article selection was performed through title, abstract, and full-text review.

The selection process was carried out in three phases: title screening, abstract review, and full-text assessment. Finally, the most relevant studies were included for the development of the review.

Results

The growing interest in the use of nutraceuticals as a complementary strategy in the management of obesity and other chronic diseases has driven research aimed at evaluating their metabolic, anti-inflammatory, and antioxidant effects. Various bioactive compounds derived from natural foods have demonstrated a favorable influence on pathophysiological mechanisms associated with excess adiposity, insulin resistance, and low-grade systemic inflammation. This section reviews and compares the main nutraceuticals studied in body weight control and the improvement of metabolic parameters associated with obesity, analyzing their mechanisms of action and the available clinical evidence, with the aim of identifying their potential as adjunctive therapies within a comprehensive approach to chronic diseases.

Dietary Fiber

The Codex Alimentarius Commission defines dietary fiber as carbohydrate polymers with ten or more monomeric units that cannot be degraded by human digestive enzymes and are therefore not absorbed in the small intestine (9). Due to these characteristics, dietary fiber plays a relevant role in metabolic regulation and the maintenance of gastrointestinal health.

According to their physicochemical properties, dietary fibers are classified as soluble and insoluble, each with distinct physiological effects. Soluble fiber has a greater capacity for water absorption, viscosity, and intestinal fermentation, and is mainly found in foods such as oats, corn, barley, fruits, vegetables, and legumes (10). In contrast, insoluble fiber has a lower degree of fermentation, and its intestinal effects largely depend on the amount consumed; its main sources include wheat bran, whole grains, and various vegetables (10).

The intestinal microbiota plays a fundamental role in host metabolic processes through fermentation mechanisms under anaerobic conditions, promoting the production of short-chain fatty acids such as acetate, butyrate, and propionate, which are involved in metabolic and inflammatory regulation (11).

Regarding obesity, dietary fiber contributes to metabolic regulation by reducing serum lipid levels and delaying the postprandial glycemic response. These effects are associated with the formation of viscous solutions in the gastrointestinal tract, which hinder nutrient digestion and absorption, promoting their fecal excretion and reducing postprandial glucose and insulin levels (11).

In a study conducted in Japan, glycemic response was evaluated using a 500 kcal food tolerance test, comparing a diet based on white rice with another including rice mixed with 50% β-glucan-rich barley. The results showed a significant reduction in postprandial glycemia and in the glucose-time area under the curve in the group consuming barley (12).

Ilex paraguariensis (Yerba Mate)

Ilex paraguariensis, commonly known as yerba mate, is a plant native to South America that has been widely studied for its effects on energy metabolism and body weight control. Its properties are attributed to bioactive compounds such as caffeine, theobromine, and polyphenols, which promote fatty acid oxidation and contribute to improved physical performance (13).

Among its beneficial effects are antioxidant and anti-inflammatory activity, hypolipidemic effects, body weight regulation, modulation of the intestinal microbiota, and hypoglycemic activity. Cardioprotective, neuroprotective, and potential anticancer properties have also been described, positioning it as a relevant nutraceutical in chronic metabolic diseases (13).

Nigella sativa (Black Cumin)

Nigella sativa oil, commonly known as black cumin, has been widely studied for its antioxidant, anti-inflammatory, and antimicrobial properties. Its supplementation has been associated with reduced body weight and improved lipid profile in patients with metabolic disorders (14).

Its main components include terpenes, saponins, quinones, sterols, proteins, and unsaturated fatty acids, with thymoquinone and thymol being particularly notable due to their biological effects. Additionally, it increases the activity of antioxidant enzymes such as glutathione peroxidase (GPx), glutathione-S-transferase (GST), and superoxide dismutase (SOD) in erythrocytes, contributing to the reduction of cellular oxidative stress (14).

Furthermore, thymoquinone administration has been shown to increase hepatic antioxidant enzymes such as catalase (CAT), glutathione reductase (GR), GPx, SOD, and reduced glutathione (GSH), regulating the production of reactive oxygen species (15). Bioactive compounds such as nigellone and α-hederin have also demonstrated antihistaminic, anti-inflammatory, and immunomodulatory effects in animal models. These effects are associated with the reduction of proinflammatory mediators such as nitric oxide (NO), inducible nitric oxide synthase (iNOS), tumor necrosis factor-alpha (TNF-α), interleukin-1β (IL-1β), interleukin-6 (IL-6), and cyclooxygenase-2 (COX-2), highlighting their significant antioxidant and anti-inflammatory potential (15).

Curcuma longa (Turmeric)

Curcuma longa, belonging to the Zingiberaceae family and also known as Indian saffron, contains curcumin, a polyphenolic compound with beneficial effects on weight reduction and improvement of metabolic parameters associated with chronic diseases (16).

It possesses antioxidant and anti-inflammatory properties capable of modulating lipid and glucose metabolism. Its biological activity is also related to the regulation of multiple molecular targets, including growth factors, transcription factors, cytokines, and kinases involved in inflammatory and cellular proliferative processes (16).

In oncology, clinical trials have evaluated its therapeutic potential. In a study involving patients with advanced pancreatic cancer treated with oral curcumin, anticancer activity was observed in some participants, including prolonged clinical stability and significant tumor reduction. Similarly, in patients with cutaneous squamous cell carcinoma, combined administration of curcumin and monoclonal antibodies showed favorable results in tumor control (16).

The anti-inflammatory effect of turmeric can be explained through several physiological mechanisms, including:

a) Reduction of histamine release
b) Enhancement and prolongation of cortisol action
c) Improvement of microcirculation, facilitating the elimination of metabolites and cellular waste products (16)

The World Health Organization has established safe daily intake ranges of curcumin between 0–3 mg/kg, with benefits reported in joint diseases, metabolic disorders, diabetes, and cardiovascular diseases. Its chelating capacity against heavy metals such as cadmium and lead has also been described, potentially contributing to neuroprotective effects (16).

Additionally, curcumin has demonstrated antimicrobial activity against bacteria, fungi, and viruses, including inhibitory effects against ***Helicobacter pylori***, ***Aspergillus niger***, ***Candida albicans***, and several viruses such as HPV, HIV, and SARS-CoV-2, through viral protease inhibition and modulation of cytokine-mediated inflammatory responses (16).

Camellia sinensis (Green Tea)

Green tea, derived from ***Camellia sinensis***, a plant native to Southeast Asia, particularly China, has been studied for its metabolic and antioxidant properties. During infusion, its water-soluble extract releases various bioactive compounds such as carbohydrates, proteins, vitamins, and flavonoid polyphenols (17).

Approximately one-third of its dry weight consists of catechins, considered its main functional compounds, including epigallocatechin gallate (EGCG), epigallocatechin, epicatechin gallate, epicatechin, and gallocatechin gallate (17). Among these, EGCG is the most metabolically active component, as it has been shown to increase thermogenesis and promote fatty acid oxidation, contributing to body weight control (17).

Therefore, green tea is considered a nutraceutical with potential adjunctive effects in the management of obesity and metabolic disorders due to its antioxidant, thermogenic, and lipid metabolism-modulating properties.

Glucomannan *(Amorphophallus konjac)*

Glucomannan is a soluble fiber with high water absorption capacity that forms a viscous gel in the gastrointestinal tract, increasing satiety and reducing caloric intake (18). It also decreases glucose and lipid absorption, contributing to the management of obesity and dyslipidemia.

Commonly reported doses include:

a) Body weight control: 2–3 g/day
b) Chronic constipation: 3–4 g/day for periods ranging from 10 days to 3 months
c) Hypoglycemic effect: approximately 4.8 g/day
d) Hypolipidemic effect: approximately 4.5 g/day (18)

Polyphenols

Polyphenols are antioxidant compounds found in fruits, vegetables, tea, and cocoa. They have demonstrated cardioprotective effects, including inhibition of LDL oxidation and reduction of atherogenic risk (19). Additionally, they exhibit anti-inflammatory, vasodilatory, and metabolic properties, contributing to body weight control and the prevention of chronic diseases (19).

Combined Herbal Formulations

Combinations of plant extracts have shown beneficial effects in reducing body weight and controlling metabolic syndrome. A meta-analysis demonstrated benefits in formulations including ***Camellia sinensis***, ***Phaseolus vulgaris***, ***Garcinia cambogia***, and ***Nigella sativa*** (20).

Spirulina *(Arthrospira platensis)*

Spirulina, scientifically known as ***Arthrospira platensis***, is a microalga considered a superfood due to its high content of proteins, essential fatty acids, vitamins, minerals, and antioxidant compounds. It belongs to the Oscillatoriaceae family and is a multicellular, photosynthetic, filamentous cyanobacterium with an open helical morphology (21).

It reproduces through transverse binary fission and contains a central region with genetic material and a peripheral region covered by mucilage. Its cell wall contains peptidoglycan with characteristics similar to Gram-negative bacteria. It performs aerobic photosynthesis, which explains its functional similarity to algae.

Its growth occurs at pH ranges between 4.2 and 8.5, allowing it to use ammonia as a nitrogen source, with optimal growth temperatures around 15°C (21).

Spirulina uses carbon dioxide as its main carbon source and nutrient. Species intended for human consumption include ***Arthrospira platensis***, ***Arthrospira maxima***, and ***Arthrospira fusiformis***. It is estimated to contain up to 95% of essential nutrients for humans, highlighting highly digestible proteins and high concentrations of B-complex vitamins, while lacking refined sugars and saturated fats (21).

A comparative table of the nutritional content of various superfoods is presented in Table 1, based on previously reported data (21).

Table 1. Nutritional composition of foods classified as superfoods.
Prepared by the authors, based on:
Spirulina as a superfood: uses and benefits (21)

NUTRIENT CONTENT	SPIRULINA (per 100 g)
Energy (kcal)	340–390
Protein (g)	58
Carbohydrates (g)	23
Water (g)	4.0
Fiber (g)	58
Lysine (g)	4.8
Total Fat (g)	7.2
Saturated Fatty Acids (g)	2.6
Monounsaturated Fatty Acids (g)	0.67
Polyunsaturated Fatty Acids (g)	2.87
Calcium (mg)	120
Iron (mg)	28
Magnesium (mg)	195
Selenium (µg)	7.2
Sodium (mg)	104
Potassium (mg)	136
Phosphorus (mg)	110
Zinc (mg)	2.0
Beta-carotene (µg)	342
Retinol (µg)	57
Thiamine (mg)	23
Riboflavin (mg)	36
Niacin (mg)	28
Pyridoxine (mg)	3.6
Folic Acid (µg)	90
Cyanocobalamin (mg)	0.25
Tocopherols (µg)	5.0
Carotenes (µg)	290

Own elaboration, based on: Spirulina as a superfood: uses and benefits (21).

Spirulina stands out due to its high nutritional density, resulting from the wide variety of bioactive compounds that constitute its structure. In this regard, its composition includes high-quality proteins, essential fatty acids, vitamins, minerals, amino acids, and pigments with antioxidant activity, all of which participate in various metabolic and physiological processes related to body weight regulation and inflammatory modulation.

Regarding its protein content, spirulina contains approximately 65%, a proportion considerably higher than that of many conventional food sources. These proteins exhibit high bioavailability due to the soft structure of its cell wall, primarily composed of mucopolysaccharides, which facilitates digestion and intestinal absorption. This protein contribution includes essential amino acids required for metabolic and structural processes in the body, contributing to the maintenance of muscle mass and proper cellular function (21).

Regarding its lipid profile, gamma-linolenic acid predominates—an essential fatty acid that has been studied in various degenerative diseases in which both this compound and prostaglandin E are decreased. This fatty acid acts as a precursor of prostaglandins; therefore, its supplementation has been used as an adjuvant in the management of conditions such as arthritis, obesity, insulin resistance, neurodegenerative diseases, and disorders associated with chronic alcohol consumption (21).

On the other hand, a general characteristic of algae is their ability to naturally absorb minerals, leading to a high concentration of these compounds. In spirulina, minerals such as copper, zinc, and selenium are particularly notable, playing specific roles in human tissues, especially in the nervous system. Their main functions include:

- **Copper:** Component of the zinc–copper superoxide dismutase enzyme, providing antioxidant protection against superoxide radicals.
- **Zinc:** Exerts significant antioxidant activity by protecting sulfhydryl groups and neutralizing reactive oxygen species.
- **Selenium:** Constituent of selenium-dependent glutathione peroxidase, whose primary function is the elimination of free radicals (21).

In terms of vitamin content, spirulina contains beta-carotenes, B-complex vitamins, and vitamin E; among these, vitamin B12 is particularly noteworthy, as its deficiency has been associated with polyneuropathic disorders, especially in diseases such as diabetes mellitus (21).

Additionally, spirulina contains significant amounts of methionine, an amino acid that promotes myelination by participating in the formation of choline, a precursor of myelin (21).

Furthermore, spirulina contains phycobiliproteins with antioxidant and cytoprotective functions. These act through three main mechanisms: neutralization of reactive oxygen species, thereby reducing cellular damage; chelation of heavy metals; and increased activity of antioxidant enzymes such as superoxide dismutase, glutathione, catalase, and glutathione peroxidase (21).

Among the phycobiliproteins present, phycocyanin is the most abundant component. It has the ability to scavenge alkoxyl and hydroxyl radicals, whose cellular damage is associated with enzymatic inactivation and genetic alterations. Moreover, it exhibits potential inhibitory activity against cyclooxygenase-2 (COX-2), an enzyme involved in the pathogenesis of Parkinson's disease (21).

Finally, the use of spirulina in obesity and weight reduction has led to the study of genes such as **SIRT1** and **AMPK**, which, when analyzed in relation to spirulina intake, have shown involvement in body weight reduction and modulation of inflammatory processes (22).

Clinical evidence and meta-analyses of spirulina use

Clinical trials conducted in humans on spirulina supplementation have included both healthy individuals and patients with dyslipidemia, hypertension, diabetes mellitus, metabolic syndrome, and older adults. Overall, these studies indicate that the therapeutic response to spirulina may vary depending on factors such as age, sex, comorbidities, and the dose or duration of treatment administered.

In an analysis including 145 cases, a significant reduction in body weight and body fat percentage was demonstrated following spirulina supplementation (23).

Likewise, in a review of five clinical studies, a 12-week trial reported a decrease in inflammatory biomarkers associated with obesity (24).

In a study evaluating the effect of spirulina versus placebo in 748 subjects, a significant reduction in body mass index (BMI) was observed, with a 95% confidence interval, particularly in obese individuals over 40 years of age (25).

In a meta-analysis of randomized controlled trials assessing the effect of spirulina on glycemic markers in patients with type 2 diabetes mellitus, no significant improvements were found in glycated hemoglobin (HbA1c) levels (26).

Similar findings indicated that spirulina consumption for less than 12 weeks or at doses lower than 4 g/day may not result in significant reductions in HbA1c in patients with metabolic syndrome (27).

On the other hand, a systematic review and meta-analysis of seven trials involving 283 subjects reported that spirulina supplementation may significantly reduce C-reactive protein levels, although larger studies are recommended to confirm its clinical efficacy (28).

In another meta-analysis including nine studies with 415 participants, spirulina was shown to increase total antioxidant capacity and superoxide dismutase activity, without significantly modifying glutathione peroxidase activity (29).

Finally, randomized clinical trials in patients over 50 years of age with hypertension and overweight demonstrated a significant reduction in systolic and diastolic blood pressure after more than eight weeks of supplementation, suggesting its potential clinical application as an adjuvant therapy (30).

Conclusion

Nutraceuticals, whether as functional foods or dietary supplements, represent a complementary therapeutic alternative to allopathic treatments in various chronic diseases, including cardiovascular, gastrointestinal, neurological, and autoimmune conditions, particularly those associated with states of meta-inflammation. Their bioactive properties allow for their use either individually or in combination, supported by the available scientific evidence, highlighting the importance of nutritional approaches as an integral component of clinical management and protection against cellular injury mechanisms that contribute to disease development and its complications.

Among the nutraceuticals analyzed, spirulina stands out and is considered by several authors as a “superfood” due to its high content of essential nutrients and its anti-inflammatory, antioxidant, and metabolic effects. Its consumption has been associated with improvements in lipid profile, reduction in body weight in patients with obesity, modulation of inflammatory processes, and decreased biomarkers related to cellular damage.

In recent years, the use of nutraceuticals has adopted a more systematic approach, driven by growing scientific and industrial interest in the development of complementary therapies aimed at reducing inflammation, improving symptoms, and providing cellular protection. This context is particularly relevant given the progressive aging of the global population and the sustained increase in chronic non-communicable diseases.

Various products derived from nutraceutical compounds have shown potential in the management of joint inflammatory processes, metabolic disorders, dyslipidemia, insulin resistance, diabetic neuropathy, obesity, and inflammation associated with infectious agents, in addition to contributing to the strengthening of the immune response.

Although in some cases the magnitude of clinical effects may be moderate, the combination of different nutraceuticals could enhance their therapeutic benefits. In this regard, future research should focus on evaluating combined strategies with other bioactive compounds, such as glucomannan or curcumin, in order to optimize clinical outcomes and advance toward personalized nutritional interventions.

It is essential to continue evaluating the long-term safety and efficacy of these interventions, as well as their applicability across different clinical settings. Likewise, disease prevention through the incorporation of functional foods and superfoods into the regular diet represents a promising public health strategy, with the potential to reduce the incidence and prevalence of chronic diseases, alleviate the burden on healthcare systems, and improve the quality of health services through sustainable dietary modifications.

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