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Nutraceuticals and their benefits for health: A review

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Abstract

In the modern era, lifestyle shifts have led to poor dietary habits and reduced physical activity, contributing to declining nutritional status and immune function with age. Nutraceuticals, bioactive compounds derived from food, have gained recognition for their ability to support health, prevent disease, and strengthen the body's resistance mechanisms. Categories such as dietary fibres, probiotics, prebiotics, polyunsaturated fatty acids, antioxidant vitamins, and phytochemicals play a key role in addressing chronic conditions like cancer, diabetes, cardiovascular diseases, obesity, osteoporosis, and gastrointestinal disorders. Unlike pharmaceuticals that treat diseases post-diagnosis, nutraceuticals emphasize preventive healthcare, mitigating risks associated with unhealthy lifestyles while addressing nutritional deficiencies. As global awareness grows regarding natural therapies, fitness, and holistic well-being, the demand for nutraceuticals continues to rise. This review explores their role in health promotion and disease prevention, reinforcing their significance in modern healthcare as complementary and preventive interventions.

Keywords: Nutraceuticals; Food; Health; Diet.

1. Introduction

A developing category of natural products known as "nutraceuticals" disrupts the connection between medicine and diet. Stephen De created the term "nutraceutical" by fusing the terms "pharmaceutical" and "nutrition." In 1989, Felice presided over the Groundwork for Innovation in Medicine, which he had founded in Cranford, New Jersey. According to De Felice, a nutraceutical is "A food (or part of a diet) that gives pharmacological or well-being uses, together with the suppression and therapy of a disease. However, health Canada defines a nutraceutical as “A product derived from food material, but synthesized and offered in the form of tablets, capsules, or powder form, or in another therapeutic form, not normally corresponding with foods” [1]. Nutrients are defined as "food or parts thereof that provide health or medical advantages, including disease prevention and treatment". Nutraceuticals, which are derived from food, are available in liquids, pills, and capsules and have been linked to physiological and biochemical advantages [2]. A nutraceutical is any non-toxic dietary supplement with medically validated benefits for preventing and curing illness [3]. Roberfroid asserts that an effective diet “should have a related effect on health and well-being or result in a decrease in disease risk” within the scope of this analysis [4]. Nutraceuticals as a concept are not new. It was used at the time by a variety of societies, including Sumerian, Chinese, Indian, and Roman, in addition to their traditional therapeutic method. The application of nutrition as a treatment, now known as “nutritional therapy. “The use of pharmaceuticals was minimized under nutritional therapy, and the use of moral diets to prevent and treat diseases was promoted as an alternative to pharmaceuticals [5]. The basic dietary customs of the past have been changed by the creative routine that Is now accepted by society. Being overweight is now recognized as a global issue. The leading cause of death globally is still heart disease, which is followed by osteoporosis, arthritis, cancer, and a number of other diseases [6]. Consumers who are irritated by the exclusive, state-of-the-art, disease-action strategy of the current medications are searching for comparable or different beneficial products with the red tape of targeted nutraceuticals. Hippocrates famously said,

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"Let diet be the medication and cure be the die," and it certainly holds true today. "Medicine is useless when diet is incorrect; medicine is unnecessary when medicine is correct," according to an Ayurvedic proverb [7].

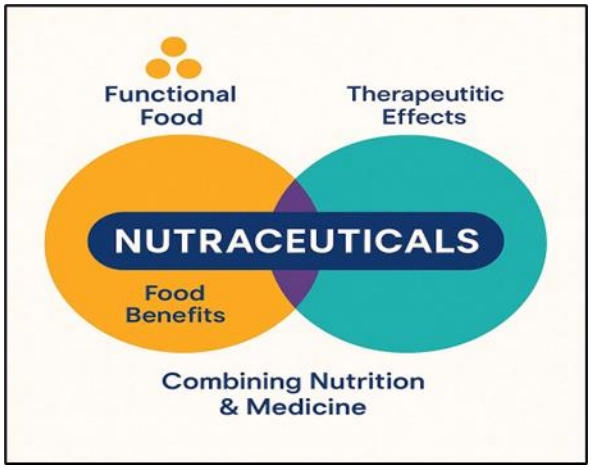

Figure 1 Nutraceuticals as intersection of food & medicine.

2. Type of Nutraceuticals:

Nutraceuticals can be utilized for nutritional guidance, clinical trial design, academic instruction, and the development of functional foods. In many cultures, nutraceuticals can be prepared in advance. Nutraceuticals can be categorized using some of the most dependable methods based on biological processes, chemical makeup, nutrient sources, and other variables [8]. The following categories apply to the natural nutrition sources found in nutraceuticals: Nutraceuticals are derived from vegetable or animal diets, and current and ongoing international research aims to fully explain their mode of action, safety, and effectiveness by confirming their claimed role through medical fact sources. The influence and views of nutritional supplements on social well-being are examined in this special issue from a variety of angles, including efficiency studies, wellness-related advantages, clinical research, and analytical insights [9].

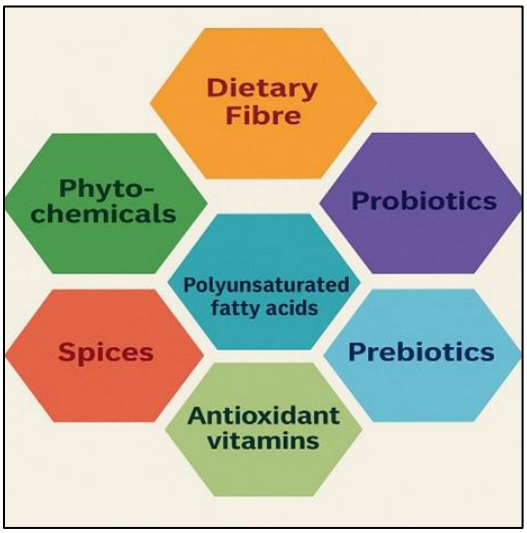

Figure 2 Types of Nutraceuticals**.**

2.1. Dietary fibers

Dietary fiber is the part of the diet, or more precisely the natural products derived from, that is absorbed by the intestinal microbiota instead of being broken down by the enzymes of the digestive system. People who consume large levels of nutritional fiber have a lower risk of heart disease, stroke, high blood pressure, diabetes, obesity, and other gastrointestinal (GI) issues than people who ingest little to no fiber. Consuming more fiber-rich food also lowers blood pressure, helps diabetics better control their blood sugar, encourages regularity, and raises serum lipoprotein levels.

According to research, some soluble fibers make people more resistant [10]. Nutritional supplements are concentrated nutritional formulations that can be consumed by humans in the form of liquid, chewable, gel caps, tablets, soft gel, lozenges, and powder [11]. Any food item containing at least one of the nutrients listed below vitamins, minerals, amino acids, antioxidants, agents that lower blood pressure, cholesterol, and stress, as well as stimulants and antidepressants is considered a nutritional supplement or diet supplement. These items are meant to be consumed in place of regular meals for health reasons [12]. Dietary supplements fall into one of three categories based on their source:

2.1.1. Natural

These are composed solely of natural sources, such as plants and animals, or organic materials, such as rock and the ocean. Natural extracts include things like pills that contain spirulina and cod liver oil.

2.1.2. Semi-synthetic

These extracts are derived from natural sources and subsequently undergo chemical alteration, much as baby food, tomato sauce, and powdered milk.

2.1.3. Synthetic

These extracts are made in an unusual manner by chemical synthesis. Examples of fake dietary supplements are vitamins and amino acids that have a synthetic appearance [10].

2.2. Probiotics

"Good bacteria or buddy bacteria" is how the layperson could perceive probiotics, which have the word "for life" in their name. Around 2,000 years ago, according to the history of probiotics, people began consuming fermented milk. A probiotic is a type of living microbial feed additive that helps the host animal by balancing the bacteria population in its intestines when taken in moderation. Probiotics come in a wide variety of forms, including liquid, gel, paste, granules, capsules, powdered prescription, and more. Lactose intolerance, severe diarrhea, and GI side effects from antibiotics are among the gastrointestinal (GI) conditions that are commonly treated with certain probiotic strains. Probiotics are resistant to stomach acid, non-toxic, and obedient to the gut's epithelial layers, which generate antimicrobial compounds. Probiotic use may reduce the risk of acquiring systemic diseases such as allergies, asthma, tumors, and various ear and urinary tract infections, according to some research [13]. By effectively converting the toxic microbiota of the large intestine into a beneficial culture of Bacillus bulbaricus, Elie Metchnikoff, a Nobel winner from the Pasteur Institute in Paris, improved the host's quality of life. The beneficial qualities of probiotics for people were discovered by this study [14].

2.3. Prebiotics

By specifically altering the GI microbiota's structure or metabolism, prebiotics are dietary elements that have a beneficial impact on the host. Prebiotics have been shown to improve lactose tolerance, anticancer properties, toxin neutralization, blood lipid and cholesterol reduction, constipation, and gut immune system stimulation, to name just a few health benefits. Bifidobacterium flourish when provided with 5–20 g of insulin and oligosaccharides daily. Again, consuming large amounts of these oligosaccharides causes gas, constipation, and diarrhea. Exhaustion, irritability, white blotchy nails, gastrointestinal difficulties, hair follicle loss, and mild nerve damage are all important aspects of treatment [15]. Peas, beans, pea shoots, sugar beets, garlic, cilantro, onion, Jerusalem artichokes, wheat, honey, bananas, barley, tomato, rye, soybean, human and animal milk, and more recently, seaweeds and microalgae, are just a few of the foods that naturally contain prebiotics. Additionally, a lot more are made artificially using simple ingredients like sugar, starch, lactose, and plants. Currently, GOS, FOS, and inulin are the three most well-known [16].

2.4. Polyunsaturated Fatty Acids (PUFAs)

PUFA lowers blood pressure, platelet aggregation, plasma triglycerides, and directly controls local and systemic inflammation that causes plaque initiation, development, and instability. Blood pressure, blood coagulation, and the proper growth and functioning of the brain and neurological system are among the biological processes that PUFAs control, depending on the location and quantity of double bonds [17]. Public interest in the relationship between nutrition and health has grown significantly in recent years. Characteristics of specific dietary fats and their consequences. One of the main areas of interest has been how acids affect human health. Omega double bond location, unsaturation level, and fatty acid chain length all affect an individual's health and nutritional well-being. Fatty acids include most dietary oils and (fats) lipids derived from sources that are both animal and plant-based. Fatty acids, the main building blocks of phospholipids, triglycerides, and cholesterol esters, are essential for the body's structure, physiology, and metabolism [18].

2.5. Antioxidant Vitamins

An initial name for a chemical that stopped oxygen from being consumed was antioxidant. When early scientists investigated the function of antioxidants in biology, they concentrated on using them to prevent rancidity caused by oxidation of unsaturated lipids. Antioxidants are substances that are stable enough to neutralize unregulated free radicals by giving them an electron, so lowering their potential for harm. These antioxidants primarily work by scavenging free radicals, which delays or limits cellular damage. Examples of antioxidant vitamins include carotenoids, vitamin C, and vitamin E. As scavengers of free radicals, these vitamins, which are found in high concentrations in a variety of fruits and vegetables, protect us against damage [19].

The two main groups of antioxidants are:

2.5.1. Enzymatic

Superoxide dismutase, glutathione systems, and catalase.

2.5.2. Non-enzymatic

Uric acid, ascorbic acid, glutathione, and melatonin.

Preeclampsia, GI tract ulcers, emphysema, organ transplantation, hemochromatosis, and acquired immune deficiency illness are all thought to be brought on by oxidative stress. Among the conditions that cause swelling or inflammation are intestinal ischemia, lupus erythematosus, glomerulonephritis, arthritis, vasculitis, and old-age respiratory disease syndrome. To treat the problems indicated above, antioxidants and other dietary supplements are utilized [20].

2.6. Phytochemicals

The primary purpose of studying phytochemicals, which are naturally occurring substances derived from plants with unique bio-activities toward mammalian biochemistry and biotransformation, is to determine how well they work. They serve as substrates for biological and chemical reactions, related components of enzymatic chemical reactions, absorbents, sequestrants that bind to and eliminate undesirable substances from the gastrointestinal lining, ligands that irritate or agonize intracellular or cell surface receptors, hazardous reactive or toxic chemicals, scavengers of reactive or toxic chemicals, and scavengers of reactive or toxic chemicals. These phytochemicals include alkaloids, phenolic compounds, terpenoids, and fiber [21]. Numerous diseases have been shown to be prevented by phytochemicals, including tumors, heart disease, diabetes mellitus, elevated blood pressure, inflammation, microbial, viral, and parasitical infections, mental health issues, spasmodic diseases, ulcerated patches, and more. It is discussed in advance how phytochemicals are used in animal studies, therapeutic applications, and cells produced in vitro or in culture. In vitro testing of anti-psychotic phytochemicals, effects on animal pain and inflammation, effects on bacteria, viruses, and parasites, cancer, studies on promyelocytic leukemia cell cultures, anti-mutagenic testing, etc. The rapidly growing use of phytochemicals in functional meals and nutraceuticals presents challenges for the food and pharmaceutical industries. [22].

2.7. Spices

The health-promoting qualities of several of these popular food additives have recently been empirically supported by a large number of animal studies and clinical trials. Given the part that oxidative stress plays in the emergence of degenerative diseases like cancer, inflammatory diseases, cardiovascular diseases, and neurological disorders, the antioxidant properties of the bioactive chemicals found in spices are very significant. In addition to adding flavor and taste to our food, spices are a natural and necessary component of our daily diet [23]. Some spices have antimicrobial qualities, and they aid in digestion and alleviate digestive disorders. They possess properties such as diuretic, stomachic, carminative, tonic, and antispasmodic. The past thirty years have seen the experimental confirmation of several of the health advantages of spices [24]. Cardiovascular protection, anti-inflammatory, anti-atherogenic, anti-lithogenic, and gastrointestinal stimulant properties, as well as antidiabetic potential Spices have a number of health benefits, including the capacity to prevent cancer and their antimutagenic and antioxidant qualities [25].

Table 1 List of Spices [26].

Sr. no.	Spices	Scientific name
1.	Curcumin	Curcuma longa
2.	Capsaicin	Capsicum annuum
3.	Piperine	Piper nigrum
4.	Gingerol	Zinger officinale
5.	Eugenol	Eugenia caryophyllus
6.	Allicin and S-allyl cysteine	Allium sativa
7.	Quercetin	Allium cepa

3. Overall benefits of Nutraceuticals

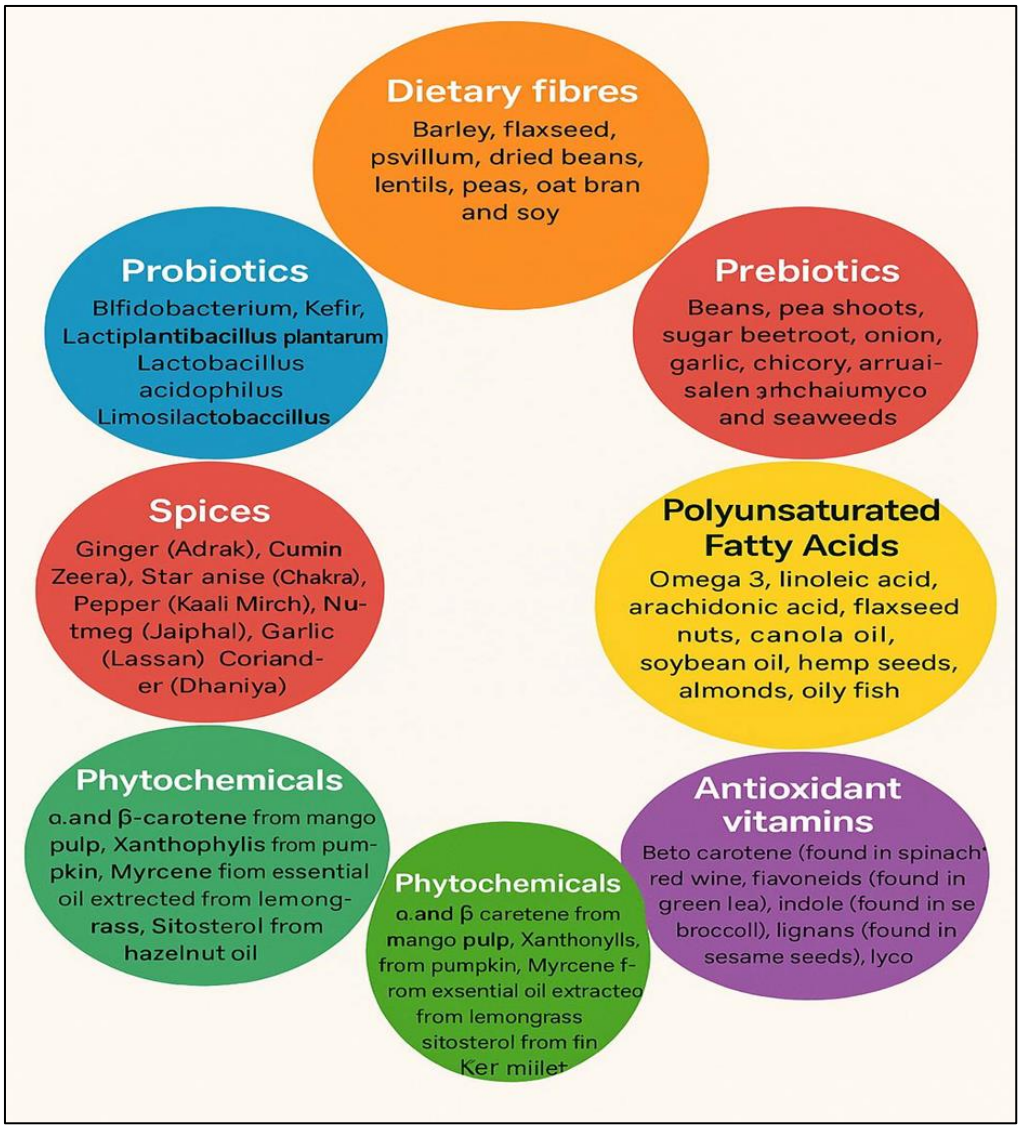

Figure 3 Some nutraceuticals and their example [38]

Nutraceuticals, which include a wide range of dietary and nutritional supplements, are increasingly recognized for their dual role in providing essential nutrients and exerting therapeutic effects [27]. These compounds are not only used to

supplement the daily diet but also contribute significantly to the prevention and management of various chronic and life-threatening diseases [28]. A growing body of evidence suggests that nutraceuticals play a pivotal role in reducing the risk and progression of numerous health conditions, including cancer, diabetes mellitus, obesity, cardiovascular disorders, osteoporosis, arthritis, hypercholesterolemia, and gastrointestinal infections [29]. Their bioactive components such as antioxidants, phytochemicals, polyunsaturated fatty acids, and dietary fibers help modulate physiological functions, boost immunity, reduce inflammation, and maintain metabolic balance [30]. With proper intake and formulation, nutraceuticals serve as a valuable adjunct to conventional therapies and offer a promising approach to improving overall health and disease outcomes [31]. The biggest benefit of nutraceuticals is their low or nonexistent side effects. Nutraceuticals and other foods that are part of a balanced diet have a significant role in biotransformation and other physiological processes that help lower the risk of developing a number of degenerative diseases [32]. Nutraceuticals are valued for their high nutrient density, offering customers a wide range of essential minerals, vitamins, and trace elements in addition to a premium protein source [33]. Due to their anticipated safety as well as possible nutritional and therapeutic benefits, nutraceuticals have drawn a lot of attention [34]. Even though certain research has verified the favorable reaction, it is still unclear how they work. Because they are affordable and the most of them show no signs of toxicity, nutraceuticals offer a promising supply of molecules with a wide range of medicinal effects [35]. Because of their excellent quality, purity, safety, and effectiveness which promote health and aid in the healing of disorders they are suitable for all age groups [36]. A new era of medicine and health has been ushered in by the most recent movement towards nutragenomics and nutraceuticals [37].

4. Conclusion

With age and changing lifestyles, the body's nutritional support and immune resistance tend to decline. This article highlights the potential of nutraceuticals in preventing and managing various health conditions. The core idea behind nutraceuticals is simple: "Watch what you eat to stay healthy." Each type of nutraceutical offers unique health benefits, making them valuable preventive tools against diseases linked to poor lifestyle and nutrition. Conditions such as cancer, diabetes, obesity, cardiovascular disorders, osteoporosis, arthritis, and gastrointestinal infections can be managed or prevented through proper intake of dietary fibers, probiotics, prebiotics, polyunsaturated fatty acids, antioxidant vitamins, phytochemicals, and spices. As public awareness of fitness and natural health solutions grows, so does interest in nutraceuticals. This review aims to promote greater understanding of their role in disease prevention and overall health improvement.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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