



Nutraceuticals in disease prevention and management: A systematic review

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Abstract

The word "Nutraceutical" describes food products that are both nutritionally and medically valuable, both as a whole and as individual components. Numerous metabolic and degenerative diseases are gradually becoming more prevalent in the contemporary population, most of them are caused by dietary inadequacies. Recently, people and health professionals have expressed a special interest in the pharmaceutical product known as "Nutraceuticals" for their nutritional renewal. India continues to be a developing country. Many people in rural areas suffer from non-communicable diseases and disorders as a result of a lack of knowledge about diet, food, and nutrition. An article about "Nutraceuticals" provides some information. In recent years, the market has demonstrated a growing interest in nutraceuticals. This article's main goal is to provide basic knowledge on nutritional supplements and the various ways they can be used to treat various illnesses. This article also covers important legal prerequisites for registering a nutraceutical product. It is an immune-boosting, natural antioxidant, anticancer, anti-inflammatory, antidiabetic, cardioprotective, and organ protective agent, among other health-promoting advantages. They ultimately promise a better quality of life, and the purpose of this study is to provide a summary of the current state of the science in this sector, which could help with the development of a more innovative research approach in the emerging field of nutraceuticals. Many more dietary aspects are described by the Ayurvedic method. The use of food as medicine and the concept of nutraceuticals to improve quality of life are examples of novel Ayurvedic techniques.

Keywords: Nutraceuticals; Diseases; Herbal plants; Probiotics; Dietary supplements

1. Introduction

Over the past 50 years, urbanization, industrialization, busy schedules, and shifting cultural norms have all contributed to a significant change in human lifestyles [1]. Since neither humans nor animals can synthesize carotenoids, they must consume foods or supplements that contain them [2]. The term "food, or parts of a food, that provide medical or health benefits, including the prevention and treatment of disease" is used to describe nutrients [3]. Although they are commodities made from food, nutraceuticals come in a variety of forms, such as liquids, tablets, and capsules, and they have been shown to have physiological and biochemical benefits [4]. In order to confirm the effects, clinical test findings from animal experiments and research are necessary during the pharmaceutical development process [5]. Nutraceuticals met the need for complementary or alternative beneficial goods in the treatment approaches of disease in modern medicine [6]. The dietary supplements consist of protein supplements, plant extracts, herbal supplements, and vitamin and mineral supplements [7]. Due to their less adverse effects than synthetic medications, nutraceuticals have the advantage of being safer and more affordable [8]. Nutraceutical foods widespread acceptability and recognition in contemporary global therapy has spurred quick research on the topic, producing a vast amount of literature [9]. Developing current, evidence-based, and clinically applicable guidelines was the main goal in order to guide the proper prescription of plant-based "phytoceuticals" or nutrient-based "nutraceuticals" as either monotherapy or adjunctive therapy for the treatment of various psychiatric disorders [10]. Food and ideas about its importance to life form the basis of much of human culture. Certain foods are offered to commemorate noteworthy events, to signify life transitions,

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to celebrate, and to aid healing. Additionally, the majority of our energy and essential macro- and micronutrients come from basic foods; all cultures add different flavors and condiments to improve our culinary experiences [11]. Health care practitioners understand that our overly processed food supply, which comes from crops cultivated with chemical pesticides, herbicides, fertilizers, and often genetically modified seeds, is deficient in nutrients needed for good health [12]. With consumers searching for methods to enhance their health and fend off illness, nutraceuticals are growing in popularity. In addition to foods and drinks, they are present in a number of different forms, such as tablets, powders, and capsules. Omega-3 fatty acids, probiotics, and antioxidants are a few examples of typical nutraceuticals. Nutraceuticals have been used more and more as curative and preventative agents in recent years [13]. In contrast to functional foods, which are defined as any new or manufactured item that has beneficial effects on health and stops diseases in addition to having a healthy capacity, nutraceuticals are composed of bioactive elements produced from natural sources and obtained from various food grids [14]. Nutraceuticals contain natural drug Clove which is used as an expectorant and demulcent. It is also used as an antispasmodic. The major diseases for prevention and or treatment of which, nutraceuticals have been associated are heart diseases, cancer, hypertension and diabetes [15]. In the United States, nutraceuticals are regarded as pharmaceuticals, food additives, and dietary supplements. Although not defined the same way in every country, nutraceuticals are often described as a substance extracted from foods to be offered medically [16]. Overtime, the accumulation of such oxidative damage leads to biological aging and, ultimately, death. This condensed form of the free radical theory of aging, however, has since been demonstrated by a number of studies to be insufficient in explaining the mechanics behind aging processes. The hormesis hypothesis of aging is another proposal that has been widely employed to explain the effects of nutraceuticals on longevity [17]. Plant flavonoids are the main active components in nutraceuticals. They can have strong antioxidant and metal-chelating properties, as is common for phenolic compounds [18]. "Nutraceutical" is a term that combines the words "pharmaceutical" (a medicinal drug) and "nutrient" (a nourishing meal or meal component). While "natural" ingredients with the stated goal of curing or preventing illness can also be found in nutraceuticals, they may no longer be typically recognized as safe [19]. Products that offer health advantages beyond basic nourishment fall under the nutraceutical category of dietary supplements. This area has three important subcategories: i) Medicinal foods, ii) Functional foods, and iii) Dietary supplements containing botanicals. Because of their capacity to promote digestive health and reduce symptoms, nutraceuticals are essential in the management of gastrointestinal disabilities. For example, the gut microbiota can be balanced with probiotics, which are good bacteria that can be found in some foods and supplements. This helps improve digestion and lessen the symptoms of diseases like inflammatory bowel disease (IBD) and irritable bowel syndrome (IBS) [20].

2. History

The concept of Nutraceuticals went back as far as 3000 years ago. Hippocrates (460–377 B.C) stated 'let food be thy medicine and medicine be thy food'. In the early 1900s the United States of America food manufacturers started adding small quantity of iodine to salt to prevent goiter. The term nutraceuticals were coined in 1989 by Stephen DeFelice who was the Chairman and Founder of the Foundation for Innovation in Medicine, Cranford, New Jersey (Bieselkl 2001). According to DeFelice, nutraceutical can be said to be "a food (or part of a food) that provides medical or health benefits, including the prevention and/or treatment of a disease." However, the term nutraceutical as commonly used in marketing has no regulatory definition (Zeisel 1999) [21]. To prevent goiter, food makers in the United States began incorporating a little amount of iodine into salt. Nutraceuticals are already a part of the dietary landscape in Japan, England, and other nations. They are currently one of the industry's fastest-growing areas, and the global nutraceutical market is valued at USD 117 billion [22]. High scurvy mortality rates were recorded by ship crews; this issue was resolved by a diet high in vitamin C. Similar results were also shown in patients with goitre, when iodine-rich salt was effective. In summary, it can be said that as scientific knowledge advanced over time, eating habits were cleverly adjusted for the prevention and treatment of illness. This may have been the catalyst for the creation of contemporary nutraceuticals [23]. The Dietary Supplement Health and Education Act is the name of this law. By including vitamins, minerals, herbs, and other botanicals, as well as amino acids and dietary components, this regulation broadened the scope of nutraceuticals. Although the concept of nutraceuticals is not wholly new, it has undergone significant evolution throughout time [24].

3. Classification of Nutraceuticals

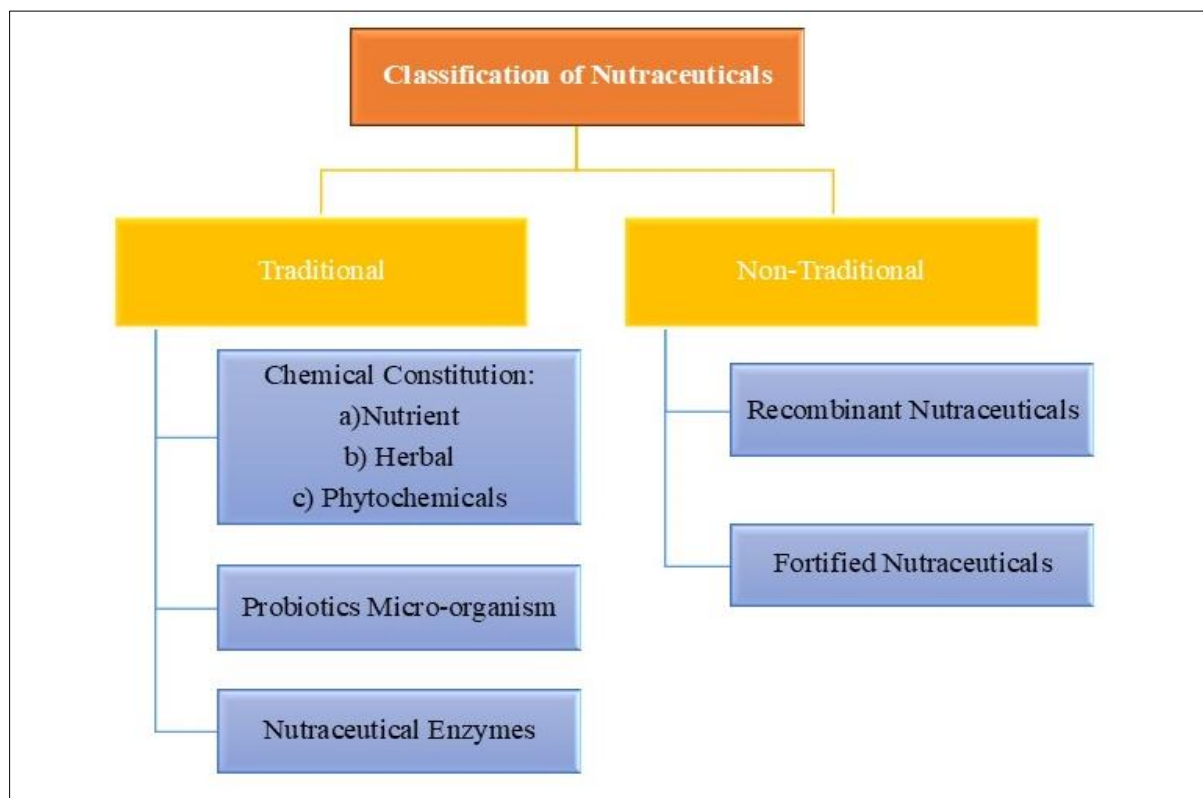


Figure 1 Flow chart classification of nutraceuticals

3.1. Traditional Nutraceuticals:

These foods fall under the category of classic nutraceuticals, which are just natural, whole foods with new information regarding their possible health benefits. Only the consumer's perception of the foods has changed, not the meals themselves. Numerous fruits, vegetables, cereals, fish, dairy products, and meat products contain natural ingredients such as lycopene in tomatoes, omega-3 fatty acids in salmon, or saponins in soy that provide advantages beyond simple nourishment [25].

3.1.1. Chemical constituents

Nutrients

In plants and animals, nutrients are the main metabolite substances that aid in human growth and development as well as a number of metabolic processes. These products and foods are not made from chemicals. This means that foods that are found in nature contain fatty acids, vitamins, and amino acids, among other things. For example, omega 2 PUFA's fatty acids, vitamins, and amino acids [26]. "A feed ingredient in a form and quantity that will support an animal's life." The main categories of feed nutrients are vitamins, minerals, proteins, fats, and carbs [22].

Herbals

In addition to being used in their natural forms, herbs and botanical products are also used as extracts and concentrates. Herbs can strengthen the immune system by acting as antiviral, antibacterial, and antioxidant agents. Herbs have been used as food and medicine for millennia. The most popular natural health products and the foundation of all therapeutic food recipes, according to Ayurveda, are garlic, onion, and ginger. They are regarded as medicine, food, and spices. Likewise, turmeric's antiviral, antifungal, antibacterial, and antiparasitic qualities are widely recognized [7]. The goods are either concentrations or extracts. For instance, Alovera gel has wound-healing qualities and dilates capillaries. Echinacea aids in the treatment of flu and cold symptoms. Post-thrombotic syndrome can be treated with ginkgo [27].

Table 1 Herbal plants and their active constituent as a nutraceutical [26]

Common Name	Biological source	Active constituent	Uses
Salix nigra	willow bark of Salisnigra	Salicin	Anti- inflammatory Antipyretic, Astringent Anti arithmetic
Peppermint	Mentha piperita	Menthol	Cures cold and flu
Garlic	Dried bulb of Allivumsativum	Alline and allicin	Antigout, Antibacterial, Nerve tonic
Ginger	Dried Rhizomes of Zingiber officinale	Znigiberene and gingerol	Chronic bronchitis, Hyperglycemia, Throat ache
Bael	Unripe fruit of Aeglemarmelos Correa	Marmelosin	Treatment of diarrhea and dysentery

Phytochemicals

Fruits and vegetables include flavonoid polyphenolics, which are powerful antioxidants, phytoestrogens, and preventers of breast and prostate cancer as well as diabetes. Non-flavonoid polyphenolics, which are found in dark grapes, raisins, berries, peanuts, and turmeric roots, have anti-inflammatory, antioxidant, anticoagulant, and cholesterol-lowering properties. Chlorella and spirulina are often utilized as dietary supplements [28]. Utilized in the diet, phytochemicals derived from plants provide health benefits like intestinal absorbents, enzyme inhibitors, substrates for biochemical reactions, and enzymatic reaction cofactors that bind to and eliminate undesirable components while improving the stability and/or absorption of vital nutrients by scavenging reactive or hazardous molecules [14].

3.1.2. Probiotics Microorganisms

Probiotics are live microorganisms that are administered to the host in large enough quantities to provide a health benefit. They are typically used to treat gastrointestinal (GI) issues such lactose intolerance, acute diarrhea, and antibiotic-related gastrointestinal side effects. They come in powder, liquid, gel, paste, or granule form, as well as pill form. Enhancing intestinal health through microbiota guidance, boosting the immune system, delivering and increasing the bioavailability of supplements, lowering the side effects of lactose influence, and lowering the risk of various diseases are just a few of the vital effects of probiotic treatment [19]. In addition to reducing pathogen adherence in the intestinal epithelium and creating competition with the nutrients necessary for pathogen growth, probiotics have antibacterial activity by changing the microbial flora. This prevents microorganisms from causing GI tract illnesses and diseases. It also increased the gastrointestinal epithelium's responsibility for retaining dietary nutrients for improved absorption [26].

3.1.3. Nutraceutical Enzymes

Without enzymes, our bodies could not operate properly, making them vital to life. Incorporating enzyme supplements from microbial, plant, and animal sources into one's diet may help those with digestion problems such hypoglycemia, blood sugar irregularities, or obesity [29].

3.2. Non-Traditional

These are foods that have been supplemented or biotechnologically engineered to increase their nutrient content; for instance, broccoli and rice are high in vitamins and β -carotene, respectively. Bioactive ingredients found in food samples are designed to create goods that promote human health [30].

3.2.1. Recombinant Nutraceuticals

It includes using genetic engineering and biotechnology to produce foods that provide energy, such cheese and yogurt, or to extract bioactive ingredients via fermentation or enzymatic processes. Gold kiwifruit has been genetically modified to have a high ascorbic acid concentration [31].

3.2.2. Fortified Nutraceuticals

Enhanced with vitamins and minerals, frequently reaching 100% of the nutrient's dietary reference intake [32]. Fortified nutraceuticals are foods that have extra micronutrients or vitamins added to them to increase their value, such as milk with cholecalciferol vitamin or orange juice with calcium added. These foods provide the body with vital nutrients that help enhance health and avoid anaemia. For instance, adding calcium to certain foods, such orange juice, can improve glycemic management [33].

Table 2 Health benefits of natural Nutraceuticals [34]

Sr. No	Nutraceuticals	Health Benefits and Functions
1	Cinnamon	Rich in antioxidant like polyphenol, phenolic acid and flavonoids. Helps to control diabetes and prevent cancer.
2	Garlic	AIDs in digestion process. Strength, immunity. Helps in weight loss possess antifungal and antibacterial properties
3	Ajwain	Contains thymol aids in digestion and prevents CDV (cardio vascular diseases)
4	Aloe Vera	Rich in antioxidant, promotes immunity. Aids in weight loss.
5	Green Tea	Prevents allergy. Possess antibacterial activity. Helps in lowering blood cholesterol. Preventing bone loss.

4. How nutraceuticals differ from food supplements? [35]

Food supplements, which are sold in "dose" form such as pills, tablets, and capsules, are concentrated sources of nutrients, such as vitamins and minerals, or other compounds with physiological or nutritional effects. Food supplements are designed to enhance particular physiological processes, maintain adequate consumption of particular nutrients, or address nutritional deficiencies. Since they are not pharmaceuticals, they are unable to have pharmacological, immunological, or metabolic effects; as a result, their use is not meant to cure or prevent illnesses or alter human physiological processes.

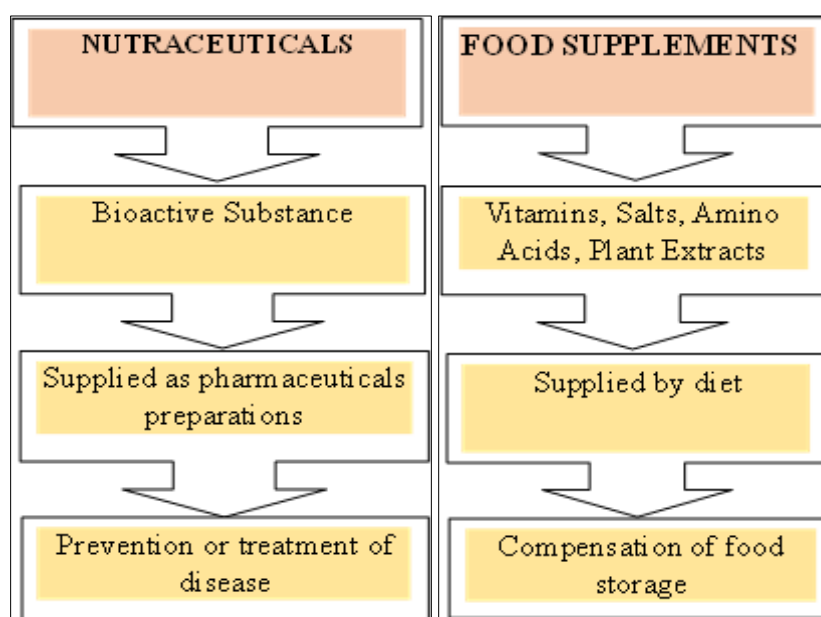


Figure 2 Difference between Nutraceuticals and Food Supplements

5. Role of Nutraceuticals in Various Disease

Higher levels of sugar and saturated fats are found in the current human diet, and eating fast food increases the risk of developing common lifestyle issues like obesity, atherosclerosis, and heart disease [36].

5.1. Cardiovascular diseases

The prevalence of chronic disease such as obesity, diabetes, cancer, and cardiovascular disease is rising quickly on a global scale. About 46% of the world's disease burden and 59% of the 56.5 million recorded deaths worldwide in 2001 were attributable to chronic illnesses. Low consumption of fruits and vegetables has been linked to a high death rate from cardiovascular disease. A healthy diet, nutraceuticals, vitamins, minerals, and antioxidants, together with weight loss, exercise, quitting smoking, limiting alcohol and caffeine, and other lifestyle changes, can prevent, postpone, lessen, and manage hypertension. Calcium channel blocking nutrients and nutraceuticals, including α -lipoic acid, magnesium, vitamin B6 (pyridoxine), vitamin C, n-acetylcysteine, hawthorne, celery, ω -3 fatty acids, and others, have antihypertensive properties. Apples, cherries, berries, black grapes, red wine, endives, onions, and cruciferous vegetables are all rich sources of flavonoids [37]. By inhibiting the "suicide" enzyme cyclooxygenase, which breaks down prostaglandins, flavonoids limit platelet stickiness and, consequently, platelet aggregation. They also block the angiotensin-converting enzyme (ACE), which causes blood pressure to rise. Additionally, flavonoids fortify the microscopic capillaries that provide all cells with oxygen and vital nutrients and shield the vascular system. Flavonoids inhibit the enzymes responsible for estrogens, lowering the chance of malignancies brought on by estrogens [5].

5.2. Diet related diseases

The prevalence of diet-related disease is steadily rising in Western nations as a result of sedentary lifestyles and increased access to high-calorie foods. Low-grade inflammation is a shared pathogenic denominator among the major diet-related diseases of obesity, diabetes, atherosclerosis, and neurodegeneration. Given their capacity to provide anti-inflammatory effects, functional foods and nutraceuticals may offer a novel treatment strategy to prevent or reduce diet-related disease. Low-grade inflammation in diet-related disorders may be lessened, namely, by intestinal T regulatory cell activation and gut microbiota homeostatic modulation [38].

5.3. Cancer

Nutraceuticals are used to enhance human health and treat chronic illnesses. Flavonoids inhibit estrogen-induced malignancies by blocking the enzymes that create estrogen. A wide variety of phyto-pharmaceuticals with purported hormonal activity, known as "phytoestrogens," are advised to prevent prostate and breast cancer. Curcumin from curry and soy isoflavones, which are found in soy foods, have the ability to prevent cancer by chemopreventive effects. In order to prevent cancer, lycopene is concentrated in the skin, testes, adrenal glands, and prostate [39].

5.4. Diabetes

Diabetes mellitus is characterized by abnormally elevated blood glucose levels, which can be caused by either insufficient insulin production or its ineffectiveness. kind 1 diabetes, an autoimmune disorder, is the most common kind of diabetes. Obesity is associated with type 2 diabetes. During pregnancy, gestational diabetes develops. It is projected that there will be 366 million people with diabetes globally in 2003, up from 171 million in 2000. Vitamin C: It has scavenging properties, is an antioxidant that breaks chains, and stops chain reactions that would cause reduction. Insulin resistance is impacted by vitamin C levels. Vitamin D/CALCIUM: Consuming a lot of calcium helps prevent the development of diabetes. It works by inhibiting parathyroid hormone secretion, and a healthy calcium and vitamin D level helps ward off diabetes. [40].

5.5. Obesity

Is the buildup of excess body fat a sign of a medical condition? Obesity as a condition is linked to a lower life expectancy and/or more health issues. Therefore, obesity is more than just a cosmetic issue. Higher body fat percentages have been linked in numerous studies to an elevated risk of a number of harmful medical disorders. Losing weight is becoming more widely acknowledged as having significant health benefits for overweight individuals and is associated with longer life expectancy for those who suffer from obesity-related problems. Over 20 million children under the age of six are obese or overweight globally, according to data from the International Obesity Task Force (IOTF). Numerous interactions between genes and the environment contribute to the development of obesity, making it a complex issue [41]. Stimulants made from herbs, such ephedrine. Green tea, chitosan, ma huang-guarana, and caffeine all aid in weight loss. The proteins in buckwheat seeds function similarly to the fibers found in food. Green tea extract and 5-hydroxytryptophan may help people lose weight; the latter raises energy expenditure while the former reduces hunger.

A nutritional supplement containing glucomannan, chitosan, fenugreek, and vitamin C dramatically decreased body weight [22].

6. Types of Foods Used in Nutraceuticals [42]

- Probiotics
- Dietary Fiber
- Prebiotics
- Polyunsaturated fatty acids
- Antioxidant vitamins
- Polyphenols

6.1. Probiotics

It can assist you in keeping your body's beneficial bacteria in check. Probiotics can aid in the passage of food through your digestive system when added to a nutritious diet [43]. When given in sufficient amounts, these live microbial feed supplements such as lactobacilli and bifidobacteria help to improve the host's gut microbial balance. Its administration has been linked to a lower incidence of cancer, allergies, asthma, and urinary tract and ear infections [44]. The gut microbiota's balance is altered. By inhibiting the growth of harmful bacteria, it improves gut health and facilitates digestion [42].

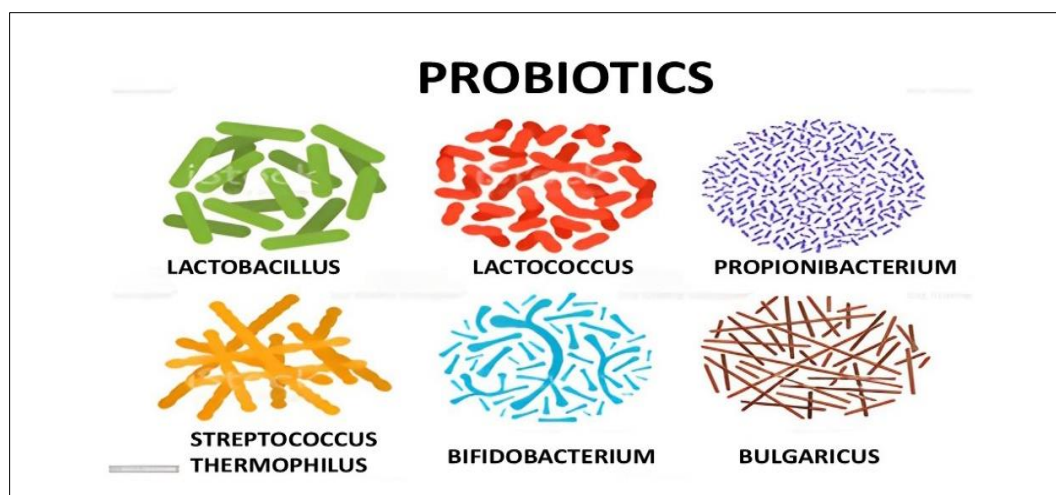


Figure 3 Probiotics [19]

6.2. Prebiotics

Prebiotics are generally indigestible fiber compounds that pass undigested through the upper portion of the gastrointestinal tract and act as substrates for beneficial bacteria that inhabit the big bowel, thereby stimulating their development or activity. Like probiotics, prebiotics are considered a functional dietary component that falls somewhere between foods and medications. They usually undergo an intermediate level of regulatory examination, depending on the country, especially with regard to the health claims made about them. Not all fiber is prebiotic, even if all prebiotics are fiber. A food element must be scientifically proven to be a prebiotic in order to be classified as such.

- Prevents absorption in the upper gastrointestinal tract, breakdown by mammalian enzymes, and stomach acidity.
- The gut microbiota ferments it.
- Intestinal bacteria that may be linked to health and wellbeing are selectively stimulated in their development and/or activity [45].

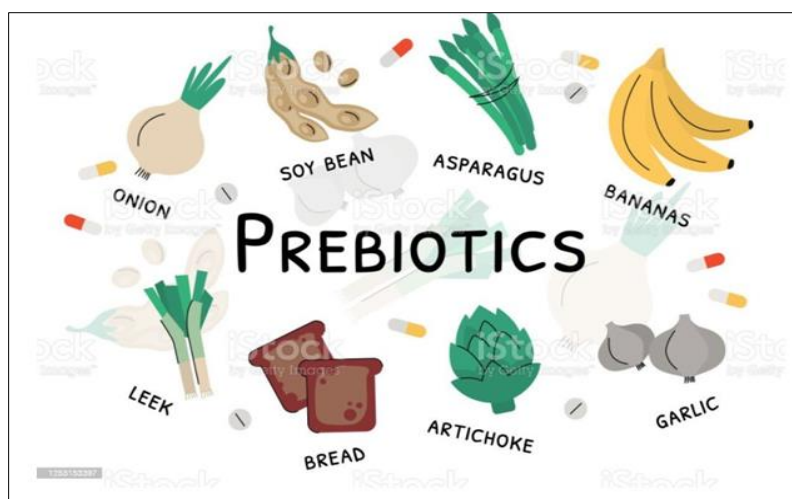


Figure 4 Prebiotics [19]

6.3. Dietary Fiber

Dietary fibers are edible plant material that is broken down by the gut microbiota rather than being hydrolyzed by digestive system enzymes. Non-starchy polysaccharides like cellulose, hemicelluloses, gum and pectin, lignin, and resistant dextrins are all considered dietary fiber. Dietary fibers soluble components can produce viscosity and bulk, which slows down the stomach's gastric emptying. This has an impact on the rate of digestion, nutrient absorption, and satiety. It increases glucose tolerance and decreases LD. Dietary fiber is the portion of food more specifically, plant matter that is broken down by gut microbes rather than hydrolyzed by digestive system enzymes. Non-starch polysaccharides (NSP), osteoporosis celluloses, hemicelluloses, gums and pectins, lignin, resistant dextrins, and resistant starches are the main components of dietary fibers. Foods high in soluble fiber include beans, barley, oats, and fruits. It has been demonstrated how much dietary fiber is present in particular foods [46].



Figure 5 Dietary Fibre [19]

6.4. Antioxidants

Since oxidative stress is a prominent factor in most chronic diseases, antioxidants are extremely important in the treatment of nearly all illnesses. One of the main causes of neurodegenerative illnesses like phosphatidylserine is oxidative stress [18]. The compound of phosphatidylserine is quite intriguing. The primary phospholipid in the brain, phosphatidylserine, forms the fundamental structure of the cell membrane. Cell-to-cell communication and the delivery of biochemical messages to the cell depend heavily on membrane phosphatidylserine and phospholipids. Phosphatidylserine improves communication and cellular metabolism, and oral supplementary results include improved neuronal membranes, cell metabolism, and certain neurotransmitters, such as dopamine, serotonin, and acetylcholine [47].

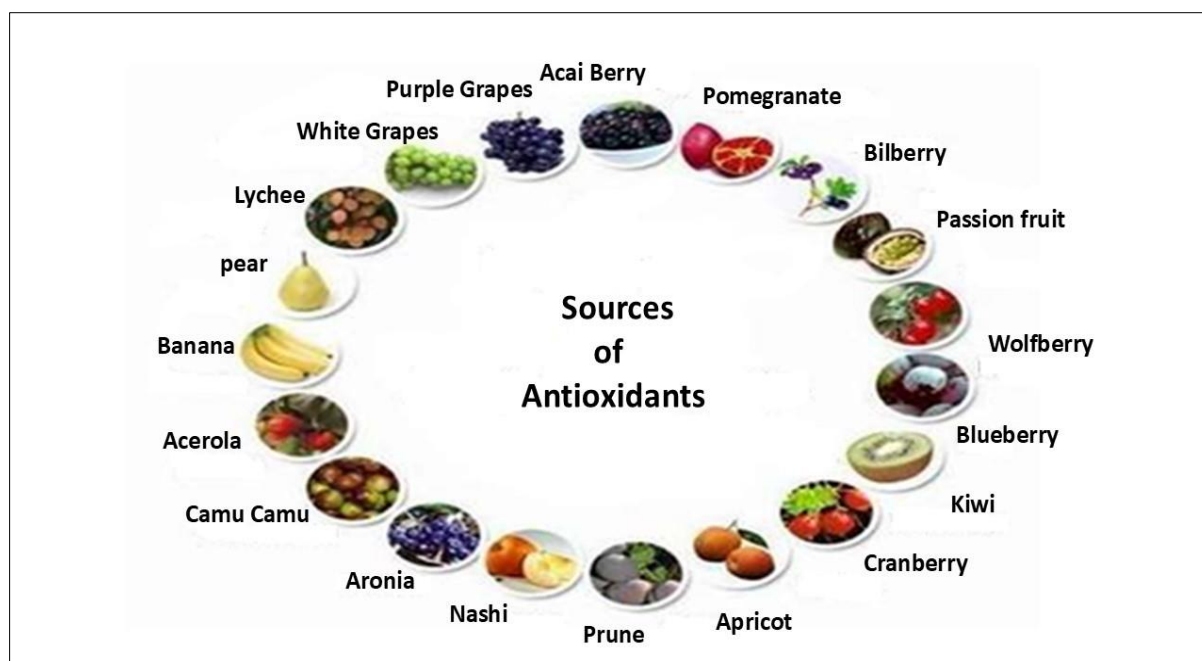


Figure 6 Antioxidant [19]

6.5. Polyunsaturated fatty acids (PUFA)

The production of foul-smelling secondary oxidation products controls the topical use of PUFAs in skin treatments and cosmetics. Studies on the topical use of fish oil have revealed a significant increase in plaque thickness and a statistically significant growth in erythema and scaling. It has been demonstrated that a fish oil concentrate can help patients suffering from atopic dermatitis. Evening primrose oil has been used to treat atopic eczema because it contains 9% γ -linoleic acid (GLA). Another study evaluated skin limits in healthy older adults who took 360–720 mg of GLA (from borage oil) daily for two months. Dry skin condensed and cutaneous layer function improved by 11% [48].

6.6. Polyphenols

Polyphenols are micronutrients that are typically found in fruits and vegetables but are absent from animal products. These consist of antioxidants, hydroxy acids, leucon anthocyanins, and catechins. These can be found in the tissues of woody plants, such as grapes, apples, peaches, and almonds. Fruit quality is affected by the amount of polyphenols. Polyphenols may help with weight management, diabetes, heart disease, and digestive problems. Food sources include berries, cocoa powder, all fruits and vegetables, nuts, soy products, green tea, cloves, ginger, garlic, rosemary, and saffron, among other seasonings [42].

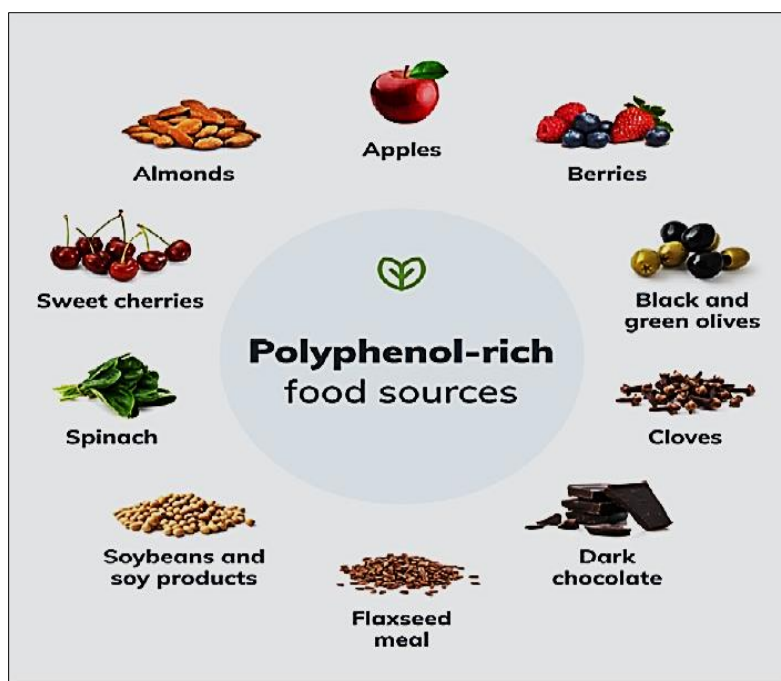


Figure 7 Polyphenols [19]

7. Nutraceuticals are either drugs or foods.

Foods or dietary ingredients that have therapeutic or health advantages are known as nutraceuticals. The distinction between food and medications is blurred by this new class of items. They frequently fall into a gray area between the legal classifications of food and drug [49].

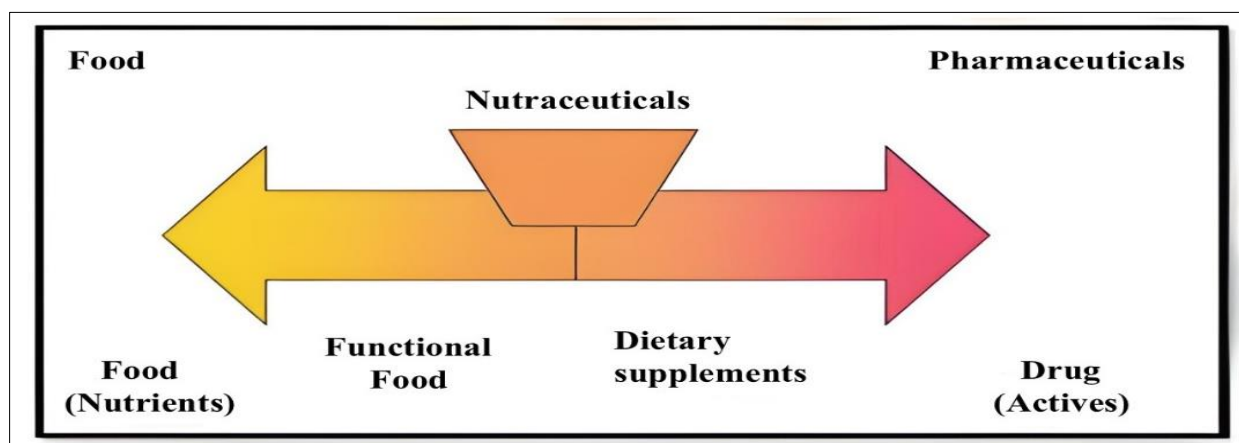


Figure 8 Nutraceuticals are partly Considered as food as partly as drugs.[49]

By definition, feed is any consumable material that adds nutrients or energy to an animal's diet. Feeds are only permitted to make statements regarding the nutrients they contain and their scientific roles. Nutraceuticals either say they are "needed for normal body structure and function" or contain the word "food" [41].

7.1. Dietary supplements

Dietary supplements are goods, usually in liquid or tablet form, that contain specific nutrients obtained from diet. They include a wide range of dietary components, including as minerals, vitamins, herbs, amino acids, and materials like organ tissues and enzymes [32]. The remaining 40% of the Indian nutraceutical market is accounted for by this segment. Supplements of vitamins and minerals, herbal remedies, protein supplements, and chyawanprash are all included in this class [50]. Usually, dietary supplements are offered in pill form, like the vitamin B supplement mentioned above. A

dietary supplement is a concentrated liquid or pill solution that incorporates nutrients from food products. A dietary supplement is defined as a product taken orally that contains a "dietary ingredient" meant to enhance the diet in the United States by the Dietary Supplement Health and Education Act (DSHEA) of 1994. A label stating that "These statements have not been evaluated by the Food and Drug Administration" must be put on dietary supplements, which, with a few clear exceptions, may only be marketed to support the body's structure or function and cannot be used to treat any illness or condition [51].

7.2. Functional Food

Functional foods, also referred to as nutraceuticals, are extremely nutrient-dense and linked to several potent health advantages. For instance, they may prevent nutrient shortages (vitamins and minerals), encourage healthy growth and development, and guard against conditions like hypertension, inflammation, allergies, Alzheimer's, and others [52]. A functional food is "any food or food ingredient that may offer a health benefit beyond the traditional nutrients it contains," according to the Food and Nutrition Board of the US Institute of Medicine. "Food products to be taken as part of the usual diet in order to have helpful effects that go beyond basic nutritional function" is the concept behind functional foods. Physiologically active ingredients derived from either plant or animal sources are found in functional foods [19].

7.3. Medicinal food

Medical foods are a subset of therapeutic substances designed to help treat a particular ailment through nutrition. Formulations known as "medical foods" are designed to treat individuals who have inherited abnormalities in the metabolism of amino acids. More recent medical foods are intended to treat a variety of illnesses, including cancer cachexia, inflammatory disorders, pancreatic exocrine insufficiency, and hyperhomocysteinemia. Examples include transgenic plants for oral vaccination against infectious diseases, health bars containing extra drugs, and cows and lactoferrin for immune boosting [30]. Food plants whose eaten portions are recognized as helpful in traditional medicine, ethnomedicine, or biomedicine are known as medicinal food plants. The study led to a holistic approach to the idea of medicinal foods, which not only provide the body with necessary macro and micronutrients but also bioactive ingredients that help prevent diseases linked to poor nutrition and promote physical and mental health. On the other hand, "food or part of food that provide medical or health benefits, including the prevention and treatment of disease" is the definition of a nutraceutical [43].

8. Current status of nutraceuticals as Immunity boosters

Nutraceuticals that fall under the immune booster or antiviral agent category can help strengthen the immune system and hasten the healing process of wounds. Coneflower extracts, Echinacea herb extracts (such as *Echinacea purpurea*, *Echinacea angustifolia*, and *Echinacea pallida*), and their combinations, as well as extracts from Sambuca herb extracts (such as elderberries and Goldenseal extracts) are among them [53]. Numerous nutrients in the diet are essential for preserving a "optimal" immune response, depending on the immunological status of the organism and its vulnerability to a range of illnesses. For the prevention of numerous disorders linked to a disturbed hormonal balance, a wide variety of phytopharmaceuticals known as "phyto-estrogens" with purported hormonal activity are advised [37]. The effects of bacteria and herbal remedies on the immune system and intestinal epithelial cell function have led to a greater usage of nutraceuticals and probiotics in clinical settings. Probiotics can help cure two conditions in children: infectious diarrhea and recurrent infections caused by *Clostridium difficile* [42].

9. Regulatory Aspects

The regulatory landscape surrounding nutraceuticals is complex and region-specific, with important regulatory frameworks created by organizations such as the Food Safety and Standards Authority of India (FSSAI), the Dietary Supplement Health and Education Act (DSHEA) in the United States, and the U.S. Food and Drug Administration (FDA). The FDA is in charge of regulating nutraceuticals in the United States, classifying them as dietary supplements under the DSHEA [20]. The 1994 Dietary Supplement Health and Education Act (DSHEA) is the main set of regulations controlling the nutraceutical industry. The 2011 Food Safety and Standard Rule has been published. Additionally, the Food Safety and Standard Authority has developed regulations pertaining to food product standards, manufacturing, packaging and labelling, licensing and registration of food businesses, and more. As of August 2011, the Food Safety and Standard Rule and Regulations are in force. Manufacturers will be encouraged by this act to conduct clinical trials and establish trustworthy protocols for product research and development. 2012 saw the passage of the Foreign Direct Investment Act, which opened up new markets for foreign companies looking to produce and market nutraceutical goods in India. Therefore, there is only one body that may control the manufacturing, sale, and distribution of

nutraceuticals in India [54]. India's Standards Authority (FSSAI). The FDA is in charge of regulating nutraceuticals in the US and classifies them as dietary supplements under the DSHEA. Manufacturers are required by these rules to guarantee product safety and correct labeling. Additionally, without FDA approval, the DSHEA forbids the promotion of supplements that make claims to treat or prevent particular conditions. The FSSAI oversees the quality and safety of nutraceuticals in India, including nutritional supplements and functional foods. Before products may be marketed, the FSSAI ensures that they fulfill safety and quality standards by establishing criteria for ingredients, labeling, and claims. In India, producers, importers, and retailers of nutraceuticals must abide by FSSAI laws [20]

9.1. Adverse effects of Nutraceuticals

Nutraceuticals have the following detrimental consequences on human health:

- In elderly individuals who use multivitamins, pyridoxine-associated sensory polyneuropathy may result from a higher consumption of pyridoxine (vitamin B6).
- These phytoconstituents, α -Tocopherol and β -Carotene, are studied in cancer prevention studies; however, male smokers may be affected by these phytoconstituents, i.e., at risk for lung cancer.
- Women who consume high amounts of vitamin A may have a higher chance of congenital irregularities in their offspring.
- After 12 years, intrahepatic cholestasis has also been recorded in patients with chronic hypervitaminosis, who take supplements.
- When taken at a dose range of 1000–2000 mg/day, omega-3 fatty acids and fish oil are said to be well tolerated and mildly harmful. However, anticoagulants, such as warfarin, can worsen anticoagulation and increase bleeding in individuals [55].

9.2. Safety and Efficacy

Products like Benecol, a margarine substitute that contains plant stanol esters that have been demonstrated to lower cholesterol, demonstrate the enormous potential of nutraceuticals. However, as was the case with ephedrine, a common botanical ingredient in weight-loss treatments, they may also have the potential to be harmful. After the drug was connected to serious negative health effects, such as heart attacks and strokes, the FDA prohibited it. Customers like these items because they promise health benefits and provide them more control over their health [41].

9.2.1. Herbal nutraceuticals must be regulated because it

- Provides greater legal security and a more stable environment.
- Encourages innovation in drink, food, and herbal goods.
- Prohibits unfair competition from producers who make false or deceptive claims.
- If it is not possible to make confident claims, the rule does not encourage others to make unfavorable statements about the product [21].

9.3. Advantages of nutraceuticals

Supplement use has innumerable benefits, and new uses are being investigated on a daily basis. Nutraceuticals are medications that have the potential to treat a variety of ailments, including those related to mental and physical health. Select dietary supplements from reliable Indian producers to receive the benefits listed below:

- Boost energy
- Improve overall health
- Improve Eye Health
- Treat Inflammation
- Relieve Anxiety
- Prevent chronic diseases
- Support and regulate bodily functions
- Increase life expectancy
- Improves sleeping pattern [42].

10. The Growing Nutraceuticals Market in India:

Even though the term "nutraceuticals" has foreign roots, what it means is native to India. Herbal remedies and vitamins have a long history in India, and our mythology and folklore have reflected this. In India, the market for nutraceuticals is anticipated to increase from \$4 billion in 2017 to \$18 billion in 2025 due to the growing demand from

the upper and middle classes for dietary supplements. The Indian nutraceuticals market is one of the strongest in the world, and its strength also stems from specific supply drivers. Several of the market's supply drivers include:

- India has the lowest labor costs among South Asian and South East Asian nations;
- It has the largest number of US FDA-approved plants outside the US, a strong testament to its ability to compete globally;
- It has the largest coastline, spanning over 7,500 km with over 12 major and 200 minor ports, making it an ideal manufacturing hub for the global value chain;
- It has the better GDP growth rate among the trillion-dollar economies.

The convergence of medicine, food, and technology is also expected to boost India's food processing industry and retail sector, which are expected to grow to over US\$958 billion by 2025 and US\$1.7 trillion by 2026, respectively, as nutraceuticals give pharmaceutical companies the chance to make their products more consumer-oriented and food producers the chance to develop brands with a medical image. [43].

During this COVID-19 era, immunity became a crisis, and nearly everyone grew alarmed and began spending money on natural or herbal immunity-boosting therapies. Therefore, several well-known brands, such as Mother Dairy, a milk provider based in Delhi-NCR, introduced haldidhoodh or turmeric milk to increase immunity. Additionally, there are combo meals that include all of the popular ingredients of the day, such as broccoli, spinach, bell peppers, garlic, dark chocolate, lime, parsley, cinnamon, etc [27]. Dietary supplements and herbal/natural goods are the two primary divisions of the nutraceutical sector. Nutraceuticals has grown to be a multi-billiondollar sector on the global market, with an estimated cost of investment of USD 117 billion (INR 5148 billion). The potential for growth in Canada's nutraceutical sector is anticipated to reach \$50 billion USD. The United States of America (USA) is the world's largest market, followed by Japan, which has a consistent average annual growth rate of 9.6%, according to the Nutrition Business Journal in 2017. The industry's two fastest-growing segments were natural/herbal goods at 11.6% annually and dietary supplements at 19.5% annually [29]. The majority of toiletries, cosmetics, and personal care items are sold in India's "mainstream market" under the "Fast Moving Consumer Goods" (FMCG) category, however there aren't many options for healthy products. For many businesses, this group of customers is their main objective. Additionally, India has an unexplored market for Ayurveda and other medicinal herbs, which is why people are flocking there [56].

11. Scope and Opportunity India Nutraceuticals Markets

The incidence of lifestyle-related diseases has increased due to a rise in poor eating habits, sedentary lives, fewer physical activities, and a rise in the number of individuals working in sitting positions, all of which have fueled the expansion of the nutraceutical market. The market for nutraceuticals will grow in the future due to a number of other causes as well as some other chances [57]. The trend in the health care industry is changing, as seen by the transition from pharmaceuticals to nutraceuticals. The food, pharmaceutical, and agricultural sectors are all impacted by the tremendous rise in the nutraceutical industry. A recent study by Grand View Research projects that the nutraceutical industry would grow at a compound annual growth rate (CAGR) of 8.8% to reach USD 578.23 billion by 2025.[43].

According to a survey released today, the Indian nutraceutical market, which was valued at \$1,480 million in 2011, might reach \$2,731 million in 2016. According to a survey by the consulting and business research firmFrost & Sullivan, until 2015, functional foods would increase at the fastest rate, followed by dietary supplements. However, it also stated that the biggest opportunity areas for nutraceutical makers will be dietary supplements, particularly herbal and dietetic supplements. A food or food product that purports to offer health and medical benefits, such as the prevention and treatment of diseases, is called a nutraceutical, a portmanteau of the word's "nutrition" and "pharmaceutical". According to the research, dietary supplements currently make up the largest category, accounting for 64% of all entries. In 2010, the global nutraceutical market was valued at \$140.1 billion. The two biggest markets for this were the US and Europe, with 36% and 25% of the total, respectively. According to estimates, the Indian nutraceutical market was worth \$2 billion in 2010, or around 1.5% of the global market. Dietary supplements account for 40% of the Indian nutraceutical sector, while functional foods and beverages make for 60% [49]. Due to Indian customers ignorance about the application and potential of traditional nutraceutical ingredients, India continues to encounter numerous obstacles in the development of nutraceuticals. Since the majority of the bioactive phytochemicals are still being studied, there are no established methods for handling or measuring them the government regulatory agencies in this new health product category also encounter difficulties. More research is required to determine the effectiveness and safety of nutraceuticals [27].

12. Conclusion

Nutraceuticals are compounds that offer health advantages or aid in the prevention or treatment of Diseases. Since nutraceuticals are more nutritious and have no negative side effects, they are far more significant than medications. There are a few nutraceuticals that help the body detox, prevent vitamin and mineral shortages, and establish good eating and digesting patterns. Lower the risk of numerous illnesses, including heart disease, neurological disorders, Alzheimer's disease, and others. For this reason, we can say that nutraceuticals play a significant role in our everyday lives and that they offer more health benefits than medications while having fewer negative effects. It been a major market in India and also has lot of work opportunities for the peoples, this nutraceutical product has its natural ingredient with pharmaceutical touch to enhance its safety, quality & efficacy which make this "Nutraceutical" products more effective and helpful to costumers.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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