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Review

Nutraceuticals in Modern Pharmacy: Bridging Nutrition and Therapeutics

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Abstract

Nutraceutical products encompass components of both nutrition and medications. Nutraceuticals are foods or food components that have a crucial role in altering and maintaining normal physiological functions, hence promoting human health. The final section of the assessment emphasises the substantial growth in the market value of nutraceuticals by citing numerous patents related to their application in agriculture and the treatment of various conditions. Nutraceuticals, in addition to their nutritional benefits, have demonstrated potential as supplementary therapy in the treatment and prevention of several illnesses, including cancer, by alleviating certain toxic side effects of radiation and chemotherapy. Innovative nanoformulation methods have demonstrated efficacy in addressing challenges during the development of new nutraceutical formulations. Mitigating the adverse effects of nutraceutical supplements may be achievable with previous awareness of various drug combinations. Enhanced health advantages from micronised dietary products and other nutraceutical supplements are an additional result of nanotechnology. This review article encompasses the latest significant findings from clinical studies on nutraceuticals, illustrating the therapeutic effects of bioactive chemicals present in nutraceuticals across many illnesses. Current demographic and health trends are the primary catalysts for the growth of the global nutraceutical market. Nutraceutical foods encompass a diverse range of herbal and natural components, such as dietary fibre, prebiotics, probiotics, polyunsaturated fatty acids, antioxidants, and others. Nutraceuticals have been utilised to address obesity, heart disease, cancer, osteoporosis, arthritis, diabetes, cholesterol, and numerous other significant health concerns. Ultimately, the term "nutraceutical" has heralded a new era in health and medicine, wherein the food industry has evolved into a research-oriented sector.

Keywords: Nutraceutical, Dietry fiber, Probiotics, Nutrient supplement, Herbal medicine.

INTRODUCTION

Nutraceuticals are defined as "specially formulated preparations" that have been scientifically developed to address specific nutritional requirements and/or offer preventive health care [1]. Nutraceuticals, with dietary supplements, aid in disease prevention and treatment through nutrient formulation. The term "nutraceutical" was coined by Dr. Stephen De Felice in 1989, derived from the amalgamation of "nutrition" and "pharmaceutical." These foods or food components confer health advantages, including assistance in the treatment or prevention of the illness[2]. The area of nutrition science has broadened its scope, encompassing the prediction of dietary deficiencies and its increasing importance in human health, as well as the prevention and treatment of chronic diseases. The concept initially introduced by Dr. De Felice has undergone multiple modifications, resulting in the terms "nutraceuticals," "food supplements," and "dietary supplements." Regulatory authorities have not established a distinct demarcation between nutraceuticals and dietary supplements. Reevaluating nutraceuticals concerning their efficacy, safety, and toxicity has emerged as a significant focus in recent literature. Food and other consumables are vital for sustaining life, generating energy, and promoting development, as they are nourishing substances[3-5]. The extraction of nutrients from diverse food sources is a recognised and prevalent practice currently. Distinguishing nutraceuticals from food and dietary supplements commences with the identification of an epidemiological target, succeeded by safety and efficacy studies to ascertain the mechanism of action. A method to differentiate between the two formulation types is to consider "food supplements" as substances that compensate for deficiencies in micro- or macronutrients; additionally, robust scientific evidence is required to support the use of a "nutraceutical" for the treatment of a pathological condition. Nutritional supplements characterised by optimal bioavailability, low side effects, and a robust safety profile are substantiated by adequate clinical evidence[6]. Claims delineate the distinction between a nutraceutical and a food supplement, however the differentiation between these two formulations is subtle. Food supplements encompass various combinations of minerals, vitamins, proteins, functional foods, herbal products, and pro- and prebiotic substances, whereas nutraceuticals consist of food items particularly designed for medical applications. Nutraceuticals, when incorporated into a nutritious diet, may aid in the prevention of pathological diseases by prolonging the duration individuals can forgo drugs while pursuing nonpharmacological therapies for their ailments. Spices and herbs, as asserted by several claims, may enhance health and prolong life expectancy by reducing the risk of various diseases. Nutraceuticals provide numerous benefits, including their potential in the treatment and prevention of intricate illnesses[7-10]. Nutraceuticals, however, require prescription and administration to mitigate their potentially detrimental and excessively prescribed adverse effects. Numerous studies have examined nutraceuticals derived from pharmaceutical components to enhance bioavailability and efficacy. Pregnant women have also gained advantages from the use of statins for the prophylaxis of cardiovascular diseases, owing to their safety and efficacy. Alongside traditional therapy, nutraceuticals demonstrated to be safe and beneficial during pregnancy may aid in the prevention of diabetes mellitus and hypertension disorders. Probiotic supplements, calcium, folic acid, vitamin D, resveratrol, zinc, inositol, and omega-3 polyunsaturated fatty acids are promising innovative nutraceutical candidates awaiting demonstration. The nutraceutical ezetimibe has been investigated for persons susceptible to elevated statin levels, which may lead to cardiovascular diseases. The efficacy and safety of a novel nutraceutical in conjunction with non-steroidal anti-inflammatory drugs (NSAIDs) have shown promising results for osteoarthritis treatment[11-13].

Classification of Nutraceuticals

- Dietary Fiber
- Probiotics
- Prebiotics
- Polyunsaturated fatty acids
- Antioxidant vitamin
- Polyphenols
- Spices

Dietary Fiber

Dietary fiber, also known as cellulose, is a type of carbohydrate that cannot be digested by the human body and is found naturally and unprocessed in plants. The term "functional fiber" refers to a group of carbohydrates that cannot be digested and that have been found to have beneficial effects on the physiology of humans. Both dietary fiber and functional fiber contribute to the total amount of fiber in the body. In light of these classifications, carbohydrates that were not digested in the past, such as resistant starches and oligosaccharides, can now be categorized as functional fibers. According to the Dietary Reference consumption (DRI), the recommended amount of fiber consumption for women is 25 grams per day, while the recommended amount for men is 38 grams per day. There was not enough evidence to establish a safe upper limit for the

amount of dietary fiber or functional fiber that could be consumed. Beneficial bacteria and yeasts are what make up probiotics, and they can be ingested to improve both one's general health and digestion. It is common knowledge that bacteria are responsible for the spread of disease. On the other hand, your body harbors both beneficial and harmful types of bacteria. The "good" or "helpful" bacteria that are found in probiotics are the ones that are responsible for keeping the digestive system in good health. Probiotics are already present within your body. In addition, they can be found in certain meals and dietary supplements. Since the middle of the 1990s, people have only begun to show an interest in learning more about probiotics and the health advantages they provide. They are a typical treatment suggested by medical professionals for patients who suffer from stomach problems. Their rise to popularity over the past few years has resulted in their incorporation into a diverse range of foods, from chocolate to yogurt[14].

Probiotics

Probiotics were initially introduced into the human diet more than 2,000 years ago, when people started drinking fermented milks for the first time. Metchinkoff's efforts to change the toxic flora of the large intestine into a colony of Bacillus bulgaricus that is friendly to the host have aroused a renewed interest in this area of research. The administration of a live microbial feed supplement known as a probiotic to an animal has the potential to restore a more healthy microbial balance in the animal's digestive tract. The following strains of bacteria are frequently discovered in probiotics: -Lactobacilli, which may include Lactobacillus acidophilus, Lactobacillus casei, Lactobacillus delbrueckii subsp. bulgaricus, Lactobacillus brevis, and Lactobacillus cellobiosus, Streptococcus bacteria, which may include Streptococcus thermophilus. Gram-positive cocci include examples such as Enterococcus faecium, Streptococcus salivarius subsp. thermophilus, and Lactococcus lactis. Bifidobacteria such as Bifidum bifidum, Bifidum adolescentis, Bifidum infantis, Bifidum longum, and Bifidum thermophilum[15].

Food additives known as prebiotics are able to improve an individual's overall health by manipulating the metabolic processes of the microbiota that live in the digestive system. Because of the peculiar chemical properties of these short-chain polysaccharides, such as fructose-based oligosaccharides, they cannot be digested by humans. These short-chain polysaccharides can either exist naturally or be introduced artificially. Consuming meals rich in prebiotics is generally considered to be good to one's metabolism since it promotes the expansion of beneficial bacteria such as Lactobacillus and Bifidobacterium in the intestines. There are a number of vegetables that are rich in fructo-oligosaccharides, including chicory roots, bananas, tomatoes, and onions, to name just a few. Additionally, raffinose and stachyose are oligosaccharides that can be found in beans and peas. It has been demonstrated that prebiotics can improve lactose tolerance, limit the formation of tumors, deactivate harmful compounds, boost the immune system in the intestines, reduce blood fat and cholesterol levels, and relieve constipation. Oligosaccharides and insulin in doses ranging from 5 to 20 grams per day are the perfect food for bifidobacteria. When ingested in large numbers, these oligosaccharides result in abdominal distention, diarrhea, and gas[16].

Polyunsaturated fatty acid

On the basis of the position of the first double C-bound, polyunsaturated fatty acids, also known as PUFAs, can be divided into two distinct subgroups: omega-3 (n-3) PUFAs and omega-6 (n-6) PUFAs. Two types of polyunsaturated fatty acids (PUFAs) known as essential fatty acids are required by the human body, but the body cannot create them on its own. Because of this, they have to be taken in by the body. A good illustration of this is the n-6 fatty acid known as linoleic acid (LA). The other one is linolenic acid (LNA), which is an n-3 fatty acid. We lack the enzymes required to convert between n-3 and n-6 fatty acids, but we do have the ability to convert these essential precursor molecules into long-chain (LC) fatty acids[17].

Antioxidants

It is believed that the damage to cells that is caused by free radicals is a primary factor in the aging process as well as the development of diseases. Antioxidants prevent damage to cells that can be caused by free radicals and are, as a result, critical to maintaining overall health. Oxygen, due to its high level of reactivity, can play a role in the creation of potentially hazardous molecules known as "free radicals." To put it more simply, the structure and function of healthy cells in the body might be compromised when free radicals are present. Antioxidants can stabilize or deactivate free radicals, thereby preventing the damage that these unstable molecules cause to cells. Antioxidants are an absolute necessity if we want to maintain the health of both our individual cells and the entirety of our bodies. The antioxidant defense system that originated in human beings is among the most sophisticated and intricate found in the animal kingdom[18]. A network of interconnected and synergistic components, some of which originate from within the body and others of which originate from outside it, is responsible for the neutralization of free radicals. The use of antioxidants as dietary supplements has shown some promise in the treatment of chronic diseases such as cancer and cardiovascular disease. Through the neutralization of potentially dangerous free radicals, they prevent the oxidation of LDL cholesterol.

Antioxidant vitamins can be found in abundance in vegetables, fruits, fish, and fixed oils. These vitamins work to prevent the formation of oxygen free radicals by either entrapping those that already present or by preventing their production. A diet that is high in antioxidants has been found in a few epidemiologic studies of people suffering from coronary heart disease to reduce the risk of death and morbidity. Antioxidant dietary supplements, such vitamins C and E, are helpful in warding against coronary heart disease. However, because there is a possibility of unpleasant side effects, beta-carotene supplements are not recommended. In a large cohort trial of American men and women aged 25 to 74, who were followed for over 10 years and randomly assigned to receive one of 10 different combinations of nutritional supplements, the consumption of vitamin C was demonstrated to reduce the incidence of coronary heart disease[19].

Polyphenols

Whole plant foods such as fruits, vegetables, whole grains, cereal, legumes, tea, coffee, wine, and cocoa have been found to contain over 8,000 different polyphenolic compounds. These compounds include phenolic acids, flavonoids, tilbenes, lignans, and polymeric lignans. Plants manufacture these chemicals, which are referred to as secondary metabolites, in order to defend themselves against potentially damaging factors such as ultraviolet light, oxidants, and viruses. The number of phenol rings in a polyphenol as well as the structural components that bind these rings to one another make it possible to classify polyphenols in a variety of ways. Phenolic acids make up approximately one third of all of the polyphenolic chemicals found in food. These acids can be broken down into two primary categories: a) hydroxycinnamic acid derivatives, which include caffeic acid, chlorogenic acid, coumaric acid, Ferulic acid, and sinapic acid; and b) hydroxybenzoic acid derivatives, which include protocatechuic acid, gallic acid, and p-hydroxybenzoic acid. Anthocyanins are found in the berry family, red wine, red cabbage, cherries, black grapes, and strawberries. Anthocyanins are classified as one of the six subclasses of flavonoids. Other subclasses include pelargonidin, delphinidin, and malvidin[20].

Spices

Spices have been used extensively by chefs ever since ancient times in order to impart nuanced flavors into their cuisine. Spices are fragrant plant compounds that are used mostly for flavoring rather than for their nutritional value. Spices can be purchased whole, cracked, or crushed. Dishes get their distinctive flavors, aromas, and astringencies from the seasonings that are used in them. The meal gets its scent, flavor, and oleoresin from the volatile oil spices, which are also the source of the dish's spiciness. Because spices can be used for so many things in addition to seasoning and flavoring food, the economy of the nation that is responsible for their production is very important. Traditional medicines, pharmaceuticals, nutraceuticals, aromatherapy, preservatives, drinks, natural colors, perfumes, dental preparations, cosmetics, and plants used as pesticides all contain them to varying degrees[21-25]. These positive effects can be attributed to the large range of chemicals that are produced when these spices are cooked. Not just to fulfill the needs of the conventional food manufacturing business, but Indian spices are in high demand everywhere else in the world as well. Nearly fifteen percent of the total spice production in the country is currently devoted to the non-traditional applications of spices, such as in the production of nutraceuticals. Chawanprash is one of the most well-known and widely used nutraceutical items in India. Some of the spices that are included are cinnamon, clove, saffron, long pepper, and various species of curcuma. These are advantageous due to the high levels of vitamin C and other antioxidants that they contain. Vitamin C and other antioxidants strengthen the body's defenses against illness, improve digestion, and reduce the risk of conditions such as the common cold, asthma, fever, heart disease, impotence, and foul language. Neurodegenerative disorders are characterized by a steady decline in brain function over time. Some examples of neurodegenerative diseases are Alzheimer's disease, Parkinson's disease, multiple sclerosis, brain tumors, and meningitis. There is evidence to suggest that some spices, such as cinnamon, saffron, nutmeg, clove, ginger, garlic, coriander, rosemary, and saffron, as well as spiciness like turmeric, can assist in the fight against neurodegenerative diseases[26].

Nutraceuticals in various Diseases

Nutraceuticals help enhance health, wellbeing and modulating immunity, thus preventing and treating various diseases and health issues. There are a variety of diseases that can be treated with the help of nutraceuticals which are discussed below:

Cardiovascular diseases

Anti-oxidants, Fiber in the diet, omega-3 polyunsaturated fatty acids, vitamins, and minerals are all important components in the treatment and prevention of cardiovascular disease. Grape polyphenols impede the beginning stages of atherosclerosis as well as its further development. Flavonoids, which can be found in onions, vegetables, grapes, red wine, apples, and cherries, are responsible for strengthening the minute blood capillaries that deliver oxygen and nutrients to every cell in the body because they suppress an enzyme called ACE. Rice bran consumption raises both the "good" HDL cholesterol and the "bad" LDL cholesterol in the

blood serum, with the latter having a larger positive impact on cardiovascular health. The greater the ratio, the greater the likelihood that a person would develop coronary heart disease. Rice bran contains two antioxidants called lutein and zeaxanthin, both of which work to stave against cataracts and improve eyesight. Rice bran is beneficial to the health of your eyes due to the presence of folic acid, vitamin E, and the essential fatty acids omega-3, omega-6, and omega-9 in its composition. A diet that is lacking in fruits and vegetables has been related to a high death risk owing to cardiovascular disease (CVD)[27].

Diet related diseases

The dramatic rise in the frequency of diet-related illnesses in Western nations is being contributed to by a number of variables, including increases in the availability of foods that are rich in calories and the popularity of lifestyles that are sedentary. Inflammation of a low grade is a common pathogenic factor that contributes to the development of major diet-related diseases such as obesity, diabetes, atherosclerosis, and neurodegeneration. As a result of the anti-inflammatory effects that they possess, functional foods and nutraceuticals have the potential to be an innovative therapy technique for the prevention and management of diet-related illnesses. In particular, the homeostatic regulation of the gut microbiota and the activation of intestinal T regulatory cells have the ability to diminish low-grade inflammation in conditions that are connected to food[28].

Heart attack and lung cancer

Not only does corn give a significant amount of fiber, which is beneficial to heart health, but it also supplies a significant amount of folate, which also plays a role. Corn acts as a preservative by preventing the breakdown of homocysteine, which is a result of the methylation cycle, an essential metabolic process. Damage to the blood arteries caused by homocysteine can lead to a number of different types of cardiovascular illness, including heart attacks, strokes, and peripheral vascular disease[29-32]. It has been demonstrated that a one hundred percent consumption of the necessary amount of folate can reduce the risk of cardiovascular disease by ten percent. In addition, the maize kernels contain the carotenoid pigment known as cryptoxanthin. It has been demonstrated that a daily consumption of cryptoxanthin can reduce the chance of developing lung cancer by 27%.

Diabetes

Patients who suffer from diabetes might gain something from n-3 fatty acid ethyl esters. Docosahexaenoic acid is crucial for neurovisual development and also modulates insulin resistance. Antioxidant lipoic acid for diabetic neuropathy. Dietary fibers made from psyllium have been utilized in the treatment of diabetes and hyperlipidemia, with the respective goals of bringing glucose and lipid levels down.

Obesity

When medical professionals speak of the global epidemic of obesity, they are referring to the accumulation of unhealthy levels of fat throughout the body. It has been demonstrated that it can increase the risk of a number of ailments, including coronary artery disease, heart failure, high blood pressure, high cholesterol, breathing issues, kidney disease, rheumatoid arthritis, cancer, and infertility.

Cancer

In recent years, cancer has evolved into a significant hazard to the general public's health in the poorest nations of the world. According to projections made in the World Cancer Report, there will be 15 million newly diagnosed cases of cancer across the globe by the year 2020. This is a fifty percent increase from the rates that are currently observed. It is possible to stave off cancer by leading a healthy lifestyle and maintaining a nutritious diet. Carotenoids are a category of phytochemicals that are responsible for the myriad of colors found in food. They also contain antioxidant qualities, which contribute to their effectiveness in warding against cancer. In recent years, a lot of attention has been paid to carotenoids because of the possible benefits that lycopene could have for human health. In addition, the proliferation of prostate cancer cells can be inhibited by genistein, isoflavones, daidzein, and plants high in biochanin. Because of its unsaturated structure, lycopene has the capacity to quench singlet oxygen and scavenge free radicals. Lycopene, an antioxidant that helps prevent cancer, is found in the highest concentrations in the prostate, testicles, skin, and adrenal glands. In light of the association between carotenoids and the prevention of cancer and coronary artery disease (CAD), emphasis has been placed on the significance of vegetables and fruits in the human diet. It has been demonstrated that eating vegetables and fruits that are rich in lycopene can protect against cancer by reducing the levels of oxidative stress and DNA damage. There is only one food source for the carotenoid lycopene, and it can be found in tomatoes, guava, pink grapefruit, watermelon, and papaya. Beta-carotene is an antioxidant that protects cells from damage caused by free radicals, which can lead to cancer and other diseases. The carotenes all have some level of antioxidant action, but beta-carotene has the most. The antioxidant activity of alpha-carotene is approximately 50-54%, which is slightly higher than the antioxidant activity of epsilon-carotene, which is

approximately 42-50%. There is a substantial link between inflammation and the development of cancer. Immunosuppression, which can be a contributor to the development of cancer, is also associated with chronic inflammation. Ginseng is one example of a substance that works to reduce inflammation by acting on numerous links in the chain that connects inflammation with the development of cancer. In recent years, there has been a great deal of interest in phytochemicals because of their potential to assist in the prevention of cancer. Fruits and vegetables include chemopreventive components that may have antimutagenic and anticarcinogenic characteristics, in addition to the numerous positive effects they have on one's health. Some examples of these herbs include soapberry, soapwort, and soapbark. Additionally, tomatoes, potatoes, alfalfa, spinach, and clover all contain them, in addition to clover. Saponins are mostly derived from Yucca schidigera and Quillaja saponaria, which are both used in commercial production. Consuming walnuts, pecans, strawberries, cranberries, pomegranate seeds, and red raspberry seeds can help reduce the risk of developing cancer. Glucosinolates undergo biotransformation, which results in the production of byproducts such as dithiol thiones, isothiocyanates, and sulforaphane. They are particularly effective at blocking the enzymes that contribute to the growth of tumors in the gastrointestinal tract, the lungs, the breasts, the stomach, and the esophagus. According to a number of studies, the sulfur-containing compounds in garlic improve the body's ability to fight off infections, lower the risk of developing cancer, and inhibit the development of atherosclerosis and platelet stickiness. Because it contains a high concentration of sulforaphane, broccoli is an effective inducer of phase 2 enzymes. There, production of D-glucarolactone takes place, which is an effective inhibitor of breast cancer. Sulforaphane is an effective detoxifier that also performs the role of an antioxidant. Researchers have looked into the potential anti-cancer effects of sulforaphane in relation to breast and prostate cancer. Curcumin, a polyphenol, can be extracted from the spice turmeric, also known as Curcuma longa. There have been reports of curcumin having properties that are anti-inflammatory, anti-carcinogenic, and antioxidant. Consuming meals high in cysteine, glutathione, selenium, vitamin E, vitamin C, lycopene, and other phytochemicals is one way to boost one's antioxidant capacity. Other methods include exercise and proper sleep. However, additional research is necessary before we can have a complete understanding of their potential applications in cancer prevention and treatment. In large-scale clinical trials, the prevention of prostate cancer with green tea, vitamins D and E, selenium, lycopene, soy, anti-inflammatory medicines, and inhibitors of 5a-reductase all showed encouraging results. To minimize their chance of developing cancer, smokers did not benefit from consuming beta-carotene, N-acetylcysteine, alpha-tocopherol, retinol, retinyl palmitate, or isotretinoin[33].

Anti-inflammatory activities

It has been demonstrated that the polyphenol curcumin, also known as diferuloylmethane, found in turmeric possesses anti-inflammatory, antioxidant, and cancer-fighting properties. It has been suggested that some components of plants, such as the rhizomes of turmeric, the leaves of spinach, the fruits of cucumbers, and the roots of beets, may inhibit the growth of tumors. Gamma linolenic acid is used as a treatment for inflammation as well as autoimmune illnesses. This acid can be found in foods such as green leafy vegetables, almonds, vegetable oils (including evening primrose oil, blackcurrant seed oil, and hemp seed oil), and cyanobacteria (such as spirulina). Because they are able to control the generation of PGE2 and the expression of genes that are involved in the disease, glucosamine and chondroitin sulfate are effective treatments for osteoarthritis. It has been shown that cat's claw has substantial anti-inflammatory benefits. Uncaria guianensis is the species of cat's claw that is most usually used for traditional wound treatment. On the other hand, Uncaria tomentosa is the species of cat's claw that is most commonly encountered in supplements due to the vast range of therapeutic applications it possesses. There are 17 different alkaloids, glycosides, tannins, flavonoids, and sterol fractions discovered in cat's claw, in addition to other types of chemicals. Cat's claw also contains a variety of other components.

Alzheimer’s disease

Antioxidants such as beta-carotene, curcumin, lutein, and lycopene, as well as turmerin, have the potential to reduce oxidative stress, mitochondrial dysfunction, and neurodegeneration in certain diseases.

Parkinson’s disease

There is some evidence that consuming foods that are rich in vitamin E can lower the chance of getting Parkinson's disease. Researchers from Canada found a correlation between eating foods rich in vitamin E and a lower likelihood of acquiring Parkinson's disease. It appeared that creatine could affect the characteristics of Parkinson's disease, as evidenced by a reduction in the severity of clinical symptoms. In spite of the fact that exploratory research on nutritional supplements for Parkinson's disease has shown some hopeful outcomes, it is essential to keep in mind that there is not currently sufficient data to recommend that people use them. Patients need to be cautioned that over-the-counter (OTC) medications can be expensive and can have unfavorable interactions with other prescriptions.

Osteoarthritis

An estimated 21 million people in the United States are afflicted with osteoarthritis (OA), a joint condition that can severely limit one's mobility. It was projected that the direct and indirect costs associated with treating all types of arthritis totaled around $86 billion in the year 2004. Because of the associated discomfort, people who suffer from osteoarthritis (OA) and other joint illnesses may reduce the amount of physical activity they participate in. Extra weight places additional strain on the joints, which can exacerbate preexisting conditions and make them much more difficult to manage. Supplements that contain glucosamine (GLN) and chondroitin sulfate (CS) are widely used for the goal of achieving this objective. Because these nutraceuticals have both nutritional and pharmacological properties, it is possible that their anti-inflammatory effects are caused by the fact that they alter the expression of genes as well as the production of nitric oxide and prostaglandin E2.

Adrenal Dysfunction

Adaptogens are a category of natural herbs that have balancing effects on the body that are not tissue specific. Adaptogens are substances that broaden and generalize the body's tolerance to the effects of stress. In addition to the mushroom Cordyceps sinensis, the following plants and mushrooms are all examples of adaptogens: Eleutherococcus senticosus, Ginkgo biloba, Ocimum sanctum, Panax ginseng, and Withania somnifera. The following provides a concise explanation of each option. Ginkgo biloba has been used to treat a variety of symptoms, including tiredness, amnesia, and dizziness, for thousands of years in China. Standardized preparations of ginkgo have been shown to possess antioxidant and neuroprotective properties, such as slowing the progression of dementia and reducing the risk of developing the condition altogether. Holy basil, also known as Ocimum sanctum, is a herb that has been utilized in Ayurvedic medicine due to its sedative effects. In the study conducted by Sembulingham et al., rats were subjected to both acute and chronic noise stress, with and without occimum therapy. In rats that had been subjected to either acute or chronic noise, pretreatment with ocimum resulted in a substantial reduction in corticosterone levels.

Eye disorders

Age-related macular degeneration (AMD) may be slowed down by eating foods high in antioxidants, such as those containing omega-3 fatty acids, lutein, and zeaxanthin. There is a correlation between nutraceuticals that are high in polyphenolic flavonoids and the presence of antioxidant activity. Green tea, Allium spp., vitamins C and E, polyphenols, carotenoids (mainly lycopene and -carotene), and coenzyme Q10 all have antioxidant characteristics and are useful in the treatment of AMD. Other herbs and herbal extracts also have these features and are useful in treating AMD. Natural sources of astaxanthin can be found in a variety of significant marine creatures, including sea bream, salmon, trout, and shrimp. In aquatic creatures, it plays a key part in a variety of processes, including the immune response, pigmentation, the prevention of oxidation, and the protection against ultraviolet light. In addition to that, it possesses powerful antioxidant capabilities. Astaxanthin is a powerful antioxidant that prevents macular degeneration and offers great eye protection. Astaxanthin has a wide variety of beneficial effects, some of which include protecting the heart from oxidative damage, the nervous system from degenerative illnesses such as Alzheimer's disease, and increasing the immune system's performance. There is a pigment called lutein, and foods like sweet potatoes, carrots, squash, tomatoes, mangoes, corn, and leafy greens like kale and collards are all good sources of it. Patients who are experiencing difficulties with their vision are often given lutein and zeaxanthin as eye supplements. Plants also create lutein and zeaxanthin as mono- and diesters of fatty acids, which can be found in egg yolks, corn, green vegetables and fruits such as brussel sprouts, cabbage, kale, broccoli, green beans, green peas, lettuce, kiwi, collard greens, spinach, and honeydew melons. Zeaxanthin is also present in egg yolks. The marigold flower, also known as Tagetes erecta, is a new source of the antioxidants zeaxanthin and lutein. Both of these compounds are present in the plant at amounts that are approximately 86% by weight.

Nutraceuticals growth market in India

The nutraceutical sector is currently transferring its attention to the developing markets of Asia and the Pacific as a result of the stabilization that has occurred in the international markets. It is anticipated that the Indian market will be worth approximately $5 billion by the end of 2019, a decrease from its all-time high of 2% of the global nutraceuticals sector in 2017. It is anticipated that it will reach 11 billion US dollars by 2023, expanding at a compound annual growth rate of 21%. Additionally, it is anticipated that India will account for at least 3.5 percent of the global market by the year 2023. The fiscal year 2020, India's pharmaceutical exports brought a revenue of USD 16.3 billion. By the end of November 2020, India had raked in a total of USD 15.86 billion from the sale of pharmaceuticals during the previous fiscal year. The value of pharmaceutical exports increased to $2.07 billion in October of 2020, from $2.28 billion in the previous fiscal year. The Indian market currently imports nutraceuticals worth 2.7 billion USD, which is far higher than the 1.5 billion USD that it earns from exporting these products. The market is projected to have grown at a healthy 22% CAGR by the year 2023,

according to the experts Fig.1. In India, the nutraceuticals business has been developing at a pace of 25% per year despite the pandemic that has been going on there. There has been a considerable increase in the amount of foreign direct investment (FDI), as seen by the growth from USD 131.4 million in FY12 to USD 584.7 million in FY19. The expanding emphasis on preventative healthcare in India is supported by rising disposable income, a growing urban population, and a burgeoning e-commerce industry. These three factors, along with others, have all contributed to the rise of India's nutraceuticals market in recent years.

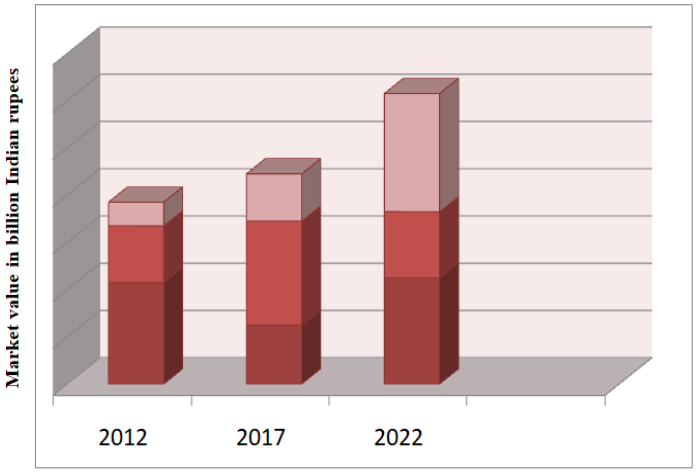

Fig 1: Nutraceuticals growth market in India

Once the e-commerce platform began operating during the lockdown period, sales of nutraceuticals began to rise further as people being at home had ample amount of time for a workout at home, and an increasing number of workout videos led to a rise in the demand for nutraceuticals. Additionally, the spread of covid-19 in 2020 boosted the nutraceuticals market of India due to the increased health awareness amongst people to curb the spread of the virus. The demand for supplements, healthy foods, and drinks is growing and will experience a big surge in the next few years as people focus more on boosting their immunity as a result of the rising fitness industry caused by an increase in health awareness among people and covid-19. This is due to the fact that the fitness industry is rising as a direct result of an increase in people's awareness of their own health. The increasing amount of discretionary cash in India, along with an increased focus on preventative health care, has led to a boom in the nutraceutical industry. People, particularly those of a younger generation, are lured to e-commerce platforms because of the sales and discounts that are offered on a wide variety of products, including nutraceuticals. These platforms give these deals and discounts on a variety of products.

CONCLUSION

The term "nutraceutical" denotes a category of naturally occurring compounds in food and beverages that may include medical and nutritional attributes, potentially aiding in illness treatment or prevention, prolonging longevity, and improving general health. Oxidative stress arises when antioxidant defence mechanisms are surpassed by the active human lifestyle. Moreover, the levels of antioxidant defence mechanisms diminish considerably with age. A multitude of diseases may arise as a consequence of them. Consequently, numerous nutraceuticals have been the primary focus of research during the past few decades. Vitamins and polyunsaturated fatty acids exemplify antioxidants with a natural capacity to neutralise free radicals, while other antioxidants enhance the immune system. This review reflects the potential advantages and disadvantages of nutraceuticals in healthy individuals. Lifestyle factors, like smoking and excessive alcohol intake, along with genetic predisposition, significantly influence an individual's vulnerability to various diseases.

REFERENCES

1. Abdelwahab SI, Taha MM, Mariod AA, Al-Foraih M, Al-Asmari H. Exploring Nutraceuticals: A Comprehensive Examination of Inception, Thematic Mapping, Evolution, Emerging Trends, and Gaps. Current Research in Nutrition and Food Science Journal. 2024 Apr 25;12(1):41-57.

2. Singh D, Chanana A, Gupta P, Patel A, Madaan V, Singh RP. Breaking Ground in Nutraceutical Medicine: Recent Advancements and Promising Trends. focus.;9:10.
3. Blagun OD, Balynska MV, Duchenko MA, Bidzilia NV, Us AV. The place of dietary supplements in modern pharmacy and some aspects of legislative regulation of their circulation. Reports of Vinnytsia National Medical University. 2025 Mar 20;29(1):136-41.
4. Vij S, Kumar R, Singh AP, Singh AP, Sharma P. Nutraceuticals: A Review. Safety. 2024;8(2).
5. Rama Rao T, Anand A. Investigating Nutraceuticals: Recent Developments and Future Growth. Pharmaceutical and Biomedical Research. 2024 Oct 10;10(4):291-302.
6. Pandey P, Pal R, Koli M, Malakar RK, Verma S, Kumar N, Kumar P. A traditional review: The utilization of nutraceutical as a traditional cure for the modern world at current prospectus for multiple health conditions. J. Drug Deliv. Ther. 2024 Mar 17;14:154-63.
7. Bose A, Sharma S. Global Regulatory Trends and Comparative Insights: Nutraceuticals in the USA, India, and Europe. PharmaNutrition. 2025 Jan 7:100430.
8. Chavan S, Kazi S, Bais SK. Categorization, Current Trends and Upcoming Opportunity of Herbal Nutraceutical.
9. Bajaj M. A Study on Nutraceuticals. International Journal of Nutrition-7 (4). 2024 Mar 11:36-54.
10. Dama A, Shpati K, Daliu P, Dumur S, Gorica E, Santini A. Targeting metabolic diseases: the role of nutraceuticals in modulating oxidative stress and inflammation. Nutrients. 2024 Feb 10;16(4):507.
11. Vignesh A, Amal TC, Sarvalingam A, Vasanth K. A review on the influence of nutraceuticals and functional foods on health. Food Chemistry Advances. 2024 Jun 8:100749.
12. Matos J, Cardoso C, Serralheiro ML, Bandarra NM, Afonso C. Seaweed bioactives potential as nutraceuticals and functional ingredients: A review. Journal of Food Composition and Analysis. 2024 Jun 22:106453.
13. Fernandes F, Carocho M, Prieto MA, Barros L, Ferreira IC, Heleno SA. Nutraceuticals and dietary supplements: balancing out the pros and cons. Food & Function. 2024.
14. Elazzazy AM, Baeshen MN, Alasmi KM, Alqurashi SI, Desouky SE, Khattab SM. Where Biology Meets Engineering: Scaling up microbial nutraceuticals to bridge nutrition, therapeutics, and global impact. Microorganisms. 2025 Mar 2;13(3):566.
15. Kocsis AE, Kucsápszky N, Santa-Maria AR, Hunyadi A, Deli MA, Walter FR. Much More than Nutrients: The Protective Effects of Nutraceuticals on the Blood–Brain Barrier in Diseases. Nutrients. 2025 Feb 21;17(5):766.
16. Alu'datt MH, Rababah T, Tranchant CC, Al-u'datt DA, Gammoh S, Alrosan M, Bani-Melhem K, Aldughpassi A, Alkandari D, AbuJalban D. Date palm (Phoenix dactylifera) bioactive constituents and their applications as natural multifunctional ingredients in health-promoting foods and nutraceuticals: A comprehensive review. Comprehensive Reviews in Food Science and Food Safety. 2025 Jan;24(1):e70084.
17. Ahmad S, Jan K, Sahu JK, Habib M, Jan S, Bashir K. A comprehensive review on recent trends and utilization of algal β-glucan for the development of nutraceuticals and functional foods. Food Reviews International. 2025 Feb 17;41(2):469-90.
18. Mohanakumar KP, Rendeiro C, Beart PM. Neuro-nutraceuticals: Emerging molecular and functional insights into how natural products improve brain health. Neurochemistry International. 2025 Feb 13:105948.
19. Fornaro M, Caiazza C, Billeci M, Berk M, Marx W, Balanzá-Martinez V, De Prisco M, Pezone R, De Simone G, Solini N, Iasevoli F. Nutraceuticals and phytoceuticals in the treatment of schizophrenia: a systematic review and network meta-analysis "Nutra NMA SCZ". Molecular Psychiatry. 2025 Jan;30(1):168-87.
20. Hyderi Z, Kannappan A, Ravi AV. The Multifaceted Applications of Seaweed and Its Derived Compounds in Biomedicine and Nutraceuticals: A Promising Resource for Future. Phytochemical Analysis. 2025 Apr;36(3):491-505.
21. Shamsudin SN, Abu Bakar E, Osman S, Mohd Dali NR. Application of social cognitive theory and Islamic theory of consumer behavior in accessing Muslim behavior toward halal nutraceuticals. Journal of Islamic Marketing. 2025 Jan 20;16(2):651-67.
22. Charles AP, Rajasekaran B, Awasti N, Choudhary P, Khanashyam AC, Majumder K, Wu Y, Pandiselvam R, Jin TZ. Emerging chitosan systems incorporated with polyphenols: Their applications in intelligent packaging, active packaging, and nutraceutical systems–A comprehensive review. International Journal of Biological Macromolecules. 2025 Mar 31:142714.
23. Bhattacharjya A, Roychowdhury P. Nutraceuticals for good health and optimum sleep. InNutraceuticals in Insomnia and Sleep Problems 2025 May 9 (pp. 23-41). Apple Academic Press.

24. Banez MJ, Geluz MI, Chandra A, Hamdan T, Biswas OS, Bryan NS, Von Schwarz ER. A systemic review on the antioxidant and anti-inflammatory effects of resveratrol, curcumin, and dietary nitric oxide supplementation on human cardiovascular health. Nutrition Research. 2020 Jun 1;78:11-26.
25. Mirabelli M, Chiefari E, Arcidiacono B, Corigliano DM, Brunetti FS, Maggisano V, Russo D, Foti DP, Brunetti A. Mediterranean diet nutrients to turn the tide against insulin resistance and related diseases. Nutrients. 2020 Apr 12;12(4):1066.
26. Leri M, Scuto M, Ontario ML, Calabrese V, Calabrese EJ, Bucciantini M, Stefani M. Healthy effects of plant polyphenols: molecular mechanisms. International journal of molecular sciences. 2020 Feb 13;21(4):1250.
27. Devi SA, Chamoli A. Polyphenols as an effective therapeutic intervention against cognitive decline during normal and pathological brain aging. Reviews on New Drug Targets in Age-Related Disorders. 2020:159-74.
28. Lévesque S, Pol JG, Ferrere G, Galluzzi L, Zitvogel L, Kroemer G. Trial watch: dietary interventions for cancer therapy. Oncoimmunology. 2019 Jul 3;8(7):e1591878.
29. Kang JS. Dietary restriction of amino acids for Cancer therapy. Nutrition & metabolism. 2020 Mar 14;17(1):20.
30. Weber DD, Aminzadeh-Gohari S, Tulipan J, Catalano L, Feichtinger RG, Kofler B. Ketogenic diet in the treatment of cancer–where do we stand?. Molecular metabolism. 2020 Mar 1;33:102-21.
31. Ha X, Wang J, Chen K, Deng Y, Zhang X, Feng J, Li X, Zhu J, Ma Y, Qiu T, Wang C. Free fatty acids promote the development of prostate cancer by upregulating peroxisome proliferator-activated receptor gamma. Cancer management and research. 2020 Feb 24:1355-69.
32. Ghoneum A, Afify H, Salih Z, Kelly M, Said N. Role of tumor microenvironment in ovarian cancer pathobiology. Oncotarget. 2018 Apr 27;9(32):22832.
33. Ha JH, Ward JD, Radhakrishnan R, Jayaraman M, Song YS, Dhanasekaran DN. Lysophosphatidic acid stimulates epithelial to mesenchymal transition marker Slug/Snail2 in ovarian cancer cells via Gαi2, Src, and HIF1α signaling nexus. Oncotarget. 2016 May 7;7(25):37664.