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Review

A systematic review on unveiling the potential of nutraceuticals: a new era in disease management

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Abstract

Nutraceuticals are formulation that are designed with The sole purpose of fulfilling specific dietary requirements and prevent diseases, in this article, we will understand about what nutraceuticals is, the core History behind it, the various benefits that has been observed in treating and preventing various diseases over the past years, the economic value and its contribution in India and World GDP, and finally the future expects and development of the nutraceuticals. The combination of the words "nutrition" and "pharmaceutical", or "nutraceuticals", has drawn increasing interest due to its potential health benefits. This abstract provides an overview of the current state of nutraceuticals, including their categories, definitions, and mechanisms of action. Nutraceuticals encompass a broad category of products that include functional foods, herbal supplements, and dietary supplements. The idea behind these products is that they provide additional health benefits beyond basic nutrition. Nutraceuticals contain bioactive substances such vitamins, minerals, antioxidants, and phytochemicals that are essential for maintaining and preventing disease. Nutraceuticals may support immune system function, metabolic health, cardiovascular health, and cognitive function, among other areas of health, according to research. But there are still problems like inconsistent evidence, quality control, and regulations. Notwithstanding these difficulties, nutraceuticals are nonetheless gaining popularity as people seek natural alternatives to prescription drugs. To fully realize the potential advantages of nutraceuticals for human health and well-being, more investigation is required to determine their safety, effectiveness, and ideal dosage.

Keywords: nutraceutical, dietary supplement, peptides, balanced diet, nutritional supplements

Introduction

Nutraceuticals are defined as formulations that are specifically created to meet dietary requirements, provide preventative healthcare, and aid in the prevention and treatment of certain illnesses. They are regarded as non-specific biological therapies that control and prevent malignant processes while enhancing overall well-being. Dr. Stephen DeFelice, the founder and head of the Foundation for Innovation in Medicine, coined the term "nutraceuticals" in 1989 [1]. It is a compound word that combines the terms "nutrient" and "pharmaceutical". A food that provides medical or health benefits, including the prevention or treatment of a disease", is how he described nutraceuticals. The idea behind nutraceuticals is to emphasise prevention, as expressed in the proverb "let food be your medicine", attributed to the Greek physician Hippocrates. Considering the efficacy, safety, and toxicity of these products when redefining the term "nutraceuticals", it is clear that there is no clear distinction between food supplements and nutraceuticals. Food supplements are defined as agents that make up for deficiencies in either macro- or micronutrients; furthermore, a nutraceutical's application in the management of a pathological condition needs to be backed by substantial scientific

data. If sufficient clinical data are available, dietary supplements must demonstrate increased bioavailability and minimal adverse effects [2]. Nutraceuticals and functional food can be distinguished from one another by the following: nutraceuticals are foods that are created with the intention of preventing or treating a specific disease or disorder, such as anaemia, while functional food is created without understanding how or why it is being used. The inclusion of nutraceuticals in a regular diet may help prevent pathological diseases by extending or completely removing the need for pharmaceuticals in people who are suitable for an alternate non-pharmacological treatment for a pathological condition. Nutraceuticals must be administered and prescribed, nevertheless, and their usage must be tightly controlled to avoid unintended consequences and uncontrollable use (Figure 1).

History

Civilised civilizations have always had a keen interest in and concern for the security of the food supply. The importance of a daily diet in maintaining both individual and public health was recognised by philosophers and later by doctors long before the field

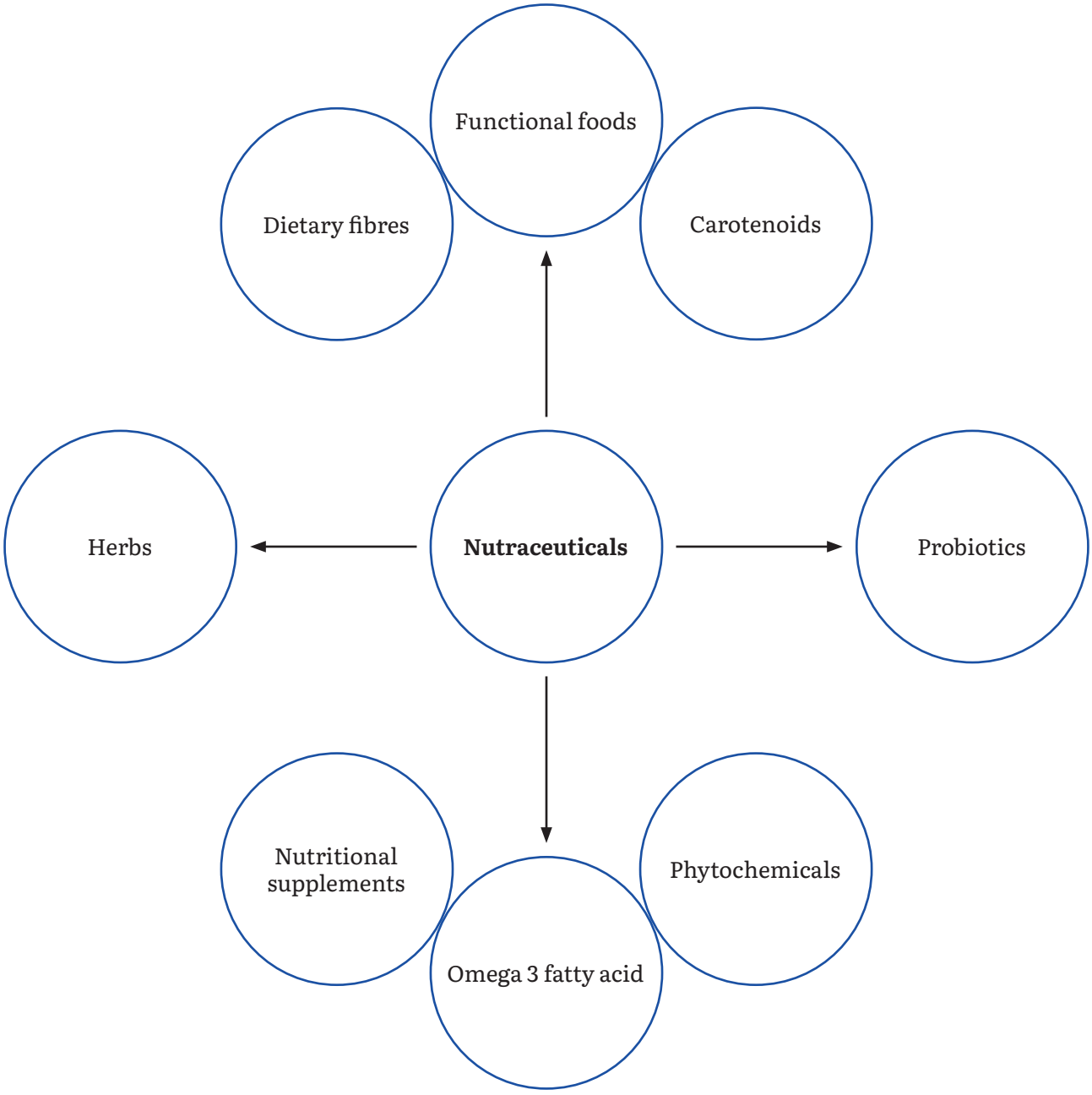

Figure 1: Various sources of nutraceutical.

of nutrition became a separate scientific field. Nutraceuticals have been around for as long as 3000 years. Hippocrates was the first to explain the use of diet to maintain health, fitness, and immunity to disease. He also said that good health should be prioritised over hazardous health conditions [3]. Food manufacturers in the United States of America began adding trace amounts of iodine to salt in the early 1990s to prevent goiter. Nutraceuticals are already being included into diets in England, Japan, and other nations.

Benefits of nutraceuticals in the treatment and prevention of various diseases and disorders

In recent years, a new diet health pattern is evolving which places more emphasis on the positive aspects of diet. The new lifestyle adopted by people today has completely replaced the basic food and nutrient requirements of the latter. Consumption of junk food has increased manifold leading to a number of diseases caused due to improper nutrition. Obesity is now recognised as a global issue, and heart diseases continue to be a primary cause of death in most of the developing countries worldwide, followed by cancer, osteoporosis, arthritis and many other diseases. Thus, to prevent such diseases, we must treat themthem at the root by changing our diet and through the use of Nutraceuticals [4].

There has been a shift in nutritional patterns in recent years, with a greater focus on the benefits of a balanced diet. The fundamental dietary and nutritional needs of the latter have been entirely superseded by the modern lifestyle that people lead. Junk food consumption has skyrocketed, which has resulted in a host of ailments linked to poor nutrition. Nowadays, obesity is acknowledged as a global problem. Heart disease is still the leading cause of mortality in the majority of developing nations, followed by cancer, osteoporosis, arthritis, and numerous other illnesses. Therefore, we must treat these diseases from the ground up by altering our diet and utilising nutraceuticals in order to prevent them (Figure 2) [5, 6].

Nutraceuticals based on diseases

There are various nutraceuticals which are designed and formulated to treat or prevent any particular disease or disorder, various nutrients or nutrient

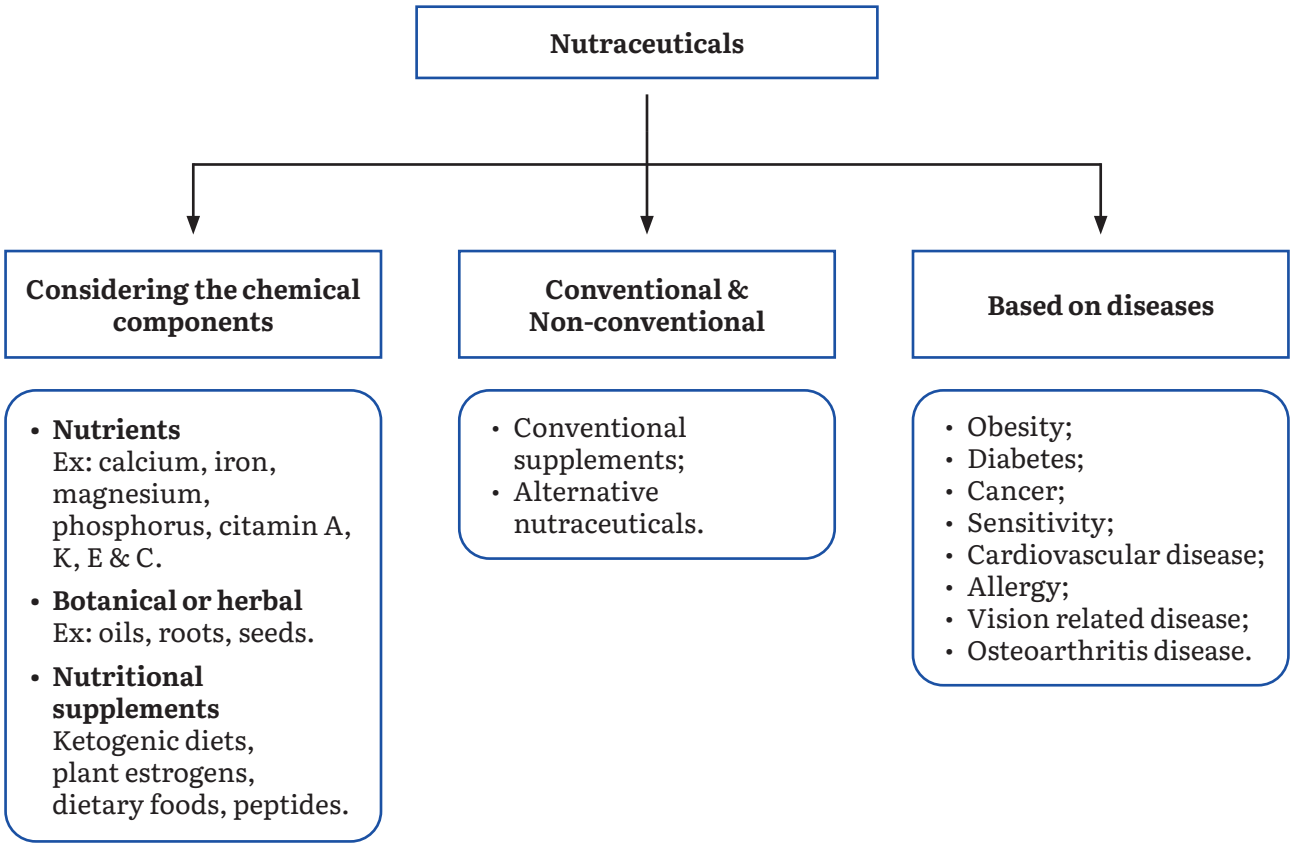

Figure 2: Classification of nutraceuticals.

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materials are extracted from animals or plants which are then turned into supplements for the betterment of the human health, now we will dwell deeper into how the nutraceuticals treat each of the diseases in order given above in the classification (Figure 3) [7].

Effect of nutraceuticals in the prevention and treatment of diabetes

Diabetes is becoming more and more common, particularly in developing nations. It is fuelled by a rise in obesity during the lifetime, primarily as a result of poor dietary choices and physical inactivity. In not too distant a time, it is predicted that 9.3% of people worldwide will have diabetes. Approximately 500 million individuals worldwide have type 2 diabetes, and an additional 500 million have impaired glucose tolerance, partly as a result of inadequate dietary consumption [8].

Every diabetic patient has a unique calorie requirement based on their age, weight, sex, level of physical activity, and other factors. The distribution of macronutrients is also influenced by their renal function, lipid profile, intake pattern, way of life, and use of hypoglycaemic medications. Above all, cultural, personal, and familiar preferences must be taken into account. Consequently, necessary nutrients such as lipids, proteins, carbs, and fiber are required. Diabetes can be treated with formulas designed with these nutrients in mind. The majority of scientific institutions advise treating diabetes using carbs and other nutrients as previously described—Table 1 lists the different nutrients and their respective characteristics [9].

Effect of nutraceuticals in the prevention and treatment of obesity

The pathological disorders of obesity and overweight are closely connected and pose a substantial global public health concern due to their significant effects on the cardiovascular, metabolic, musculoskeletal, and oncological levels. In addition to using food supplements, the conventionally suggested therapy approaches address behavioural, pharmaceutical, psychological, and nutritional aspects of health [10].

Recent research by Watanabe *et al*. Identified and analysed 33 food supplements that are most frequently used to aid in weight loss. The supplements were categorised based on their primary effects on energy expenditure modulation, hunger regulation, fat and carbohydrate metabolism, and nutrient absorption. Probiotic substances enhance host metabolism and nutrient absorption by selectively stimulating elements of the microbiota that can have beneficial effects, such as boosting immunological function and protecting against infections. Therefore, in addition to exercise, a food rich in nutritional value and nutraceutical formulation can aid in weight loss and the maintenance of excellent, hygienic health [11, 12]. Table 2 lists the different nutrients, nutrient-based products, and their respective benefits in preventing obesity.

Effect of nutraceuticals in the prevention and treatment of cancer

Dietary habits are among the most significant predictors of many cancer forms, as epidemiological studies

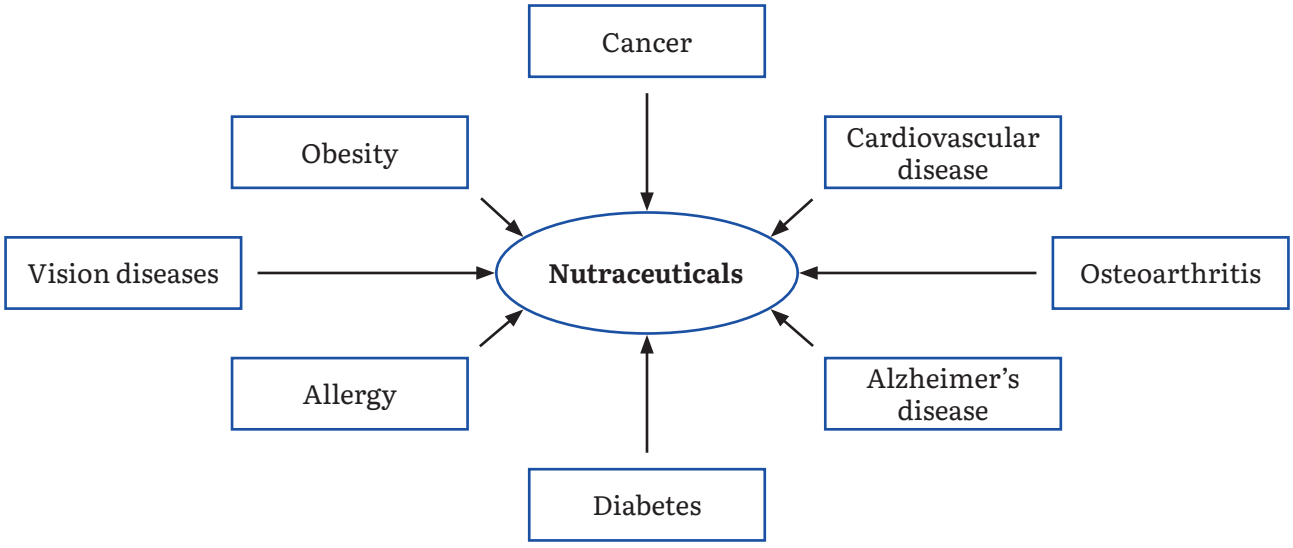

Figure 3: Nutraceuticals in various diseases.

Table 1: Daily supplement of neutraceuticals.

Parameters	European diabetes association, 2004	American diabetes and Nutrition Association, 2008	Canadian diabetes association, 2008
Proteins	10–20% ICT	15–50% ICT	15–20% ICT (as the general population)
Carbohydrates	45–60% (as personalized)	>130 g/day	45–60% ICT
Low Glycemic Index	Yes	Modest benefit	Yes
Sugar	50 g/day is a good control	No limit within total content	<10% ICT
Fibre	>40 g/day	14 g/Kcal (as general population)	25–50 g/day
Total fat	<35% ICT; <30% ICT if overweight	Personalized	<35% ICT
Saturated fat	<10% ICT; <8% if high LDL	<7% ICT	<7% ICT
Polyunsaturated fat	<7% ICT	>2 fish/week	<10% ICT
Mono-unsaturated fat	10–20% ICT	No reference	Use instead of saturated
Cholesterol	<300 mg/day (less if high LDL)	<200 mg/day	
Alcohol	<10 g (women) <20 g (men)	1 glass/day (women); 2 glass/day (men)	Consume as much fish as plants
Omega-3 fatty acids	2–3 servings of fish a week	>2 fish servings a week	Limit to 1/day (women); 2/day (men) with rich of high hypoglycemia

have repeatedly demonstrated. Humans have developed a complex and cooperative antioxidant defence mechanism against harmful oxygen intermediates through nutrition, as demonstrated by epidemiological and biochemical data. A higher consumption of antioxidants through diet may reduce the chance of developing illnesses like cancer [13].

As previously indicated by epidemiological and animal model research, phytochemicals found in most nutraceuticals—derived from nutritional or medicinal plants, including soybeans, garlic, ginger, tea, propolis, honey, and others—may have chemopreventive properties. There has been a boom in *in vitro* studies investigating the biological effects of nutraceuticals on cultured human cells due to the possibility of employing them as chemopreventive reagents. Unlike chemotherapeutics, which employ largely manufactured chemicals to treat or reduce cancer symptoms, chemoprevention uses tiny molecules, such as those found in food or herbal remedies, to prevent cancer [14]. Table 3 lists the different nutraceuticals and how they work in conjunction with different chemotherapy regimens to treat cancer.

Effect of nutraceuticals in the prevention and treatment of cardiovascular diseases

Heart problems are widespread; in fact, most people over sixty will have some form of cardiovascular disease. Although the majority of patients can be saved with medicine and surgical procedures, there is still a risk to human health, hence prevention is preferable to treatment [15].

Certain nutraceuticals, such as spirulina, polyphenols, and sterols, have been shown to have beneficial effects against various diseases. By using these nutrients, heart diseases such as dyslipidaemia, hypertension, and diabetes mellitus have been avoided [16].

Evidence currently available suggests that the use of nutraceuticals may enhance the efficacy of therapy in certain cases, particularly when conventional medical treatments for managing these diseases in high-risk individuals are insufficient [17]. Table 4 lists the different nutrients, or nutraceuticals, that have demonstrated efficacy in preventing or treating certain cardiovascular diseases.

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Table 2: Role of different neutraceuticals in the prevention and treatment of obesity.

Substance	Subject	Interventions	Clinical outcomes	Gut microflora modifications
β-glucans	26 subjects healthy	2 months of 3 g/day barely β-glucans	Marked increase in the level of the main SCFA	Increases the level of *Roseburia hominis*, *Clostridiaceae*, *Ruminicoccus spp.*, and reduces the abundance of Furmicutes, Fusobacteria
COS	120 Chinese coronary heart disease patients	COS consumption of 1–2 gm/day for 6 months	Increase SOD and GSH serum levels; Reduce the level of AST &ALT; Improved lipid profile.	Decreased Faecalibacterium, Alistipes, and *Escherichia spp.* abundance. *Bacteroides*, Megasphaera, Roseburia, Prevotella, and *Bifidobac-terium spp.*, increased abundance of *Lactobacillus*, Lactococcus and *Phascolarctobacterium spp.*
Chitosan	10 healthy volunteers	3 g chitosan/day before meal for 28 days	Improved blood urea nitrogen and serum creatinine, with high circulating antioxidant levels	Increase level of *Bactericides spp.*
Curcumin	30 healthy subjects	1 gm curcumin 1.25 mg extract of piperine every tablet – 3 times/day		Increase in *Clostridium*, *Bacteroides*, *Citrobacter*, *Cronobacter*, *Enterobacter*, *Enterococcus*, *Klebsiella*, *Parabacteroides*, and *Pseudomonas spp.* and decreased abundance of *Blautia* and *Ruminococcus spp.*
Green tea	8 healthy subjects (4 men & 4 women)	400 ml/day for 2 weeks	Elevation in SCFA, reduction in bacterial LPS synthesis in feces	Increases the Furmicutes to Bacteroidetes ratio, reduces fecal level of *Fusobacterium spp.*
L-carnitine	15 Japanese patients receiving hemodialysis	L-carnitine tablet (900 mg) for 3 months	Improved muscle discomfort, gastrointestinal orders	Decrease in the abundance of the genus Clostridia subcluster 4
Whey protein	24 Criss country runners	20 g isolated + 10 g hydrolyzed Whey protein for 10 weeks		Increase the abundance of the Bacteroidetes phylum, decrease the presence of health-related taxa
Psyllium	16 constipated patients & 7 healthy volunteers	7 g/day of psyllium for 7 days	Increased acetate, propionate, and butyrate, which correlated with improved gut health markers, including increased abundance of Veillonella and decreased levels of *Fusobacterium spp.*, suggesting a positive modulation of gut microbiota associated with enhanced fermentation of fiber and improved colonic health	Healthy adults increased Veillonella and decreased

Table 3: Role of nutraceuticals in the prevention and treatment of cancer.

Nutraceutical	Doses	Model	Effect of nutraceutical alone	Combined effect with chemotherapy
Ascorbic acid	Vitamin C + various doses of chemotherapy drugs	*In vitro*	Increased ROS and anti-tumorigenic effect with high doses of Vitamin C in cancer cells without meaningful toxicities to normal cells	High doses of Vitamin C inhibited cancer cells' proliferation, increased apoptosis in BC cells; additionally inhibitory effect on cell growth.
Berberine	BBR from 2.5–320 μM doxorubicindifferent concentration	*In vivo* & *in vitro*	AMPK activator, activated caspase; PARP-1 cleavage; cytochrome c release; cell cycle arrest	BBR sensitized drug-resistant BC to chemotherapy; directly induced apoptosis through the dose-orchestrated AMPK signaling pathway
Carotenoids, lycopene	0.5–10 uM	*In vitro*	Cell proliferation inhibition cell cycle arrest, increased apoptosis of cancer cells	Protective effects against cisplatin induced nephrotoxicity and doxorubicin-induced cardio toxicity
Curcumin	20 uM curcumin	*In vitro*	Cell proliferation inhibition anti-invasive activity, angiogenesis inhibition; Nef2 enzymes activation; promoted tumor suppressor p53 & TGF- beta & COX-2 reduction	Curcumin enhanced the efficacy of docetaxel, induced apoptosis, inhibited proliferation, downregulated NF-kB, COX-2, RTKs, and kinasesP13K and phosphate -AKT by Combined treatment
Eugenol	1 μM eugenol + 30 μM cisplatin 2 mg/kg cisplatin + 50 mg/kg eugenol (*in vivo*)	*In vitro* and *in vivo* (mouse)	Growth and proliferation, inhibition induced apoptosis thorough targeting the E2F1/surviving pathway	Co-treatment significantly increases the cytotoxic and pro-apoptotic effects of eugenol by potentiating cisplatin inhibition of NF-κB signaling pathways. Down regulating of IL-6 & IL-8 cytokines
Gingerol	10 μM gingerol or 300 μM gingerol+ 2 μg/mL cisplatin	*In vitro*	Inhibited proliferation and metastasis, cell cycle arrest through inhibition of Akt and p38MAPK activity, suppressed epidermal growth factor receptor expression	Co-treatment inhibited cell viability, enhanced cell cycle arrest at G1 phase; inhibited cell migration and invasion ability; decreased cyclin D1, cyclin A2, MMP-9, p-P13K protein expression and decrease P21 & P27 mRNA levels
Genistein	1 μM genistein, 10 μM cisplatin, 10 nM paclitaxel, 10 μM tamoxifen	*In vitro*	Cell cycle arrest, improved mitochondrial functionalities, regulated OS, uncoupling Proteins, antioxidant enzymes and sirtuin, enhanced effects of anti-cancer drug	Co-treatment increases cell viability and antioxidant protein levels, decreases ROS, and decreases autophagy and apoptosis.
Resveratrol	Differential concentration	*In vitro* (rats)	Inhibited CYPA1 drug metabolism and COX activity. Suppressed TNF-α and IL-17. Influenced fatty acids, oxidation, mitochondrial biogenesis, respiration, glycogenesis	RES prevented bone loss from MTX chemotherapy-induced and bone marrow adiposity, and had bone protective properties.

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Table 4: Role of nutraceuticals in the prevention and treatment of cardiovascular diseases.

Study design interventions	Subject characteristics	Intervention
Meta-analysis of 9 RCTs	263 participants	Plant sterols dose range: 1.0
Meta-analysis of 124 RCTs	624 participants	Phytosterols dose range 0.2–9.0 g/d
Nested case-reference study	1005 individuals	Plant sterols, 128–341 g/d
Observational studies	35597 Dutch men and women	Phytosterols dose range: 231–366.0, follow-up 12.2 years
Randomized, double blind, parallel	282 mildly to moderately hypercholesterolemic subjects	Stanols or sterols, 2 g/day for a year
Single-arm interventions	26 healthy subjects	Red grape juice 150mL twice *per* day for 4 weeks
Open-label, non-randomized	36 healthy subjects	Spirulina maximum 4.5 g/day for 8–48 weeks
Randomised, double blind	40 hypertensive patients with a lack of evidence of CVD	Hawaiian spirulina 2 g/day for 3 months

Effect of nutraceuticals in the prevention and treatment of allergy

Over the past few decades, food intolerance has become a significant global health concern. Food-related health disorders are on the rise, affecting 10% of the world's population, and the most affected group is young children. While food sensitivity issues are more common in industrialised developing countries than in developing countries, their frequency is still rising in these regions as well [18].

The finding that persons with multiple allergies had a lower diversity of bacteria in their gut microbiota provides evidence of a link between gut microbiota and allergies. Peanuts have been found to have a greater impact on the gut flora than any other food type in individuals with a single food allergy. In actuality, the gut microbiota of a person who is more allergically sensitive was unbalanced and had fewer good gut bacteria. By enhancing gut microflora, the ingestion of probiotic foods, drinks, or symbiotic products strengthens the immune system. This is especially helpful for individuals who suffer from allergies, as it helps restore the lost diversity of their gut flora [19]. Table 5 lists some probiotics that enhance gut health and shield against allergies.

Effect of nutraceuticals in the prevention and treatment of Alzheimer's disease

Declines in a wide range of cognitive capacities, including language, reasoning, memory, and perceptual

Table 5: Role of nutraceuticals in the prevention and treatment of allergy.

Nutraceutical	Examples
Vitamins	Vit C, Vit D, Vit E, B-carotene
Polyphenols	Resveratrol, catechins, curcumin, Rosmarinic acids, Gingerol
Omega-3 fatty acids	Fish oil, flaxseed oil
Probiotics	Lactobacilli, Bifidobacteria
Prebiotics	Insulin, FOS (fructo-oligosaccharides)
Post biotics	Short-chain fatty acids
Oligo-elements	Selenium, zinc, iron
Flavonoids	Quercetin, rutin, spirien
Immuno-modulants	Lactoferrin, melatonin, and glucans

Table 6: Role of nutraceuticals in the prevention and treatment of Alzheimer's disease.

Groups	Molecules	Food source
Flavanols	Catechin, epicatechin, epigallocatechin, epigallocatechin gallate (EGCG)	Cocoa & chocolates, green tea, grapes
Flavanols	Kaempferol, quercetin	Onions, apples, green tea, capers, leeks, broccoli
Flavones	Luteolin, apigenin	Celery, parsley, rosemary
Isoflavones	Daidzein, genistein	Soy
Flavonones	Hesperetin, naringenin	Citrus fruit, tomatoes
Anthocyanidis	Pelargonidin, cyanidin, malvidin	Berry fruits and red wines

speed, are frequently associated with advanced age. Dementia is the term used to describe a prolonged impairment of more than one of these functions that is linked to a loss of function. The most prevalent and dreaded type of dementia, Alzheimer's disease, accounts for over 70% of cases and is experiencing a catastrophic epidemic as a result of the world's massive ageing population expansion [20]. The prevalence of dementia has increased recently, despite recent epidemiological research appearing to indicate a drop that will require further confirmation. Randomised controlled trials have reported on the impact of a healthy diet on human health. A diet high in particular nutritional food groups can lower the incidence and prevalence of some major clinical outcomes, and certain types of flavones and isoflavones have been shown to have promising effects in the treatment and prevention of Alzheimer's disease [21]. The various flavone types and their extraction methods for combating Alzheimer's disease are presented in Table 6.

Effect of nutraceuticals in prevention and treatment of vision related issues

Numerous ocular illnesses, such as diabetic retinopathy (DR), age-related macular degeneration (AMD), glaucoma, and dry eye disease (DED), have been linked to oxidative stress. It has been demonstrated that reactive oxygen species (ROS), whether from internal or external sources, are essential for the cell survival of ocular tissues. Because of this, novel medicinal strategies based on various diets and certain nutrients with antioxidant properties have made the eye a distinct focus [22].

To treat these kinds of diseases, a variety of nutrients and nutraceuticals, such as zinc, copper, lutein, zeaxanthin, vitamin C, and vitamin E, should be taken. In addition, some other sources, such as thiamine, which provides vitamin B, and omega-3 fatty acids from fish, as well as many other supplements, provide these kinds of nutrition [23]. Table 7 lists several nutraceutical supplements that have an impact on these vision-related illnesses.

Effect of nutraceuticals in the prevention and treatment of Osteoarthritis

Currently affecting about 58 million adults, Osteoarthritis is a degenerative inflammatory disorder of the joint cartilage. By 2040, the number of cases is predicted to rise to 78.4 million [24].

Current guidelines recommend three different techniques for treating osteoarthritis; these approaches can also be combined if needed. The first strategy involves pharmaceutical treatment, which is comprised of opioids, cyclooxygenase-2-specific medications, and non-steroidal anti-inflammatory medicines. The second strategy focuses on altering one's lifestyle. It is a non-pharmacological strategy that includes physical

Table 7: Daily requirements of nutraceuticlas for management of vision problems.

Nutraceutical	Requirement
Vitamin C	500 mg
Vitamin E	400 IU
Lutein	10 mg
Zinc	80 mg
Copper	500 mg
Zeaxanthin	2 mg

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activity, rehabilitation to support a healthy body composition, and the optimisation of a diet plan and nutraceutical treatment [25].

Last but not least, the third strategy highlights the growing interest in nutraceutical supplements, which contain a diverse class of compounds with significant potential to alleviate pain, inflammation, oxidative stress, joint stiffness, and enhance cartilage formation. The action of pain, which is usually persistent in Osteoarthritis and is the primary cause of impairment for this ailment, may be very intriguing for the application of nutraceuticals [26]. Table 8 lists many nutraceuticals that effectively prevent Osteoarthritis.

Economic growth and the effect of nutraceuticals on the economy of India and the world

At USD 4–5 billion, India's nutraceuticals sector is poised to lead the world. By 2025, the growth of almost USD 18 billion is anticipated. The Indian market for dietary supplements is estimated to be worth USD 3924.44 million in 2020 and is projected to increase at a rate of 22% annually to reach USD 10,198.57 million by 2026 [27].

Examples demonstrating the nutraceuticals industry's strength as a collaborator in the economy. Purchases of nutraceuticals are increasing, even as the severity of the pandemic has decreased. The second wave demonstrated that the nutraceuticals industry has established and will maintain a strong market position. The value of the worldwide nutraceutical market is estimated to be around USD 117 billion (as of 2021). The Indian nutraceutical industry has the potential to significantly boost the country's GDP and address health-related issues [28].

At the all-India level, the nutraceutical market has a penetration rate of little over 10%. It is only 6.32% present in rural India, compared to 22.51% in urban India. Even though pharmaceuticals have historically held a dominant position in the industry, dietary supplements have some potential. Nutraceuticals, which encompass both functional food and beverages, now account for 67% of the industry due to the recent shift in consumer behaviour. Approximately 2% of the worldwide nutraceuticals market is made up of the Indian

Table 8: Effect of nutraceuticals in the prevention and treatment of vision-related issues.

Nutraceutical	Tested daily dose	Molecular mechanism	Effect of OA & related behaviour
Avocado/soybean	300 mg	IL-1, IL-6, IL-8 & PGE 2	Decreases VAS pain, WOMAC pain, Analgesic and NSAIDs use
Capsaicin	10 mg	TRPVI agonist	Decreases VAS pain, WOMAC pain
Curcumin	1000–3000 mg	IL-1 beta TNF-alpha NF-kB, COX-2, PGE 2	Decreases VAS pain, WOMAC pain, stiffness, functional and total, decreases analgesics & NSAIDs use
Epigallocatechin 3-gallate	400–1000 mg	1L-1beta, TNF, CCR2, NF-kB, ROS, NO, COX-2, PGE 2	Decreases VAS pain, WOMAC pain
Gingerols	500–1500 mg	IL-1, IL-6, TNF, IL-1Beta, TGF MMPs, NF-kB, ROS foundation	Decreases VAS pain, WOMAc pain, and analgesic and NSAIDs use
Hyaluronic acid	80–200 mg	CD44 receptors, IL-1 beta MMPs., PGE 2, RHAMM, TLR4, ICAM, Nf-kB	Decreases VAS pain, WOMAC pain, Stiffness, Functional & total
Pycnogenol	100–200 mg	MMps, COX-1, NF-kB, ROS	Decreases VAS pain, WOMAC pain
Vitamin C	500–2000 mg	MMPs, ROS	Decreases VAS pain
Vitamin D	2000–60000 UI	Bone formation & mineralization, MMPs, osteoclast & osteoblast activity VEGF	Unclear

market. This market is expanding quickly, with a 15.8% CAGR [29].

Currently, the Indian market imports US$2.7 billion worth of nutraceuticals and exports US$1.5 billion worth. By 2023, the market is anticipated to expand at a substantial 22% CAGR. Throughout the pandemic, the Indian nutraceuticals market has grown at a rate of 25% per year. There has also been an increase in Foreign Direct Investment (FDI) from US$131.4 million to US$584.7 million [30].

One major reason driving the growth of the global nutraceuticals market is the increasing demand for these products due to their potential medical benefits. They contain polyunsaturated fatty acids, probiotics, and antioxidants that help regulate conditions such as diabetes, obesity, cancer, heart disease, and high cholesterol. In addition, one of the major trends in the nutraceuticals market that propels growth is the increasing desire for customised nutrition on a global scale [31].

Geographically speaking, the nutraceuticals market is comprised of five major regions: North America, Europe, Asia Pacific, South and Central America, and the Middle East and Africa. North America, which generated USD 93.52 billion in revenue in 2018, dominated the global nutraceuticals market. Asia Pacific, on the other hand, contributed significantly as well, accounting for over 30% of the market. Furthermore, Europe continues to grow at a CGAR of 6.9%, indicating significant growth. In the European region, there is an increasing need to lead the nutraceutical industry due to the rising prevalence of cardiovascular diseases and obesity [32].

Furthermore, the main drivers of the North American market are likely consumers' growing concerns about their health and increasing awareness of the benefits of ingesting nutraceuticals. Furthermore, the ageing population, shifting buying habits for healthcare items, and altered lifestyles have all contributed to the expansion of the nutraceutical industry in these countries. Several variables are suppressing this market in all these locations, including the government's laws regarding nutraceutical items and the market's vast product array (Figure 4) [33].

Future recommendations

The medical affairs role serves as a conduit between research and development, commercial departments like sales and marketing, and external stakeholders, including the public and healthcare professionals. Thus, it is essential to provide commercial teams and healthcare professionals, that is, internal and external stakeholders, with relevant and scientifically supported information on nutraceutical goods. Medical affairs must contact key opinion leaders and medical specialists to identify unmet needs and deliver important scientific messages about the products.

By 2025, the nutraceutical industry is expected to grow at a rate of $18 billion, making it a prime candidate to become a global leader. These numbers highlight the enormous potential of the Indian nutraceutical market and its ability to attract investment in the years to come. The ministry also projects that by 2026,

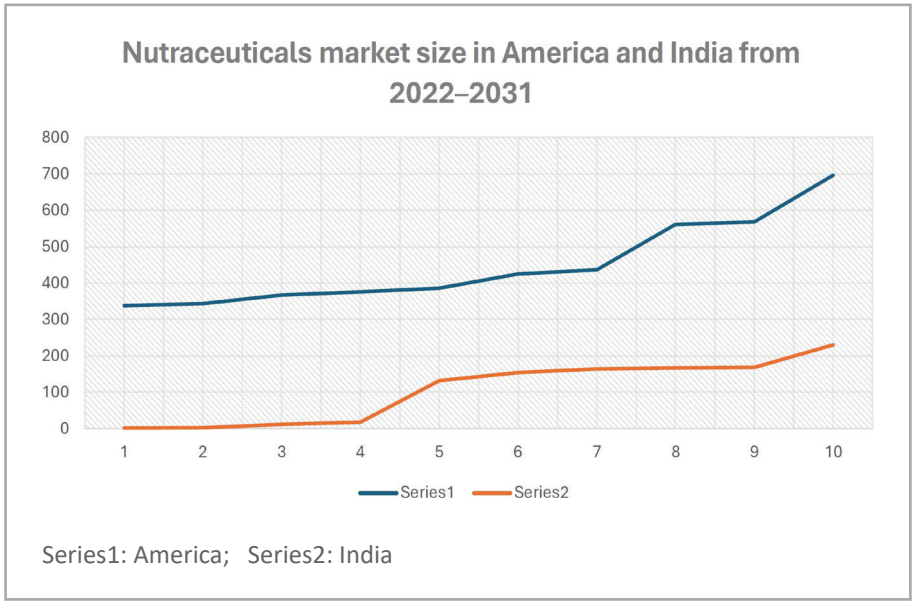

Figure 4: Economic growth and the effect of nutraceuticals on the economy of India and the world.

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the Indian market for nutritional supplements will reach $10,198.57 million, indicating a yearly increase.

Conclusion

Thus, with the increase in public healthcare and various diseases, relying solely on old drugs will not be sufficient for our survival. So, we need nutrients in some way or another, and with the rise of the nutraceutical sector and its rapid growth, there is no doubt that nutraceuticals are the next big thing in the medical field around the world.

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Conflict of interest

The authors declare no conflict of interest.

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