EXPLORING THE EVIDENCE: A COMPREHENSIVE REVIEW ON NUTRACEUTICALS AND ITS APPLICATIONS

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ABSRACT

Nutraceuticals' basic concept is derived from the combination of the terms "*pharmaceutical*" and "*nutrition*." Nutraceuticals are products of both medicine and nutrition. Another meaning would be a substance that provides defence against different illnesses or has physiological advantages for the body. Three categories comprise the nutraceutical industry: functional foods, herbal/natural goods, and dietary supplements. The most popular nutraceutical items that are sold commercially are β-carotene soft gel capsules, *Phytol* (sterols produced from plants), *Revital* (multivitamins and minerals), *Yakult* (probiotics), and others. According to their origins, chemical makeup, availability for use, and other factors, nutraceutical products have been categorized into a number of classes in this review article. Ayurveda, Traditional Chinese Medicine, and other indigenous approaches have long used a variety of herbs and plants, commonly referred to as nutraceuticals, because of their potential health advantages. Apart from their nutritional importance for humans, nutraceuticals are highly effective in treating and preventing a number of diseases, including as diabetes, cancer, heart disease, osteoporosis, obesity, and other chronic and degenerative conditions like Parkinson's and Alzheimer's. In order to preserve mitochondrial integrity, promote cell proliferation, activate antioxidant defences, alter gene expression associated with cell survival, and modulate signal transduction pathways, nutraceuticals work. Flavonoids, flavonones, flavones, cruciferous vegetables, onions, apples, cherries, blackberries, and berries are types of nutritional supplements that inhibit the cyclooxygenase pathway and the Angiotensin Converting Enzyme (ACE).

Keywords: ***Nutraceuticals, functional foods, dietary supplements, phytochemicals, chronic diseases***

INTRODUCTION

Products known as nutraceuticals provide both medical and health advantages, such as illness prevention and treatment. Nutraceuticals is a combination of the terms "*nutrient*" (i.e., nutritious dietary ingredients) and "*pharmaceutical*" (a therapeutic medicine). In **1989**, ***Stephen DeFelice***, the founder and chairman of the New Jersey-based American organization known as the Foundation for Innovation in Medicine (FIM), came up with the word. The components of nutraceuticals, which can be found in food or in other forms, have been shown to benefit the human body by improving physiological functions or healing one or more illnesses. Ingredients in nutraceuticals can be derived from plants, animals, or microbes. They can also be synthetic versions of natural nutraceuticals that are marketed as tablets, powders, capsules, or other pharmaceutical forms. If basic nutrients provide advantages beyond their primary function in normal growth, they may also be regarded as nutraceuticals **(Vision *et al.*, 2022).** Nutraceutical products are widely recognized for their health-promoting qualities. Reduced risk of cancer and heart disease, as well as prevention or treatment of menopausal symptoms, cholesterol, hypertension, osteoporosis, obesity, diabetes, cataracts, insomnia, macular degeneration, poor memory and concentration, digestive disturbances, and constipation, are among them **(Bhattacharyya *et al.*, 2024).**

Figure 1:Nutraceuticals

The primary components of nutraceuticals include (saran maurya *et al*., 2002)

1. **Nutrients**: Materials with known nutritional properties, i.e. vitamins, minerals, amino acids, fatty acids, etc.
2. **Phytochemicals/Herbals**: Botanical products or herbs.
3. **Dietary supplements**: Such as enzymes, probiotics, prebiotics, and antioxidants.

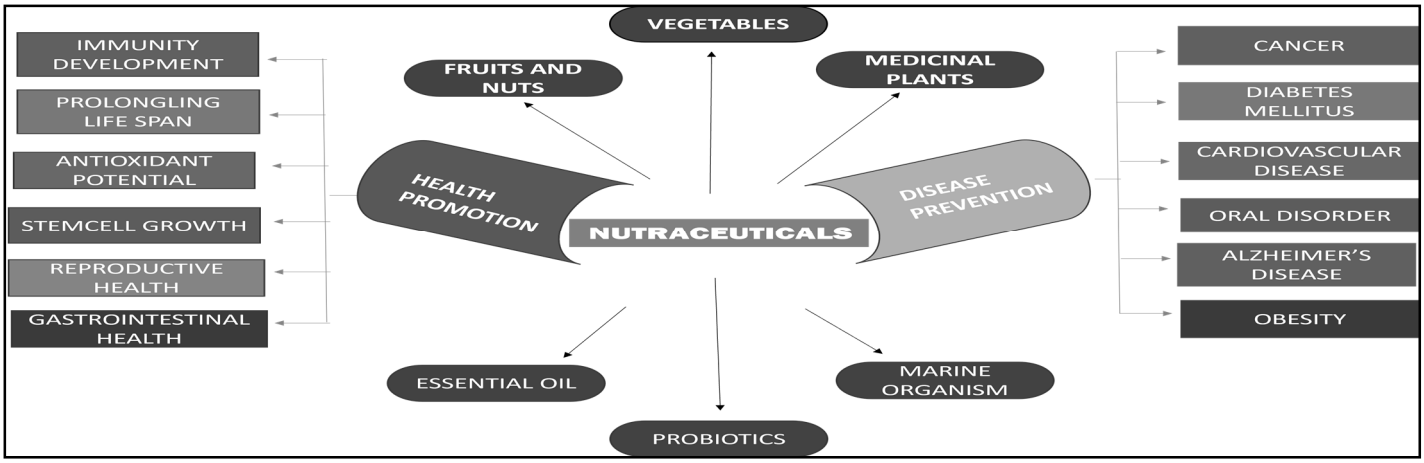

Figure 2: Concept of Nutraceuticals

HISTORY

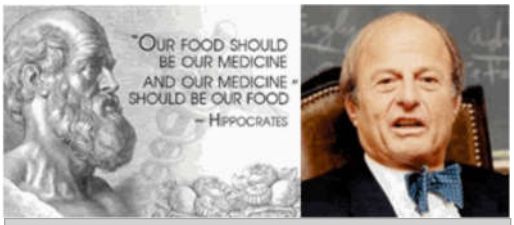

Figure 3: The phrase "Nutraceutical" was first used by Hippocrates, the Father of Medicine, and Dr. Stephen DeFelice, Chairman of the Foundation for Innovation in Medicine .

Three thousand years ago was the fundamental idea behind these thoughts. In order to accurately predict the connection between healthy diets and their medicinal advantages, ***Hippocrates*** (460–377 BC), the widely acknowledged founder of modern medicine, said, "Let food be thy medicine and medicine be thy food". The factual accuracy of this proverb is now universally acknowledged. Although the idea of nutraceuticals has changed significantly over time, it is not wholly original. During the early 1900s, American food makers started fortifying salt with iodine to avoid goitre. This was one of the first attempts to create a functional component. Researchers are still discovering new things about the multifaceted advantages of phytochemicals—non-nutritive plant-based molecules with protective or disease-preventive features—in dietary requirements, and they have already discovered hundreds of substances with functional qualities. Demand for knowledge on nutraceuticals has surged due to consumer interest in the connection between nutrition and health. Nutraceuticals are already an important aspect of the diets of nations like Japan, England, and others. Nutraceuticals are becoming more popular in the United States due to a number of causes, including rapid scientific and technological advancements, rising health care expenses, changes in food regulations that impact product claims and labels, an aging population, and a growing interest in achieving wellness via nutrition. Numerous possible health advantages of dietary components are shown by reliable scientific study. These advantages could increase the number of health claims that the Food and Drug Administration is now allowed to identify **(Varma Shekhar *et al.*, 2014).**

CURRENT SCENARIO

Table 1: Nutraceuticals Market Value

Global market	Nutraceutical market value	Current status
US	$50.4 billion USD in 2010	Due to the nutraceutical industry's rapid growth, attempts to preserve natural health are paying off, and consumer demand is rising.
Europe	US $35 billion in 2010	Innovation and an increase in R&D are the cornerstones of the nutraceutical sector. The three main European centres for nutraceutical innovation are now Germany, the Netherlands, and Sweden.
Japan	In 2010, US $27.7 billion	The Japanese government has allowed functional foods with recognized health claims as well as foods that may have health advantages without a health claim.
South East Asia	In 2009, US $10.96 billion	Because of its international emergence, the marketing curve is growing. The 2008 market share of 7% shows how much room there is for growth in this sector (**Sharma ruchi *et al.*, 2017**)
China	In 2008, US $15 billion	The market benefits from effective industrial expansion as a result of product diversity and rising customer demand.
India	USD 2bn approx	Indian nutraceutical encompassing functional food, beverages and dietary supplement, it raises the growth rate.

US NUTRACEUTICAL MARKETS

The US market for dietary supplements is worth $32 billion. All of these items—vitamins, minerals, botanicals, sports nutrition supplements, weight management products, and specialized supplements—are referred to as dietary supplements in the United States. Each year, almost 150 million Americans use dietary supplements. Nutritional product sales reached $11.5 billion in 2012 and are projected to reach $15.5 billion in 2017 **(Ganesh *et al.*, 2015).**

INDIAN MARKET

Useful foods and drinks and dietary supplements make up the two primary segments of the two-billion-dollar Indian nutraceutical sector.

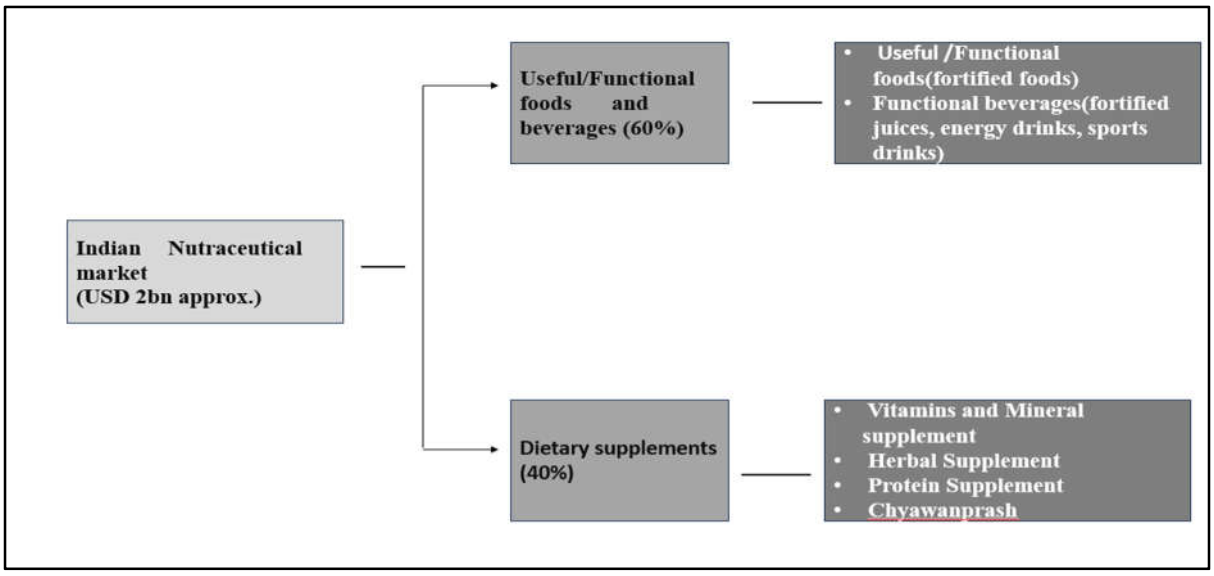

Figure. 4: Indian Nutraceuticals Market

i. Useful foods and drinks

Approximately 60% of the market is covered by this category. The WHO defines "fortified food" as processed food that has been enhanced with micronutrients. This covers all of the energy drinks, sports drinks, juices, and meals that have been fortified.

ii. Dietary supplements

This segment comprises the remaining 40% of the Indian market for nutraceuticals. Chyawanprash is included in this category, along with supplements of vitamins and minerals, herbal remedies, and proteins.

CLASSIFICATION

TRADITIONAL NUTRACEUTICALS

The food in this category doesn't go through any manual modifications. The natural ingredients have some potential and actively contribute to health advantages. One example of this type of substance is lycopene, which is found in tomatoes.

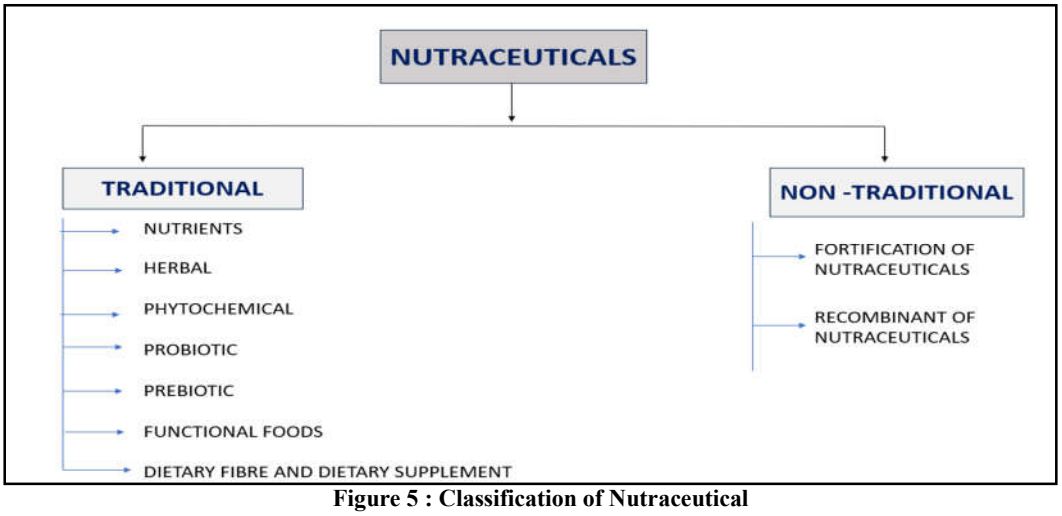

Figure 5 : Classification of Nutraceutical

NUTRIENTS

A feed constituent should be available in the form and given at a level that will help support the life of an animal. Some of the feed nutrients are proteins, fats, carbohydrates, minerals and vitamins. examples: vitamin A-anti oxidant, vitamin K- essential for blood clotting, iodine necessary for thyroid functioning etc**. (Chintale ashwine *et al.,* 2013).**

HERBS

One of the oldest medications used since the beginning of human history, traditional Indian herbal remedies are crucial in the fight against a variety of illnesses. The Indian Ministry of AYUSH (Ayurvedic, Yoga, and Naturopathy, Unani, Siddha, and Homeopathy) recommended consuming "Kadha" during the COVID-19 epidemic. Kadha is only an extract made from a variety of herbal medications, and it has been shown to have immune-boosting properties. It has been discovered that certain Indian herbal medications, including *Phyllanthus emblica*, *Ocimum sanctum*, *Curcuma longa*, and *Withania somnifera*, are beneficial against COVID-19. *Aloe vera* gel, another example, is made from *Aloe vera* L. N.L. Burm. has anti-inflammatory, emollient, wound-healing, and capillary-dilating effects. **(Prasad Sakhare *et al.,* 2025).**

PHYTOCHEMICAL

Pharmacological proof that compounds included in plant diets or nutraceuticals can preserve, improve, or even reverse cognitive decline. The majority of research on dementia and normal aging-related cognitive decline has been on curcuminoids, particularly curcumin Goji berry bioactive phytochemicals have anti-oxidative, antidiabetic, immunoregulatory, vision-protective, hepatoprotective, and prebiotic properties that are linked to lowering the risk of developing chronic illnesses like diabetes, cancer, heart disease, Alzheimer's disease, cataracts, and age-related conditions. **(Prasad Sakhare *et al.,* 2025)**.

PROBIOTICS

Probiotics are included in functional foods and are thought to be one of the primary mechanisms delivering positive outcomes. It has been demonstrated that the gut microbiota's activity is crucial to the host's energy supply. Thus, adding living microorganisms to the diet, like probiotics, benefits the intestinal with this significant responsibility.

Additionally, probiotic bacteria defend the gut epithelium's mucosal barrier from harmful microbes. For instance, since probiotic bacteria like *Lactobacillus helveticus* can produce factors during milk fermentation that stimulate the production of the enzyme calcineurin,

fermented foods, like some types of milk (which are widely consumed beverages), have been shown to be good functional foods. According to certain research, probiotics have anti-cancer, anti-plaque, and antioxidant properties.

As a result, it offers several health advantages, such as assisting in the prevention of arthritis, colon cancer, and obesity. Foods high in probiotics include yogurt, fermented tea, dark chocolate, pickles, and olives. **(Prasad Sakhare *et al.,* 2025).**

PREBIOTICS

The prebiotics notion was initially presented by Glenn Gibson and Marcel Roberfroid in 1995. According to one definition, a prebiotic is "a nondigestible food ingredient that improves host health by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon". If prebiotics are found in pill form rather than in a food matrix, they would also be considered a component of nutraceuticals. **(Prasad Sakhare *et al.,* 2025)** when they discovered that eating dairy products, such as yogurt, as part of a diet by lowering oxidative stress, inhibiting pro-inflammatory markers, and reducing intestinal dysbiosis, fermented milk and cheese supplemented with potential probiotic strains of *Lactobacillus acidophilus*, *Bifido bacterium,* and prebiotics or symbiotics (i.e., a combination of both: probiotics and prebiotics) alleviated the symptoms of type 2 diabetes mellitus. For instance, processed foods have made extensive use of the prebiotic inulin **(Ruby *et al.,* 2021**).

FUNTIONAL FOODS

Nutrients that supply more than the amounts needed for growth, development, and maintenance. The phrase is specifically reserved for foods or food ingredients that have been shown to offer health benefits beyond simple nourishment. Cereals, legumes, and fermented foods are just a few of the numerous subcategories that fall under the umbrella of functional foods. There are several ways in which functional foods, such as cereals like rice, corn, wheat, millets, sorghum, and buckwheat, might reduce the risk of coronary heart disease, tumor incidence, and blood pressure. Legumes are another category of functional foods that are essential to both traditional and contemporary dietary patterns, much like cereals. These are very nutrient-dense and abundant in amino acids, bioactive peptides, and physiologically useful proteins. Kidney beans, split beans, chickpeas, lentils, and soybeans are a few examples. These have been shown to have strong antioxidant properties and to protect against diabetes and heart disease. Furthermore, it has been discovered that chocolate is a subclass of functional foods and the best supplier of calcium, iron, magnesium, riboflavin, and proteins. Another class of

functional food is citrus fruits, which have been shown to have antiviral, anticancer, and antioxidant properties in addition to the ability to boost the immune system. Another example of a functional food with positive digestive benefits is fermented milk and its derivatives. Another useful meal is colostrum, which is the term for the first milk released upon childbirth. It differs from later-secreted milk because it includes lactoprotein and lactalbumin. It is abundant in proteins, immunoglobulins, growth factors, and antibodies that give a baby passive immunity. According to recent evidence, it can be used to treat autoimmune diseases. Furthermore, pork products can be categorized as a functional food as well. Comminuted meat products have been made using soy-based proteins as a meat (**Sharma ruchi *et al.*, 2017).**

DIETARY SUPPLEMENTS AND DIETARY FIBERS

A product that has an additional dietary element added as a treatment for illnesses or deficiencies is called a dietary supplement. Dietary supplements have become increasingly popular as a way to enhance performance, body building, fitness, health, and age prevention. Any element that improves the food's nutritional value is considered a dietary ingredient. There are both single-ingredient and multi-ingredient vitamin and mineral supplements available on the market. Dietary supplement demand is startlingly rising in developing nations like Brazil, China, India, and Russia, and it has already secured a position in industrialized regions o of several nations. Herbs, botanicals, amino acids, pure extracts, concentrates, or combinations of various components, gland extracts, and organ tissues are also included in dietary supplements that are not vitamins and minerals. It is not intended to be a regular component of meals or a diet, nor is it to be used as a typical or conventional dietary ingredient. The substantial health advantages of dietary fibers and high-fiber products have generated a lot of interest. The American Association of Cereal Chemists (AACC) defines it as an edible portion of a plant or a comparable carbohydrate that is difficult for the small intestine to digest and absorb. The intestinal transit time is normalized by these goods. Cereals, oats, dry beans, legumes, brown rice, and bananas are some of its sources (**Sharma ruchi *et al.*, 2017).**

DIETARY FIBERS

Dietary fiber, which is made up of plant-based carbohydrates that are indigestible by digestive enzymes encoded in the human genome, including amylase, has long been recognized as a nutritionally significant and health-promoting dietary element. Non-starch polysaccharides (NSP) include celluloses, hemicelluloses, gums, pectins, lignin, resistant dextrins, and resistant starches make up the majority of dietary fibers.

NON -TRADITIONAL NUTRACEUTICALS

As an unconventional strategy, nontraditional nutraceuticals are foods or food items that have been artificially created. In order to improve food qualities and human health, nutrient-dense components are added through the use of biotechnology or agricultural breeding. Non-traditional nutraceuticals can be divided into fortified and recombinant categories according to the processing technique. Cereals enriched with vitamins, rice enhanced with β-carotene, and One type of nutraceutical that contains provitamins that can increase antioxidant activity is minerals (**Sharma ruchi *et al.,* 2017).**

FORTIFICATION OF NUTRACEUTICALS

The practice of adding micronutrients, such as vitamins and critical trace elements, to food in order to increase its nutritional worth and efficacy is known as fortification. Milk fortified with cholecalciferol, which is used to treat vitamin D insufficiency, is one example.

RECOMBINANT NUTRACEUTICALS

It entails using genetic engineering and biotechnology to produce foods that provide energy, like cheese and yogurt, or to extract bioactive ingredients via fermentation or enzymatic processes. Gold kiwifruit is genetically engineered to have high levels of carotenoids, lutein, zeaxanthin, and ascorbic acid (**Sharma ruchi *et al.,* 2017).**

Table 2: Example

β-Carotene	Neutralises free radicals**. (Tilman grune et al., 2010)**
Lycopene	Reduce the risk of prostate cancer (**Ping chan *et al.,* 2015)**
β-Glucan	Reduce the risk of cardiovascular diseases (CVDs) **(Jiezhong chen *et al.,* 2008)**
Conjugated Linoleic Acid (CLA)	Improve body composition; and decrease the risk of certain cancer **(Tatiana *et al.,* 2015)**
Flavonoids	Neutralise free radicals; and reduce the risk of cancer **(Mehak Zahra *et al.,* 2014)**
Caffeic acid	reduce the risk of degenerative diseases **(Muhammad Ikram *et al.,* 2020)**
Saponins	Lower LDL cholesterol **(Ting Liu *et al.,* 2016)**

REGULATIONS

The appropriate authorities must pay attention to India's nutraceutical regulatory framework. While regulatory bodies around the world are cognizant of the evolving needs of consumers and actively work to protect them by modifying current legislation to reflect these changes, manufacturers in India are still subject to outdated laws like the Prevention of Food Adulteration Act, 1954, which governs packaged foods. They also have to follow a lot of other onerous laws **(Lakshmana Prabu *et al.,* 2012),**

- Both the 1976, Standards of Weights and Measures Act and the Standards of Weights and Measures
- The 1977, SWMA (Packaged Commodities) Rules
- Infant Foods, Bottles, and Milk Substitutes (Production Regulation, Supply and Distribution) Act, 1992 with Rules, 1993 (IMS)
- Regulations for the Packaging of Edible Oils Order, 1998
- The FPO or Fruit Products Order of 1955
- The 1973, Meat Product Order
- The Vegetable Oils Products (Regulation) Order 1998 (VOP) and the Milk and Milk Products Order 1992
- The Atomic Energy (Control of Irradiation of Food) Rules of 1996 and the Atomic Energy Act of 1962
- The 1986 and 1988 General Grading and Marking Rules (AG Mark)
- The 1986 Act of the Bureau of Indian Standards (BIS**) (Sumeet Gupta *et al.,* 2010**)

INTERNATIONAL REGULATION

Since people have been consuming entire foods for thousands of years, nutraceuticals are just natural and do not officially represent a separate food category. Consequently, they are subject to the same FDA regulations as all foods: All statements must be supported by evidence and be accurate and non-misleading, and the safety of the components must be guaranteed beforehand Many nations, like the United States, Canada, the European Union, China, and India, have stringent laws governing the production, consumption, marketing, and service of food and medications, but these laws are not comprehensive **(Santini *et al.,* 2018).** Numerous governments are tackling problems with fresh justifications or enacting complementing laws or regulations The appropriate authorities must pay attention to India's nutraceutical regulatory framework. While regulatory bodies around the world are

cognizant of the evolving needs of consumers and actively work to protect them by modifying current legislation to reflect these changes, outdated laws like the Prevention of Food Adulteration Act, 1954, which governs packaged foods, still apply to manufacturers in India. They must also put up with several additional onerous laws **(Sharma Ruchi *et al.*, 2017).**

FUTURE PROSPECT

As a result of better healthcare and longer life expectancies, the manufacturing of nutraceuticals is becoming one of the main worldwide food businesses. Given the abundance of therapeutic herbs and spices and trees are located in India, which is becoming into a significant producer and supplier of nutraceuticals and functional foods. Research is now being done on traditional herbal extracts that were formerly associated with improving health and preventing chronic illnesses, as well as proving their usefulness and safety. The cumulative effect of several ingredients in the product, rather than a single substance, is what gives nutraceuticals their function in preventing a variety of ailments. As a result, biomarker research is crucial for comparing the preventive benefits of various diet types **(Mathangi Ganapathi *et al.*, 2016).** Furthermore, criteria for evaluating illness prevention should be developed. The identification of differences in the composition of functional foods and nutraceuticals for niche markets can result in the development of new goods and the creation of plants with biochemically homogeneous produce with extremely predictable nutritional and health qualities. New techniques for isolating, characterizing, and purifying functional foods should be developed in order to lower their costs to the industry. The growth of the worldwide market may be aided by raising public knowledge of the benefits of food products for health and their value-added qualities **(Sharma Ruchi *et al.*, 2017).**

CHALLENGES

The nutraceutical formulations are used as dietary supplements rather than medications. Nutraceuticals formulations must thus meet many more standards than pharmaceutical preparations. Food-grade ingredients must be utilized in the formulation since nutraceuticals include nutritional supplements, functional foods, etc. This reduces the range of developments in the nutraceutical field and restricts the options available to researchers. As a result, choosing appropriate materials to prepare the formulation is quite difficult The choice of the distribution mechanism presents the next difficulty after the materials have been chosen. The biological products included in nutraceuticals, including proteins, peptides, vitamins, hormones, and

herbal extracts, have a propensity to break down quickly. One aspect that cannot be sacrificed is the formulation's stability.

Additionally, the primary component should only be released in response to external stimuli like temperature, pH, or pressure. Therefore, the capacity of the delivery system to efficiently distribute the food product and achieve the intended impact must be taken into consideration when selecting an appropriate delivery system. Once the formulation has been prepared, the items need to be tested once again We can learn more about the pharmacokinetic process as well as the pace and magnitude of the core active ingredient's release thanks to the in vitro tests conducted for this purpose. These assays do have certain drawbacks, though, in that they cannot reveal information on the product's active absorption, metabolic reactions, or biological variability **(Sharma Ruchi *et al.,* 2017).**

APPLICATIONS

Cardiovascular diseases (CVD)

Chronic conditions like obesity, diabetes, cancer, and heart disease are rapidly increasing in prevalence worldwide. Cardiovascular diseases (CVD) include peripheral vascular disease, heart failure, cerebrovascular disease, coronary heart disease, stroke, hypertension, and other conditions affecting the heart and blood vessels. Most CVDs are preventable and controllable. A greater death rate from cardiovascular disease has been associated with a lower diet of fruits and vegetables. In several studies, a diet high in fruits and vegetables has been associated with a decreased risk of cardiovascular disease.

In addition, physical exercise, vitamins, minerals, omega-3 polyunsaturated fatty acids (n-3 PUFAs), dietary fiber, antioxidants, and nutraceuticals are recommended for the prevention and treatment of CVD. It has been demonstrated that polyphenols, which are present in grapes and wine, affect cellular metabolism and communication, which is in line with the prevention of vascular disease **(Saran Maurya *et al.,* 2002).**

Alzheimer’s disease

The most prevalent kind of dementia is Alzheimer's disease (AD), also known as primary degenerative dementia of the Alzheimer's type (PDDAT), senile dementia of the Alzheimer type (SDAT), or just Alzheimer's. The different nutraceuticals that are used to treat Alzheimer's *Ginkgo biloba,* enhancement of memory consolidation and working memory

Hericium erinaceus, enhancement of memory and learning abilities in the NOR and Y-maze tests PUFAS causes CA1 pyramidal neurons' spine density to grow. Increase in CA1 neuron density due to chlorogenic acid Luteolin, enhanced neuroprotection against toxicity mediated by AMYLOID- β To reduce inflammation, resveratrol inhibits TNF-α, IL-1β, IKKα, IKKβ and COX-2. Alpha-linoic acid - Increased brain glucose uptake and activation of the insulin receptor substrate **(Muhammad Ikram *et al.*, 2020).**

Parkinson's disease

Nerve damage in certain brain areas causes Parkinson's disease, a brain ailment that often manifests in mid- to late-adulthood and causes muscular stiffness, tremors, and difficulty walking. Vitamin E in diet may offer protection against Parkinson's disease, according to Canadian experts. A decrease in the clinical symptoms suggested that creatine altered the characteristics of Parkinson's disease. Glutathione has also been investigated by researchers to ascertain its impact on nerve function and antioxidant capacity. The best way to administer it, its negative effects, and the right long-term dosage are still unclear. Though exploratory studies have shown some encouraging effects, it is crucial to keep in mind that there is currently insufficient scientific evidence to support the use of nutritional supplements for Parkinson's disease. Patients should be informed that over-the-counter pharmaceuticals are costly and can have negative effects and combinations with other prescriptions **(Saran Maurya *et al.*, 2002).**

Obesity

Obesity is a well-known risk factor for a variety of diseases, including angina pectoris, congestive heart failure, hypertension, hyperlipidemia, respiratory problems, renal vein thrombosis, osteoarthritis, cancer, and impaired fertility. Obesity has become a global public health issue, with an estimated 315 million individuals falling into the WHO's obesity classifications. Approximately 23% of women and 20% of men in the WHO European Region were obese in 2008, while over 50% of both men and women were overweight. One of the main causes of the sharp increase in obesity rates is the increased availability of high-fat, high-energy meals. The diet should restrict saturated and trans fats, as well as sweets and salt, because excessive intake of energy-dense meals (snacks, processed foods, and drinks) can result in weight gain. Increased physical activity and calorie restriction have only been proven to be slightly beneficial in treating obesity.

Because of this, a lot of medical professionals and obese individuals are using drugs and nutraceuticals to help them lose weight. For body weight loss, a safe and efficient nutraceutical that can raise energy expenditure and/or lower calorie intake is preferred. A dietary supplement including glucomannan, chitosan, fenugreek, G sylvestre, and vitamin C reduced body weight and accelerated fat loss in obese individuals. To ascertain long-term effectiveness and any adverse effects, more study is required. The prevention and treatment of obesity, which has a high prevalence globally, depend heavily on diet and exercise. On a large scale, nutraceutical therapies are presently being researched as potential treatments for weight reduction and obesity. Nutraceuticals with potential anti-obesity effects include Psyllium fiber, *Momordica charantia* (MC), capsaicin, and conjugated linoleic acid (CLA) **(Saran Maurya *et al.*, 2002).**

Cancer

Cancer has emerged as a major public health problem in developing countries. The World Cancer Report (2018) states that the number of new cases of cancer is expected to increase by 50% to 15 million in 2020. The prostate, testes, skin, and adrenal glands are where lycopene is concentrated and provides cancer protection. The connection between carotenoids and the prevention of CAD and cancer has increased the significance of fruits and vegetables in a person's diet. Fruits and vegetables high in lycopene reduce oxidative stress and DNA damage, which has a cancer-preventive impact. One of the main carotenoids, lycopene, is only present in tomatoes, papaya, guava, pink grapefruit, and watermelon. Because of its antioxidant properties, β-carotene helps prevent cancer and other illnesses. The carotenoid with the highest antioxidant activity is β-carotene. Alpha-carotene possesses 50–54% of the antioxidant activity of β-carotene, whereas epsilon carotene has 42–50% of the antioxidant activity. A increased risk of cancer is linked to chronic inflammation. Additionally linked to immune suppression, a risk factor for cancer, is chronic inflammation. Ginseng is an example of an anti-inflammatory molecule that targets many of the key players in the inflammation-to-cancer sequence. These days, there is a lot of interest in phytochemicals that have the ability to prevent cancer. Chemo-preventive components in fruits and vegetables, among other beneficial health effect, have potential anticarcinogenic and antimutagenic activities. A broad range of phyto-pharmaceuticals with a claimed hormonal activity, called “phyto-estrogens,” is recommended for prevention of prostate and breast cancers. Citrus fruit flavonoids are able to protect against cancer by acting as antioxidants. Soya foods are a unique dietary source of isoflavones, the polyphenolic phytochemicals exemplified by epigallocatechin gallate from tea, curcumin from

curry and soya isoflavones possess cancer chemo-preventive properties. Soybean seems to offer protection against breast, uterine, lung, colorectal, and prostate cancers. β-carotene found in yellow, orange, and green leafy vegetables and fruits such as tomatoes, lettuce, oranges, sweet potatoes, broccoli, cantaloupe, carrots, spinach and winter squash has anticancer activity.

According to reports, saponins have antimutagenic and anticancer properties. They may also reduce the risk of human cancer by stopping the growth of cancer cells. Peas, soybeans, and certain plants with names that suggest they have foaming qualities, such soapberry, soapwort, and soapbark, contain compounds called saponins.

Additionally, tannins detoxify carcinogens and scavenge dangerous free radicals. Blackberries, blueberries, cranberries, lentils, and grapes all contain tannins, which have been shown to have anticarcinogenic properties and are used in complementary and alternative medicine to prevent cancer. Ellagic acid is an anticancer substance found in red raspberry

A higher consumption of cruciferous vegetables and glucosinolates and their hydrolysis products, such as indoles and isothiocyanates, have been linked to a decreased risk of lung and colorectal cancer. Glucosinolates undergo biotransformation to produce sulforaphane, isothiocyanates, and dithiol thiones. Specifically in the liver, colon, lung, breast, stomach, and oesophagus, they inhibit the enzymes that encourage the formation of tumors

Garlic's sulfur components have been shown to strengthen the immune system, lower cancer risk, and decrease atherogenesis and platelet stickiness. Broccoli contains sulforaphane, a strong inducer of phase 2 enzymes. It generates D-gluconolactone, a potent breast cancer inhibitor. Sulforaphane is an antioxidant and stimulator of natural detoxifying enzymes. According to reports, sulforaphane lowers the incidence of both prostate and breast cancer.

The plant Curcuma longa, also known as turmeric, is the source of the polyphenol curcumin. According to reports, curcumin contains anti-inflammatory, anti-carcinogenic, and antioxidative qualities.

Prostate cancer may be prevented by a number of substances, according to extensive clinical research, including green tea, vitamins D and E, selenium, lycopene, soy, anti-inflammatory drugs, and 5a-reductase inhibitors. Cancer was not prevented by β-carotene, N-acetylcysteine,

α-tocopherol, retinol, retinyl palmitate, or isotretinoin in smokers. Ongoing trials may help define new avenues for chemo prevention **(Iyen *et al.*, 2019).**

Nutraceuticals in Stem Cell Therapy

Stem cell research has recently been shown to be useful in the treatment of a number of illnesses. As an alternative to stem cell transplantation, several researchers have also looked at how specific nutraceuticals affect the development and proliferation of stem cells, which may encourage indigenous stem cells to achieve healing and regenerating objectives. When compared to human granulocyte macrophage colony-stimulating factor, Bickford et al. found that blueberries, green tea, catechin, carnosine, and vitamin D3 had a dose-related effect on the proliferation of human bone marrow. Additionally, combinations of nutrients can work in concert to promote the proliferation of human hematopoietic progenitors, indicating yet another possible function or mechanism through which nutraceuticals support the body's capacity for health and healing. The development and differentiation of newborns and early children are crucial for the health of future generations, even though the effects of nutraceuticals on pregnant women should be carefully examined, as should any prescription, including herbs, used during pregnancy. Early dietary determinants are thought to have long-term implications on health, illness, and mortality risks in adulthood in addition to short-term effects on growth, body composition, and bodily functioning. Nutraceuticals including antioxidant vitamins, vital amino acids, and polyunsaturated fatty acids in baby food have been shown to have positive benefits on the immune system's development. In actuality, the growth and development of bone and the human neurological system depend on the consumption of minerals including calcium, phosphorus, magnesium, iron, zinc, iodine, folic acid, and vitamin D and K **(Iyen *et al.*, 2019).**

Diabetes and Nutraceuticals

Type 2 diabetes, which has a 95% incidence and is linked to obesity, is the most prevalent kind of the disease. The number of persons with diabetes worldwide is rising despite the introduction of several medications for the disease's prevention and treatment. Diabetes causes significant financial consequences for society as a whole in addition to for individual patients and their families (Baradaran 2012). Numerous herbal medications and dietary supplements have been clinically shown to help type 2 diabetes in recent years.

Isoflavones are phytoestrogens that resemble human estrogen in both structure and activity. Consuming soy isoflavones has been linked to a decreased incidence and death rate of type II diabetes, heart disease, osteoporosis, and several types of cancer.

It has been proposed that omega-3 fatty acids can lower glucose tolerance in those who are at risk for diabetes. Since insulin is necessary for the production of long-chain n-3 fatty acids, diabetes may make the heart more vulnerable to their depletion. Patients with diabetes may benefit from n-3 fatty acid ethyl esters.

An antioxidant called lipoic acid is used to treat diabetic neuropathy and appears to be a useful long-term dietary supplement for preventing problems in diabetics. Numerous plant extracts, including bitter melon, cinnamon, and *Toucrium polium*, have been demonstrated to either prevent or cure diabetes **(Iyen *et al.*, 2019).**

Osteoarthritis

The most prevalent kind of arthritis in the US, osteoarthritis (OA), is a crippling joint condition that affects an estimated 21 million individuals. The combined direct and indirect medical expenses for all types of arthritis came to over 86 billion dollars in 2004. People who suffer from OA and other joint problems may become less active due to joint discomfort, which can lead to weight gain and energy imbalance. Weight gain can make pre-existing issues worse by putting more strain on joints. Chondroitin sulfate (CS) and glucosamine (GLN) are frequently used to reduce OA symptoms. These nutraceuticals appear to control NO and PGE2 generation and gene expression, which explains their anti-inflammatory effects. They also have pharmacological and nutritional qualities **(Iyen *et al.*, 2019).**

Adrenal Dysfunction Adaptogens

Natural herbs known as adaptogens have generic, balancing effects on physiology; they just slightly alter regular bodily processes to promote nonspecific resilience to stimuli. Adaptogens include the fungus Cordyceps sinensis and the herbs *Eleutherococcus senticosus*, *Ginkgo biloba*, *Ocimum sanctum*, *Panax ginseng*, and *Withania somnifera*.

Chinese herbal therapy has long utilized *Eleutherococcus senticosus*, sometimes known as Siberian ginseng, to improve memory, appetite, longevity, and overall health. Despite being very distantly related to Panax ginseng, it gained popularity in Russia in the 1950s because

panax was quite expensive and scarce. Eleutherococcus is recognized to have immunomodulatory qualities in addition to antistress and antifatigue benefits. According to a research looking at how eleutherococcus affected steroidal hormone markers of stress, endurance athletes produced more cortisol.

The Chinese have been using ginkgo biloba for thousands of years to treat a variety of illnesses, such as vertigo, short-term memory loss, and inattention or lack of attentiveness. It has been demonstrated that standardized ginkgo extracts have neuroprotective and antioxidant qualities, including the ability to halt the course of dementia.

Ayurvedic medicine uses Ocimum sanctum, often known as holy basil or tulsi, which has been demonstrated to have antistressor properties. Rats were exposed to either acute or chronic noise stress, with and without the administration of Ocimum. Corticosterone levels were considerably lower in rats that had received Ocimum pretreatment, regardless of whether they had been subjected to acute or continuous noise **(Iyen *et al.*, 2019).**

CONCLUSION

Nutraceuticals are an essential link between nutrition and pharmaceutical science. Traditional knowledge and recent research support their therapeutic potential in the treatment of chronic and lifestyle-related disorders. However, more clinical trials and regulatory clarity are required to ensure their safety, efficacy, and inclusion in mainstream healthcare. With increasing consumer awareness and demand for natural health solutions, the future of nutraceuticals looks promising.

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