



Research Paper

## Nutraceuticals: A Holistic Approach to Disease Management and wellness

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### Abstract:

Nutraceuticals are essential food constituents that provide nutritional benefits as well as medicinal effects. The benefits of these foods are due to the presence of active compounds such as carotenoids, collagen hydrolysate, and dietary fibers. Nutraceuticals have been found to positively affect cardiovascular and immune system health and have a role in infection and cancer prevention. Nutraceuticals can be categorized into different classes based on their nature and mode of action. In this review, different classifications of nutraceuticals and their potential therapeutic activity, such as anti-cancer, antioxidant, anti-inflammatory and anti-lipid activity in disease will be reviewed. Moreover, the different mechanisms of action of these products, applications, and safety upon consumers including current trends and future prospect of nutraceuticals will be included.

**Keywords:** functional foods, anti-cancer, anti-inflammation, antioxidant activity, anti-lipid activity, nutraceuticals safety and toxicity

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### I. INTRODUCTION

Nutraceuticals are any food product (or component thereof) that offers additional health advantages beyond the fundamental nutritional value of food, such as illness prevention and/or treatment. Nutraceutical compounds are usually separated from food and then offered for sale in pill form. The nutraceutical sector is a vibrant, ever-changing market that opens new avenues for combining scientific research with the increasing demand from consumers for foods that promote health. Particular attention is shown in nutraceuticals as a means of reducing the frequently costly illness treatment modalities now used in industrialised nations. Functional foods, dietary supplements, and herbal/natural goods are the three primary categories that make up the nutraceutical business.[1]

Due to the widespread usage of different chemicals, heavy metals, electromagnetic waves, and other potentially hazardous man-made materials, industrialization has resulted in multiple pollutions of the air, water, soil, and food. An increase in diabetes, obesity, vascular disease, cancer, physiological issues, and other degenerative diseases have been linked to these issues. The cost of medical treatment has increased significantly due to the rising demand for healthcare services. Research on nutrition and health has experienced a rebirth as a result of the investigation of novel dietary components with therapeutic qualities. A new era of study is ushered in by nutraceuticals to support quality of life. It can lower the chance of illness by maintaining good health and boosting immunity.. [2]

One of the most significant sources of food and medication for humans is the plant kingdom. Growing understanding of plant biotechnology, nutrition, and medicine has revolutionised and fundamentally altered ideas surrounding food, health, and agriculture. Natural products and meals that promote health have drawn a lot of interest from the public and health professionals as a result of recent developments in the fields of nutrition and medicine.. [3,4]

According to Stephen De Felice, a "nutraceutical" is "a food or parts of food that provide medical or health benefits, including the prevention and treatment of disease." He invented the phrase in 1979. The philosophy of nutritional treatment is centred on the complementary use of nutraceuticals, as food serves as a source of nutrients and energy in addition to having therapeutic properties. Nutraceuticals help our bodies detoxify while also reestablishing a healthy digestive system and eating patterns. [5]

Nutraceuticals are sold in concentrated forms as single- or combination-substance pills, capsules, powders, and tinctures. A naturally nutrient-rich food, like spirulina, garlic, or soy, or a particular part of a food, such as omega-3 oil from salmon, might be considered a nutraceutical. They go by other names, such as dietary supplements, nutritional supplements, and medical foods. The demand for both herbal and non-herbal extracts is steadily rising worldwide. Nutraceuticals such as ginkgo biloba for cognitive function enhancement and green tea for weight loss and cancer treatment have been extensively utilised [6]. The market for nutraceuticals has grown over the last several years as a result of researchers' increasing interest and the development of advanced methods for determining both qualitative and quantitative criteria. [7,8]

### **GROUPS OF NUTRACEUTICALS**

Nutraceuticals can be broadly classified into 4 groups-

1. **Nutrients:** Substances with established nutritional functions such as vitamins, minerals, amino acids and fatty acids
2. **Herbals:** Herbs or botanical products as concentrates and extracts
3. **Sports nutrition and dietary supplements:** Reagents derived from other sources eg. Pyruvate, Chondroitinsulphate, steroid hormones, precursors serving specific functions
4. **Functional food & beverages:** Natural or processed form that contains known biologically active compounds which when in defined quantitative and qualitative amounts provides clinically proven and documented health benefit, and thus, an important source in the prevention, management and treatment of chronic diseases of the modern age.

### **THE NECESSITY OF NUTRACEUTICALS**

Regarding the administration, pricing, and management of their health care, consumers have serious concerns. Their dissatisfaction with the costly, high-tech approach to treating diseases that characterises modern medicine has led them to look for complementary or alternative useful products[9]. It is tough for a lot of us to obtain enough nourishment from our regular diet. Second, the very hazardous modern living environment is full of pesticides and pollution, which causes the body to lose its ability to operate properly[13]. It might be argued that the multitude of conditions that are frequently associated with vitamin deficiencies, such as lupus, chronic tiredness, and Epstein-Barr. A sensible strategy to strengthen our system would be to minimize the use of antibiotics which has lost their effectiveness. There are side effects raised as a result of administration of synthetic drugs. A good quality dietary supplementation absorbed and utilized by the body can truly strengthen our body and add vitality, for which we are in need of nutraceuticals.[10]

### **GLOBAL DEMAND FOR NUTRACEUTICALS**

The nutraceuticals sector began to take shape in the early 1990s, but the first ten years of this century saw an unprecedented surge in its global expansion. The nutraceuticals business increased at an average yearly growth rate of 7.3 percent between 1999 and 2002, but over the last few years, this growth rate has doubled to 14.7 percent. The current projected value of the worldwide nutraceutical market is \$117 billion USD. In the nutraceutical sector, the creation of increasingly customised and personalised products is becoming more and more popular, especially in the world's more developed countries. Verifying the health claims of products, doing market research, and investing more in research and development projects are some of the primary techniques employed by the modern nutraceutical sector to identify novel approaches. Customer demand is one of the main drivers of the nutraceutical industry's explosive expansion. To prevent diseases like diabetes, high blood pressure, and obesity, people are striving for optimal nutrition and healthy lives. China is expected to overtake all of the present global leaders in the nutraceuticals industry by 2030, despite the fact that the US, EU, and India currently hold the top three positions.[11]

### **CURRENT STATUS**

Foods high in nutrients, or food ingredients that aid in the treatment or prevention of illness, are derived from raw materials found in herbs and plants. These natural products are used by millions of people worldwide, and the industry is growing at a rate of 7–12% year. By 2015, the global market for nutraceuticals is expected to reach \$450 billion. Recent research from Euro Monitor indicates that by 2017, sales of health and wellness products worldwide are expected to hit a record of over \$1 trillion, driven by functional and fortified goods created to provide certain health benefits.

Conventional nutraceutical ingredients are not well known to Indian consumers, so manufacturers of these goods must take up the cause and educate the Indian public about their offerings. Over the past ten years, the global nutraceutical market has grown at its fastest rate. Over the course of the next five years, it is anticipated that the growth rates of beverages and functional foods in India will be significantly larger than those of dietary supplements.

China is the largest consumer in the Asia Pacific nutraceutical product market, followed by Japan. It is anticipated that the functional food market in India would develop at a moderate rate, with functional foods and beverages making up over 71% of the dietary supplement industry in 2017. With an approximate 31% annual growth rate between 2007 and 2011, dietary supplements constituted the fastest-growing market segment in the Middle East and Africa nutraceutical market.

In 2011, the most profitable market segment was proteins and peptides, while the fastest-growing category was non-herbals. The market growth for nutraceutical products in Eastern Europe is being driven by the expansion of the functional food and dietary supplement categories. The main user of nutraceuticals in the region is Russia. Just over 20% and just under 24.5% of the nutraceutical market are expected to be accounted for, respectively, by Hungary and Russia in 2017. Modern nutraceuticals are available as food forms, as ingredients in meals, or as full foods like yoghurt and probiotic drinks. Historically, nutraceuticals were only available in pharmaceutical forms, such as capsules, tablets, or powder in prescribed dosages.

Current issues include an imbalance in the amount of food provided to the undernourished through government programmes, a shortage of funding, and a lack of focus on research and development.

To address these issues, we should fund research in the field of nutraceuticals, support nutraceutical companies' R&D infrastructure so they may conduct research, collaborate with academia and industry, and expand public-private partnerships..[12]

## **CONCEPT OF NUTRACEUTICALS**

Clinical test findings are necessary in the pharmaceutical development process for animal research and tests, as well as for confirming the therapeutic effects of the products. However, there used to be no way to confirm that certain meals could actually prevent certain diseases when it came to nutrition. But as dietary composition has grown in importance as a social concern in recent years—it has been scientifically shown to induce diseases related to lifestyle choices. The health benefits of nutraceutical products are well-established and include lowering the risk of heart disease and cancer, as well as treating or preventing high blood pressure, high cholesterol, being overweight, osteoporosis, diabetes, arthritis, macular degeneration (which results in irreversible blindness), cataracts, menopausal symptoms, insomnia, constipation, upset stomach, headaches, and thinning hair. Other products are promoted as treatments for lethargy, poor complexion, varicose veins, lack of confidence, alcoholism, depression, and thinning hair. Nutraceuticals are beginning to be recognised as a potential preventative strategy for certain disorders. [13-18]

## **CLASSIFICATION**

### **1. Traditional -**

- Chemical constituents Nutrients, Herbals,
- Phytochemicals
- Probiotic organisms.
- Nutraceutical enzyme.

### **2. Non Traditional-**

- Fortified nutraceuticals
- Recombinant Nutraceutical.

### **3. Substance with established nutritional functions -**

- Vitamins,
- Minerals,
- Amino acids,
- Fatty acids

**4. Herbs (or) Botanical products**

**5. Reagents derived from other sources -**

- Pyruvate,
- Chondroitin sulphate,
- Steroid hormone precursors

**6. Functional foods**

**7. Probiotics and prebiotics**

**8. Polyunsaturated fatty acids**

**9. Antioxidant vitamin**

**10. Polyphenols**

**11. Spices**

**1. TRADITIONAL NUTRACEUTICALS**

The foods in this category are those that are not manually altered. The ingredients are natural and may actively contribute to certain health advantages. For instance, Tomatoes, pink grapefruit, guava, papaya, and water melon are good sources of lycopene, which has antioxidant properties and may prevent the development of some cancers, including leukaemia, prostate, bladder, and cervical cancer.

**2. NON-TRADITIONAL**

This category of nutraceuticals is of Boosting of nutritional content by addition of nutrients, dietary elements that will raise the nutritional quality. [14] For example,  $\beta$ -carotene found in carrots and other fruits and vegetables. The possible health benefits of carrots, oranges, and tangerines include their anti-oxidant activity, which neutralises free radicals, protects the cornea from UV light, and has anti-carcinogenic and anti-cancer properties.

- **FORTIFIED NUTRACEUTICALS**

The technique of adding micronutrients, such as vitamins and necessary trace elements, to food to improve its nutritional value and efficacy is known as fortification. One instance of it is cholecalciferol-fortified milk, which is used to treat vitamin D insufficiency.

- **RECOMBINANT NUTRACEUTICALS**

It involves the use of genetic engineering and biotechnology to produce foods that provide energy, such as cheese and yoghurt, or to extract bioactive ingredients via fermentation or enzymatic processes. The genetic modification of gold kiwifruit results in a high concentration of ascorbic acid, carotenoids, lutein, and zeaxanthin. For instance, lutein can be found in spinach, corn, avocado, egg yolk, and avocado and may have anti-cancer properties. [15-17]

**3. SUBSTANCE WITH ESTABLISHED NUTRITIONAL FUNCTIONS**

- **VITAMINS**

Different vitamins play crucial roles in preserving a healthy metabolism and general state of health. Any type of vitamin deficiency might result in distinct clinical signs. As a result, the majority of nutritional treatment or nutraceutical products include some vitamins, such as common vitamins like A, B, C, D, and E. Since plant foods provide a significant amount of human vitamin intake, plant biotechnology has been utilised to increase the vitamin content of crops.

<b>Vitamin</b>	<b>Sources</b>	<b>Uses</b>
Vitamin A	Liver, fish oils, dairy products, fortified foods	Vision health, immune function, skin health
Vitamin B Complex	Meat, poultry, fish, eggs, dairy products, leafy greens, beans, peas, fortified cereals	Metabolism, energy production, nerve function, red blood cell formation
Vitamin C	Citrus fruits, strawberries, kiwi, tomatoes, bell peppers, broccoli	Antioxidant, immune support, wound healing, iron absorption
Vitamin D	Sunlight, fatty fish (salmon, mackerel), fortified foods (milk, cereal)	Bone health, calcium absorption, immune function
Vitamin E	Nuts, seeds, vegetable oils, leafy greens	Antioxidant, immune support, skin health
Vitamin K	Leafy greens (spinach, kale), broccoli, Brussels sprouts, fermented foods	Blood clotting, bone health
Biotin (B7)	Egg yolks, liver, nuts, seeds, some vegetables	Metabolism, hair, skin, nails health
Folate (B9)	Leafy greens, legumes, eggs, citrus fruits, fortified grains	DNA synthesis, cell divi

**TABLE 1 :- DIFFERENT TYPES OF VITAMINS AND THEIR SOURCES AND USES**

- **MINERALS**

Mineral elements such as Ca, I, Zn, Fe, Mn, and Mg are vital to human health. Any one of these mineral deficiencies can lead to dangerous health issues. Meats as well as plant meals provide dietary calcium, zinc, iron, and other nutrients. Mineral deficiencies—primarily those in Ca, Zn, and Fe—are the main cause of health issues in developing nations, especially for young children and newborns. These deficiencies can arise from a variety of factors. However, one significant way to improve mineral nutrition is to increase the amount of Ca, Fe, and Zn in plant meals. [20]

#### **4.HERBS (OR) BOTANICAL PRODUCTS**

Herbs and botanical products can be acquired in the form of extracts and concentrates. Since herbal medicine has been used for as long as human civilization, it offers a vast array of solutions for both acute and chronic illnesses. The oldest known recorded system of natural medicine, known as "Ayurveda," is found in India and offers numerous efficient ways to guarantee health care. The essential component of medicinal plants contains a variety of nutraceuticals..

#### **5.REAGENTS DERIVED FROM OTHER SOURCES**

- **GLUCOSAMINE AND CHONDROITIN**

A substance called a glycosaminoglycan, which is involved in the development and maintenance of cartilage, is derived from glucose. Source: cartilage from cows or calves In a number of European nations, glucosamine sulphate is the first line of treatment for arthritis. In joint fluid, hyaluronic acid synthesis is stimulated by glucosamine sulphate. Damaged cartilage is given more mobility and pain relief by hyaluronic acid. After glucosamine was administered, an in vitro experiment revealed a dose-dependent rise in proteoglycan. Usually, it is sold as sulphate or hydrochloride salt. The two substances have anti-inflammatory properties. There is glucosamine and chondroitin combination available. The most prevalent glycosaminoglycan in cartilage, chondroitin, gives cartilage its resilience.

- **FLAVONOIDS**

Flavonoids are the main active components of plants that are used as nutraceuticals. In addition to their profound effects on the central nervous system, phenolic compounds, as is typical of them, also have antioxidant, antimicrobial, antibacterial, antiviral and antifungal, antiulcer, hepatoprotective, anti-inflammatory, anti-diabetic, vasorelaxant, anti-atherosclerotic, antithrombogenic, cardio protective, and anti-neoplastic activities. [21]

- **DIETARY SUPPLEMENTS AND DIETARY FIBERS**

A product that has an additional dietary element added to treat deficiencies or illnesses is called a dietary supplement. The popularity of dietary supplements to enhance performance, develop muscle, improve health, and prevent ageing has increased dramatically. An ingredient that improves food and its nutritional value is

considered dietary. There are products on the market with one component or several ingredients that contain vitamins and minerals as dietary supplements. [18] Herbs, botanicals, amino acids, pure extracts, concentrates or combinations of several substances, gland extracts, and organ tissues are additional dietary supplements besides vitamins and minerals. It is not meant to be incorporated into meals or diet plans as a regular ingredient or as a traditional or conventional dietary item. [22]

## 6.FUNCTIONAL FOODS

Nutrients that are absolutely important and found in greater quantities than those needed for growth, development, and maintenance can be found in functional foods.[23] There are numerous other subclasses within the functional food class, including fermented foods, legumes, and grains. There are numerous ways in which the potential of functional foods, such as grains like rice, corn, wheat, millets, sorghum, and buckwheat, can reduce the risk of blood pressure, tumour incidence, and coronary heart disease.[ 24,25]

Research has shown that soybeans, split beans, kidney beans, chickpeas, lentils, and chickpeas have strong antioxidant and anti-diabetic properties. [35–36] Furthermore, chocolate has been discovered to belong to the category of functional foods, which are the best sources of proteins, calcium, iron, magnesium, and riboflavin. [26-28]

Another kind of functional food is citrus fruits, which have been shown to have antiviral, antioxidant, and anticancer properties. They may also strengthen the immune system. [29] Another example of a functional food that has positive effects on digestion is fermented milk and its byproducts. Yoghurt, for example, is a highly nutritious fermented food that has been linked to anticancer activity. It also has the potential to protect atherosclerosis and gastrointestinal illnesses. For those who are lactose intolerant, it is advised. [30]

Food	Function(s)
Spinach	Excellent source of iron, vitamin K, vitamin A, and folate; supports bone and eye health
Salmon	Rich in omega-3 fatty acids, vitamin D, and protein; supports heart and bone health
Eggs	Good source of protein, vitamins B2, B12, and D; supports muscle and bone health
Almonds	High in healthy fats, fiber, vitamin E, magnesium, and protein; supports heart health
Greek Yogurt	Rich in protein, calcium, probiotics; supports gut health and bone health
Blueberries	Packed with antioxidants, vitamin C, fiber; supports brain and heart health
Quinoa	High in protein, fiber, and various vitamins and minerals; supports weight management
Avocado	Rich in healthy fats, fiber, potassium, and vitamins C, E, K; supports heart health
Broccoli	Excellent source of fiber, vitamins C and K, and folate; supports immune and bone health
Sweet Potatoes	Rich in fiber, vitamins A and C, and potassium; supports eye and skin health

**Table 2 :- DIFFERENT TYPES OF FOODS AND THEIR FUNCTIONS**

## 7.PROBIOTICS AND PREBIOTICS

Food ingredients that contain live microorganisms and are good for your health are included in the probiotic category. They adhere to the gastrointestinal tract at particular locations, and their existence causes infections to be eliminated. [31-34] Prebiotic foods fall into the category of carefully fermented foods or fibre that supports alterations in the microbiota in the gastrointestinal tract and its activity, which benefits the host's health. They serve as the probiotic bacteria in the colon's fertilising agents. Digestion acids and stomach pH have little effect on them. Insulin is one example, which upon additional hydrolysis yields galacto oligosaccharide and oligo fructose.[35-39]

## 8.POLYUNSATURATED FATTY ACIDS

Due to differences in the location of the first double C-bound, the group of polyunsaturated fatty acids (PUFAs) is split into two groups: omega-3 (n-3) and omega-6 (n-6) PUFAs. Since the human body is unable to synthesise two PUFAs, which are required for maintaining physiological integrity, they are referred to as essential fatty acids. As a result, diet is the only way to get them.

### **9.ANTI-OXIDANT**

Free radical-induced cell damage is thought to be a major factor in the ageing process and the development of illness. Our first line of defence against the harm caused by free radicals is antioxidants, which are also essential for preserving our best possible health and wellness. Being a highly reactive atom, oxygen can combine to form potentially harmful compounds known as free radicals. The body's healthy cells can be attacked by free radicals, which can lead to the loss of their structural integrity. Free radicals can be stabilised, or rendered inactive, by antioxidants prior to their damaging effects on cells. To preserve the best possible cellular and systemic health and well-being, antioxidants are vital. An very complex and effective antioxidant defence mechanism has evolved in humans. It involves a range of elements that have both endogenous and external origins and work cooperatively to neutralise free radicals.

### **10 POLYPHENOLS**

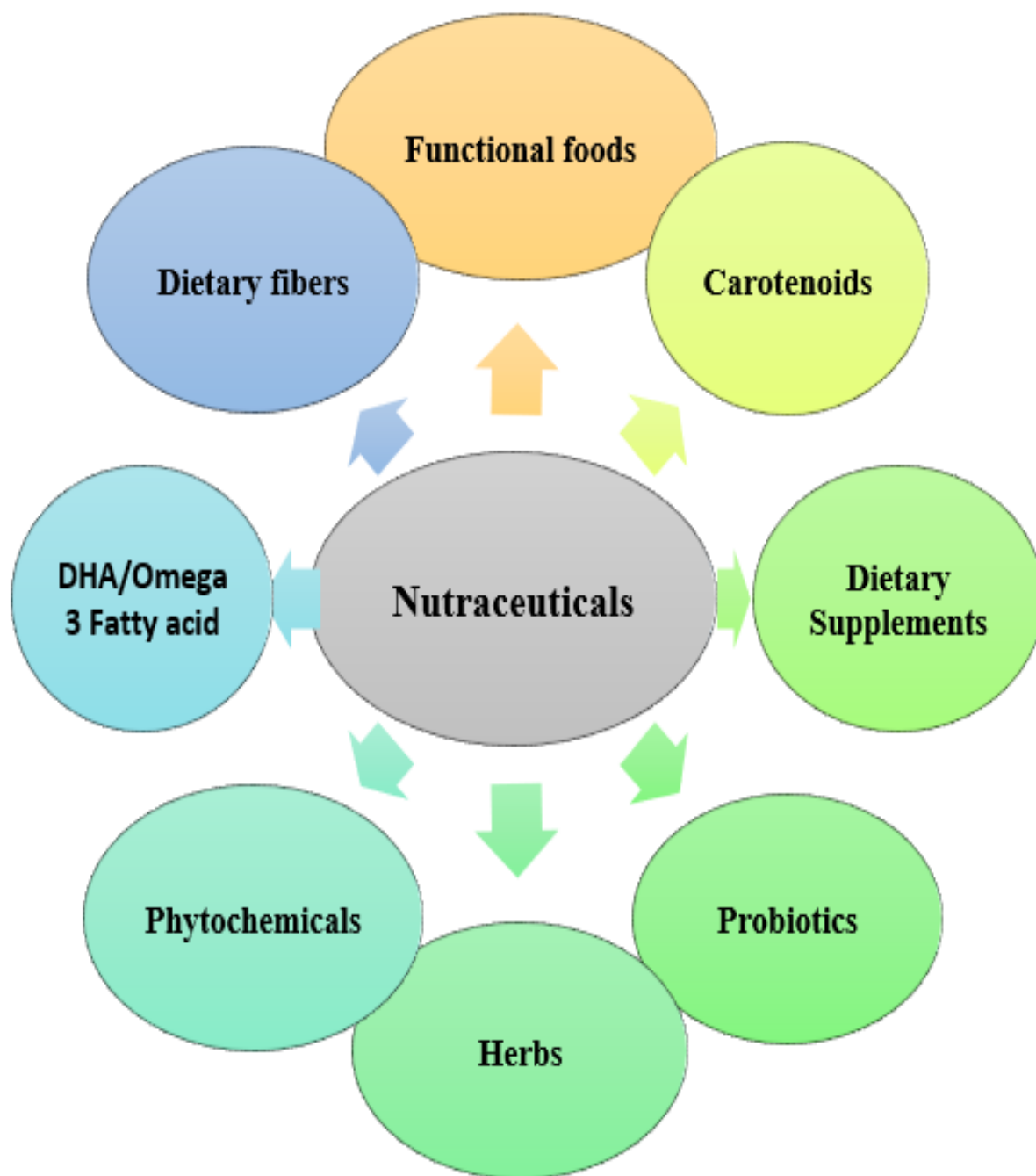
Plant-based foods such fruits, vegetables, whole grains, cereal, legumes, tea, coffee, wine, and cocoa naturally contain phytochemicals called polyphenols. Over 8000 polyphenolic substances, including flavonoids and phenolic acids, have been found in entire plant diets. These substances are the plants' secondary metabolites and serve as protection from oxidants, pathogens, and UV light. Based on the amount of phenol rings and the structural components that connect these rings, polyphenols can be divided into a number of groups. About one-third of the chemicals that are polyphenolics are phenolic acids. In the diet and fall into two main categories: a) derivatives of hydroxybenzoic acid (protocatechuic acid, gallic acid, p-hydroxybenzoic acid) and b) derivatives of hydroxycinnamic acid (caffeic acid, chlorogenic acid, coumaric acid, Ferulic acid, sinapic acid); foods high in these phenolic acids include berry fruits, kiwi, cherry, apple, pear, chicory and coffee.

### **11.SPICES**

Spices are aromatic vegetable materials that can be whole, broken, or pulverised. They are used mostly for seasoning food, not for nutritional purposes. These spice components give meals their distinct flavour, fragrance, and pungency. Spices with volatile oils that provide flavour, fragrance, and oleoresin are what give food its pungency. In addition to being used as seasoning and flavouring, spices are widely used in natural medicines, pharmaceuticals, nutraceuticals, aromatherapy, beverages, natural colouring, perfumes, dental preparations, cosmetics, and botanicals as insecticides. As a result, they are important to the local economy of the nation that produces them. These characteristics result from the wide range of compounds that these spices produce. It has been demonstrated that certain spices, such as turmeric, red pepper, black pepper, clove, ginger, garlic, coriander, rosemary, saffron, and cinnamon, have anti-neurologic effects.



**.DIFFERENT CLASSES OF NUTRACEUTICALS AND FUNCTIONAL FOODS**



**FIG 1 – DIFFERENT CLASSES OF NUTRACEUTICALS**



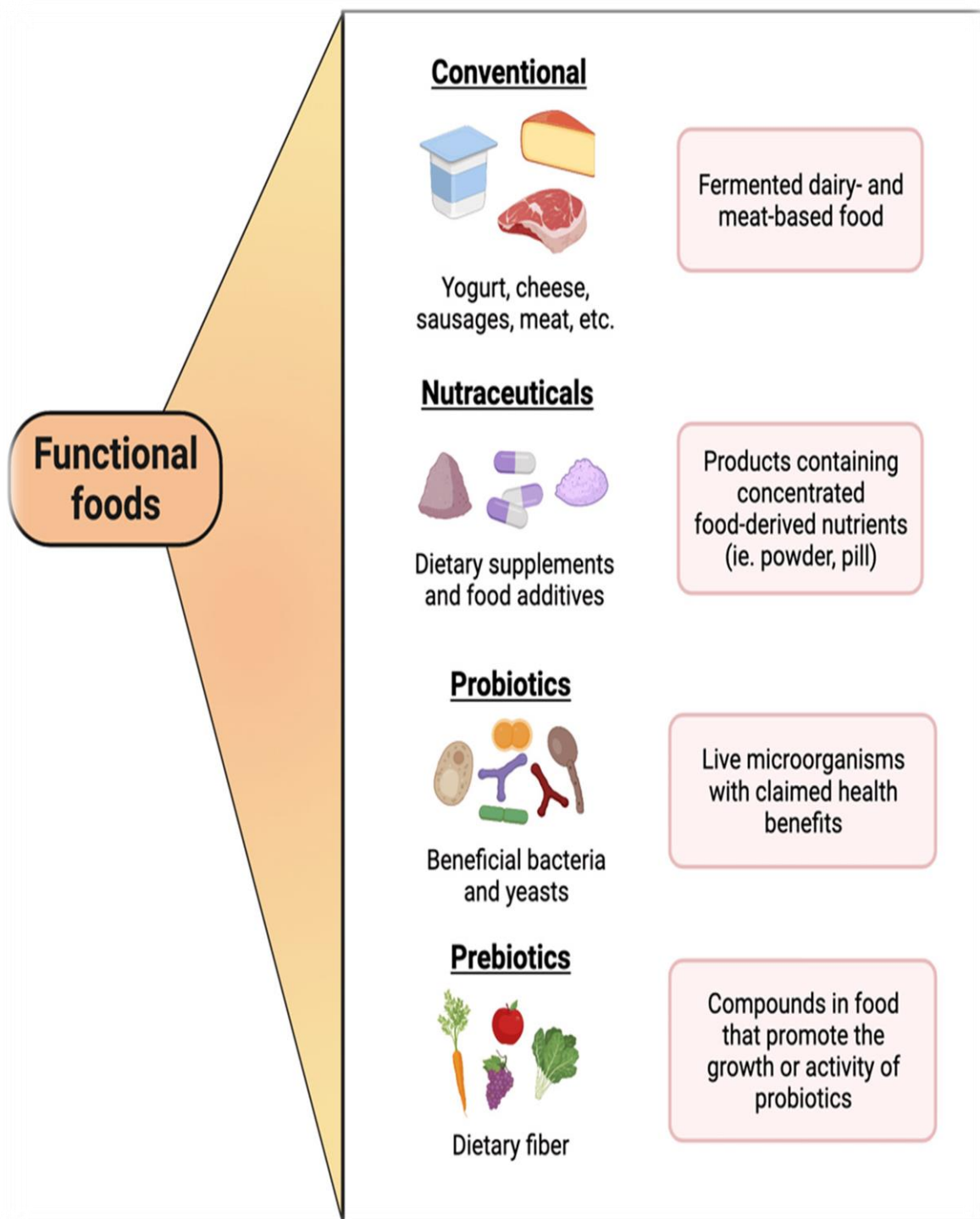


FIG 2 – DIFFERENT CLASSES OF FUNCTIONAL FOOD

### MERITS OF NUTRACEUTICALS

Consumption of nutraceuticals has following benefits

- Increases the health value of the diet.
- Helps in promoting longevity.
- Provides psychological benefits.
- Perceived to be more "natural" than traditional medicines and less likely to produce unpleasant side-effects.
- Nutrient rich foods are made available especially for elder people.

- f. Rich in health protective polyphenolic compounds.
- g. Rarely exhibits side effects.
- h. Possess prolonged half-life.
- i. Can be easily absorbed in the intestine
- j. Easily procured without prescription.
- k. Many people believe that nutraceutical approach is more natural than using medical practitioner prescribed drug. People are of the opinion that dietary supplements will help them to feel stronger and healthier and give them more energy and prevent illness.[73]

#### **DEMERITS OF SYNTHETIC NUTRACEUTICALS**

The FDA has issued warnings regarding the negative effects of artificial nutraceuticals. Any product that contains one of the prohibited substances,  $\gamma$ -Hydroxybutyric acid,  $\gamma$ -Butyrolactone, or  $\gamma$ -1,4-Butanediol, might cause a coma, seizures, or even death. Poisonous plants contain a herbal laxative called chomper, which can cause a deadly heart block. Because the word "fen-phen" suggests an anti-obesity goal and has an amphetamine impact on the central nervous system or heart, the FDA views herbal remedies containing ephedra, L-tryptophan, and mahuang as unapproved drugs. 5-Hydroxy-Ltryptophan is a sedative substance. Myocardial infarction can result from plantains, which wrongly contain *Digitalis lanata* and are used as a laxative. The foetus is harmed by Sleeping Buddha, an unmarked prescription medication that includes estazolam.[40]

#### **THE GLOBAL NUTRACEUTICAL INDUSTRY**

The nutraceutical market in the United States continues to be the biggest worldwide. As a matter of fact, a lot of American businesses are trying to expand the range of goods they offer and shift towards using more natural components. This shift in strategy is mostly the result of pressure from American consumers, many of whom are very health-conscious and insist on certain ingredients being included in the goods they buy.

In Europe, the nutraceutical market is undergoing significant consolidation, with an emphasis on new product development and innovation. The European nutraceutical business is predicted to develop at a compound annual growth rate of 7.5% by 2025. While Spain and the United Kingdom serve as important test markets for new goods, Germany, Sweden, and the Netherlands have emerged as Europe's leading centres of nutraceutical innovation. A recent analysis claims that the Indian market as a whole for nutraceuticals is expanding at a rate of 21% annually.

The market for traditional herbal ingredients—many of which are ayurvedic—into the nutraceutical portfolio is still in its infancy. However, in recent years, its growth has outpaced global rates, mostly due to the functional food and beverage categories.[41]

#### **MARKET SCENARIO OF NUTRACEUTICALS**

The national and worldwide markets are seeing an increase in demand for plant-based medications, health goods, pharmaceuticals, food supplements, cosmetics, etc. The need for nutraceuticals will only grow on a global scale. One enormous commercial potential that the Indian pharmaceutical sector will face in the upcoming years is nutraceuticals. Many of them are merely dietary supplements with no particular medicinal benefits. Its success or failure will be largely determined by its rapid expansion, research and development, lack of standards, marketing fervour, quality assurance, and regulations. The main ingredients of nutraceuticals include nutrients, herbals, and dietary supplements, which makes them useful for preserving health, preventing disease, and improving quality of life. [42]

#### **APPLICATIONS OF NUTRACEUTICALS IN DISEASE MANAGEMENT**

Numerous studies have demonstrated the potential of nutraceuticals to cure a wide range of ailments that require specialised attention, including depression, sleeplessness, delayed gastric emptying, blood pressure anomalies, colds and coughs, and many more. These days, nutraceuticals are being acknowledged for their potential benefits in the treatment of cancer, osteoporosis, obesity, diabetes, heart disease, and other degenerative and chronic illnesses including Parkinson's and Alzheimer's. Research suggests that a diverse range of biological processes are involved in the mechanistic actions of natural compounds. These processes include the preservation of mitochondrial integrity, signal transduction pathways, antioxidant defences, cell survival-associated gene expression, and cell proliferation and differentiation..

These characteristics seem to be essential for defence against the pathologies of many chronic or age-related illnesses. The risk of dying from cardiovascular diseases (CVDs) may be decreased by using nutraceuticals such as flavonoids, flavones, flavonones, quercetin in onions, cruciferous vegetables, black berries, cherries, berries, apples, and other antioxidant vitamins and minerals. They prevent high blood pressure by blocking the angiotensin converting enzyme (ACE) and the cyclooxygenase pathway. [43]

Flavonoid groups fortify the microscopic capillaries that supply all cells with vital nutrients and oxygen. Ginger, a strong antioxidant and anti-inflammatory, is advised to prevent palpitations and hypertension. Allicin reduces cholesterol and blood pressure. Different lipid-lowering nutraceuticals could be supplemented to lower cholesterol in addition to maintaining a healthy lifestyle. [44] Products made of poly-herbal ingredients may work in concert to accomplish a possible therapeutic goal.[45]

## **CANCER**

Dietary components high in bioactive nutrients have the potential to prevent cancer. [46] Herbal nutraceuticals have qualities that prevent cancer and mutation. Lycopene and other carotenoids have powerful anti-cancer properties. They reduce oxidative stress and act as an oxygen quencher. Nutraceuticals inhibit DNA transcription in tumours and regulate factors that damage DNA in cells. Fruits and vegetables include chemopreventive ingredients that may have anti-mutagenic and anti-carcinogenic properties. Orange and yellow fruits contain beta carotene, which has anti-cancer properties. The risk of lung and colorectal cancer is decreased by cruciferous vegetables. They inhibit the enzymes that give rise to tumour growth. Herbal nutraceuticals have the potential to modify the metastatic spread of cancer, according to recent studies.

## **DIABETES**

Nutraceuticals included in herbal dietary supplements have been shown to have therapeutic benefits for type 2 diabetes. Spices like cinnamon and fenugreek, as well as universal antioxidants like lipoic acid and catechins, are utilised to treat diabetic retinopathy, nephropathy, and neuropathy. Magnesium, chromium, calcium, and vitamin D enhance glycemic control, increase insulin sensitivity, and other benefits. Insulin-resistant patients' high plasma glucose is decreased with caffeinic acid. Insulin resistance is improved and fasting and postprandial glucose levels are decreased by green tea and epicatechin 3 gallate. Pomegranates and bitter melon are beneficial for diabetes because they control metabolism and move glucose from the bloodstream into cells. [47]

## **OBESITY**

A medical condition called obesity is defined by the buildup of extra body fat. Excellent anti-obesity qualities can be found in nutraceuticals such as capsaicin, psyllium, and conjugated linoleic acid. Body weight is decreased by herbal nutraceuticals such as bottle guard, fenugreek, chitosan, caffeine, green tea, curcumin, and black gramme. They release leptin and other cytokines, such as IL-1 and IL-6, which lower LDL and total cholesterol and control appetite. [48]

## **OSTEOARTHRITIS**

All joint tissues are affected by osteoarthritis, a complex disease whose aetiology combines biochemical and mechanical elements that work together to erode cartilage. Joint pain limits physical activity, which leads to an imbalance in energy and weight gain. The problems are relieved by using nutraceuticals such as chondroitin sulphate, glucosamine, diacerin, banana, ginger, green tea, pomegranate, boswellia, oxaceprol, tipi, willow bark, curcumin, avocado, soybean, and collagen hydrolysates. Along with their usual role as nutrients, they also have pharmacological effects and play a significant role in the regulation of gene expression. There is a lot of data supporting the use of nutraceutical antioxidant compounds to treat joint degradation, pain, and inflammation. [49] Applying olive oil also improves knee status, physical function, and lessens discomfort, stiffness, and swelling.

## **ORAL DISEASES**

A new term, odonto nutraceuticals, has been identified. In dentistry, it stands for pleiotropic phytotherapeutic compounds that modulate several molecular and biochemical targets. Odonto Nutraceuticals contains extracts from cocoa seeds, green tea, and grapes that are high in proanthocyanidins, flavonoids, and polyphenols. Aloe vera gel relieves oral lichen planus patients' pain and promotes the healing of mucosal wounds. [50]

Additionally beneficial in preventing dental cavities, gingivitis, periodontitis, halitosis, malodor, etc. are probiotics.

**Alzheimer's disease**

Another name for Alzheimer's disease is senile dementia. It seems that antioxidants slow down the disease's progression. Utilising their antioxidant properties, nutrients such as beta carotene, lycopene, curcumin, lutein, and lavandula can prevent brain damage caused by oxidative stress. These substances have the capacity to postpone dementia's onset. [51]

**PARKINSON'S DISEASE**

Parkinson disease is characterised by neurodegeneration, which damages the brain's dopamine-releasing cells. It ranks as the second most prevalent age-related condition globally. Unsaturated fatty acids, soybean and other phytoestrogens, plant polyphenols, and stilbenes have all been linked to protection against the advancement of Parkinson's disease. [52] Herbal Nutraceutical (Brahmi) is a naturally occurring brain tonic that aids in hormone secretion, blood circulation in the brain, brain cell regeneration, mental calm and relaxation, migraine, headache, insomnia, melancholy, and anxiety.

**EYE DISORDERS**

A diet high in nutraceuticals may be helpful in treating age-related macular degeneration. Antioxidant-producing substances such as lutein, DHA, green tea, carotenoids, flavonoids, vitamin E, and coenzyme Q10 can help prevent cataracts and presbyopia. For retinitis pigmentosa, flavonoids, ascorbic acid, tocopherol, carotenoids, caffeine, and pyruvate are effective treatments. [53] Rice bran, fruits, and vegetables are rich sources of lutein and zeaxanthin, which enhance vision and lower the risk of cataract development. Rice bran contains folic acid, omega 3, 6, and 9 important fatty acids, and other nutrients that support eye health.

**STRESS MANAGEMENT**

An essential component of our psychological makeup is stress. The naturally occurring bioactive substances known as adaptogens aid in preventing cellular damage brought on by stress. They work to restore normalcy and have a balancing effect for mental health and stress. They progressively boost emotional functioning, which aids in recovering from trying circumstances. Herbal supplements such as ginseng and ashwagandha are potent adaptogens that stimulate the synthesis of heat-shock protein 70 (HSP-70), a protein that suppresses stress. Additionally, they enhance resilience to environmental stress, stabilise physiological systems, encourage homeostasis, lessen moderate-to-severe anxiety, enhance sleep, lessen sadness, and enhance secondary memory. [54]

Disease	Nutraceutical	Mechanism of Action	Examples
Cardiovascular	Omega-3 fatty acids, Coenzyme Q10, Flavonoids, Plant sterols	Reduces inflammation, lowers cholesterol, improves blood flow	Fish oil supplements, Red yeast rice supplements, Green tea extracts
Diabetes	Chromium, Alpha-lipoic acid, Polyphenols, Fiber	Regulates blood sugar levels, improves insulin sensitivity	Chromium picolinate, Alpha-lipoic acid supplements, Cinnamon extracts
Cognitive	Omega-3 fatty acids, Curcumin, Vitamin E, Ginkgo Biloba	Reduces inflammation, enhances neurotransmitter function	Fish oil supplements, Turmeric supplements Vitamin E supplements, Ginkgo Biloba extracts
Bone Health	Calcium, Vitamin D, Vitamin K2, Magnesium	Supports bone density, calcium absorption, and bone strength	Calcium supplements, Vitamin D supplements Vitamin K2 supplements, Magnesium supplements
Immune Support	Vitamin C, Zinc, Probiotics, Echinacea	Boosts immune function, reduces risk of infections	Vitamin C supplements, Zinc supplements Probiotic supplements, Echinacea supplements
Digestive Health	Fiber, Digestive enzymes, Probiotics	Improves digestion, supports gut microbiome balance	Psyllium husk supplements, Digestive enzyme supplements, Yogurt with live

Disease	Nutraceutical	Mechanism of Action	Examples
			cultures

**TABLE 3 :- APPLICATION OF NUTRACEUTICALS IN DISEASE MANAGEMENT**

**ADVANCEMENT IN DRUG DELIVERY SYSTEMS WITH MEDICATED HERBS**

Scientists and researchers are searching for effective delivery systems due to customer desires for healthier food items and the evidence that nutraceuticals can prevent and cure a wide range of illnesses. More and more researchers are focusing on the utilisation of innovative medicine delivery systems to address product efficacy concerns.

**Nano emulsions**

An emulsifying agent is used to combine two immiscible liquids into a single phase, thermodynamically stable, isotropic system to create a nano-sized formulation known as a nano emulsion. The size distribution of the droplets is 20–200 nm. [55] It has been discovered that resveratrol, a naturally occurring substance present in peanuts, blueberries, and red grape skin, has potent antioxidant qualities. Nevertheless, the compound's low bioavailability is the issue. It has therefore been encapsulated in the nano emulsion created using the spontaneous emulsification method in order to solve the issue and improve the effect, which has improved retention and improved system attributes.

**LIPOSOMES**

Liposomes are spherical vesicles made of phospholipids with a lipid bilayer inside of them. These can be made with natural phospholipids and cholesterol and have a spherical structure. Liposomes are also favoured as a cutting-edge nutraceutical product delivery technology. Comparably, it has been demonstrated that silymarin in buccal liposomal formulation offers hepatoprotective action with increased product bioavailability leading to improved therapeutic response. Colchicine's anti-gout topical liposomal formulation has also shown to be highly successful in the treatment of gout. [56]

**PHYTOSOMES**

The combination of phospholipids and physiologically active components is known as a phytosome. The low solubility of ginseng has been discovered to be resolved by the oral formulation of ginseng phytosomes, which is made via phospholipid complexation. This increases ginseng's absorption in the body and improves its therapeutic impact as an immunomodulator. It has also been observed that oral phytosomal extract of hawthorn (a flavonoid) with cardioprotective and antihypertensive characteristics offers increased efficacy. With its dual roles as an antioxidant and an anticancer agent, quercetin was also made into oral phytosomes, which increased the medication's therapeutic effectiveness. [57] Additionally, studies have been conducted on curcumin phytosomal oral preparation, which employs the curcuminphospholipid complexation process. This preparation has demonstrated enhanced antioxidant activity and raised bioavailability.

**MICROSPHERE**

The spherical vesicular particles having diameters between one and one thousand micrometres are known as microspheres. Microspheres' small size allows them to be injected or consumed, customised to have any desired release profile, and capable of delivering drugs to specific organs and sites. [58] It has been reported that the intravenous preparation of microspheres loaded with camptothecin (a natural product) and prepared utilising the oil-in-water evaporation method has a lasting anticancer effect.

**TRANSFERSOMES**

Transfersomes, often referred to as ultra-deformable vesicles, are composed of a lipid bilayer complex encircling an aqueous phase at its centre, allowing the formulation to self-optimize and self-regulate. Colchicine transfersomal formulation has also been investigated as a means of improving gout treatment through improved penetration. [59] Curcumin transfersomes that are transdermally formulated have also been shown to improve entrapment efficiency and increase skin penetration, which enhances curcumin's anti-inflammatory effects.

## HEALTH BENEFITS

- Avoid the side effect.
- May increase the health beneficial effect
- May have naturally dietary supplement, so do not have unpleasant side effect
- May increase the health value, our diet and improve medical condition of human.
- May easily be available and economically affordable.

Nutraceuticals or dietary treatments are used as supplemental therapies in nutritional therapy, which is a healing approach. The foundation of this therapy is the idea that food can have therapeutic properties in addition to serving as a source of nutrition and energy. The premise behind nutritional therapy and nutraceuticals states that this is accomplished by utilising these products' effectiveness in helping the body detoxify, preventing vitamin and mineral shortages, and reestablishing a balanced diet and digestive system. In essence, phytonutrients are plant nutrients that have specific biological properties that promote human health..[60]

## COMMON HERBALS AS NUTRACEUTICALS

Common name	Biological name	Constituent	Health benefits
<b>Garlic</b>	Dried bulbs of <i>Allium sativum</i> (Liliaceae).	Alliin and allicin	Anti-inflammatory, antibacterial, antigout, nervine tonic
<b>Ginger</b>	Rhizomes of <i>Zingiber officinale</i> (Zingiberaceae.)	Zingiberene and gingerols	Stimulant, chronic bronchitis, hyperglycemia and throat ache
<b>Ginseng</b>	Dried root of	Ginsenosides and Panaxosides	Stimulating immune and nervous system and adaptogenic properties
<b>Liquorice</b>	Dried root of <i>Glycyrrhiza glabra</i> (leguminosae)	Glycyrrhizin and liquirtin	Anti-inflammatory and Anti-Allergic, Expectorant
<b>Turmeric</b>	Rhizome of <i>Curcuma Longa</i> (Zingiberaceae)	Curcumin	Anti-inflammatory, antiarthritic, anticancer and antiseptic
<b>Aloes</b>	Dried juice of leaves <i>Aloe barbadensis</i> Mill. (Liliaceae)	Aloins and aloesin	Dilates capillaries, anti-inflammatory, emollient, wound healing properties
<b>Senna</b>	Dried leaves of <i>Cassia angustifolia</i> (Leguminosae)	Sennosides	Purgative
<b>Bael</b>	Unripe fruits of <i>Aegle marmelos</i> Corr. (Rutaceae)	Marmelosin	Digestive, appetizer, treatment of diarrhea and dysentery
<b>Brahmi</b>	Herbs of <i>Centella asiatica</i> (Umbelliferae)	Herbs of <i>Centella asiatica</i> (Umbelliferae)	Nervine tonic, spasmolytic, anti-anxiety

**TABLE 4:- HERBALS USED AS A NUTRACEUTICLES**

### List of marketed nutraceutical products

Product	Category	Contents	Manufacturer
<b>Calcirol D-3</b>	Calcium supplement	Calcium and vitamins	Cadilla healthcare limited, Ahmedabad, India
<b>GRD[23-25]</b>	Nutritional supplement	Proteins, vitamins, minerals and carbohydrates	Zydus Cadila Ltd. Ahmedabad, India
<b>Proteinex®</b>	Protein supplement	Predigested proteins, vitamins, minerals and carbohydrates	Pfizer Ltd., Mumbai, India
<b>Coral calcium</b>	Calcium supplement	Calcium and trace minerals	Nature's answer, Hauppauge, NY, USA
<b>Chyawanprash</b>	Immune booster	Amla, ashwagandha, pippali	Daburindia ltd.
<b>Omega woman</b>	Immune supplement	Antioxidants, vitamins and phytochemicals (e.g. Lycopene and resveratrol)	Wassen, Surrey, U.K.
<b>Amiriprash (Gold)</b>	Good immunomodulator	Chyawanprash Avaleha, Swarnabhasma and RasSindur	UapPharma Pvt. Ltd.

**TABLE 5:- MARKETED NUTRACEUTICLE PRODUCTS**

## II. CONCLUSION

Increasing awareness about fitness and health spurred in media coverage prompted the society to lead healthier lifestyles through exercise and by eating healthy foods. The expanding nutraceutical market indicates that end users are seeking minimally processed food with extra nutritional benefits. This development, in turn, is propelling expansion in the nutraceutical market globally. The emerging nutraceuticals industry is destined to occupy the landscape in the new millennium. Its tremendous growth has implications in food, pharmaceutical, healthcare and agricultural industries. Global trends seen at present towards healthy products cannot be reversed. Health improvements mediated by “Nutraceuticals” or “Dietary supplement” have triggered an increased global interest. Supplements are products such as vitamins, minerals, amino acids derived from natural sources which are included in the diet, but without any therapeutic benefit. However nutraceuticals possess an additional advantage in the prevention or management of diseases or disorders and used as a conventional food. A number of biological mechanisms and pathophysiological processes are influenced by nutraceuticals and positioned well in order to contribute to the human health and National economy. Even though a large number of nutraceutical companies are emerging and market for nutraceutical products is expanding, further research investigations, legal implements and quality control processes should be focused to obtain healthy and safe human society through the usage of valuable nutraceuticals.

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