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INNOVATIVE FOOD PRODUCTS - NUTRACEUTICALS AND FUNCTIONAL FOODS

Editors

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Review Based Book Chapter

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REVIEW BASED BOOK CHAPTER

PRODUCTION, NUTRITION AND NUTRACEUTICALS

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Abstract

Nutraceuticals include various bioactive compounds present in edible natural sources like anti-oxidants, phytochemicals, probiotics, amino acids and fatty acids. In 1989, De Felice first described the term "Nutraceutical" that comes from the terms "Nutrition" and "Pharmaceutical". According to him, nutraceutical as a component of food plays an important role to prevent and treat different illnesses. Currently, nutraceutical business is increasing fast as people are very much concern about their health. The international market of nutraceutical is expected to rise from $241 billion to $373 billion from 2019-2025. Nutraceuticals are capable of providing additional health benefits when taken as part of daily diet. Nutraceuticals are critically important in normal physiological functions of human body and also minimize the danger of life-threatening aliments. Nutraceuticals are derived from both plant and animal sources. Nutraceuticals are globally used as dietary supplements, herbal products, probiotics, prebiotics and medicinal foods to treat and prevent various health problems like overweight, CVD, cancer, bone problems, diabetes, insomnia, gastrointestinal issues, various types of cancers, blood pressure, hyperlipidemia, pain management and depression. Mostly, nutraceuticals as dietary supplements are available in the concentrated form as pills, powders, liquid, capsule and soft gels which can be utilized orally along with daily food. Nutraceuticals offer a safer and more natural substitute to synthetic drugs with no or fewer side effects. In conclusion, nutraceutical industry has become well-known and popular all over the world due to its therapeutic benefits.

Keywords
Nutraceuticals, Functional Foods, Phytochemicals, Probiotics, Herbs, Supplements

1. Overview

Industrialization may result in air, water, soil pollutions and food contamination due to their wide spread usage of chemicals, heavy metals and pollutants made by human.

These problems increased the prevalence of problems related to blood sugar, overweight, different types of cancers and many health issues related to functioning of human body. The cost of medicines may increase due to elevated demands of health care. Therefore, for the safety and better quality of life, people start consuming natural sources like vegetables, fruits, and other plant foods, taking dietary supplements or nutraceuticals with no side effects to body. Due to more public awareness about nutraceuticals, the industry of supplements, phytonutrients and natural therapeutic services, have been growing very fast [1].

The intake of health and nutrient-dense foods items may affect the overall health and wellness of human beings. Foods may comprise different nutrients that have lot of health benefits and able to improve human health. Naturally occurring health-enhancing substances come from plant sources, animal sources may also contain various nutritious components that need attention of community for their significant role in improving human health. Eating fruits and vegetables rich in nutrients have been associated with combating illnesses like cancer, cardiovascular disease (CVD), obesity, and disorders related to Gastro-Intestinal tract (GIT) [2].

Phytochemicals present in the food that are linked with numerous health benefits are glucosinolates, flavonoids, terpenoids and polyphenols. In the recent years, nutraceuticals have received much attention from the researchers, consumers, and food producers. The well-known nutraceutical compounds like vitamins, probiotics, bioactive peptides, antioxidants are able to support the health due to presence of health-promoting food ingredients. Functional foods are the therapeutic foods when administrated daily may exert a specific positive health effect beyond their nutritional properties [3].

2. Methodology

Electronic databases including Google Scholar, online library of Willey, Scopus, Science Direct, PubMed and Springer Link were used for searching the data. Data was explored using keywords including "Nutraceutical", "functional food", "dietary supplement", "dietary fiber", "bioactive compounds", "essential fatty acid", "probiotics", "prebiotics", "human Gut", "antioxidants", "polyphenols", "cardiovascular health", "immune system" and "formulation of nutraceutical". Finally, appropriate researches

published before January 2025 were selected, assessed and estimated for the final version.

3. Nutraceuticals

The idea of "Nutraceuticals" is as old as 3000 years ago. Hippocrates stated that the food must be drug and the drug for the treatment of any aliment must be the food. The word "Nutraceutical" was discovered in 1989 by DeFelice. According to him, nutraceutical can be a part of food that delivers health benefits to prevent and treat various diseases. Nutraceuticals as a food products old in the forms of pills, powders, capsules and soft gels [4].

The term "nutraceuticals" comes from two words" nutrition" and "pharmaceuticals," representing a fascinating intersection of food and medicine. It encompasses a diverse array of products derived from specialized diets, dietary supplements, herbal sources, and processed foods like cereals, beverages, and soups. These products serve purposes beyond basic nutrition, doubling as medicinal aids, by virtue of their dual roles, offer a compelling synergy between nutrition and healthcare, embodying a holistic approach to wellness. Nutraceuticals are renowned for their multifaceted therapeutic properties, garnering significant attention in recent years for their potential nutritional, safety, and therapeutic benefits [5].

4. Classification of Nutraceuticals

Nutraceuticals are made from the plant and animal source. Currently, the health problems dedicated the important role of nutraceuticals in social well-being of human beings due to their additional health benefits without any adverse effects [6].

The nutraceuticals used in daily life fall into following categories on the basis of various criteria:

4.1. Classification Based on Food Availability

4.1.1 Traditional Nutraceuticals

Traditional nutraceuticals are one of the major categories of nutraceuticals. Under this category unchanged foods are made. It is totally natural. The nutrition of actual food remains same even after processing and dietary modification. Numerous fruits, vegetables, cereals, fish, milk and meat products contain several natural components. Traditional nutraceuticals are generally obtained directly from nature [7].

Different types of traditional nutraceuticals are given below:

4.1.1.1. Based on Chemical Constituents

i. Nutrients

Nutrients are the substances like fatty acids, amino acids, vitamins and minerals that have strong nutritional profile. Plant and animal products are rich in macronutrients and micronutrients that have various health benefits. They help in curing diseases related to vital organs. Nutrients like vitamins, amino acids, and fatty acids have specific roles in the pathways involved in the metabolism. Natural products from plants are used in treating various illnesses like diseases related to heart and central nervous system. Furthermore, they also strengthen the bones and muscles. Essential fatty acids have great impact on inflammation, brain functionality and reduced the blood cholesterol level. Vegetables, wholegrain cereals, milk products, fruits having vitamins are able to cure many diseases common all over the world. Not only the plant products but also animal products like meat, poultry are widely used to cure various disorders. Minerals mostly present in plant, animal and milk products are beneficial in numerous health-related issues. Fat-soluble vitamins, antioxidant, and water are most commonly known nutrients. Antioxidants have many potential benefits in the form of supplementation or dietary intake. Cancer and cerebrovascular diseases may be prevented by antioxidants. The vitamin E intake in greater amount as part of regular diet may prevent from disorders related to nervous system. Supplementation with selenium in genetically predisposed patients may help to prevent from pancreatic cancer having low level of Se. Zinc is one of the essential components in hundred enzymes which involve digestion, metabolism and wound healing [8].

ii. Herbals

Herbals are as old as human civilization and are utilized for the treatment of almost all the serious and life-threatening illnesses. Nutraceuticals obtained from herbs are able to improve health and save the humans from chronic ailments. Parsley contains flavonoids that increase the urine output, decreased the inflammation and GIT related problems. Menthol in Peppermint is an active constituent that helps to cure cough and fever. Lavender contains tannin and helps to treat depression, hypertension, cough and respiratory ailments. Cranberries contain proanthocyanin which are useful in cancer,

ulcers and urinary tract infection. Herbals are widely used to prevent and cure countless ailments from ancient times [9].

iii. Phytochemicals

Phytochemicals are vital for various physiological activities. Carotenoids are present in vegetables and have the ability to improve the immune system, due to its strong anti-cancer properties. Carotenoids in legumes, palm oil and grains reduced the blood cholesterol level according to previous research. More than 4000 Flavonoids have been identified that are capable to prevent degenerative illnesses [10].

Flavonoid and polyphenols are primarily present in fruits, vegetables and legumes and have strong anti-inflammatory, anti-oxidants, and anti-clotting attributes. Phenols are the largest class of secondary metabolites. They also show anti-cancer and anti-tumor property. Phytochemicals protect against metabolic disorders, microbial infection and mental ailments that had been proven scientifically. Phytochemicals when enter into our bodies, are able to improve optimal health and cure numerous ailments [11].

4.1.1.2. Probiotic Microorganisms

The term was coined by Metchnikoff. It has capacity of forming the friendlier in intestine for break down and absorption of food. Probiotics remove the toxic flora of intestine for making life smoother and maintain friendly environment. The meaning of word 'Probiotics' is 'for life' and is described as alive microbes, which when taken in tolerable quantities, acted effectively on the host. They are beneficial bacteria that elevate the breakdown and absorption of essential nutrients. They act to force out pathogens which may cause diseases and develop synergetic association with the human GIT. They also have an anti-microbial effect. They compete with pathogens and prevent their bonding to the epithelial cells of intestine, also produce an anti-toxin effect and reverse the negative impact of infection on the epithelial cells of intestine. Moreover, probiotics are helpful in lactose intolerance to break down the lactose into its sugar components by the release of ß-galactosidase [12].

4.1.1.3. Nutraceutical Enzymes

Enzymes are biocatalyst which are formed by the cell and are protein in nature. Enzyme supplements are used for the treatment of gastrointestinal tract (GIT) related medical issues like gastroesophageal reflux disease, diarrhea, constipation and

ulcerative colitis. At present time, numerous rare ailments can be treated with enzyme therapies. Enzymes are the vital part of life; without enzyme human body is unable to do proper function. The people with the health problems such as anti-hyperglycemia, digestive problems and obesity, when utilized enzyme supplements with their diets may results in the elimination of severe symptoms. The enzymes used for the cure of numerous diseases mostly come from plant, animal and microbial sources [13].

4.1.2. Non-traditional Nutraceuticals

Non-traditional nutraceuticals are the food products synthesized artificially, produced by using biotechnology or agriculture breeding. These techniques include addition of nutrients for upgrading the food properties and improving the human health. On the basis of processing techniques, non-traditional nutraceuticals may be distinguished into fortified and recombinant nutraceuticals [14]. Examples of fortified and recombinant nutraceuticals are given in Table 1.

Table 1. Classification of Nutraceuticals based on Food Availability and Chemical Nature [5]

Nutraceuticals		
Fortified Nutraceuticals	**Based on Chemical Nature**	**Recombinant Nutraceuticals**
Calcium in Orange Juice	Carotenoids	Yoghurt
Vitamins and Minerals in Cereals	Polyphenolic Compounds	Cheese
Folic acid in Flour	Phytoestrogens	Vinegar
Cholecalciferol in Milk	Dietary Fibers	Fermented Starch
*Bifidobacterium lactis*in Milk	Fatty acids	Bread

Non-traditional nutraceuticals are classified as follows:

4.1.2.1 Fortified Nutraceuticals

The fortified food originates from agricultural breeding e.g., calcium is fortified in orange juice; micronutrients are added in cereals and folic acid fortified in wheat flour. Other examples include milk fortified with cholecalciferol to prevent and treat vitamin D deficiency. Fortified nutraceuticals comprise addition of well-suited nutrients as a chief element to prevent and treat different nutritional deficiencies [15].

4.1.2.2. Recombinant Nutraceuticals

Recombinant nutraceuticals are food products that are formed by utilization of genetic engineering and biotechnology. The health benefits related to different foods and crops are enhanced by genetic modification in which recombinant compounds and proteins are added. Biotechnology is widely applied for the development of energy-giving food products (bread, alcohol, fermented starch and fermented milk products), production of probiotics and plant-based extract containing bioactive components [16].

4.1.3. Classification Based on Mechanism of Action

Nutraceuticals may also classify on the basis of their specific mechanism of action into different categories (Figure 1). Due to these attributes, nutraceuticals have strong capability to reduce the microbial infections, inflammation and boost immunity.

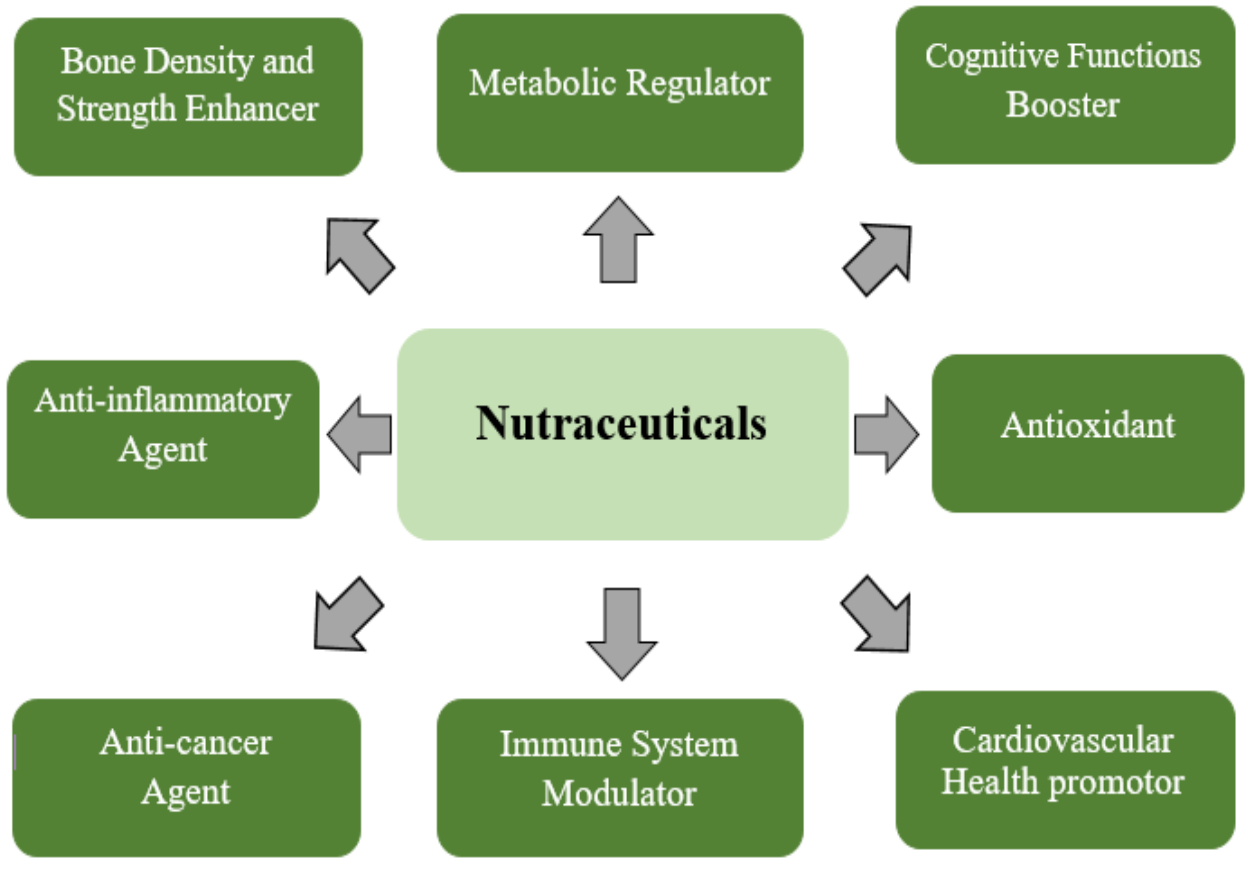

Figure 1. Classification of Nutraceuticals on the basis of Mechanism of Action

4.1.4. Classification Based on Chemical Nature

Nutraceuticals may be classified on the basis of presence of primary and secondary metabolites such as phenolic constituents, isoprenoid by-products, amino acids, fatty acids, and carbohydrates-based elements [16].

4.1.4.1 Food Sources of Nutraceuticals

The food sources from which all nutraceuticals come from are natural and can be characterized as:

i. Dietary Fiber

Dietary fiber are indigestible carbohydrates and lignins that comes from plant sources. Functional fiber contains non-digestible carbohydrates which have advantageous impact on the body functions. Total fiber is made of dietary and functional fiber. Starches, oligosaccharides and other non-digestible carbohydrates are all functional fibers. Dietary fiber is digested by the action of gut microflora, as the enzymes released by the digestive tract are not able to break down the fiber [17]. Dietary fiber comprises non-starch polysaccharides, resistant dextrin and starches. Foods containing soluble fiber contain fruits, cereals and beans. Chemically, dietary fibers do not break down and absorbed in the small intestine as they are complex carbohydrate.

On the basis of solubility in water, dietary fibers are classified into two types; soluble and Insoluble dietary fiber. These two types of dietary fibers also known as non-starch polysaccharides [18].

ii. Probiotics

A probiotic is live microbial feed supplement when taken in enough quantity. It boosts the intestinal microbial balance by giving the host animal good effects. Commonly, different classes of bacteria comprise of probiotics [19] (Figure 2).

Probiotics are present in several forms like liquid form, powdered form, pasted or gel form, granular form and capsule form. Probiotics are usually used in treatment of GIT conditions (acute diarrhea, lactose intolerance) and anti-biotic related GI adverse effects. Probiotic agents are non-toxic and non-pathogenic. They are resistant to the gastric acid. They adhere to anti-bacterial constituent forming gut epithelial tissues. Previous studies showed that intake of probiotics declines the danger of respiratory infections, urinary tract infections, different food and non-food allergies [20].

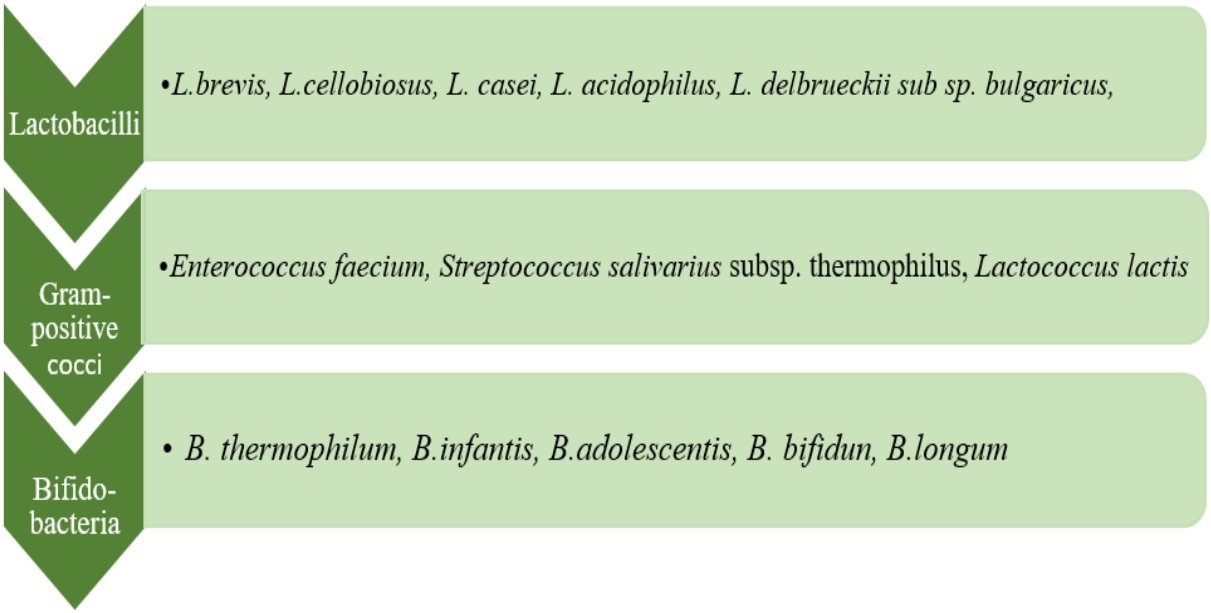

Figure 2. Common Classes of Bacteria used as Probiotics with Examples

iii. Prebiotics

Prebiotics are dietary constituents which positively affect the host by breakdown of the gut microbiota or selective alteration in chemical moieties. These are short-chain polysaccharides that have unique chemical structures which are not assimilated by humans; specifically, fructose-based oligosaccharides that occur naturally in food or are added in the food. Normally, the growth of *Bifidobacterial* and *Lactobacillus* in the gut is enhanced by the utilization of prebiotic that help in breakdown. Vegetables like banana, tomato, alliums contain fructo-oligosaccharides. Raffinose in beans and stachyose present in peas are some other examples of these oligosaccharides. The prebiotics enhanced the lactose tolerance, anti-tumor activities, toxins neutralization, and intestinal immune system stimulations, decrease of constipation, complete lipid profile. The growth of bifidobacterial is raised by the everyday consumption of 5g to 20g of insulin and oligosaccharides. Oligosaccharides intake in large quantities may cause flatulence diarrhea, and abdominal discomfort [21].

iv. Polyunsaturated Fatty acids

Polyunsaturated fatty acids (PUFAs), come from diet and are vital for the functioning of human body, are called as "essential fatty acids" (EFAs). PUFAs fall within two classes

Omega-3 fatty acids (N-3) and Omega-6 fatty acids (N-6). DHA, EPA, and ALP are the three main example of omega-3 fatty acids. The main sources of these essential fatty acids (DHA & EPA) are fish oils and fatty fish. Moreover, Plant-based oils are rich in LA. PUFA have anti-inflammatory activity that results in the reduction of triglycerides, blood pressure levels, and platelet accumulation. Depending on the double bond's location and number, PUFAs control number of biological functions that includes reduction of blood pressure and blood clotting. Furthermore, they also play a vital role in the normal development and physiological functions of brain and other parts of nervous system [22].

Overall health and nutritional well-being are affected by the location of double bond, the level of unsaturation, and the fatty acid's chain length. Fatty acids are building blocks of various dietary oils and (fats) lipids that originates from both plant and animal sources. As the chief constituents of phospholipids, triglycerides, and cholesterol esters, fatty acids play important structural, functional, and metabolic roles in the body [23].

v. Antioxidants

All the metabolic reactions in the human body takes place in the presence of oxygen. Free radicals are produced during oxidation when oxygen reacts with body compounds. These unstable molecules (free radicals) attack the human body's healthy cells and affects the structure and function of these cells. When anything come in contact with free radicals at a molecular level, they destroy them. More production of free radical, more damage may occur and various health issues can develop. Oxidative stress due to increased formation of free radicals, may results in low cognitive performance, fasten aging process and develop degenerative diseases like cancer, arthritis, cataracts, and heart disease.

Antioxidants can deactivate the free radicals before they attack the healthy cells and lessen the oxidative damage. Antioxidants have the ability to inhibit the oxidants chain reactions and finally rebuild the damaged membranes. Antioxidants avert against free radical damage, and are life-threatening for keeping optimal health and wellbeing. It involves various endogenous and exogenous components, that are involved in the neutralization of free radicals [8].

Antioxidants inactivate ROS at cellular and molecular level and under specific low concentration delay oxidative processes. Examples of anti-oxidants are polyphenols, carotenoids, tocopherols, ascorbates and lipoic acids that have strong free radical scavenging activities. Earlier investigations confirmed that many known diseases are cured by the utilization of antioxidants. The importance of antioxidants makes them crucial part of the nutraceutical industry [24].

Antioxidants are also present in the vegetable oils. Antioxidants are used in the treatment of all the chronic diseases that occurs mostly due to oxidative stress. Oxidative stress plays a main role in the different neurodegenerative diseases. The ageing process fastens due to deficiency of anti-oxidants and increased oxidative stress [19].

vi. Polyphenols

Plants as secondary metabolites, forms a large group of phytochemicals "Polyphenols" that give protection against oxidative stress due to production of ROS. There are almost 8,000 different types of polyphenols, among all flavanones. Flavones, flavan-3-ols, flavonols, and anthocyanin are the most common polyphenols. Most of the polyphenols are formed by the pathway of branched phenylpropanoid. The flavonoids and phenols are the most common examples of polyphenols present in food items. Polyphenols also have anti-inflammatory, cardio protective, antioxidative, and anti-microbial properties and play a pivotal role in preventing diabetes and diseases related to central nervous system. In vitro studies found that on the molar basis, polyphenols are more effective antioxidants than vitamin E and C. Biological activity of polyphenols is determined by using bioavailability of polyphenols, their chemical properties, enzymes available for breakdown, and intestinal absorption rate [25].

vii. Spices

Since 5000 BC spices have been utilized as part of daily diets. Traditionally, spices are used in the various food recipes as flavoring agents due to their therapeutic importance and positive impact on human health. Spices that are rich in bioactive compounds recognized as first functional food and have a noteworthy valuable influence on the health of human beings [26].

Spices enhanced the sensory attributes of foods and give them specific color, flavor, taste aroma, and texture. Most of the spice constituents are terpenes and essential oils which have been found to be useful in many forms. Consumption of garlic with fish oil may reduce the complete lipid profile of patients with hyperlipidemia. As a part of food, spices and herbs are non-toxic and safe. Interactions of spices with synthetic medicines may results in toxicity, or when used as natural drug in higher dose. Spices may improve the digestion, treat digestive issues, and also have anti-bacterial, cardioprotective, anti-diabetic, anti-cancer and anti-inflammatory properties [27].

5. Production and Formulation Process of Nutraceuticals

Dietary supplements come from foods or other natural and nontoxic sources, that are generally concentrated in different forms [28], as shown in Figure 3.

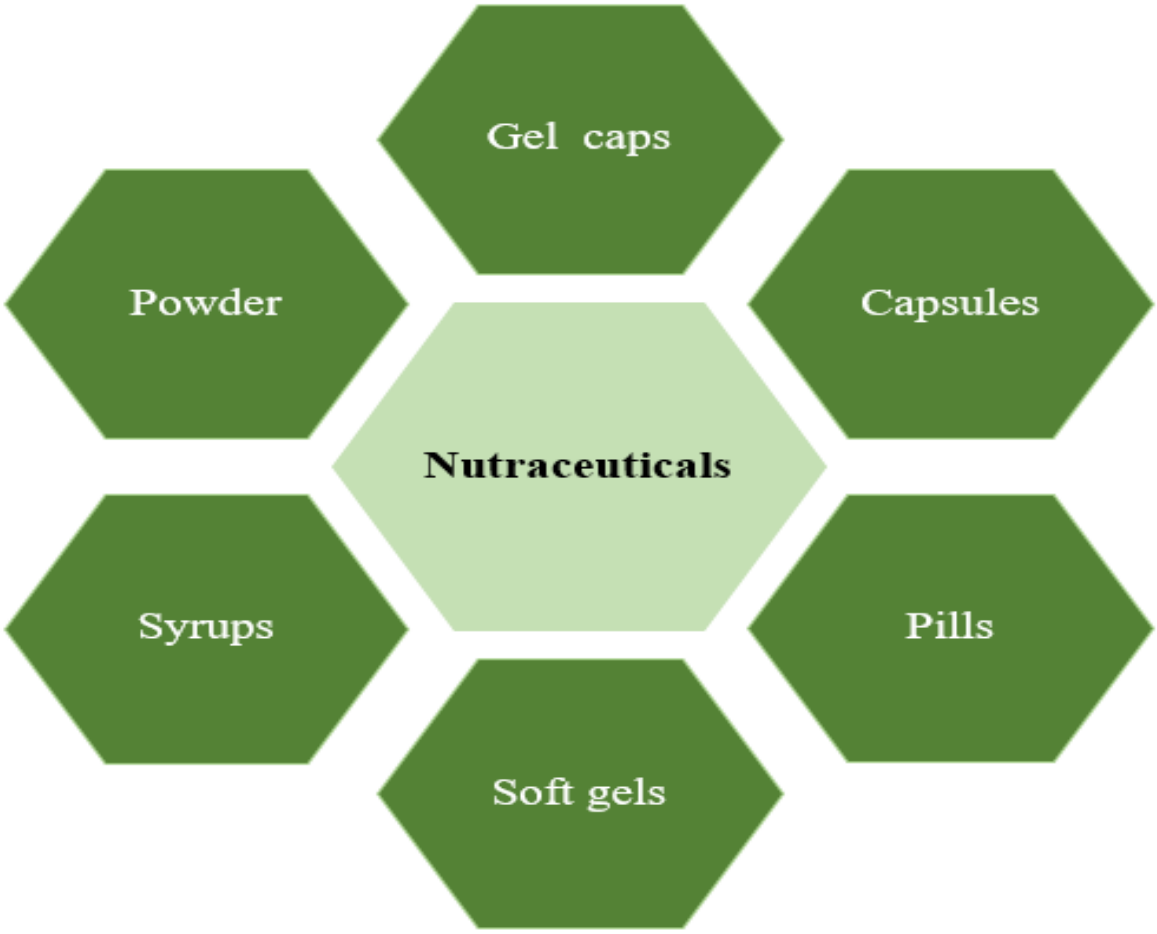

Figure 3. Concentrated Forms of Dietary Supplements

Dietary supplements are sold in the concentrated form as minerals, vitamins, amino acids, herbs secondary metabolites, enzymes and organ tissues. Medical food is defined as a modified food used for the cure of specific health condition along with fulfilling the nutritional needs. As components of medical value, pharmaceuticals have been defined by merging the terms "farm" and "pharmaceuticals", produced from the alteration of plant and animal sources. Functional foods and dietary supplements are the major types of nutraceuticals. Functional foods are taken as part of daily diet and have additional health benefits apart from the basic benefits as proved by scientific researches. The role of functional foods other than physiological benefits also have capability to lessen the dangers of various aliments [29]. Nutraceuticals as a part of food have medicinal and physiological properties, and present in the form of pills, powders, and capsules. Nutraceuticals' effectiveness mainly depends on their sources and constituents, with their division chiefly linked with their origin, chemistry and pharmacology [30].

6. Nutraceuticals and Diseases

Following are some ailments where nutraceuticals play a significant role:

6.1. Anti-diabetic Activity

Diabetes is a metabolic illness which happens when the body do not secrete adequate insulin or cannot utilize it efficiently. Approximately 422 million persons are affected from diabetes internationally. Furthermore, diabetes may result in the death of 1.5 million people annually. The main barriers to widespread access are high cost and inadequate supply of human insulin. Previous researches showed that plant-based diets provide micronutrients and phytochemicals that have anti-diabetic properties. Additionally, adverse effects of artificial medicines are reduced due to utilization of natural food sources [31].

Genistein in soybean seeds, has been revealed to be an active drug for the management of diabetes. According to previous investigations, genistein enhanced the secretion of insulin in animal modelling. In a human study, genistein therapy may also significantly lowered the fasting blood sugar levels of diabetic females. In another animal study, grape seed extracts noticeably lowered the blood glucose levels in type

2 diabetic rats. Furthermore, Sage extract have been noted to decreased the blood glucose levels in patients with diabetes [32].

6.2. Anti-hypertensive Activity

Globally, hypertension is one of the most common causes of serious health issues. Numerous studies showed relation of different dietary components with decreasing the hypertension. *Hibiscus* tea is rich in various bioactive compounds that play a vital part in declining blood pressure. Animal studies have confirmed that intake of sour tea containing *Hibiscus sabdariffa* extract lowered the levels of systolic and diastolic blood pressure. Ginger as a food supplement has a beneficial impact on the functioning of endothelial cells and blood pressure. 2g/day to 6g/day ginger addition in daily diet significantly reduced the LDL and cholesterol levels of hyperlipidemic rats [33]. Additionally, ginger is rich in potassium, due to which it can control blood pressure. Recent investigations depicted that saffron has ability to protect against cardiovascular diseases due to its strong antioxidant potential. In hypertensive rats, saffron administration for five weeks can prevent from increase of blood pressure [34]. The older studies investigated that cinnamon has ability to treat metabolic disorders. Furthermore, cinnamon's polyphenols help in the normal regulation of blood pressure levels [35].

6.3. Anti-hypercholesterolemic Activity

Previous studies suggested that total cholesterol levels dropped significantly in the experimental group that take red-yeast-rice when compared to the control group. Berberine an alkaloid is found in many medicinal plants like *Coptis chinensis* may decrease the lipid profile by lessening the production of liver's cholesterol and triglycerides [36]. Human blood lipid levels, intake of plant based and animal-based protein were studied and compared. The investigations found that plant-based protein consumption as compared to protein from animal source significantly reduced lipid profile of individuals with hyperlipidemia. The impact of the drink made from herbal plant "Tiwai" on hypercholesterolemic patient's lipid profiles were evaluated. The results concluded that taking the herbal drink for 7 days reduced the total cholesterol levels of patients. Findings related to impact of eating tree nuts on lipid profile depicted that the tree nuts reduced triglycerides, LDL and total cholesterol levels [37].

6.4. Cardioprotective Activity

Omega-3 polyunsaturated fatty acids, dietary fibers, antioxidants, and many micronutrients are mostly used for the prevention and treatment of CVD. Many reports show that low consumption of fruits and vegetables are related with a high death rate in CVD. Rice bran helps lowering serum cholesterol and LDL levels in the blood and rises the HDL levels. Rice bran contains lutein as well as Zeaxanthin, which improves eyesight. Important factors responsible for CVD include obesity, increased blood cholesterol level, increased blood pressure and type 2 diabetes. Consumption of poor diets and lifestyle habits strengthens the risk of CVD. People who take a healthy diet, do not smoke and consume less amount of alcohol tend to have a reduced risk of CVD. Food sources can elevate complete lipid profile except lead HDL levels. While treating hypercholesterolemia, increase of cholesterol and bile acids in the fecal excretion may be observed. Diet modification helps to reduce the formation of cholesterol in human liver. People with family history of CVD, must take diet rich in calcium, phosphorus and magnesium. Alcoholic beverages and sodium consumption should be less in these people [38].

6.5. Anti-microbial Activity

An experimental data showed that tannins and other phytochemicals from different medicinal plants may include abundant natural anti-microbial and anti-fungal agents used in the formulation of energy-rich tea formulations. The anti-bacterial activity of larch bark extract was checked on the pathogens that results in respiratory-tract infection in an investigation, and the outcomes confirmed that extract of larch bark had stronger anti-microbial activity than the extract containing grapefruit seed powder. Phytochemicals from LBE can therefore be utilized as active anti-bacterial in the formulation of nutraceuticals. Quercetin, a flavonoid, found mainly in vegetables and fruits has anti-viral, anti-atopic and anti-inflammatory activities. *Thymus vulgaris* essential oil confirmed very noteworthy bactericidal and anti-fungal activity. Apigenin (bioactive compound) in parsley, shows strong activities against inflammation [39].

6.6. Anti-cancer Activity

Laboratory research confirmed that many natural food products rich in bioactive components have strong anti-cancer capabilities. Nutraceuticals also help in

diminishing the side effects of cancer treatment and improving the over-all health of patient. Some research estimates that one-third of all cancer's deaths are preventable by life-style changes, which include appropriate nutrition. Botanicals are widely used in the treatment of cancer. There are many nutraceuticals available for the reduction of the risks of cancer [40]. Preventing the cancer by dietary modifications generally highlights the food items from plant, marine and animal sources and skipping the refined and processed food products. In addition, carotenoids from plant nutraceuticals having anti-oxidant activities are effective for the prevention of cancer. Many phytochemicals including polyphenols and flavonoids have strong anti-cancer potential. Flavonoids present in citrus fruit, also have anti-tumor activities [41]. Alkaloids are effective in treatment of cancer disease. Turmeric is rich in bioactive compound "Curcumin" which possess free radical scavenging, anti-inflammatory, and anti-cancer activities. Nutraceuticals may also help to reduce the toxicity, associated with cancer therapies [42].

7. Conclusion

In conclusion, nutraceuticals have additional nutrients that play vital role for promoting health, preventing disease, and managing various health conditions. Bioactive compounds, that are derived from natural sources such as plants and animals as dietary supplements, offer a wide-ranging therapeutic benefit; from anti-oxidant and anti-inflammatory effects to immune support and detoxification. Furthermore, nutraceuticals are helpful in modulating the bodily functions, support vital organs and immune system, and contribute to overall optimal health. Nutraceuticals may also offer a safer and more natural substitute to synthetic drugs with fewer side effects and a lower risk of toxicity when used in appropriate dose. Overall, nutraceuticals have potential to be used as therapeutic agents to support health and prevent from diseases.

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Author Contributions

Conceptulization, writing – original draft, U.A.; Writing – review and editing, M.; visualization,F.N and R. R.

Conflict of Interest:

The authors declared that they have no conflict of interest.

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