International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Nutraceuticals: A Comprehensive Review of the Current State and Future Directions of Food-Based Therapeutics

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Abstract: ***Nutraceuticals are the hybrid of 'nutrition' and 'pharmaceutical'. Nutraceuticals, in broad, are food or part of food playing a significant role in modifying and maintaining normal physiological function that maintains healthy human beings. The principal reasons for the growth of the nutraceutical market worldwide are the current population and health trends. The food products used as nutraceuticals can be categorized as dietary fiber, prebiotics, probiotics, polyunsaturated fatty acids, antioxidants, and other different types of herbal/ natural foods. These nutraceuticals help in combating some of the major health problems of the century such as obesity, cardiovascular diseases, cancer, osteoporosis, arthritis, diabetes, cholesterol, etc. On the whole, 'nutraceutical' has led to a new era of medicine and health, in which the food industry has become a research oriented sector.***

Keywords: Nutraceuticals, Food, Health, Nutrition, Medicine, Phytochemicals, Antioxidants

1. Introduction

The concept of nutraceuticals is rooted in the ancient wisdom of Hippocrates, who famously said, "Let food be your medicine." This phrase has been revived in modern times by Stephen DeFelice, MD, who coined the term "nutraceuticals" in 1989. Simply put, nutraceuticals are products derived from food that have an additional health benefit beyond their basic nutritional value. These multi-targeted mixtures can provide a range of health benefits, from preventing diseases to promoting social well-being. Unlike pharmaceuticals, which are designed to target specific health issues, nutraceuticals are non-specific bio-therapies that work on multiple levels.
While nutraceuticals may seem like a new idea, they are rooted in the traditional wisdom of using food as medicine. In fact, many foods have been used for centuries to treat a range of health issues, from spices to herbs to fermented foods. Today, scientists are uncovering the secrets of these ancient foods and developing new nutraceuticals that can help prevent and treat diseases.

But what exactly does it mean to say that nutraceuticals are not regulated or tested like pharmaceuticals? Simply put, it means that the FDA does not require nutraceutical manufacturers to conduct the same level of testing and quality control as pharmaceutical companies. This can be both a blessing and a curse - while it allows for innovation and flexibility, it also means that consumers must be more vigilant in their research and selection of nutraceutical products.

Despite these challenges, the field of nutraceuticals is growing rapidly, with new products and research emerging all the time. As we continue to learn more about the power of food and nutrition, we may find that nutraceuticals play a bigger role in our health and wellness journey than we ever imagined. So next time you reach for your favorite superfood or supplement, remember the ancient wisdom of Hippocrates - and the modern science behind the power of food as medicine."

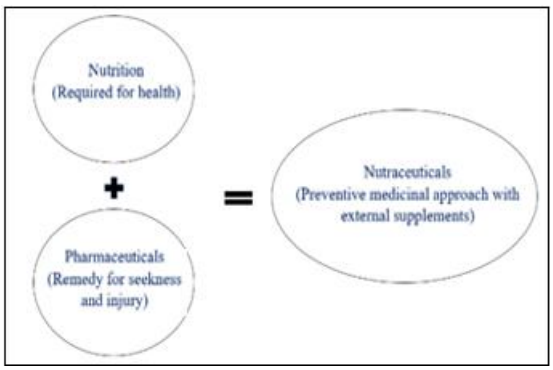

Diagram 1: General diagrammatic representation of the concept of nutraceutical terms.

Nutraceuticals and their related products are usually classified based on their origin, chemical constituents, pharmacological properties, etc. Mostly these are grouped as dietary supplements, functional food, and medicinal food. Nutraceuticals is not well accepted globally or in regulatory systems where whereas dietary supplements have shown a prominent consideration. There are over 470 nutraceutical products available in the market that are well known for various health benefits. Now, patients are shifting their interest towards nutraceuticals because they have the least

side effects and contraindications as compared to chemical drugs in the long term as well as short term therapy. So, the interest to avoid the use of chemical drugs has become to trend and eventually led to new research with alternate therapies with the help of nutraceuticals. This review is generally based on the promising therapeutic approaches of nutraceuticals as commercial remedies[1]-14]

1) Aim and objective of these review article

Aim:
To provide a comprehensive overview of the current state of nutraceuticals and their applications in promoting health and preventing diseases.

Objectives:
- To discuss the definition, classification, and characteristics of nutraceuticals.
- To highlight the various types of nutraceuticals, including their sources, production methods, and quality control measures.
- To summarize the current scientific evidence on the health benefits of nutraceuticals, including their effects on chronic diseases such as cancer, cardiovascular disease, and diabetes.
- To explore the potential mechanisms by which nutraceuticals exert their biological effects, including their antioxidant and anti-inflammatory activities.
- To discuss the regulatory aspects of nutraceuticals, including their classification as foods or drugs, and the need for standardized quality control measures.
- To identify future research directions and potential areas of application for nutraceuticals in human health.

2) History

The concept of Nutraceuticals went back three thousand years ago. Hippocrates (460-377 B.C.) Stated Let food be the medicine and medicine be the food' to predict the relationship between appropriate foods for health and their therapeutic benefits. In the early 1900s. in the United States food manufacturers started adding small quantities of iodine to salt to prevent Goiter. In Japan, England, and other countries. Nutraceuticals are already becoming part of the directory landscape, nowadays Nutraceuticals are the most rapidly growing segment of the industry & the global nutraceutical market is estimated at USD 117 billion.[2] [12]

3) Sources of Nutraceuticals

Many products endorsed to treat various disease states, whether as given medication or as supplements, find their origin in the plant kingdom. This is unsurprising because plants produce many secondary compounds, such as alkaloids, to protect themselves from infection as well as these constituents are often useful in the treatment of human disease. One example is the recently introduced Taxol, derived from toxoids of the American yew tree then now used in ovarian cancer. Similarly, the role of flavonoids besides other plant compounds as antioxidants and free-radical scavengers is beginning to have profound effects in areas of chronic inflammatory disease as well as cancer.

Crude extracts of different parts of plants are screened for pharmacological activity, often based on usage in folk medicine Once a result is found, the substances are identified by chromatography as well as purified further before in vivo testing is started, A few of these lead compounds may eventually become licensed as medicines. However, the main drawback to this process is the vast cost involved.[3]

4) Emerging Trends in Nutraceuticals

Nutraceuticals may be divided into herbal/ natural products, dietary supplements, and functional foods. Out of these, the most rapidly growing segment is herbal/ natural products followed by dietary supplements. The generation of scientific research linked foods of plant origin and health has resulted in the understanding that plant bio-active compounds have antioxidant and other health-promoting properties

High dietary intake of fibers in the form of fruits, vegetables, and whole grains is strongly linked to a reduced risk of chronic diseases like cancer and cardiovascular diseases. Cancer development is a chronic, stepwise complex process culminating into metastasis if not tackled in time. Epidemiological studies now provide convincing evidence that dietary factors may modify carcinogenesis. Several phytochemicals as well as some plant origin foods with yet unidentified components possess anti-carcinogenic and anti-mutagenic properties. Thus, the use of these bioactive compounds as chemo-preventive substances, in the future, cannot be overlooked

Similarly, flavonoids or soy products and flaxseed can decrease total and low-density lipoprotein cholesterol (LDL-C) and increase high density lipoprotein cholesterol (HDL-C) resulting in reduced risk of cardiovascular diseases (CVDs). Phytoestrogens are also reported to be beneficial in the prevention of CVDs. For CVD, important risk factors include obesity and hyperlipidemia. Hypertension and diabetes can be countered by phytochemicals. Phytochemicals help in reducing oxidative stress also which is implicated in the process of atherosclerosis. Nutraceuticals help boost the antioxidant defense system of the body.[4]

5) Nutraceutical Concept

The pharmaceutical drug development process includes various preclinical and clinical studies for the verification of the pharmacological effect of a drug moiety. On the other hand, for nutritional products, in the past, there was no such significant method for the verification of certain foods in preventing a disease However in the last decade various foods and their compositions has been reported to cause lifestyle-related diseases and hence it developed as a social issue. As a result, many nutraceutical products are developed and used to treat such lifestyle and dietary complications.[5] [14]

6) Classification of Nutraceuticals

a) Based on the chemical constituent:

Nutraceuticals under this category include substances with conventional nutritional value like amino acids, fatty acids minerals, and vitamins.[6] [14]

The table below highlights the common nutrients that are considered nutraceuticals, along with their associated healthcare benefits. These nutrients are essential for maintaining overall health and well-being, and may also

provide additional health benefits when consumed as part of a nutraceutical supplement.

Table 1: Classification of nutraceuticals based on the chemical constituents

S. No.	Nutrients	Health Benefits
1	Vitamin A	Antioxidant properties is essential for proper growth development and treatment of various skin diseases.
2	Vitamin B1	Helpful in ATP production and neurological functioning.
3	Vitamin B2	Helps in ATP production and metabolism, also necessary for healthy eyes and nerve functioning.
4	Vitamin B3	Maintain glycolysis and brain functions.
5	Vitamin B6	Production of DNA and RNA in cells, RBSs, amino acids and metabolized carbohydrates, facts, proteins are also helpful in maintaining brain functions.
6	Vitamin E	Antioxidant immune stimulants boost cell formation, lungs, muscles, and nervous tissues.
7	Vitamin K	Blood clotting
8	Calcium	Production and maintenance of bones, teeth and are important in glandular, muscle, and nerve functions.
9	Chromium	Along with insulin helpful in the metabolism of coenzymes when orally ingested.
10	Cobalt	The major component of Vitamin B12 acts as a B12 coenzyme when orally ingested.
11	Copper	An essential component of collagen and hemoglobin synthesis. ATP production, proper heart functioning, and helps in iron absorption from GIT.
12	Folic acid	Helpful in the production of genetic material in cells, and in infants during pregnancy and prevents birth defects, erythropoiesis, and shields against cardiovascular diseases.
13	Iodine	Necessary for proper thyroid functioning.
14	Iron	ATP production carries and delivers oxygen to various body parts.
15	Magnesium	Maintain healthy muscle and nervine functioning. Osteoporosis and helpful in preventing premenstrual syndrome (PMS)

7) Nutraceuticals Based on Food Availability

Traditional Nutraceuticals: These classes are generally sourced directly from nature, without any changes in the natural form. Various constituents such as lycopene in tomatoes, omega-fatty acids in salmon, or saponins in soy are available and consumed for different health benefits, Further, various types of traditional nutraceuticals are as follows:[7] [13]

Chemical Constituents:

- Nutrients
- Herbals
- Phytochemicals
- Dietary supplements
- Functional foods
- Medical foods

Probiotic microorganisms
Nutraceutical enzymes
Chemical Constituents:

1) **Nutrients:** Primary metabolites such as amino acids, various vitamins, and fatty acids have well-defined functions in various metabolic pathways. Plant and animal products along with vitamins have many health benefits and help cure diseases related to heart, kidney, lungs, etc.

Natural Products obtained from plants are beneficial in treating various disorders such as brittle bones and low hemoglobin count, and they provide strength to bones and muscles, help in neuron transmission, and maintain the rhythm of heart muscles. Fatty acids, and omega-3 PUFAs present inflammatory response and brain function and reduced cholesterol in the arteries.[7][13]

2) **Herbals:** Nutraceuticals along with herbs had an excellent impact on the prevention of various chronic diseases to make life better. Salicin present in the willow bark (Stalingrad) has been proven for anti-inflammatory, analgesic, antipyretic, astringent, and ant arthritic responses clinically. Flavonoids such as psoralen present in parsley (Petroselinumcrispum) is useful in diuretic, carminative, and antipyretic. Peppermint (Mentha piperita) contains various terpenoids especially menthol, a bioactive constituent, and cures cold and flu. Tannin contents of lavender (Lavandula angustifolia) help release stress and blood pressure and are useful for lung disorders such as asthma.[7] [13]

3) **Phytochemicals:** They are mainly classified based on phytochemicals. Carotenoids (isoprenoids) are present in vegetables, enhancing the immune system, mainly killer cells accounting for an anticancer response. Legumes (Chickpeas and soybeans).

Flavonoids, a class of secondary metabolites, that are present in most of plants having more than 4000 varieties had been proven clinically to prevent various diseases such as cancer, diabetes, heart diseases, and kidney problems through its antioxidant properties and their bioactive components.

Phenolic acids are the largest class of secondary metabolites, mainly found in citrus fruits and red wine, and have the antioxidant activity of scavenging the free radicals produced because of various metabolic pathways such as protein, carbohydrate, and fat. They also have anticancer and antitumor activity.One of the classical examples is curcumin (turmeric), used as phytochemicals in most of the kitchen[7] [13]

4) **Dietary Supplements:** Dietary Supplements are products administered through mouth that contain a dietary ingredient intended to add something to the foods you eat. A dietary supplement is a product that is intended to supplement the diet that bears or contains one or more ingredients like a vitamin, mineral, herb, amino acid or concentrate, metabolite, constituent, extract, or a combination of these. Examples of dietary supplements are black cohosh for menopausal symptoms, ginkgo biloba for memory loss, and glucosamine/chondroitin for arthritis. Supplement ingredients may contain vitamins, minerals, herbs or other botanicals, amino acids, enzymes, organ tissues, gland extracts, or other dietary

substances.[7] [13]

5) **Medical foods:** Medical foods are a specific category of therapeutic agents that are intended for the nutritional management of a specific disease. Medical foods are formulations intended to manage patients with inborn errors in amino acid metabolism. Newer medical foods are designed to manage hyperhomocysteinemia, pancreatic exocrine insufficiency, inflammatory conditions, cancer cachexia, and other diseases. An example of health bars with added medications, transgenic cows and lactoferrin for immune enhancement, and transgenic plants for oral vaccination against infectious diseases [7]-[13]

6) **Functional Foods:** When food is being cooked or prepared using "scientific intelligence" with or without the knowledge of how or why it is being used, then the food is called as "functional food." Thus, functional food provides the body with the required amount of vitamins, fats, proteins, and carbohydrates necessary for healthy survival.. When functional food aids in the prevention and/or treatment of disease disorders other than deficiency conditions like anemia it is called a nutraceutical. Nutraceuticals include fortified dairy products (milk as such is a nutrient and its product casein is a pharmaceutical) and citrus fruits (orange juice is a nutrient and its constituent ascorbic acid is a pharmaceutical.[7] [13]

Probiotic Microorganisms

Metchnikoff coined the term "probiotic." Its application is well boosted in modern medicine due to its ability to make the intestine more friendly for processes such as absorption and metabolism. Probiotics are very important to make life smoother by removing the toxic flora of the intestine and maintaining a friendly environment, for example, the useful consumption of Bacillus bulgaricus. Currently, various probiotic products are available in the market with adequate nutrients to counter various pathogens so that many ailments related to the human body can be treated.

The antimicrobial property usually has an altering impact on the microflora, making the epithelial tissues more grounded and making a situation for the supplements for better retention, which is required by the body. Moreover, probiotics are very useful in lactose intolerance by the production of related enzymes (β-galactosidase) and hydrolysing lactose into its sugar components.[7] [13]

Nutraceutical Enzymes:

Enzymes are proteinous in structure, are produced by the cell, and act as a biocatalyst. It eases the metabolic rate and fastens the life process. The medical problem mainly related to the GIT whether GERD (gastroesophageal reflux disease) or constipation diarrhoea or ulcerative colitis could be treated with enzyme supplements. The enzyme could be a better option for diabetic patients. Nowadays, enzyme therapies are used for several rare diseases such as Gaucher disease, Hunter syndrome, Fabry disease, and Pompe disease. Although enzymes are produced by their own cells, microbial sources are preferred more over plant and animal sources as they are more economical.[7] [13]

Non-traditional Nutraceuticals:

They are foods enriched with supplements or biotechnologically designed crops to boost the nutrients; for example, rice and broccoli are rich in β-carotene and vitamins, respectively. Food samples contain bioactive components which are engineered to produce products for human wellness. They are arranged as follows [8] [13]

Fortified Nutraceuticals:

These types of nutraceuticals include breeding at the agriculture level or the addition of compatible nutrients to the main ingredients such as minerals added to cereals, flour fortified with calcium, iron, and folic acid, and milk fortified with cholecalciferol commonly used for vitamin D deficiency [7]-[13]

Recombinant Nutraceuticals:

Biotechnology tools have been well applied through a fermentation process in various food materials such as cheese and bread to extract the enzyme useful for providing necessary nutrients at an optimum level.[8] [13]

7.2 Classification Based on Chemical Nature:

These types are classified depending on their primary and secondary metabolite sources such as isoprenoid derivatives, phenolic substances, fatty acids, carbohydrates, and amino acid-based substances. [13]

Table 2: Experimentally documented potential health benefits of spices

Potential health benefits	Spices observed to exert
Lowering of blood cholesterol	Garlic, Onion, Fenugreek, Turmeric/Curcumin, Red paper/ Capsaicin.
Prevention and dissolution of cholesterol gallstones protection of erythrocyte integrity in hypercholesterolemic condition Hypoglycemic potential.	Curcumin, Capsaicin, Garlic, Fenugreek, Onion, Turmeric, Cumin
Amelioration of diabetic nephropathy Antioxidant effect	Curcumin, Onion Turmeric/Curcumin, Capsaicin, Eugenol
Anti-inflammatory and anti-arthritic effect	Turmeric/Curcumin, Capsaicin, Eugenol
Anti-mutagenic effect/ Cancer preventing	Turmeric/Curcumin, garlic, Ginger/Gingero, Mustard
Digestive stimulant action	Curcumin, Capsaicin, Piperine, Ginger, Cumin, Ajowan Fennel, Coriander, Onion, Mint

7.3 Vitamin Supplements:

Vitamin B-Complex:

Specific vitamin B indicated for the daily requirement in the duty of high homocysteine level known to be the risk factor for cardiovascular diseases. Homocysteine is accrued in the blood along with protein intake, especially from meat. Vitamin B1 or thiamin deficiency is commonly seen in people who take white rice. Riboflavin-5- phosphate is the cofactor of vitamin B2 which is beneficial in people who lack the enzyme to translate vitamin B2 due to nutritional factors or

disease conditions. Niacin amide deficiency may lead to neurological and skin disorders.

Vitamin B6 is required for the glucose production, hormone modulation as well as neurotransmitter synthesis. Vitamin B12 deficiency may be checked in vegetarian people as the plants have no considerable vitamin B12. Folic acid is the B complex vitamin that helps healthy bone formation.

Vitamin C is needed for the development as well as the restoration of the tissue in all parts of our body. Collagen production needs vitamin C. Vitamin C is extremely essential for wound healing and the repair then maintains cartilage, bones, and teeth.

Vitamin C insufficiency can lead to dry and splitting hair, gingivitis, rough, dry, scaly skin, wound-healing rate, scurvy, easy bruising, nose bleeds, swollen and painful joints, anemia, etc[10]

Table 3: Vitamin Supplements

Name of vitamin	Source	Deficiency disease
Vitamin A1	Fish liver oil, liver	Night Blindness, exophthalmia,
Vitamin A2	Kidney cheese, butter	Keratomalacia
	Carrots, spinach, pumpkins, papaya	
Vitamin D	Fish liver oil, wheat germ oil, egg yolk, milk, butter	Rickets in children osteomalacia in adults
Vitamin E	Wheat germ oil , cotton seed oil, peanut oil	Sterility, degenerative changes in muscle, aging of skin
Vitamin K	Cabbage, cauliflower, tomatoes, alfalfa	Hemorrhagic condition
Vitamin B1	Cereals pulses	Beriberi
Vitamin B2	Nuts, yeast	Cheilosis, corneal opacity
Folic acid	Rice polishing yeast, egg, milk	Macrocytic anemia
Biotin (Vitamin H)	Rice polishing, egg, milk	Anemia, glossaries, Naiusia

Proteins

Soya Products: Soybean is also a foremost spring of lecithin which harvests liposomes used to express stable emulsions and finds major use in food technology. The main is flavones in soya, genistein as well as daidzein are anatomically like to estrogenic steroids and have been stated to have estrogenic as well as ant estrogenic activities. Southeast Asian population who ingest 20-80 mg of genistein per day are found to have expressively lower incidence of breast then prostate cancer. Genistein has been conveyed to be a potent as well as specific inhibitor of protein tyrosine kinase. Genistein also hinders DNA topoisomerase II activity, alters cell cycle specific events, induces apoptosis and inhibits angiogenesis which is vital for lump growth.[10]

Milk Constituent as a Nutraceutical

Milk concealments components that deliver critical nutritive elements, immunological defense as well as organically vigorous substances to neonates Milk proteins are presently the chief cause of a range of naturally active peptides concentrates as well as these peptides are potential health improving Nutraceuticals for food and pharmaceutical applications. Milk also covers some natural bio active materials. These comprise oligosaccharides, fucosylated oligosaccharides, hormones, growth factors, mucin, gangliosides as well as endogenous peptides which are present in milk at secretion. Bioactive Proteins or Peptides as Natural Ingredients of Milk.[10]

- Thyrotropin -releasing hormone (TRH)
- Luteinizing -releasing hormone (LHRH)
- Somatostatin (SIH)
- Gastrin-releasing peptide (GRP)
- Calcitonin
- Adrenocorticotropic hormone (ACTH)
- Insulin
- Growth factors
- Prolactin
- Thyroid-stimulating hormone (TSH)

Healthcare impact of Nutraceutical

a) Polyunsaturated fatty acids:

The topical usage of PUFAs in cosmetics as well as topical skin formulations is controlled due to the formation of malodorous secondary oxidation products. Research into the topical use of fish oil has exposed a statistically important development in erythema as well as scaling and marked development in plaque thickness. A fish oil concentrate has been shown to advantage patient's anguish from atopic dermatitis. Atopic eczema has been cured with evening primrose oil , due to the 9% content of g-linoleic acid (GLA). One further trial assessed skin limitations in healthy elderly people after supplementation with 360- 720 mg GLA (from borage oil) daily, over two months. Cutaneous layer function was better quality by 11% and dry skin condensed.[10]

b) Coenzyme Q10:

Ageing as well as photo ageing are related with an increase in cellular oxidation, possibly produced by declining levels of coenzyme Q10 (Co Q10). Topical solicitation of Co Q10 has been shown to lance into viable layers of the epidermis and then to reduce the level of oxidation, ensuing in a reduction in wrinkle depth. It has also been initiated to be effective against UVA-mediated oxidative stress in human kerationocytes and to prevent oxidative DNA damage.[10]

c) Melatonin:

Topical use of melatonin either single-handedly or in combination with vitamins C and E has been shown to reduce UV-induced skin erythema after topical application 30 minutes before exposure.[10]

d) Cardiovascular diseases :

The nutraceuticals used are antioxidants, dietary fibers, omega-3 fatty acids, vitamins, and minerals for the prevention and treatment of CVD. Polyphenol (in grape) prevents and controls arterial diseases. Flavonoids (in onion, vegetables, grapes, red wine, apples, and cherries) block the ACE and strengthen the tiny capillaries that carry oxygen and essential nutrients to all cells [10]

e) Obesity :

Herbal stimulants, such as ephedrine. Caffeine, ma huang-guarana, chitosan and green tea help in body weight loss. Buckwheat seed proteins acting similarly to fibres present in food. 5-hydroxytryptophan and green tea extract may promote

weight loss, while the former decreases appetite, the later increases energy expenditure. A mixture of glucomannan, chitosan, fenugreek and vitamin C in dietary supplements significantly reduced body weight [10]

f) Cancer:

Flavonoids block the enzymes that produce estrogen reducing estrogen induced cancers. Phytoestrogens is recommended to prevent prostate/breast cancer Soy foods are a source of Iso-flavones, and curcumin from curry and soya isoflavones possess cancer chemo preventive properties. Lycopene concentrates in the skin, testes, adrenal and prostate and protects against cancer. Saponins contain antitumor and antimutagenic activities Curcumin (diferuloylmethane) which is a polyphenol of turmeric possesses anti-carcinogenic, anti-oxidative, and anti-inflammatory properties. Beetroots, cucumber fruits, spinach leaves, and turmeric rhizomes were reported to possess anti-tumor activity.[10]

g) Anti-inflammatory activities :

Cucurmin which is a polyphenol of turmeric have anticarcinogenic, anti-oxidative and anti-inflammatory properties .Linoleic acid(found in green leafy vegetables, nuts vegetable oils i.e., evening primrose oil, blackcurrant seed oil, hemp seed oil, cyanobacteria and from spirulina) are used for treating problems with inflammation and auto immune diseases. Glucosamine and chondroitin sulfate are used against osteoarthritis and regulate gene expression. [10]

h) Vision improving agents :

Lutein (found in mangoes, corn, sweet potatoes, carrots, squash, tomatoes and dark leafy greens such a skale, collards and bokchoy) also known as helenine is used for the treatment of visual disorderrs. Zeaxanthin (found in corn, egg yolks and green vegetables and fruits, such as broccoli, green beans, green peas, brussel sprouts, cabbage, kale, collard greens, spinach, lettuce, kiwi and honeydew) used in traditional Chinese medicine mainly for the treatment of visual disorders[10]

i) Osteoarthritis :

Glucosamine (GLN) and chondroitin sulfate (CS) is used for the treatment of osteorathrits[10]

j) Alzheimer's disease :

β-carotene, curcumin, lutein, lycopene, and turmeric may exert positive effects on specific diseases by neutralizing the negative effects of oxidative stress mitochondrial dysfunction, and various forms of neural degeneration[10]

k) Diabetes:

Isoflavones are phytoestrogens; they have a structural as well as functional resemblance to human estrogen as well as have been expended by humans worldwide. Of all phytoestrogens, soy isoflavones have been studied the most. A high isoflavones intake (20-10 mg/day) is connected with lower incidence besides mortality rate of type II diabetes, heart disease, osteoporosis as well as certain cancers, Omega-3 fatty acids have been proposed to reduce glucose tolerance in patients predisposed to diabetes. Ethyl esters of n-3 fatty acids may be potentially beneficial in diabetic patients. Docosahexaenoic acid modulates insulin resistance and is also vital for neurovascular development. This is particularly significant in women with gestational diabetes mellitus which fosters the recommendation for essential fatty acids during pregnancy. Lipoid acid is a universal antioxidant, now used in Germany for the suggested that Nutraceuticals with meaningful doses of combinations may substantially prevent as well as presumably could be marketed for other uses.[10]

a) Immune boosters and anti-inflammatory agents
b) Immune boosters
c) Inflammatory disorders
d) Allergy
e) Degenerative diseases
f) Macular degeneration
g) Parkinson's disease

2. Conclusion

In conclusion, this review article provides a comprehensive overview of the current state of nutraceuticals, their applications, and their potential health benefits. The article highlights the diverse range of nutraceuticals, including their sources, production methods, and quality control measures, and summarizes the scientific evidence supporting their health benefits. The article also explores the potential mechanisms by which nutraceuticals exert their biological effects, including their antioxidant and anti-inflammatory activities.
Future research directions and potential areas of application for nutraceuticals include standardization of quality control measures, mechanistic studies, clinical trials, personalized nutrition approaches, fermentation technology, and nutrigenomics. Potential areas of application for nutraceuticals include cancer prevention, cardiovascular disease prevention, diabetes management, and neuroprotection. By addressing these challenges and opportunities, future research can unlock the full potential of nutraceuticals to improve public health and well-being.

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