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## Nutraceuticals classification and their health benefits: A review

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#### Abstract

The concept of nutraceutical evidence based medicines was started from a survey held in United Kingdom, Germany and France which concluded that diet is rated more highly by consumers than exercise or hereditary factors for achieving good health. Nutraceutical, a portmanteau of the words "nutrition" and "pharmaceutical", is a food or food product that reportedly provides health and medical benefits, including the prevention and treatment of disease. Nutraceutical is a term that does not easily fall into the legal category of food and drug and often inhabits a grey area between the two. Nutraceuticals may range from isolated nutrients herbal products, dietary supplements and diets to genetically engineered "designs" foods and processed products such as cereals, soups and beverages and hence also referred to as functional foods. A nutraceutical is demonstrated to have a physiological benefit or provide protection against chronic disease. Apart from disease prevention, they play an important role in disease management and therapy. Also, the growing consumer awareness regarding health care has led to the tantalizing opportunity for a "nutraceutical" break through in the pharmaceutical battleground as an alternative to modern medicine. This revolution will lead us into a new era of medicine and health, in which the food industry will become research oriented, one similar to the pharmaceutical industry. This review article focuses on the definition, history, development, classification, challenges and opportunities.

**Keywords:** Nutraceutical, dietary supplements, functional foods, diseases, developments, global market scenario

#### Introduction

The quality of life in terms of income, spending and lifestyle has improved with economic development. However, it has also thrown up a major challenge in the form of 'lifestyle diseases'. The first victim of this lifestyle change has been food habits. Consumption of junk food has increased manifold, which has led to a number of diseases related to nutritional deficiencies. Nutraceuticals can play an important role in controlling them. No wonder more and more people are turning to nutraceuticals (Pandey *et al.*, 2010) [1]. The link between food and health was established long ago. Hippocrates once said, "Let food be thy medicine and medicine be thy food." Traditional medicine in Europe, Asia, Africa and pre-Columbian America is rife with examples of foods used to prevent and cure disease. Under the influence of rationalistic Western medicine, however, food has come to be viewed chiefly as a source of nutrition (that is energy, protein and fat) to the exclusion of other purposes. Yet as changing demographics accelerate the proliferation of chronic diseases, a growing body of evidence suggests that targeted nutrition using naturally occurring substances might be able to stabilize or even cure many of the most challenging health problems.

The term "Nutraceutical" was coined by combining the terms "Nutrition" and "Pharmaceutical" in 1989 by Dr Stephen DeFelice, Chairman of the Foundation for Innovation in Medicine. "Nutraceutical" is a marketing term developed for nutritional supplement that is sold with the intent to treat or prevent disease and thus has no regulatory definition. Hence a "nutraceutical" is any substance that may be considered a food or part of a food and provides medical or health benefits, encompassing, prevention and treatment of diseases. Such products may range from isolated nutrients, dietary supplements and diets to genetically engineered "designer" foods, herbal products and processed foods such as cereals, soups and beverages.

#### Definitions to be understood

Several terms need to be defined in order to gain an understanding of nutraceuticals.  
Functional food: A functional food is similar in appearance to, or maybe, a conventional food

that is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions, i.e. they contain bioactive compound. Bioactive compounds: These are the naturally occurring chemical compounds contained in, or derived from, a plant, animal or marine source, that exert the desired health/wellness benefit (e.g. omega-3 fatty acids in flax or fish oils and betaglucans from oats and barley). Natural Health Products: Natural Health Products (NHPs) includes homeopathic preparations; substances used in traditional medicines; minerals or trace elements; vitamins; amino acid; essential fatty acids; or other botanical, or animal or microorganism derived substances. These products are generally sold in medicinal or “dosage” form to diagnose, treat, or prevent disease; restore or correct function; or to maintain or promote health. As a product group, NHPs include nutraceuticals. (Srividya *et al.*, 2010)<sup>[19]</sup>.

Nutrient: A feed constituent in a form and at a level that will help support the life of an animal. The chief classes of feed nutrients are proteins, fats, carbohydrates, minerals and vitamins. Feed: Edible materials which are consumed by animals and contribute energy and/or nutrients to the animal’s diet. Food: As defined by the Food, Drug and Cosmetic Act (1968), “an article that provides taste, aroma or nutritive value. Food and Drug Administration (FDA) considers food as ‘generally recognized as safe’ (GRAS).”

Drug: As defined by AAFCO (1996), “a substance intended for use in the diagnosis, cure, mitigation, treatment or prevention of disease in man or other animals. A substance other than food intended to affect the structure or any function of the body of man or other animals.” Dietary Supplement: As defined by the Dietary Supplement Health and Education Act (DSHEA, 1994), “A product that contains one or more of the following dietary ingredients: vitamin, mineral, herb, or other botanical, and amino acid (protein). Includes any possible component of the diet as well as concentrates, constituents, extracts or metabolites of these compounds.” Nutraceutical: As commonly defined by the dietary supplement industry, “any nontoxic food component that has scientifically proven health benefits, including disease treatment and prevention.”

### Nutraceuticals

Most commonly used nutraceuticals are compounds derived from fruits and vegetables. They are often compounds with anti-oxidant or anti-inflammatory properties which are suggested to provide protection against chronic diseases such as cardiovascular disease, diabetes, cancer and osteoporosis. Widely consumed nutraceuticals include flavonoid plant pigments such as anthocyanins from berries, flavonols from dark chocolate, polyphenols such as resveratrol from red grapes, and catechins from tea and quercetin. There is little data to suggest that these compounds are toxic. However, metabolites of EGCG – the active catechol in green tea extract, typically considered to be responsible for green tea’s antioxidant properties – are suspected to enhance oxidative stress and have been associated with liver injury. It is also far from clear that consumption of these nutraceutical supplements have true health benefits given a lack of large clinical trials (Weaver *et al.*, 2012)<sup>[21]</sup>. The most intensively studied nutraceutical flavonoids are the soy derived isoflavones genistein and daidzein, and the daidzein metabolite equol. Unlike other flavonoids, the isoflavones in their purified form have been shown to possess estrogenic

properties *in vitro* and in animal models, including the ability to produce uterine hypertrophy or reproductive tract malformations, reduce testis size, inhibit androgen production, reduce fertility, and stimulate estrogen-dependent tumor growth. Since evidence emerged demonstrating health risks following hormone replacement therapy in post-menopausal women, menopausal women have increasingly turned to use of dietary supplements to treat symptoms such as hot flashes, depression and bone loss. A recent survey indicated that as many as 42% of such women were using soy products including isoflavone extracts and purified isoflavones such as genistein (Mazzanti *et al.*, 2009)<sup>[3]</sup>. Since these are concentrated or purified products, they can achieve far higher plasma levels than when isoflavones are consumed as part of SPI or soy foods, which are complex mixtures of bioactive proteins, peptides and over one hundred phytochemicals. There have been case reports of endometriosis in women consuming isoflavone supplements and, given the clear evidence of estrogenicity, there is a likelihood of increased risk of estrogen sensitive cancers in consumers of these products.

### Weight-Loss Sports and Body building Supplements

As more and more of the world population becomes overweight and obese, there is a huge market for weight-loss products, including dietary supplements. Among military service members, athletes and bodybuilders it is also common to ingest dietary sports supplements intended to burn fat and increase performance, muscle mass or strength. As examples, 53% of active-duty US Army soldiers report using at least one dietary supplement per week, and 64% of college students participating in athletics use dietary supplements to enhance performance (Hoyte *et al.*, 2013)<sup>[4]</sup>. The supplements are often proprietary blends of several supposedly natural ingredients. They are not without risk of adverse effects. In a recent review, it is estimated that the proportion of drug-induced liver injuries that are due to dietary supplements is currently around 20%. Furthermore, bodybuilding and weight loss supplements account for almost half of these injuries (Navarro *et al.*, 2017)<sup>[5]</sup>. Among emergency department visits for adverse events related to dietary supplements in the US, around 25% were due to weight loss products. There are two classes of adverse effects that may occur. Supplements can have components according to the product description that cause certain side effects. Supplements may also be intentionally spiked with unlisted or illegal compounds, or drugs such as anabolic steroids. These are so-called adulterated supplements. Supplements containing declared compounds that have not been adequately tested for safety can also be declared adulterated by the US Food and Drug Administration (FDA). It has been argued that adulterated supplements shouldn’t be considered real dietary supplements (Brown, 2016)<sup>[6]</sup>. Yet, such supplements exist and can readily be obtained e.g. over the internet. Furthermore, they may be more likely to give real physiological effects desired by the consumer due to the pharmacological efficiency of anabolic steroids or other drugs incorporated in the supplements. Medical providers and toxicologists should be therefore be aware of symptoms elicited by these compounds.

### Classification of Nutraceuticals

The food sources used as nutraceuticals are all natural and can be categorized as

1. Dietary Fiber
2. Probiotics
3. Prebiotics
4. Polyunsaturated fatty acids
5. Antioxidant vitamin
6. Polyphenols
7. Spices (Kalia AN, 2005)<sup>[7]</sup>

### Dietary fiber

Dietary fiber (DF) consists of non-digestible carbohydrates and lignins that are intrinsic and intact in plants. Functional fiber (FF) consists of isolated, non-digestible carbohydrates that have beneficial physiological effects in humans as shown in table-1. Total fiber is the sum of dietary and functional fiber. These definitions broaden the category and allow resistant starches, oligosaccharides and other non-digestible carbohydrates to be classified as functional fibers. The adequate intake for fiber defined by the Dietary Reference Intake (DRI) is 38 grams/day for adult men and 25 grams/day for adult women. There was insufficient evidence to set a tolerable upper intake level for dietary or functional fiber.

Probiotics are live bacteria and yeasts that are good for your health, especially your digestive system. We usually think of bacteria as something that causes diseases. But your body is full of bacteria, both good and bad. Probiotics are often called "good" or "helpful" bacteria because they help keep your gut healthy. Probiotics are naturally found in your body. You can also find them in some foods and supplements.

It's only been since about the mid-1990s that people have wanted to know more about probiotics and their health benefits. Doctors often suggest them to help with digestive problems. And because of their newfound fame, you can find them in everything from yogurt to chocolate.

### Bifidobacterium

You can also find it in some dairy products. It may help ease the symptoms of irritable bowel syndrome (IBS) and some other conditions.

Probiotics help move food through your gut. Researchers are still trying to figure out which are best for certain health problems. Some common conditions they treat are:

1. Irritable bowel syndrome
2. Inflammatory bowel disease (IBD)
3. Infectious diarrhea (caused by viruses, bacteria, or parasites)
4. Antibiotic-related diarrhea

There is also some research to show they help with problems in other parts of your body. For example, some people say they have helped with:

1. Skin conditions, like eczema
2. Urinary and vaginal health
3. Preventing allergies and colds
4. Oral health

Prebiotics are substances that induce the growth or activity of microorganisms (e.g., bacteria and fungi) that contribute to the well-being of their host. The most common example is in the gastrointestinal tract, where prebiotics can alter the composition of organisms in the gut microbiome. However, in principle it is a more general term that can refer to other areas of the body as well. For example, certain hand moisturizers have been proposed to act like prebiotics to improve the

activity or composition of skin microbiota.

In diet, prebiotics are typically non-digestible, fiber compounds that pass undigested through the upper part of the gastrointestinal tract and stimulate the growth or activity of advantageous bacteria that colonize the large bowel by acting as substrate for them (Gibson GR *et al.*, 1991)<sup>[8]</sup>. As a functional food component, prebiotics, like probiotics, are conceptually intermediate between foods and drugs. Depending on the jurisdiction, they typically receive an intermediate level of regulatory scrutiny, in particular of the health claims made concerning them.

Although all prebiotics are fiber, not all fiber is prebiotic. Classification of a food ingredient as a prebiotic requires scientific demonstration that the ingredient (Jacob RA, 1995)<sup>[9]</sup>:

1. Resists gastric acidity, hydrolysis by mammalian enzymes, and absorption in the upper gastrointestinal tract;
2. Is fermented by the intestinal microflora;
3. Selectively stimulates the growth and/or activity of intestinal bacteria potentially associated with health and well-being.

### Health benefit of prebiotics

The health outcome data for prebiotic intake is substantially more limited than for dietary fiber. However, it has been suggested that prebiotic intake may:

1. Reduce the prevalence and duration of infectious and antibiotic-associated diarrhea;
2. Reduce the inflammation and symptoms associated with inflammatory bowel disease;
3. Exert protective effects to prevent colon cancer;
4. Enhance the bioavailability and uptake of minerals, including calcium, magnesium, and possibly iron;
5. Lower some risk factors for cardiovascular disease; and
6. Promote satiety and weight loss and prevent obesity.

### Polyunsaturated fatty acids

The group of poly-unsaturated fatty acids (PUFAs) is divided into two groups: omega-3 (n-3) and omega-6 (n-6) polyunsaturated fatty acids (PUFA), differing in the position where the first double C-bound is located. Two PUFAs are called essential fatty acids since they cannot be synthesized in the human body and are vital for physiological integrity. Therefore, they must be obtained from the diet. One is linoleic acid (LA) and belongs to the n-6 family. The other one is  $\alpha$ -linolenic acid (LNA) belonging to the n-3 family. These essential parent compounds can be converted in the human body to long-chain (LC) fatty acid but humans cannot interconvert n-3 and n-6 fatty acids.

### Antioxidants

Damage to cells caused by free radicals is believed to play a central role in the aging process and in disease progression. Antioxidants are our first line of defense against free radical damage, and are critical for maintaining optimum health and wellbeing. Oxygen is a highly reactive atom that is capable of becoming part of potentially damaging molecules commonly called "free radicals." Free radicals are capable of attacking the healthy cells of the body, causing them to lose their structure and function. Antioxidants are capable of stabilizing, or deactivating, free radicals before they attack cells. Antioxidants are absolutely critical for maintaining optimal

cellular and systemic health and well-being.

Humans have evolved a highly sophisticated and complex antioxidant protection system. It involves a variety of components, both endogenous and exogenous in origin, that function interactively and synergistically to neutralize free radicals.

#### These components include

- **Nutrient-derived antioxidants** like ascorbic acid (vitamin C), tocopherols and tocotrienols (vitamin E), carotenoids, and other low molecular weight compounds such as glutathione and lipoic acid.
- **Antioxidant enzymes**, such as superoxide dismutase, glutathione peroxidase, and glutathione reductase, which catalyze free radical quenching reactions.
- **Metal binding proteins**, such as ferritin, lactoferrin, albumin, and ceruloplasmin that sequester free iron and copper ions that are capable of catalyzing oxidative reactions.
- **Numerous other antioxidant phytonutrients** present in a wide variety of plant foods.

#### Additional physiological antioxidants are

##### Endogenous Antioxidants

- a. Bilirubin
- b. Thiols, e.g., glutathione, lipoic acid, N-acetyl cysteine
- c. NADPH and NADH
- d. Ubiquinone (coenzyme Q10)
- e. Uric acid
- f. Enzymes:
  - copper/zinc and manganese-dependent superoxide
  - iron-dependent catalase
  - selenium-dependent glutathione peroxidase

##### Dietary Antioxidants

- a. Vitamin C
- b. Vitamin E
- c. Beta carotene and other carotenoids and oxycarotenoids
- d. such as lycopene and lutein
- e. Polyphenols, e.g., flavonoids, flavones and flavonols
- f. Proanthocyanidins

##### Metal Binding Proteins

- a. Albumin (copper)
- b. Ceruloplasmin (copper)
- c. Metallothionein (copper)
- d. Ferritin (iron)
- e. Myoglobin (iron)
- f. Transferrin (iron)

Polyphenols are natural phytochemical compounds in plant-based foods, such as fruits, vegetables, whole grains, cereal, legumes, tea, coffee, wine and cocoa; more than 8000 polyphenolic compounds, including phenolic acids, flavonoids (Ndiaye M *et al.*, 2008) [10], tilbenes, lignans and polymeric lignans have been identified in whole plant foods. These compounds are secondary metabolites of the plants that act as a defense against ultraviolet radiation, oxidants and pathogens (Wang L *et al.*, 2010) [11]. Polyphenols may be classified into several categories based on the number of phenol rings and structural elements that bind these rings to one another (Moreno T *et al.*, 2010). Phenolic acids are approximately a third of the polyphenolic compounds in the

diet and include two main classes-

- a. hydroxybenzoic acid derivatives (protocatechuic acid, gallic acid, *p*-hydroxybenzoic acid) and
- b. Hydroxycinnamic acid derivatives (caffeic acid, chlorogenic acid, coumaric acid, Ferulic acid, sinapic acid); berry fruits, kiwi, cherry, apple, pear, chicory and coffee are the foods with high content of these phenolic acids.

There are six subclasses of flavonoids including anthocyanins, flavonols, flavanols, flavanones, flavones and isoflavones; anthocyanins (cyanidin, pelargonidin, delphinidin, malvidin) are found in the berries family, red wine, red cabbage, cherry, black grape and strawberry (Ndiaye M *et al.*, 2004, Wang L *et al.*, 2010) [10, 11].

Spices have been virtually indispensable in the culinary art of flavoring foods since antiquity. Spices are aromatic vegetable substances, in the whole, broken or ground form, whose significant function in food is seasoning rather than nutrition. These spice ingredients impart characteristic flavor, aroma and pungency to foods. Volatile oil spices responsible for aroma, flavor and oleoresin contribute the pungency.

#### Nutraceuticals and Diseases

##### Cardiovascular diseases

Anti-oxidants, Dietary fibres, Omega-3 poly-unsaturated fatty acids, Vitamins, minerals for prevention and treatment of CVD. Polyphenol(in grape) prevent and control 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. Rice bran lowers the serum cholesterol levels in the blood, lowers the level of (LDL) and increases the level (HDL) in cardiovascular health. Higher the ratio more will be the risk of coronary heart diseases. Rice bran contains both Lutein and Zeaxanthin, which improves eyesight and reduces the chance of cataracts. The essential fatty acids, omega-3, omega-6, omega-9 and folic acid in rice bran are also promoting eye health. It is reported that low intake of fruits and vegetables is associated with a high mortality in CVD (Temple WJ *et al.*, 2003; Vyas LK *et al.*, 2010) [13].

##### Diet related diseases

In Western societies, the incidence of diet-related diseases is progressively increasing due to greater availability of hyper caloric food and a sedentary lifestyle. Obesity, diabetes, atherosclerosis, and neurodegeneration are major diet-related pathologies that share a common pathogenic denominator of low-grade inflammation. Functional foods and nutraceuticals may represent a novel therapeutic approach to prevent or attenuate diet-related disease in view of their ability to exert anti-inflammatory responses. In particular, activation of intestinal T regulatory cells and homeostatic regulation of the gut microbiota have the potential to reduce low-grade inflammation in diet-related diseases.

##### Heart attack and lung cancer

Corn's contribution to heart health lies not just in its fiber, but in the significant amounts of folate that corn supplies. Corn maintains the homocysteine, an intermediate product is an important metabolic process called the methylation cycle. Homocysteine is directly responsible for damage of blood vessel heart attack, stroke, or peripheral vascular disease. It

has been estimated that consumption of 100% of the daily value (DV) of folate would, by itself, reduce the number of heart attacks suffered by 10%. Corn also contains cryptoxanthin, a natural carotenoid pigment. It has been found that cryptoxanthin can reduce the risk of lung cancer of 27% on daily consumption.

### Diabetes

Ethyl esters of n-3 fatty acids may be beneficial in diabetic patients. Docosahexaenoic acid modulates insulin resistance and is also vital for neurovisual development. Lipoic acid, an antioxidant, for treatment of diabetic neuropathy. Dietary fibers from psyllium have been used for glucose control in diabetic patients and to reduce lipid levels in hyperlipidemia.

### Obesity

Obesity is a global public health problem and is defined as accumulation of unhealthy amount of body fat. It is a well-established risk factor for many disorders like angina pectoris, congestive heart failure (CHF), hypertension, hyperlipidemia, respiratory disorders, renal vein thrombosis, osteoarthritis, cancer and reduced fertility (Cateron ID *et al.*, 2002) [15].

### Cancer

Flavonoids which block the enzymes that produce estrogen reduce the estrogen-induced cancers. Prevent prostate/breast cancer a broad range of phyto-pharmaceuticals with a claimed hormonal activity, called "phytoestrogens" is recommended. Soyfoods source of isoflavones, curcumin from curry and soya isoflavones possess cancer chemopreventive properties. Lycopene concentrates in the skin, testes, adrenal and prostate where it protects against cancer.

### Anti-inflammatory activities

Curcumin (diferuloylmethane) which is a polyphenol of turmeric possesses anticarcinogenic, antioxidative and anti-inflammatory properties. Top of Form Beet roots, cucumber fruits, spinach leaves, and turmeric rhizomes, were reported to possess anti-tumor activity. Gamma linolenic acid (found in green leafy vegetables, nuts, vegetable oils i.e. evening primrose oil, blackcurrant seed oil and hemp seed oil, and from spirulina, cyanobacteria) are used for treating problems with inflammation and auto-immune diseases. Glucosamine and chondroitin sulfate are used against osteoarthritis and regulate gene expression and synthesis of PGE2. Cat's claw

acts as a potent anti-inflammatory agent. The two known species of cat's claw are *Uncaria guianensis*, used traditionally for wound healing; and *Uncaria tomentosa*, which has numerous medicinal uses & is most commonly found in supplements. Cat's claw is a rich source of phytochemicals 17 alkaloids, glycosides, tannins flavonoids, sterol fractions and other compounds (Balch SA *et al.*, 2003) [16].

### Alzheimer's disease

$\beta$ -carotene, curcumin, lutein, lycopene and turmerin may exert positive effects on specific diseases by neutralizing the negative effects oxidative stress mitochondrial dysfunction, and various forms of neural degeneration.

### Parkinson's disease

Vitamin E in food may be protective against Parkinson's disease. Canadian researchers indicated that vitamin E in food may be protective against Parkinson's disease. Creatine appeared to modify Parkinson's disease features as measured by a decline in the clinical signs (Brower V, 2005) [17]. Nutritional supplements have shown some promising results in preliminary studies, it is important to remember that there is not sufficient scientific data to recommend them for Parkinson's disease at present. The patients should be cautioned that over-the-counter medications do have side effects and interactions with other drugs and are also expensive.

### Osteoarthritis

Osteoarthritis (OA), a debilitating joint disorder, is the most common form of arthritis in the United States, where it affects an estimated 21 million people. In 2004, the direct and indirect health care costs associated with all forms of arthritis were approximately 86 billion dollars. Joint discomfort from OA and other joint disorders may reduce physical activity in individuals experiencing this condition, resulting in energy imbalance and weight gain. Increased weight can exacerbate existing problems, through additional stress on joints (Kallio *et al.*, 2006). Glucosamine (GLN) and chondroitin sulfate (CS) are widely used to alleviate symptoms of OA. These nutraceuticals have both nutrient and pharmaceutical properties and seem to regulate gene expression and synthesis of NO and PGE2, providing a plausible explanation for their anti-inflammatory activities.

**Table 1:** Physiological properties of dietary fibers and proposed health benefits

Physiological property	Proposed effect	Health benefits
Soluble dietary fiber	Delays gastric emptying and prolonging intestinal phase	Contribute to safety.
	Prevent or delays nutrients uptake in small intestine	Lower blood cholesterol level.
	Prevent the reabsorption of bile acid	Prevents breast cancer.
	Prevent the digestive enzymes from reaching lipid substrates, inhibits enzyme activity	Lowers glucose, insulin and lipid level after meal.
Interaction/binding	Binding to bile acids	Lower blood cholesterol level.
	Interaction with digestive enzymes	Lowers glucose, insulin and lipid level after meal.
Fermentation	Growth of health promoting bacteria	Protect against inflammation and colorectal cancer.
	Production of short chain fatty acids	Lowers blood cholesterol level and protect against cancer.
Insoluble dietary fiber	Increase stool weight	Reduce the incidence of colorectal cancer and intestinal diseases.
	Accelerate transit time	Reduce time for nutrients to absorb, lowers glucose, insulin and lipid level.

**Table 2:** Common nutrients and their associated health benefits

Nutrients	Health benefits
Fat Soluble Vitamins Vitamin A	Antioxidant, essential, for growth and development, maintains healthy vision, skin and mucous membranes, may aid in the prevention and treatment of certain cancers and in the treatment of certain skin disorders
Vitamin D	Essential for formation of bones and teeth, helps the body absorb and use calcium
Vitamin E	Antioxidant, helps form blood cells, muscles, lung and nerve tissue, boosts the immune system
Vitamin K	Essential for blood clotting
Water Soluble Vitamins	Antioxidant, necessary for healthy bones, gums, teeth and skin, helps in wound healing,
Vitamin C	May prevent common cold and attenuate its symptoms
Vitamin B1	Helps to convert food in to energy, essential in neurologic functions
Vitamin B2	Helps in energy production and other chemical processes in the body, helps maintain healthy eyes, skin and nerve function
Vitamin B3	Helps to convert food in to energy and maintain proper brain function
Vitamin B6	Helps to produce essential proteins and convert protein in to energy
Vitamin B12	Helps to produce the genetic material of cells, helps with formation of red blood cells, maintenance of central nervous system and synthesize amino acids and is involved in metabolism of fats, protein and carbohydrates
Folic acid	Necessary to produce the genetic materials of cells, essential in first three months of pregnancy for preventing birth defects, helps in red blood cell formation, protects against heart disease
Pantothenic acid	Aids in synthesis of cholesterol, steroids and fatty acids, crucial for intra-neuronal synthesis of acetylcholine
Minerals calcium	Essential for building bones and teeth and maintaining bone strength, important in nerve, muscle and glandular functions
Iron	Helps in energy production, helps to carry and transfer oxygen to tissues
Magnesium	Essential for healthy nerve and muscle function and bone formation, may help prevent premenstrual syndrome (PMS)
Phosphorous	Essential for building strong bones and teeth, helps in formation of genetic material, energy production and storage
Trace elements Chromium	With insulin helps to convert carbohydrates and fats into energy
Cobalt	Essential component of vitamin B12, but ingested cobalt is metabolized <i>in vivo</i> to form the B12coenzymes
Copper	Essential for hemoglobin and collagen production, healthy functioning of the heart, energy production, absorption of iron from digestive tract
Iodine	Essential for proper functioning of the thyroid
Selenium	Antioxidant, essential for healthy functioning of the heart muscle
Zinc	Essential for cell reproduction, normal growth and development in children, wound healing, production of sperm and testosterone
Vitamin like compounds Biotin	Required for various metabolic functions
L- Carnitine	Oxidation of fatty acids, promotion of certain organic acid excretion and enhancement of the rate of oxidative phosphorylation
Choline	Lipotropic agent used to treat fatty liver and disturbed fat metabolism
Vitamin F	Involved in proper development of various membranes and synthesis of prostaglandins, leukotrienes and various hydroxyfatty acids
Inositol	Lipotropic agent necessary for amino acid transport and movement of potassium and sodium
Taurine	Aids in retinal photoreceptor activity, bile acid conjugation, white blood cell antioxidant activity, CNS neuromodulation, platelet aggregation, cardiac contractility, sperm motility, growth and insulin activity

## Conclusion

Nutraceuticals has proven their health benefits and disease prevention capability, which should be taken according to their acceptable recommended intake. In the present scenario of self-medication nutraceuticals play major role in therapeutic development. But their success depends on maintaining on their quality, purity, safety and efficacy.

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