

# Nutraceuticals as Functional Foods

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**Abstract:** Nutraceuticals are considered to be fortified or enriched foods providing all the essential nutrients required for maintaining the optimal health. A numerous studies have suggested the potential association of nutraceuticals with diet and health. This article gives a brief review on the classification of nutraceuticals on the basis of the availability of the nutraceutical from the natural sources which is further being processed and proving its medical health benefits in the market. The review also summarizes about the functional nutraceuticals acting as dietary supplements, suggested to have the capacity to significantly contribute to the modulation of the complex mechanisms of disease pathology with a view being that they may be essential in optimizing *in vivo* defences and help in maintaining wellness. Nonetheless, several more clinical and biological studies are needed to support guidelines for the intake of nutraceutical for the prevention and treatment in specific diseases and its medical benefits.

**Keywords:** Nutraceutical, Functional foods, Disease, Fortified foods, Health benefits.

## INTRODUCTION

The word nutraceutical was coined by the Foundation for Innovation in Medicine (New York, US). As the name implies, nutraceutical are the product used parallel, in the same manner as pharmaceutical is being used. Nutraceutical can be defined as any substance that may be considered a food or part of food and provides medical or health benefit including the prevention and treatment of disease. The foundation elaborated the growing field of biomedical research mainly focussed on isolation of nutrients/bioactive compounds from the natural products, genetically modification of dietary supplements/ diets, processed foods (such as soups, beverages) and herbal products [1]. In the food industry the major progressive segment is nutraceutical due to the advanced food technologies merged with peculiar properties of nutrients leads to the creation of fortified nutritive products [2]. So, in the recent years these products have drawn great attention due to its high potential that have been proven to help prevent or cure diseases [3]. As increasing, consumer health care has been centre of attraction for which various extensive researches have been directed towards the clinics and studies on nutrients and genomics, to meet the consumer needs [1]. So these nutraceutical aimed primarily maintaining health as according to the U.S. Food and Drug Administration (FDA) defines as "formulated to be consumed or administered enterally under the supervision of a physician and which is intended for the specific dietary management of a

disease or condition for which distinctive nutritional requirements, on the basis of recognized scientific principles, are established by medical evaluation" [4].

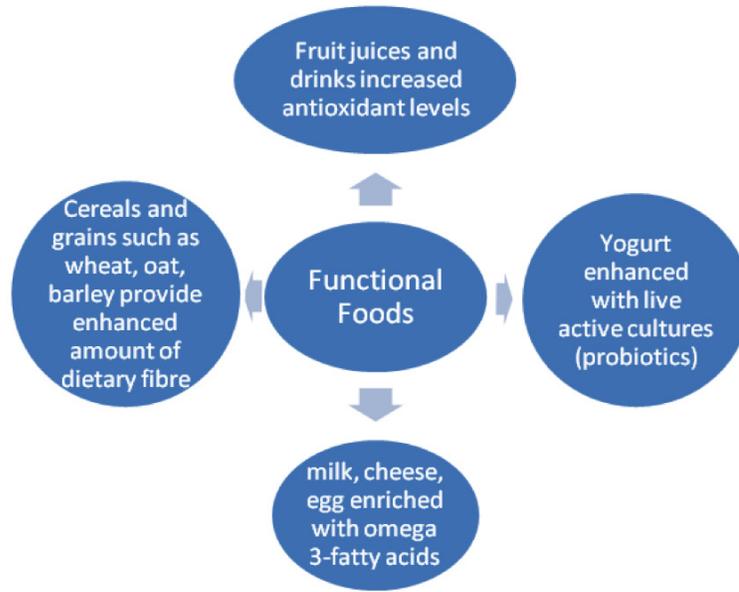
However, nutraceuticals or pharmaconutrient are exactly not drugs, but surely they can be referred as nutrient or dietary supplement which defends, supports, and normalizes physiologic or metabolic function, also having the ability to increase the effect, antagonize, or otherwise modify physiologic or metabolic functions. Nutraceutical may comprise of single natural nutrient in the form of tablet or powder, essentially not a complete food neither a drug [5].

## FUNCTIONAL FOODS

Functional foods denotes to a new and challenging concept which is slightly different from the nutraceutical so these can be regarded as food products or ingredient, consumed as a part of usual diet providing the beneficial effects beyond the basic nutrients that traditionally it contains are called as functional foods [6]. Such as nuts, garlic, green tea.

Functional foods provide carbohydrates, proteins, fat and vitamins to the body in required amount for healthy survival of the body. When functional food contributes in the prevention and treatment of disease then it is referred to as nutraceuticals [7]. Otherwise the difference between the functional food and nutraceutical is not exactly clear but the main difference is the form in which they are consumed that is the nutraceutical are ingested in the form of tablet, capsules or pills while functional foods are ingested as "ordinary foods". When phytochemical is added to the food formulation then they are considered as functional foods and when phytochemical is included in the

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**Figure 1:** Some examples of functional food products exerting the biological activities.

capsule or any dosage forms then they are established as nutraceutical [8].

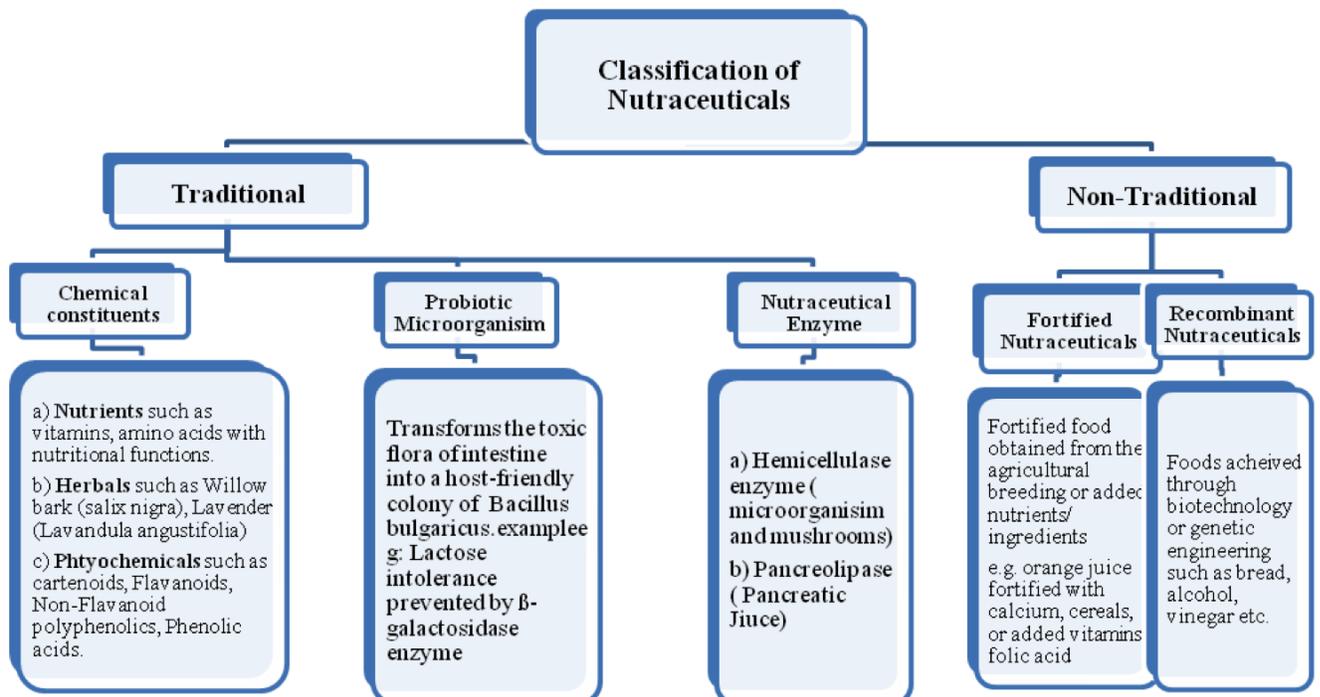
Few examples of functional foods are represented in Figure 1.

**CLASSIFICATION OF NUTRACEUTICALS**

There is large number of compounds; therefore it is difficult to classify all types of nutraceuticals. Hence, an approach is made for classification of nutraceuticals on

the basis of nutraceuticals available in the market as shown on Figure 2 [9, 10].

Plant-derived foods have the capacity to reduce the risk of chronic diseases. Since the phytochemical present, found to have low potency as compared to the pharmaceutical drugs but when ingested regularly they are expected to exert some favourable influences on the pathophysiological function of the body [8]. There are some examples of bioactive compounds present in



**Figure 2:** Tabular representation of classification of nutraceuticals.

**Table 1: Bioactive Compound Based Nutraceuticals Possessing Health Benefits**

S. No.	Nutraceutical	Natural sources	Health benefits	References
1.	Glycerolipids	Seed oils	Skin-care	[11]
2.	Milk-lipids (triglycerides, saturated fatty acids)	Milk	Anti-inflammatory, immunosuppressive	[12]
3.	Squalene	Vegetable oils	Lowering cholesterol and anti-cancer activity	[13]
4.	Sterols	Italian walnut	Lowering cholesterol, decrease the risk of coronary heart- disease	[14]
5.	Gangliosides	Dairy products (Milk)	Protect against pathogens and prebiotic activity	[15]
6.	Selenopeptides	Nuts	Anti-oxidant, anti-cancer, heart disease	[16]
7.	Peptides	Fishes	Anti-coagulant, antihypertensive, anti-oxidant	[17]
8.	Amino acids	Sprouts, sports drinks	Effects on nervous sytem, anti-oxidant, muscle energy	[18]
9.	Milk proteins, peptides	Milk derived products	Immuno stimulating, anti-hypertensive, antimicrobial	[15]
10.	Cyclopeptides	Cow-cockle seed	Estrogen activity <i>in-vivo</i>	[19]
11.	Vitamin B1 and Vitamin B2	Mushrooms	Anti-oxidant	[20]
12.	Tocopherols(Vitamin E)	Vegetable and vegetable oils	Anti-tumor, anti-oxidant, treatment of cardiovascular diseases	[21,22]
13.	Vitamin U (S-methyl-L-methionine)	<i>Centella asiatica</i>	Wound Healing	[23]
14.	Vitamin C (L-ascorbic acid)	Fruits	Anti-oxidant	[24]
15.	Glycosides (glycyrrhetic acid, Glycyrrzhin)	Plants	Diuretic, anti-cancer, anti-oxidant properties	[25]
16.	Saponins	Vegetables	Increase testosterone levels, and stimulate muscle growth and Anti-diabetic or anti-obesity effects,	[26]
17.	Galactooligosaccharides	Dairy-based prebiotic	Improved elimination of toxic compounds and increased absorption of calcium and magnesium	[27]
18.	Flavonoids	Citrus Peel	Anti-cancer, anti-inflammatory	[28]
19.	Phenolics	Pepper	Anti-oxidant	[29]
20.	Phenolics	<i>Vanilla plantfolia</i>	Anti-oxidant	[30]
21.	Catechins	Green tea	Anti-oxidant	[31]
22.	Flavonoids and Phenolic acids	Chinese Herbal tea	Anti-oxidant	[32]
23.	Lignans	<i>Myristica fragrans</i> (nutmeg)	Anti-cancer	[33]
24.	Catecholamines	Banana Peel	Anti-oxidant	[34]
25.	Anthocyanins	Fruit and tubers	Anti-oxidant	[35]
26.	Curcuminoids	<i>Curcuma longa</i>	Anti-oxidant	[36]
27.	Rutin	Buckwheat	Anti-oxidant	[18]
28.	Capsaicinoids	Pepper	Anti-inflammatory, anti-tumour, anti-oxidant	[37]
29.	Sulforaphane	Crucifer vegetables	Anti-cancer	[38]
30.	Monacolins	Rice	Decreasing cholesterol level, anti-carcinogenic	[39]

the natural matrices such as lipids, proteins, vitamins, glycosides etc. exerting possible health benefits are utilized as nutraceuticals as shown in Table 1.

## NUTRACEUTICALS AND DISEASES

Many of the natural bioactive compounds showed their beneficial properties [40] meanwhile the researchers also manifested that nutraceuticals found to have possible health benefits and utilized in treatment of several diseases such as diabetes, bone diseases, cancer [41]. Here are some nutraceuticals summarized below showing its benefits against diseases.

### a. Cancer

From the extensive research revealed that chronic inflammation or diseases can be suppress by the use of nutraceuticals metabolites derived from fruits, vegetables, vitamins, spices, legumes etc. which have proven successfully in regulating tumour metabolism and growth. Vitamins also play a major role in cancer prevention and treatment by DNA methylation and DNA synthesis. However, due to low bioavailability *in-vivo* limits its use in treatment of cancer but by the use of nanotechnology several nutraceuticals such as catechins, curcumin, polyphenol green tea, quercetin can be manifested in nanoprevention and nanochemotherapy resulting in enhanced bioavailability of the administered nutraceuticals [42]. For eg. Ursolic acid is poorly water soluble natural product, thus its bioavailability and stability is enhanced by administering in the form of ursolic acid phospholipid nanopowders [43].

### b. Dry Eye Disease

Major cause of dry eye disease is hyperlipidemia and a diet low in omega-3 fatty acids. The studies have profound that oral supplementation with antioxidants, omega-3 (e.g. fish oil and linseed oil) and omega-6 (e.g. evening primrose oil) fatty acids with lesser benefit. However, clinical trials looked upon the effectiveness of nutritional supplementation with omega fatty acids and antioxidants alone or in combination and omega-lipid-based dietary nutraceutical reported better comfort in dry eye disease and had improved tear volume and tear clearance [44].

### c. Diabetes

Researchers have also focussed on the potential effects of the citrus fruits in the context of beneficial

management of diabetes. Citrus fruits not only provide vitamins, pectins, minerals and dietary fibres rather they also constitute active phytochemicals such as phenolic acids, flavanoids, flavanones, flavanol etc. they have been widely used in the improvement of health due to its biological properties such as anti-oxidant, anti-inflammatory, inhibition of blood clots. Thus, unlike citrus fruits many other nutraceuticals [45] such as phenolic acids, flavonoids, stilbenes, lignans and polymeric lignans have potential efficacies in preventing and alleviation of metabolic disorder and complications induced by diabetes [46]. Thus, offering various unique opportunities in the risk management of diabetes [45].

### d. Cardiovascular Diseases

Nutraceutical potential of flavanoids for the management of cardiovascular disease. As flavanoids demonstrates, in stimulating antioxidant activity due to presence of polyphenolic compounds, possessing health benefits. Flavanoids are considered to be cardioprotectors against antitumor agent because of high ability to transfer electrons, chelate ferrous ions, and scavenge reactive oxygen species. Thus, flavanoids show its full propensity in prevention and treatment of cardiotoxicity caused by the antitumor agent [47].

### e. Oral Health

Oral infection such as dental caries, teeth loss, periodontal diseases etc. can greatly affect the human health. Dental caries may be caused due to the various infections related to the numerous reasons such as bacterial infections, nutritional deficiencies. There are many growing evidence that the use of green tea and its polyphenol plays a beneficial role in oral health [48]. It is suggested that intake of green tea defend healthy cells from transformation into malignant cells, additionally it also abolish halitosis through modification of odorant sulphur components. Nonetheless, consumption of green tea can be useful in prevention and treatment of oral pathologies [49].

### f. Bone Health

Osteoarthritis is a degenerative disorder with little or less curative treatment. Nutritive approach has proven to be useful in maintenance and joint integrity and or health. Many researchers found that oral joint supplements work as anti-inflammatory agent acting as building block for the formation and maintenance of

**Table 2: Commercially Available Nutritional Products [54, 55, 56, 57]**

S. No.	Product	Source	Category	Ingredient	Benefit	Manufacturer
1.	Glucon-D	Fortified glucose	Energy supplement	Glucose	Provide instant energy & rejuvenation	Heinz
2.	Glucose-D	Fortified glucose	Energy supplement	Dextrose monohydrate, Calcium phosphates, Vitamin D	Provide instant energy & rejuvenation	Dabur
3.	Proteinex	-	Protein and nutritional supplement	Essential vitamins, minerals, protein hydrolysate, sugar, malt extract	Supports healthy physical and mental growth	Pfizer Ltd.
4.	GRD	-	nutritional supplement	Vitamins, carbohydrate, protein	Helps in faster tissue growth and repair	Zydus
5.	B-Protein	-	nutritional supplement	Protein, soy, whey and casein, essential vitamins and minerals	nutritional supplement as well as aid in the formation of haemoglobin	British Biologicals
6.	Tropicana	Vitamin C	Energy drinks	B-vitamin, thiamine, folate	Nutrient rich juice and good source for heart health	Tropicana products, Inc.
7.	Frooti	mango	Energy drinks	Water, mango pulp, sugar, anti-oxidant	Refreshing juice	Parle Agro. Pvt. Ltd.
8.	Abcor	-	Heart supplement	-	Lowers cholesterol	Nutri Pharma
9.	Cod liver oil	Fish	Vitamin and mineral supplement	Omega 3 fatty acids, vitamin A, D	Improves Immunity	Sanofi
10.	Fish oil plus	Salmon	Brain supplement	Omega 3 fatty acids	reduce risk of heart disease, maintains healthy cholesterol and blood pressure	Pacific Health Inc.
11.	Calcium plus milk	Fortified milk	Energy supplement	Carbohydrate, vitamin D, calcium	Lower risk of osteoporosis	Shamrock Farms
12.	Cognisure	Protein-rich polypeptide complex	Protein supplement	Proline-Rich Polypeptide Complex (from colostrum), Fructose, sorbitol	Supports healthy aging of brain for alzheimer's disease	Metagenics Inc.
13.	Phenorex	Orange	Health supplement	Carnipure, falcate extract, Caffeine, Advantra Z citrus aurantium extract	Burn fat	Gaspari Nutrition
14.	Vectomega	Salmon	Dietary supplement	Omega 3 fatty acids	Enhance the absorption of omega-3	Europharma
15.	Collagen enhance chews	Red wine from grapes	Youth activating supplement	Anti-oxidants, hyaluronic acid	Age-defying properties	Res Vitale
16.	Pediasure	Natural supplement	Nutritional supplement	Protein, vitamins	Help the kids to grow	Abott Nutrition
17.	Revital	-	Daily health supplement	Ginseng, vitamin and mineral	Fight fatigue and keep you energetic, improve health and immunity	Ranbaxy

(Table 2). Continued.

S. No.	Product	Source	Category	Ingredient	Benefit	Manufacturer
18.	Threptin diskettes	-	Protein supplement	Protein and vitamin B	offering the right amount of nutrients, especially Protein to the growing child	Raptakos, Brett&Co. ltd
19.	Proplus	-	Immune supplement	Mushroom, polysacchride and folic acid	Provides powerful immune system	Native remedies
20.	Weight smart	-	Nutritional supplement	Vitamin and trace elements	maintain a healthy metabolism and Aid proper muscle function	Bayer Corporation
21.	Rox	-	Energy drink	Taurine, caffeine and glucuronolactone	Provides energy	Rox America, Spartanburg
22.	Snapple-a-day	-	Meal replacement beverages	Vitamins and minerals	Satisfies hunger, promote health	Snapple Beverages Groups

normal joint cartilage. It has been established that oral joint supplements contains chondroitin sulphate and/or glucosamine. From the experimental evidence, witnessed that nutraceuticals are capable of promoting or improving cartilage health, when it reaches to the joint through the blood stream demonstrating effective improvement and management in the osteoarthritis/joint health [50].

#### g. Obesity

Obesity is deposition of unhealthy amount of body fat associated with various risk factors such as hypertension, diabetes, reduced fertility etc. The major cause of obesity is increased consumption of energy rich foods [51]. Thus, many health practioners are seeking help for nutraceutical interventions on the large basis as potential treatments for obesity and weight management. Nutraceutical like glucomannan, chitosan, fenugreek, G sylvestre, and vitamin C have significantly reduced fat and body-weight in obese individuals and thus, possessing potential anti-obese properties [52].

#### h. Migraine

Clinically few recommended nutraceuticals utilized in attacks of migraine such as feverfew, Petasites, Coenzyme Q10 etc. In this feverfew (*Tanacetum parthenium*) is a species of dried chrysanthemum leaves, majorly constitute melatonin and an essential oil, chrysanthenyl acetate. These constituents reported significantly in preventing attacks of migraine.

Regardless of lack of evidence, the European Scientific Cooperative on Phytotherapy (ESCOP) also recommends the use of feverfew in prophylaxis of migraine. Additionally, *Petasites hybridus*, known commonly as butterbur also found to be safe and effective for long-term use in management of migraine [53].

#### Some Marketed Products Available as Nutraceuticals

Many pharmaceutical companies are attempting to manufacture nutraceuticals in therapeutic areas. Some of the commercially available nutraceuticals are discussed in Table 2.

#### CURRENT AND FUTURE DEVELOPMENT

Nutraceutical presents one of the most exciting areas for health innovation, offering inexpensive, safe and effective results for the today's most challenging health problem. Full potential of the functional foods will not be achieved until unless further extensive research is made to ensure safety and efficacy of these products. The main focus for the research is required to meet the scientific standards for efficacy, which is substantial investment. Scientific literature reports daily insights onto the role of existing nutrients, advances on the bioactive compounds and their health benefits. In addition, continued basic and applied nutritional research must pursue a more precise understanding of the mechanisms of action for known nutrients. However, individual, industry, health professional, governments need to adapt new resolution to achieve its full potential.

## CONCLUSION

Nutraceutical are the bioactive compounds providing the essential beneficial effects beyond the basic nutrition. These are mainly isolated from the nutrients, genetically engineered foods or processed foods. Moreover, these are less expensive, easier to develop and distribute. Nutraceuticals are offering attractiveness not only to the food companies but also to the both pharmaceutical and biotechnology firms. Here, we have gathered several studies highlighting the effectiveness of nutraceutical in management of various diseases such as cancer, diabetes, dry eye disease or prevention and treatment related to the joint health. There are some pharmaceutical companies such as Ranbaxy, Abbott healthcare groups providing wide range of nutraceutical utilized in variety of effects. Further, investigation is needed regarding the safety and efficacy of the nutraceuticals. However, there is needed a big battle to won by the pharmaceutical companies as whole, concentrating on nutrition as core component both by the consumers as well as health professionals for prevention and treatment of disease and live longer and healthier lives.

## CONFLICT OF INTEREST

It is hereby declared that the authors do not have any conflict of interest.

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