

NUTRACEUTICAL AS FUNCTIONAL FOODS**Kirti Rani*¹, Nayyar Parvez¹ and Pramod Kumar Sharma¹**

Department of Pharmacy, School of Medical and Allied Sciences, Galgotias University, Plot No. 2, Sector 17-A, Yamuna Expressway, Gautam Buddh Nagar, Greater Noida, Uttar Pradesh 201306, India.

Article Received on
05 May 2016,

Revised on 25 May 2016,
Accepted on 15 June 2016

DOI: 10.20959/wjpr20167-6540

Corresponding Author*Kirti Rani**

Department of Pharmacy,
School of Medical and
Allied Sciences, Galgotias
University, Plot No. 2,
Sector 17-A, Yamuna
Expressway, Gautam Buddh
Nagar, Greater Noida, Uttar
Pradesh 201306, India.

ABSTRACT

Nutraceuticals are a diverse product category with various synonyms used internationally. Nutraceutical is recognized as a linguistic combination of “nutrient” and “pharmaceutical” and is accepted as *“Any substance that may be considered a food or part of a food and provides medical or health benefits, including the prevention and treatment of disease.”* Nutraceuticals have received considerable interest because of their presumed safety and potential nutritional and therapeutic effects. By using nutraceuticals, it may be possible to reduce or eliminate the need for conventional medications, reducing the chances of any adverse effect. Nutraceuticals often possess unique chemical actions that are unavailable in pharmaceuticals. Nutrients, herbals and dietary supplements are major constituents of nutraceutical which make them instrumental in maintaining health, act against

various disease conditions and thus promote the quality of life. Nutraceuticals are a diverse product category with various synonyms that are used internationally. Nutraceuticals create an open environment for new products that promise novel solutions to health-related issues. Nutraceuticals will play important role in future therapeutic developments. This current review article is to examine the impact of Nutraceuticals as an alternative treatment for different types of disease. In these scenario natural products (nutraceutical) play vital role which is plant based. The term of Nutraceuticals was coined by Dr. Stephen Defelice in 1989. This article briefly discusses about the basic information about the nutraceutical and its importance.

KEYWORDS: Nutraceuticals, Functional foods, Used in the treatment of different diseases.

INTRODUCTION

The term “nutraceutical” combines the word “nutrient” (a nourishing food or food component) with “pharmaceutical” (a medical drug). Nutraceuticals may contain substances that are “natural” expressed intent of treatment or prevention of disease but may not be generally recognized as safe.^[1] The role of dietary active compounds in human nutrition is one of the most important areas of investigation with the findings having wide-ranging implications for consumers, health care providers, regulators, food producers, processors and distributors.^[2,3]

Thus, the concept of ‘adequate nutrition’ is beginning to be replaced by ‘optimal nutrition’ with consumer belief increasing at an unprecedented pace.^[4,5] Scientists and food manufacturers have coined several terms to describe these physiologically active components and health benefits of these foods. None have clear and generally accepted definitions.^[6,7]

Nutraceuticals are a diverse product category with various synonyms used internationally. The term “nutraceutical” was coined by Stephen DeFelice, founder and chairman of the Foundation for Innovation in Medicine. This term has been part of the industry lexicon for almost a decade. Unfortunately, it still seems to be held up in a scrambled web of complementary definitions, regulatory watchdogs and consumer confusion.^[8] “Functional foods,” “nutraceuticals,” “pharmaconutrients,” and “dietary integrators” are all terms used incorrectly and indiscriminately for nutrients or nutrient-enriched foods that can prevent or treat diseases.^[7]

Plants are one of the most important resources of human foods and medicines. Rapidly increasing knowledge on nutrition, medicine and plant biotechnology has dramatically changed the concepts about food, health and agriculture, and brought in a revolution on them. With recent advances in medical and nutrition sciences, natural products and healthpromoting foods have received extensive attention from both health professionals and the public. New concepts have appeared with this trend, such as nutraceuticals, nutritional therapy, phytonutrients, and phytotherapy.^[9-11] These functional or medicinal foods and phytonutrients or phytomedicines play positive roles in enhancing health and improving immune function to prevent specific diseases and also hold great promise to reduce side effects and health care cost.^[12]

Modern nutritional science is providing even more information on the functions and mechanisms of specific food components in health promotion and/or disease prevention.

Current nutritional approaches are beginning to reflect a fundamental change in our understanding of health. Today, foods are intended to deliver a health benefit beyond providing sustenance and nutrition.^[13]

The pharmaceutical companies favor the terms medical foods, nutraceuticals, and functional foods, whereas the food companies prefer functional foods and nutritional foods. While the food industry's approach is based on a nutritional concept, the pharmaceutical industry's approach is based on a medicine concept.^[14] The role of dietary active compounds in human nutrition is one of the most important areas of investigation with the findings having wide-ranging implications for consumers, healthcare providers, regulators and industry.^[11] Foods and nutrients play a vital role in the normal functioning of the body. They help to maintain the health of the individual and to reduce the risk of various diseases. Worldwide Acceptance of this fact formed a recognition link between "nutrition" and "health", and thus the concept of "nutraceuticals" evolved.^[12] Risk of toxicity or adverse effects of medical drugs led to consider safer nutraceutical and functional food based approaches for health management. This resulted in a world-wide nutraceutical revolution.^[15]

Nutrigenetics is a nascent area that is developing quickly and riding on the wave of "personalized medicine" providing opportunities in nutraceutical product development.^[16] Nutraceuticals are considered as pharmaceutical forms (tablets, capsules, powders, etc.) containing bioactive food compounds as active principles.^[17] The word "nutraceutical" has often been used to describe a broad list of products sold under the premise of being food components, but with the expressed intent of treatment or prevention of disease.^[18]

The term 'nutraceutical' has been part of the industry lexicon for almost a decade. Unfortunately, it still seems held up in a scrambled web of complementary definitions, regulatory watchdogs and consumer confusion.^[19]

"Functional foods," "nutraceuticals," "pharmaconutrients," and "dietary integrators" are all terms used incorrectly and indiscriminately for nutrients or nutrient-enriched foods that can prevent or treat diseases¹⁹. While several terms have been used with similar meanings to the term nutraceutical, one of most frequently used terms is functional food.^[20]

The scope of nutraceuticals is significantly different from functional food for several reasons. These include: (i) Prevention and treatment of disease (i.e., medical claims) are relevant to

nutraceuticals, but only reduction of disease, not the prevention and treatment of disease, is involved with functional foods. (ii) Nutraceuticals include dietary supplements sold in forms that are similar to drugs: pills, extracts, tablets, etc as well as other type of foods, functional foods must be in the form of ordinary food.^[14, 17] Since there is no distinct regulatory framework for “functional foods” or “nutraceuticals”, they are both often regulated as foods^[21] The pharmaceutical industry is known for the high costs of research and development associated with drug development and the use of patents to protect the discoveries from this research; therefore, the industry is associated with high product margins. The food industry is noted for its low margins and the commoditization of its inputs and in some cases its products.^[22] Nutraceutical products represent an excellent growth opportunity but, companies must take appropriate actions to develop, preserve and protect their intellectual property rights in order to stay competitive.^[23] The rational use of nutraceuticals is based on objective evaluation of the clinical evidence as well as subjective evaluation of the risks, benefits, economic costs and potential drug interactions.^[24]

Nutraceutical Categories

I) Dietary Supplements including botanicals

A product that contains one or more of the following dietary ingredients: vitamin, mineral, herb or other botanical, amino acid (protein) and also includes the diet as concentrates, constituents, extracts or metabolites of these compound EG: Vitamins, co-enzymes, minerals, carnitine.

II) Functional Foods

- a. Oats, bran, Psyllium and lignin's for heart disease and colon cancer
- b. Prebiotics - Oligofructose for control of intestinal flora
- c. Omega-3 milk in prevention of heart disease
- d. Canola oil with lowered triglycerides for cholesterol reduction
- e. Stanols (Benecol) in reduction of cholesterol adsorption

III) Medicinal Foods

- a. Transgenic cows and lactoferrin for immune enhancement
- b. Transgenic plants for oral vaccination against infectious diseases
- c. Health bars with added medications.

IV) Inorganic mineral supplements

Large number of element control variety of physiological and biochemical function of human body. Most of these minerals are provided through the diet but their deficiency in diet may develop variety of health related problems and disease. EG- calcium, iron, magnesium, phosphorous, cobalt, copper, chromium, selenium, zinc.

V) Digestive enzyme

Much of the reflux is not caused by increase production of acid in the stomach but from poor digestion because of too little acid. As we grow older stomach cells responsible for acid production diminishes, this in turn slows the transit time of food in the stomach causing reflux of food from the esophagus. So we have to use a variety of digestive enzyme to help absorption and digestion of food material. There are animal as well as plant derivative digestive enzyme.

VI) Probiotics

Probiotic can be describe as a living microorganism which when ingested with or without food improves the intestinal microbial balance and consequently the health and functioning of large intestine. The major source are the cultured dairy products such as natural cheese, yoghurt and kefir and butter milk.

Most commonly used probiotics

- **Lactobacilli-casei, acidophilus**
- **Streptococci-thermophilus**
- **Bifidobacteria-bifidum, breve, longum, thermophilum**

VII) Prebiotics

Prebiotic are food components that escape digestion by the normal human digestive enzyme and reach the colon in intact form after passage through the stomach and small intestine where they selectively promote the growth of prebiotic.

Commonly known prebiotic are

- **Oligofructose**
- **Insulin**
- **Galacto-oligosaccharides**
- **lactulose**

Nutritional therapy is a healing system using dietary therapeutics. This therapy is based on the belief that foods can not only be sources of nutrients and energy but could also provide medicinal benefits.

Table 1. presents some of the more recognizable nutraceutical substances grouped according to food-source providers. Nonfood sources of nutraceutical factors have been sourced by the development of modern fermentation methods. For example, amino acids and their derivatives have been produced by bacteria grown in fermentation systems. The emergence of recombinant-genetic techniques has enabled new avenues for obtaining nutraceutical compounds. These techniques and their products are being evaluated in the arenas of the marketplace and regulatory concerns around the world. An example is the production of eicosapentaenoic acid (EPA) by bacteria. This fatty acid is produced by some algae and bacteria. The EPA derived from salmon are produced by algae and are later incorporated in the salmon that consume the algae. EPA can now be produced by non-EPA producing bacteria by importing the appropriate DNA through recombinant methods.^[26] The ability to transfer the production of nutraceutical molecules into organisms that allows for economically feasible production is cause for both optimism and discussion concerning regulatory and popular acceptance.

Table 1. Examples of nutraceutical substances grouped by food source

Plants	Animal	Microbial
α -Glucan	Conjugated Linoleic Acid (CLA)	<i>Saccharomyces boulardii</i> (yeast)
Ascorbic acid	Eicosapentaenoic acid (EPA)	<i>Bifidobacterium bifidum</i>
γ -Tocotrienol	Docosahexenoic acid (DHA)	<i>B. longum</i>
Quercetin	Spingolipids	<i>B. infantis</i>
Luteolin	Choline	<i>Lactobacillus acidophilus</i> (LC1)
Cellulose	Lecithin	<i>L. acidophilus</i> (NCFB 1748)
Lutein	Calcium	<i>Streptococcus salvarius</i> (subs. Thermophilus)
Gallic acid	Coenzyme Q10	
Perillyl alcohol	Selenium	
Indole-3-carbonol	Zinc	
Pectin	Creatine	
Daidzein	Minerals	
Glutathione		
Potassium		
Allicin		
δ -Limonene		

Genestein		
Lycopene		
Hemicellulose		
Lignin		
Capsaicin		
Geraniol		
β -Ionone		
α -Tocopherol		
β -Carotene		
Nordihydrocapsaicin		
Selenium		
Zeaxanthin		
Minerals		
MUFA		

Nutraceutical Factors In Specific Foods

In an organization model related to the one above, nutraceuticals can be grouped based upon relatively concentrated foods. This model is more appropriate when there is interest in a particular nutraceutical compound or related compounds, or when there is interest in a specific food for agricultural/geographic reasons or functional food-development purposes. For example, the interest may be in the nutraceutical qualities of a local crop or a traditionally consumed food in a geographic region, such as pepper fruits in the southwestern United States, olive oil in Mediterranean regions and red wine in Western Europe and Northern California.

Table 2. Examples of foods with higher content of specific nutraceutical substances

Nutraceutical Substance/Family	Foods of Remarkably High Content
Allyl sulfur compounds	Onions, garlic
Isoflavones (e.g., genestein, daidzein)	Soybeans and other legumes, apios
Quercetin	Onion, red grapes, citrus fruit, broccoli, Italian
Capsaicinoids	yellow squash
EPA and DHA	Pepper fruit
Lycopene	Fish oils
Isothiocyanates	Tomatoes and tomato products
β -Glucan	Cruciferous vegetables
CLA Beef and dairy	Oat bran
Resveratrol	Grapes (skin), red wine
β -Carotene	Rosemary
Catechins	Teas, berries
Adenosine	Garlic, onion
Indoles	Cabbage, broccoli, cauliflower, kale, Brussels sprouts
Curcumin	Tumeric

Ellagic acid	Grapes, strawberries, raspberries, walnuts
Anthocyanates	Red wine
3-n-Butyl phthalide	Celery
Cellulose	Most plants (component of cell walls)
Lutein, zeaxanthin	Kale, collards, spinach, corn, eggs, citrus
Psyllium	Psyllium husk
Monounsaturated fatty acids	Tree nuts, olive oil
Inulin, Fructooligosaccharides (FOS)	Whole grains, onions, garlic
Lactobacilli, Bifidobacteria	Yogurt and other dairy
Catechins	Tea, cocoa, apples, grapes
Lignans	Flax, rye

There are several nutraceutical substances that are found in higher concentrations in specific foods. These include capsaicinoids, which are found primarily in pepper fruit and allyl sulfur (organosulfur) compounds, which are particularly concentrated in onions and garlic.

Mechanism of action

Another term of classifying nutraceuticals is by their mechanism of action. This system groups nutraceutical factors together, regardless of food source, based upon their proven or purported physiological properties. Among the classes would be antioxidant, antibacterial, antihypertensive, antihypercholesterolemic, antiaggregate, anti inflammatory, anticarcinogenic, osteoprotective, and so on.^[27, 28] Examples are presented in Table 3.

Table 3. Examples of nutraceuticals grouped by mechanisms of action

Anticancer	Positive Influence on Blood Lipid Profile	Antioxidant Activity	Anti inflammatory	Osteogenetic or Bone Protective
Capsaicin	α -Glucan	CLA	Linolenic acid	CLA
Genestein	γ -Tocotrienol	Ascorbic acid	EPA	Soy protein
Daidzein	δ -Tocotrienol	β -Carotene	DHA	Genestein
α -Tocotrienol	MUFA	Polyphenolics	GLA (gammalinolenic acid)	Daidzein
γ -Tocotrienol	Quercetin	Tocopherols		Calcium
CLA	ω -3 PUFAs	Tocotrienols		Casein phosphopeptides
Lactobacillus acidophilus	Resveratrol	Indole-3-carbonol	Capsaicin	FOS (fructooligosaccharides)
Sphingolipids	Tannins	α -Tocopherol	Quercetin	
Limonene	β -Sitosterol	Ellagic acid	Curcumin	Inulin
Diallyl sulfide	Saponins	Lycopene		
Ajoene	Guar	Lutein		
α -Tocopherol	Pectin	Glutathione		
Enterolactone		Hydroxytyrosol		
Glycyrrhizin		Luteolin		

Equol		Oleuropein		
Curcumin		Catechins		
Ellagic acid		Gingerol		
Lutein		Chlorogenic acid		
Carnosol		Tannins		
L. bulgaricus				

Classifying nutraceutical factors based on chemical nature

Another method of grouping nutraceuticals is based upon their chemical nature. This approach allows nutraceuticals to be categorized under molecular/elemental groups. This preliminary model includes several large groups, which then provide a basis for sub classification or subgroups and so on.^[29, 30]

- Isoprenoid derivatives
- Phenolic substances
- Fatty acids and structural lipids
- Carbohydrates and derivatives
- Amino acid-based substances
- Microbes
- Minerals

Table 4: Organizational scheme for nutraceuticals

Isoprenoids (terpenoid)	Phenolic compound	Protein/Amino Acid- Based	Carbohydrate & Derivative	Fatty acid & struct, lipids	Mineral	Microbial
carotenoids	coumarins	Amino-acid	Ascorbic acid	n-3 PUFA	ca	probiotics
saponins	tannins	Allyl-s compound	oligosaccharides	Sphingolipids	se	prebiotics
tocotrienols	lagnin	capsaicinoids	Non-starch ps	lecithin	k	
tocopherol	anthrocyanins	isothiocyanates			cu	
Simple terpens	isoflavones	indoles			zn	
	flavones	Folate				
	flavonol	choline				

Marketed preparation of nutritional supplements

In world market various nutritional product^[31] are present some are given in Table no. 4.

Table 5. Marketed preparation of nutritional supplements

Product	Category	Contents
Coral calcium	Calcium supplements	Neuropathic pain supplements
Weight smart	Nutritional supplements	Vitamins and trace elements
Omega women	Immune supplements	Antioxidants, vitamins and

		phytochemicals (eg. Lycopene)
Appetite Intercept	Appetite suppressants	Caffeine, tyrosine and phenylalanine
Chaser	Hangover supplements	Activated calcium carbonate and vegetable carbon
Rox	Energy drink	Taurine, caffeine and glucuronolactone
Mushroom optimizer	Immune supplement	Mushroom, polysaccharides and folic acid
Biovinca	Neurotonic	Vinpocetine
Proplus	Nutritional supplements	Soy proteins
Snapple-a-day	Meal replacement beverage	Vitamins and minerals
wellife	Amino acids supplements	Granulated-L-glutamine
PNer plus	Neuropathic pain supplements	Vitamins and other natural

Use of Nutraceuticals in the Treatment of Different Diseases

1. Rice bran and Cardiovascular Diseases, Eye Sight

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.

2. Corn (heart attack, 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.

3. Dietary Polyphenols Used in the Treatment of Diabetes

In recent years, there is growing evidence that plant-foods Polyphenols, due to their biological properties, may be unique nutraceuticals and supplementary treatments for various aspects of type 2 diabetes mellitus. Polyphenolic compounds can also prevent the

development of long-term diabetes complications including cardiovascular disease, neuropathy, nephropathy and retinopathy.

4. Sorghum (against pathogen)

sorghum is the main dietary source for 3-deoxyanthocyanidins, which are present in large quantities in the bran of some cultivars (Awika, 2004). The defense mechanism of sorghum against pathogen is due to an active process, resulting in the accumulation of high levels of 3-deoxyanthocyanidin phytoalexins in infected tissues.^[32]

5. Buck wheat (obesity-constipation)

Buckwheat seed proteins have beneficial role in obesity and constipation acting similar to natural fibers present in food. 5-hydroxytryptophan and green tea extract may promote weight loss.

6. B-Carotene (cancer)

Beta-carotene is the main source of vitamin A and has antioxidant properties which help in preventing cancer and other diseases. Among the other carotenes, beta carotene is the most active antioxidants. Alpha and beta carotenes, along with gamma carotene and the carotenes lycopene and lutein⁶⁸ which do not convert to vitamin A, seem to offer protection against lung, colorectal, breast, uterine and prostate cancers. B-Carotene is the more common form and can be found in yellow, orange and green leafy fruits and vegetables. These can be carrots, spinach, lettuce, tomatoes, sweet potatoes, broccoli, cantaloupe, oranges and winter squash.

7. In the treatment of arthritis

Arthritis is a common disease in which the end-point results in joint replacement surgery. The use of nutraceuticals is an alternative treatment for pathological manifestations of arthritic disease. The efficacy of fish oils (e.g. cod liver oil) in the diet has been demonstrated in several clinical trials, animal feeding experiments and *in vitro* models that mimic cartilage destruction in arthritic disease. Other than this, there is some evidence of other nutraceuticals, such as green tea, herbal extracts, chondroitin sulphate and glucosamine.

8. Nutraceuticals used against Alzheimer's disease (AD)

Alzheimer's disease (AD), also called senile dementia of the Alzheimer type (SDAT), primary degenerative dementia of the Alzheimer's type (PDDAT), or simply Alzheimer's, is the most common form of dementia. The various Nutraceuticals, which are used to cure Alzheimer's disease are:

- a) **Anti-oxidants:** antioxidants like vitamin E and vitamin C.
- b) **Ginkgo biloba:** Ginkgo biloba is perhaps the most studied herbs with reference to memory, cognition, overall brain performance and certainly AD.
- c) **Huperzine alpha:** Huperzine alpha or huperzine A is a very appealing plant compound that is extracted from club
- d) **Moss, or Huperzia serrata.:** It is a sesquiterpene alkaloid, which is a potent and reversible inhibitor of acetylcholinesterase.^[33]

9. In the treatment of diet-related diseases

In Western societies, the incidence of diet-related diseases is progressively increasing due to greater availability of hypercaloric 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 Tregulatory cells and homeostatic regulation of the gut microbiota have the potential to reduce low-grade inflammation in diet-related diseases.^[33]

10. Vision improving agents

Lutein is one of most important carotenoids, found in many fruits and vegetables like mangoes, corn, sweet potatoes, carrots, squash, tomatoes, etc. Lutein dipalmitate is found in the plant *Helenium autumnale*. Lutein is also known as helenien is used for the treatment of visual disorders. Zeaxanthin is used in traditional Chinese medicine mainly for the treatment of visual disorders. Food sources of zeaxanthin include corn, egg yolk and green vegetables and fruits, such as broccoli, green beans, green peas, brussel sprouts, cabbage, kale, collard greens, spinach, lettuce, kiwi and honeydew. Lutein and zeaxanthin are also found in nettles, algae and the petals of many yellow flowers. In green vegetables, fruits and egg yolk, lutein and zeaxanthin exist in non-esterified forms.^[34]

Current Research in Nutraceuticals

A great deal of current research is focused on traditional herbal extracts. Investigators are examining claims linking these extracts with health enhancement and prevention of chronic diseases. At least in part, this represents an effort to legitimize homeopathic remedies and Eastern medicine. Additionally, it seeks to provide patients and physicians with much-needed safety and efficacy data. The explosive demand growth for bioactive ingredients for nutraceuticals and functional foods is being driven by frequently cited health concerns:

- Cardiovascular disease
- Breast, skin, colorectal and brain cancers
- Female health concerns
- CNS disorders
- Metabolism management
- Gastrointestinal disorders
- Immuno modulation

A significant problem with the use of nutraceuticals in treating diseases is the lack of serious studies published with clear clinical evidence. The development, production, packaging, marketing and sales of nutraceuticals has come a long way and is evolving constantly. Nutraceuticals are the preferred choice of today's consumer for regular usage. The latest scientific research and clinical trials continue to boost and add impetus to this industry.^[35]

Safety and Efficacy

Nutraceuticals hold great potential, as an alternative to substance obtained by plant. Yet, some time they also cause harmful effect as seen with ephedrine, a widely used botanical ingredient in weight-loss products. Now a days peoples are more conscious about there health and these products offer the promised health benefits. But danger is associated with some product due to lake of solid information about intraction andside effect.^[36]

Future issues and proposals

Change in the lifestyle can prevent the diseases like metablic syndromes. One of the solutions in the lifestyle change is changes in their diet. The key issues for Nutraceuticals are:

- Establishment of scientific assessment standard for prevention of diseases
- Establishment of assessment system for disease prevention by human trials

- Establishment of seamless system to transfer stage from basic research to industrialization.

Nutraceuticals are not necessarily a single material; therefore the expected effect for the prevention of disease might be the complex action of several components which are present in the product, it is also necessary to compare preventative effects for different types of food. Hence, it is necessary to conduct biomarker research for prevention of target diseases. Therefore, it is also necessary to define the measurement method of biomarkers and standardize indicators.^[37]

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. Nutraceuticals constitute a rapidly growing focus for research, product development and consumer interest as well as regulatory efforts in recent years. Nutraceuticals represents a unique intersection of the pharmaceutical and food industries with a wide scope. The approach to regulating and marketing of nutraceuticals is notably heterogeneous on the global level. This is largely due to the challenges in classifying these products, absence of a suitable regulatory category for these hybrid products and varying views on what is considered sufficient scientific substantiation to conclude the functionality.

ACKNOWLEDGMENT

The authors are grateful to the Department of Pharmacy, School of Medical and Allied Sciences, Galgotias University, Plot No. 2, Sector 17-A, Yamuna Expressway, Greater Noida, Gautam Buddha Nagar, Uttar Pradesh, India for providing library facilities & support

REFERENCES

1. Ross IS. Functional foods: the Food and Drug Administration perspective. *Am J Clin Nut.*, 2000; 71: 1735-1738.
2. Food Quality and Standards Service. Food and Agriculture Organization of the United Nations [Internet]. Report on Functional Foods, November 2007; c2010: [cited 2010 January 28]. Available from http://www.fao.org/ag/agn/agns/files/Functional_Foods_Report_Nov2007.pdf.

3. Roberfroid MB. Concepts and strategy of functional food science: the European perspective. *Am J Clin Nutr*, 2000; 71(6 Suppl): 1660S-1664S.
4. Tewfik S, Tewfik I. Nutraceuticals, functional foods and botanical dietary supplements; promote wellbeing and underpin public health. *World Review of Science, Technology and Sustainable Development*, 2008; 5(2): 104 -123.
5. Mollet. B., Rowland I. Functional foods: at the frontier between food and pharma. *Current opinion in biotechnology*, 2002; 13(5): 483-485.
6. The World Bank [Internet]. Kotilainen L, Rajalahti R, Ragasa C, Pehu E. Agriculture and rural development discussion paper: Health enhancing foods opportunities for strengthening the sector in developing countries, 2006; c2010: [cited 2010 January 28]. Available from: http://siteresources.worldbank.org/INTARD/Resources/Health_Enhacing_Foods_ARD_DP_30_final.pdf.
7. Arvanitoyannis IS, Houwelingen-Koukaliaroglou MV. Functional foods: A survey of health claims, pros and cons and current legislation. *Critical reviews in food science and nutrition*, 2005; 45(5): 385-404.
8. Natural Product Insider [Internet]. Granato H. Regulatory sConcerns Cloud Functional Food, Nutraceutical Markets; c2009 [cited 2009 November 13]. Available from:<http://www.naturalproductsinsider.com/articles/2000/11/regulatory-concerns-cloud-functional-food-nutrace.aspx>.
9. Bland JS. Phytonutrition, phytotherapy and phytopharmacology. *Altern Ther Health Med.*, 1996; 2: 73-76.
10. Berger MM, Shenkin A. Vitamins and trace elements: Practical aspects of supplementation. *Nutrition.*, 2006; 22: 952- 955.
11. Bagchi D. 2006. Nutraceuticals and functional foods regulations in the United States and around the world. *Toxicol.*, 2006; 221: 1-3.
12. Ramaa CS, Shirode AR, Mundada AS, Kadam VJ. Nutraceuticals-an emerging era in the treatment and prevention of cardiovascular diseases. *Curr Pharm Biotech.*, 2006; 7: 15-23.
13. Siro I, Kapolna E, Kapolna B, Lugasi A. Functional food. Product development, marketing and consumer acceptance- a review. *Appetite*, 2008; 51(3): 456-467.
14. Kwak NS, Jukes DJ. Functional foods. Part 2: the impact on current regulatory terminology. *Food Control.*, 2001; 12(2): 109-117.

15. Bagchi D, Preuss HG, Kehler JP. Nutraceutical and functional food industries: aspects on safety and regulatory requirements. *Toxicol. Lett.*, 2004; 150: 1-2.
16. Subbiah MT. Nutrigenetics and nutraceuticals: the next wave riding on personalized medicine. *Transl Res.*, 2007; 149(2): 55-61.
17. Espin JC, Garcia-Conesa MT, Tomas-Barberan FA. Nutraceuticals: facts and fiction. *Phytochemistry*, 2007; 68 (22- 24): 2986-3008.
18. Kentucky Equine Research [Internet]. Crandell K, Duren S. Nutraceuticals: what are they and do they work?; c1995 - 2009 [cited 2009 November 10]. Available from: <http://www.ker.com/library/advances/203.pdf>.
19. Natural Product Insider [Internet]. Granato H. Regulatory Concerns Cloud Functional Food, Nutraceutical Markets; c2009 [cited 2009 November 13]. Available from: <http://www.naturalproductsinsider.com/articles/2000/11/regulatory-concerns-cloud-functional-food-nutrace.aspx>.
20. Health Canada [Internet]. Ottawa, Ontario, Canada: Policy Paper Nutraceuticals/Functional Foods and Health Claims on Foods; c2009 [cited 2009 August 30]. Available from: http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfbdgpsa/pdf/label-etiquet/nutra-funct_foods-nutrafonct_aliment-eng.pdf.
21. Kruger CL, Mann SW. Safety evaluation of functional ingredients. *Food Chem Toxicol*, 2003; 41(6): 793-805.
22. Agriculture and Agri-Food Canada. Potential Benefits of Functional Foods and Nutraceuticals to the Agri-Food Industry in Canada 2002.
23. Lapointe S. Food for thought: IP protection for nutraceuticals and functional foods. *Health Law Can*, 2008; 28(3-4): 101-111.
24. Mechanick JI. The rational use of dietary supplements and nutraceuticals in clinical medicine. *Mt Sinai J Med*, 2005; 72(3): 161-165.
25. Pandey M, Verma RK, Shubhini A Saraf. Nutraceuticals: New era of medicine and health. *Asian Journal of Pharmaceutical and Clinical Research*, 2010; 3(1).
26. Barham J.B., *Nutr. J.*, 2000; 130: 1925.
27. Johnson M.M., *Nutr. J.*, 1997; 127: 1435.
28. Brower .V, *Nat Biotechnol.*, 1998; 16: 728.
29. Zeisel. S.H., *Science*, 1999; 285: 185.
30. <http://vm.cfsan.fda.gov>.
31. Nelson N.J., *Natl J, Cancer Inst.*, 1999; 91: 755.

32. Saikia D *et al.* Cereals From staple Food to Nutraceuticals. International Food Research Journal, 2011; 18: 21-30.
33. Heredia FP *et al.* Functional Foods and Nutraceuticals as Therapeutic Tools for the treatment of diet related diseases. Canadian Journal of Physiology and Pharmacology, 2013; 91(6): 387-396
34. Rajasekaran *et al.* Nutraceuticals as Therapeutic Agents- Review. Research J Pharm and Tech, 2008; 1(4).
35. <http://www.aboutbioscience.org/pdfs/Nutraceuticals.pdf> (accessed on 12 Dec 2011).
36. Bhaskaran K., Nutraceuticals, Health Administrator, 2002; 1 & 2: 76-77.
37. Sumi Y. Research and Technology Trends of Nutraceuticals. Sci & Tech Trends., 2008; 28: 10-21.