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NUTRACEUTICALS: A MODERN APPROACH TO FOOD SCIENCE

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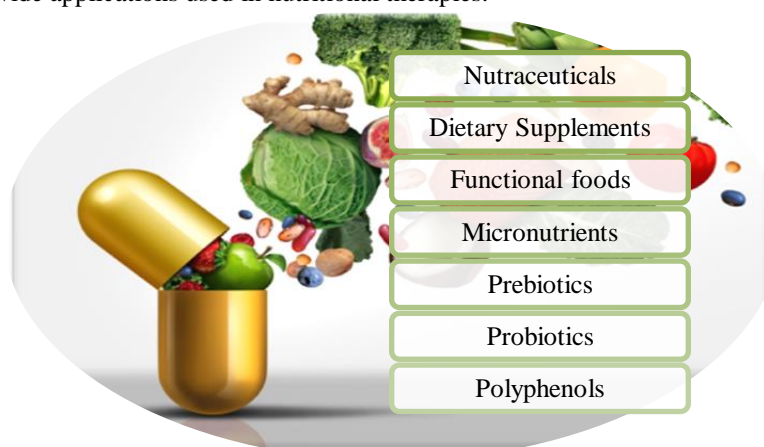
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Abstract: Nutraceuticals are recently proven the Hippocrates quote” Let the food to be your medicine and medicine to be your food”. Nutraceutical refers to products that may be food or a part of foods that provide extra health benefits in addition to nutritive value. A nutraceutical is defined as any substance that is a food or part of a food and provides medical or health benefits, including the prevention and treatment of disease. These are a group of substances that are not nutrients but have numerous health benefits for humans. Nutraceuticals may be categorized on the basis of source of origin, chemical composition and pharmacology. Part of food or any food, dietary supplements, herbal products, soluble or insoluble fibre, phytochemicals are also considered as nutraceuticals. These compounds provide potential to the human body against prevention of diseases. The functional foods provide all nutrients i.e. vitamins, protein, carbohydrates, fats, minerals, needed for survival of human beings. According to USDA dietary supplements are included in the category of food. Nutraceuticals also include fortified and enriched food products.

Index Terms Pharmaceuticals, Nutraceuticals, Potential use, Prevention, Diseases, Health Benefits, Dietary supplements, Medicinal, functional foods

I. INTRODUCTION

The term “nutraceutical” consists of two words “nutrition,” that means nourishing component of food, and “pharmaceutical,” which refers to a medical drug. The term nutraceutical was first introduced in 1989 by Stephen DeFelice who was founder and chairman of the Foundation for Innovation in Medicine, which is an American organization situated in Cranford, New Jersey. Moreover the term used in marketing has no regulatory definition. It can be meant as natural functional/ medicinal foods or bioactive phytochemicals with health promoting, disease-preventing or medicinal qualities. It may include vitamins, lipids, proteins, carbohydrates, minerals, or many other necessary nutrients. Depending on their chemical structures and biological functions, it has wide applications used in nutritional therapies.



Nutraceuticals are found in a range of products developed by various industries like food industry, herbal and dietary supplement market. Intake of nutraceuticals in daily diet has become important for attaining the optimum nutritional and health status. Overconsumption of food also causes harmful effects on human health. However, currently available nutraceuticals are available in large numbers and varieties, having more therapeutic applications. These are available in various forms i.e. Concentrated forms as pills, capsules, powders and tinctures that may contain either single product or in combination.

The objective to introduce nutraceuticals is to focus on prevention and control against diseases, according to the saying by a Greek physician Hippocrates who was known as the father of medicine, said “let food be your medicine”. Their role in human nutrition is one of the most important areas of research, keeping in view the great interest for consumers, healthcare providers, regulators, food producers and distributors.

Categories of nutraceuticals

The definition of nutraceuticals and their related products generally depends on the source. These products can be classified on the basis of their natural sources, pharmacological conditions, as well as chemical constitution of the products. Most often, nutraceuticals are grouped into four categories that include dietary supplements, functional foods, medicinal foods, and pharmaceuticals.

- Dietary Supplements
- Functional foods
- Medicinal foods
- Farmaceuticals
- **Dietary Supplements:** A dietary supplement represents a product that contains nutrients derived from food products and is often concentrated in the form of liquid, capsule, powder or pill. Although dietary supplements are regulated by the United States Food and Drug Administration (FDA) as foods, their regulation differs from that which is involved in drugs and other food products.
- **Functional foods:** The term functional food includes whole foods and fortified, as well as enriched or enhanced dietary components that may reduce the risk of chronic diseases and provide a health benefit beyond the traditional nutritional effects.
- **Examples of functional foods:**
 - Yogurt : probiotics promote intestinal health
 - Fortified or enriched Foods/snacks/cereals: treatment of nutritional deficiencies
 - omega -3 enriched oils: lowers cholesterol
 - Oats/Bran/Lignins: Reduces heart risks
 - Stanols: Regulation of cholesterol absorption
 - Prebiotics: Control of intestinal flora
- **Medicinal foods:** Medicinal foods are designed to be consumed or administered internally under the supervision of a qualified physician. They are used in specific dietary management of a disease or condition for which distinctive nutritional requirements are established by the medical evaluation and on the basis of recognized scientific principles. These constitute different parts of plants viz. seeds, berries, leaves, roots, flowers and barks that possess nutraceutical properties. They are helpful in prevention of different kinds of illnesses. These are now widely used in the form of medicinal nutritional therapies.
- **Farmaceuticals:** Farmaceuticals are components produced from modified agricultural crops or animals, having high intent of medicinal value. This term includes a combination of the two words “farm” and “pharmaceuticals.”

On the basis of prevalence of nutraceuticals in marketing they can also be categorized in to:

- Traditional Nutraceuticals
- Non-traditional Nutraceuticals

Traditional Nutraceuticals: No alterations can be made on this kind of nutraceuticals. They contain natural active components of food that provide health benefits to mankind. Nutrients, herbs and phytochemicals may be covered under this category.

Non-Traditional Nutraceuticals: The alterations may be made in foods to derive health benefits for mankind with the help of certain scientific processing techniques. They can be grouped into categories.

i. Fortified Nutraceuticals

ii. Recombinant Nutraceuticals.

Fortified Nutraceuticals: Fortified foods supply health and nutritional benefits. Examples are as follows: calcium fortified orange juice, folic acid fortified flour, fortified milk with Bifidobacterium, Iron fortified rice, iodine and iron fortified salt, fortified banana with soybean ferritin gene, etc.

ii. Recombinant Nutraceuticals: In this category of nutraceuticals, Biotechnology plays a vital role in the production of this type of nutraceuticals. Production of energy-yielding foods like bread, alcohol, fermented starch, yogurt, cheese and vinegar has been possible only with the use of biotechnology. In addition to this, enzyme or fermentation technology is also used for production of recombinant nutraceuticals like probiotics.

Foods that show nutraceutical properties can be discussed as:

- Dietary Fibre
- Probiotics
- Prebiotics
- Polyunsaturated fatty acids
- Antioxidant vitamins
- Polyphenols
- Spices and Herbs
- **Dietary Fibre:** Whole grains cereals and pulses, fruits and vegetables are a major source of dietary fibre in our diet. These cannot be digested completely in our gut and thus provide roughage and are essential for healthy functioning of our gut. Based on solubility in water, fibre is categorized into soluble and insoluble dietary fibre. Soluble dietary fibre is soluble in water that can be obtained from food sources like beans, fruits and oat products. They play a vital role in decreasing the level of cholesterol in blood and controls blood sugar level. Whereas insoluble dietary fibre are immiscible in water, hence passes directly through the gastrointestinal tract. Whole grain products and vegetables are good sources of insoluble dietary fibre.

Dietary fibre content of common foods:

High (>10)	Medium (1-10)	Low (<1)	Nil
Wheat	Rice	Refined and processed foods	Sugar
Jowar	Most of the vegetables and Fruits		Fats /Oils
Bajra	Coconut		Milk
Ragi	Sesame		All types of meat
Maize			
Legumes			
Fenugreek			

These take more time for digestion, hence providing the feeling of fullness to individuals after consuming it, plays a great role in maintaining weight. It also regulates bowel movement and prevents the occurrence of diverticular disease and constipation. It also minimizes the chances of diabetes and colorectal cancer. Soluble fibres also mix properly with digestive enzymes, cholesterol, starch, glucose and toxins, forming a viscous solution, which is excreted via feces. Therefore become helpful for both obese and diabetic patients.

Probiotics: It includes both live bacteria and yeasts having a good impact on health, especially on gut health. Actually the body is a home of both good and bad bacteria. “Good” or “helpful” bacteria constitute this category that is important for a healthy digestive system of the body. They are found to be suitable for the treatment of diarrhea, irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), allergies, cold and skin conditions like eczema. Their use is helpful for good urinary, vaginal and oral health and lactose intolerance. They are found in dairy products like yogurt, fermented products, and chocolates.

Prebiotics: Their intake causes the growth or activity of microorganisms like bacteria and fungi that promote well being of their host. Prebiotics change the constitution of gut microbiota. Some of the prebiotics boost the functions of skin microbiota. Scientific studies revealed that all prebiotics act as fiber, but not all fiber performs the function of prebiotic. Scientifically a prebiotic can be defined as a substance that withstands gastric acidity, hydrolyzed by certain enzymes, and absorbed in the upper gastrointestinal tract, fermented by the intestinal microflora and selectively stimulates the growth or activity of intestinal bacteria potentially associated with health and well-being. Functions of prebiotics are very limited compared to that of dietary fibre.

Beneficial Health effects of lactic acid bacteria:

Formation of lactic acid inhibit growth of poisonous bacterias
Promotion of antimicrobial compounds
Enhancement of immunity
Better utilization of Calcium, Phosphorous and Iron
Source of energy
Increases efficiency of Bowl tranport, relief from constipation
Production of B vitamins and lactase enzymes
Decreases cholestrol level

Polyunsaturated Fatty Acids: They exhibit health promoting effects and are helpful in curing various disorders and lifestyle chronic diseases like coronary heart disease, hypertension, diabetes, arthritis and other inflammatory conditions and autoimmune disorders. Sunflower oil, soybean oil, olive oil, canola oils and other vegetable oils, fish oils, oily fishes like salmon, soybean, flaxseed, canola, pumpkin, walnut are major sources of polyunsaturated fatty acids. Some studies revealed that regular consumption of fish oils reduce both morbidity and mortality risks from cardiovascular disease including ischemic heart disease, nonischemic myocardial heart disease, and hypertension.

Antioxidant Vitamins: Vitamins like vitamin C, vitamin E and carotenoids are collectively known as antioxidant vitamins. Antioxidants form the first line of defense against this mutilation, and play an important role in the optimum health maintenance. Antioxidants stabilize or deactivate free radicals in turn prevent damage to cells. These compounds are considered as nutrient-derived antioxidants (vitamin C, vitamin E, carotenoids, glutathione and lipoic acid), antioxidant enzymes (superoxide dismutase, glutathione peroxidase, and glutathione reductase), metal binding protein (ferritin, lactoferrin, albumin, and ceruloplasmin).

Dominant plant pigments:

Colour	Pigment	Fruit or Vegetable
Red	Anthocyanins	Strawberries , Raspberries , Cherries, Cranberries, Pomegranate, Apple, Red Grapes
	Lycopene	tomato , Pink grapefruit, watermelon
	Betacyanins	Beets
Orange	Beta-carotene	Carrots , Mangoes, Apricots, Cantaloupe, Pumpkin, Sweet potatoes
	Beta-cryptoxanthin	Oranges, Tangerines
Blue / Purple	Anthocyanins	Blueberries, plums, Egg plant, Grapes
Yellow	Lutein zeaxanthin	Avocado, Corn
	Curcumin	Turmeric
Green	Chlorophyll	Broccoli, Spinach, Cabbage, Asparagus, Green tea

Polyphenols: These are phytochemical components found in plant-based foods. Fruits, vegetables, whole grains, cereal, legumes, tea, coffee, wine and cocoa are naturally rich source of polyphenols. Today, around more than 8000 polyphenols viz. phenolic acids, flavonoids, stilbenes, lignans and polymeric lignans have been found in plant foods. Polyphenols are secondary metabolites of plants having a protective role against ultraviolet radiation, oxidants and pathogens. Phenolic acids are mainly found in fruits like berry fruits, kiwi, cherry, apple, pear, chicory and coffee. These may be grouped into various classes on the basis of the number of phenol rings and structural elements. Phenolic acids constitute one third of polyphenols in diet and include two main classes, a) Hydroxybenzoic acid derivatives (protocatechuic acid, gallic acid, p-hydroxybenzoic acid). b) Hydroxycinnamic acid derivatives (caffeic acid, chlorogenic acid, coumaric acid, Ferulic acid, sinapic acid).

Spices: They have been key ingredients in the culinary art since ancient times. Spices are aromatic vegetable components, may be used in the form of whole, broken or ground. They play a major role in seasoning food rather than providing nutrition. The spices provide significant flavor, aroma and pungency to foods. Besides it, spices are also important in indigenous medicines, pharmaceuticals, Nutraceuticals, aroma therapy, preservatives, beverages, natural colors, perfumes, dental preparations, cosmetics and botanicals as pesticide. Some spices are having nutraceutical effects such as cinnamon, clove, curcuma spp., saffron and long pepper etc. They are a good source of vitamin C and rich in antioxidants, Hence boosts immunity, promotes digestion and prevents cough, asthma, fever, heart diseases. Turmeric, red pepper, black pepper, clove, ginger, garlic, coriander, rosemary, saffron and cinnamon has been shown to exert its activity against neurodegenerative diseases like Alzheimer's disease, Parkinson's disease, multiple sclerosis, brain tumor and meningitis, etc. Herbs and spices have been proved to have a significant role in maintaining and enhancing human beauty. Especially, use of turmeric in skin care. Spices like turmeric, cardamom, clove, aniseed, coriander, basil, saffron, garlic and sage have important use in the beauty and cosmetic industry.

On the basis of food source nutraceuticals can be grouped as:

- Plants
- Animal
- Microbial

Plants	Animal	Microbial
Alpha-glucan	Calcium	Saccharomyces boulardii (Yeast)
Beta- carotene	Choline	Bifidobacterium bifidum
Ascorbic acid	Coenzyme Q ₁₀	B. longum
Capsaicin	Creatine	B. infantis
Gallic acid	Lecithin	Lactobacillus acidophilus
Glutathione	Minerals	Streptococcus salivarius (subs Thermophilus)
Hemi cellulose	Selenium	
Lignin	Zinc	
Lutein	Sphingolipids	
Lycopene		
Minerals		
MUFA		
Pectin		
Cellulose		

Potential health benefits

In recent years, nutraceuticals have created remarkable interest in their potential nutritional and therapeutic effects. These products have a role in biological processes, including antioxidant defenses, cell proliferation, gene expression and mitochondrial integrity.

Mechanism of action of nutraceuticals

Anticancer	Positive influence on blood profile	Antioxidant activity	Anti inflammatory	Osteogenic or Bone protective
Alpha tocopherol	Alpha Glucan	CLA	Linolenic acid	CLA
Capsaicin	Tocotrienol	Ascorbic acid	EPA	Soya protein
CLA	MUFA	Beta- carotene	DHA	Genestein
Daidzein	Quercetin	Polyphenols	GLA	Daidzein
Ellagic acid	Omega-3 PUFA	Tocopherols	Capsaicin	Calcium
Equol	Resveratrol	Tocotrienols	Quercetin	Casein
Genistein	Tannins	Indole 3-carbinol	Curcumin	Phosphopeptides
L. bulgaricus	Saponins	Alpha tocopherols		FOS (fructooligosaccharides)
Lactobacillus acidophilus	Pectin	Ellagic acid		Inulin
Lutein	Guar	Lycopene		
Sphingolipids		Lutein		
Curcumin		Glutathione		
		Luteolin		
		Oleuropein		
		Catechins		
		Tannins		
		Gingerol		
		Chlorogenic acid		

Therefore, nutraceuticals may be used to promote health, prevent chronic diseases, postpone the aging process and in turn increase life expectancy or just support the functions and overall integrity of the body. These products are considered to be healthy sources for the prevention of various diseases such as diabetes, renal disorders, gastrointestinal diseases and different infections.

A wide range of nutraceuticals has proved to impose crucial roles in immune status and susceptibility to certain diseases. Nutraceuticals also exhibit diseases related to oxidative stress including allergies, Alzheimer's disease, cardiovascular diseases, cancer, eye conditions, Parkinson's diseases, and obesity.

STATUS OF NUTRACEUTICALS IN INDIA

Dietary supplements and nutraceuticals have become popular in India due to absence of adequate intake of nutrition in the food. The intake of micronutrients in the Indian daily diet is not satisfactory. Several programs have been launched over the years in India to improve nutrition and health status of the Indian population; in spite of this a large portion of the population is still affected by micronutrient deficiencies. There is clear evidence of a demographic, epidemiological and nutrition transition in India. There are tremendous growth opportunities for the nutraceuticals in India, as of increased consumer base. Nutraceuticals and functional foods segment currently stands at US\$2.8 billion (2015) and is expected to grow to US\$8.5 billion by 2022. Numerous Indian companies are offering diet supplements/nutraceuticals/functional foods such as Kellogg India Limited (cornflakes and oats), Britannia Industries Limited (Nutrichoice biscuits, Tiger glucose biscuits) Nestle India Limited (ActiPlusDahi, CEREGROW, MILO, Baby and Me), Agro Tech Foods Limited (Sundrop cooking oil), Ruchi Soya Industries Limited (Nutrela), Amway India Enterprises Limited (Nutrilite), Dabur India Limited (Glucose-D), Patanjali (Aloe vera Fiber Juice).

REGULATION OF NUTRACEUTICALS

A product claiming any nutritional or health benefit must be based on scientific principles to guarantee validity, safety, efficiency and trust. To generate and maintain consumers' confidence and trust, it is imperative that correct health claims are made. These health claims must be made in consultation with health authorities, industry and appropriate regulations. Although it is difficult to achieve the international consensus in terms of definition, composition and labeling of Nutraceuticals, it is important to adhere to these standards because of global markets.

Since 2006, various laws such as Prevention of Food Adulteration Act, 1954; Fruit Products Order, 1955; Meat Food Products Order, 1973; Vegetable Oil Products (Control) Order, 1947; Edible Oils Packaging (Regulation) Order 1988; Milk and Milk Products Order, 1992 existed to handle food related issues. The Food Safety and Standards Act, 2006 (FSS Act) was formed in 2006 which merged all the above-mentioned laws. This Act was formulated with an objective to establish a single reference goal for all matters relating to regulation and supervision of food safety and standards.

FSSAI came into existence in 2011 which regulates the health supplements and nutraceuticals through Food and Safety Standards Act, 2006 and the regulations framed there under. India has notified the Food Safety and Standards Regulations, 2016 in the Gazette of India on 23 December 2016. The regulations cover these categories of food: i) health supplements, ii) nutraceuticals, iii) food for special dietary use, iv) food for special medical purpose, v) functional food and vi) novel food. Different countries' legislations have different definitions of health supplements and nutraceuticals. The term Nutraceuticals, globally, can be divided into 3 segments i.e., functional/fortified food, functional beverages and dietary supplements.

Further, FSSAI has released the Food Safety and Standards (Fortification of Foods) Regulations, 2017 on 19 May 2017. These regulations prescribe standards for fortification of oil, salt, milk, vanaspati, atta, maida and rice.

REGULATORY GUIDELINES FOR NUTRACEUTICALS IN INDIA

The manufacturing and sale of Nutraceuticals can be done in the form of tablets, capsules and syrups. It must fulfill requirements related to quality and standards.

* The formulation should be based on strong medicinal or nutritional principles which must be supported by proven scientific data.

* The presence of Hormones, steroids or psychotropic ingredients is not legitimate in the formulation of Nutraceuticals.

* It is also important to take into consideration the nutrients quantity recommended for daily consumption (RDA) by the Indian Council of Medical Research.

* The product label should be made in accordance with the Food Safety and Standards (Packaging and Labeling) Regulations, 2011. The label and advertisement of each type of food item must provide sufficient information about the nature and purpose of food; detailed instructions and precautions for its use.

CONCLUSION

Health improvement and maintenance must be the primary goal of both individuals and government alike. Despite a rapid proliferation of nutraceuticals in the consumer market, there are some lacunas in the information regarding specific utility of these products for health promotion and disease prevention. However, research regarding nutraceuticals and their uses in relation to their components and their biological effects are still awaiting. There are few researches that claim the benefits of nutraceuticals and their usage by the public in their day today life, in relation to their potential for promoting public health.

It can be concluded that nutraceuticals are available in various forms and are easily accessible. They provide all the essential nutrients necessary to promote health. In addition, nutraceuticals are having protective, healthy and novel approaches that can conquer various illnesses without harming individuals. These can be a suitable alternative to modern medicines.

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