Nutraceuticals and functional foods: an innovative approach for management of lifestyle diseases

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ABSTRACT

Nutraceuticals and functional foods have attracted considerable interest recently because of their well-known safety and potential nutritional and therapeutic effects. The interest in nutraceuticals continues to grow, powered by progressive research efforts to identify properties and potential applications of nutraceutical substances, coupled with changing consumer behavior and demand. Nutraceuticals include food supplements, dietary supplements, value-added processed foods as well as non-food supplements such as tablets, soft gels, capsules etc; which are packed with bioactive flavonoids, carotenoids, anthocyanins, vitamins, and other polyphenolics. These active components provide health as well as medical benefits; including the prevention and treatment of disease. Life expectancy continues to rise and along with a rise in the lifestyle diseases i.e. obesity, diabetes, hypertension, cancer and cardio-vascular diseases (CVD). It is estimated that by 2030, India will have 23.6 million people with CVD, 40 million diabetics and 215 million hypertensive populations. It is an inevitable fact that affluence is one of the causes of lifestyle diseases, which nutraceuticals and dietary supplements often address. The consumption of foods such as oats, flaxseeds, soybean, green tea, citrus fruits, tomatoes, garlic and nuts etc along with their associated physiologically active components is linked to disease risk reduction. People can optimize the health-promoting capabilities of their diet by way of supplementation and by consuming foods that have been formulated or fortified to include health-promoting factors. Nutraceuticals and Functional food is one of the innovative approaches for management of lifestyle diseases. Any health benefits attributed to functional foods should be based on sound and accurate scientific criteria, including rigorous studies of safety and efficacy. Consumers must realize that functional foods are not a “wonder food” or a panacea for poor health habits. Diet is only one aspect of a comprehensive lifestyle approach to good health, which should include regular exercise, maintenance of healthy body weight, stress reduction and other positive health practices. Nutraceutical and functional foods become part of an effective strategy to maximize health and reduce disease risk; only when healthy lifestyle practices are followed. A collective effort by the academia, industry, government and research institute must continue to promote nutraceutical and functional food to contain the menace of lifestyle diseases.

Key words: Nutraceuticals, functional foods, lifestyle disorders, healthy foods

INTRODUCTION

“Nutraceuticals and functional foods have received considerable interest recently because of their resumed safety and potential nutritional and therapeutic effects”. 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. Presently over 470 nutraceutical and functional food products are available with documented health benefits. There is a lot of confusion regarding the terminologies like “nutraceuticals,”“functional foods,”“dietary supplements,”“designer foods,”“medical foods,”“pharmafoods,”“phyto-chemicals” etc. There seems to be thin dividing line in their interchangeable usage by different people on different occasions.

“Pharmaceuticals” may be considered as drugs used mainly to treat diseases, while “nutraceuticals” are those that are intended to prevent diseases. Pharmaceuticals are substances which have patent protection as a result of expensive testing to conform to the specifications of respective Governments. Both pharmaceuticals and nutrients can cure and prevent disease(s) but only pharmaceuticals have governmental sanction. Many pharmaceuticals have their origin in plants and animals and are no less "natural" than nutrients. Classic example of nutrients is synthetic vitamins.

Nutraceuticals sometimes referred as “functional foods,” have caused heated debate because they blur the traditional dividing line between food, and medicine. When food is being cooked or prepared using "scientific intelligence" with or without the knowledge of how or why it is being used, then the food is called as "functional food." Thus, functional food provides the body with the required amount of vitamins, fats, proteins, and carbohydrates, necessary for healthy survival. When functional food aids in the prevention and/or treatment of disease(s)/disorder(s) other than deficiency conditions like anemia, it is called a “nutraceutical.” Thus, a functional food for one consumer can act as a
nutraceutical for another. Examples of nutraceuticals include fortified dairy products (milk as such is a nutrient and its product casein is a pharmaceutical) and citrus fruits (orange juice is nutrient and its constituent ascorbic acid is a pharmaceutical). The use of nutraceuticals, as an attempt to accomplish desirable therapeutic outcomes with reduced side effects, as compared with other therapeutic agents has met with great monetary success. The preference for the discovery and production of nutraceuticals over pharmaceuticals is, well appreciated by the pharmaceutical and biotechnology companies.

CATEGORIES OF NUTRACEUTICALS

Nutraceuticals can broadly be categorized as products which are extracted from natural sources (nature like) or manufactured synthetically (man-made), which supplement the diet to provide nutrition over and above regular food and help prevent nutrition related disorders. Nutraceuticals are categorized as follows:

1. Based on chemical constituents
   (a) Nutrients : Substances with established nutritional functions, such as vitamins, minerals, amino acids and fatty acids.
   (b) Herbals : Herbs or botanical products as concentrates and extracts
   (c) Dietary Supplement : Dietary supplements are products administered through mouth that contain a dietary ingredient intended to add something to the foods you eat. Examples of dietary supplements are black cohosh for menopausal symptoms, ginkgo biloba for memory loss, and glucosamine/chondroitin for arthritis. They also serve specific functions such as sports nutrition, weight-loss supplements and meal replacements. Supplement ingredients may contain vitamins, minerals, herbs or other botanicals, amino acids, enzymes, organ tissues, gland extracts, or other dietary substances. They are available in different dosage forms, including tablets, capsules, liquids, powders, extracts, and concentrates.

2. Traditional and Non-Traditional nutraceuticals
   Wide variety of nutraceutical foods are available in the market which falls in the category of traditional foods and non traditional foods.
   (a) Traditional Nutraceuticals: Under the category of traditional Nutraceuticals comes food in which no change to the food are made; It is simply natural, whole foods with new information about their potential health qualities. There has been no change to the actual foods, other than the way the consumer perceives them. Many fruits, vegetables, grains, fish, dairy and meat products contain several natural components that deliver benefits beyond basic nutrition, such as lycopene in tomatoes, omega-3 fatty acids in salmon or saponins in soy. Even tea and chocolate have been noted in some studies to contain health-benefiting attributes. Tomatoes and salmon are two types of food that researchers have found to contain benefits beyond basic nutrition - in this case, lycopene and omega-3 fatty acids, respectively.

   (b) Nontraditional Nutraceuticals : They are the outcome from agricultural breeding or added nutrients and/or ingredients such as orange juice fortified with calcium, cereals with added vitamins or minerals and flour with added folic acid are nontraditional nutraceutical.

   Agricultural scientists successfully have come up with the techniques to boost the nutritional content of certain crops. Research currently is being conducted to improve the nutritional quality of many other crops.

NUTRACEUTICAL SCENARIO IN INDIA

The Indian nutraceutical industry has great prospects. Over the last decade a wide range of products have been available, giving an insight into the tremendous growth. On one hand, a booming economy has resulted in overall increase in disposable income of population. Added to this unhealthy, eating habits coupled with sedentary lifestyle have led to increase incidence of diet and its related health issues. On the other hand, there is a growing awareness on the importance of nutrition and diet for long-term good health. These have contributed to a favorable market conditions for Nutraceutical industry in India. India has a lot of advantages like qualified human resources, world class R & D facilities and varied raw material-aspects that give our country a leading edge.

   The Indian Nutritional market is estimated to be USD 1 Billion. While the global market is growing at a CAGR of 7%, the Indian market has been growing much faster at a CAGR of 18% for the last three years, driven by Functional food and beverages categories. However, the latent market in India is two to four times the current market size and is between USD 2 to USD 4 billion with almost 148 million potential customers. In USD 1 billion market size functional food having 54% market share followed by 32% market share of Dietary supplement and 14% share of Functional beverages. The Indian nutraceutical market is dominated primarily by pharmaceuticals and FMCG companies, with very few pure play nutraceutical companies. Some major companies Marketing Nutraceuticals in India are GlaxoSmithKline consumer healthcare, Dabur India, Cadila Health care, EID Parry’s, Zandu Pharmaceuticals, Himalaya herbal Healthcare, Amway, Sami labs, Elder pharmaceuticals and Ranbaxy.

   Functional foods do not possess clear-cut legal definition. Quite often it is difficult to decide whether a new product...
should be labeled as food, supplement or drug. These categories are regulated differently in different countries. Most countries do not have standard for functional food and do not permit health claims. In India, many health supplements are available under Ayurvedic health care system. The functional foods, nutraceuticals, novel foods etc are dealt in chapter IV of the New food Safety and Standards Act, 2006. These products will be examined by the Scientific Panel of Food Safety and Standard Authority of India (FSSAI).

**WHY THERE IS A NEED?**

There has been an explosion of consumer interest in the health enhancing role of physiologically-active specific nutraceuticals. These products include food supplements, dietary supplements, value-added processed foods as well as non-food supplements such as tablets, soft gels, capsules etc. These materials are rich source of bioactive flavonoids, carotenoids, anthocyanins, vitamins, and other polyphenolics. They help in prevention of various diseases through antioxidant activity and reduce the disease risks.

The interest in nutraceuticals continues to grow, powered by progressive research efforts to identify properties and potential applications of nutraceutical substances, and coupled with public interest and consumer demand. Phytochemicals and antioxidants are two specific types of nutraceuticals. Research has proved that foods with phytochemicals may help to provide protection from diseases such as cancer, diabetes, heart disease, and hypertension, e.g. carotenoids found in carrots. Antioxidants may be helpful in avoiding chronic diseases, by preventing oxidative damage in our body.

**Health scenario of India**

- **Diabetes in India**: The estimate of the actual number of diabetics in India is around 40 million.
- **Hypertension – the silent killer**: 140 million in 2008 to nearly 215 million by 2030. As per the World Health Organization (WHO), high blood pressure affects every third person above the age of 18.
- **Cancer Scenario in India**: Cancer is the second most common disease in India responsible for maximum mortality with about 0.3 million deaths per year.
- **Obesity in India**: Incidence: 12% males and 16% females in India 30% males and 37.5% females in Punjab
- **India: ‘Heart disease capital of world’**: An estimated 17.3 million people died from CVDs in 2008, representing 30% of all global deaths. Of these deaths, an estimated 7.3 million were due to CHD and 6.2 million were due to stroke.

Over 80% of CVD deaths take place in low and middle income countries and occur almost equally in men and women. By 2030, almost 23.6 million people will die from CVDs, mainly from heart disease and stroke.

**BENEFITS OF FUNCTIONAL FOODS AND NUTRACEUTICALS**

Some of the benefits of nutraceuticals and functional foods supported by scientific evidence are given below:

- Cardiovascular agents
- Anti-obese agents
- Anti-diabetics
- Anticancer agents
- Immune boosters
- Chronic inflammatory disorders
- Degenerative diseases

**Functional Foods of Plant Origin**

Numerous plant foods or physiologically active ingredients derived from plants, have been investigated for their role in disease prevention and health. However, only a small number of these have had substantive clinical documentation of their health benefits. Those plant foods currently eligible to bear an FDA-approved health claim include oat soluble (β-glucan) fiber, soluble fiber from psyllium seed husk, soy protein and sterol- and stanol-ester–fortified margarine (FDA 2000). Some plant-based foods or food constituents currently do not have approved health claims, but have growing clinical research supporting their potential health benefits, and thus would be described as having moderately strong evidence. These include cranberries, garlic, nuts, grapes and chocolate.

**Oats**

Oats have high fiber content andavenanthramides as active compounds. Oat fiber helps to remove cholesterol from the digestive system that would otherwise end up in the bloodstream. Antioxidant compounds unique to oats, calledavenanthramides, help prevent free radicals from damaging LDL-C, thus reducing the risk of CVD.

In its health claim petition, the Quaker Oats Company summarized 37 human clinical intervention trials conducted between 1980 and 1995. The majority of these studies revealed statistically significant reductions in total and LDL-cholesterol in hyper-cholesterolemic subjects consuming either a typical American diet or a low fat diet. The daily amount of oat bran or oatmeal consumed in the above studies ranged from 34 g to 123 g. Quaker Oats determined that 3 g of b-glucan would be required to achieve a 5% reduction in serum cholesterol, an amount equivalent to approximately 60 g of oatmeal or 40 g of oat bran (dry weight). Thus, a food bearing the health claim must contain 13 g of oat bran or 20 g oatmeal, and provide, without fortification, at least 1.0 g of b-glucan.
Flax seed

Flax seeds have cardio-protective effects in many ways. Flax fiber can help prevent and combat constipation as well as soothing and healing the intestinal system. It prevents your body reabsorbing cholesterol. Its mucoadhesive -gelatinous texture bulks up the stool and gently pulls toxins, cholesterol and waste out of the body. The Lignans in flax seeds acts as antioxidants and helps to decrease plasma cholesterol. This is important since high plasma cholesterol levels are associated with the increased risk of coronary artery disease and atherosclerosis (thickening artery walls) and protects from cancers. Omega-3 fatty acids present in flax seeds help to reduce the bad cholesterol and it also helps the body and brain fight off stress, anxiety and tension, which can help prevent heart disease. (Bloedan et al., 2008)

Dodin et al. (2008) analyzed the effect of flaxseed on cardiovascular disease in 199 healthy menopausal women. During the intervention, 40 g of flaxseed or wheat germ placebo was given daily for 12 months. It was reported that flaxseed increased plasma alpha-linolenic, docosapentaenoic and total omega-3 fatty acids. From baseline, flaxseed raised apolipoproteins A-1 and B by 4.4% and 3%, whereas wheat germ increased these apolipoproteins by 11.6% and 7%, respectively. Both treatments increased lipoprotein(a) and decreased LDL levels.

Meta-analysis of the effects of flaxseed interventions on blood lipids was done which included 28 studies. The daily doses used in the flaxseed interventions included in this meta-analysis, ranged from 20.0 to 50.0 g/d (median dose: 38.0 g). The results of the meta-analysis revealed that there was a reduction in total and LDL-C by 0.10 mmol/L and 0.08 mmol/L. A significant reduction were observed with whole flaxseed (20.21 and 20.16 mmol/L, respectively) and lignin (20.28 and 20.16 mmol/L, respectively) supplements but not with flaxseed oil

Soy bean

Soy is made up of proteins, isoflavones and fiber which are beneficial to good health. Soy protein has essential amino acids that help breakdown bad cholesterol. Soy has lower saturated fatty acids compared to cow’s milk. Studies showed that those given soy milk to drink had reduced their hypertension levels to about 10% in just about nine weeks of continuous drinking; compared to those who were given cow’s milk with almost no change in their hypertension conditions. Further, isoflavones content in soy protein that greatly affected the decrease of hypertension. Isoflavones, which are active ingredients in soy, reduced cholesterol levels especially the bad cholesterol in hypertensive patients.

Yang et al. (2005) found that soy protein intake was inversely associated with both systolic BP (P for trend = 0.01) and diastolic BP (P for trend = 0.009) after adjustment for age, body mass index, and lifestyle and other dietary factors. The adjusted mean systolic BP was 1.9 mm Hg lower (95% CI: −3.0, −0.8 mm Hg) and the diastolic BP was 0.9 mm Hg lower (−1.6, −0.2 mm Hg) in women who consumed ≥25 g soy protein/d than in women consuming <2.5 g/d. The inverse associations became stronger with increasing age (P for interaction < 0.05 for both BPs).

Soy and milk protein intake reduce systolic BP compared with a high glycemic index refined carbohydrate among patients with prehypertension and stage 1 hypertension. Partially replacing carbohydrate with soy or milk protein might be an important component of nutrition intervention strategies for the prevention and treatment of hypertension (Pal and Ellis, 2009).

Supplements of milk and soy protein lowered blood pressure modestly among hypertensive patients. Replacing some refined carbohydrates such as white bread and white rice in the diet with soy or milk protein might be an important component of nutrition intervention strategies for the prevention and treatment of hypertension (Jiang, 2011).

Cranberries

Cranberries have been recognized since the 1920s for their efficacy in treating urinary tract infections. A landmark clinical trial (Avorn et al., 1994 ) confirmed this therapeutic effect in a well-controlled study involving 153 elderly women. More recent researches has confirmed that condensed tannins (proanthocyanidins) in cranberry are the biologically active component and prevent E. coli from adhering to the epithelial cells lining the urinary tract (Howell et al., 1998). New preliminary research suggests that the antiadhesions properties of the cranberry may also provide other health benefits, including in the oral cavity (Leahy et al., 2001).

Garlic

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Garlic has been used for thousands of years for a wide variety of medicinal purposes; its effects are likely attributable to the presence of numerous physiologically active organosulfur components (e.g., allicin, allylic sulfides). Allicin, the immunologically active component, has been found to affect oxidative stress and immune response. Allicin is not present in raw garlic, but it is rapidly produced by the action of CS-lyase (allinase) on alliin. Allinase is activated by crushing or cutting the garlic cloves. It prevents heart disease, including atherosclerosis or hardening of the arteries (plaque buildup in the arteries that can block the flow of blood and may lead to heart attack or stroke), high cholesterol, high B, and to boost the immune system. Garlic has been shown to have a modest blood pressure–lowering effect in clinical studies (Silaghy et al, 1994), while a growing body of epidemiologic data suggests an inverse relationship between garlic consumption and certain types of cancer (Fleischauer et al, 2000) particularly of the stomach. Kojuri and coworkers (2007) conducted a study to observe the effects of anethum graveolens and garlic on lipid profile of 150 hyperlipidemic patients. Subjects were divided into three equal groups. Group 1 was given enteric-coated garlic powder tablet (equal to 400 mg garlic) twice daily. Group 2 was given anethum tablet (650 mg) twice daily, and Group 3 was given placebo tablet. Six weeks later, lipid profiles were checked. It was found that in garlic group: TC decreased by 12.1% and LDL-C decreased by 17.3%. HDL cholesterol increased by 15.7% and triglyceride dropped by 6.3%.

Another study conducted by Ashraf et al (2011) revealed that garlic supplementation with standard anti-diabetic agent provided better diabetic control in type 2 diabetes patients. For the study, 60 patients with type 2 diabetes were taken. They were divided into 2 groups. Group 1 was given tablet Garlic 300 mg thrice daily + Metformin 500 mg twice daily. Group 2 was given Placebo + Metformin 500 mg twice daily respectively for 24 weeks. It was found out that in Group 1 showed considerable decrease in TC (-2.82%), LDL-C (-2.18%) TGs (3.12%) while HDL-C was significantly increased (6.72%) as compared to Group 2. Thus, it was concluded that Garlic may be a good addition in the management of patients with diabetes and hyperlipidemia.

Mahmoodi et al (2011) conducted a study to see the effects of consumption of raw garlic on serum lipid level, blood sugar and a number of effective hormones on lipid and sugar metabolism in hyperglycemic and/or hyperlipidemic individuals. The subjects were divided into 3 groups. Group 1: having blood sugar more than 126 mg/dl (30 volunteers); Group 2: having cholesterol higher than 245 mg/dl(30 volunteers) and Group 3: having blood sugar over 126 mg/ dl and cholesterol more than 245 mg/dl (25 volunteers). 10 g/day raw garlic was given for 6 weeks to the three groups. It was revealed that garlic consumption (10 grams daily) decreased TC, TGs and increased HDL-C in the second and third group.

Green Tea

Green tea contains a active compound: polyphenolic compounds and catechins. The major tea catechins include (-) epicatechin (EC), (-)epigallocatechin (EGC), (-)epicatechin-3-gallate (ECG), and (-)epigallocatechin- 3-gallate (EGCG). Tea can be classified into 3 main categories according to the degree of fermentation: fully fermented black tea, semi fermented Oolong tea, and unfermented green tea. Catechins lower lipids levels, reduce oxidative stress, inhibit platelet aggregation, and decrease apolipoprotein B levels and increase the ratio of ApoA-1/ApoB. Green tea catechins containing a galloyl group in the 3’ position inhibit tissue factor-induced thrombin generation.

Green tea consumption and mortality due to cardiovascular disease and cancer in Japan was studied by Kuriyama and coworkers (2006). It was revealed that the green tea consumption of ≥5 cups/d had lower risk of all-cause and CVD mortality as compared with those consumed <1 cup/day. Thus, concluded that green tea consumption is associated with reduced mortality due to cardiovascular disease. Yang et al (2011) studied the preventive effects of drinking green tea on cancer and cardiovascular disease. It was found out that consumption of >10 cups/day green tea decreased the relative risk of death from CVD. Onakpoya et al (2014) studies that green tea intake results in significant reductions in systolic blood pressure, total cholesterol and LDL cholesterol. The effect size on systolic blood pressure is small, but the effects on total and LDL cholesterol appear moderate. Longer-term independent clinical trials evaluating the effects of green tea are warranted.

Nuts

Nuts have an active compound: unsaturated fats and plant fiber (both of which may be responsible for the reduction of LDL) and arginine. Arginine, a precursor to nitric acid, which is a substance made in the walls of blood vessels that relaxes the blood vessels and prevents clotting. Some nuts, especially walnuts contain alpha-linolenic acid, a precursor to omega-3 fatty acid, which helps protect against heart disease. A systematic review of the effects of nuts on blood lipid profiles in humans was conducted. Almond (50–100 g/d), peanuts (35–68 g/d) and walnuts (40–84 g/d) were given for ≥5times/week. It was seen that there was a decreases in TC between 2-16% and LDL-C between 2- 19% compared with subjects consuming control diets. (Petersen et al, 2005). Rajaram et al (2009) studied the effect of walnuts and fatty fish on different serum lipid fractions in normal to mildly

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Tomatoes and tomato products are also being investigated for their role in cancer chemoprevention and are unique because they are the most significant dietary source of lycopene, a non-provitamin A carotenoid that is also a potent antioxidant (Clinton, 1998). A comprehensive review of 72 epidemiologic studies (Giovannucci, 1999) found an inverse association between tomato intake or plasma lycopene concentration and the risk of cancer.

Citrus fruits

Several epidemiological studies have shown that citrus fruits are protective against a variety of human cancers. Although oranges, lemons, limes and grapefruits are a principal source of such important nutrients as vitamin C, folate and fiber, Elegbede et al (1993) has suggested that another component is responsible for the anticancer activity. Citrus fruits are particularly high in a class of phytochemicals known as the limonoids (Hasegawa and Miyake, 1996).

Over the last decade, evidence has been accumulating in support of the cancer preventative effect of limonene (Gould, 1997). Crowell (1997) showed this compound to be effective against a variety of both spontaneous and chemically- induced rodent tumors. Based on these observations, and because it has little or no toxicity in humans, limonene has been suggested as a good candidate for human clinical chemoprevention trial evaluation. A metabolite of limonene, perrillyl alcohol, is currently undergoing Phase I clinical trials in patients with advanced malignancies (Ripple et al., 1998).

There is growing evidence that wine, particularly red wine, can reduce the risk of CVD. The high phenolic content of red wine, which is about 20-50 times higher than white wine, is due to the incorporation of the grape skins into the fermenting grape juice during production.

Functional Foods of Animal Origin

Probably the most intensively investigated class of physiologically-active components derived from animal products are the (n-3) fatty acids, predominantly found in fatty fish such as salmon, tuna, mackerel, sardines and herring (Kris-Etherton et al., 2000). The two primary (n-3) fatty acids are eicosapentaenoic acid (EPA; 20:5) and docosahexaenoic acid (DHA; 22:6). DHA is an essential component of the phospholipids of cellular membranes, especially in the brain and retina of the eye and is necessary for their proper functioning. DHA is particularly important for the development of these two organs in infants (Crawford, 2000) and just recently, the FDA cleared the use of DHA and arachidonic acid for use in formula for full-term infants (FDA 2002). Hundreds of clinical studies have been conducted investigating the physiologic effects of (n-3) fatty acids in such chronic conditions as cancer, rheumatoid arthritis, psoriasis, Crohn’s disease, cognitive dysfunction and cardiovascular disease (Rice, 1999) with the best-documented health benefit being their role in heart health. A recent meta-analysis of 11 randomized control trials suggests that intake of (n-3) fatty acids reduces overall mortality, mortality due to myocardial infarction and sudden death in patients with CHD (Bucher et al., 2002).

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<th>Health food constituents from plant and animal sources and their uses</th>
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| Rice | • Soluble and insoluble dietary fibre  
      • Phenols (tricin)  
      • Antioxidants (tocopherols, tocotrienols, oryzanols)  
      • Help in treating gastrointestinal problems  
      • Prevention of cancers |
| Flaxseed | • α – linoleic acid (ω – 3 fatty acid) in oil  
       • Phenolic acids (trans-ferulic, trans-sinaptic, f-coumaric, trans-caffeic)  
       • flavonoids  
       • Protection against cardiovascular (CV) diseases  
       • Reduces mortality due to cancer  
       • Retarded tumour growth  
       • Anti-parasitic and antimalarial activities  
       • Anti-bacterial, anti-viral, anti-inflammatory properties |
| Citrus fruits | • Vitamin C, E carotenoids  
       • Flavonoids (Quercitin, limonene)  
       • Delaying cancers, CV diseases, cataracts  
       • Anti-cancers properties |
| Grapes | • Phenolic compounds, anthocyanins, flavonols, flavan-3-ols.  
       • Delay onset of CV diseases, antioxidants, anti ulcer, reduced risk of cancer |
| Brassica vegetables | • Glucosinolates glycosides  
       • Isothiocyanate  
       • Vitamin C, A, K1  
       • Reduced risk of cancer  
       • Wound healing  
       • Erythrocytes formation  
       • VIT. K1 is important in synthesis of blood clotting factors in liver |
| Onion and Garlic | • Forms sulphur compounds (S-alk(en)y) cysteine sulphoxide and sulphonic acid  
       • Flavonoids (quercitin glucosides) anthocyanins  
       • Prostaglandins  
       • Sterols, steroidal glycosides  
       • Anticarcinogenic  
       • Lower serum cholesterol  
       • Reduced blood sugar level so beneficial in diabetes  
       • Reduced hypertension  
       • Improve body immune system |
Another class of biologically active animal-derived components that has received increasing attention in recent years is probiotics. A recent Scientific Status Summary on probiotics from the Institute of Food Technologists summarized the scientific support for the therapeutic and/or preventive use of these functional ingredients for various health concerns including cancer, intestinal tract function, immune function, allergy, stomach health, urogenital health, cholesterol lowering and hypertension (Sanders, 1999).

The Future of Functional Foods

Academic, government and private research institutes around the globe are devoting substantial efforts to identifying how functional foods and food ingredients might help prevent chronic disease or optimize health, thereby reducing healthcare costs and improving the quality of life for many consumers. An emerging discipline that will have a profound effect on future functional foods research and development efforts is nutrigenomics, which investigates the interaction between diet and development of diseases based on an individual’s genetic profile. Interest in nutrigenomics was greatly augmented by the recent announcement that a rough draft of the complete sequence of the human genome had become available. Nutrigenomics will have a profound effect on future disease prevention efforts including the future of the functional foods industry.

Another technology that will greatly influence the future of functional foods is biotechnology. Recent examples of biotechnology-derived crops which have tremendous potential to improve the health of millions worldwide include golden rice and iron-enriched rice (Falk et al., 2002). These grains are genetically engineered to provide enhanced levels of iron and β-carotene which could, in turn, help prevent iron deficiency anemia and vitamin A deficiency–related blindness worldwide. In the future, other foods enhanced with other nutritive or nonnutritive substances may even help to prevent chronic diseases such as heart disease, osteoporosis or cancer. The acceptance of biotechnology by consumers (currently a major issue in Europe) will be important if the potential of this powerful methodology is to be realized.

In Punjab state with abundance of food grains and increasing trends in fruits and vegetables, there is options for producer and to promote growth in the nutraceuticals sector through partnership between research centers, private entrepreneurs and indigenous communities. However, the success requires sufficient proof to establish the health claim and capacity to accurately market functional food to consumers in high end-product. These products can find demand in the domestic market and for export. Identification of export mark, certification and other regulations and consumer demand for the product. Further studies are required to establish the most critical bottlenecks in production system and identify opportunities with the potential rural employment and competitive advantage for small-scale farmers as producers of nutraceuticals.

Conclusion

Although many functional foods may hold promise for public health, there are concerns that the promotion of functional foods and structure/function claims may not rest on sufficiently strong scientific evidence. Therefore, any health benefits attributed to functional foods should be based on sound and accurate scientific criteria, including rigorous studies of safety and efficacy. Interactions with other dietary components and potential adverse interactions with pharmaceutical agents must be clearly imparted. Consumers must realize that functional foods are not a “wonder food” or a panacea for poor health habits. Diet is only one aspect of a comprehensive lifestyle approach to good health, which should include regular exercise, maintenance of healthy body weight and other positive health practices. Only when all of these issues are addressed, can functional foods become part of an effective strategy to maximize health and reduce disease risk.

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