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RESEARCH ARTICLE

ROLE OF FUNCTIONAL FOOD IN THERAPEUTIC NUTRITION: BRIEF REVIEW

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ABSTRACT

A fortified food which delivers all health benefits along with vitamins and minerals is defined as "Functional Food". Nutrition is important for good health and defense from various diseases. There are two types of physiologically active components in foods known as phytochemicals and zoochemicals. Ideally, there should be a scientific relevance between benefits of function food and human health. However, all the functional foods do not full fill this criterion of scientific relevance. Diet is only one part of essential nutrient to good health. How much amount to be consumed, is also important regarding functional food? Recently consumer are taking deep interest in functional food containing physiologically/ biologically active components in addition to the nutrients. In this brief review, functionality of functional food according to scientific relevance and recommended intakes has been reviewed.

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INTRODUCTION

Food contains bioactive components and thus protects us from various diseases. These foods are known as "functional foods". Good nutrition and access to an adequate diet and health are essential for human growth and development. Diet, food habits and lifestyle are contributory in global health. Human knew the medicinal supremacy of foods even before the 2,500 years when Hippocrates stated "Let food be thy medicine and medicine be thy food." For proper national development; adequate nutrition and a healthy productive population are necessary. Food nutrient are essential in improvements in health of whole family. Functional foods affects children's health, intelligence and educational performance and thus their economic status in adulthood. Physiologically active ingredient in foods like phytochemicals and zoochemicals are useful to reduce risk for many chronic diseases. All foods are functional, as they provide taste, aroma, or nutritive value. Within the last decade, however, the term functional food has adopted a different meaning that of providing an additional physiological benefit beyond that of meeting basic nutritional needs (Clare Hasler, 2002). This brief article includes definition of functional foods, safety consideration along with future of this new food group.

Definition and Concept of Functional Foods: A functional ingredient can be defined as a dietary ingredient that influence health of consumer in positive manner.

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So, functional foods are foods that have health approving qualities over and above their nutritional value. Ideally the functional food should fulfill the following conditions:

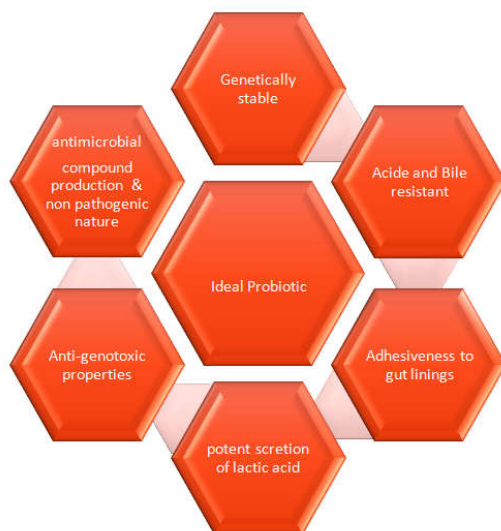
- Such product that is labelled as a "Functional Food" should be in the form of powders, granules, tablets, capsules, liquids, jelly meant for oral intake;
- Such product does not include a drug as defined in clause (b) and ayurvedic, sidha and unani drugs as defined in clauses (a) and (h) of section 3 of the Drugs and Cosmetics Act, 1940 and rules made there under;
- Does not assert to cure or diminish any specific disease, disorder or condition (except for certain health benefit or such promotion claims) as may be permitted by the regulations made under this Act;
- Does not include a narcotic drug or a psychotropic substance as defined in the Schedule of the Narcotic Drugs and Psychotropic Substances Act, 1985 and rules made thereunder and substances listed in Schedules E and EI of the Drugs and Cosmetics Rules, 1945 (2)

It is essential to establish the safe amount or permissible intake for functional foods to avoid harmful effect of over consumption. For example proper amount of garlic reduces the risk of heart disease and cancer while excess can result in gastrointestinal bleeding.

Functional food full of therapeutic: Probiotics, prebiotics and Synbiotics are useful in control acute infantile, travelers,

and antibiotics associated diarrhea, IBS, IBD, lactose intolerance, immunomodulation and obesity

Probiotics: The term Probiotics is derived from a Greek word meaning “for life” and used to define living non-pathogenic organisms and their derived beneficial effects on hosts. The term “Probiotics” was first introduced by Vergin, when he was studying the detrimental effects of antibiotics and other microbial substances, on the gut microbial population. He observed that “probiotika” was favourable to the gut microflora. Probiotic were then redefined by Lilly and Stillwell as “A product produced by one microorganism stimulating the growth of another microorganism”. Subsequently the term was further defined as “Non-pathogenic microorganisms which when ingested, exert a positive influence on host’s health or physiology” by Fuller. The latest definition put forward by FDA and WHO jointly is “Live microorganisms which when administered in adequate amounts confer a health benefit to the host”. Ideal probiotic should have following properties (Kavita *et al.*, 2015).

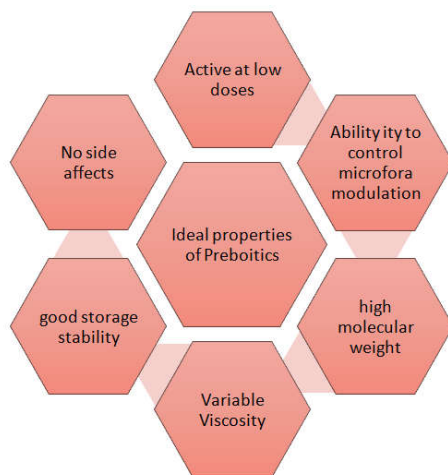


Probiotics are live microbial food supplements and assist in maintaining superb stability and composition of the intestinal microbiota and thus enhancement the resistance against infection by pathogens. Probiotics are now recognized as a hopeful category of food supplement. It is scientifically proved that probiotics are useful management of different types of diarrheal diseases, the modulation of immune function, the prevention of colon cancer, and other chronic gastrointestinal inflammatory disorders. In recent years, researcher are investigating the use of probiotics in a wide range of neurological diseases. (4) Probiotics are the ideal examples for functional foods. (5) In the recent past, Ice cream, flavored liquid milk, fermented milk, baby food, milk powder, frozen dairy desserts, cheese, buttermilk, whey-based beverages, and normal and sour cream have produced with probiotic bacteria. Several non-dairy probiotic products such as vegetarian-based products, fruit juices, soya-based products, oat-based desserts, baby foods, and breakfast cereal have been produced due to lactose intolerance. (6,7) The technique by which probiotics expresses its decent effects on health is still not clear. Probiotics prevent pathogen growth by synthesizing antimicrobial compounds. They also produce lactase, modifying gut pH, challenge the binding of pathogens and receptor sites as well as existing nutrients and growth factors, and excite immunomodulatory cells.(8)

One should be very careful while adding probiotic microbes to the food products to maintain the product quality or the sensory characteristics.(9) Human bodies have several groups of microorganisms which boost food consumption and digestion thus reduce the steps required to modify complex food structures to simpler ones.(10) In 1994, the World Health Organization considered probiotics to be the next-most significant immune defense system. The use of probiotics in antibiotic resistance is called as microbial interference therapy.(11,12) Probiotics are useful in maintaining good state of the genitourinary tract(13), tocheck the serum cholesterol levels (14),to control hypertension(15), to cure diarrheal diseases (15,16), to control side effects of antibiotic(17), tostop putrefactive-type fermentation(18), to support the production and secretion of antibacterial peptides(17), to decrease the incidence of allergy in vulnerable people.(15)Probiotics also support bioavailability and synthesis of nutrients and augment the immune system,(19) thus expand the intestinal tract health.(20) Saccharomyces boulardii, bifidobacteria spp., Lactobacillus reuteri, and Lactobacillus GG are generally employed for the treatment of diarrhea.(21,22)

Probiotics are very effective in inhibiting diarrheal diseases caused by rotaviruses in infants and traveler’s diarrhea.(20,23) Probiotics inhibit diarrhea-causing microbes by producing bacteriocins or by competing with pathogenic bacteria or viruses and stopping them from binding to the epithelial cells.(24) Probiotic bacteria can subdue gastric colonization and functions of Helicobacter pylori, by adding Lactobacillus salivarius which has the ability to produce high amounts of lactic acid and thus overpower the growth of H. pylori in vitro and in mice.(25, 26)Much interest has been shown regarding the possible role of the probiotics to cure inflammatory bowel diseases like ulcerative colitis.(27,28)The gut microbiota plays a very important role as environmental factor they control the development of both immune and metabolic functions at the time of pre and post neonatal life thus effect child and mother health.(29) A regular oral dose of 108 viable probiotic lactobacilli can re-establish and preserve the urogenital health of women.(30) Probiotic interventions in the control of type 2 diabetes by changing gut hormones. Because of the discovery of gut hormones such as glucose-dependent insulinotropic polypeptide (GIP) and glucagon-like peptide-1 (GLP-1) incretins and their implications in glucose homeostasis, the gut connection to type 2 diabetes has now been recognized much more than peripheral insulin resistance and the failure of the beta cell. Some of the strains of *Lactobacillus* spp. could exert a beneficial effect by reducing the body fat percentage in individuals suffering from diet-induced obesity, particularly by reducing the cell size of the white adipose tissues.(31)Colon cancer is a one of the common cancer throughout the world and probiotics helps in controlling colon cancer by (i) attaching and removing potential carcinogens ; (ii) synthesizing antimutagenic or antitumorigenic compounds in the colon; (iii) supporting the host’s immune response; (iv) modifying the intestinal microflora qualitatively and quantitatively; (v) altering the metabolic functions of the intestinal microflora; (vi) beneficial effects on the physiology of the host; and (vii) changing the physicochemical environment in the colon.(32) The intestinal microbiota affect the human brain growth and its activities.(33) The exchange of regulatory signals through bidirectional and integrative communication between the central nervous system and the digestive tract represents the gut–brain axis.(16)

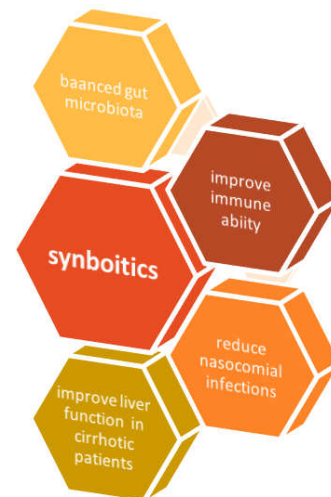
This complex system acts through direct and indirect mechanisms that comprises immunological, hormonal, and neural pathways.(34) In fact, many studies have reported that a stressful experience particularly in childhood can disturb the microbiota profile, limiting its multiplicity and thus affect the microbial species, and promote the translocation of the species known to provoke inflammation, such as Clostridia, and decrease the population of anti-inflammatory bacteria, such as Lactobacillus.(35) The intestinal microbiota has a powerful effect on many neuromodulators and neurotransmitters such as GABA, serotonin, monoamines, and brain-derived neurotrophic factors, which carry signals to the brain via the enterochromaffin cells, the enteric nerves, and the systemic circulation crossing the blood-brain barriers, in which permeability appears to be controlled by the microbiota in experimental models.(36) Overall, these scientific investigations demonstrate the potential effects of probiotics in curing neurological diseases and describe the immunological, neural, and metabolic pathways involved.(37) Currently, the successful utilization of probiotics in treating and preventing neurological disorders is a new trend.



Prebiotics: Prebiotics are mostly fibers that are non-digestible food ingredients and beneficially affect the host's health by selectively stimulating the growth and/or activity of some genera of microorganisms in the colon, generally lactobacilli and bifidobacteria. Prebiotics are substances that can stimulate the growth of beneficial microorganisms, mainly in the human gut and thus modify the colonic microbiota. The following health benefits are due to prebiotics e.g. relief from poor digestion of lactose, increased resistance to bacterial infection, better immune response and possible protection against cancer, reduction of the risk of diseases such as intestinal disease, cardiovascular disease, non-insulin dependent diabetes, obesity and also reduced risk of osteoporosis because inulin promotes the uptake of calcium and thereby increases bone mass.(38) Ideal prebiotic should have following properties:- Some examples of prebiotics include fructooligosaccharides, galactooligosaccharides, arabinose, galactose, inulin, raffinose, mannose, lactulose, stachyose, mannanoligosaccharides, xylooligosaccharides, palatinose, lactosucrose, glyooligosaccharides, isomaltooligosaccharides, soybean oligosaccharides, etc. (39). To be considered as having prebiotic action, the compound must reach the colon without degradation or alteration and must be a food substrate that stimulates the existing saprophytic bacterial flora. Food ingredients with prebiotic characteristics generally exhibit certain unique characteristics, such as limited hydrolysis and absorption in the upper gastrointestinal tract, selective

stimulation of the multiplication of beneficial bacteria in the colon, potential to suppress pathogens and limit virulence by processes such as immunostimulation and the stimulation of the beneficial microflora, which promote resistance to colonization by pathogens (40). Prebiotics can be found in some vegetables, such as leeks, onions, chicory, tomatoes, asparagus, artichokes, bananas, and alfalfa. It can also be added to industrial products such as foods for children, dairy and confectionery products, beverages, light mayonnaise and low-fat cheese, and they can be used as dietary supplements also. (41) Prebiotics are being used in the food industry as functional ingredients in beverages (fruit juices, coffee, cocoa, tea, soft drinks and alcoholic beverages), milk products (fermented milk, milk powder and ice cream), probiotic yogurts and synbiotic products (42,43). Other applications include desserts (e.g., jellies, puddings, fruit-flavored ice cream), confectionery items (e.g., sweets), biscuits, breakfast cereals, chocolates, breads and pastas, meat products (e.g., fish paste) and tofu. Prebiotics can also be used in cosmetics, pharmaceuticals and products for people with diabetes (43). The administration of prebiotics reduces blood lipids and blood pressure, increases the synthesis and absorption of nutrients and has anti-carcinogenic action. In addition to its functional properties, prebiotics show interesting properties that have implications for the food processing industry and the content of its end-products. The proper administration of prebiotics consists of following the recommended daily intake, which should be specific to the pathology indicated and at levels that do not cause side effects.

Synbiotics: To get the best effects of prebiotics, these can be combined with probiotics and this combination is termed as Synbiotics.

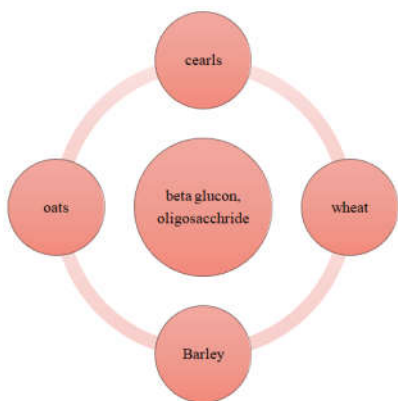


A synbiotic food activate the metabolism of one or a few body friendly bacteria and thus produce additional benefits to human body. Prebiotics and probiotics work in synergism. Synbiotics increase longevity of probiotics bacteria during the passage through the upper intestinal tract and thus implant them in the colon. This process helps in stimulating effect of the growth of probiotics. The probiotic strains used in synbiotic formulations include Lactobacilli, Bifidobacteria spp, S. boulardii, B. coagulans etc., while the major prebiotics used include oligosaccharides. The health benefits claimed by synbiotics consumption by humans include (3):

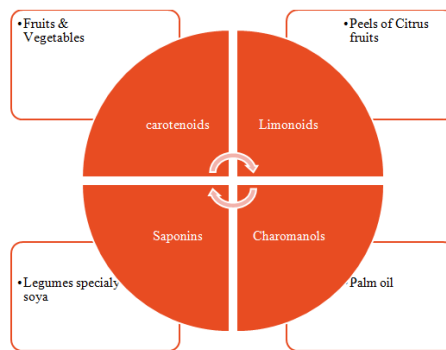
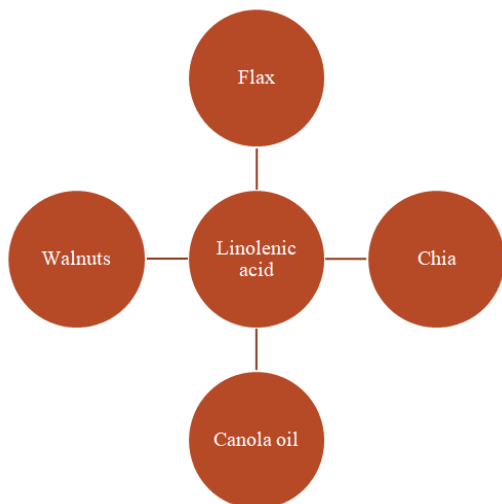
Plant as functional Food: The plant foods or physiologically active ingredients derived from plants have role in prevention of chronic disease (cancer) and in maintenance of health.

Chances of cancer is about half in people who eat diets full of fruits and vegetables. (44) There are nutrients in a plant-based diet that can reduce cancer risk. These components are biologically active plant chemicals and are known as “phytochemicals”. They are also known as non-nutritive plant based chemicals. They have preventive and therapeutic action. These compound diminishes the chances of cancer, metabolic diseases, neurodegeneration and viral infections due to anti-inflammatory property. They act as antioxidants. They have hormones regulatory effect so act as anti-aging agents. Phytochemicals act as anti-cancer due to apoptosis, cell cycle arrest, autophagy and epigenetic modification properties. They act as anti-obesity chemicals also. There are few deficiencies in phytochemicals also as they have higher minimum inhibitory concentration (MIC) than drugs, so, cannot used as monotherapy.(45) They have fewrestraint such as high dose requirement in food system, poor bioavailability, unknown mode of action, availability of raw material etc. The recent advance in science and technology such as biotechnology, combinatorial chemistry, nanotechnology, active packaging have enormous potential to address these existing limitations with enhanced antimicrobial activity.

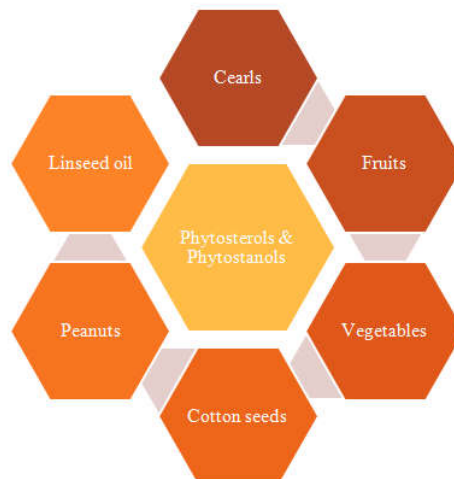
Beta glucon & Oligosaccharide: Beta glucon has Positive therapeutic effects on coronary heart disease, help in reductions of cholesterol and glycemic response. Oligosaccharides are effective in stimulating the growth of bifidobacteria and lactobacilli in human large intestine.(46-50)



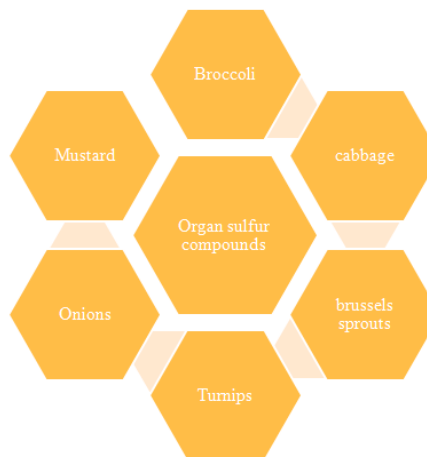
Linolenic acid: Linolenic acid cause inhibition of mammary carcinogenesis, decrease body fat and increase bone density. (51,52)



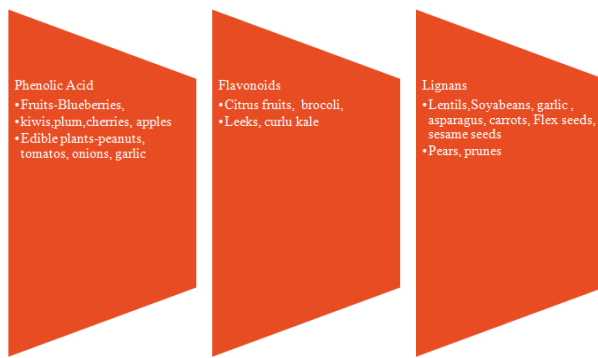
Carotenoids, Limonoids, Saponins, Charomanols: Carotenoids are biological antioxidants and protects cells and tissues from the damaging effects of free radicals and singlet oxygen. Limonoids are useful in protection of lung tissue, helps in clearing congestive mucus from the lungs of patients with chronic obstructive pulmonary disease, have cancer and cardioprotective effect. Saponins have cholesterol lowering, antioxidant, anticancer, and immunostimulatory properties. Charomanols inhibit breast cancer cell growth, cardiovascular health effects.(53-55)



Phytosterols and Phytostanols: These have cholesterol-lowering, anti-inflammatory, antiatherogenicity, anticancer, and antioxidative activities. (56-59)



Organ sulfur compounds: Organ sulfur compounds have antibacterial, antiviral, antifungal, strong antioxidants, antiatherosclerotic and anticancer activities, especially for those of the gastrointestinal tract.(60-62)



Phenolic Acid, Flavonoids, Lignans: Phenolic Acids have antioxidant properties, lower the risk of stomach cancer by reducing the formation of carcinogenic nitrosamines. Flavonoids lower incidence of heart disease, ischemic stroke, cancer, and other chronic diseases and have antioxidant activity. Lignans have antioxidant and (anti)estrogenic properties, reduce the risk of certain hormone-related cancers and cardiovascular diseases (63-68). There is a strict need for research to clarify the interaction of fortified functional/preservative constituents to the bioactive molecule of food. The search of new bioactive compounds from old-style food and explanation of its metabolic pathway is also required for the justifiable production of plant based bioactive compounds. Therefore, a complete multidisciplinary team works involving scientists with different expertise in plant science, molecular biology, agronomy, food engineering and environmental chemistry etc., are wanted to solve these challenges. (69)

Safety consideration: For healthy national population, functional foods in the diet is a necessity. What is the ideal levels of the biologically active components is not clear yet. Although there is evidence that certain functional foods or food ingredients can play a role in disease prevention and health promotion, still safety considerations should be prime considerations. Safety concerns have recently been raised due to high & haphazard consumption of functional food and health nutrients. Thus, Paracelsus' 15th century doctrine that "All substances are poisons . . . the right dose differentiates a poison from a remedy" is even more proper these days as people are becoming too fond dietary supplements. The absence of such safety information poses a significant safety risk to some consumers."

Ideally following recommendations should be made regarding the safety of functional foods:

- Develop and circulate regulations or other guidance for industry on the suggestions needed to document the safety of new dietary ingredients in dietary supplements.
- Develop and publicize regulations or other guidance for industry on the safety-related information required on labels for dietary supplements and functional foods.
- Develop an improved system to record and scrutinize reports of health problems associated with functional foods and dietary supplements

The future of functional foods: Extensive research work is being done to enhance our understanding of "functional foods" to improve the quality of life. Nutrigenomics is a technology which explores the interaction between diet and development of diseases based on an individual's genetic profile (human

genome). (70). This technological development could ultimately make it possible to amend a diet for an individual's specific genetic profile. Nutrigenomics will have a philosophical effect on future disease prevention efforts including the future of the functional foods industry. Another technology is biotechnology which effect the future of functional foods. Biotechnology has helped to develop golden rice and iron-enriched rice. (71) These grains are genetically engineered to provide superior 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 functional foods enriched with other nutritive or nonnutritive substances may even support to prevent chronic diseases such as heart disease, osteoporosis or cancer.

Conclusion

Functional foods hold promise for public health but there should be sufficiently strong scientific evidence and consumers should be made to understand the scientific bases of such claims. Any health benefits attributed to functional foods should be based on sound and accurate scientific criteria, including dynamic studies of safety and efficacy. Interactions with other dietary components and potential adverse interactions with pharmaceutical agents must be clearly conveyed. Consumers must appreciate that functional foods are not a complete solution for poor health habits. Dietary pattern is equally important as functional food. Thus, they should be cautious of claims made about benefits of these foods and there should be a trustworthy regulation by Govt. Consumers must do regular exercise, avoid alcohol and tobacco and should have stress free life to have maximum health benefits as health does not come from only from functional food and nutrients but also come from peace of mind, peace in heart and soul.

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