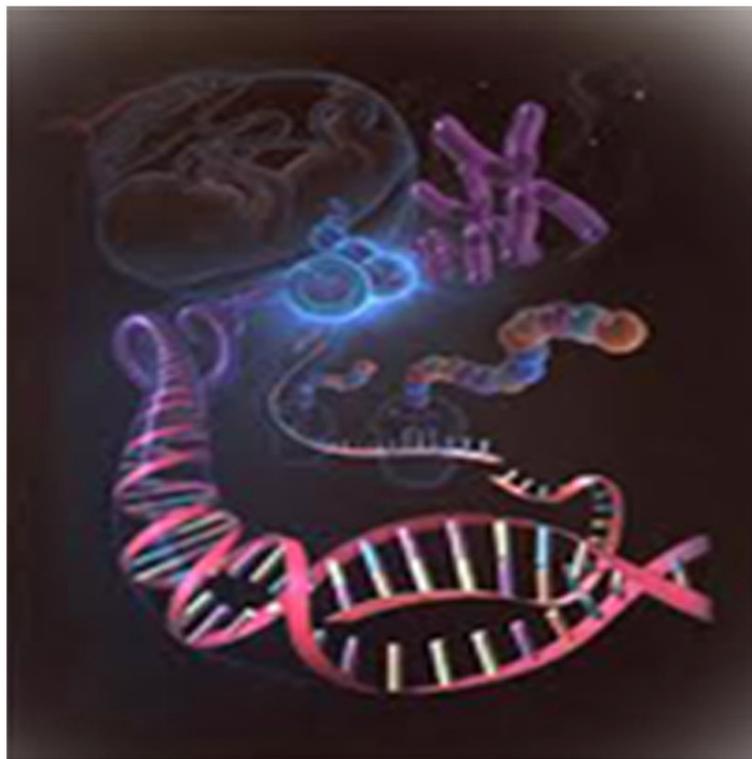


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Review Article

FUNCTIONAL FOOD PRODUCTS AND THEIR ROLE IN HEALTH AND PREVENTION OF DISEASE

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Now-a-days, there has been an explosion of consumer interest in the health enhancing role of specific foods or physiologically-active food components, so-called functional food. This is a new and emerging area of the food and nutrition sciences. The term functional food was first introduced in Japan in the mid-1980s. Although, there is no consensus on what constitutes a functional food, yet it refers to processed foods containing ingredients that aid specific bodily functions in addition to being nutritious foods. However, the functional foods may have potential to modify disease, promote health, and reduce cost of health care. Presently, the functional foods have become a significantly growing industry. These benefits are now permitted to be identified by the Food and Drug Administration in USA. The suitable combination of different natural foods is required to provide specific health benefits beyond the traditional nutrients contained by the individual natural foods. They may be consumed as part of regular diet either as supplementary foods or as substitutes of current faulty diets to promote good health and prevent diseases like cardio-vascular disease diabetes mellitus, cancer and obesity, etc. In particular alpha-carotene and beta-carotene obtained from various vegetables and fruits neutralize free radicals which may cause damage to cells and The cardio-protective effect of fish consumption has been observed in some prospective investigations and $\omega-3$ fatty acids-DHEA/EPA obtained from Tuna fish and marine oils is being reported to reduce the risk of cardio-vascular disease. *Prebiotics and Probiotics* are being often prescribed for gastrointestinal health. However, the use of probiotic in patients of severe acute pancreatitis has been associated with increased risk of mortality. The field of functional foods, however, is in its infancy and prescription or promotion of health benefits of functional foods must be based on sound scientific criteria.

Keywords: Functional food, Prebiotics and Probiotics

INTRODUCTION

High prevalence of diseases like cardio-vascular diseases, cancer, diabetes mellitus and obesity in Indian population, highest levels of childhood

malnutrition, poor nutritional status of Indian women during pregnancy and lactation shows the importance of nutritious and balanced diets in our daily food consumption. Recent

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researches have also established that diet has a strong influence on the etiology of several, diseases. Consumption of fruits and vegetables that contain many non-nutritive and nutritive compounds is associated with decreased risk of several types of cancers, including Colorectal carcinoma and dietary habit is instrumental in more than 50% of human colorectal carcinoma (Takuji *et al.*, 2008). These research studies have led to formulation of several dietary guidelines for prevention and management of some of the above mentioned diseases as well as in natural cure. These dietary guidelines normally emphasize on the dietary modifications and use of certain types of food and food groups, which, because of their unusual content of nutrients or non-nutrient components, may have a protective influence on diseases. Functional foods may include foods or food ingredients that exert a beneficial effect on

human health and/or reduce the risk of chronic disease beyond basic nutritional functions (Huggett and Schliter, 1996).

Table 1 lists some such natural foods which, because of their certain health promoting components are identified to be useful in the prevention of some diseases.

However all natural types of foods individually may not be ideal, as they may not include all the desirable health promoting components. They may also not contain all essential nutrients in amounts and proportions necessary for adequate health. Consumption of food which may have high or low contents of both nutritive and non-nutritive components may create health problems in human body.

In light of above discussions, it becomes necessary to use balanced diet, which contains

Table 1: Natural Food Useful in Management and Prevention of Diseases

S. No.	Specific Food/ Food Group	Health Promoting Component	Health Promoting Component
1.	Whole cereal grains and /or legumes	Carbohydrates (Starch), protein and dietary fibre	Carbohydrates (Starch), protein and dietary fibre
2.	Fruits (Yellow fruits in particular)	Carotenes and ascorbic acid, pectin	Carotenes and ascorbic acid, pectin
3.	Vegetables (Yellow-green), leafy	Carotenes, ascorbic acid, fatty acids, fibre and Mg.	Carotenes, ascorbic acid, fatty acids, fibre and Mg.
4.	Vegetable fats, high in PUFA (poly unsaturated fatty acids)	High in PUFA, low in saturated fats and cholesterol, rich in vitamin E and linoleic acid	High in PUFA, low in saturated fats and cholesterol, rich in vitamin E and linoleic acid
5.	Fish/fish oils	ω -3 fatty acids	ω -3 fatty acids
6.	Rice bran oil	Sterols, PUFA	Sterols, PUFA
7.	Primrose oil and other related seed oils	Di-homo-gamma linolenic acid	Di-homo-gamma linolenic acid
8.	Red plum oil	Carotene, tocopherol, tocotrianol	Carotene, tocopherol, tocotrianol
9.	Linseed oil supplement	ω -3 fatty acids (linolenic acid)	ω -3 fatty acids (linolenic acid)
10.	Spices, turmeric, chillies, etc.	Antimutagenic compounds, w-3 fatty acids	Antimutagenic compounds, w-3 fatty acids
11.	Gums (guar gum), isabgol, fenugreek seeds	Gums and mucilages	Gums and mucilages
12.	Spirulina, algae	Carotenes, fibres and B-vitamins	Carotenes, fibres and B-vitamins
Source: Rao, 1993			

different nutrients and non-nutrient components in right proportion and amounts. It also becomes necessary, therefore, to fabricate health and functional foods from natural foods in proper combination and after appropriate processing to derive the maximum health advantages. Such fabricated health or functional foods can be used as supplementary food for preventing specific diseases. Such foods should, however have unchanged sensory attributes keeping in view the unwillingness of the consumers to change dietary habits.

'Because of the negative image of drug use and uncertainty about supplements, health and functional foods are becoming popular. Thus many opportunities exist for food processing industries to manufacture specially designed, value added health food products to meet the special nutritional requirements of young children, adolescents, women of child bearing age, sports enthusiasts, the middle aged and the elderly persons. (Richardson, 1996). It is anticipated that rapid growth in the health/functional foods market will continue well into the next millenium also. Naturally this demands continued research and development efforts keeping in view, the availability of a wide range of food raw materials in our country. However such development of fabricated health/functional foods in India should be based on our own R&D and available information on regional dietary patterns and disease prevalence. The western trends must not be followed blindly (Rao, 1993).

This paper briefly discusses the important role of nutrients and non-nutritive food components in disease management and recommended dietary guidelines suitable for formation of health/functional food products. The paper also reports

about some cereal legume-oilseed based health/functional foods developed by leading R&D institutions in India, which may be popularized for their medicinal and therapeutic properties.

Role of Nutrients and Non-nutritive Food Components in Disease Management and Health Improvement

The natural foods are composed of hundreds of different kinds of substances, commonly known as nutrients which when consumed in adequate quantities along with water fulfill all the functions of the body. The five general classes or kinds of nutrients found in all foods are carbohydrates, proteins, vitamins, fats and minerals. The non-nutritive components of food includes a large number of compounds with diverse structural and chemical properties, viz., fibres, indoles, phenols, flavones, isothiocyanates, etc. All these play very important role in maintaining or providing good health. However, the cells of the body can not use foods in their native stage. They first go through the process of digestion within the intestinal tract releasing nutrients, which are then transported across the muscular wall of the intestine. Ultimately they enter the blood stream and are transported to the tissues.

Among various non-nutritive components of food, fibres or unavailable carbohydrates comprise of cellulose, pectin, hemicellulose gums, mucilages and lignin. All of these, except lignin, are polysaccharides. The health benefits of dietary fibre in several diseases like cancer, Cardiovascular Diseases (CVD), diabetes and obesity are well recognized (Vahound and Krichevsky, 1982).

The important attribute for which dietary fibres have protective role in disease management are

their water binding property as a result of which it can act as (i) bulking agent and can reduce energy density of diets (useful in management of obesity) and increases the transit time of food in GI tract; and (ii) to decrease retention time of feces in the colon (useful in cancer management). They can bind bile acids and steroids and help to reduce to blood cholesterol (useful in CVD management). Some of the components of dietary fibres, viz., gums and mucilages tend to slow down glucose absorption and are therefore useful in management of certain types of diabetes (Anderson, 1980). They also bind toxins and hence are useful in detoxifying food borne carcinogens and their toxins.

The other non-nutritive components of food, viz., indoles, phenols, flavones, etc., inhibit carcinogenesis and tumorigenesis. Cholesterol is one non-nutritive component in the diet, which is a risk factor in atherosclerosis. It is present in higher concentration in animal fats and foods but its presence is less in plant foods and vegetable oils. On the other hand, some plant sterols and the unsaponifiable matter in vegetable oils, viz., rice bran oil have a hypocholesterolemic property (Sharma and Rukmini, 1989). Excess energy intake may lead to positive risk of diabetes and CVD (American Diabetic Assoc., 1987; Grundy, 1989; Kesaniemi and Grundy, 1983). For reduction in calorie intake, which is desirable in obesity, heart disease and diabetes, high fibre diets should be consumed. Through restriction of carbohydrates in diabetes has been practiced for a long time and potential harmful effects of high carbohydrate's intakes on lipoprotein levels including triglycerides must be recognized (Garg *et al.*, 1988). The replacement of dietary fat with

carbohydrates reduces blood cholesterol (risk factor in CVD) (Wolf and Grundy, 1983).

Vitamin A itself and many of the retinoids are able to suppress chemically induced cancer and the intake of foods rich in carotene and vitamin A are associated with reduced risk of cancer (Committee on Diet, Nutrition and Cancer, 1982). Similarly consumption of vitamin C containing foods is associated with lower risk of certain cancers, particularly gastric and oesophageal cancers. (Committee on Diet, Nutrition and Cancer, 1982).

Based on above recommendations some of the specific natural food groups may be used for fabrication of health/functional foods.

Health/Functional Food Products

The health and functional foods may be those food products which contain significant levels of biologically active components that impart health benefits beyond basic nutrition (Rao, 1993; Drozen and Harrison, 1998).

As most of the natural foods individually may not contain all essential nutrients in appropriate amounts, it becomes necessary to fabricate health/functional foods from selected natural foods in proper combination and after appropriate processing to derive the maximum advantage. In some cases, one or more additional ingredients may have to be added to impart health benefits above and beyond those of regular foods (Stuaffer, 1998). The developed health/functional food products should be definable in terms of their physico-chemical and nutritional qualities and predictable biological functionality in the prevention of a specific disease (Rao, 1993).

SELECTED HEALTH AND FUNCTIONAL FOOD DEVELOPED IN INDIA

Various agricultural produce such as cereals, pulses, oilseeds, fruits and vegetables, spices and condiments, plantation crops, reared animals, milk, chicken, eggs, fishes, etc., are the natural foods or food raw materials. Depending upon their physico-chemical composition, many new food products may be developed by appropriate food processing operations to combine their desirable food characteristics. Some of the health/functional foods developed in India are also described in short.

Cereals, Pulses and Oilseeds and Their Health/Functional Foods

Cereals

Cereals supply the bulk of the food consumed by human. They are the cheapest source of food energy and constitute a high percentage of the calorie and protein intake of man. The chemical constituents of cereals are carbohydrates, protein, lipids, minerals and water, together with small quantities of vitamins, enzymes and other substances. Carbohydrates are the major constituents (80% of dry matter) comprising of crude fibre and soluble carbohydrates. The nutritive value of cereals depends on their chemical composition. Their nutritive value also depends on the nature of the processing operations.

Pulses

Pulses (legumes) have a high protein content ranging from 20-40% and this makes them very important in human food from the point of view of nutrition. Some of the pulses are rich in carbohydrates while some are rich in oil (viz.,

soybean). They are also source of other nutritionally important materials, viz., vitamins and minerals. However some pulses also contain several heat stable and heat labile anti-nutritional and/or toxic factors. These include enzyme inhibitors, toxic substances, and factors inciting clinical disorder. These factors need to be eliminated or reduced to make pulses more acceptable as a source of inexpensive nutritional proteins in human food.

Oil Seeds

Oilseeds are the chief source of fats and oils which provide energy. They provide the essential fatty acid linoleic acid. The excessive intake of saturated fatty acids increase the level of serum lipids and the incidence of arteriosclerosis and heart diseases.

Cereals, Legume and Oil Seed Based Health and Functional Foods

Table 2 presents the characteristics and applications of several cereals-legumes-oil seeds based health foods developed in India which may be useful in prevention and management of some of the diseases as described earlier. These health foods products include energy food, multipurpose food, Paustic atta, weaning food, Instant nutro-cereals mixed, precooked dehydrated kichidi mix, composite breakfast cereals, sorghum flakes, instant curried dals, compressed cereals bar and protein chewy candy.

SOYBEAN PRODUCTS

Among various legumes/oil seeds, soybean is today the focus of most stimulating research in phyto-chemicals. Although these chemicals are technically not nutrients, they never the less, have far reaching effects on our health. The soybean and its product can powerfully influence the

Table 2: Cereals-legumes Oilseeds Based Health Foods

Name of the Product and its Ingredients	Nutritional/others Characteristics	Applications	Developed at
Energy Food: Wheat, chickpea, groundnut flour, jaggery fortified with vitamins and minerals.	100g product provides 15g protein, 390 calories, essential vitamins and minerals.	For combating protein-calorie mal nutrition.	CFTRI, Mysore
Multipurpose Food: Roasted chickpea flour, ground nut flour fortified with vitamins and minerals.	51g supplements/day significantly enhances the nutritional level of the consumer.	For combating protein deficiency beneficial to children, expectant and nursing mothers.	CFTRI, Mysore
Paustik Atta: Blend of 75% whole-wheat flour, 17% tapioca flour and 8% ground nut flour.	It is low cost protein rich flour.	For combating proteins deficiency	CFTRI, Mysore
Food for Toddlers or Weaning Food: (a) Malted rag, powder and green gram powder (b) Sorghum green gram and chickpea (c) Roasted gram green gram or soybean	Protein content 12%	For combating mal nutritional children	CFTRI, Mysore
Instant Nutro-cereals Mix: Cereals, pulses and vegetables and spiced	Rich in protein and calorie, palatable and delicious, shelf life over one year	For combating protein-calorie mal nutrition.	CFTRI, Mysore
Precooked Dehydrated Kichidri Mix: Rice, whole green gram, spices and vegetables.	Nutritionally balanced food, convenient as lunch or dinner reconstituted by summarizing in water, shelf life over one year	As convenience lunch/dinner food	DFRL Mysore
Instant Kichidi Mix: Rice, whole green gram, spices and vegetables	Rich in dietary fibre, easily digestible, stable for about 2 years can be reconstituted by many with hot water	Suitable for all age groups	DFRL Mysore
Composite Break Fast cereals	Delicious and nutritious porridge shelf life over 6 months, addition of hot water/ milk is enough for the item to be served at the breakfast table shelf life of 6 months	Suitable for all age groups	DFRL Mysore
Sorghum Flakes: Sorghum (may be used after addition of milk and sugar)	An ideal substitute to corn flakes, nutritive easily digestive, shelf life over 12 months, available with different flavours	Suitable for all age groups	DFRL Mysore
Instant Curried Dals: Pulses and Spices	Rich in protein, reconstituted in just two minutes by adding water shelf life over one year	Combating protein deficiency	DFRL Mysore
Compressed Cereals Bar: Rice/ sorghum, sugar, milk solids, Nuts and raisins	Calorie rich ready-to-eat wholesome products. Shelf life of over one year.	–	DFRL Mysore
Protein Chewy Candy: Vegetable protein isolate or soyflour, groundnut flour and condensed milk	Nutritious product with 12-16% protein content	Suitable for children and aged people	CFTRI Mysore

reduction of the risk of cancer and other diseases. The soybean provides high quality protein with minimal saturated fat. It is unique dietary source of isoflavones or phytoestrogens. Because of

isoflavones, soybeans are thought of to reduce the risk of a wide array of diseases including osteoporosis coronary heart diseases, menopause symptoms.

A variety of soy products (soy nuggets, soy-granules, soy flour, soy oil, totu or paneer, soymilk, soy biscuits, texturized soy products, etc.) are available in the Indian market with different flavors and textures and a low-fat, nutritionally balanced diet can be developed from them. The soy-based diets can help to control weight by providing high quality protein in a concentrated form and can be met in specifically designed low-calorie/high nutrient, ready to eat meals. In India R&D institutions like CIAE, Bhopal, GBPUAT, Pant Nagar, PAU Ludhiana, AMU, Aligarh, etc., has been engaged in new product developments from soybean.

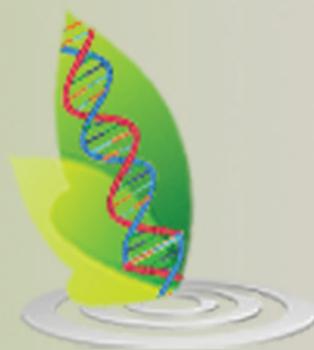
Based on the research studies, it can be safely assumed that a daily intake of 20-50 g isolated soy protein could result in 20-30% reduction in heart diseases risks (Potter *et al.*, 1993, Bakhit *et al.*, 1994, Widhalm, 1993). Lee and Co-workers (1991) have pointed towards link between soy consumption and reduced risk of certain types of cancer including those of breast, lung, colon, rectum, stomach and prostate.

However, the optimum intake level of functional foods and their recommended amounts have not yet been fully established. Thus, further research studies are necessary, both in experimental animals and in humans. The efforts should be directed towards the ultimate goal, that is, a 'functional diet'.

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