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## Development of various functional food components in health aspects

**Pukhraj Meena**

### Abstract

Numerous bioactive components isolated from legumes, cereals, grains, fruits and vegetables have been shown to be efficacious in reducing lipid and cholesterol levels, increasing bone mineral density and antioxidant status as well as possessing anticancer properties [6]. Cereals contain water soluble fiber, such as beta-glucan and arabinoxylan, oligosaccharides, such as galacto and fructo-oligosaccharides and resistant starch, which have been suggested to fulfill the prebiotic concept. The idea of using food for health purposes rather than for nutrition opens up a whole new field for the meat industry. The future viability and success of functional foods in the market place depend on several elements i.e., consumer acceptance of such products on specified cost.

**Keywords:** anticancer properties, resistant starch, beta-glucan & consumer acceptance.

### 1. Introduction

The primary role of diet is to provide enough nutrients to meet metabolic requirements, while giving the consumer a feeling of satisfaction and well-being. Recent knowledge, however, supports the hypothesis that, beyond meeting nutrition needs, diet may modulate various physiological functions and may play detrimental or beneficial roles in some diseases [15]. Now concepts are expanding from the past emphasis on survival, hunger satisfaction, and preventing adverse effects to an emphasis on the use of foods to promote a well-being state, improving health, and reducing the risk of diseases. These concepts are particularly important for increasing cost of health care, the steady increase in life expectancy and the desire of older people for improved life quality [19].

Functional food is a recent concept that originated in Japan but was further developed in the United States, Europe and other parts of the world. This concept implies that foods and food components have the ability to beneficially influence body functions to help improve the state of well-being, health and reduce the risk of diseases. The market of these products is significant [11]. In total, more than 1700 functional food products have been launched in Japan between 1988 and 1998 with an estimated turnover of around 14 billion US\$ in 1999. The market was estimated to be 5 billion US\$ in 2003 (Side, 2006) and 5.73 billion US\$ in 2006, while more than 500 products were labeled as FOSHU in 2005 [7, 21].

### From a practical point of view, a functional food can be

- A natural food in which one of the components has been naturally enhanced through special growing conditions.
- A food to which a component has been added to provide benefits (e.g. the addition of selected probiotic bacteria with proven health benefit characteristics to improve gut health).
- A food from which a harmful component has been removed so that the food has less adverse effects on health (e.g. the reduction of saturated fatty acids [SFA]).
- A food in which the nature of one or more components has been chemically modified to improve health (e.g. the hydrolyzed protein in infant formulas to reduce the likelihood of allergenicity).
- A food in which the bioavailability of one or more components has been increased to provide greater absorption of a beneficial component.
- Any combination of the preceding possibilities.

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Functional foods are similar in appearance to conventional foods; the former being consumed as part of the normal diet. In contrast to conventional foods, functional foods, however, have demonstrated physiological benefits and can reduce the risk of chronic disease beyond basic nutritional functions, including maintenance of gut health [8]. When food is being cooked or prepared using "scientific intelligence" with or without knowledge of how or why it is being used, the food is called "functional food".

Functional foods may improve the general conditions of the body (e.g. pre and probiotics), decrease the risk of some diseases (e.g. cholesterol-lowering products), and could even be used for curing some illnesses.

## 2. Development of Functional Foods

Functional food development implies the incorporation of specific bioactive compounds with positive physiological effects [10]. There are different technological strategies that modify food composition to accomplish health improvement by adding those bioactive compounds [5]. Most bioactive compounds characterized as nutraceuticals are derived from plants.. Hundreds of plant-derived nutraceuticals that have been identified, few have been incorporated into common foods for habitual consumption. Table 1 shows different functional components with their source and benefits.

**Table 1:** Examples of various functional components

Class/Components	Source	Potential Benefits
<b>Carotenoids</b>		
Beta-carotene	Carrots, Pumpkin, Sweet potatoes, Papaya, cantaloupe, Mango, Spinach, Tomatoes	Neutralizes free radicals which may damage cells; bolsters cellular antioxidant defenses; can be made into vitamin A in the body
Lutein, Zeaxanthin	Kale and collards (Leafy vegetables commonly used as saag), spinach, corn, eggs, citrus fruits, asparagus, carrots, broccoli	Supports maintenance of eye health
Lycopene	Tomatoes and processed tomato products, watermelon, red/pink grapefruit	Antioxidants, supports maintenance of prostate health and protect from cardio-vascular diseases
<b>Dietary (functional and total) fiber</b>		
Insoluble fiber	Wheat bran, corn bran, fruit skins	Supports maintenance of digestive health; reduce the risk cancer
Beta glucan	Oat bran, oat meal, oat flour, barley, rye	May reduce risk of coronary heart disease (CHD)
Soluble fiber	Psyllium seed husk (Isabgol), peas, beans, apples, citrus fruits	May reduce risk of CHD and some types of cancer
Whole grains	Cereal grains, whole wheat bread, oatmeal, brown rice	May reduce risk of CHD and some types of cancers; maintenance of blood glucose levels
<b>Fatty acids</b>		
Monounsaturated fatty acids (MUFAs)	Tree nuts, olive oil, canola oil	May reduce risk of CHD
Polyunsaturated fatty acids (PUFAs) Omega-3 fatty acids -ALA	Walnuts, flaxseeds, flaxseed oil	Maintenance of heart and eye health; maintenance of mental function
PUFAs – Omega-3 fatty acids - DHA/EPA	Salmon fish, tuna fish, marine and other fish oils, Flaxseed oil	May reduce risk of CHD; supports maintenance of eye health and mental function
Conjugated linoleic acid (CLA)	Beef and lamb; some cheese	Supports maintenance of desirable body composition and immune health
<b>Flavonoids</b>		
Anthocyanins – Cyanidin, Pelargonidin, Delphinidin, Malvidin	Berries, cherries, red grapes	Boost cellular antioxidant defenses; supports maintenance of healthy brain function
Flavanols – Catechins, Epicatechins, Epigallocatechin	Tea, cocoa, chocolate, apples, grapes	Supports maintenance of heart health
Procyanidins and Proanthocyanidins	Cranberries, cocoa, apples, strawberries, grapes, red wine, peanuts, cinnamon, tea, chocolate	Supports maintenance of urinary tract health and heart health
Flavanones – Hesperetin, Naringenin	Citrus fruits	Neutralizes free radicals which may damage cells; bolster cellular antioxidant defenses
Flavonols– Quercetin, Kaempferol, Isorhamnetin, Myricetin	Onions, apples, tea, broccoli	Neutralizes free radicals which may damage cells; bolster cellular antioxidant defenses
<b>Isothiocyanates</b>		
Sulforaphane	Cauliflower, broccoli, broccoli sprouts, cabbage, kale, horseradish	May enhance detoxification of undesirable compounds; bolsters cellular antioxidant defenses
<b>Minerals</b>		
Calcium	Sardines fish, spinach, yogurt, low-fat dairy products, fortified foods and beverages	May reduce the risk of osteoporosis
Magnesium	Spinach, pumpkin seeds, whole grain breads and cereals, halibut fish, almonds, brazil nuts, beans	Supports maintenance of normal muscle and nerve function, immune health and bone health
Potassium	Potatoes, low-fat dairy products, whole grain and cereals, citrus, beans, banana, leafy greens	May reduce the risk of high blood pressure and stroke, in combination with a low sodium diet
Selenium	Fish, red meat, whole grains, garlic, liver, eggs	Neutralizes free radicals which may damage cells;

		supports maintenance of immune and prostate health
<b>Phenolic acids</b>		
Caffeic acid, Ferulic acid	Apples, pears, citrus fruits, some vegetables, whole grains, coffee	Cellular antioxidant defenses; supports maintenance of eye and heart health
<b>Plant stanols/sterols</b>		
Free Stanols/Sterols	Corn, soy, wheat, fortified foods and beverages	May reduce risk of CHD
Stanol/Sterol esters	Stanol ester dietary supplements, fortified foods and beverages, including table spreads	May reduce risk of CHD
<b>Polyols</b>		
Sugar alcohols Xylitol, Sorbitol, Mannitol, Lactitol	Some chewing gums and other food applications	May reduce risk of dental caries
<b>Prebiotics</b>		
Inulin, Fructo-oligosaccharides (FOS), Polydextrose	Whole grains, onions, some fruits, garlic, honey, leeks, banana, fortified foods and beverages	Supports maintenance of digestive health; supports calcium absorption
<b>Probiotics</b>		
Yeast, Lactobacilli, Bifidobacteria and other specific strains of beneficial bacteria	Certain yogurts and other cultured dairy and non- dairy applications	Supports maintenance of digestive and immune health; benefits are strain-specific
<b>Phytoestrogens</b>		
Isoflavones– Daidzein, Genistein	Soybeans and soy-based foods	Maintenance of bone and immune health, and healthy brain function; In women, supports menopausal health
Lignans	Flax seeds, rye, seeds and nuts, lentils, triticale, broccoli, cauliflower, carrot	Support maintenance of heart and immune health
<b>Soy protein</b>		
Soy Protein	Soybeans and soy-based foods like milk, yogurt, cheese and tofu	May reduce risk of CHD
<b>Sulfides/thiols</b>		
Diallyl sulfide, Allyl methyl trisulfide	Garlic, onions, leeks, scallions (Looks like green onion)	Enhance detoxification of undesirable compounds; supports maintenance of heart, immune and digestive health
Dithiolthiones	Cruciferous vegetables	May enhance detoxification of undesirable compounds; supports maintenance of healthy immune function
<b>Vitamins</b>		
A	Organ meats, milk, eggs, carrots, sweet potato, spinach	Supports maintenance of eye, immune and bone health; contributes to cell integrity
Thiamin (Vitamin B <sub>1</sub> )	Lentils, peas, brown or enriched white rice, pistachios and certain fortified breakfast cereals	Supports maintenance of mental function; helps regulate metabolism
Riboflavin (Vitamin B <sub>2</sub> )	Lean meats, eggs, green leafy vegetables, dairy products and certain fortified breakfast cereals	Supports cell growth; helps regulate metabolism
Niacin (Vitamin B <sub>3</sub> )	Dairy products, poultry, fish, nuts, eggs and certain fortified cereals	Supports cell growth; helps regulate metabolism
Pantothenic acid (Vitamin B <sub>5</sub> )	Sweet potato, organ meats, lobster (Sea Products), soybeans, lentils and certain fortified breakfast cereals	Helps regulate metabolism and hormone synthesis
Pyridoxine (Vitamin B <sub>6</sub> )	Beans, nuts, legumes, fish, meat, whole grains and certain cereals	Supports maintenance of immune health; helps regulate metabolism
Folate or folic acid (Vitamin B <sub>9</sub> )	Beans, legumes, citrus fruits, green leafy vegetables and fortified cereals, pasta, rice	Reduce a woman's risk of having a child with a brain or spinal cord defect; maintenance of immune health
Vitamin B <sub>12</sub> (Cobalamin)	Eggs, meat, poultry, milk and certain cereals	Supports maintenance of mental function; helps regulate metabolism and supports blood cell formation
Biotin	Liver, salmon, dairy products, eggs, oysters and certain cereals	Helps regulate metabolism and hormone synthesis
Vitamin C	Guava, sweet red/green pepper, kiwi, citrus fruit, strawberries, fortified foods and beverages	Neutralizes free radicals which may damage cells; supports maintenance of bone and immune health
Vitamin D	Sunlight, fish, fortified foods such as yogurts or cereals, and beverages, including milk and juices	May reduce the risk of osteoporosis; helps regulate calcium and phosphorus; supports immune health; helps support cell growth
Vitamin E	Sunflower seeds, almonds, hazelnuts, turnip greens, fortified foods and beverages	Neutralizes free radicals, which may damage cells; supports maintenance of immune and heart health

Source: <http://foodinsight.org>

The most prominent types of functional products are presented briefly as follows:

## 2.1 Functional Fruits

Apart from traditional fruits, the functional fruits and vegetables like pomegranate, kiwi, Cranberry, Bottle guard, Bitter guard have meticulous health beneficial effects. Some of them are discussed here:

**Table 2:** Functional components of different parts of pomegranate

Plant component	Constituents
Pomegranate juice	Anthocyanins, glucose, organic acid, ascorbic acid, EA, ETs, gallic acid, caffeic acid, catechin, quercetin, rutin, minerals
Pomegranate seed oil	Conjugated linolenic acid, linoleic acid, oleic acid, stearic acid, punicalic acid, eleostearic acid, catalpic acid
Pomegranate peel	Luteolin, quercetin, kaempferol, gallagic, EA glycosides, EA, punicalagin, punicalin, pedunculagin
Pomegranate leaves	EA; fatty acids
Pomegranate flower	Polyphenols, punicalagin punicalin, EA
Pomegranate roots and bark	Alkaloids, ETs

Pomegranate juice exert antiatherogenic, antioxidant, antihypertensive, and anti-inflammatory effects.

- Punicic acid, a conjugated fatty acid present in pomegranate has an *in vivo* anti-inflammatory effect by limiting neutrophil activation and lipid peroxidation consequences.
- Pomegranate fruit and derivatives endowed with a very high antioxidant activity as an anti-proliferative, anti-invasive, and pro-apoptotic agent in various cancer cell lines and animal models
- The protective effects of pomegranate poly-phenolics against UVA- and UVB-induced cell death of human skin fibroblasts may be attributed to reduced generation of intracellular ROS and increased intracellular antioxidant capacity
- Pomegranate peel possesses antibacterial properties. Several studies conducted on aril juice is reported to possess anti-viral activity.

### 2.1.2 Kiwi Fruit

Kiwi fruit is rich in vitamin- C, Lutein and Xanthine and exert strong antioxidant activity. It helps to prevent cardiovascular diseases, cancer & insomnia. It improves the iron absorption and digestion.

### 2.1.3 Cranberry

Cranberry is a rich source of bioactive phenolic compounds with anti-proliferative, antioxidant, anti-inflammatory, and antimicrobial activities. Cranberries contain bioactive compounds such as anthocyanins, flavonoids and tannins. Cranberry has been traditionally used to treat and prevent urinary-tract infections.

### 2.1.4 Tomatoes

Lycopene is the principal component of the tomato. It exhibits strong antioxidant effects to higher number of conjugative double bonds. Lycopene helps in prevention of prostate cancer and stress induced diseases.

### 2.1.5 Amla

Amla is a rich source of Vitamin C. Amla enhances food absorption, balances stomach acid, fortifies the liver, nourishes the brain and mental functioning, supports the heart, strengthens the lungs, regulates elimination of free radicals, enhances fertility, helps the urinary system,

### 2.1.1 Pomegranate

The health benefits of pomegranate have been attributed to its wide range of phytochemicals, which are predominantly polyphenols, including primarily hydrolyzable ellagitannins, anthocyanins, and other polyphenols. Antioxidant activity of pomegranate has been attributed to its high polyphenolic content, specifically punicalagins, punicalins, gallic acid and ellagic acid.

increases skin health, promotes healthier hair, acts as a body coolant, flushes out toxins, increases vitality, strengthens eyes, improves muscle tone and, acts as an antioxidant. Amla is used for hair loss, eye sight, cardiovascular disease, diarrhea, digestion disorders etc. it possess anti ageing components and helps in mineral absorption.

### 2.2 Probiotics

Probiotics are defined as “live microorganisms, consumed in adequate numbers for health benefit on the host”. *Lactic acid bacteria* (LAB) and *bifidobacteria*, the most studied and widely employed bacteria within the probiotic field, are normal components of the intestinal microbiota and have a long tradition of safe application within the food industry [14]. This success of dairy probiotics can partly be explained by their general positive image among consumers [17, 25]. Recently, encapsulation was found as possible technology for decreasing sensitivity of probiotics [4, 6]. Fruit juice has also been suggested as a novel, appropriate medium for fortification with probiotic cultures [26].

### 2.3 Prebiotics

Prebiotics are non-digestible food ingredients that beneficially affect the host by stimulating the growth and/or activity of one or a limited number of bacteria in the colon, thus improving host health. Fructo-oligosaccharide (FOS), inulin, isomalto-oligosaccharides (IMO), polydextrose, lactulose and resistant starch are considered as the main prebiotic components. Oligosaccharides play important role in obesity control [1]. Besides being prebiotics, these compounds have shown to increase calcium absorption, thus improve both bone mineral content and bone mineral density (BMD) [2]. Furthermore, they influence the formation of blood glucose, and reduce the levels of cholesterol and serum lipids [16]. Prebiotics enhance the growth and survival of the probiotic cultures by influencing the growth and metabolites of both the probiotic and the starter. Due to the potential synergy between probiotics and prebiotics, foods containing a combination of these ingredients are often referred to as synbiotics [9].

### 2.4 Functional drinks

Another important product category within the functional food segment is non-alcoholic beverages fortified with vitamins A, C and E or other functional ingredients.

Although, there is a relatively high number of a product available in this segment e.g. functional drinks are those of cholesterol-lowering drinks (with combination of omega-3 and soy), “eye health” drinks (with lutein) or “bone health” drinks (with calcium and inulin)<sup>[13]</sup>.

In India, the tea is popular drink among Indian population. In

some regions, the tea is incorporated with different spices and herbs which add the nutritional value to tea. Masala tea becoming quite popular all over world and excellent for preventing seasonal diseases, cough, cold, fever and influenza etc.

**Table 3:** Components of Masala tea

Components	Functions
Cloves	Antioxidant, anti-septic, local anesthetic, anti-inflammatory, Warming, carminative and anti-flatulent properties. Active component: Eugenol.
Cardamom	Cardamom (100g) contains energy (300 kcal), carbohydrates (68 g), protein (11 g), dietary fiber (28 g), Vitamin C, Thiamine, Vitamin B6, Riboflavin, Manganese, Iron Magnesium, Zinc. Antidepressant, Lower Cholesterol, Cure Asthma, Helps in Sore throat, Improve Blood circulation
Cinnamon	Cinnamon bark contains a natural antiseptic that have antibacterial, antifungal and anti viral activity Natural pain killer and reduce the inflammation It contain polyphenols which maintain metabolism, reduce blood sugar, improve digestion It increase the bioavailability of medicines
Ginger	Gastroprotective; helps in gastritis, antioxidant, anti-inflammatory, antibacterial activity, act as appetizer It Protect the brain cells
Tulsi	Antibiotic, germicidal, fungicidal and disinfectant, Antidepressant, Antiinflammatory agent Cure respiratory disorders and bronchitis Antioxidant activity; helps in prevention of cancer and cardiovascular diseases Antiageing effects; fights with free radicals, Wound healing effects Active components: Camphene, Eugenol and Cineole
Black pepper	Cure respiratory disorders, coughs, constipation, indigestion, anemia, impotency and cardiovascular diseases

**2.4.1 Juice Blends**

A Juice blend of Pomegranate, Amla and green turmeric is consider to be excellent for post cancer operated patients and coronary heart diseases. The medicinal of pomegranate and amla is already mentioned in this article. The turmeric is also known for its meticulous antiseptic, antioxidant, anti-inflammatory, neuroprotective, cardioprotective, anti-depression and anti-ageing effects. Curcumin (generally 3%) is the main active ingredient in turmeric. It has powerful anti-inflammatory effects and is a very strong antioxidant. Curcumin also helps to relieve arthritis pain.

**Functional Soup:** Moringa dried/fresh leaves powder/paste soup amalgamated with sweet corn, green pea, ginger, black pepper and cardamom is commonly used by Indian population. Moringa leaves possess good quality proteins and several medicinal effects. Moringa is also rich in vitamin A, B and C and minerals like calcium, iron and phosphorous. Moringa helps in the prevention of diabetes and high blood pressure. Other components of soup also contribute to the excellent taste and medicinal value.

**2.5 Functional cereals**

Oat and barley, offer another alternative for the production of

functional foods. Cereals can be used as fermentable substrates for the growth of probiotic microorganisms. Additionally, cereals can be applied as sources of non-digestible carbohydrates that besides promoting several beneficial physiological effects can also selectively stimulate the growth of *lactobacilli* and *bifidobacteria* present in the colon and act as prebiotics. Cereal constituents, such as starch, can be used as encapsulation materials for probiotics in order to improve their stability during storage and enhance their viability during their passage through the adverse conditions of the gastro-intestinal tract<sup>[3]</sup>.

Some functional cereal components such as beta-glucan, however, applied also in the dairy and bakery industries. Recent research has focused on the use of beta-glucans, in the manufacture of low-fat ice creams and yogurts. Incorporation of beta-glucans with other soluble dietary fiber, into low-fat dairy products can make their mouthfeel, scoopability and sensory properties resemble those of full-fat products<sup>[3]</sup>.

In India, the lactating women take some traditional food supplements made from Rice/Wheat Flour, dry fruits, nuts and seeds, ghee (Clarified Butter), resins, herbs, brown/black pepper, coconut shreds, gums etc. These traditional supplements are not only energy rich but also provide minerals and vitamins.

**Table 4:** Functions of Components of Traditional Food Supplements for lactating women

Components of Panjiri	Function
Gums	It helps in uterus contraction. It is also a source of fibres
Ginger Powder	Antiseptic. Promotes circulation.
Cardamom seeds	Antispasmodic, warming
Melon seeds	Essential Fatty acids, Minerals
Nuts and dry fruits	Essential fatty Acids, protein, vitamins
Ghee	energy
Rice/Wheat Flour	Fibres, Minerals and vitamins
Resins	Laxative, minerals
Coconut	Medium Chain Fatty Acids, Energy, fibre
Jaggery	Warming, Clear the mucus
Pepper	Prevent anemia, antiseptic, digestion
Fennel Seeds	Antiseptic, Promote milk Flows, anti-spasmodic

## 2.6 Functional meat

Meat and its derivatives may also be considered functional foods to the extent that they contain numerous compounds thought to be functional. The idea of using food for health purposes rather than for nutrition opens up a whole new field for the meat industry. In addition to traditional presentations, meat industry can explore various possibilities, including the control of the composition of raw and processed materials via reformulation of fatty acid profiles or inclusion of antioxidants, dietary fiber or probiotics, etc <sup>[20]</sup>.

## 3. Perspectives

The future viability and success of functional foods in the marketplace depend on several elements. The key issue is consumer acceptance of such products. For consumers to agree to pay the cost associated with functional foods, they must be convinced by its health claims through clear, truthful, and unambiguous messages.

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