Functional foods of natural origin—An overview

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Over the last few years consumer’s interest in health and functional foods has increased considerably in industrialized countries thus offering an opportunity for agro-food sector to add value to agricultural commodities. Functional food is any fresh or processed food claimed to have a health-promoting or disease-preventing property beyond the basic function of supplying nutrients. The market of functional food is indeed one of the fastest-growing within the global food industry. Functional foods offer potential health benefits that could enhance well-being of consumers and reduce the economic and social costs of non-communicable diseases. This review provides a report of various functional foods and their contribution in preventing and reducing the risk factors for several diseases thus suggesting avenues for future research efforts.

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Introduction

Functional food acceptance is defined as giving a score of minimum 3 on a 5-point scale, simultaneously for acceptance if the food tastes good, and if the food tastes somewhat worse as compared to its conventional counterpart. With this specification, 46.5% of the sample claimed to accept the concept of functional foods.1 The relationship between diet and health has increased considerably in recent years, based on the emerging evidence that a healthy diet can contribute to reduce the risk of fatal disease like prostrate cancer.2 Functional foods are foods that in addition to supplying nutrients offer potential health benefits that could enhance the well-being of consumers. They offer the opportunity to reduce the direct and indirect health costs associated with a number of prevalent chronic diseases like diabetes, coronary heart disease, cancer, etc. Functional foods affect beneficially one or more target functions in the body, beyond adequate nutritional effects, to either improve stage of health and well-being and/or reduce the risk of diseases.3

Despite the widespread attention, the functional food concept eludes precise definition. The Food and Nutrition Board of the National Academy of Sciences has suggested that a functional food is “any modified food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains”. Others state that a functional food is any food promoted or consumed for a specific health effect, regardless of whether the food has been modified in some fashion.

Foods qualify as functional foods because they contain non-essential substances with potential health benefits. A considerable array of food has been described as “functional” in one or more respects, including calcium-fortified orange juice, whole grains, fruits and vegetables soybeans, omega-3 fatty acids, phytosterols and cocoa. Among the wide range of foods available the impetus is to identify those functional foods that have the potential to improve health and well-being, reduce the risk from, or delay the onset of, major diseases. Classic examples include the enrichment of dairy products with conjugated linoleic acid and soy proteins in bakery products to reduce the risk of certain cancers. Functional dairy foods were studied with specific emphasis on the key success factors influencing length and timing of individual product development phases on the total length of product development. Key factors which were identified as being the most critical were (1) the specificity and action mechanism of the added health benefit of the final product (2) the range of new product or process alternatives, (3) the selection of the consumer target group and, (4) legal and marketing.4

The development of these foods largely depends on nutritional knowledge, awareness and also consumer

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acceptance which in turn are influenced by the perceived risks and benefits of these products. The market for functional foods has shown a consistent growth over the last decade and the major markets being Europe, Canada. Among the consumer groups, there is considerable heterogeneity in consumer acceptance of functional foods creating scope for market segmentation. Thus the success of marketing strategies and policies aimed at promoting the consumption of such products must take account of variations in levels of acceptability and the relative role of particular determining factors.

Joint research in food and health has large potential benefits and can substantially reduce the risks for metabolic diseases. Nutritionists have started working transdisciplinarily using molecular and cellular biology as well as physiology to develop research strategies going from knowledge on gene expression to dietary recommendations in order to meet individual requirements. Changing food habits in order to follow nutritional recommendations is hard but possible. The communication of health benefits to consumers is of crucial importance so that they have the knowledge to make informed choices about the food they consume and enjoy. This review focuses on a wide range of functional foods (Plate 1) and their health benefits beyond their basic nutrient content.

**Functional food items**

**Broccoli Tomato Salad**

Broccoli is a plant of the cabbage family Brassicaceae. It is rich source of vitamin C and soluble fibre and contains multiple nutrients with potent anti-cancer properties including diindolylmethane and selenium. Diindolylmethane found in broccoli is a potent modulator of the innate immune response system with anti-viral, anti-bacterial and anti-cancer activity. The combination of tomato and broccoli was more effective at slowing tumour growth than either tomato or broccoli alone and supports the public health recommendations to increase the intake of a variety of plant components. It can be served once a day in lunch.

**Tomato drink**

A daily intake of a formulated tomato drink affects carotenoid plasma and lymphocyte concentrations particularly those of lycopene, phytoene, phytofluene and beta-carotene. It also improves protection against DNA damage in lymphocytes. The intake of the tomato drink significantly reduced (about 42%) DNA damage in lymphocytes subjected to oxidative stress. A low intake of carotenoids from tomato products improves cell antioxidant protection. Serving size of tomato drink may be two glasses per day.

**Oatmeal**

Whole grains of oatmeal can have a beneficial effect on risk factors for coronary heart disease (CHD). The relationship between the consumption of wholegrain foods and the effects on CHD mortality, morbidity and on risk factors for CHD, in participants previously diagnosed with CHD or with existing risk factors for CHD was assessed by Kelly et al. Studies reported lower total and low density lipoproteins (LDL) cholesterol with oatmeal foods than control foods. Oat bran flour high in beta-glucan had a low glycemic response and acted as an active ingredient decreasing postprandial glycemic response of an oral glucose load in subjects with type 2 diabetes. Oatmeal can be consumed once a day during breakfast with fat free milk for diabetics.

**Apple peel and juice**

Main structural classes of apple constituents include hydroxycinnamic acids, dihydrochalcones, flavonols (quercetin glycosides), catechins and oligomeric procyanidins, as well as triterpenoids in apple peel and anthocyanins in red apples. Several lines of evidence suggest that apples and apple products possess a wide range of biological activities which may contribute to beneficial effects on health against cardiovascular disease, asthma and pulmonary dysfunction, diabetes, obesity and cancer.

The usefulness of apple constituents, apple juice, apple peel, apple extracts and its components was studied by Gerhauser and concluded that extracts and components, especially oligomeric procyanidins influence multiple mechanisms relevant for cancer prevention. These include antimutagenic activity, modulation of carcinogen metabolism, antioxidant activity, anti-inflammatory mechanisms, modulation of signal transduction pathways, antiproliferative and apoptosis-inducing activity, as well as novel mechanisms on epigenetic events and innate immunity. Apple juice thrice a week and apple peel everyday with fruit salad may be consumed.

**Berries**

Berries are a natural source of anthocyanin, antioxidants and have a broad spectrum of biomedical functions. This includes cardiovascular disorders, advancing age-induced oxidative stress, inflammatory
responses, etc. They also improve neuronal and cognitive brain functions, ocular health as well as protect genomic DNA integrity. The effect of a novel combination of selected berry extracts known as ‘optiberry’ (wild blueberry, wild bilberry, cranberry, elderberry, raspberry seeds and strawberry) was studied by Zafra-Stone et al and it was found that optiberry exhibited a high antioxidant efficacy as shown by its high oxygen radical absorbance capacity value, a novel antiangiogenic and antiatherosclerotic activity and also possess cytotoxicity towards *Helicobacter pylori* a noxious pathogen responsible for various gastrointestinal disorders like duodenal ulcer and gastric cancer. Berries can be consumed everyday with other fruits.
Strawberry
The effect of adding strawberries, as a source of antioxidants, to improve the antioxidant effect of a cholesterol-lowering diet was assessed by Jenkins et al. Strawberry supplementation was found to reduce oxidative damage to LDL while maintaining reductions in blood lipids and enhancing diet palatability. Therefore, strawberry can be taken regularly with other fruits or dessert.

Orange juice
The orange juice has been found effective in protecting cells against hydrogen peroxide-induced DNA damage in mononuclear blood cells. The comparison was made with Vit. C (C drink) or sugar drinks (S drink). Orange juice can be consumed twice a day.

Grapes and grape juice
The beneficial effects of grape juice in the prevention of some inflammatory-mediated diseases including cardiovascular disease have been reported. The active components from grape extracts, which include the grape seed, grape skin, and grape juice, have been identified as sources of polyphenols such as resveratrol, phenolic acids, anthocyanins, and flavonoids. All possess potent antioxidant properties and have been shown to decrease low-density lipoprotein-cholesterol oxidation and platelet aggregation. Consumption of grapes once a day and grape juice thrice a week is recommended.

Papaya juice
An important and promising group of compounds which possess cancer-chemopreventive property are organosulfur compounds, such as isothiocyanates (ITCs). The molecular mechanisms underlying the relationship between cell cycle regulation and apoptosis induced by benzyl ITC (BITC), a major ITC compound isolated from papaya (Carica papaya Linn.) fruit has been reported by Nakamura. Serving size may be one glass per day.

Blackberry juice
Cyanidin-3-glucoside (C3G), a compound found in blackberry possesses chemopreventive and chemotherapeutic activity. It was reported that a purified compound of anthocyanin inhibits tumor promter-induced carcinogenesis and tumour metastasis in vivo.

Citrus fruit smoothie (components: citrus fruits & soy milk)
Citrus fruits and juices are rich in several types of bioactive compounds. Their antioxidant activity and related benefits derive not only from vitamin C but also from other phytochemicals, mainly flavonoids. A meta-analysis found that soy protein consumption achieved an average 9.3% decrease in total cholesterol, a 12.9% decrease in low-density lipoprotein (LDL) cholesterol and a 10.5% decrease in triglycerides. Soy pills and supplements such as isoflavone are not recommended. The cholesterol-lowering benefit has only been observed when the intact soy protein is used. Soy milk can be used in place of milk in coffee or over breakfast cereal, as well as in milkshakes and other blended drinks. Soy milk can be substituted for milk in many recipes. Citrus fruit smoothie can be taken twice a week.

Cocoa powder
Cocoa powder is rich in polyphenols, such as catechins and procyanidins, and it has inhibited oxidized LDL and atherogenesis in variety of subject models. The alterations of Plasma LDL and HDL cholesterol and oxidized LDL concentrations in normo- and hypercholesterolemic humans after intake of different levels of cocoa powder have been investigated by Baba et al. The results suggested that polyphenolic substances derived from cocoa powder may contribute to a reduction in LDL cholesterol, an elevation in HDL cholesterol and the suppression of oxidized LDL.

Almond
It is reported that almond intake is associated with an enhancement in antioxidant defense and a reduction in the risk of cancer and cardiovascular disease. Almond skins are rich in polyphenols (ASP) that may contribute to these putative benefits. It has been reported that these ASP act as antioxidants and induce quinone reductase (QR) activity, but these actions are dependent upon their dose, method of extraction and interaction with antioxidant vitamins. Presoaked almond (10-12nos) every morning with or without milk can be taken.

Peanut and peanut butter
Consumption of peanuts, peanut butter and other nuts is associated with a lower risk of cholecystectomy. Similarly, eating half a serving of peanut butter (about 1 good teaspoon) 5 or more days per week reduced the risk of gallbladder disease by 15%. Consistent evidence from major epidemiological and clinical studies shows that consuming peanuts regularly can help reduce coronary heart disease (CHD) risk. Peanut
consumers have also been shown to have significantly higher intakes of dietary fibre and vitamin E, both valuable nutrients that can help reduce the risk of CHD and lower cholesterol levels\textsuperscript{24}. Peanut can be taken with snacks and peanut butter can be used as bread spread in breakfast everyday.

**Green iced tea**

Green tea is a type of tea made solely with the leaves of *Camellia sinensis* (Linn.) O. Kuntze which has undergone minimal oxidation during processing. Green tea contains polyphenols which are thought to improve health, particularly catechins the most abundant of which is epigallocatechin gallate. *In vitro* and animal studies as well as preliminary observational and clinical studies on humans suggest that green tea can reduce the risk of cardiovascular disease and cancer as well as beneficial impact on bone density, cognitive function, dental caries and kidney stones. The free radical scavenging effects of green tea extract and green tea tannin mixture and its components using a nitric oxide (NO) and superoxide (O\textsubscript{2}\textsuperscript{-}) generating system was investigated *in vitro* by Nakagawa and Yokozawa. The results confirmed that green tea tannin has excellent antioxidant properties, which may be involved in the beneficial effect of this compound. Mint added to the tea, makes it a strong diuretic beverage. Green tea may be consumed without milk everyday\textsuperscript{25}.

**Red wine**

Red wine polyphenols consisting of various powerful antioxidants such as flavonoids and stilbenes have been implicated in cancer prevention and promote human health without recognizable side effects. Resveratrol a major component of red wine polyphenols has been studied and reviewed extensively for its chemopreventive activity to interfere with the multi-stage carcinogenesis. It has been reported to exhibit several physiological activities including anticancer and anti-inflammatory activities in experimental animal models, as well as in humans. Anticancer activity of resveratrol is mainly due to induction of apoptosis via several pathways, as well as alteration of gene expressions, all leading to a decrease in tumor initiation, promotion and progression. Its anti-inflammatory activity is through modulation of enzymes and pathways that produce mediators of inflammation and also induction of programmed cell death in activated immune cells. When consumed at high concentrations, resveratrol produced no adverse effects; hence, it possesses good potential to be used as an adjunctive or alternative therapy for cancer and inflammatory diseases. The mechanism of selective cytotoxicity induced by red wine polyphenols against MCF-7 breast cancer cells was investigated by Hakimuddin *et al.* in relation to their interference with calcium homeostasis. They reported that the treatment of MCF-7 breast cancer cells with a red grape wine polyphenol fraction results in disruption of calcium homeostasis and cell cycle arrest causing selective cytotoxicity. Red wine may be consumed occasionally or can be used as a flavouring agent for food preparation\textsuperscript{26,27}.

**Garlic**

Attention has been paid to the prebiotic effect of garlic. Garlic has an unusually high concentration of sulphur compounds compared to other food plants, it also contains 26-30\% (fresh weight) or up to 77\% (dry weight) of a non digestable carbohydrate-inulin. The results of the study carried out by Kanner *et al.* suggested that the garlic and inulin supplement could stimulate the microflora growth, particularly in foods that contains high amount of fat, carbohydrate and dietary fibre. Small piece of crushed garlic can be consumed along with cooked curries\textsuperscript{28}.

**Fish oil**

Fish oil is a rich source of the essential fatty acids, eicosapentaenoic acid (EPA) and docosahexaneanoic acid (DHA). Essential fatty acids are integral components in the diet for the normal development of the brain, nervous system and for the maintenance of healthy eyesight. Fish oils have been shown to help maintaining normal blood lipid levels and support the integrity and mobility of the joints. LipoCell is an emulsification process making nutritional oils soluble in water to enhance their absorption\textsuperscript{22}. Two tea spoons are recommended as serving size of fish oil\textsuperscript{29}.

**Dark chocolate**

Epidemiologic studies suggest that high flavonoid intake confers a benefit on cardiovascular outcome. The effect of flavonoid-rich dark chocolate on endothelial function, aortic stiffness, wave reflections and oxidant status was investigated by Vlachopoulos *et al.* The study reported that consumption of dark chocolate acutely decreases wave reflections, it does not affect aortic stiffness and it may exert a beneficial effect on endothelial function in healthy adults. Dark chocolate can be consumed occasionally\textsuperscript{30}.
Fermena

It is a revolutionary fermented Prebiotic Superfood (over 50 vegetables, fruits, nuts and grains fermented for about 6 months) formulated by the Father of Macrobiotics, Dr. Michio Kushi. It is flawless, fermented blend of dozens of enzymes and beneficial bacteria which help to promote maximum healthy absorption in human system causing better digestion and improved intestinal health. It is a powerful prebiotic that promotes healthy probiotic activity in the human system by developing a synergistic interaction between live enzymes from healthy food and friendly bacteria that live in the digestive tract. Fermena is safe for adults and children of all ages. It is 100% natural, contains no preservatives, and yet requires no refrigeration. Fermena should be taken alone or with food one to three times a day.  

Conclusions

Functional foods which are integral components of the diet are understood to contribute added health benefits and are subjected to intense and widespread research in food and nutritional science. Many polyphenolic substances, isothiocyanates, isoflavones, etc. possess antioxidant and other properties which are responsible for decreasing the risk of vascular diseases and cancer. Practicing physicians are advised to stay abreast of these findings in order to enrich the knowledge of their patients on the value of health-promoting diets in disease prevention. There is a growing interest in this area of functional foods from food manufacturers all over the world. It is likely that there will be competition between the food industry and the pharmaceutical industry in the grey area of overlapping interest in the near future.

Reference


29. BioCare LipoCell (Fish Oils Prebiotics and Fruit Concentrate), [http://www.revital.co.uk/BioCare_Lipocell_Fish_Oils_Prebiotics_and_Fruit_Concentrate](http://www.revital.co.uk/BioCare_Lipocell_Fish_Oils_Prebiotics_and_Fruit_Concentrate)
