



Functional food of plant origin

Sonia Sangwan and Raman Seth

ABSTRACT : “Functional food”. is a fortified food which delivers vitamins, minerals, various nutrients and nutrition. Nutrition is important for good health as well as for protection from various diseases. In recent era, functional food has attained a significant position in maintenance of human health. Phytochemicals and zoo chemicals are physiologically active components in foods. Both composition as well as amount to be consumed, are important regarding functional food? Presently, consumers are health conscious and getting total awareness regarding composition of functional food. In this brief review, scientific relevance and recommended eating of functional food of plant origin, has been reviewed.

KEY WORDS : Functional food, Phytochemicals, Zoochemical

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INTRODUCTION

The presence of bioactive components in food makes it protective against various diseases. These foods are known as “functional foods”. Proper diet, good food habits and lifestyle are essential for good 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; a healthy productive population is necessary. Functional foods affect children’s health, intelligence and educational performance and thus their economic status in adulthood. Physiologically active ingredient in foods like phytochemicals and zoochemical are useful to reduce risk for many chronic diseases. Recently, “Functional Food” means a food which provides additional physiological benefit more than basic nutritional needs (Clare, 2000). The interest in functional foods has

increased in developed countries as people look for safer way to improve general health and living. This brief article includes definition of functional foods of plant origin and safety consideration.

Definition and concept of functional foods:

Functional foods are regularly eaten foods that are eaten as part of our normal diet. A functional ingredient can be defined as a dietary ingredient that influence health of consumer in positive manner. So, functional foods are foods that have health approving qualities over and above their nutritional value. Ideally the functional food should satisfy the following conditions: “Functional Food should be in the form which can be taken orally, it should not include a drug as defined in clause (b) and ayurvedic, siddha 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. It 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, it does not include a narcotic drug or a psychotropic substance as defined in the schedule of the

MEMBERS OF RESEARCH FORUM

Address for correspondence :

Sonia Sangwan, Dairy Chemistry Division, ICAR- NDRI, Karnal (Haryana) India

Email : soniasangwanera03@gmail.com

Associated Authors’ :

Raman Seth, Dairy Chemistry Division, ICAR- NDRI, Karnal (Haryana) India

Narcotic Drugs and Psychotropic Substances Act, 1985. (Crawford, 2000). It is essential to establish the permissible safe amount of functional foods. For example, proper amount of garlic reduces the risk of heart disease and cancer while excess can result in gastrointestinal bleeding.

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 (Koh and Pan, 2018). 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. Phytochemical diminishes the chances of cancer, metabolic diseases, neuro degeneration 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 (Blankson *et al.*, 2000). Medicinal plants and their derivatives exert radio-protective effects by 3 main ways *i.e.* anti-oxidant activity, anti-inflammatory and anti-apoptotic activity.

Some plant-based foods or food constituents currently do not have approved health claims, but have clinical research supporting their potential health benefits. These include cranberries, garlic, nuts, grapes and chocolate and others are discussed briefly below.

Oats :

Oat is a dietary source of the cholesterol-lowering soluble fibre b-glucan. Consumption of oat food can reduce the risk of coronary heart disease as it reduces total and low-density lipoprotein (LDL) cholesterol in blood. 3 g of b-glucan would be required to achieve a 5 per cent 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

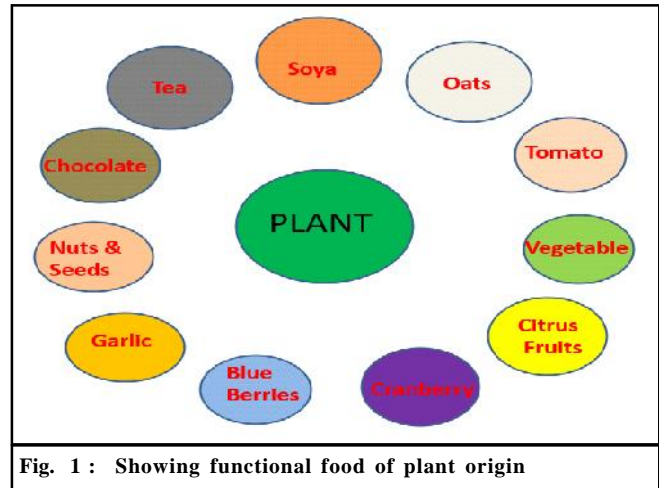


Fig. 1 : Showing functional food of plant origin

claim must contain 13 g of oat bran or 20 g oatmeal, and provide, without fortification, at least 1.0 g of b-glucan per serving.

Soy:

Soybeans are a good source of fibre and vegetable protein along with riboflavin, folate, vitamin K, magnesium and potassium (Potter, 1998). Soybeans are also very high in omega-6 fatty acids (1241 mg in half a cup, or 1443 mg per 100 g (3.5oz)). Soy plays a preventive and therapeutic roles in cardio-vascular disease (CVD), cancer, osteoporosis and the alleviation of menopausal symptoms. The cholesterol-lowering effect of soy is the well-known physiological effect. Soy specific component isoflavones can cause significant reductions in total cholesterol (9.3%), LDL cholesterol (12.9%) and triglycerides (10.5%), with a small but insignificant increase (2.4%) I in high density lipoprotein (HDL) cholesterol (Messina and Barnes, 1991). The exact mechanism of hypocholesterolemic action is not fully clear. Idea daily intake 25 g soy protein is needed to reduce risk of CHD. Anticarcinogens like protease inhibitors, phytosterols, saponins, phenolic acids, phytic acid and isoflavones are present in Soy beans (Erdman and Potter, 1997). Of these, isoflavones (genistein and daidzein) are particularly noteworthy because these are heterocyclic phenols structurally similar to the estrogenic steroids. Because they are weak estrogens, isoflavones may act as antiestrogens by competing with the more potent, naturally-occurring endogenous estrogens (e.g., 17b-estradiol) for binding to the estrogen receptor and thus, have reduced risk of estrogen-dependent cancer.

Soy may also benefit bone health and about 40 g isolated soy protein (ISP) per day (containing 90 mg total isoflavones) significantly increased (approximately 2%) both bone mineral content and density in the lumbar spine after 6 months (Albertazzi *et al.*, 1998). The theory that soy may lessen menopausal symptoms hot flushes and night sweats and dose needed is about 60 g of ISP daily for 3 months (Clinton *et al.*, 1996). However, it is too early to propose that soy may be used in place of hormone replacement therapy for menopausal symptoms.

Tomatoes:

Tomatoes and tomato products are full of lycopene, a non-provitamin A carotenoid which is a potent antioxidant. It is strong anticarcinogenic. A comprehensive review of 72 epidemiologic studies shows that anticarcinogenic is statistically significant. Lycopene is useful in cancers of the prostate (Li *et al.*, 1997), lung, stomach, pancreas, colon and rectum, esophagus, oral cavity, breast, cervix and skin (Clinton *et al.*, 1996). Follow-Up Study (HPFS) followed from 1986 to 1992 found that >10 servings/wk. of tomato sauce, tomatoes, tomato juice or pizza could reduce risk of prostate cancer by 35 per cent, advanced prostate cancer (*i.e.*, more aggressive tumors) was reduced by 53 per cent. More importantly, of the 46 fruits and vegetables evaluated, tomato products were the only foods that were associated with reduced risk of prostate cancer. Additional follow-up data from the HPFS through 1998 further supported the earlier observation that lycopene reduces prostate cancer risk and more specifically, found that that intake of tomato sauce (2+ servings/wk) was associated with a 23 per cent reduction in prostate cancer risk (560 due to lycopene's ability to selectively accumulate in the prostate gland, perhaps serving an antioxidant function in that organ (Chen *et al.*, 2001). This hypothesis was strengthened by a recent study that found that men with localized prostate adenocarcinoma had significantly reduced prostate DNA oxidative damage after consumption of tomato-sauce based meals containing 30 mg lycopene for 3 wks (Kohlmeier *et al.*, 1997). Proposed mechanisms by which lycopene could influence cancer risk are related to its antioxidant function. The antioxidant function of lycopene may also explain the recent observation in a multi-center European study that carotenoids were inversely associated with risk for myocardial infarction (Block, 1992).

Garlic:

Garlic (*Allium sativum*) has been used for medicinal purposes since long. It contains physiologically active organo sulfur components (e.g., allicin, allylic sulfides) (Silagy and Neil, 1994). Health benefits of garlic are as cancer chemo preventive, as antibiotic, as antihypertensive and as cholesterol-lowering properties. The characteristic flavour and pungency of garlic are due to an abundance of oil and water-soluble sulfur-containing elements, which are also likely responsible for the various medicinal effects ascribed to this plant. When the garlic cloves are crushed, the odorless amino acid, alliin is converted enzymatically by alliinase into allicin. This latter compound is responsible for the characteristic odor of fresh garlic. Allicin then spontaneously decomposes to form numerous sulfur-containing compounds, some of which have been investigated for their chemo preventive activity. Garlic components have been shown to inhibit tumorigenesis in several experimental models. Garlic has been shown to have a modest blood pressure-lowering effect in clinical studies (Dorant *et al.*, 1993). As garlic inhibits the activity of *Helicobacter pylori*, reduce chances of stomach cancer. Garlic reduces blood cholesterol also. Several epidemiologic studies show that the garlic may be effective in reducing human cancer risk (Steinmetz *et al.*, 1994). More recently, in a study of more than 40,000 postmenopausal women, garlic consumption was associated with nearly a 50 per cent reduction in colon cancer risk (Verhoeven *et al.*, 1996). Garlic has also been advocated for the prevention of CVD, possibly through antihypertensive properties. The cardio protective effects are more likely due to its cholesterol-lowering effect. It is currently unclear which component in garlic is responsible for its cholesterol-lowering effect.

Broccoli and other cruciferous vegetables:

Epidemiological evidence has associated the frequent consumption of cruciferous vegetables with decreased cancer risk due to presence of glucosinolate which has got anticarcinogenic properties (Michnovicz and Bradlow, 1991). The percentages of case-control studies showing an inverse association between consumption of cabbage, broccoli, cauliflower and Brussels sprouts and cancer risk were 70, 56, 67 and 29 per cent, respectively. Glucosinolates are a group of glycosides stored within cell vacuoles of all cruciferous vegetables. Myrosinase,

an enzyme found in plant cells, catalyzes these compounds to a variety of hydrolysis products, including isothiocyanates and indoles. Indole-3 carbinol (I3C) is currently under investigation for its cancer chemopreventive properties, predominantly of the breasts. I3C may lessen breast cancer risk by modulating estrogen metabolism. In humans, I3C administered at 500 mg daily (equivalent to 350-500 g cabbage/day) for 1 week significantly increased the extent of estradiol 2-
et al., 2000) suggesting that this compound may be a novel approach for reducing the risk of breast cancer. The broccoli sprouts, a dietary supplement, contain physiologically active component sulforaphane which has got cancer-preventive action. Such enzymes speed the inactivation of toxic substances and thus accelerate their elimination from the body.

Dark green leafy veg:

(Spinach, Kale, Turnip green, Collard green, Swiss Chorda)-Dark green leafy vegetables contain lutein (another carotenoid) has got ability to neutralize free radicals and thus, reduce chances to develop age-related macular degeneration (AMD) (Mares-Perlman, 1999) or cataracts, the two most common causes of vision loss in adults. Lutein in supplement form may not provide the same benefit as the lutein found naturally in foods (Crowell, 1997). Good sources of lutein include green leafy vegetables such as spinach (7.4 mg/100 g) and cooked cabbage (14.4 mg/100g).

Citrus fruits :

Citrus fruits are defensive 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 fibre, the phytochemicals, the limonoids is responsible for the anticancer activity (Crowell, 1997). Over the last decade, evidence has been accumulating in support of the cancer preventative effect of limonene. Crowell (1997) showed this compound to be effective against a variety of both spontaneous and chemically-induced rodent tumors (Avorn *et al.*, 1994).

Cranberry:

Cranberry juice, benzoic acid-rich fruit results in acidification of the urine and thus, inhibit the adherence of *Escherichia coli* to uroepithelial cells. This phenomenon

has been attributed to two compounds: fructose and a non-dialyzable polymeric compound. The latter compound, subsequently isolated from cranberry and blueberry juices, was found to inhibit adhesins present on the pili of the surface of certain pathogenic *E. coli*. One hundred and fifty-three elderly women consuming 300 ml cranberry beverage per day had significantly reduced (58%) incidence of bacteriuria with pyuria compared to the control group after six months (Harbowy and Balentine, 1997).

Tea:

According to many studies, the green or black tea consumption has effect on cancer treatment. Green tea is abundant in specific polyphenolic components known as catechins. The major catechins in green tea are - epicatechin, epicatechin-3-gallate, epigallocatechin and epigallocatechin-3-gallate (EGCG) (Nakachi *et al.*, 1998). One cup (240 ml) of brewed green tea contains upto 200 mg EGCG, the major polyphenolic constituent of green tea. The consumption of five or more cups of green tea per day was associated with decreased recurrence of stage I and II breast cancer in Japanese women (Meister *et al.*, 2000). Green tea contains five flavonoids (quercetin, kaempferol, myricetin, apigenin and luteolin) and its consumption reduces mortality from CHD.

Wine and grapes :

Grapes full of high concentrations of phenolic antioxidant polyphenolics compound in red grape skins. Wine made from these grapes reduce the risk of heart disease in selected populations (St. Leger *et al.*, 1979). The grape juice also exert the same beneficial as red wine as both are rich in phenolic antioxidant compounds. Consumption of grape juice and red wine has been shown to reduce platelet aggregation. The non-alcohol component of wine, the flavonoids, help in increasing HDL cholesterol. There is growing evidence that wine, particularly red wine, can reduce the risk of CVD as it increases HDL cholesterol (Obisesan *et al.*, 1998). The non-alcohol components of wine, the flavonoids, is an essential element. The high phenolic content of red wine is due to the incorporation of the grape skins into the fermenting grape juice and is about 20-50 times higher. The black seedless grapes and red wines contain high concentrations of phenolics: 920, 1800 and 3200 mg/L, respectively, while green. Thomson grapes contain only

260 mg/kg phenolics. Phenolic substances stop the oxidation of LDL which is essential for atherogenesis. There is decreased risk of age-related macular degeneration in people who consume moderate amount of wine (Jang *et al.*, 1997). Alcohol-free wine is better than wine with alcohol as it increases total plasma antioxidant. The grape juice is effective in preventing the oxidation of LDL. Phytoalexin (trans-resveratrol) is also found in grape skins which have estrogenic properties and thus, have the cardio-vascular benefits of wine drinking. Red wine has also shown to obstruct carcinogenesis *in vivo* (Feldman, 2002).

Nuts:

Nuts which contain low amount of saturated fat and cholesterol, Vitamin E and antioxidants are useful in CVD. Almonds significantly reduce total cholesterol by 4–12 per cent and LDL cholesterol by 6–15 per cent. The walnuts decreases total and LDL cholesterol and thus lower the risk of CHD. Walnuts are very nutritious and loaded with fibre. They also contain high amounts of copper, manganese, vitamin E and important plant compounds. However, do not remove. The skin of walnuts as it contains most of the phenol antioxidants and 7 walnuts (about one ounce) contain 2542 mg of Omega-3 (Rickard *et al.*, 1999).

Blueberries:

Dark blue berry that supplies several phytonutrients such as vitamin C and E. Due to this, can reduce the risk of inflammation and cancer.

Flaxseed and chia seeds :

Chia seeds are incredibly nutritious. They are rich in manganese, calcium, phosphorus and various other nutrients. A standard 1-oz (28 g) 2-tbsp. serving (24 g) of chia seeds contains 4 g of protein, including all eight essential amino acids and 4915 mg of Omega-3 and the risk of cancer. Flaxseed lignans also benefits by preventing cancer as it contains the most (57%) of the omega-3 fatty acid, α -linolenic acid (Yan *et al.*, 1998). Recent research, however, has focused more specifically on fibre-associated compounds known as lignans. Flaxseed is the richest source of mammalian lignan precursors. The ingestion of 10 g of flaxseed per day elicited several hormonal changes associated with reduced breast cancer risk, colon and lung cancer. Consumption

of flaxseed has been shown to reduce total and LDL cholesterol as well as platelet aggregation (Wan *et al.*, 2001).

Chocolates:

Another food that is a source of polyphenolics and is just beginning to be investigated for its potential benefits to heart health is chocolate. Chocolate contains flavonoids (procyanidins), which may reduce oxidative stress on LDL cholesterol. In a recent clinical trial involving 23 subjects consuming a diet supplemented with chocolate and cocoa powder providing 466 mg procyanidins/d, time to oxidation of LDL cholesterol was increased by 8 per cent compared with subjects consuming a normal American diet (Fogg-Johnson and Meroli, 2000).

Certain phytochemicals present in diet have effect on gut microbial signaling. Compound extracted from garlic, coffee and grapefruit have impact on virulence potential of bacteria such as *Pseudomonas aeruginosa in vitro*. Phytochemicals from these foods inhibit the quorum sensing and thus have the potential to be developed as next generation antimicrobials without the chance of resistance.

Effect of processing on functional components in food from plants:

The food processing procedures affect the functional components in food. It has been shown that the length of post-harvest storage, steam blanching and thermal processing effect the holding of functional compounds in fruits and vegetables. Heat processing results in losses of about 30–80 per cent of bioactive isothiocyanates and

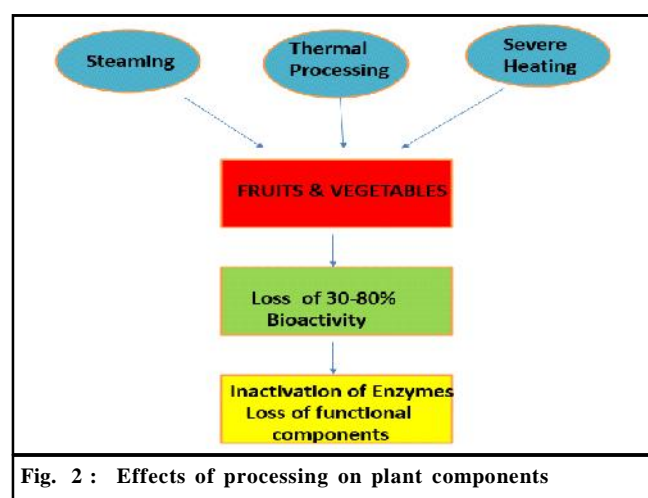


Fig. 2 : Effects of processing on plant components

causes inactivation of key enzymes, myrosinase in Cruciferae and alliinase in allium vegetables and thus, decrease the number of functional components. Heat needed for normal cooking does not affect functional components. Microwave-heating of garlic for 30–60 s results in significant losses of its anti-inflammatory, anticancer, antimicrobial and anti-oxidative activities. Processing technique that increase surface area and breaks down protein and carbohydrate matrix increase the bioavailability of carotenoids and other lipid-soluble functional food. The brewing of tea leaves, whether black or green, releases 69–85 per cent of their bioactive flavonoids within 3–5 min in hot water.

Safety consideration:

For healthy national population, functional foods in the diet is a necessity. What are the ideal levels of the biologically active components is not clear? 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 and 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 of dietary supplements. We should evaluate the benefits and risks of functional food to human health. Knowledge of the facts of toxicity of functional food components is important to decrease the risk: benefit ratio. For example, soy phytoestrogens may represent a "double-edged sword" because of reports that genistein may actually promote certain types of tumors in animals. Still there are no developed regulations or guidance to the companies on the type of safety-related information. Ideally, they should mention safety guide lines on the labels of functional foods and dietary supplements. The absence of such safety information poses a significant safety risk to 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) (Falk *et al.*, 2002).

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 (Falk *et al.*, 2002). 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 non-nutritive 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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