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# Use of Phytochemicals as Functional Food: An Overview

**Divya G. Nair** | Research Scholar, Department of Chemistry, Bishop Moore College, Mavelikkara Kerala

**ABSTRACT**

Functional foods have potentially positive effect on health outside basic nutrition and the advocates of functional foods claim that they encourage optimal health and help to reduce disease risks. Staggering evidence from epidemiological, in vivo, in vitro, and clinical trial data suggests that plant-based diet can reduce the risk of several diseases. Mounting evidence supports the widely accepted notion that functional foods containing biologically-active components, either from plant or animal origin, not only enhance health but also prevents from diseases. However, functional foods are not a magic bullet or universal nostrum for poor health habits.

**KEYWORDS**

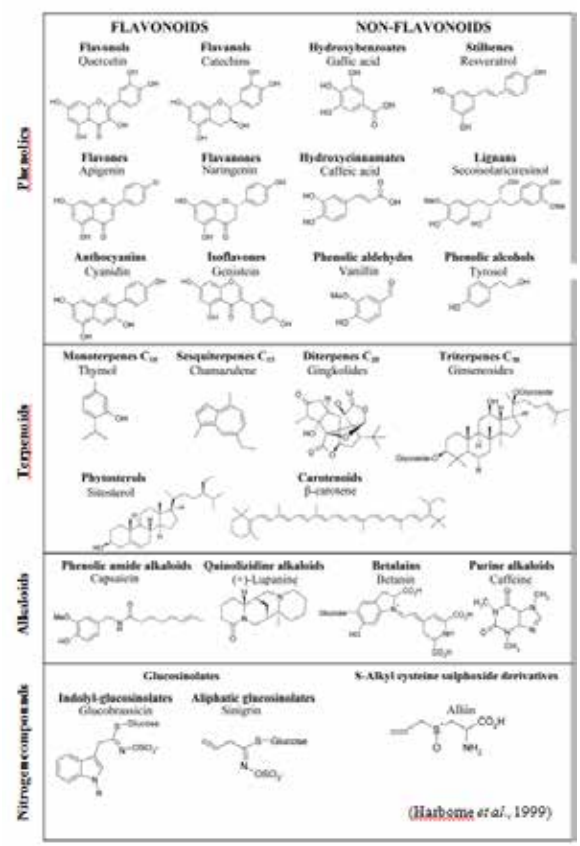
**Introduction**

Phytochemicals are "*plant chemicals*" identified from vegetables, fruits, beans, grains, nuts and seeds. Phytochemical rich food eating helps to prevent various ailments and also to maintain improved health. In short, phytochemicals have distinct bio-activities towards animal biochemistry and metabolism. Various phytochemicals are involved in an array of metabolic reactions as substrates, cofactors, inhibitors, absorbents/sequestrants, intracellular receptors, scavengers, essential nutrients absorption enhancers, elective growth factors and fermentation substrates for beneficial gastrointestinal bacteria, and selective inhibitors of injurious intestinal bacterial flora (Krzyzanowska *et al*., 2010).

Functional food provides additional health benefits outside basic nutrition and has a role in mitigating disease risks and improving overall health conditions (Block *et al*., 1992; Arai, 1996). Recently, several studies noted the relationship between dietary patterns, health and its association with the prevention and/or treatment to extenuate leading causes of death. Phytochemicals have protective and health-promoting impressions which have the possibility of being integrated into foods or food supplements as nutraceuticals or into pharmaceuticals for overall health and well being (DeFelice, 1995). Thus, a nutraceutical is any non-toxic food extract supplement that has proven health benefits for both disease treatment and prevention. On the other hand, functional foods are foods which have a germane effect on well-being and health or decreasing disease risks (Roberfroid, 1999). The functional component of a functional food can be an essential macronutrient or micronutrient, a nutrient that is not considered essential or a non-nutritive component, according to the plant origin.

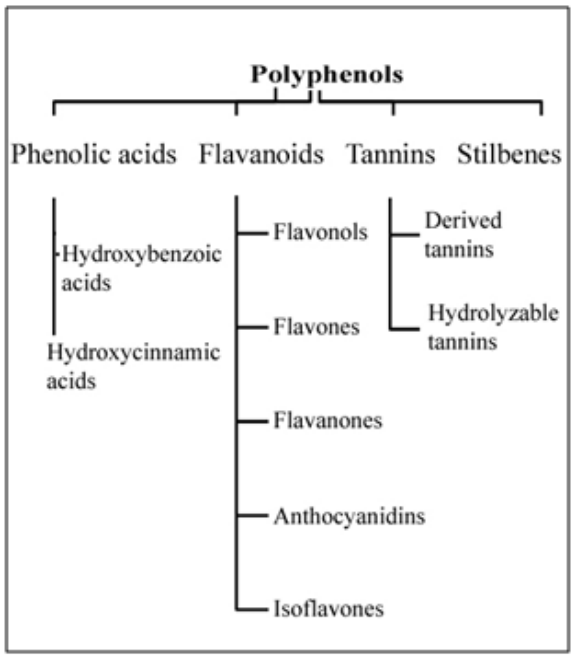
Eventhough, a wide spectrum of bioactives are known to deliver beneficial effects, the mechanisms behind these effects are motleyed and may work individually or collectively in providing the effects (Yuan, 2008). Functional foods are widely used for treating various diseases like cardiac diseases, chronic diseases of aging (Ferrari and Torres, 2003), intestinal diseases (Cencic and Chingwaru, 2010), cancer (Zeng *et al*., 2013), diabetes (Suja, 2013), pet diseases (Cerbo *et al*., 2014) and metabolic syndrome (obesity, diabetes, hypertension and dyslipidemia) (Suhaila *et al*., 2014).

Phytochemicals in foods have diverse and complex chemical structures and are classified into polyphenols, terpenoids, alkaloids and other nitrogen compounds, carbohydrates and lipids (Harborne *et al*., 1999) (Fig 1).




**Phenolics**

Phenolics comprise the largest group of phytochemicals which are secondary metabolites with wide distribution with a myriad of characteristics. Phenols have a distinctive ability to form non-covalent, intermolecular complexes with each other and with both large and small molecules. Phenolics, possess an aromatic ring bearing one or more hydroxyl groups and their structures may range from that of a simple phenolic molecule to that of a complex high-molecular weight polymer are often denoted as "*polyphenols*". Phenolics are secondary metabolites which are derived from pentose phosphate, shikimate, and phenylpropanoid pathways in plants (Escarpa and Gonzalez, 2001). The available categorization of phenolics are given below (Bravo, 1998).




The major polyphenol characteristics are radical-scavenging capacity, which is involved in antioxidant properties (key factor involved in the chemical defense of plants against pathogens and predators and in plant-plant interferences), and the ability to interact with proteins.

Phenolic compounds as functional food render their effects *via* antioxidation and relief from oxidative stress and its consequences. The antioxidative effect of phenolics in functional foods is due to the direct free radical scavenging activity, reducing activity and an indirect effect arising from chelation of pro-oxidant metal ions. The chelation of metal ions generally requires ortho-dihydroxylation on the phenyl ring in phenolic acids and flavonoids or the presence of a 3- or 5-hydroxyl group in flavonoids (Obied, 2013). The potential of polyphenols tempted industry and attracted consumers due to their antioxidative potential in preservation of food and maintaining human health.

**Terpenoids**

Terpenoids (isoprenoids) are the hydrocarbons of plant origin of the general formula $(C_5H_8)n$ as well as their oxygenated, hydrogenated and dehydrogenated derivatives and are classified on the basis of value of n or number of carbon atoms present in the structure.

| Sl. No. | Number of carbon atoms | Value of *n* | Class |
|---|---|---|---|
| 1. | 10 | 2 | Monoterpenoids($C_{10}H_{16}$) |
| 2. | 15 | 3 | Sesquiterpenoinds($C_{15}H_{24}$) |
| 3. | 20 | 4 | Diterpenoids($C_{20}H_{32}$) |
| 4. | 25 | 5 | Sesterpenoids($C_{25}H_{40}$) |
| 5. | 30 | 6 | Troterpenoids($C_{30}H_{48}$) |
| 6. | 40 | 8 | Tetraterpenoids($C_{40}H_{64}$) |
| 7. | >40 | >8 | Polyterpenoids($C_5H_8$)n |

**Table-1: Classification of Terpenoids**

Each class can be further subdivided into subclasses according to the number of rings present in the structure. Most of the terpenoids are colourless, fragrant liquids which are soluble in organic solvent and majority are optically active with open chain or cyclic unsaturated compounds having one or more double bonds

- Acyclic Terpenoids : They contain open structure.
- Monocyclic Terpenoids : They contain one ring in the structure.
- Bicyclic Terpenoids : They contain two rings in the structure.
- Tricyclic Terpenoids : They contain three rings in the structure.
- Tetracyclic Terpenoids : They contain four rings in the structure.

The biological relevance of terpenoids was well established (Wagner and Elmadfa, 2003). Terpenes have unique antioxidant activity as they react with free radicals by partitioning themselves into fatty membranes by virtue their long carbon side chain. The use of γ-tocotrienol, a mixed isoprenoid, and γ-ionone, a pure isoprenoid, to suppress the growth of diverse tumor cell lines *via* initiation of apoptosis and concomitant arrest of cells in the G1 phase of the cell cycle was already reported (Mo and Elson, 1999).

**Alkaloids**

Alkaloids are alkaline nitrogen-containing heterocyclic compounds derived from higher plants and exhibiting marked pharmacological activity. Alkaloids are too numerous with very complex molecular structure with a myriad of metabolic actions and effects.

- Pyrrolidine alkaloids: contain pyrrolidine (tetrahydropyrrole) ring system. E.g Hygrine found in Erythroxylum coca leaves.
- Pyridine alkaloids: have piperidine (hexahydropyridine) ring system. E.g Coniine, piperine and isopelletierine.
- Pyrrolidine-pyridine alkaloids: ring system is Pyrrolidinepyridine. E.g Myosmine, Nicotine alkaloid found in tobacco (Nicotiana tabacum) plant.
- Pyridine-piperidine alkaloids: have pyridine ring system eg. Anabasine alkaloid isolated from Anabasis aphyllan.
- Quinoline Alkaloids: have basic heterocyclic ring system quinoline .E.g Quinine occurs in the bark of cinchona tree. It has been used for centuries for treatment of malaria.
- Isoquinoline alkaloids: contain heterocyclic ring system isoquinoline. E.g Opium alkaloids like narcotine, papaverine, morphine, codeine, and heroine.

Alkaloids are antibacterial, antifungal, insecticidal, and also have allelopathic activities (Molyneux *et al*., 1996). The use of alkaloids containing plants as dyes, spices, drugs or poisons can be traced back time immemorial. The use of alkaloids as functional food was also well reported (Yao *et al*., 2012). Functional foods with alkaloids have numerous pharmacological activities including antihypertensive effects, antiarrhythmic effect, antimalarial activity, and anticancer actions.

**Phytochemicals as functional food**

A number of phytochemicals usually consumed with the human diet, influence health and contributes to prevention of diseases. Currently, there has been an explosion of sake in the health raising role of specific foods or physiologically-active food components, the functional foods. Deluging evidence from epidemiological, *in vivo*, *in vitro*, and clinical trial data indicates that plant-based diet can reduce the risk of chronic diseases (Manach *et al*., 2009).

Health-conscious people around the globe are increasingly seeking functional foods in an effort to control their own health and well-being. The field of functional foods, however, is still in infancy. The conglomerating factors to function as a functional food are complexity of the food substance, effects on the food, compensatory metabolic changes that may occur with dietary changes, and lack of surrogate markers of disease development. In short, the functional food provides the body with the required amount of vitamins, fats, proteins, carbohydrates, *etc*., needed for healthy survival (FAO, 2007). Scientific advances, user need, increasing health care costs, an aging population, technical advances in the food industry, and

changing regulatory environment have stimulated the field of functional foods (Hasler, 1996).

The demonstration for individual phytochemicals is not as obliging, overwhelming evidence from epidemiological, biological and experimental studies coupled with clinical intervention trials depicted that plant-based diet can reduce the risk of degenerative diseases (Kaur and Kapoor, 2001). Evidence suggests that plant-based diets prevent 20-50% of all cases of cancer (Steinmetz and Potter, 1996). Thus, dietary recommendations for precluding cancer and other chronic diseases have always underscored the intake of a variety of plant foods.

The effects of Broccoli and other cruciferous vegetables, oats, flaxseed (linseed), tomato, soybean, citrus, berries, tea, grapes and wine, garlic as functional food in disease prevention was already accentuated.

**Conclusion**

The future of functional foods reckons on the unequivocal presentation of their efficacy in promotion of health. Epidemiological and intervention studies are the need of the hour to cope with enormous amount of inquiries and demands for functional food all around the world. It should be noted that the role of functional food can be investigated and employed for enhanced immunity, anoxia endurance, improved nutritional anemia, skin water content, skin oil content, sleep, child growth and development, assistance in protecting against chemical injury to the liver, antioxidative, elimination of acne, skin chloasma, eye fatigue, assistance in memory, blood sugar reduction, blood pressure reduction facilitation of lead excretion, digestion, milk secretion, faecal excretion, moisten and clean throat, regulation of gastrointestinal tract flora, protecting against gastric mucosa damage, in irradiation hazard protection, blood lipid reduction, alleviation of physical fatigue, weight loss and increased bone density.

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