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# Bioactive Food Components

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# BIOACTIVE FOOD COMPONENTS

**BIOACTIVE FOOD COMPONENTS.** The term "bioactive food component" refers to nonessential biomolecules that are present in foods and exhibit the capacity to modulate one or more metabolic processes, which results in the promotion of better health. Bioactive food components are usually found in multiple forms such as glycosylated, esterified, thiolyated, or hydroxylated. Bioactive food components also have multiple metabolic activities allowing for beneficial effects in several diseases and target tissues. In general, it is thought that bioactive food components are predominantly found in plant foods such as whole grains, fruit, and vegetables. However, probiotics, conjugated linolenic acid, long-chain omega-3 polyunsaturated fatty acid, and bioactive peptides are most commonly found in animal products such as milk, [fermented milk](https://www.encyclopedia.com/sports-and-everyday-life/food-and-drink/food-and-cooking/fermented-milk) products and cold-water fish.

Table 1 summarizes the biological function and food sources for both plant-and animal-based bioactive food components. However, a review of both plant-and animal-based bioactive food components is beyond the scope of this article. Therefore, this article will focus on plant-based bioactive food components.

## Common Forms Found in Foods

There are myriad bioactive food components in plant-based foods. A partial list includes the polyphenols, phytosterols, carotenoids, tocopherols, tocotrienols, organosulfur compounds including isothiocyanates and diallyl- (di, tri)sulfide compounds, soluble and insoluble fiber, and fruto-ogliosaccharide. It is most common to find mixtures of these compounds within a plant food rarely is one class of bioactive food component found singly.

Polyphenols are the most numerous and widely distributed group of bioactive molecules. Polyphenols are a diverse group of plant substances that contain one or more benzene rings and varying number of hydroxyl (OH), carbonyl (C O), and [carboxylic acid](https://www.encyclopedia.com/science-and-technology/chemistry/organic-chemistry/carboxylic-acid) (COOH) groups. These commonly exist with one or more attached sugar residues (that is, conjugated). The most common class of polyphenols is the flavonoids. Other types of polyphenols include catechins, thearubingens, theaflavins, isoflavones, and over eight thousand others. Food sources of polyphenols and flavonoids include vegetables, fruits, cereals, legumes, nuts, tea, wine and other beverages made with fruit, vegetables, and grains. The polyphenol content can vary tremendously between food sources and within foods of the same type. For example, Bravo (1998) reported the following ranges for total polyphenols in barley and millet as 590 to 1,500 mg/100 g dry matter, 8.7 to 30.9 mg/100 g dry matter for oats and corn, 20 to 2,025 mg/g fresh onions and leeks, and 6 to 15 mg/100 g fresh brussels sprouts. For blueberries, strawberries, cranberries, and raspberries the total polyphenol content is 37 to 429 mg/100 g berries.

The organosulfur compounds are commonly found in cruciferous vegetables such as broccoli, cauliflower, and brussels sprouts or allium vegetables such as garlic, leeks, and onions. Organosulfur compounds contain sulfur atoms that are bound to a cyanate group or a carbon atom in a cyclic or noncyclic configuration. The bioactive components of foods containing organosulfur compounds are obtained only after cutting, chewing, or crushing has damaged the vegetable. In cruciferous vegetables various isothiocyanates such as sulforaphane, phenethyl-isothiocyanate, and benzyl isothiocyanate are formed from glucosinolyates by the action of myrosinase. In alliums, allicin is formed from alliin and then rapidly converted to diallyl sulfide, diallyl disulfide or diallyl trisulfide by the action of allinase. In both cruciferous and allium vegetables, these hydrolytic breakdown products are the health-promoting bioactive food components.

Phytosterols are the plant counterparts of cholesterol in animals. The structures are similar, however; the side-chain in plant sterols contains additional double bonds and methyl and/or ethyl groups. The most common bioactive phytosterols are beta-sitosterol, campesterol, and stigmasterol. The nonvegetarian diet contains approximately 250 mg/day of unsaturated phytosterols while a vegetarian diet contains over 500 mg/day. The best food sources include nuts, seeds, unrefined plant oils, and legumes. The saturated derivatives of plant sterols are plant stanols, the most common being sitostanol. Plant stanols occur naturally in wood pulp, tall oil, and soybean oil, but are most commonly obtained in the diet by chemical hydrogenation of plant sterols. Western diets contain approximately 20 to 50 milligrams of plant stanols.

The carotenoids are lipid-soluble plant pigments that are either oxygenated or non-oxygenated hydrocarbon containing at least forty carbons and an extensive conjugated double bond system. Beta-carotene, alpha-carotene, and lycopene are the predominant nonpolar bioactive carotenoids and lutein is the primary polar bioactive carotenoid. Carotenoids can be found esterifed to fatty acids or unesterifed in plant tissue. Carrots, squash, [sweet potato](https://www.encyclopedia.com/plants-and-animals/plants/plants/sweet-potato), and spinach are abundant in both beta-and alpha-carotene and the dark green leafy vegetables such as kale, spinach, mustard greens, and green beans are good sources of lutein. Lycopene is found predominately in tomatoes. The total carotenoid content of fruits and vegetables varies with age and storage (Parker).

The tocopherols and tocotrienols are lipid-soluble bioactive compounds that contain a phenolic-chromanol ring linked to an isoprenoid side chain that is either saturated (tocopherols) or unsaturated (tocotrienols). There are also four primary forms of tocopherols and tocotrienols—alpha, beta, gamma, and delta—that differ in the number and position of methyl groups on the phenolic-chromanol ring. In addition, the tocopherols have three asymmetrical carbons at position 2, 4 , and 8 of the isoprenoid side chain. Consequently, there are eight isomeric forms of tocopherols, of which RRR-a-tocopherol has the greatest bioactivity and is also the most abundant in human blood and tissues. Typical dietary sources of both tocopherol and tocotrienols include vegetable oils; nuts and the germ portion of grains are rich sources of both these compounds.

## Biological Actions

There is a significant lack of understanding of the precise biological mechanism(s) of how plant-based bioactive food components impart health-promoting benefits. It is clear that bioactive food components act simultaneously at different or identical target sites. Bioactive food components have been shown to have the potential to reduce the risk of cancer, cardiovascular disease, osteoporosis, inflammation, type 2 diabetes, and other chronic degenerative diseases.

Bioactive food components have health-promoting roles at various stages of diseases that are associated with multiple progressive steps, from initiation to development. For example, in cardiovascular disease, isoflavones may reduce circulating oxidized low-density lipoproteins in the plasma, bind cholesterol in the intestinal tract thereby reducing absorption of dietary cholesterol, enhance bile excretion thereby reducing endogenous cholesterol levels, and modulate arterial elasticity thereby improving blood vessel dilation and constriction response.

As antioxidants, polyphenols, carotenoids, tocopherols, and allyl sulfides quench [free radicals](https://www.encyclopedia.com/sports-and-everyday-life/food-and-drink/food-and-cooking/free-radicals) and reactive oxygen species. A [free radical](https://www.encyclopedia.com/science-and-technology/chemistry/organic-chemistry/free-radical) is a carbon or oxygen atom that has an unpaired electron and is highly unstable. Free radicals can form in lipids, proteins, and carbohydrates. The primary actions of antioxidants include the regulation of the redox potential within a cell and the reduction of potential initiators of carcinogenesis. The redox potential refers to the balance of the reducing and oxidizing reactions that occur within the cell. Redox changes within a cell are able to trigger various molecular responses such as induction of apoptosis (cell death) and activation of signal transduction (the transfer of messages between cells and within a cell). Therefore, redox and antioxidant regulation of physiological and pathological processes is important in optimizing health and disease prevention.

Other bioactive compounds are able to bind to toxins or carcinogens in the intestinal tract thereby preventing transformation or even absorption such as the binding of *N-* nitroso compounds in the intestinal tract by polyphenols in tea. The lipid-lowering mechanism of [dietary fiber](https://www.encyclopedia.com/sports-and-everyday-life/food-and-drink/food-and-cooking/dietary-fiber) and phytosterol/stanols occurs by sequestering cholesterol in the intestinal tract and reducing cholesterol absorption. Dietary fiber is the indigestible parts of plant foods; it provides structure to the plant cell walls and is composed of long straight chains of carbohydrate molecules held together by bonds that cannot be broken by human digestive enzymes. This long fibrous structure allows dietary fibers to entrap harmful toxins and carcinogens in the digestive tract. There are two types of [dietary fiber](https://www.encyclopedia.com/sports-and-everyday-life/food-and-drink/food-and-cooking/dietary-fiber): soluble and insoluble. Soluble dietary fiber can dissolve in or absorb water and is effective in binding toxins and cholesterol in the intestinal tract. Insoluble dietary fiber, on the other hand, cannot dissolve in water and is effective in adding bulk and increasing the rate of passage of food through the intestinal tract. Insoluble dietary fiber, therefore, acts by diluting out potential carcinogens and decreasing contact of toxins and carcinogens with the intestinal tract by speeding their passage out of the body. Foods rich in soluble dietary fiber include apples, cranberries, mango, oranges, asparagus, broccoli, carrots, peanuts, walnuts, most legumes, oats, and psyllium. Rich food sources of insoluble dietary fiber include apples, bananas, berries, broccoli, green peppers, spinach, almonds, sesame seeds, most legumes, brown rice, whole-wheat breads, and cereals.

The structural similarity between several isoflavone metabolites and the metabolite of estrogen, estradiol, suggests the possibility of estrogen-like biological activities. Isoflavones or phytoestrogens, however, exhibit antagonist estrogen activity resulting in lower overall exposure to estrogen in premenopausal women and reducing breast cancer risk (Cassidy et al. 1994, 1995; Shimizu et al.). In postmenopausal women phytoestrogen-rich diets reduce the hormone-sensitive increases in plasma cholesterol levels and bone loss (Potter et al.; Setchell and Cassidy).

The induction of enzyme systems that detoxify toxic chemicals such as the phase I and phase II detoxifying enzymes is thought to reduce one's susceptibility to mutagenic effects. Bioactive food components with antioxidant functions are able to activate phase II detoxifying enzymes via an antioxidant-responsive element (Mukhtar and Ahmad). Isothiocyanates, in particular sulforaphane, are potent mono-inducers of phase II detoxifying enzymes (Zhang et al.). Diallyl sulfides from garlic preparations, on the other hand, are inducers of both phase I and phase II detoxifying enzymes (Yang et al.).

A primary mechanism for immune-modulation is the multiple antioxidant capability of polyphenols, tocopherols, carotenoids, isothiocyanates, and allyl sulfides. Together these compounds are able to reduce the deleterious effects of reactive oxygen species and [free radicals](https://www.encyclopedia.com/sports-and-everyday-life/food-and-drink/food-and-cooking/free-radicals), which cause premature death of immune cells (Brennan et al.). Bioactive food components have also been shown to stimulate the phagocytic action of macrophages and synthesis of several immune cell types, which increases the protection against infection. Among the foods that have been shown to have benefical immuno-modulatory effects are broccoli, garlic, onions, vegetable oils, almonds, walnuts, and others that are listed in Table 1.

## Effects of Food Processing

In general, processing of fresh fruits and vegetables results in changes in composition of the bioactive food components. These changes can be beneficial or detrimental to the total content of health-promoting phytochemicals. It has been shown that coarseness of cutting, length of storage post-harvest, steam blanching, and thermal processing all influence the retention of bioactive compounds in cruciferae and allium vegetables (Howard et al.; Song and Milner). Reported losses of 30 percent to 80 percent of bioactive isothiocyanates have been reported (Howard et al.). Temperatures of 212°F (100°C) and higher result in the inactivation of key enzymes, myrosinase in cruciferae and allinase in allium vegetables, thereby reducing the amount of bioactive components. However, temperatures associated with normal cooking have shown little evidence of substantial loss of isothiocyanates. Leaching of glucosinolates and hydrolysis products also results in a reduction in total phytochemical content following cooking. Research has shown that heating garlic to a temperature of 140 to 212°F (60 to 100°C) or microwave heating for 30 to 60 seconds results in significant losses of the anti-inflammatory, anticancer, antimicrobial, and antioxidative activities of garlic (Song and Milner). However, the protective effect of garlic was nearly restored if the garlic preparation was allowed to sit for 10 minutes at room temperature prior to any heat treatment.

The bioavailability of carotenoids and other lipid-soluble bioactive food components has been shown to be improved with processing that increases surface area, such as cutting and chopping, and heat treatments that break down the protein and carbohydrate matrix that bind carotenoids (Stahl and Sies; Parker). The brewing

| **Summary listing of various bioactive food components,** **common food sources, and biological functions** | | |
| --- | --- | --- |
| **Bioactive component** | **Food source** | **Function** |
| Glucosinolates, diallyl sulfides, isothiocyanates | Broccoli, cauliflower, brussels sprouts, garlic, onions | Induction of detoxifying enzyme systems, antimicrobial, immunomodulator, anticancer |
| Tocopherols and tocotrienols | Vegetable oil, nuts, seeds | Antioxidant, immunomodulator |
| Isoflavonoids and polyphenols | Grapes, red wine, tea, fresh fruit, and vegetables | Antioxidant, lipid- lowering, immunomodulator, antiosteoporotic, anticancer |
| Phytoestrogens (genistein, daidzein) | Soybean and other soy-based products, flaxseed, cabbage, legumes, tea | Antiestrogen, anti- osteoporotic, antiproliferative |
| Phytosterols | Vegetable oils, nuts | Lipid-lowering |
| Dietary fiber | Whole grains, oats, fresh fruit with skin | Lipid-lowering |
| γ-linolenic acid, α-linolenic acid, and omega-3 fatty acids | Evening primrose or borage oil, walnuts, rapeseed, flaxseed, fish, microalgae | Anti-inflammatory, lipid- lowering |
| Lutein | Green leafy vegetables | Reduction in age- related macular degeneration |
| Carotenoids | Carrots, corn, squash, green leafy vegetables, oranges, papaya, red [palm oil](https://www.encyclopedia.com/science-and-technology/chemistry/organic-chemistry/palm-oil) | Antioxidant immunomodulators |
| Lycopene | Tomatoes | Antiproliferative, anticancer |
| Bioactive peptides: lactoferrin, glycomacropeptide | Milk and fermented milk products | Immune system enhancing, antiproliferative, antimicrobial |
| Probiotics | Fermented milk products | Immunomodulators, anticancer , gastrointestinal health modulators |

of tea leaves, whether black or green, releases 69 to 85 percent of bioactive flavonoids within 3 to 5 minutes in hot water (Trevisanato and Kim).

## Dietary Recommendations

Clearly, bioactive food components will play an important role in health maintenance in the future. However, information is needed in regards to the bioavailability of bioactive food components and the effective dosage required in humans to optimize health benefits. Current information suggests that to obtain and maintain blood levels of beneficial polyphenols, especially phytoestrogens and isoflavonoids, and carotenoids one needs to consume on a daily basis 25 to 60 grams of soy protein, five to nine servings of fruits and vegetables, one fresh clove of garlic, and four to six cups of green or black t ea (Klotzbach-Shimomura). To achieve optimal phytosterol/stanol and fiber levels a daily intake of 25 to 35 grams of fiber is recommended by consuming seven to eleven servings of whole grains, legumes, pastas or nuts, and five to nine servings of fruits and vegetables.

The average American diet consists of two to four servings of fruits and vegetables and only five to seven servings of whole grains. Consequently, there is still a need to provide information and food choices to consumers to aid in the selection of a diet that contains optimal levels of health-promoting bioactive food components.

*See also* **Antioxidants** ; **Assessment of Nutritional Status** ; **Dairy Products** ; **Dietary Assessment** ; [**Dietary Guidelines**](https://www.encyclopedia.com/sports-and-everyday-life/food-and-drink/food-and-cooking/dietary-guidelines) ; **Fiber, Dietary** ; **Fish** ; **Fruit** ; **Lipids** ; **Nutrient Bioavailability** ; **Vegetables** .

## BIBLIOGRAPHY

Bravo, L. "Polyphenols: Chemistry, Dietary Sources, Metabolism, and Nutritional Significance." *Nutrition Reviews* 56 (1998): 317–333.

Brennan, L. A., G. M. Morris, G. R. Wasson, B. M. Hannigan, and Y. A. Barnett. "The Effect of [Vitamin C](https://www.encyclopedia.com/medicine/anatomy-and-physiology/anatomy-and-physiology/vitamin-c) or [Vitamin E](https://www.encyclopedia.com/medicine/anatomy-and-physiology/anatomy-and-physiology/vitamin-e) Supplementation on Basal and H2O2-Induced DNA Damage in Human Lymphocytes." *British Journal of Nutrition* 84 (2000): 195–202.

Cassidy, A., S. Bingham, and K. D. R. Setchell. "Biological Effects of Isoflavones Present in Soy in Premenopausal Women: Implications for the Prevention of Breast Cancer." *American Journal of Clinical Nutrition* 60 (1994): 330–340.

Cassidy, A., S. Bingham, and K. D. R. Setchell. "Biological Effects of Isoflavones in Young Women—Importance of the Chemical Composition of Soya Products." *British Journal of Nutrition* 74 (1995): 587–590.

Howard, L. A., E. H. Jeffery, M. A. Wallig, and B. P. Klein. "Retention of Phytochemicals in Fresh and Processed Broccoli." *Journal of Food Science* 62 (1997): 1098–1104.

Klotzbach-Shimomura, K. "Functional Foods: The Role of Physiologically Active Compounds in Relation to Disease." *Topics in Clinical Nutrition* 16 (2001): 68–78.

Mukhtar, H., and N. Ahmad. "Tea Polyphenols: Prevention of Cancer and Optimizing Health." *American Journal of Clinical Nutrition* 71 (2000): 1698S–1702S.

Parker, R. S. "Phytochemicals: Carotenoids." In *Wiley Encyclopedia of Food* [*Science and Technology*](https://www.encyclopedia.com/science-and-technology/technology/technology-terms-and-concepts/science-and-technology), 2nd ed., vol. 3, edited by F. J. Francis, pp. 1909–1915. [New York](https://www.encyclopedia.com/places/united-states-and-canada/us-political-geography/new-york): John Wiley and Sons, 2000.

Potter, S. M., J. A. Baum, H. Teng, R. J. Stillman, N. F. Shay, and J. W. Erdman. "Soy Protein and Isoflavones: Their Effects on Blood Lipids and Bone Density in Postmenopausal Women." *American Journal of Clinical Nutrition* 68 (1998): 1325S–1379S.

Setchell, K. D. R., and A. Cassidy. "Dietary Isoflavones: Biological Effects and Relevance to Human Health." *Journal of Nutrition* 129 (1999): 758S–767S.

Shimizu, H., R. K. Ross, L. Bernstein, M. C. Pike, and B. E. Henderson. "Serum Estrogen-Levels in Postmenopausal Women—Comparison of American Whites and Japanese in Japan." *British Journal of Cancer* 62 (1990): 451–453.

Song, K., and J. A. Milner. "The Influence of Heating on the Anticancer Properties of Garlic." *Journal of Nutrition* 131 (2001): 1054S–1057S.

Stahl, W., and H. Sies. "Uptake of Lycopene and Its Geometrical Isomers Is Greater from Heat-Processed Than from Unprocessed Tomato Juice in Humans." *Journal of Nutrition* 122 (1992): 2161–2166.

Trevisanato, S. I., and Y.-I. Kim. "Tea and Health." *Nutrition* *Reviews* 58 (2000): 1–10.

Yang, C. S., S. K. Chhabra, J.-Y. Hong, and T. Smith. "Mechanisms of Inhibition of Chemical Toxicity and Carcinogenesis by Diallyl Sulfide (DAS) and Related Compounds from Garlic." *Journal of Nutrition* 131 (2001): 1041S–1045S.

Zhang, Y., T. W. Kensler, C.-G. Cho, G. H. Posner, and P. Talalay. "Anticarcinogenic Activities of Sulforaphane and Structurally Related Synthetic Norbornyl Isothiocyanates." *Proceedings of the* [*National Academy of Sciences*](https://www.encyclopedia.com/science-and-technology/physics/science-general/national-academy-sciences) 91 (1994): 3147–3150.

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[Binswanger, Mathias 1962-](https://www.encyclopedia.com/arts/educational-magazines/binswanger-mathias-1962)

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