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Physiological Functions of Phytonutrients, Part 1 of 3

By John Maher, DC, DCBCN, BCIM

"Phytochemical" refers to a classification system of botanical chemicals. Broadly stated, these are chemicals plants produce to perform metabolic functions, i.e., wood creating cellulose; sugar cane manufacturing sucrose; or opium poppies producing morphine.[1]

Within the context of natural health and nutrition, "phytonutrient" has come to refer to bioactive plant chemicals humans eat that may have significant positive effects on human metabolism. Phytochemicals concentrated or prepared in such a dosage as to have likely therapeutic effects are generally becoming referred to as "nutraceuticals."

Phytonutrients are not essential for life, but they appear to be essential for optimal health and longevity. Therefore, they may properly be classified as micronutrients, along with vitamins and minerals. The technical classification includes: terpenes; amines; organosulfurs; phenols; poly-saccarides; organic acids; and lipids. One food can contain several classifications of phytonutrients. For example, an orange contains terpenes (carotenoids and limonoids) and phenols (bioflavinoids).

This article will examine some of the major subgroups of phytonutrients and how they may contribute to optimal function.

Phytosterols

Phytosterols, saponins, phenolics, pectins and soluble fibers are subclassifications of phytonutrients known particularly for their cholesterol-lowering abilities. Examples from each subgroup include flax, pumpkin and sesame seed (phytosterols); fenugreek and ginseng (saponins); cherries and green tea (phenolics); apples and prunes (pectins); and oat beta glucan and rice bran (soluble fibers). Phytosterols are lipids; saponins are terpenes; phenolics are phenols; and pectins and soluble fibers are polysaccarides.

Nuts are the richest source of phytosterols in the Western diet. Numerous studies demonstrate that diets rich in nuts and seeds are associated with a decreased occurrence of cardiovascular disease (CVD).[2] Cold-pressed unrefined vegetable oils, such as flaxseed; hazelnut; olive; sesame; wheat germ; and walnut, are excellent sources of phytosterols. Refining and hydrogenation drastically reduces phytosterol concentrations by 40-85 percent.[3]

Phytosterols are absorbed poorly. They lower cholesterol by interfering with its absorption in the small intestine. Three grams of phytosterols daily show significant lipid-lowering effects.[4]

Algae and fungi also manufacture phytosterols. For example, as presented at the **American Heart Association's** 39th Annual Conference in 1999, ergosterol from red yeast grown on rice has lipid-lowering effects similar to statins. Various mushrooms, seaweeds and spirulina contain many sterols, including fucosterol, sitosterol and ergosterol.

Phytosterols also can mimic hormone precursors or modulate hormones. For example Swedish tree pollen, pumpkin seeds, pygeum, and saw palmetto are all used in cases of benign hypertrophic prostate disease (BHP) and prostatitis. These phytosterols inhibit the conversion of testosterone to dehydroxytestoterone (DHT).[5]

Phytosterol steroid mimicry also contributes to the anti-inflammatory effects of cold-processed oils, as from flaxseeds and olives. The essential fatty acid (EFA) lipids help modulate eicosanoid production: the omega-6 EFAs are precursors to prostaglandin E1, and the omega-3 EFAs serving as precursors for prostaglandin E3. Both anti-inflammatory in action.[6] Specially prepared and concentrated phytosterols (sterols and sterolins) from sesame seed are used to modulate immune function through thymus hormones (T1 and T2) and interleukins, while also modulating DHEA/cortisol balance.[7]

The Carotenoids

Carotenoids, a fat-soluble group of naturally occurring plant pigments, are a subclassification of the terpenes. Perhaps the most familiar of phytonutrients, carotenoids function as powerful antioxidants and immunopotentiaters. Diets rich in carotenoids are linked with a decreased risk of heart disease, cancer, and degenerative eye disease, such as macular degeneration and cataracts.[8]

There are approximately 600 known carotenoids 50 of which are present in our diets, mostly from fruits and vegetables. Twenty have been identified in the human body.[9] Chemically, they are classified in two main groups: carotenes and xanthophylls. Carotenes refer to the carotenoids that contain only carbon and hydrogen (betacarotene and lycopene). Xanthophylls refer to compounds that also contain a hydroxyl group (lutein, zeaxanthin and beta-cryptoxanthin), a keto group (canthaxanthin) or both (astaxanthin).

Alphacarotene, betacarotene and cryptoxanthin are the main vitamin-A precursors. Carotenoids are considered potent membrane antioxidants because of their reactivity with singlet oxygen. Ranked by antioxidant power, astaxanthin; canthaxanthin; betacarotene; zeaxanthin; and lutein are all stronger than vitamin E!

Leafy green vegetables contain mostly lutein and zeaxanthin. Carrots, oranges, sweet potatoes and squash contain mainly carotenes. Interestingly, the yellow yolk of eggs is rich in lutein, and the astaxanthin group from red algae is what makes salmon pink. Lutein and zeaxanthin are the only carotenoids identified in the macula, where they filter blue light from the retina and inhibit oxidative damage. Such damage leads to macular degeneration, the leading cause of blindness in those over 65.

Researchers at the University of Utah Medical School found lutein intake inversely associated with colon cancer.[10] A study on serum carotenoid levels in women in India with breast cancer showed lutein and zeaxanthin to be significantly lower than in healthy controls, at least in postmenopausal women.[11]

Lycopene is most abundant in tomatoes, with smaller amounts in pink grapefruit, watermelon, guava and rose hips. Lycopene makes up approximately 50 percent of the total carotenoids in blood plasma of those persons consuming Western diets. It protects against prostate; cervical; breast; digestive tract; and lung cancers, and possibly atherosclerosis.[12]

Zeta carotene, phytoene and phytofluene also are found in tomatoes, and according to one company, the latter two may be more effective in inhibiting LDL oxidation than other carotenoids. The company has filed a patent for a blood-pressure-lowering combination of lycopene; phytofluene; phytoene; astaxanthin; and canthaxanthin, claiming administration of these in therapeutic dosages can lower blood pressure rapidly by reducing blood viscosity and increasing vessel flexibility.

Astaxanthin, found mostly in red yeasts and red algae, is now fed to salmon, trout, crabs, krill and shrimp in "fish farms" to provide the red and pink color of their natural-red-algae-eating wild brethren. Astaxanthin,

the most powerful of the carotenoid antioxidants, has been shown to enhance secondary immune response in humans, and help reduce symptoms of *helicobacter pylori*, CTS and RA. *13*. Betacarotene intake is associated with reduced risk of breast, stomach, esophageal and pancreatic cancers.[14] Researchers at Johns Hopkins University reported in 1994 that smokers with the lowest blood levels of betacarotene had approximately a 350-percent greater risk of heart attack compared to nonsmokers with high betacarotene levels.

Betacryptoxanthin, found mostly in fruits such as oranges, tangerine and papayas, is second only to betacarotene as a source of vitamin A. Cryptoxanthin is the only carotenoid that appears to be related inversely to bladder cancer risk,[15] a point that emphasizes the uniqueness of each phytonutrient.

Of note, some carotenoid-rich foods, such as carrots and tomatoes, yield more betacarotene and lycopene, respectively, when cooked. Lutein and lycopene require fat for optimal uptake of carotenoids, whereas dietary fiber inhibits its absorption of lutein, lycopene and betacarotene by 40 percent to 75 percent.[16,17]

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John Maher, DC, ABAAHP
Encinitas, California
jmaher -at- doctorsfornutrition.com
www.greensfirst.com

Click here for more information about John Maher, DC, DCBCN, BCIM.

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