

The Physiological Functions of Phytonutrients, Part III

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The Organosulfur Group

The strength of evidence supporting the anti-cancer benefits of fruits and vegetables is convincing.¹ Clearly underlying the importance of the organosulfur group are cruciferous vegetables (a member of that group), which were the first to be promoted by the American Cancer Society as cancer-preventive!

The organosulfur group provides sources of sulfur vital for phase-II enzyme activities (i.e., glutathione S-transferase AKA GST) involved in the detoxication of carcinogens. More specifically, organo-sulfurs provide glucosinolates that are converted into several biotransformation products in the human body, particularly indole-3-carbinol, isothiocyanates, and thiosulfonates. The sulfur compounds in these three groups are slightly different; consequently, each has specific health benefits.

The indoles and isothiocyanates are most especially found in the cruciferae family of brassica and mustard plants: horseradish, cabbage, broccoli, Brussel sprouts, kale, arugula, bok choy, cauliflower, mustard seeds, mustard greens, watercress, turnip greens, daikon, wasabi and kohlrabi. The thiosulfonates are predominant in the allium family, of which garlic, onion, leek, asparagus, shallots, chive and scallions are representative.²

A recent case-controlled study reported that cruciferous consumption of one to two servings per day (150-220 grams) reduced breast cancer risk by 40 percent to 50 percent in postmenopausal women. In such women, elevating daily intake from the current average 9 gm per day to 193 gm created a favorable shift in urinary excretion ratio of 2-hydroxy versus 16-alpha-hydroxysterone (the so-called "good" and "bad" estrogen metabolites, at least as far as breast cancer is concerned.)³

Inhibition of esophageal, lung and several other cancers has been shown in animal studies at Ohio State University. Scientists proposed that activation of cytochrome P450 enzymes was the likely cancer-protective method.⁴ The protective agents of the brassica are thought to be the most protective, especially the phytonutrients isothiocyanate, sulforaphane, and indole-3-carbinol (I3C), with its metabolite di-indolymethane (DIM).

The phytonutrient content of cruciferous vegetables can vary widely. For example, sulforaphane (which helps turn on t4 cells, so they recognize cancer cells and destroy them) in three-day-old broccoli sprouts was measured and found to be between 10 and 100 times higher than the amount in mature broccoli,⁷ and 125 mg of such broccoli "super sprouts" may be equal to approximately one five-ounce serving of most mature broccoli!⁵

Two reductionist approaches to ingesting physiologically significant amounts of organosulfurs

utilize broccoli extracts of I3C and DIM. According to Dan Lukaczer, ND, director of clinical research at the Functional Medicine Research Center in Gig Harbor, Wash., I3C is a secondary metabolite in cruciferous vegetables, formed after an enzyme in the vegetable (myrosinase) is exposed to a phytochemical in the vegetable (glucobrassicin). This can occur only when vegetable cells are crushed or eaten, and is referred to as enzymatic hydrolysis. Once formed, I3C is broken down in the presence of stomach acid into several byproducts, such as DIM, which are then absorbed. Both appear to be of value in inhibiting cancer cells in animal cancer models, but it is not clear whether DIM is the only breakdown product of importance.

As most of the research to date has focused on I3C, it may be prudent to utilize supplements containing I3C instead of DIM. The former must be taken with meals, and individuals supplementing with I3C must have sufficient acidifying capacity in their stomachs. Nonetheless, one source²³ advises that DIM should be taken with a light meal containing some fat. Four hundred mg of DIM represents the amount one might normally ingest in two to three pounds of brassica. However, a study in the *Journal of the National Cancer Institute* relates that it only took three and one-half servings a week of broccoli, Brussel sprouts and cauliflower, which contain high levels of indoles, to decrease the risk of prostate cancer by 41 percent.⁸ Interestingly, the bioavailability of indoles is increased by light cooking.

While the thiosulfonates are also able to assist Phase II detoxication, and thereby enhance protection against carcinogenesis, they are perhaps better known for their ability to promote a more favorable HDL-LDL ratio, lower blood pressure and stimulate nonspecific immunity

Like their cruciferous cousins, when thiosulfonates are cut or smashed, the sulfur compounds release biotransformation products, including allicin, ajoene, allylic sulfides, vinyl dithin and D-allyl mercaptocysteine. Some of these are considered anti-atherosclerotic; antioxidant; or anti-cancer agents, while others are antibacterial, antiviral and antifungal.⁹⁻¹² Europe's *Commission E Monograph* declares garlic antibacterial, antimycotic, lipid-lowering, and an inhibitor of platelet aggregation (thus prolonging bleeding and clotting time), with concomitant enhancement of fibrinolytic activity.

Organic Acids

Phytochemicals in this group are small to large complex carbon compounds found in grains, herbs, teas and some vegetables and fruits. These compounds, which include esters and lactones, act primarily as antioxidants, cancer preventives, liver protectors and inflammatory mediators.¹³ The acids include oxalic in spinach, rhubarb, tea and coffee; tartaric in apricots and apples; cinnamic in aloe and cinnamon; caffeic in burdock and hawthorn; ferulic in oats and rice; gallic in tea, coumaric in tumeric; salicylic in spearmint; and tannic in nettles, tea and berries.

Perhaps of most current interest is ellagic acid, found in guava, currants, apples, grapes, strawberries, and most particularly, in red raspberries and wild cherry cherries. According to the Hollings Cancer Institute at the University of South Carolina, ellagic acid is a proven anti-carcinogen, anti-mutagen, and anti-cancer initiator.

Nine years of study have shown that for breast, pancreas, esophageal, skin, colon and prostate cancer cells, ellagic acid strongly inhibits cancer cell division within 48 hours and promotes apoptosis (normal cell death) within 72 hours. Clinical tests also show that ellagic acid prevents the destruction of the p53 gene by cancer cells. Additional studies suggest that one of the mechanisms by which ellagic acid inhibits mutagenesis and carcinogenesis is by forming adducts with DNA,

thus masking binding sites that might otherwise be occupied by the mutagen or carcinogen.¹⁴

Organic acids can form complexes with other phytochemicals to yield new compounds with even more powerful effects. For example, gallic acid complexes combine with polyphenolic catechins to form catechin gallates; catechin-gallate complexes (esters) are antioxidants with enhanced anti-cancer and anti-tumor effects.¹⁵ This surprising finding again argues for the oft-repeated conservative guideline in supplementing phytonutrients for general health benefits: Consider first a wide spectrum from fruits, vegetables, legumes, grains and spices (of all colors) over mega-doses of single or several phytonutrients.

The Amines

The amines include both chlorophyll (as in chlorella, spirulina, hydrilla, and the leafy greens and grasses) and plant enzymes (as in papain and bromelain). It is well-known that chlorophyll detoxifies carcinogens found in cooked muscle meats (heterocyclic amines); smoked or barbecued foods (polycyclic hydrocarbons; and peanut mold (aflatoxin)).¹⁶ Chlorophyll has also been recognized for its anti-inflammatory, anti-mutagenic, and antioxidant properties.¹⁷⁻¹⁸ Researchers found that the naturally occurring chlorophyll derivative, pheo-phorbide, showed antioxidant activity against lipid auto-oxidation comparable to alphanatocopherol (a.k.a. vitamin E).^{17,19,20}

Chlorophyll has been cited as strengthening the immune response; therapeutic for inflammation of the ear and the mucous membrane of the nose and sinuses; supportive of normal kidney function; accelerating wound and ulcer healing; and reducing fecal, urinary and body odor in geriatric patients.^{21,22} Plant enzymes are also well-accepted as useful in assisting digestion, having the advantage of being active in a wide pH range. Taken between meals, they assist in injury resolution by increasing the blood enzymes available to digest proteins related to fibrolytic and inflammatory processes and immune responses.

Conclusion

This is a very cursory review of the major phytonutrient compounds, namely the polysaccharides, lipids, terpenes, phenols, organosulfurs, organic acids, and amines. The message is that our dietary and supplementation habits should include a wide variety of whole foods and whole food supplements nutrient dense in a broad spectrum of phytonutrients.

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