


Fruit's Plentiful Phytochemicals

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Loaded with vitamins, minerals and fiber, fruits have always been considered an essential part of a healthy diet. More-recent study has uncovered another group of components in fruits called “phytochemicals.” Phytochemical could technically refer to almost any plant chemical. However, today’s health and nutritional communities use this term to describe several families of naturally occurring biochemicals that, although not considered essential nutrients (protein, carbohydrate, fats, minerals or vitamins), appear to affect human health on varying levels, and to varying degrees.

Phytochemicals appear to have evolved with plants, helping them adapt to environmental changes. Some compounds, for example, evolved to protect plants from increasing levels of reactive oxygen in an atmosphere that was previously dominated by carbon dioxide. These “antioxidants” paved the way for the evolution of oxygen-tolerant plants. Today, many of our favorite fruits’ colors, aromas — even tastes — are defined in part by phytochemicals.

Top of the rainbow

The carotenoid family creates red, orange, and yellow-red hues in a host of fruits, such as apricots, cantaloupe, grapefruit, oranges, kiwi fruit and watermelon. The group contains over 700 fat-soluble nutrients classified by chemical structure as carotenes or xanthophylls. Carotene hydrocarbons include alpha- and beta-carotene, as well as lycopene. Although tomatoes provide the best source of lycopene, watermelon, pink grapefruit, peaches and apricots can provide lower levels of this important compound. Lycopene has been the subject of much study recently, linking it to reductions in the risk of cancers of



Pomegranates contain high levels of ellagic acid, a phenolic compound shown to inhibit tumor growth caused by carcinogens. Other studies indicate that it helps prevent cancers cells from spreading.

the prostate, colon, breast, lung and digestive tract. Lycopene becomes more readily absorbed with heating. For this reason, people should consider processed tomato products, such as soups, sauces and even pizza, as their primary source of lycopene.

Beta-carotene is probably the most

familiar carotenoid. One of several provitamin-A compounds, beta-carotene most effectively converts to vitamin A, a crucial element in human vision, bone growth, cell division and reproduction. While many people think of carrots as the primary source of beta-carotene, fruits such as apricots, cantaloupe, kiwi and papaya contain it. As with lycopene, beta-carotene is also a powerful antioxidant linked to the prevention of several types of cancers. In addition, beta-carotene has been shown to help the body combat cold and flu by helping strengthen the immune system. Formulating foods with beta-carotene is possible with oil- and water-soluble forms used in fortification of a variety of cereal items and beverages.

Xanthophylls are oxygenated deriva-

tives of carotenes found in yellow fruits as well as some green vegetables where they are masked by the effect of chlorophyll. Two particular xanthophylls are present in the human eye, where they are responsible for the color of the yellow spot on the retina referred to as the macula. Lutein and zeaxanthin are believed to help in the prevention of age-related macular degeneration (AMD), an irreversible deterioration of the macula lutea that has become one of the leading causes of blindness. Although similar in color to their cousins, xanthophylls' high price tag makes them an unlikely choice for use as coloring agents.

Nature's antioxidants

Blue, dark red and most of the deeply colored fruits provide good amounts of another group of phytochemicals known as flavonoids. These compounds help extend vitamin C activity, protect LDL cholesterol from oxidation, inhibit platelet aggregation and have anti-inflammatory and antitumor actions. Population studies have revealed reduced rates of lung cancer and heart disease related to high intakes of some flavonoids.

Researchers have been studying quercetins, found in fruits such as apples, pears, cherries, raspberries and grapes, for a host of health benefits. Like many plant pigments, quercetin is a powerful antioxidant, reducing risk of cancer by preventing oxidation of LDL ("bad") cholesterol. Preliminary research at the Mayo Clinic, Rochester, MN, shows that quercetin may block certain hormones that facilitate growth of prostate cancer cells. Additional studies have shown links between reduced risk of asthma, bron-

chitis and emphysema with consumption of apples (rich in other flavonoids as well).

Another group of compounds gaining attention is the proanthocyanidins, also known as oligomeric proanthocyanidins (OPCs). Unlike many of their phytochemical cousins, proanthocyanidins are water-soluble condensed tannins, found in the seeds and skins of red grapes as well as cranberries, not pigments. Rapid absorption and subsequent distribution throughout the body allow proanthocyanidins to quickly get to work tying up free radicals that ravage the human body as it ages. High numbers of reactive sites capable of scavenging both positively and negatively charged free radicals make proanthocyanidins more-effective antioxidants than vitamins C or E.

While numerous studies show the antioxidant effects of proanthocyanidins, current studies underway at Rutgers University Blueberry and Cranberry Research and Extension Center, Chatsworth, NJ, have been investigating additional positive effects of these unique compounds. Amy Howell, Ph.D., a research scientist, explores the effect of proanthocyanidins in the prevention of urinary tract infections. “By inhibiting the adhesion of infectious bacteria to cellular surfaces, the bacteria is not able to reproduce,” she notes. “Preventing infections means fewer antibiotics are prescribed, reducing resistance development and helping preserve the effectiveness of the antibiotics for situations where they are really needed.” As trials continue, cranberry juice has been tapped as the preferred source of proanthocyanidins. It’s a familiar product that yields an effective level of the test compound in one 8-oz. glass. Howell

notes that “whole foods provide a broad spectrum of compounds,” which work singly, or in combination, to improve overall health. She warns that overloading on single antioxidants can interfere with the body’s natural production of these protective compounds.

Researchers believe that resveratrol, a phenolic compound found in red and purple grapes, as well as red grape juices and wines, is related to reductions in the risks of cancer, blood clots and stroke, and might promote healing and even prevent wrinkles. The presence of resveratrol in red wine has, in the past, been the focus of studies into possible links between consumption of red wine and improved coronary health. Interestingly, white wines do not provide the same levels

of resveratrol as reds, approximately 800 mg per 5-oz. glass, due to skin removal prior to fermentation. Wine fanciers should not get too excited, though. Increased red-wine consumption is not a recommended method of increasing intake of resveratrol or other

Current studies indicate that proanthocyanidins contain more than just antioxidant effects.

Those found in cranberries, for example, may help prevent urinary tract infections.



Photo: Rutgers University Blueberry and Cranberry Research and Extension Center

flavonoids. Grape juice can provide the same benefits without the potential risks of overindulgence in the fermented fruit of the vine.

Less-familiar phytos

Lesser-known phytochemicals include the flavonoids hesperidin and tangeritin. Both occur in citrus fruits, such as oranges, tangerines and grapefruit, as well as their juices. Researchers believe that hesperidin can protect against heart disease, while tangeritin may help prevent head and neck cancers.

Ellagic acid is a phenolic compound present in many fruits, with the highest levels being found in raspberries, strawberries and pomegranates. Animal studies show that ellagic acid helps inhibit tumor growth caused by carcinogens. It is also believed to prevent the binding of certain carcinogens to DNA, which can stop cancer cells from spreading. Further studies are underway investigating reduction in heart disease, birth defects and liver fibrosis, all linked to consumption of ellagic acid.

Many healthy elements can be found in fruits' skins. Rinds and edible white membranes of citrus fruits, like tangerines, oranges, grapefruits, lemons and limes, provide rich sources of limonene. A member of the monoterpene group of phytochemicals, researchers believe that limonene can help prevent certain types of cancer.

Other phyto tricks

Just as phytochemicals help create the vivid colors of our favorite fruits, manufacturers can use them to bring the rich hues of Mother Nature's palette to today's food product designer.

Beta-carotene, a very powerful coloring agent, lends yellow, orange or red hues to a variety of products. Although

beta-carotene is fat-soluble in its native form, manufacturers can process it into value-added market forms to permit use in water- and fat-based systems. Leonard Johnson, Ph.D., director of food technical services, DSM Nutritional Products, Parsippany, NJ, notes that for fat-based applications, beta-carotene crystals are suspended in an oil medium, such as corn oil. These products should be agitated thoroughly prior to use as the crystals can fall out of suspension with time. Water-based applications can accept several types of powders or emulsions, depending on application, desired color, etc. "For bakery mixes," he suggests, "a spray-dried powder works well, as the small particle size is easily dispersed in the dry ingredients." Products with larger particle size, referred to as beadlets, are better for beverage applications where segregation is not a factor. The color imparted by the beta-carotene will hinge on several factors. "A 7% powder will lend more of a yellow tone, while a 10% beadlet can provide deeper orange color," he continues. "How a powder is prepared will also affect the brightness or dullness of the color provided." Another new 10% beta-carotene emulsion is now available for processors to create strawberry or raspberry colors in dairy items, such as ice cream or yogurt.

Beta-carotene's provitamin A equivalence, 1,667 IUs/1 mg (pure), can add notable levels of vitamin A to products, allowing manufacturers to claim the healthy character of their products. In addition, beta-carotene is more stable than typical FD&C colors when used in conjunction with vitamin C, a common combination in nutritional beverages.

Other carotenoids, such as lutein,

lycopene and zeaxanthin, can provide some coloring effects. They are not, however, approved for use as food colorants at this time. "These compounds are typically used for nutrient fortification of items such as soups, salad dressings, dairy products and analogues, cereals, nutritional bars and beverages," says Harry Madeka, technical services manager, DSM Nutritional Products.

"Anthocyanins from a variety of red fruits have been used for coloring for a long time," notes Kim Gray, principal scientist for WILD Flavors, Cincinnati, OH. Anthocyanins have a high oxygen radical absorbance capacity (ORAC), indicating a strong antioxidant character. As consumers become more aware of the potential health effects of antioxidants, products that contain them will increase in popularity. Since a recommended daily intake (RDI) level for anthocyanins has not yet been established, specific antioxidant claims are not yet allowed on the principle display of a product. "Use of these natural colorants does," she continues, "allow marketers to promote the presence of these powerful antioxidants in the product's marketing materials and back labels."

Product designers can use these natural colorants, typically in aqueous or dry forms, in a variety of applications. Systems with a pH of 3.0 to 3.5 are ideal for anthocyanins as this is the range in which their colors are most vibrant. The overall coloring effect will also depend greatly on the source from which they are extracted. "Different extraction sources will give varying ratios of anthocyanins," says Gray. "These individual colors can be blended, though, to create specialized colors for a given application." While these natural colors can be more

Quercetin, found in fruits such as pears, is a powerful antioxidant with many health benefits. For example, it helps reduce the risk of cancer by preventing oxidation of LDL (“bad”) cholesterol.

susceptible to fading from exposure to light, they offer processors the opportunity to create a range of rich tones with an “all natural” label.

Processors can also use products extracted from certain fruits and standardized to a certain level of a particular phytochemical. This allows developers to include the benefit of a given type or group of phytochemicals without requiring the use of the fruit itself. Ellen Schutt, vice president of marketing and brand strategy, RFI Ingredients, Blauvelt, NY, describes a pomegranate extract standardized to 40% ellagic acid, and an apple extract standardized to 75% polyphenol, both of which are ideal for a variety of food and beverage products. Developers may be cautious of polyphenols in beverages, as their inherent taste is bitter. Careful optimization of the complete formulation, however, will allow high levels of the healthful component without off flavors. These extracts also allow marketers to promote high ORAC values for their finished products, using structure-function claims such as “provides antioxidant equivalent of



Photo: Pacific Northwest Canned Pear Service

one serving of vegetables.” She notes that “this can be of great interest to carbohydrate-conscious shoppers who are constantly looking for ways to obtain the health benefits of fruits and vegetables that they are limiting in their diets.”

Another source of phytochemical benefit for processors is grape seed oil. Source and processing can yield flavors with a hint of grape or butter — or virtually no flavor at all. Its high levels of proanthocyanidins can also offer some of the health benefits associated with consumption of the grapes from which the oil is derived.

It appears that an apple a day is only the beginning. The Washington, D.C.-based National Cancer Institute’s “5 A Day for Better Health” program,

suggests that more is definitely better. As research continues, it is clear that we will realize many additional benefits associated with the consumption of fruits, as well as ingredients derived from fruits, all stemming from the presence of phytochemicals. Nature’s rainbow of colors, it seems, is more than a visual display. It’s a roadmap for our diets, leading us down the path of a long and healthy life. ■

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