

Broccoli



What's New and Beneficial About Broccoli

- Broccoli can provide you with some special cholesterol-lowering benefits if you will cook it by steaming. The fiber-related components in broccoli do a better job of binding together with bile acids in your digestive tract when they've been steamed. When this binding process takes place, it's easier for bile acids to be excreted, and the result is a lowering of your cholesterol levels. Raw broccoli still has cholesterol-lowering ability—just not as much.
- Broccoli has a strong, positive impact on our body's detoxification system, and researchers have recently identified one of the key reasons for this detox benefit. Glucoraphanin, gluconasturtian, and glucobrassicin are 3 glucosinolate phytonutrients found in a special combination in broccoli. This dynamic trio is able to support all steps in body's detox process, including activation, neutralization, and elimination of unwanted contaminants. Isothiocyanates (ITCs) are the detox-regulating molecules made from broccoli's glucosinolates, and they help control the detox process at a genetic level.
- Broccoli may help us solve our vitamin D deficiency epidemic. When large supplemental doses of vitamin D are needed to offset deficiency, ample supplies of vitamin K and vitamin A help keep our vitamin D metabolism in balance. Broccoli has an unusually strong combination of both vitamin A (in the form of beta-carotene) and vitamin K. For

people faced with the need to rebuild vitamin D stores through vitamin D supplements, broccoli may be an ideal food to include in the diet.

- Broccoli is a particularly rich source of a flavonoid called kaempferol. Recent research has shown the ability of kaempferol to lessen the impact of allergy-related substances on our body. This kaempferol connection helps to explain the unique anti-inflammatory benefits of broccoli, and it should also open the door to future research on the benefits of broccoli for a hypoallergenic diet.

Health Benefits

It's no coincidence that more than 300 research studies on broccoli have converged in one unique area of health science—the development of cancer—and its relationship to three metabolic problems in the body. Those three problems are (1) chronic inflammation (2) oxidative stress, and (3) inadequate detoxification. While these types of problems have yet to become part of the public health spotlight, they are essential to understanding broccoli's unique health benefits. Over the past 5 years, research has made it clear that our risk of cancer in several different organ systems is related to the combination of these three problems.

The Cancer/Inflammation/Oxidative Stress/Detox Connection

Exposure to potentially toxic substances in our food and water, or in the air we breathe both indoors and outdoors, exposure to allergy-triggering substances, poor general health, dietary deficiencies, use of prescription and over-the-counter medications, and other lifestyle practices can result in a level of danger to our bodies that prompts our inflammatory system to work in overdrive on a 24/7 basis. Researchers often refer to this phenomenon as "chronic inflammation." Often contributing to this level of danger is a weakened detox ability in our body. If our liver, skin, and other organ systems cannot keep up with and detoxify the number of potential toxins that we encounter, too many potential toxins remain at large

throughout our body. Once again, the result is a level of risk that prompts chronic inflammation.

On a more temporary, short-term basis, inflammation is part of good health. Whether physical or chemical in nature, whenever our body detects a wound, it typically responds by trying to heal with an inflammatory response. That process is healthy, so long as it is not constant and uninterrupted. But unlike the helpful inflammation that takes place we get a simple cut or bruise, chronic inflammation—when it becomes a standard feature of our metabolism—is incompatible with good health. When our bodies are overwhelmed day in and day out with chronic inflammation, many other metabolic balances can get thrown out of kilter, including the balance in our oxygen metabolism. An unwanted imbalance starts to occur in which too many overly reactive, oxygen-containing molecules are formed. This condition is called oxidative stress. The increased presence of these overly reactive molecules can do damage to many parts of our cells, including their genetic material (and especially their deoxyribonucleic acid, or DNA). Over time, the constant and cumulative DNA damage inside our cells can pose a major risk factor for conversion of healthy cells into cancerous ones.

It's equally possible for this sequence of events to start not with chronic, excessive inflammation, but with chronic oxidative stress. Over time, when overly reactive oxygen-containing molecules cause damage to DNA and other cell structures, our body reads this situation as being highly dangerous and it initiates an inflammatory response to try and reduce the threat posed by the oxidative stress. In either case, we end up with a combination of inadequate detoxification of toxic substances, chronic inflammation and oxidative stress that puts us at greater risk for developing cancer.

In a way that might be unique among foods, the nutrients found in broccoli are able to change this set of connections between inflammation, oxidative stress, detox and cancer. In fact, it would be fair to describe broccoli as containing anti-inflammatory nutrients, antioxidant nutrients, detox-support nutrients, and anti-cancer nutrients as well!

Broccoli's Anti-Inflammatory Benefits

When threatened with dangerous levels of potential toxins, or dangerous numbers of overly-reactive, oxygen-containing molecules, signals are sent within our body to our inflammatory system, directing it to "kick in" and help protect our body from potential damage. One key signaling device is a molecule called Nf-kappaB. When faced with the type of dangers described above, the NF-kappaB signaling system is used to "rev up" our inflammatory response and increase production of inflammatory components (for example, IL-6, IL-1beta, TNF-alpha, iNOS and COX-2). This process works beautifully in temporary, short-term circumstances when healing from injury is required. When it continues indefinitely at a constant pace, however, it can put us at risk for serious health problems, including the development of cancer.

Research studies have made it clear that the NF-kappaB signaling system that is used to "rev up" our inflammatory response can be significantly suppressed by isothiocyanates (ITCs). ITCs—the compounds made from glucosinolates found in broccoli and other cruciferous vegetables—actually help to shut down the genetic machinery used to produce NF-kappaB and other components of the inflammatory system. These anti-inflammatory benefits of ITCs have been demonstrated in the laboratory, and with consumption of the ITCs themselves. While they have yet to be demonstrated on consumption of broccoli in an everyday diet, we fully expect future research to show anti-inflammatory benefits from the routine consumption of broccoli (and its glucosinolates), not just from consumption of ITCs.

Lack of omega-3 fat is dietary problem that can cause over-activation of the inflammatory system. The reason is simple: many key anti-inflammatory messaging molecules (like PGH3, TXA3, PGI3, and LTE5) are made from omega-3 fats. We are not accustomed to thinking about non-fatty vegetables as sources of omega-3 fats, but we need to change our thinking in this area. While it is true that there are limited amounts of omega-3s in vegetables like broccoli, it is equally true that their levels of omega-3s can still play an important role in balancing our inflammatory system activity. In 100 calories' worth of broccoli (about 2 cups) there are approximately 400 milligrams of omega-3s (in the form of alpha-linolenic acid, or ALA). That

amount of ALA falls into the same general ballpark as the amount provided by one soft gel capsule of flax oil. While we would not want to depend on broccoli as our sole source of dietary omega-3s, we still get important anti-inflammatory benefits from the omega-3s it provides.

As mentioned earlier in this section, chronic inflammation can sometimes get triggered by overexposure to allergy-related substances. In this context, broccoli has yet another anti-inflammatory trick up its sleeve, because it is a rich source of one particular phytonutrient (a flavonol) called kaempferol. Especially inside of our digestive tract, kaempferol has the ability to lessen the impact of allergy-related substances (by lowering the immune system's production of IgE-antibodies). By lessening the impact of allergy-related substances, the kaempferol in broccoli can help lower our risk of chronic inflammation.

Broccoli's Antioxidant Benefits

Amongst all of the commonly consumed cruciferous vegetables, broccoli stands out as the most concentrated source of a premiere antioxidant nutrient—vitamin C. This central antioxidant vitamin can provide longer-term support of oxygen metabolism in the body if it is accompanied by flavonoids that allow it to recycle. Broccoli provides many such flavonoids in significant amounts, including the flavonoids kaempferol and quercetin. Also concentrated in broccoli are the carotenoids lutein, zeaxanthin, and beta-carotene. All three of these carotenoids function as key antioxidants. In the case of lutein and beta-carotene, broccoli has been shown not only to provide significant amounts of these antioxidants but to significantly increase their blood levels when consumed in the amount of three cups. Other antioxidants provided by broccoli in beneficial amounts include vitamin E and the minerals manganese and zinc.

Considered as a group, the vitamins, minerals, flavonoids, and carotenoids contained in broccoli work to lower risk of oxidative stress in the body. The ability of these nutrients to support oxygen metabolism and avoid excess formation of overly reactive, oxygen-containing molecules makes them equally helpful in lowering risk of chronic inflammation and risk of cancer. If cancer development is compared to a 3-legged stool, the antioxidant benefits of broccoli can be viewed as weakening one leg of the stool,

namely the leg called "oxidative stress." We've already seen how the glucosinolates and omega-3 fats in broccoli can be viewed as helping to weaken a second leg of the stool (chronic inflammation). In the next section, we'll look at a third leg of the stool (inadequate detoxification) and see how the nutrients found in broccoli can serve to weaken this leg as well.

Broccoli Can Enhance Detoxification

Most toxins that pose a risk to our cells must be detoxified in our body by a 2-step process. What's remarkable about broccoli is its ability to alter activity in both of these two detox steps. Isothiocyanates (ITCs) made from the glucosinolates in broccoli are well-documented modifiers of the first step in detoxification (called Phase I). In fact, some ITCs like sulforaphane can actually help shut down the genetic machinery that produces certain Phase I enzymes. ITCs are equally capable of altering the activity of enzymes involved in the second step of detoxification (called Phase II). From research in the field of genetics, we know that ITCs can help bridge gaps in Phase II activity when it is insufficient. Taken in combination, the impact of ITCs on Phase I and II detox events is unique—and equally unique is the presence of glucosinolate compounds in broccoli that can be used to make ITCs. Glucosinolates like glucoraphanin, gluconasturtiin, and glucobrassicin are simply not found in other foods in the same combination and concentration that is offered by broccoli. By helping to promote as well as regulate detox activity in our cells, the ITCs made from broccoli can help prevent insufficient detoxification of dangerous substances that threaten our cells.

Broccoli and Cancer Prevention

The unique combination of antioxidant, anti-inflammatory, and pro-detoxification components in broccoli make it a unique food in terms of cancer prevention. Connections between cancer development and oxidative stress, chronic inflammation, and inadequate detoxification are so well-documented in the research that any food improving all three of these metabolic problems would be highly likely to lower our risk of cancer. In the case of broccoli, the research is strongest in showing decreased risk of

prostate cancer, colon cancer, breast cancer, bladder cancer, and ovarian cancer. We expect that risk of other cancer types will also eventually be shown to undergo reduction from regular consumption of broccoli.

How Much Broccoli Is Needed for Cancer Prevention?

Recent studies have also provided us with a much better idea about the amount of broccoli that we need to lower our cancer risk. At the lower end of the spectrum, it looks like an average of 1/2 cup of broccoli per day—only 22 calories' worth of broccoli!—is enough to provide some measurable benefits. Few people have broccoli on a daily basis. But a 2-cup serving twice a week would still meet this minimum average amount. It's important to remember how little this amount actually is within the context of one week's food. A person eating 2,000 calories per day would be consuming 14,000 calories per week. A 2-cup serving of broccoli twice a week would provide about 178 calories—only 1% of the total weekly calories! At the higher end of the spectrum, studies show that more broccoli might be needed to accomplish other cancer-preventing tasks. For example, one study showed significantly higher urinary excretion of potential carcinogens from well-done, grilled meats given daily consumption of broccoli in the range of 9 ounces (250 grams) per day. That gram amount corresponds to approximately 1.6 cups of broccoli on a daily basis. We've also seen a study showing that "generous" amounts of broccoli can help optimize levels of antioxidants in the blood, especially beta-carotene and lutein. (Optimal antioxidant levels can help lower the risk of oxidative stress in healthy cells, which also helps lower their risk of becoming cancerous.) In this study, the term "generous" was used to describe consumption of broccoli in the amount of 3 cups daily. Once again, that amount would not be ridiculously high in terms of calories—3 cups would provide about 132 calories, or 6-7% of a 2,000-calorie diet. But it might be a greater amount that many people would want to consume on a regular basis.

For us, the bottom line here is not to treat broccoli like garnish. In recipes like our Asian-Flavored Broccoli with Tofu or 5-Minute Broccoli with Feta Cheese and Kalamata Olives recipes, we use 1 pound of broccoli to provide two servings. That's approximately 1.5 cups of broccoli per serving.

There is no reason to shy away from 2-3 cup servings of broccoli when enjoying this cruciferous vegetable, especially if you want to optimize its cancer-preventing benefits. But make sure you're not simply "decorating" your plate with single broccoli stalk and floret.

Broccoli and Digestive Support

The digestive support provided by broccoli falls into two basic categories: fiber support, and ITC (isothiocyanate) support. At approximately 1 gram of dietary fiber for every 10 calories, you don't have to eat much broccoli to get a large amount of your daily requirement! For 100 calories—only 5% of a 2,000-calorie diet—you get about 10 grams of fiber, or 40% of the Daily Value (DV). And, 250 calories of broccoli (about 12% of a 2,000-calorie diet) will give you the full daily requirement for this important nutrient! Few components of food support our digestive system as well as fiber. The speed that food travels through us, the consistency of food as it moves through our intestine, and bacterial populations in our intestine are all supported as well as regulated by dietary fiber.

Alongside of broccoli's dietary fibers are its glucosinolates. These phytonutrients are converted by our bodies into isothiocyanates (ITCs). ITCs—and particularly sulforaphane—help protect the health of our stomach lining by helping prevent bacterial overgrowth of *Helicobacter pylori* or too much clinging by this bacterium to our stomach wall. Broccoli sprouts appear to have especially strong stomach support properties in this regard.

Broccoli and Cardiovascular Support

Although research in this area is still in the early stages, anti-inflammatory substances found in cruciferous vegetables are becoming the topic of increasing interest with respect to heart disease. One particular focus here involves the anti-inflammatory properties of sulforaphane, one of the isothiocyanates (ITCs) derived from the glucoraphanin in broccoli. In some individuals susceptible to high blood sugar, sulforaphane may be able to prevent (or even reverse) some of the damage to blood vessel linings that can be caused by chronic blood sugar problems. Decreased risk of heart

attacks and strokes may also eventually be linked in a statistically significant way to intake of broccoli and its glucoraphanin.

A second area you can count on broccoli for cardiovascular support involves its cholesterol-lowering ability. Our liver uses cholesterol as a basic building block to produce bile acids. Bile acids are specialized molecules that aid in the digestion and absorption of fat through a process called emulsification. These molecules are typically stored in fluid form in our gall bladder, and when we eat a fat-containing meal, they get released into the intestine where they help ready the fat for interaction with enzymes and eventual absorption up into the body. When we eat broccoli, fiber-related nutrients in this cruciferous vegetable bind together with some of the bile acids in the intestine in such a way that they simply stay inside the intestine and pass out of our body in a bowel movement, rather than getting absorbed along with the fat they have emulsified. When this happens, our liver needs to replace the lost bile acids by drawing upon our existing supply of cholesterol, and as a result, our cholesterol level drops down. Broccoli provides us with this cholesterol-lowering benefit whether it is raw or cooked. However, a recent study has shown that the cholesterol-lowering ability of raw broccoli improves significantly when it is steamed. In fact, when the cholesterol-lowering ability of steamed broccoli was compared with the cholesterol-lowering ability of the prescription drug cholestyramine (a medication that is taken for the purpose of lowering cholesterol), broccoli bound 33% as many bile acids (based on a standard of comparison involving total dietary fiber).

The B-complex vitamins in broccoli can also make a major contribution to our cardiovascular health. Especially with respect to excessive formation of homocysteine—an event which raises our risk of atherosclerosis, stroke, and heart attack—B-complex vitamin deficiency intake can pose a major risk. Three B vitamins especially important for lowering our risk of hyperhomocysteinemia (excessive formation of homocysteine) are vitamin B6, vitamin B12, and folate. By making an important contribution to our B6 and folate intake, broccoli can help us lower our risk of excessive homocysteine formation and cardiovascular problems that are related to excess homocysteine.

Other Health Benefits Provided by Broccoli

Three other areas of health benefits are important to mention when considering broccoli and its unique combination of nutrients. The first area is eye health. Two carotenoids found in significant concentrations in broccoli—lutein and zeaxanthin—play an especially important role in the health of the eye. In fact, no tissue in the body is more concentrated with lutein than the area in the outer portion of the retina (called the peripheral retina). Similarly, in the macula near the central portion of the retina, zeaxanthin is uniquely concentrated. Risk of problems involving the macula of the eye (for example, macular degeneration) and problems involving the lens area of the eye (for example, cataracts) have both been shown to lessen with intake of foods (including broccoli) that provide significant amounts of the lutein and zeaxanthin carotenoids.

A second area is skin support, including support of sun-damaged skin. Here it is the glucoraphanin found in broccoli—converted into sulforaphane by the body—that has received the most research attention. Since skin cells can carry out the process of detoxification, it may be detox-related benefits of sulforaphane that are especially important in helping to counteract sun damage.

A third area of increasing research interest involves the metabolism of vitamin D. Broccoli is not a source of this vitamin, but it is an excellent source of vitamin K and also of vitamin A (in one of its precursor forms, beta-carotene). Many individuals have large vitamin D deficiencies that cannot be remedied through diet alone, and these deficiencies require sizable amounts of vitamin D to be provided through dietary supplementation. When large supplemental doses of vitamin D are needed to offset deficiency, ample supplies of vitamin K and vitamin A appear to help keep our vitamin D metabolism in the proper balance. Assuring adequate intake of vitamins K and A alongside of vitamin D supplementation may turn out to be important in achieving optimal vitamin D supplementation results and avoiding potential problems related to supplementation. Broccoli may turn out to play a particularly helpful role in balancing this set of events by providing its unusually strong combination of both vitamin A and vitamin K.

Description

Broccoli is a member of the cabbage family, and is closely related to cauliflower. Its cultivation originated in Italy. *Broccolo*, its Italian name, means "cabbage sprout." Broccoli's name is derived from the Latin word *brachium*, which means branch or arm, a reflection of its tree-like shape that features a compact head of florets attached by small stems to a larger stalk. Because of its different components, this vegetable provides a complex of tastes and textures, ranging from soft and flowery (the florets) to fibrous and crunchy (the stem and stalk). Its color can range from deep sage to dark green to purplish-green, depending upon the variety. One of the most popular types of broccoli sold in North America is known as Italian green, or Calabrese, named after the Italian province of Calabria where it first grew.

Other vegetables related to broccoli are broccolini, a mix between broccoli and *gai-lin* (Chinese broccoli), and broccoflower, a cross between broccoli and cauliflower. Broccoli sprouts have also recently become popular as a result of research uncovering their high concentration of the anti-cancer phytonutrient, sulforaphane.

History

Broccoli has its roots in Italy. In ancient Roman times, it was developed from wild cabbage, a plant that more resembles collards than broccoli. It spread through out the Near East where it was appreciated for its edible flower heads and was subsequently brought back to Italy where it was further cultivated. Broccoli was introduced to the United States in colonial times, popularized by Italian immigrants who brought this prized vegetable with them to the New World.

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