

# TECHNICAL BULLETIN

## FOOD COMPOUND VITAMIN



Clinical Research Pearls

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Food Compound References

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## TECHNICAL BULLETIN

### CLINICAL RESEARCH PEARLS

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- It's hard to go wrong if you fortify your diet with colorful foods. Almost every one of them is loaded with disease-proofing compounds.

Whole-foods colorful foods delivers protection against a broad range of ailments. Scientists are starting to think of these diseases (heart disease and cancer) as a shortage of phytochemicals. -James Duke.

- The three most important ways food compounds protect health are antioxidant power, anti-inflammatory strength and the ability to boost our bodies' detoxification systems.
- Evidence is mounting that chronic inflammation may contribute to certain types of cancer. The reasons are not fully understood. But inflammation leads to the release of damaging substances that can encourage cell proliferation in tumors. Inflammation plays a role in heart disease and stroke.
- When it comes to phytochemicals you want the whole team on your side, too, not just an isolated MVP. You want the myriad of antioxidants, the full host of health-preserving chemicals.
- "The only way to take advantage of them (food compounds) all is by eating a diet rich in brightly colored fruits and vegetables". T. Colin Campbell, a Cornell University Biochemist.
- The greatest number of healthful compounds can be found in the most colorful foods. Perhaps the first inklings of this truth came from Harry Steenbock, a biochemist at the University of Wisconsin way back in 1919. Fed rats a white diet and another a yellow diet.
- Susan S. Percival at the University of Florida divided mango extracts into two fractions, or parts- the fat-soluble compounds (including carotenoids) and the water-soluble compounds (including phenolics). When she did the calculations, she found the water-soluble fraction was ten times more effective than the carotenoid fraction. "We're very interested in finding out what is in the water-soluble fraction", Percival said.

Charles Elson, professor of nutritional sciences of University of Wisconsin College of Agriculture and Life Sciences, believes that small amounts of phytochemicals also have a protective effect when they're combined. "Our interest is in showing you don't need lots of any single terpene," says Elson. "If you eat a huge variety, the effects are additive and synergistic."

Many scientists now believe that small doses of a great many phytochemicals may just as effective as large doses of a single compound.

- "People always want to isolate a chemical and put it in a pill. Well, now we know that food is the magic bullet." Susan Davis, nutritionist.
- The body is not always able to extract lycopene from raw tomatoes. That's because the pigment is tightly bound up in cell walls and fibers. If digestive juices can't pry it free, then the body can't use it.

In one study, rats with prostate tumors were fed either lycopene beads or freeze-dried tomato powder. The tomato powder, with its full complement of phytonutrients outperformed the lycopene alone.

- “**Ferulic acid** is only moderately inhibitory of cancer, but when you eat fruits and vegetables, you get a mixture of these compounds. It may very well be that the interaction is more beneficial than the compounds themselves.” Robert Teel, professor of physiology and pharmacology at Loma Linda U.

- Ronald Prior who helped devise the ORAC test recommends consuming 3,500 ORAC units a day. The top four ORAC scores for fruits (per 100g or 3.5oz) are: Blueberries 2,400, Blackberries 2,036, Cranberries 1,750 and Strawberries 1,540.

- The top four ORAC scores of vegetable (100g or 3.5oz) are: Watercress 2,223, Kale 1,770, Spinach, raw 1,260 and Asparagus 1,241.

- **Benzoic acid**, found in cranberries is a strong antioxidant.

- Butternut squash delivers more carotenes than summer squash.

- Pink grapefruits have lycopene and beta-carotene, white grapefruit does not.

- Red peppers also contain nine times more Vitamin A than green peppers.

- In a small study of 16 men, Hotchkiss found tomatoes to be the second most potent inhibitor of nitrosamine formation in the body after green peppers.

- Kale has seven more times beta-carotene than broccoli and nearly 11 times more lutein.

- **Silymarin**, found in **milk thistle** is a “miracle agent” says cancer biologist Rajesh Agarwal of the AMC Cancer Research Center. He says “silymarin has been used in Europe and Asia for centuries in the form of milk thistle seeds to treat liver toxicity-hepatitis, cirrhosis and alcohol-related problems”. His research also shows it to be a major cancer-fighting compound that functions in many ways at once. It is a strong antioxidant and potent anti-inflammatory, stifles uncontrolled replication by encouraging a process called cell differentiation, it even inhibits the internal cell signaling that tells a cell to keep growing. With all of these functions to its credit, it certainly ought to fight cancer and this is what Agarwal is finding in animal experiments.

- Broccoli is rich of protective flavonoids, terpenes and phenolics, and the cancer-preventing compounds called isothiocyanates and indoles.

- **D-glucaric acid** helps detoxify a number of carcinogens, including polycyclic aromatic hydrocarbons, heterocyclic amines and various nitrosamines. Studies in rats and mice have shown that glucaric acid inhibits tumors of the colon, mammary gland, liver, lung, skin and bladder.

- Gandhi once said “Wherever flaxseeds become a regular food item among the people, there will be better health.”

- Blueberries have as many as 25-30 different anthocyanin pigments where most other foods have only 4-5, and they are in larger concentrations in blueberries.

- All these antioxidants and anti-inflammatories in blueberries may make blueberries one of the best foods for protecting the brain as we age.

- The Nurses’ Health Study recently found that those who ate the most whole grains close to three servings a day reduced their stroke risk by 43%.

## **ACTIONS OF FOOD COMPOUNDS**

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### **ANTIOXIDANT**

- Antioxidants only work efficiently when we ingest enough to outnumber the “bad guys” enabling them to move in and quench free radicals before they can do harm

- Cancer can result from free-radical attacks on DNA, the genetic blueprint.

- Many of the strongest antioxidants are the protective pigments in fruits and vegetables.

- ORAC (oxygen radical absorbance capacity), one magazine coined the term, “anti-aging points”.

Evidence is clear that people with the greatest amounts of antioxidants in their diets show the fewest effects of aging.

- “The body is like a glass of water that antioxidants dissolve evenly through out,” says Dr. Edward Giovannucci of Harvard Medical School. “Certain antioxidants appear to be very specific in the organs they protect.” An antioxidant that works well in the blood may do nothing for the brain or the skin.
- Lester Packer, professor emeritus of molecular cell biology at the University of California. At Berkley considers glutathione and alpha-lipoic acid the two most important antioxidants in the body. Although our body makes these antioxidants, the body does not always make enough to meet its needs, especially as we age.
- Packer calls glutathione, “nature’s master antioxidant”. It plays many crucial roles in the body – detoxifying pollutants an carcinogens, maintaining a healthy liver, boosting the immune system, aiding healthy cell replication, repairing damaged DNA, and reducing chronic inflammation. Packer even believes it may help to prolong life.
- “Vitamin C generally accounts for less than fifteen percent of the antioxidant activity of fruits and vegetables.” says Ronald Prior, Developer of ORAC test. That means that the rest of the antioxidant activity in fresh foods must be coming from phytochemicals, including anthocyanins that give strawberries their bright red hue.
- Lester Packer a leading authority on antioxidants, says that Vitamins C and E and three substances that the body itself produces- alpha-lipoic acid, coenzyme Q10 and glutathione, are your body’s first line of defense.
- In lab studies, Quercetin shows numerous health benefits. It is a strong antioxidant that can “quench” a particularly damaging free radical called singlet oxygen.
- Vitamin C and *hesperetin* function together in oranges. The flavonoids, such as hesperetin work to regenerate vitamin C back to its active antioxidant form after the vitamin C has quenched a free radical.
- Rosemary contains a terpenoid called carnosic acid. This compound has the ability to grab a lot of free radicals. It quenches two free radicals, them rearranges itself to form another compound called carnosol, which grabs two more free radicals before rearranging itself yet again to swipec at two more, according to Carolyn Fisher, an organic chemist.
- Blueberries powerful antioxidant activity comes from two main sources, according to Wilhelmina Kalt a food chemist at AACC, one is chlorogenic acid (found in tomatoes and bell peppers) and anthocyanin pigments.

## PHASE I AND II ENZYMES

- **Sulforaphane** in broccoli activates the genes that make crucial detoxification enzymes. These enzymes are like the janitors that gather up garbage and put it out for trash collection. They take an insoluble carcinogen in the cell and hook it up to a soluble compound, which can then dissolve in the bloodstream.
- Dr. Paul Talalay of John Hopkins University found that foods like kale, broccoli, brussel sprouts, cauliflower, turnips and watercress, contained compounds that boosted phase 2 enzymes. Phase 2 enzymes rid the body of numerous carcinogens and pollutants, and are known to protect against many types of cancer.
- **Phenolic acids**, particularly **ellagic acid** has been shown to proven esophageal and cancer tumor in animals. According to biologist Gary Stoner, ellagic acid does this by regulating the levels of two crucial sets of enzymes. The first of these –the so-called phase 1 enzymes- help cells convert foods into forms the body can use. Unfortunately, in the process, these enzymes also take a certain number of harmless substances and transform them into carcinogens. But not to worry. That’s where the phase 2 enzymes come in. The attach the toxin to a soluble compound in the cell, then dump it into the blood to be cleared away like trash on collection night. As long as there’s more phase 2 activity than phase 1, your body is protected. Ellagic acid does both – slows down phase 1 and boosts phase 2.
- In 1992, Tallay discovered *sulforaphane*, a potent phase 2 inducer. In his study, rats that received sulforaphane had their risk of developing mammary tumors by 60%. The animals that did get cancer, the size of their tumors was cut by 75%.
- By boosting phase 2 enzymes the *sulforaphane* also helps the body fight oxidation. Talalay recently discovered that these enzymes act as ‘indirect’ antioxidants. The do not “quench” free radicals by giving up electrons, like vitamins E or C. But just they directly link carcinogens to other molecules; they can inactivate oxygen radicals by hooking them to substances that the body then disposes of.

- Ellagic acid found in fiber-rich seeds of blackberries and strawberries have been shown to battle cancer on several different fronts at once—decreasing the phase 1 enzymes that create certain carcinogens, boosting detoxifying phase 2 enzymes and also encouraging apoptosis (programmed cell death) in diseased cells .

## CARDIOVASCULAR HEALTH

- **Anthocyanins** found in **cranberries** appear to retard the oxidation of “bad” cholesterol, reduce platelet clumping in lab tests, thereby potentially reducing the risk of developing heart-attack- inducing-clots.
- **Saponins in legumes** scoop up cholesterol in the intestinal track before it can be absorbed into the bloodstream. Like efficient little conveyer belts, they keep the cholesterol moving right on through the system and out the other end.
- **Betaine**, a colorless crystal in **beets**, is important because it plays a role in detoxifying homocysteine, particularly when there is low amounts of folate and B12.
- **Pectin’s** main claim to dietary fame, it that it lowers cholesterol. In one study 25 men drank 20 ounces of unfiltered fiber-supplemented juice everyday for six weeks. On average, the apple fiber lowered their total cholesterol by 10% and LDL by 14%. The reason seems to be pectin acts as a giant sponge.

Carrots appear to reduce the risk of stroke. A Nurse’s Health Study at Harvard found those who ate just five large carrots a week lowered their risk of stroke by 68 percent, compared with those who ate only one carrot a month or none at all. Carrots lower cholesterol levels in part to their fiber content. A study in Great Britain showed that by eating two carrots a day for three weeks, participants reduced their cholesterol levels by 11 percent. That is as much as patients often achieve with medication.

- **Broccoli’s flavonoids** may also benefit the cardiovascular system. A ten-year study of 34,492 postmenopausal women in Iowa found that deaths from heart disease were 38 percent lower among women in the top bracket of flavanoid intake.
- **Beta-sitosterol**, a phytosterol is similar in structure to cholesterol, and competes with cholesterol for absorption into the body, and wins. The result is lower cholesterol in the bloodstream.

## CANCER-FIGHTING

- Many cancer-causing nitrosamines are formed in the body when nitrogen compounds link up with parts of proteins called amines. But two of the phytochemicals found in **tomatoes** – ***p-coumaric acid*** and ***chlorogenic acid***- can intervene to stop the process.
- **Lycopene** is a member of the carotenoid family, and is one of the most potent free-radical scavengers in nature, according to Paul Lachance, professor of food science and nutrition at Rutgers U. It tends to collect in certain cells of the body, including the lungs and prostate. Scientists have observed that lycopene consumption seems to reduce levels of cancers in these parts of the body.
- Researchers suspect that **betacyanins**, found in **Beets**, may prove to be potent cancer fighters, particularly the dye betaine.
- **Cranberries** contain the cancer-fighting compounds **ellagic acid and epigallocatechin gallate (EGCG)**.
- Govind Kapadia, professor of biomedical chemistry at Howard U. has found beet extract to be “profound” inhibitor of skin, lung, and liver tumors in mice. He assumes it is the red pigment in beets, but needs to investigate further.
- **Alpha-carotene** was found to be 10 times more effective at reducing the proliferation of human cancer cells than beta-carotene, in a series of studies by Michiaki Murakoshi of the Kyoto Prefectural University of Medicine. He also found that alpha outperformed beta at squelching skin, liver, and lung tumors in mice. It slashed the number of lung tumors by 70%. Increasingly studies suggest that a combination of all the major carotenoids offers the best protection.
- Researchers have recently have learned that vitamin A plays a critical role in maintaining the immune system, the skin, and the epithelial cells that line every organ. That is important because 85% of cancers start in these cells.
- Harvard researchers found that nonsmokers who consumed the most alpha-carotene rich foods reduced their risk of lung cancer by a whopping 63%. When smokers were added to the study, they benefited mostly from a combination of all six major **carotenoids: alpha, beta-carotene, lycopene, beta-cryptoxanthin, lutein and zeaxanthin**
- The orange-yellow pigment, **cryptoxanthin** also has cancer-fighting potential. Lab research in Japan, found that cryptoxanthin’s anti-cancer potential is 5 times greater than beta-carotene’s in certain tests. It has also been associated with lower incidences of breast and cervical cancer in women with high consumption.

- **Carrots** also contain *terpineol*, created to fight fungi. *Terpineol* interferes with the production of substances that fungi require to grow. Cancer cells need the same substances, so terpineol helps fight tumors, too. It also encourages something called cell cycle arrest in tumors.

- “*Ferulic acid* is only moderately inhibitory of cancer, but when you eat fruits and vegetables, you get a mixture of these compounds. It may very well be that the interaction is more beneficial than the compounds themselves.” Robert Teel, professor of physiology and pharmacology at Loma Linda U.

Several studies have found that beta-carotene supplements actually increased lung cancer rates in heavy smokers. Many scientists believe that beta-carotene is just one of the many cancer-crushing compounds in carrots. If take beta-carotene alone, you are missing out on the rest.

- Based on numerous studies, the American Institute for Cancer Research estimates that a diet rich in fruits and vegetables could reduce cancers by 30-40 percent.

- **Pumpkin seeds** contain the compounds *cucurbitacins* and *beta-sitosterol*. In a randomized, double blind study of 53 men in Sweden and Denmark, those who took a combination of pumpkin seeds and saw palmetto showed significant relief of symptoms of benign enlargement of the prostate gland. The researchers speculated that the beta-sitosterol in the seeds was the contributing factor. Beta-sitosterol, has been shown in animal tests to slow abnormal cell proliferation.

- *Cucurbitacins*, reduce the conversion of the male sex hormone testosterone into a related hormone, dihydrotestosterone, which stimulates the proliferation of prostate cells.

- **Turmeric** pigment: *curcumin*. Although not well absorbed by the intestines into the body, it stays in the gastrointestinal tract where it appears to fight colon polyps and possibly colon cancer.

- New research indicates that *chlorophyll* is a good inhibitor of cancer-in mice and rainbow trout. It appears to work by latching onto potent carcinogens in the digestive tract and preventing their absorption into the body. These carcinogens include the heterocyclic amines (cause colorectal cancer) and aflatoxin (implicated in liver cancer).

- *Beta-sitosterol* also appears to inhibit excessive cell division, which may prevent cancer cell growth. It has been shown to reduce cancer in both animal and lab tests.

- **Broccoli** is rich of protective flavonoids, terpenes and phenolics, and the cancer-preventing compounds called isothiocyanates and indoles.

- **Sweet and Sour Cherries** have found to contain a small amount perillyl alcohol, a terpenoid, that appears to combat tumors in animals.

## ANTI-INFLAMMATORY

- One of the strongest inflammatory phytochemicals is *curcumin*, the yellow pigment in the curry spice turmeric. In animal tests, it helps prevent tumors. Other natural anti-inflammatories include the **carnosol in rosemary** and the red **anthocyanin pigments in tart cherries**.

- Salicylic acid, found in beets, has anti-inflammatory properties.

- *Curcumin's* anti-cancer action differs in part from its antioxidant strength, but is also an important anti-inflammatory. Drs. Andrew Dannenberg and Kotha Subbaramaiah of NY Presbyterian Hospital-Cornell Medical Center have shown that curcumin can block the release of damaging substances that can turn on cancer- cell proliferation, by turning off a gene called COX-2, which makes the inflammatory COX-2 enzymes. Unlike the drugs Vioxx or Celebrex, which inhibit the activity of COX-2 enzymes, Curcumin prevents their production in the first place, according to Dr. Dannenberg.

- Like *curcumin*, *resveratrol* is a potent COX-2 inhibitor, an important type of anti-inflammatory.

- **Blueberries** also appear to contain potent anti-inflammatories including pigment *cyaniding*.

- **Rosemary** also promotes detoxification, prevents carcinogens from binding to DNA, and slows the chronic inflammation that contributes to cancer development. There are no human population studies, but every indication is that rosemary should promote health.

- **Cherries** have three anthocyanin pigments that have demonstrated anti-inflammatory effects. The doctor who conducted the

research found these pigments to be as effective as aspirin or ibuprofen. Recent studies demonstrated even more potent anti-inflammatory effects.

## CAROTENOIDS

- Scientists have been recently intrigued by **beta-carotene, phytotene and phytofluene**. Frederick Khachik at the University of Maryland refers to these carotenoids the “three amigos”. “They tend to appear together in fruits and vegetables, and all are absorbed at relatively high concentrations. It is a reasonable assumption that they contribute to the biological activity of carotenoids.

- **Alpha-carotene** was found to be 10 times more effective at reducing the proliferation of human cancer cells than beta-carotene, in a series of studies by Michiaki Murakoshi of the Kyoto Prefectural University of Medicine. He also found that alpha outperformed beta at squelching skin, liver, and lung tumors in mice. It slashed the number of lung tumors by 70%. Increasingly studies suggest that a combination of all the major carotenoids offers the best protection.

- The antioxidant capacity of **beta-carotene** is also known to boost the activity of tumor-scavenging cells known as natural-killer cells. A study of 59 physicians in Boston found that natural-killer cell activity was much higher in elderly men who had taken beta-carotene supplements for 10 years than in those who had not.

- “Oxidative stress damages natural-killer cells in ways that may affect the cell’s activity” Simin Meydani, Professor of Nutrition and Immunology at Tufts.

- Harvard researchers found that nonsmokers who consumed the most alpha-carotene rich foods reduced their risk of lung cancer by a whopping 63%. When smokers were added to the study, they benefited mostly from a combination of all six major **carotenoids –alpha, beta-carotene, lycopene, beta-cryptoxanthin, lutein and zeaxanthin**.

- Several studies have found that beta-carotene supplements actually increased lung cancer rates in heavy smokers. Many scientists believe that beta-carotene is just one of the many cancer-crushing compounds in carrots. If take beta-carotene alone, you are missing out on the rest.

- Frederick Khachik an organic chemist at U. of Maryland speculates that high doses of beta-carotene may even block the absorption of other, equally important carotenoids such as alpha-carotene.

- Beta-carotene also behaves differently at very high supplemental doses than it does when it is consumed in foods. “Instead of inhibiting cancer, they may promote it” says Robert Russell, associate director of the Human Nutrition Research Center on Aging at Tufts.

- The orange-yellow pigment, **cryptoxanthin** also has cancer-fighting potential. Lab research in Japan, found that cryptoxanthin’s anti-cancer potential is 5 times greater than beta-carotene’s in certain tests. It has also been associated with lower incidences of breast and cervical cancer in women with high consumption.

- **Red Peppers** also protect from nitrosamines, have more vitamin C than oranges, one of the top ten foods in beta-carotene content and antioxidant activity, plus they are one of the best sources of **the carotenoids lutein, zeaxanthin & beta-cryptoxanthin**.

- Pumpkin seeds contain the compounds **cucurbitacins** and **beta-sitosterol**. In a randomized, double blind study of 53 men in Sweden and Denmark, those who took a combination of pumpkin seeds and saw palmetto showed significant relief of symptoms of benign enlargement of the prostate gland. The researchers speculated that the beta-sitosterol in the seeds was the contributing factor. Beta-sitosterol, has been shown in animal tests to slow abnormal cell proliferation.

- The best source of yellow-orange lutein is from green vegetables. Kale is one of the best sources.

- Dr. Johanna Sedon of Harvard demonstrated the effectiveness of **zeaxanthin and lutein** in fight macular degeneration in 1994. The study showed that participants who ate the most carotenoid-rich foods decreased their risk of macular degeneration by 43%. A series of European studies in 1960s confirmed that bilberry extracts containing anthocyanins and beta-carotene really work-probably because they increased the regeneration rate of “visual purple”, the purple pigment in the retina that allows us to see in dim light.

- Lycopene is a member of the carotenoid family, and is one of the most potent free-radical scavengers in nature, according to Paul Lachance, professor of food science and nutrition at Rutgers University. It tends to collect in certain cells of the body, including the lungs and prostate. Scientists have observed that lycopene consumption seems to reduce levels of cancers in these parts of the body.

## PHENOLIC ACID / POLYPHENOLS

- **Tomatoes** also have **phenolic acid** – specifically **p-coumaric acid** and **chlorogenic acid**. These are antioxidants like lycopene,

but their most important cancer-fighting effect comes from their ability to inhibit the formation of nitrosamines in the body. Nitrosamines are a powerful group of more than 400 carcinogens. The body makes these itself when nitrogen compounds, such as nitric oxide, combine with components of proteins called amines. The body makes nitric oxide when fighting infections. In a small study of 16 men, Hotchkiss found tomatoes to be the second most potent inhibitor of nitrosamine formation in the body after green peppers.

- **Carrots** are another good source of *phenolic acids*.

- **Cranberries** are known to ward off UTI's due to the compound, *A-linked condensed tannins*. A member of the *polyphenolic* family act to prevent E.Coli from adhering to the walls of the bladder and urethra.

- Green Tea is exceptional source of polyphenolic compounds.

Lycopene appears to protect both hearts and lungs against oxidative damage. In one study, Venket Rao of the University of Toronto found that one to two servings of tomato juice or spaghetti sauce everyday for a week, decreased damage to proteins, DNA, and cholesterol in the blood of 19 volunteers.

In one study, rats with prostate tumors were fed either lycopene beadlets or freeze-dried tomato powder. The tomato powder, with its full complement of phytonutrients outperformed the lycopene alone.

## FLAVONOIDS

- Carrots also contain a *flavone* called *apigenin*, which has anti-bacterial, antihistaminic, anti-inflammatory, antioxidant, anti-tumor and sun-protective properties, according to the USDA database.

- Tangerines have a powerful dose of Vitamin C and contain a duo of health-promoting *flavonoids: tangeretin* and *nobiletin*. Scientists have found that these flavonoids function as both anti-inflammatories and blood thinners, indicating they may help prevent heart attacks, but this has yet to be demonstrated.

- **Broccoli's flavonoids** may also benefit the cardiovascular system. A ten-year study of 34,492 postmenopausal women in Iowa found that deaths from heart disease were 38 percent lower among women in the top bracket of flavonoid intake.

- Broccoli is rich of protective flavonoids, terpenes and phenolics, and the cancer-preventing compounds called isothiocyanates and indoles.

- The main *flavonoid* in **oranges** is *hesperetin*, also found in lemons, limes and grapefruit.

- *Hesperetin* is a heart protecting, cancer fighting, infection-stomping compound that should be in everyone's diet. Researchers have found that hesperetin slowed the replication of several viruses, including polio, herpes, and flu.

- The five heart healthy substances in oranges: Hesperetin, pectin (cholesterol reducing), Potassium (lower blood pressure), and Folate (removes excess homocysteine).

- In lab studies, Quercetin shows numerous health benefits. It is a strong antioxidant that can "quench" a particularly damaging free radical called singlet oxygen. It can also enhance the fighting capability of other antiviral compounds. And together with *flavonoids*, it fights inflammation. It is used clinically to alleviate inflammatory problems, including gout, pancreatitis, and prostatitis. Also used to treat allergic conditions such as asthma, hay fever, and hives.

- Sarah Lewis at the University of Nottingham in England examined the eating habits of 2,633 adults and correlated them with wheezing, asthma, and lung capacity. Those with the healthiest lungs ate apples at least five times a week and tomatoes three times a week.

- In another study, men who ate the most *flavonoids*-in particular, *quercetin*- had 53 percent fewer fatal heart attacks than those who ate the least.

- Scientists have found *Quercetin* to inhibit the growth of malignant cells and cause abnormal cells to self-destruct, through apoptosis.

- A recent Mayo Clinic study also found *quercetin* to restrict tumor's cells production of androgen receptors. Over stimulation of those receptors by the male hormones appears to drive the development of prostate cancer.

- Although *quercetin* appears to be one of the most potent *flavonoids* in apples, it is much more powerful when combined with the fruit's other natural compounds.
- Hai Liu, a food science teacher at Cornell U., demonstrated this by putting human cancer cells into special containers with all the nutrients they would need to grow. Then he added either *quercetin* or whole apple extract. Both inhibited the growth of cancer cells, but the whole apple extract outperformed the *quercetin* by a long shot.
- Apples with peels used in the study were 50% better at stopping cancer-cell proliferation than peeled apple extract.

## LIMONOIDS

- Guthrie found that *limonoid* compounds, a part of the *terpene* family, were 45 more times more effective than hesperetin at blocking tumor formation.
- Researchers have also found *limonoids* to inhibit lung, skin, and stomach cancers. The compounds appear to act in two ways- by stimulating the enzymes that detoxify carcinogens and by inducing abnormal cells to commit suicide.
- Limonene is found mostly in the peel of citrus fruit.
- Dr. Iman Hakim at the Arizona Cancer Clinic found that people who used lemon and orange peels in cooking, as little as once a month, reduced their squamous cell carcinoma of the skin by 50 percent.

## TERPENOIDS

- *Terpineol* has been found to also cause cell cycle arrest in tumor cells. If given in sufficient quantities, it stops cell replication in its tracks.
- *Farnesol*, found in *cumin* has been found to be very effective in suppressing pancreatic cancer in hamsters. It is hypothesized that it encourages apoptosis, or programmed cell death, among abnormal cells.
- Rosemary contains a terpenoid called carnosic acid. This compound has the ability to grab a lot of free radicals. It quenches two free radicals, then rearranges itself to form another compound called carnosol, which grabs two more free radicals before rearranging itself yet again to swipe at two more, according to Carolyn Fisher, an organic chemist.
- Broccoli is rich of protective flavonoids, terpenes and phenolics, and the cancer-preventing compounds called isothiocyanates and indoles.

## SULFORAPHANE

- *Sulforaphane* also boosts the production of glutathione and increases the levels of antioxidant generating enzymes. Also, because they do not get used up as they work, they remain in the body longer than traditional antioxidants, which often last only hours.
- In 1992, Tally discovered *sulforaphane*, a potent phase 2 inducer. In his study, rats that received sulforaphane had their risk of developing mammary tumors by 60%. The animals that did get cancer, the size of their tumors was cut by 75%.
- By boosting phase 2 enzymes the *sulforaphane* also helps the body fight oxidation. Talalay recently discovered that these enzymes act as "indirect" antioxidants. They do not "quench" free radicals by giving up electrons, like vitamins E or C. But just they directly link carcinogens to other molecules; they can inactivate oxygen radicals by hooking them to substances that the body then disposes of.

## PHYTOSTEROLS

- *Beta-sitosterol*, a phytosterol is similar in structure to cholesterol, and competes with cholesterol for absorption into the body, and wins. The result is lower cholesterol in the bloodstream.
- *Beta-sitosterol* also appears to inhibit excessive cell division, which may prevent cancer cell growth. It has been shown to reduce cancer in both animal and lab tests.
- The most important *indole* in *broccoli* is *indole-3-carbinol*. It appears to be a potent cancer fighter, mainly due to the effects it has on estrogen. First it blocks estrogen receptors in breast cancer cells. By locking into these sites first, it can block estrogen, which is beneficial as many breast cancers are driven by estrogen. Only a fraction of the cells in a woman's breast have estrogen receptors, the ones that do seem particularly vulnerable to cancer. Second, indole-3-carbinol influences the balance of estrogen in our bodies. It drives production of a less potent estrogen that does not stimulate breast cancer and diminishes production of a more harmful form

of estrogen.

- Flaxseeds contain compounds: *lignans*, which are *phytoestrogens*. Like indole-3-carbinol in broccoli, lignans alter the balance of estrogens in the body, favoring the production of an estrogen metabolite that appears to protect against breast cancer.
- One study conducted with two groups of pre and post – menopausal women, found the balance of estrogens shifted in a favorable direction when the women ate a few tablespoons of flaxseed a day

## INDOLES

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## SAPONINS/LIGNANS

- *Saponins* – chick peas, legumes, soy beans and alfalfa sprouts are excellent sources. Saponins are chemicals useful in lowering cholesterol by latching onto it in the digestive tract and carrying it right on through the system, without allowing it to be absorbed. In simple terms saponins are like natural detergents.
- *Saponins* attach to the cholesterol and break up the membranes. It is hypothesized that saponins also have this application to cancer cells. Without their membranes intact, the cancer cells die. Fortunately saponins do not have this effect on normal cells. Since cancer cells have higher levels of cholesterol in the membrane, saponins have more binding sites and therefore a greater effect on cancer cells than normal according to Venket Rao, professor of nutrition at the University of Toronto. Since saponins are not readily absorbed from the digestive tract into the bloodstream, so they appear to be useful mainly for combating colon cancer.

- Flaxseeds contain compounds: *lignans*, which are *phytoestrogens*. Like indole-3-carbinol in broccoli, lignans alter the balance of estrogens in the body, favoring the production of an estrogen metabolite that appears to protect against breast cancer.
- One study conducted with two groups of pre and post–menopausal women, found the balance of estrogens shifted in a favorable direction when the women ate a few tablespoons of flaxseed a day.

## RESVERATROL

- *Resveratrol*, a *polyphenolic* compound, is found more in **grapes** than any other foods.
- *Resveratrol* has been found to intervene in various ways to prevent tumor growth. At the onset it stimulates detoxification enzymes, and helps neutralize carcinogens before they can lead to mutations.
- Like *curcumin*, *resveratrol* is a potent COX-2 inhibitor, an important type of anti-inflammatory
- *Resveratrol* also tackles any full-fledged cancer cells that may emerge and helps wrestle them into normalcy by encouraging something called cell differentiation. Differentiation means they are able to multiply rapidly, and solid tumors may form as the cells pile up on top of one another. Pezzuto was able to take leukemia cells in the lab and using resveratrol, make them differentiate into cells that behaved normally.

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