

Carotenoid Research

The Dawn of a New Age in Medicine

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Carotenoids are nature's pigments for splashing the world with yellow, orange and red color. Sometimes the colors are hidden by chlorophyll, but when the chill winds of autumn dust the vegetable world the carotenoids materialize in a stunning variety of fall colors.

The approximately 600 members of the carotenoid family get their name from carrots. Different foods have different kinds of carotenoids. These substances were considered insignificant until it was learned that they protected plants from oxygen and the radiation of the sun. The human body needs this same kind of protection so these things can improve our health too.

Carotenoids may soon be considered as essential as other vitamins and minerals without which life can not exist. They enable the body to cope with excited oxygen called singlet oxygen and other free radicals.

Problems of a Supplement

The Neo-Life Company is the first that has offered a complete carotenoid product. Formulation of a supplement retaining the active properties of these substances proved to be a challenge. Firstly, there was no test to determine if carotenoids were in foods or what types were there. Dr. Lester Packer was hired to develop tests which would make it possible to detect presence, potency, and ratios of carotenoids in foods.

Secondly, foods vary in carotenoid profile. Foods were examined from around the globe to find potency and profiles. Neo-Life is committed to using nutrients derived from the normal human food chain.

The tryptophan episode illustrates the importance of this point. An oriental firm genetically engineered the amino acid tryptophan in bacteria. Therefore it was not derived from a normal human food like milk. Some kind of biological contaminant appeared in the genetically engineered tryptophan which caused a disease called EMS (eosinophilia-myalgia syndrome). Many people died or became ill from this poisoning. The product was cheap, used by millions, but not safe.¹ We do not always know as much as we think we do scientifically. It is better to follow nature's lead.

Returning to carotenoids, manufacturing facilities were put together to extract and encapsulate the carotenoids without destroying them. This involved a process which handles the nutrients in a nitrogen medium to assure potency.

Reference:

1. Jaffe, Russell, "Eosinophilia-Myalgia Syndrome Caused by Contaminated Tryptophan," *Int. J. Biosocial Med. Research*, Vol. 11(2); 181-184, 1989.

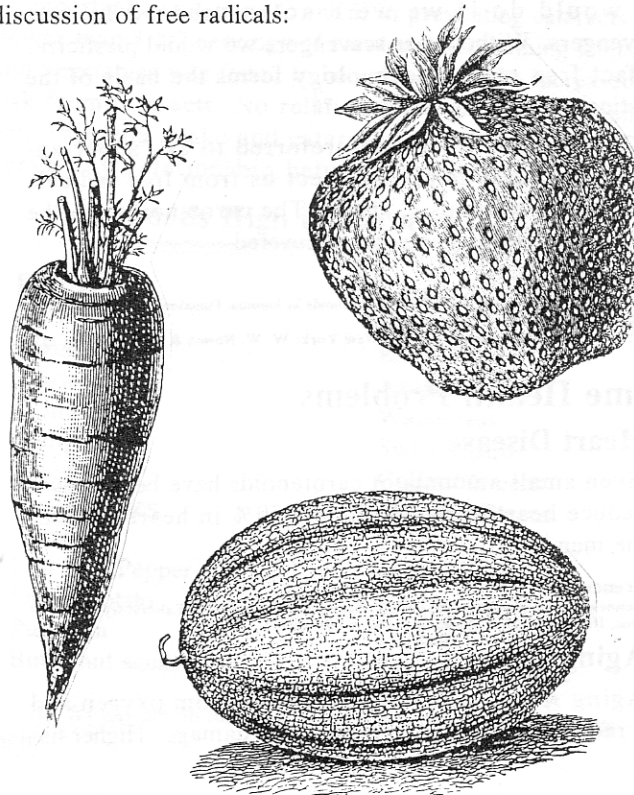
How Carotenoids Work

Carotenoids provide most of their benefits by protecting body cells from oxygen and free radicals. Oxygen can interact with the genetic material known as DNA and damage it. It can also react with the delicate fats in the cell wall. This causes the cell membrane to lose its flexibility. Immune cells can not divide to multiply themselves if they are damaged by oxygen in this way.

One researcher writes, "Carotenoids can protect lipids from oxidation and may decrease immunosuppressive peroxides and maintain cell membrane fluidity. Lymphocyte membranes must be fluid to undergo proliferative responses."¹ The overall functioning of the immune system suffers when immune cells can not reproduce.

Free Radicals

Roy Walford provides an excellent, though technical, discussion of free radicals:





“...free radicals are highly reactive chemical substances with an unpaired electron whirling around a superactivated oxygen atom. They attack membranes, DNA, and other parts of the tissues. Rancid changes in fats and oils result from a series of free radical reactions in which each step is activated by the uptake of an oxygen molecule to yield an auto-oxidation, a potential anti-self reaction besides the immune type in your own bodily butter. The free radicals within us may originate partially from the environment but are mainly produced spontaneously like sparks from the metabolic machine....All the ingredients for massive free radical oxidation are present in living cells. Cells are impregnated with iron and other metal complexes, drenched in oxygen, enveloped in and shot through with highly unsaturated fats and oils. We would instantly set solid if these became saturated, as they do and we do in rigor mortis, and as we would do if we were not protected by our scavengers. Without our scavengers we would plasticize. In fact free radical technology forms the basis of the plastics and polymer industry.”²

Carotenoids have been referred to as “super-antioxidants” and as such protect us from free radicals along with vitamins C and E. The carotenoids are the most potent antioxidants yet discovered.

References

1. Bendich, Adrienne, “A Role for Carotenoids in Immune Function,” *Clinical Nutrition* 1988;7:114.
2. Walford, Roy, *Maximum Lifespan*, New York: W. W. Norton & Co., 1983, pp. 135-136.

Some Health Problems

Heart Disease

Even small amounts of carotenoids have been shown to reduce heart problems almost 50% in heart-disease-prone men.

Reference

Hennekens, C: The U.S. Physicians' Health Study, Channing Laboratory, Dept. of Medicine, Harvard Medical School (preliminary information).

Aging

Aging is associated with damage from oxygen and free radicals. Carotenoids hinder this damage. Higher tis-

sue levels of carotenoids appear to be related to longer life.

Reference

Cutler R., “Antioxidants and Aging,” *American Journal of Clinical Nutrition* 53:373S-80S (1991).

Immune Function

The immune cells attack invaders with a process called a respiratory burst. When the body is attacked, white blood cells use oxygen and free radicals to destroy the invaders. Normally these substances are bad and even deadly, but in this situation they can save a person's life. Unfortunately, these substances can be overproduced.

Neutrophils are major immune cells which deal with invading bacteria. In one study neutrophils carried out their activity of killing invading bacteria efficiently when supplied with carotenoids. When carotenoids were not supplied in sufficient quantities, the neutrophils were damaged by their own weapons (oxygen and free radicals) they were using to attack the bacteria!

Reference

Bendich, Adrienne, “A Role for Carotenoids in Immune Function,” *Clinical Nutrition* 1988;7:113-7.

Cancer Protection

In 1971 Congress passed the National Cancer Act declaring war on cancer. Since then there has been some progress in cancers found in the young. There has been little progress in cancers of those 45 and older.

Carotenoids appear to play a role in *prevention* of cancers of epithelial tissue. In one study those with low

¹O₂ Singlet oxygen

Oxygen can exist in a variety of forms. Most oxygen is not very active. Singlet oxygen is an excited oxygen with an extra electron. Oxygen can pick up an electron from light or as a result of energy production in the human body. This excited oxygen can damage tissues in the same way that oxygen makes iron rust. Carotenoids can pull the unpaired electron from singlet oxygen and release it as heat:

electron + carotenoid → carotenoid + heat.

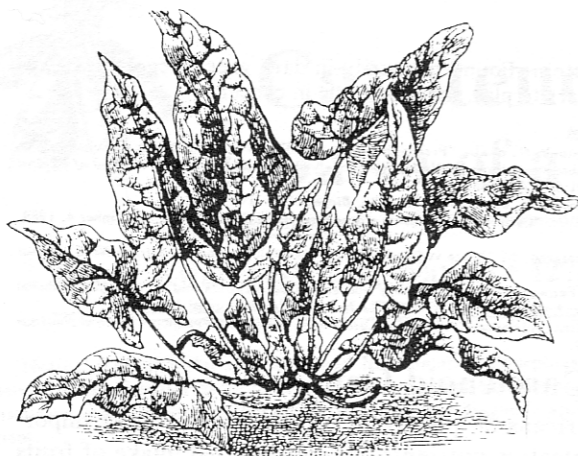
(Some people feel warm after supplementing with carotenoids.)

Think of a fireplace burning wood to keep a home warm. As long as the fire is contained it serves its purpose. But a fire throws off sparks. These sparks can burn down the home being heated by the fire. Thus a screen is placed in front of the fireplace to keep the sparks out of the living area. That screen performs the same function that carotenoids perform in the human body.

Vitamin A does not perform this same function in the body. Beta-carotene, the vegetable precursor to vitamin A, does help in this regard. Beta-carotene is not the most effective oxygen quencher. It can also be converted to vitamin A and thus be lost for this important function.

Reference

Krinsky, Norman, “The Evidence for the Role of Carotenoids in Preventive Health,” *Clinical Nutrition*, vol. 7, No. 3, May/June 1988, p. 108..



carotenoid levels in the blood were found to be 4.3 times as likely to develop lung cancer.¹

Cancer Development

Cancer develops in stages. The first stage is *initiation*. This is usually caused by a compound called a carcinogen (a chemical causing cancer). There are so many cancer causing compounds in the environment it is futile to try to prevent this stage of cancer.¹

The second stage of cancer is the *progressive or promotional*. Carotenoids appear to delay this stage and also to slow it down. In other words, animals given carotenoids after being exposed to carcinogens or being implanted with cancers either do not get cancer or the cancers appear later and grow more slowly.¹

*Low levels of carotenoids did not appear to protect from cancer.*¹ Higher levels significantly delayed the development of cancers in animals given cancer causing compounds.

In one study alpha-carotene depressed growth enhancing protein activity in cancer cells by 24% within three hours and cut activity to 18% in 18 hours.³ "Furthermore, two recent epidemiologic studies have shown an association between serum lycopene or tomato consumption and decreased risk for cancer."⁴

Cancer Defenses

The body has three cells which can kill tumors. The first is the *macrophage*, a word which means "big eater." Carotenoids enhance the ability of these cells to kill tumor cells. Macrophages communicate with other immune cells via receptors on the surface which can be destroyed by oxygen. Carotenoids protect these receptors.²

The second tumor killing cell is the *T cell*. Carotenoids protect T cells and the thymus, after which they are named, from radiation damage. Greater numbers and greater activity of T cells results when mice are fed carotenoids.²

The third cell capable of killing cancer cells is called the *natural killer cell*. Carotenoids enhanced the killing activity of these cells in sheer numbers of cancer cells killed.²

And if this is not enough, the body produces a compound called *tumor necrosis factor*. It kills tumor cells directly. Carotenoids increase production of this factor.²

Interferon is an important chemical for immune function. It helps prevent viral attack. Invaders sometimes produce inhibitors to compounds like interferon in their attack upon the body. Carotenoids have been shown to enable interferon to function even in the presence of inhibitors.²

References

1. Krinsky, Norman, "The Evidence for the Role of Carotenes in Preventive Health," *Clinical Nutrition*, vol. 7, No. 3, May/June 1988, p. 107-112.
2. Bendich, Adrienne, "A Role for Carotenoids in Immune Function," *Clinical Nutrition* 1988;7:113-7.
3. Raloff, J., "Carotenoids: Colorful cancer protection," *Science News*, November 4, 1989, p. 294.
4. Bertram, John, et al., *Carcinogenesis* 1991 Vol. 12 No. 4, p. 671.

Cataracts

A cataract is a cloudiness in the lens of the eye which causes loss of vision. The name comes from the Greek word for waterfall, since a mature cataract is white. Ancient people thought a cataract looked like a waterfall within the eye.

One physician suggests that if we live long enough we will develop cataracts. Cataracts are very common and billions in medical costs yearly are spent on the disability they cause.

The loss of transparency of the lens of the eye is caused by ultraviolet light and free radical reactions. It is pretty well established that vitamin C and possibly vitamin E help prevent and may even reduce the severity of cataracts. Dr. Gary Todd finds that these nutrients can improve vision as much as 50% over the long haul.

Recent evidence suggests that carotenoids are at least as important as vitamins C and E in preventing cataracts. Fewer than 3 1/2 servings of carotenoid containing fruits and vegetables was found to be correlated with increased risk from cataracts. No relationship was found between beta-carotene intake and cataract risk: "We did not observe any relationship between carotene intake and

Foods High in Carotenoids

Fruits

Apricot
Peach
Strawberry
Cantalope
Mango
Papaya

Vegetables

Carrot
Red Bell Pepper
Sweet Potato
Pumpkin
Butternut squash

Leafy Greens

Spinach
Kale
Arugala
Watercress
Swiss Chard
Collard Greens
Mustard Greens
Turnip Greens
Broccoli

Lycopene Foods

Tomato
Pink Grapefruit

If a food is not on this list it probably has little or no carotenoids in it.

cataract risk." The researchers suggest that beta-carotene is only one of many carotenoids and is a poor measure of "antioxidant potential."²

References

1. Todd, Gary, "Nutrition in Ophthalmology," in Yanick, Paul and Jaffe, Russell, *Clinical Chemistry & Nutrition Guidebook: A Physician's Desk Reference*, 1988, p. 199.
2. Jacques, Paul and Chylack, Leo, Jr., "Epidemiologic evidence of a role for the antioxidant vitamins and carotenoids in cataract prevention," *American Journal of Clinical Nutrition* 1991; 53:352S-55S.

Photosensitivity

Carotenoids protect plants from exposure to the radiation and light of the sun. Some people are very sensitive to sunlight. Exposure can result in itching, redness, blistering and even death of skin tissue. Researchers have found that people sensitive to sunlight often benefit by the addition of carotenoids to the diet.

Some Carotenoids

We know very little about the carotenoids. Here is a list of some of the carotenoids which have been studied and what we know about them:

- alpha-carotene: ten times more effective than beta-carotene in its ability to shut down tumor cell growth. "...alpha-carotene apparently inhibits cancer growth by locking malignant cells into the rest phase of their growth cycle. And they remain in this sort of suspended animation until the effects of the carotenoid begin wearing off."³ Possible protective role in vulvar cancer.⁵
- Beta-carotene: Protective against lung cancer, melanoma, bladder cancers.¹ The most tested of all carotenoids.
- Gamma-carotene: The second most potent singlet oxygen quencher studied thus far.²
- Canthaxanthin: Effective in immune enhancement.⁶
- Astaxanthin: Increased activity of T cells and macrophages in tumor models.⁶ Third most potent oxygen quencher.²
- Bixin: Regression of virally induced tumors in animals.⁶
- Phycotene: Increased activity of T cells and macrophages in tumor models.⁶
- Lycopene: Protective against pancreatic, bladder, and rectal cancers,¹ "Results showed that as the dietary intake and serum levels of the carotenoid lycopene increased, the risk for CIN (cervical intra-epithelial neoplasia—a precancerous condition) decreased."³ Most effective singlet oxygen quencher.² Chief source is tomatoes.⁴

- Lutein: Found primarily in dark green vegetables. Appears to play undefined role in cancer.⁴

References

1. Comstock, G. et al., "Prediagnostic serum levels of carotenoids and vitamin E as related to subsequent cancer in Washington County, Maryland," *American Journal of Clinical Nutrition* 1991;53:260S-264S.
2. Di Mascio, P., et al., *Arch. Biochem. Biophys.* 274 (1989) 532-538.
3. Raloff, J., "Carotenoids: Colorful cancer protection," *Science News*, November 4, 1989, p. 294.
4. Wichelgren, I., "More veggies join fight against lung cancer," *Science News*, August 1989.
5. Van Eenwyk, J., et al., "Dietary and serum carotenoids and cervical intraepithelial neoplasia," *Int. J. Cancer* 1991;48:34-38. *The Nutrition Report*, August 1991.
6. Bendich, Adrienne, "A Role for Carotenoids in Immune Function," *Clinical Nutrition* 1988;7:113-7.

The Carotenoid Gap

Americans do poorly in consumption of these important protective nutrients. Recommended intake of fruits and vegetables is a minimum of five servings a day. Many of these foods have little or no carotenoid content. America's most popular fruits and vegetables — apples, oranges, iceberg lettuce, potato and corn — are not good sources of carotenoids.

Only about one person in 10 consumes five servings of fruits and vegetables in a day. Average intake of carotenoids is only about 25% of what is considered desirable.¹

Daily intake of carotenoids is important. "The blood level of carotenoids is primarily regulated by ingestion: as we ingest more carotenoids, the blood level increases."²

In addition to quantity of intake, variety of intake also appears to confer greater benefits. One researcher writes, "The most surprising result indicates that routine consumption of all the vegetables listed on the study questionnaire offers stronger protection (against cancer) than consumption of any one kind of vegetable or nutrient. 'That suggests to us that we need to look at the additive and interactive effects of these [vegetable] components.'"³

References

1. Brody, Jane, "Personal Health," *The New York Times*, September 25, 1991.
2. Bendich, Adrienne, "A Role for Carotenoids in Immune Function," *Clinical Nutrition* 1988;7:113-7.
3. Wickelgren, I., "More veggies join fight against lung cancer," *Science News*, August 1989.

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