Health Benefits of Natural Mixed Carotenoids

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Carotenoids – Important Natural Micronutrients

Carotenoids have become recognised as an important component of the human diet. For many years, the health benefits of carotenoids focused predominantly on the vitamin A activity of beta-carotene. Today, many natural carotenoids are being investigated for their role in a variety of health benefits, particularly protection against chronic diseases. This interest in carotenoids beyond their vitamin A activity stems from an enormous amount of epidemiological data showing that high intakes of fruits and vegetables, which contain carotenoids, are protective against a number of different diseases states, especially some forms of cancer.

Carotenoids are highly coloured (yellow to red) pigments found in plants where they facilitate photosynthesis by aiding in the collection of radiant energy from sunlight. These pigments, which are responsible for the colour of carrots and tomatoes also protect the plants against excess ultraviolet radiation. From a chemical standpoint, carotenoids are tetraterpenoid compounds, which contain 40 carbon atoms arranged in a repeating pattern of 5 carbon units. Carotenoids are further subdivided into carotenes which contain only carbon and hydrogen and xanthophylls which also contain oxygen. More than 600 different carotenoids have been identified in nature and about 40 to 50 are present in the normal human diet. Approximately 20 different carotenoids have been found in human blood. Animals (including humans) do not synthesise carotenoids, they must obtain carotenoids from the diet.

Carotenoids – Safe Source of Vitamin A

As mentioned above, carotenoids are a safe source of vitamin A which is essential for growth, cellular differentiation and reproduction, vision and proper immune function. In high doses, preformed vitamin A can be toxic and cause birth defects, if taken during some stages of pregnancy. Because the body only converts carotenoids into vitamin A when necessary, eating large quantities will not cause vitamin A toxicity, but may result in a harmless yellow discolouration of the skin, which rapidly disappears when carotenoid consumption is reduced. About 50 different carotenoids can be converted into vitamin A, but beta-carotene is the only carotenoid with the potential of forming two molecules of vitamin A from one molecule of carotenoid. In terms of biological equivalency, 1mg all-trans retinol is equivalent to 6mg all-trans beta-carotene and 12 mg other provitamin A carotenoids.

As pigments in food products, beta-carotene and other carotenoids are very useful because of their high colour intensity and low toxicity compared to other colours. Although they are lipid soluble compounds, water digestible products are available in the form of liquid emulsions or dry powders. Because of their antioxidant properties, they readily react with oxygen and must be protected. However, once incorporated into the food product beta-carotene is usually quite stable.

Carotene Sources – Fruits, Vegetables and Bioavailable Supplements

Carotenoids also are available as supplements to enhance the diets of those who eat few fruits and vegetables on a daily basis. Despite the recommendations from multinational health organisations to eat more fruits and vegetables, many populations, on average, fail to eat a minimum of five servings per day. In addition, several recent studies have shown that bioavailability is very low in fresh fruits and vegetables, while carotenoids in supplements have excellent bioavailability. Food sources of carotenoids have the advantage of providing a wide variety of carotenoids, but using supplements containing natural mixed carotenoids, provide five of the more important and most common carotenoids. Natural mixed carotenoids are produced by the alga Dunaliella salina and contain alpha carotene, beta carotene (both cis and trans isomers), zeaxanthin, cryptoxanthin and lutein.

Positive Epidemiological Evidence of Health Benefits vs. Clinical Trials

A varied diet rich in fruits and vegetables form the basis for good health as indicated by epidemiological studies. This epidemiologic evidence supports the use of the mixed carotenoids in human nutrition and formed the basis for recent large clinical trials of beta carotene. Two large clinical trials both aimed at preventing the progression of lung cancer in high risk subjects (heavy smokers treated with synthetic beta carotene in the ATBC (alpha tocopherol beta carotene) Study, heavy smokers and asbestos workers treated with synthetic beta carotene and high doses of vitamin A in the CARET Study did not show any benefit and indicated potential harm in some individuals. However, in the Physical Health Study (PHS), which was the largest and longest clinical trial with beta carotene to date, there was clearly no harm to the 22,000 healthy male physicians over 12 years of supplements use.

At annual meeting of the American Society of Clinical Oncology, Stampfer, a principal investigator of the PHS, reported a protective effect of beta carotene against prostate cancer. As hypothesised, men with the lowest plasma beta carotene had an increased risk of prostate cancer compared to those in the highest levels. Furthermore, men with initial low beta carotene supplements had a 36% reduced risk of prostate cancer and a reduction (not statistically significant) in total cancer.

In another epidemiological study using a new carotenoid database, Ziegler investigated the relationship between consumption of various foods and the risk of developing lung cancer. This study involved approximately 2000 white males in New Jersey and found that men with the highest intakes of beta carotene had a 50% reduction in the risk of lung cancer. This result is compatible with many previous studies. However, alpha carotene was even more protective with 63% reduction in the risk of developing lung cancer. Based on these results, Dr. Ziegler concluded that beta carotene is not the dominant protective factor in vegetables and fruits.

One plausible explanation of the different results between epidemiological and clinical trials is that only one carotenoid was tested in the clinical trials, whereas the epidemiological data are based on eating a variety of fruits and vegetables which contain many carotenoids. This explanation argues that consuming a mixture of different carotenoids would have been protective.

Increased Lycopene Bioavailability and Reduced Risk of Prostate

Another carotenoid, lycopene, recently has been associated with a decreased risk of prostate cancer. Men who consumed at least 10 servings per week of tomato-based foods were found to have a 35% reduced risk of prostate cancer. Lycopene is the major carotenoid in tomatoes but several others (including beta carotene) also are present. Lycopene is the most effective carotenoid at quenching singlet oxygen, a powerful oxidising agent. The greatest benefit was obtained from cooked tomato foods such as tomato sauce. High consumption of tomato juice was not protective, which is consistent with the poor bioavailability of lycopene from raw tomatoes and tomato juice. It is interesting to note that lycopene is the most abundant carotenoid found in the prostate gland, which supports a possible protective role in this tissue.

Lutein and Zeaxanthin – Important Carotenoids in Eye Health

Another disease where carotenoids appear to be protective is age-related macular degeneration (AMD). AMD is progressive degeneration of the macula (a yellow region on the retina directly behind the iris of the eye) resulting in irreversible blindness. Dr. Seddon discovered that eating foods, such as spinach, which is rich in lutein and zeaxanthin (xanthophylls) reduced the risk of developing AMD. These results are consistent with the fact that the macula is yellow because it contains a high concentration of lutein and zeaxanthin, the only carotenoids found in the macula. Consumption of 6mg per day of lutein appeared to be effective in reducing the risk of developing AMD.

Photo-protective Effects of Carotenoids in Human Skin

Lately, interest has focused on the photo-protective properties of carotenoids. With greater evidence that excessive exposure to the sun can result not only in sunburn but also skin cancers, protection is needed against damaging UV rays. Recent human studies provide evidence that systemic UV protection by ingestion of carotenoids offers another line of defence. Recognising that beta carotene provided sun protection in plants, bacteria and mice, Mathews-Roth and colleagues demonstrated that beta carotene also protected against photo-sensitivity in people with a rare genetic disease called erythropotetic protoporphyria. More recently Gollnick and Biesalski demonstrated in normal humans that beta carotene intake of 30mg per day for 6 weeks, prior to sun exposure, resulted in sun protection that was optimised by carotene intake and sunscreen use. In addition to reduced redness, Biesalski demonstrated that Langerhans cells, important components of the immune system, were maintained by beta carotene intake, to protect against UV damage. Confirmation of UV protection by natural mixed carotenoids in normal humans was demonstrated by Heinrich with daily dose of 50mg for 6 weeks of mixed carotenoids, sourced from the D. salina algae. Oral ingestion of high doses of carotenoids provides a preventive measure in skin protection from sun exposure in addition (not as a replacement) to topical creams and sensible exposure habits.

Conclusion

In conclusion, there is much evidence that diets rich in fruit and vegetables or supplements, have important effects on disease prevention and contribute to human health. Studies also show that bioavailability is dependent on the source of carotenoids and that supplements provide a more bioavailable form than fruits and vegetables. A mixture of carotenoids appears to be more beneficial than one single compound. The most important and prevalent carotenoids in human plasma and tissues include alpha- and beta-carotenene, lycopene, lutein and zeaxanthin.