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Beta Carotene (Provitamin A)

Technical Background

- Carotenoids comprise a diverse class of antioxidant molecules that help protect the body from oxidative damage. Most are derived from plants, where they serve multiple functions as photosynthetic pigments, photoprotectants, and free radical scavengers. Some 50-60 carotenoids are present in a typical diet, with the major sources being fruits and vegetables.[1]
- Beta carotene is the best known of the carotenoids because (1) it is one of the most abundant in our diet; (2) in addition to its role as an antioxidant, beta carotene also possesses provitamin A activity.[2] [3]
- As provitamin A, beta carotene contributes to an entirely different set of functions by supplying a portion of the body's requirement for retinol (vitamin A). In fact, a single molecule of beta carotene can be cleaved in the body to produce two molecules of vitamin A.[4]
- Retinol (vitamin A) is an essential nutrient associated with three important functions. Its best-defined function is its critical role in maintaining healthy vision (as a component in rhodopsin production).[1] Vitamin A is further involved in the activation of gene expression and, subsequently, the control of cell differentiation. It is through this function that vitamin A affects immune function, taste, hearing, appetite, skin renewal, bone development, and growth.[2] Vitamin A's third role involves control of embryonic development.[2]
- Vitamin A deficiency is a major public health issue, particularly in developing countries. It is estimated that anywhere from 20-60% of children in Africa and Southeast Asia suffer from Vitamin A deficiency,[5] often resulting in night blindness, blindness, and death. More than 100 million people worldwide suffer from vitamin A inadequacy without showing clinical signs of acute deficiency. Beta carotene is known to be an effective dietary cure for vitamin A deficiency and an effective remedy for the symptoms of this disorder.[2]
- As with other anti-oxidant nutrients, evidence suggests that long-term intake of dietary beta carotene may reduce the risk of several types of cancer. Similar findings pertain to heart disease and immune health.[6] Controlled trials on the effects of beta carotene have increased lately, producing mixed and often contradictory results.
- According to a new study from Harvard, men who supplement with beta-carotene long-term may experience a slower rate of age-related cognitive decline.[10]

Sources and Recommended Intake

- Dietary sources rich in beta carotene and other provitamin A carotenoids include carrots, broccoli, yellow squash, corn, tomatoes, papayas, oranges, and dark green leafy vegetables

such as spinach, kale, and Chinese cabbage. Beta carotene is heat stable and will not degrade during prolonged boiling or microwaving.

- Two systems are used to express the amounts of beta carotene and vitamin A in foods and supplements. The method in current favor for use with foods is based on retinol equivalents (RE). In this system, 1 RE is defined as 1 mcg of all-trans retinol or 6 mcg of all-trans beta carotene. (The larger amount of beta carotene reflects the fact that the bioavailability of carotenoids in most foods is significantly lower than that of dietary vitamin A.) The second system, based on International Units (IU), is used to express potency in nutritional supplements containing vitamin A or beta carotene. Here, 1 IU of vitamin A activity is defined as 0.3 mcg of all-trans retinol or 0.6 mcg of all-trans beta carotene.[4]
- Because it is not a primary vitamin, no Recommended Dietary Allowance (RDA) has been established for beta carotene. The RDA values for vitamin A are as follows: 1,330-2,330 IU (400-700 RE) for children; [4] 3,000 IU (900 RE) for adult men; 2,333 IU (700 RE) for adult women;[7] and 4,000-4,330 IU (1,200-1,300 RE) for lactating women.
- The Tolerable Upper Intake Level (UL) of preformed vitamin A is about 10,000 IU (3,000 RE) for adults;[7] ingestion beyond this level can be toxic. Symptoms of acute and chronic toxicity include nausea, headache, blurred vision, cracking lips, dry and itchy skin, and bone and joint pain. After dosing stops, most symptoms disappear. Over-ingestion of preformed vitamin A can also cause teratogenic effects; i.e. fetal resorption, spontaneous abortion, birth defects, and permanent learning disabilities in children. Because of such effects, most health organizations recommend that women of childbearing years limit their intake of preformed vitamin A to within a reasonable range around the RDA.[2]
- Excessive intake of beta carotene is not known to induce vitamin A toxicity; negative feedback mechanisms in the body prevent the over-conversion of beta carotene to retinol. However, high levels of beta carotene in the diet will induce hypercarotenosis, a benign condition characterized by a jaundice-like yellowing of the skin. Symptoms are reversed when dietary intake is reduced.[1]
- Smokers should be especially careful not to ingest an excess of beta carotene, primarily from isolated stand-alone beta carotene supplements.[8,9] Newer research indicates, however, that long-term beta carotene supplementation in a multivitamin or in concert with other antioxidants may lower overall risk of death.[11]

Abstracts

Muzandu K, El Bohi K, Shaban Z, Ishizuka M, Kazusaka A, Fujita S. Lycopene and beta-carotene ameliorate catechol estrogen-mediated DNA damage. Jpn J Vet Res. 2005 Feb;52(4):173-84. The consumption of fruits and vegetables is associated with a reduced risk of various ailments, including cancer and cardiovascular diseases. Carotenoids, such as lycopene and beta-carotene, are natural constituents of edible plants and may protect against disease. In this study, the influence of lycopene and beta-carotene on DNA damage caused by catechol-estrogens in vitro is examined. One possible mechanism by which catechol estrogens such as 4-hydroxyestradiol (4-OHE2) and 2-hydroxyestradiol, which cause DNA damage in naked plasmid DNA as well as in cells, contributing to the process of carcinogenesis, is through the generation of reactive oxygen species. It was found that both carotenoids at concentrations ranging from 0.25 to 10 microM significantly inhibit strand breakage induced by 4-OHE2/copper sulphate by up to approximately 90% in plasmid DNA with beta-carotene being slightly more effective. No prooxidant or cytotoxic effects were observed at the concentrations tested. These carotenoids had a similar, though reduced effect on DNA damage as measured by the comet assay, in Chinese hamster lung fibroblasts. The results obtained show that both lycopene and beta-carotene, most probably and mainly through their potent antioxidant properties, are able to inhibit catechol-estrogen-mediated DNA damage.

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