6. β-Carotene (and other carotenoids)

β-Carotene is the most abundant member of the carotenoids, a group of pigments of which more than 500 are known. They are widely distributed, particularly in the plant kingdom. In terms of human nutrition, interest in the past concentrated on the function of β-carotene as a precursor of vitamin A. It can be cleaved enzymically to give retinol, mostly in the intestinal mucosa. Some other carotenoids can similarly give rise to retinol, but not so effectively as β-carotene. Most carotenoids have no provitamin A activity and in the past have not usually been considered in human nutrition.

Recently however much interest has been shown in possible functions of β-carotene other than as a provitamin A. It can act as an antioxidant, inactivating certain reactive oxygen species such as singlet oxygen. It can be a chain-breaking antioxidant in a lipid environment, differing from the major fat-soluble antioxidant, vitamin E, in being most effective at the low partial pressures of oxygen found in mammalian tissues [1].

Some of the dietary β-carotene is converted to vitamin A, but some is absorbed intact, and increased dietary intakes are associated with increased plasma concentrations [2].

Carotenoids that are not provitamins A but have a chain of nine or more double bonds would be expected to have essentially the same antioxidant properties. In considering the biological activities of β-carotene other than as a precursor of vitamin A, one should also consider other dietary carotenoids. A number of carotenoids are found in human plasma and tissues, including β-carotene, α-carotene, lycopene, cryptoxanthin and lutein. They may differ in metabolism and rate of uptake by tissues, and thus in biological action [3]. β-carotene (and other carotenoids) can therefore be considered as among the array of antioxidants, including vitamins E and C, which have been implicated in the protection of tissues from disease processes involving free radicals.

Much work with cultured cells, tissue preparations and experimental animals has indicated that β-carotene and other carotenoids may protect against mutagens, decrease malignant transformations, prevent the appearance of tumours and enhance immune responses, among other things [4]. The findings are usually based on either *in vitro* systems or the employment of much larger amounts of carotenoids than in a

normal diet, so their relevance to physiological nutritional requirements in humans is uncertain.

The most persuasive nutritional claim put forward is that a high dietary intake of β-carotene, or carotenoids, confers some protection against cancer. Dietary epidemiological studies have shown fairly consistently that people with a relatively low intake of β-carotene or total carotenoids have a higher risk of cancer, especially lung cancer [5]. There is an inverse correlation between serum β-carotene concentration and risk of cancer [6,7]. While there appears to be an inverse relationship between the consumption of carotenoid-containing fruits and vegetables and the incidence of cancer, there is no proof that β-carotene or carotenoids are the protective factor. Prospective trials of the possible health benefits of β-carotene other than as a provitamin A are in progress. Until the results of these are known, it seems unwarranted to make any recommendation other than to encourage the consumption of vegetables and fruit.

Very high doses of β-carotene may turn the skin yellow, but are not toxic [8].

Summary of proposals

There is as yet insufficient evidence to recommend the consumption of any specific amount of β-carotene, or carotenoids in general, beyond what is needed to supply vitamin A.

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