Nutri Scene

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The carotenes story

Do lycopene and other carotenes have a role in cancer prevention?

THERE was a recent story on the health benefits of tomato, linking it to reducing cancer risk (*The Star*, July 29, 2007).

The functional ingredient in tomato believed to be responsible for this health benefit is lycopene (pronounced as *lai-ko-pin*). It reminded me of an article I read some years ago encouraging eating more pizza (and hence more tomato) to reduce risk to cancer.

I recalled writing in to the papers to say that one need not be eating more pizza to consume more lycopene as our local fruits such as papaya contain large amounts of this carotene. Indeed, it may be unwise to be recommending eating more pizza at all!

Let's talk about this exciting group of pigments called carotenoids, which includes lycopene. This was the subject of my research project some years ago. Carotenoids continue to fascinate me as research continues to unravel the potential health benefits of these pigments, so abundant in our local fruits and vegetables.

Carotenoids in nature

Carotenoids, believed to have derived their name from the fact that they constitute the major pigment in the carrot root, *Daucus carota,* are found throughout the plant kingdom, although their presence is often masked by chlorophyll. It is less known that they are also found in insects, birds and other animals.

These pigments provide a whole range of light yellow to dark red colourings. Thus, a wide variety of foods, for example, yellow vegetables, tomatoes, papaya, oranges, egg yolk, chicken, butter, palm oil, shrimp, lobster, salmon and yellow corn owe their colour principally to carotenoids.

Well, you guessed it. Carotenoids are not present in nature merely to serve as colourants, to provide aesthetic qualities. Carotenoids, synthesised exclusively by members of the plant kingdom and photosynthetic microorganisms, play important physiological roles in metabolism.

There are several hundred carotenoids occurring in nature. In food, probably less than a hundred have been identified, many of them in trace amounts. Amongst these, less than a dozen have been investigated in relation to human health.

Vitamin A deficiency

Telling a story about carotenes must include their close association with vitamin A. Some 75 years ago, vitamin A was discovered as a fat-soluble growth factor found in liver, and recognised as essential for normal vision in man and animals. It is, in fact, the first vitamin to be discovered.

Vitamin A is now also known to play an important role in the maintenance of growth and epithelial cellular integrity and immune function in the body. In other words, it is important for maintaining beautiful skin and reducing infections!

The most well known signs of vitamin A deficiency are those affecting the eye, known as "xerophthalmia" or "dry eye". The earliest sign is night blindness, when affected young children stumble when going from bright to dimly-lit areas.

As the deficiency becomes more serious, changes occur to the conjunctiva and cornea. If not treated, the tragic consequence of severe vitamin A deficiency is blindness. The deficiency affects mainly young children and is an important cause of preventable blindness in several developing countries in the world.

Vitamin A deficiency was reported to be an important sight-threatening disorder in the 1950s in this country, among young children of the lower socio-economic groups. The problem was largely eradicated over the years and there are hardly any reports of children with manifest eye signs of vitamin A deficiency.

It is however recognised that marginal vitamin A deficiency occurs among the poorer segments of the community, especially among malnourished children.

Though the most well-known food source of carotene is probably carrot, many green leafy vegetables contain high levels of carotene, too.

To prevent vitamin A deficiency, the obvious solution is to have sufficient amounts of preformed vitamin A in the diet, also known as retinol. Only foods of animal origin contain preformed vitamin A and these include liver, meat of animals, egg yolk and milk.

For many communities, especially those in developing countries, the main source of vitamin A is carotenes found in vegetables and fruits. Now you see how the carotene story is intertwined with the vitamin A tale.

Carotenes and vitamin A

In communities where foods from animal sources are too expensive, carotenes from plant sources become important sources of vitamin A. After absorption from food, the carotenoid is converted to form vitamin A in the small intestine and stored in the liver.

Not all carotenoids can be converted to vitamin A. Indeed, only a few carotenoids can function as provitamin A. The best known is beta-carotene and it has been estimated that one molecule of this carotenoid can be enzymatically converted to two molecules of vitamin A in the body.

However, because of the poorer absorption and utilisation, the overall biological efficiency of conversion has been estimated to be one sixth of the amount consumed.

Only a few other carotenes can be converted to vitamin A in the body, for example alpha-carotene, gamma-carotene and cryptoxanthin. Conversion of these carotenes to vitamin A is even less efficient compared to beta-carotene. The conversion is estimated to be one-twelfth that of the amount consumed.

Antioxidant role of carotenoids

A new frontier in carotenoid research has been the examination of a possible association between carotenoids and the prevention of certain cancers.

Carotenoids are known to be able to act as antioxidants, and to inactivate highly active chemical species such as singlet oxygen and free radicals, which would otherwise induce potentially harmful processes including cell damage. Through these actions, it has been suggested that carotenoids may play important roles in cancer prevention.

The antioxidation function of carotenoids and their potential in reducing cancer risk is not related to the provitamin A activity of these pigments. Several carotenes that cannot be converted to vitamin A have been shown to be potential anticarcinogens. One of these is lycopene.

A large amount of research has been undertaken over the years to investigate this important relationship between carotenoids and cancer.

Carotenes and cancer risk

There has indeed been convincing evidence to support the role of fruits and vegetables in reducing cancer risk. An international review coordinated by the WHO International Agency for Research on Cancer (IARC) concluded that eating fruit and vegetables may lower the risk of some cancers, particularly cancers of the gastrointestinal tract.

IARC estimated that the preventable percentage of cancer due to low fruit and vegetable intake ranges from 5-12 % for all cancers, and up to 20-30% for upper gastrointestinal tract cancers worldwide. A Joint FAO/WHO Expert Consultation on diet, nutrition and the prevention of chronic diseases in 2003 has recommended the intake of a minimum of 400g of fruit and vegetables per day for the prevention of chronic diseases such as heart disease, cancer, diabetes and obesity.

However, the evidence is much less convincing when the association between individual vegetable and cancer risk is examined.

In the tomato story I referred to earlier, it was reported that upon reviewing available evidence, the United States Food and Drug Administration (USFDA) "*found no evidence that tomatoes reduced the risk of lung, colorectal, breast, cervical, or endometrial cancer. However, there was very limited evidence for associations between tomato consumption and reduced risk of prostate, ovarian, gastric, and pancreatic cancers. Based on this assessment, the FDA decided to allow qualified health claims for a very limited association between tomatoes and these four cancers*".

Upon reviewing the evidence for lycopene in the tomato with cancer risk, this July 18 report in the JNCI concluded that there was "*no credible evidence that lycopene, either in food or in a dietary supplement, was associated with reduced risk of any of the cancers evaluated*".

Indeed, over the years, several large intervention trials, involving tens of thousands of subjects and followed up for several years have failed to provide evidence for the protective role of specific carotenes, in the form of supplements, in reducing cancer risk.

For example the alpha-tocopherol, beta-carotene cancer prevention trial (ATBC) of Finland, reported in 1994, showed that daily supplementation of these two vitamins did not provide any evidence of beneficial effect in terms of lung cancer. Indeed, men given beta-carotene were found to have lung cancer more frequently than those who did not receive carotene.

The American study of beta-carotene and retinol efficiency trial (CARET) of 1996 showed that a combination of beta-carotene and retinol had no benefit but may have an adverse effect on incidence of lung cancer. In the same year, findings from the Physicians' Health Study showed that taking beta-carotene on alternate days neither benefited nor caused any harm in terms of incidence of malignant neoplasms, cardiovascular diseases or death from all causes.

Carotenes in local fruits and vegetables

The most well-known food source of carotene (although not the highest in content) is probably carrot. This orange coloured root contains very high levels of alpha- and beta-carotene. Many green leafy vegetables contain high levels of carotene, but only in the form of beta-carotene.

Hence, vegetables such as *sawi,* spinach, *kai-lan* and *kau-kei-coy* and several local *ulam,* such as *cekur manis, pucuk paku* and *daun turi* are very good sources of provitamin A. Unlike carrot, the high concentration of carotenes is not clearly evident because the orange colour of the pigment is masked by the chlorophyll present.

Among fruits, it is easy to recognise those with high carotenoid content. Orange coloured fruits such as mango, as expected, contain high amounts of carotenes, most of which are beta-carotene. The carotenes in papaya and watermelon are more varied, as the lycopene makes up the major proportion of the pigment present. The lycopene content of papaya and watermelon are in fact three and six times higher than in tomato respectively.

Orange-coloured sweet potatoes, pumpkin, tomato and red chilli are other commonly consumed foods with high levels of carotenes.

My message

It is abundantly clear that we can only obtain the health beneficial effects of carotenes by consuming the fruits and vegetables that contain them. The pills and tablets that contain the extracted carotene have not shown to have the same benefits. There must be other biologically active components in the fruits and vegetables that allow the beneficial effects to be manifested.

Do eat sufficient amounts of fruits and vegetables. Carotenes are just another reason for you to consume these plant foods that are rich in many vitamins and minerals and dietary fibre.

Do make the effort to encourage young children to eat vegetables. It will require more effort and patience on the part of parents. I assure you that the effort is well worth it because I believe there will be more to the carotenes story.

**Data on carotene content of local foods cited in this write up are based on Nutrient Composition of Malaysian Foods, Tee et al., 1997, Institute for Medical Research.*

■ *NutriScene is a fortnightly column by Dr Tee E Siong, who pens his thoughts as a nutritionist with over 30 years of experience in the research and public health arena. For further information, e-mail starhealth@thestar.com.my.*

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