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# Carotenoids in durian fruit pulp during growth and postharvest ripening

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ABSTRACT

Durian (*Durio zibethinus*) cvs. Chanee and Monthong fruit were severed from the tree during 14 day intervals, from 10 weeks after anthesis until commercial maturity. We determined the pulp (i.e. aril; fruit flesh) carotenoid composition, together with pulp firmness, color and total soluble solids (TSS) and postharvest quality. In ripe cv. Chanee fruit the main carotenoids were β-carotene (about 80%), and α-carotene (20%), with minor levels of lutein and zeaxanthin. In ripe fruit total carotenoid concentration (expressed per gram FW) was about 9-fold higher in cv. Chanee than in cv. Monthong. Large differences between the cultivars were also found in β-carotene levels (about 11 times more in cv. Chanee), and even larger ones in those of α-carotene. Differences in lutein and zeaxanthin concentrations were small. Pulp color was deeper yellow in cv. Chanee than in cv. Monthong, which was correlated with α-carotene and β-carotene concentrations. Durian contains a high fat percentage, which is conducive to carotenoid uptake. It is concluded that it is advisable to consume cv. Chanee rather than cv. Monthong if intake of carotenoids is considered important.



## 1. Introduction

Durian is a climacteric fruit with a short storage life and shelf life (Amornputti, Ketsa, & van Doorn, 2014; Booncherm & Siripanich, 1991; Tongdee, Suwanagul, Neamprem, & Bunruengsri, 1990). Due to its high sensitivity to chilling injury the storage temperature cannot be lower than 15 °C (Booncherm & Siripanich, 1991; Ketsa & Paull, 2008). The most popular cultivars of durian grown commercially in Thailand are Chanee and Monthong. The pulp of cv. Chanee is dark yellow and has a strong aroma, while that of cv. Monthong is light yellow and has a mild aroma (Ketsa & Paull, 2008).

Red and yellow colors in fruit peel and fruit flesh can be due to carotenoids (Ampomah-Dwamena et al., 2009; Barreto et al., 2011; Carmona, Zacarías, & Rodrigo, 2012; Cazzonelli, 2011). Carotenoid consumption is important for health. Humans convert α-carotene and β-carotene to Vitamin A, which is crucial for vision. In many developing countries children can become blind because of malnutrition. The regular intake of only a few vegetables and fruit with high concentrations of α- and β-carotene can prevent this (World Health Organisation, 1991).

Other health claims of carotenoids are more disputed. Most carotenoids have antioxidant properties and are free radical scavengers (Paiva & Russell, 1999) and therefore might protect against diseases (Mayne, 2003). Carotenoids have antimutagenic effects, at least *in vitro* and in microorganisms (Arriaga-Alba et al., 2000; Rauscher, Edenharder, & Platt, 1998).

Epidemiologic studies showed an inverse relationship between intake of dietary carotenoids and the incidence of various cancers and of cardiovascular disease (Halliwell, 2000; Paiva & Russell, 1999). A correlation was found of low disease risk with blood β-carotene concentration (Halliwell, 2000), although it was not shown that β-carotene was the cause of the low disease incidence (Rowe, 1996). In a study on mice, α-carotene was more effective in preventing cancer than β-carotene (Murakoshi, Nishino, & Satomi, 1992). Recently an inverse relationship was found between α-carotene concentrations in human blood serum and the risk of death (Li et al., 2011). These positive effects of carotenoids were thought to be due mainly to their antioxidant activity (Stahl & Sies, 2003).

Here we report on total carotenoid concentrations, as well as those of individual carotenoids, in durian pulp, during growth and at the ripe fruit stage. We used cvs. Chanee and Monthong, the main cultivars grown in Thailand. The two cover about 90% of the total area planted, with cv. Monthong recently becoming more widely grown than cv. Chanee. We observed a considerable difference in pulp color in these two cultivars. We tested the hypothesis that the deeper yellow color in cv. Chanee was due to

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a higher concentration of carotenoids, in particular α-carotene and β-carotene.

## 2. Materials and methods

### 2.1. Plant material

Durian (*Durio zibethinus* Murr.) cvs. Chanee (international code D123) and Monthong (code D159) trees grew in a commercial orchard in Chanthaburi province (Eastern Thailand). Flowers were tagged one week after anthesis, in January. The two cultivars have the same flowering period. Fruits were severed from the tree starting 10 weeks after anthesis, at 2 week intervals until the fruit was commercially mature. i.e., week 15 after anthesis in cv. Chanee or week 17 after anthesis in cv. Monthong. Cut fruit were immediately brought to a packing house and submerged in aqueous 0.5 mL $L^{-1}$ imazalil solution for 20 s to control fruit rot caused by *Phytophthora palmivora*. Fruit were then allowed to dry in the packing house at ambient temperature (about 28–32 °C). Transport to the laboratory took place in a temperature-controlled truck (25 °C). Transport took about 6 h. Fruit arrived in the laboratory within a day of cutting. In the laboratory the fruit that was severed at the mature harvest stage (here called 'harvested' fruit) was held at 25 °C until they had reached the ripe stage, i.e. until they were ready for consumption. The period in the laboratory is called the 'postharvest phase'.

### 2.2. Carotenoid analysis

For total pulp carotenoids assessment, pulp was extracted and concentrations were determined using a modification of the method described by de Carvalho et al. (2012). Fifteen g of the sample was homogenized with 25 mL of acetone to obtain a paste, which was transferred into a 500 mL separatory funnel containing 40 mL of petroleum ether. The acetone was removed through the slow addition of ultrapure water (Milli-Q – Millipore) to prevent emulsion formation. The aqueous phase was discarded. This procedure was repeated two times until no residual solvent remained. Then, the extract was transferred through a funnel to a 50 mL volumetric flask containing 15 g of anhydrous sodium sulfate. The volume was made up by petroleum ether, and the samples were read at 450 nm. The total carotenoid content was calculated using the following formula:

$$\text{Carotenoids content } (\mu g/g) = \frac{A \times V(\text{mL}) \times 10^4}{A_{1cm}^{1\%} \times P(\text{g})}$$

where $A$ = absorbance; $V$ = total extract volume; $P$ = sample weight; $A_{1cm}^{1\%} = 2592$ (β-carotene extinction coefficient in petroleum ether).

Carotenoids were separated by HPLC as described by Craft (2001). Five g of the ground sample was homogenized with 10% (w/w) magnesium carbonate and 25 mL of 50:50 methanol/tetrahydrofuran. Ten mictoliter of the sample was analyzed using a Waters 2998 Photodiode array detector, a Waters 600 Controller, and a Waters 717 plus Autosampler (Waters, Milford, MA), using a 250 mm × 4.6 mm column, 5 μm particle size (YMC, Kyoto, Japan) and methanol: methyl-*tert*-butyl ether: 1.0 M ammonium acetate, pH 4.4 (63:35:2). Flow rate was 1 mL $min^{-1}$ and the column temperature 30 °C. Concentrations were measured at 450 nm.


**Fig. 1.** Morphology of durian cvs. Chanee (left) and Monthong (right) fruit, and surface color of the aril (pulp) in ripe fruit. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)