

ภาคผนวก

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# Proceeding



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**Effect of Different Temperature on Carotenoid Content and Antioxidant Activity in 'Khak Dam' Papaya****Kanthee SIRIVEJABANDHU<sup>1</sup> and Lampan KHURNPOON<sup>1\*</sup>**<sup>1</sup>Department of Plant Production Technology, Faculty of Agricultural Technology, King Mongkut's Institutes of Technology Ladkrabang, Bangkok 10520 Thailand

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**ABSTRACT**

The effect of different temperatures (4, 12 and 25°C) on carotenoid content and antioxidant activity in whole fruits and fresh cut 'Khak Dam' papaya fruits were studied. At 6 days in storage of whole fruits at 4 and 12°C showed significant difference in L\*, a\* and b\* values in peel and pulp color from fruits stored at 25°C. Fruits stored at 4 and 12°C had lower in a\* value of the peel about -10.1 and -8.6, respectively, while it was about 3.3 when stored at 25°C. Low temperature storage could delay the reduction in fruit firmness, about 126.4, 98.9 and 66.1 N after being stored at 4, 12 and 25°C, respectively, but lower in percentage of weight loss and TSS/TA ratio. The percentage of free radical inhibition in fruit stored at 4, 12 and 25°C were about 62, 64 and 70%, respectively. Highest carotenoids content was found when fruit stored at 4°C about 3.4 µg/g FW. In fresh cut sample after being stored at 4 and 12°C showed significant difference in L\* and a\* values of the pulp but no difference in b\* value when compared to sample stored at 25°C. Fruits stored at 4 and 12°C could delay the change in a\* value of the pulp and preserved the fruit firmness better than fruit stored at 25°C. Significant difference between storage temperatures was found in percentage of weight loss but not in TSS/TA ratio. Low temperature storage could maintain the change in carotenoid content but lower in the percentage of free radical inhibition than stored at 25°C.

**Keywords:** Papaya, Weight loss, Free radical, Carotenoid, Antioxidant**Introduction**

Papaya (*Carica papaya* L.) fruit is rapidly becoming and important commodity worldwide, both as a fresh fruit and as processed products. Papaya is a very healthy fruit, and it is appreciated because of its attractive pulp color, flavor, succulence, and characteristic aroma (Rivera-Lopez *et al.*, 2005). Papaya fruit grow in tropical and sub-tropical regions and are marketed around the world. Several tropical fruits are rich in antioxidants such as polyphenols, vitamins and carotenoids (Rivera-Pastrana *et al.*, 2010). Like other climacteric fruits, papaya undergoes a series of biochemical changes after harvest. Although low temperature may extend storage life of tropical fruit, it also causes chilling injury, characterized by browning of the skin, greater firmness and off-flavours in the fruit (Mittra, 1997). Papaya is a good source of carotenoids; natural pigments responsible for the color of the fruit and related to biological functions or action in human such as provitamin A activity, carotenoids present in red-fleshed papayas are more efficient antioxidants and have been linked reduction of the risk of cancer (Ahmed *et al.*, 2012). Several carotenoids such as  $\beta$ -carotene, lycopene, lutein, and zeaxanthine are known to exhibit antioxidant activity, but  $\beta$ -carotene has been the most thoroughly studied. As a group, vitamin C, E, and  $\beta$ -carotene comprise the so-called antioxidant vitamins (Kaur and Kapoor, 2001). The objective of this study was to determine the effect of temperature on the amount of carotenoid content and antioxidant activity in 'Khak Dam' papaya.

### Material and Methods

'Khak Dam' papaya fruits were cleaned with water and air-dried. Samples were separated into two groups; whole fruit and fresh cut samples. Fruits were peeled then cut into the size of 2\*3 cm<sup>2</sup>, packed on foam tray and wrapped with PVC film. Both groups of samples were stored at 4, 12 and 25°C until senescence. Peel and pulp color change was measured by Color Flex spectrophotometer and reported as L\*, a\* and b\* values. The L\* value represented the lightness, a\* value represented the redness (+a) or greenness (-a) and b\* value represented the yellowness (+b) or blueness (-b). Pulp firmness was measured by using fruit firmness tester and reported as newton (N). Total soluble solids (TSS) content was measured from the fruit juice by using hand refractometer and report as %brix. Titratable acidity (TA) content was measured from the fruit juice titrated with a standard alkaline solution (0.1N NaOH) and report as %titratable acidity. The percentage of weight loss was obtained from the different between the initial weight and one at the end of storage. Extraction and analysis of carotenoid content were done by modified the method of Dere *et al.* (1998) and the percentage of free radical inhibition by modified the method of Torun *et al.* (2013).

### Result and Discussion

After 6 days in storage, whole fruits stored at 4 and 12°C showed significantly difference in L\*, a\* and b\* values in peel and pulp color from fruits stored at 25°C. Fruits stored at 4 and 12°C had lower in lightness (L\* value), redness (a\* value) and yellowness (b\* value) of the peel when compared with fruits stored at 25°C. This result confirmed by the report from Caron *et al.* (2013) that high temperature increase ripeness by increasing external color papayas. In the pulp color change, fruits stored at low temperature had higher in L\* value than fruits stored at 25°C but lower in a\* and b\* value than fruits stored at 25°C.

Fruits stored at 4 and 12°C had higher in fruit firmness than fruit stored at 25°C about 65 and 37N, respectively, on 6 days and preserved at 133.9 and 20.8N at the end of storage. Fruits stored at low temperature had lower in the percentage of weight loss than fruits stored at 25°C approximately 3 and 7%, respectively. Fruits stored at 4 and 12°C had the TSS/TA ratio lower than fruits stored at 25°C. The TSS/TA ratio was about 35.2, 39.1 and 49.9 at the end of storage when stored at 4, 12 and 25°C (Table 1).

Carotenoid content in fruits stored at 4, 12 and 25°C decreased during storage. Fruits stored at 25°C had rapidly decreased in carotenoid content from 3.4 to 1.8µg/g FW on days 3 then to about 1.5µg/g FW at the end of storage. Fruits stored at 4 and 12°C had lower carotenoid content at the beginning than those stored at 25°C. It was about 1.7 and 1.5µg/g FW on days 12 (Table 1). Rivera-Pastrana *et al.*, 2010, reported the effect of low temperature on carotenoid content was observed lower carotenoid levels in papaya fruit stored at 1°C could be a result of a delayed ripening or abnormal maturation as a symptom of chilling injury. Maximum levels of carotenoids were observed in fruit stored at 25°C, which correspond to the development of orange-red mature flesh color.

At 12 days after storage fruits stored at 4 and 12°C had the percentage of free radical inhibition about 61.5 and 68.6%, respectively (Table 1).

**Table 1** Changes in weight loss (%), firmness (N), TSS/TA ratio, carotenoid content ( $\mu\text{g/g}$  FW) and Free radical inhibition (%) in whole fruit 'Khak Dam' papaya stored at different temperature for 12 days.

Storage temperatures	Quality parameters				
	Percentage of weight loss	Pulp firmness	TSS/TA ratio	Carotenoid content	Percentage of free radical inhibition
4°C	10.0 $\pm$ 0.4 <sup>U</sup>	133.9 $\pm$ 10.6	35.2 $\pm$ 2.6	1.7 $\pm$ 0.2	61.5 $\pm$ 6.4
12°C	5.5 $\pm$ 0.6	20.8 $\pm$ 6.1	39.1 $\pm$ 6.2	1.5 $\pm$ 0.8	68.6 $\pm$ 2.3
25°C	8.8 $\pm$ 0.3	61.6 $\pm$ 7.8	49.9 $\pm$ 4.6	1.5 $\pm$ 0.6	70.8 $\pm$ 8.4

<sup>U</sup> Data shown are mean  $\pm$  standard deviation.

In fresh cut sample after stored at 4 and 12°C showed significantly difference in L\* and a\* values of the pulp but no difference in b\* value when compared to sample stored at 25°C. At 3 days after storage, fruits stored at 4 and 12°C had higher in L\* value than fruits stored at 25°C were about 64.3, 64.2 and 60.1, respectively. Fruits stored at 4 and 12°C could delay the change in a\* value of the pulp color but not difference in b\* value of the pulp among treatment (Table 2).

Fruits stored at 4, 12 and 25°C had significantly different in fruit firmness and then decrease during storage. During 3 days in storage, fruits stored at 25°C had decreased rapidly in fruit firmness. Fruits stored at 4 and 12°C had higher in fruit firmness than fruit stored at 25°C about 124 and 80N, respectively, on days 6 and preserved at 107.5 and 35.1N at the end of storage. Fruits stored at 4 and 12°C had lower percentage of weight loss than fruits stored at 25°C approximately 7 and 6%, respectively (Table 2). The firmness loss of fresh cut papaya 'Maradol' was observed as a result of higher storage temperature (Rivera-Lopez *et al.*, 2005). Fruits stored at 4 and 12°C had the TSS/TA ratio higher than fruits stored at 25°C. The TSS/TA ratio was about 49.7, 42.6 and 35.1 at the end of storage when stored at 4, 12 and 25°C (Table 2).

Carotenoid content in fruits stored at 4, 12 and 25°C decreased during storage. Fruits stored at 25°C had rapidly decreased in carotenoid content from 3.4 to 1.5 $\mu\text{g/g}$  FW on days 3 in storage. Fruits stored at 4 and 12°C had lower carotenoid content at the beginning than those stored at 25°C. It was about 1.8 and 1.4 $\mu\text{g/g}$  FW at the end of storage (Table 2). Falah *et al.*, 2015 reported carotenoid content of fresh-cut papaya was still increase during stored under different storage conditions, this indicate that the sample of the fresh-cut papaya still to be maturity and ripening processes.

At the end of storage fruit stored at 4, 12 and 25°C had percentage of free radical inhibition were about 64, 60 and 77%, respectively (Table 2). The storage temperature significantly affected the ORAC value of fresh-cut papaya fruit. Fresh-cut papaya changed slightly during storage at 5°C. However, significant reduction of ORAC values were found in fresh-cut papaya at 10°C and 20°C (Rivera-Lopez *et al.*, 2005).

**Table 2** Changes in pulp color, weight loss (%), firmness (N), TSS/TA ratio, carotenoid content ( $\mu\text{g/g}$  FW) and free radical inhibition (%) in fresh cut 'Khak Dam' papaya stored at different temperature for 12 days.

Storage temperatures	Quality parameters							
	Pulp color			Percentage of weight loss	Pulp firmness	TSS/TA ratio	Carotenoid content	Percentage of free radical inhibition
	L*	a*	b*					
4°C	64.4 $\pm$ 7.0 <sup>U</sup>	13.0 $\pm$ 7.1	30.5 $\pm$ 2.5	7.8 $\pm$ 2.9	107.5 $\pm$ 6.6	49.7 $\pm$ 8.0	1.8 $\pm$ 0.2	63.6 $\pm$ 8.4
12°C	65.1 $\pm$ 6.4	12.0 $\pm$ 7.2	30.4 $\pm$ 2.8	9.3 $\pm$ 8.5	35.1 $\pm$ 7.2	42.6 $\pm$ 6.0	1.4 $\pm$ 0.5	59.5 $\pm$ 6.9
25°C	60.1 $\pm$ 5.9	20.8 $\pm$ 4.0	31.0 $\pm$ 2.9	8.9 $\pm$ 4.6	4.3 $\pm$ 1.3	35.1 $\pm$ 3.5	1.5 $\pm$ 0.5	77.0 $\pm$ 6.1

<sup>U</sup> Data shown are mean  $\pm$  standard deviation.

### Conclusion

‘Khak Dam’ papaya fruits stored at 4 and 12°C showed lower significantly difference in L\*, a\* and b\* values in peel and pulp color change than fruits stored at 25°C. Fruits stored at 4 and 12°C could maintained pulp firmness, reduced percentage of weight loss, TSS/TA ratio and percentage of free radical inhibition but higher in carotenoid content than fruits stored at 25°C. In fresh cut sample after stored at 4 and 12°C showed significantly difference in L\* and a\* values in pulp color change but no difference in b\* value when compared to stored at 25°C. Fruits stored at 4 and 12°C had significantly lower pulp softening, percentage of weight loss and percentage of free radical inhibition than fruits stored at 25°C, but no difference in TSS/TA ratio among treatments. Fruits stored at 4, 12°C had carotenoid content higher than fruits stored at 25°C.

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สารต้านอนุมูลอิสระในมะละกอพันธุ์แขกดำ

(ภาษาอังกฤษ) Effect of different temperature on carotenoid content and antioxidant activity

in 'Khak Dam' papaya.

ชื่อ-สกุลหัวหน้าโครงการวิจัยผู้รับทุน/ผู้วิจัย (อ./ดร./ผศ./รศ./ศ.) ..... ผศ.ดร.ลำแพน ขวัญพูล

รายงานในช่วงตั้งแต่วันที่.....1 ตุลาคม 2557.....ถึงวันที่.....30 กันยายน 2558

ระยะเวลาดำเนินการ 1.....ปี.....เดือน ตั้งแต่วันที่.....1 ตุลาคม 2557.....ถึงวันที่.....30 กันยายน 2558

ข้อมูลการรายงานค่าใช้จ่ายงบประมาณโครงการวิจัย

1. การเบิกจ่ายงบประมาณ (กรณีการจ่ายเงินถ้าจ่ายงวดเดียวให้ลบข้อที่ไม่เกี่ยวข้องออก)

งวดที่ 1.....บาท.....% วันที่ได้รับอนุมัติให้เบิกจ่ายเงิน (ป/ด/ว).....

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หมวดค่าใช้จ่าย	งบประมาณรวมทั้งโครงการ	ค่าใช้จ่าย (บาท)	คงเหลือ (หรือเกิน)
งบบุคลากร: ค่าจ้างชั่วคราว	60,000	60,000	-
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ค่าตอบแทน	-	-	-
ค่าใช้สอย	11,000	11,000	-
ค่าวัสดุ	29,000	29,000	-
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รวม	100,000	100,000	-

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