The future Journal of Biology
2019;2:57-68

EFFECT OF MATURITY STAGES ON QUALITY AND SHELF LIFE OF "SOLO" PAPAYA FRUITS DURING STORAGE

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RESEARCH PAPER

Accepted: 12 April 2019 published online: 30 May 2019

ABSTRACT

"Solo" papaya fruits were harvested in October, 2016 & 2017 seasons from a commercial orchard located in Ismailia Governorate, Egypt. Papaya fruits were harvested at three maturity stages: 25% yellow (stage 1), 50% yellow (stage 2) and 100% yellow (stage 3) and evaluated during storage at ambient temperature (20°C ± 2) for 4 days + at 80- 85% RH or during cold storage at 6°C + 90- 95% RH for 20 days. Papaya fruits softened very rapidly at room temperature after harvest and had 4 days shelf life. However, the fruit can be stored for 20 days at 6°C with little changes in firmness and the fruit apparently progressed in normal ripening upon removal to ambient temperature (20°C) for 3 days. All colour values (a*, L* and C*) were linearly increased during cold storage. Conversely, as a result of colour change from green to orange-red, h° values decreased. Soluble solids content was not affected during ripening at 20°C and remained steady. Fruit harvested at stage 2 and stored at 6°C for 20 days following 3 days at 20°C had superior score for sensorial evaluation.

Key words: *Carica papaya L.; Postharvest; Maturity stages; Quality attributes.*

INTRODUCTION

In Egypt, as a result of increasing consumer's awareness, papaya trees (*Carica papaya* L.*)* are widely planted and fruits have been considered as a nutritional fruits for table fresh meals and for juice. The fruit has a lot of health and beauty benefits. Papaya contains proteolytic enzyme (papain) which extracted from immature fruits and some parts of the tree which is valuable for digestion and cosmetics industry. In addition, Papaya seeds are used for antibacterial properties, kidney protection and liver diseases. Papayas are an excellent source of vitamin C as well as a good source of vitamin E and vitamin A **(Bari *et al*., 2006)**. Also, it contains very powerful antioxidants. Besides, there are many uses of ripe papaya fruit such as fresh eating, juice, jam and ice cream.

Papaya fruit is a climacteric which produces ethylene and subsequently very perishable and having a short shelf life. It is highly susceptible to bruises, mechanical damage and postharvest disorder during handling. For all the pre-mentioned cases, the fruits substantially deteriorate during handling chain (storage, transportation, marketing and at households **(Manenoi *et al*., 2007)**.

Other than the decline in fruit firmness and/or in green colour, there are no obvious indicators of fruit maturity. But **Arpaia and Kader (2013)** stated that for the papaya fruit to attain a proper quality it should

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ISSN:2572-3006(Print)2572-3111(Online)
http://www.thefuturejournals.org

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be harvested with a minimum TSS. Fruits usually harvested when they have just begun ripening and have lost some of their firmness **(Peterson, 1991)**.

Papaya industry is, however, experiencing serious problems which holding it back and impacting negatively on the domestic market operation. Quality problems that are seen in the markets include morphology distortions, mechanical damage, imperfections (freckles), dehydration and taste deterioration. Many techniques need to be established to distinguish the most applicable ones to extending papaya storage life while keeping up high fruit quality. The main objectives of this research were to preserve fruit quality and to improve postharvest storage life through picking the fruits at different maturity stages and store them at proper cold storage.

MATERIALS AND METHODS

A lot of 300 "Solo" papaya fruits were harvested in October, 2016 & 2017 seasons from a commercial orchard located in Ismailia Governorate, Egypt.

The fruits were sound and uniform in size and shape free from mechanical injury and physiological & pathological wounds.

Fruits were grouped into three classes according to the maturity: stage 1 (25% yellow, green rind with well-characterized yellow stripes; near seed cavity pulp was orange in colour and light green near rind; albeit still hard; 100 fruit). Stage 2 (50% yellow rind with some blemished orange colour; pulp almost completely orange in colour except near rind was pale yellow and the pulp still hard; 100 fruit). Stage 3 (fully yellow rind with clearly orange in colour with some light green areas; pulp completely orange except near peduncle was light green and the pulp still hard and unacceptable for consumption; 100 fruit; Fig. 1; **Gonzalez-Aguilar *et al.*, 2010)**. The fruits were washed by water to remove latex and soaked in a 0.05% Thiabendazole solution for fungi control **(FAO, 2003).** After soaking, fruits were air dried.

Stage 1 Stage 2 Stage

Fig. 1: Maturity stages of "Solo" papaya fruits

Fruit weight (g), Pulp firmness (N), Soluble solids content (SSC %), Titratable acidity (%), Vitamin C (%), Total carotene (%) and rind colour values, a*, L*, C* and h° were determined at harvest (zero time) on ten papaya fruit for each stage of maturity (Tables 1 & 2).

From each stage of maturity, the fruits were divided into two unequal sub-groups, the first one (30 fruit) was held at ambient temperature 20°C ± 2 and 60- 65% RH for 5 days. The second group (70 fruit) was stored at 5°C ± 1 and 90- 95% RH for 20 days **(Báez-Sañudo *et al.*, 2017)**.

As for shelf life period twenty papaya fruit were weighed individually initially and after 5 days, and fruit weight loss was expressed as follow:

$$FWL\% = \frac{Wi-Ws}{Wi} x100$$

Where: *Wi* = initial fruit weight,
Ws = fruit weight at sampling date.

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On the same fruit, the rind colour was measured. Another ten papaya fruit were specified for destructive analysis at the end of shelf life period (5 days).

Evaluation of cold stored fruit quality [firmness, pulp colour, titratable acidity (TA), soluble solids content (SSC), vitamin C, total carotene content and antioxidant activity] was performed at four-day intervals on 10 fruit, while accumulation of weight loss, decay percentage and change on rind colour were evaluated on the rest of 20 fruit along the cold storage period.

Patches of skin were removed from 4 opposite sides around the equator of papaya fruit to measure flesh firmness (N) using the hand Magness Taylor pressure tester.

Colour was measured using a Minolta CR-200 Colorimeter which provided CIE L*, a*, and b* values. Negative a* value indicates green while positive a* value indicates red colour. Positive b* value indicates yellow rind colour while negative b* value indicate blue colour. These values were then used to calculate hue degree, where 0◦ = red-purple; 90◦ = yellow; 180◦ = bluish green; and 270◦ = blue [H=arctan (b*/a*)] **(McGuire, 1992; El-Shiekh, 2002; Basulto *et al.*, 2009)** and Chroma, which indicates the intensity or colour saturation (C= (a^{*2} + b^{*2}) 0.5). Rind colour was measured with six measures near the peduncle, the center and the apex on opposite sides of the fruit **(Basulto., *et al.*, 2009)**.

Four opposite peeled segments, from the rose to the stem, were squeezed and the obtained juice was used for determination of titratable acidity by using 0.1 NaOH in the presence of phenolphthalein until pH 8.0 and expressed as citric acid percent. Soluble solids contents were determined in the same juice using ATTAGO hand refractometer at 20˚C and expressed as a percent. Vitamin C was evaluated as mg Ascorbic acid / 100 ml same fruit juice by titration with 2,6 dichlorophenol – indophenol solution in the presence of oxalic acid solution **(A.O.A.C. 1998)**. Flesh total carotene content was determined using acetone extracts and the absorption was measured spectrophotometerically at 663, 644 and 440 *nm* to determine chlorophyll a, b and carotene, respectively (mg /100 g fresh weight; **Grodzinsky and Grodzinsky, 1973).**

As for antioxidant activity determination, the samples were analyzed using DPPH assay according to **Von-Gadow *et al*. (1997)** and **Maisuthisakul *et al.* (2007)** technique with some modifications. The stock solution was prepared by mixing 2.5 mg of DPPH radical with 100 mL of pure methanol. The solution was adjusted at an absorbance of (0.7±0.02) at 515 *nm*. Trolox (6-hydroxy-2, 5, 7, 8-tetramethylchromane-2-carboxylic, an antioxidant vitamin E derivative) was used as a standard and 80% methanol was used as a blank. A 3.9 mL of DPPH radical were placed in a test tube and 100 µL of the extract (2:8 dilution) were added. The mixture was shaken in a vortex and kept 30 min in the dark. The final solutions were estimated at 515 *nm* using a spectrophotometer (UNICO UV/Visible 2100, USA). Results were expressed in EC50 (concentration of antioxidant required to reduce the absorbance of the radical by 50 %); g FW $mL^{-}1$. Analyses were performed in triplicate per each treatment.

For sensorial evaluation, two pieces of papaya fruit pulp were placed in a plastic recipient and offered to 20 untrained panelists. Fruits were evaluated for flavour, odor, firmness and appearance on a five points scale (excellent, good, regular, bad and very bad; **Bron and Jacomino, 2006)**.

The experimental design was completely randomized blocks **(Snedecor and Cochran, 1980)**. The data analyzed using the Co-Stat program version 3 (Co.Hort. Software) and treatments means were statistically compared using the **Duncan's, 1955** (P ≤ 0.05).

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RESULTS AND DISCCUSION

There was a significant ($P \leq 0.05$) effect of maturity stage and storage temperature (ambient temperature, 20℃±2) on "Solo" papaya fruit weight loss and firmness.

The data presented in (Table 3) showed a significant difference in weight loss percentages (4.5 and 3.8; 6.8 and 6.6; 8.6 and 8.4 in stage 1, 2 and 3 for the two seasons, respectively) among the three maturity stages. Maturity stage 3 had a significantly higher effect on papaya fruit weight loss and firmness which cruelly declined followed by stage 2 and stage 1 in the two seasons. Weight loss is the outcome of fruit dehydration which leads to loss of quality **(Sagar and Kumar 2010)**.

Pulp softening is a standout amongst the most restricting variables for papaya postharvest life. The rate of firmness loss was affected by maturity stage at harvest and following ambient temperature storage. Possibly, in stages 1 and 2 the enzymes related to softening were still not completely synthesized and activated. In addition, the quantity of ethylene receptors is reduced in fruits harvested when still green and for this reason, the ethylene–dependent process can be delayed **(Trewavas, 1982).**

Significant ($p \leq 0.05$) differences were obtained in a* values among three stages of maturity followed by ambient temperature storage. Negative values of a* demonstrated that fruit were for the most part green. Additionally, positive values demonstrated the progressive difference in rind colour from green to red toward ripening (Table 3). As for luminosity (L*) of papaya fruit rind, it was significantly affected by stage of maturity followed by shelf life. The rind colour of S1 was the darkest in comparison with S2 and S3 principally impacted by the presence of green and orange-red colour, respectively (Table 3). For Chroma (C) values, which reflect the degree of saturation or intensity of colour, an increment in rind colour intensity was noticed and there was a significant difference among stages of maturity under ambient conditions.

The C* values were 40.6 and 41.3; 66.3 and 68.1; 77.2 and 76.9 for fruits of stage 1, 2 and 3 in the two seasons, respectively (Table 3). As expected, for rind colour, hue angle (h°) of fruit rind was significantly differed among maturity stages, it diminished with maturity development (mean values of 100.2 and 100.5; 88.5 and 89.3; 74.7 and 75.2 for fruits of stage 1, 2 and 3 in the two seasons, respectively). This indicated that there was a change in the fruit rind colour from green (values over 100°) to yellow (value below 80°). Mean of h° value esteemed for stage 1 and was lower than values revealed in 'BH65' papaya and other cultivars harvested for commercial handling (higher than 100; **Bron and Jacomino, 2006; Rancel *et al*., 2007)**; implying that harvested papaya in this work was done in more advanced maturity (more intense yellow in the rind) than fruit generally marketed (Table 3). The obtained results on fruit colour, came in agreement with the findings of **Sancho *et al.* (2010); Ruslan and Roslan (2016); Pinillos *et al.* (2018).**

Concerning the effect of maturity stages and subsequent ambient temperature on soluble solids content (SSC) of papaya fruit, it was clear from (Table 4) that SSC slightly and gradually increased during ripening process. The highest value of SSC content was 12.6 for S3 while the lowest value was 10.8 and 10.4 in both seasons, respectively, for S1. Independent of the maturity stages, soluble solids content did not vary during ripening process. According to **Zhou and Paull (2001)**, papaya sugar content remained constant during postharvest ripening suggesting that sugar accumulation in pulp is related to continued sugar translocation from plant to fruit. The data reported herein were in line with those found by **Schweiggert *et al*. (2011)** who reported the same gradual increase in SSC during ripening process of papaya fruits. In this work, the optimum stage to consume fresh "Solo"

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papaya fruit is during S3 with SSC content range from 12 to 12.5. The same results were stated for fruits SSC of different cultivars **(Yao *et al.*, 2014)** and the values with fully ripe “Solo” fruit were 10° to 11.2° Brix. On the other hand, **Schweiggert *et al.* (2011)** with Pococi cv., found that the range was 10.5° to 11.5° Brix while the range was 9° to 13° Brix for Bangladeshi cv. **(Zaman *et al.*, 2006).**

Fruits titratable acidity was reduced during ripening mainly in fruit harvested at maturity stages 2 and 3 (Table 4). **Lazan *et al.* (1989)** concluded that the titratable acidity increased with fruit ripening until approximately 75% of yellow rind and then decreased. **Wills and Widjanarko (1995)** observed that the titratable acidity reached the maximum values when fruits had already achieved a completely yellow rind. This pattern was comparable for “Golden” papayas at various ripe stages **(Bron and Jacomino, 2006).**

It is quite evident from (Table 4) that fruit of S3 had the highest vitamin C. These data are quite similar to those of **Pal *et al*. (1980)** and **Bron and Jacomino (2006).**

Conklin (2001) reported that in plants, Mannose and L-galactose are key substrates for ascorbic acid synthesis. In this manner, cell wall degradation during ripening process may give substrates for ascorbic acid synthesis, clarifying the ascorbic acid increment in "Solo" papaya after held at ambient temperature (20°C).

No significant ($p \leq 0.05$) effect was found of maturity stage on flesh total carotene content of “Solo” papaya fruit followed by 4 days at 20°C in both seasons (Table 4). However, the fruits had higher content of flesh total carotene than those at harvest. **Bari *et al.* (2006)** concluded that the major vitamins in papaya are carotene, riboflavin, thiamine and ascorbic acid. The highest percentage of carotene was detected at the more advanced stage of ripening.

In this study, the estimations of the Antioxidant capacity (EC50) showed a significant ($p \leq 0.05$) difference among the three stages of maturity. The S1 presented the highest antioxidant capacity (33.8 and 36.3) in both seasons, respectively. The lowest value of Antioxidant capacity (EC50) was noticed in S3, 63.2 and 65.3 in both seasons, respectively. These were in concurrence with those found by **Mahattanatawee *et al.* (2006)** who reported that in Red Lady papaya cv., antioxidant capacity (EC50) in green stage was higher than in ripe or yellow stage. The same findings were stated by **Gonzalez-Aguilar *et al.* (2010)** who observed that the greatest Antioxidant capacity in papaya fruit was for stage 1 of ripening, in both rind and flesh (593.77 and 160 μMET/100 g FW, respectively) while the lowest value was for stage 4 of ripening (547.88 and 116.02 μMET/100 g FW, respectively).

As presented in (Fig. 2) there was a gradual reduction in fruit firmness during cold storage period, but all maturity stages remained firm until the end of cold storage. Cold storage at 6°C had strong effect on delaying softening until the end of storage (12.8%, 16.5% and 22.1% firmness was noticed for stages 1, 2 and 3, respectively) compared with 54.6%, 58.9% and 61.7% for fruits held at ambient temperature (these percentages as average of two seasons).

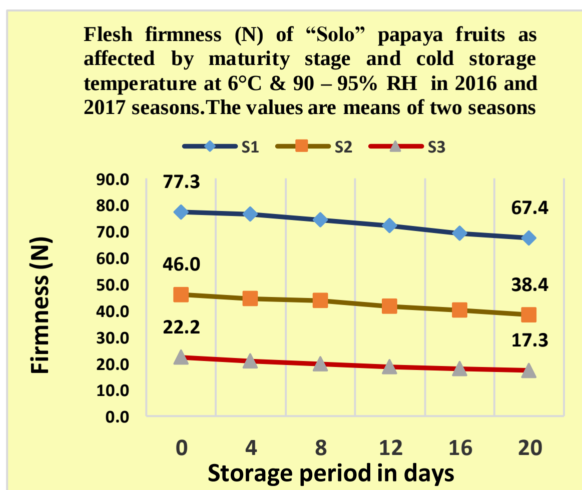

Fig. 2

As for the effect of maturity stage and cold storage on "Solo" papaya fruit rind colour, Figures 3, 4, 5 and 6, delineate the colour changes along the cold storage period for *a**, *L**, *C** and h° colour values. Colour values increased through the cold storage while *h*° value showed inverse pattern. Rind colour of papaya changes through chlorophyll degradation, lycopene synthesis and/or carotenoid development which later diverts rind colour from green to red **(Saad *et al*., 2014).** For a* colour value, a significant difference among the stages of maturity was noticed (Fig.3); the highest a* value obtained from S3 (9.8 and 10.0) while the lowest value (-8.8 and -8.5) for S1 at the end of cold storage in the two seasons, respectively. The negative values of a* means that the fruit of S1 remained green until the end of storage. The same trend was observed by **Zuhair *et al*. (2013)** and **Chutichudet and Chutichudet (2014)**. In Fig. 4, L* value increased gradually during storage and there was a significant difference among stages. The highest L* values for S3 were 79.8 and 80.0 while the lowest values for S1 were 48.4 and 49.5. The increase in L* value reflects the changing of colour from dark green to light green. A similar pattern was seen by **Ruslan and Roslan (2016).** As noticed in Fig. 5, the C* value increased significantly with the advances in maturity where S3 scored the highest value till the end of cold storage. High rind C* value for S3 was because of the exceptional yellowish orange rind colour of the papaya compared to S1. The h* value was the main variable demonstrating negative pattern throughout the cold storage. There was a significance difference among stages of maturity (Fig. 6). The reduction in h* value means that the rind colour moves in the negative side in the colour wheel; from green colour to yellow and finally to orange. These data were quite similar to those of **Pereira *et al.* (2009) and Fuggate *et al.* (2010).**

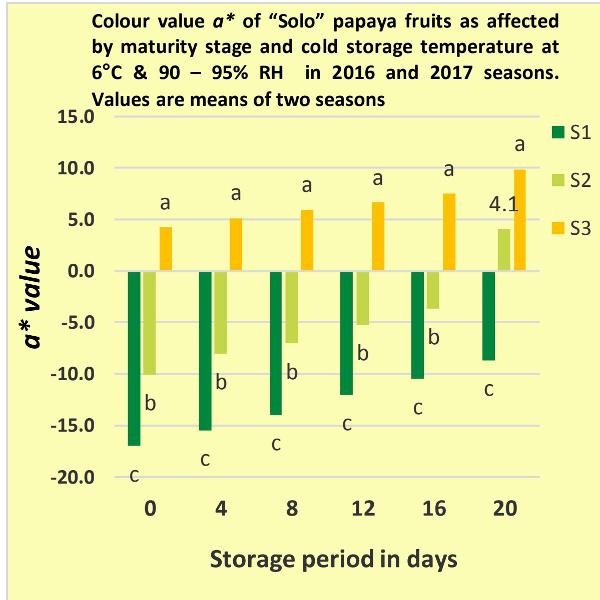

Fig. 3: Values followed by the same letter (s) are not significantly different at P ≤ 0.05 according to the Duncan's multiple range test.

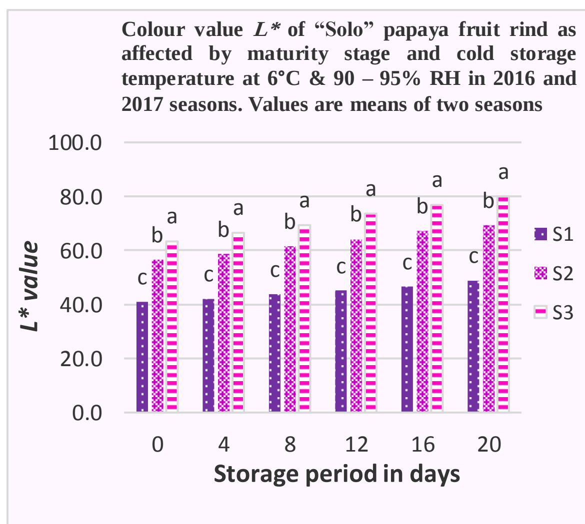

Fig. 4: Values followed by the same letter (s) are not significantly different at P ≤ 0.05 according to the Duncan's multiple range test.

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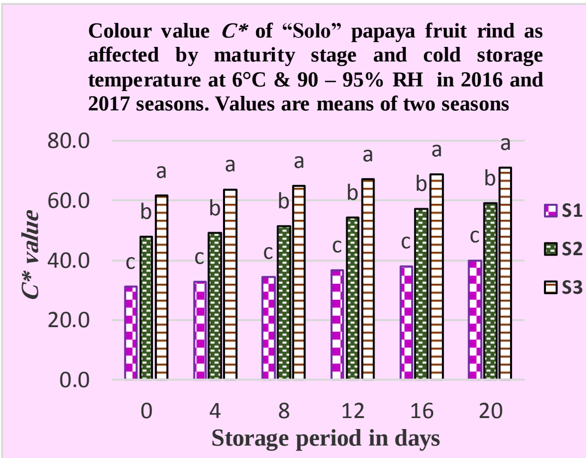

Fig. 5: Values followed by the same letter (s) are not significantly different at $P \leq 0.05$ according to the Duncan's multiple range test.

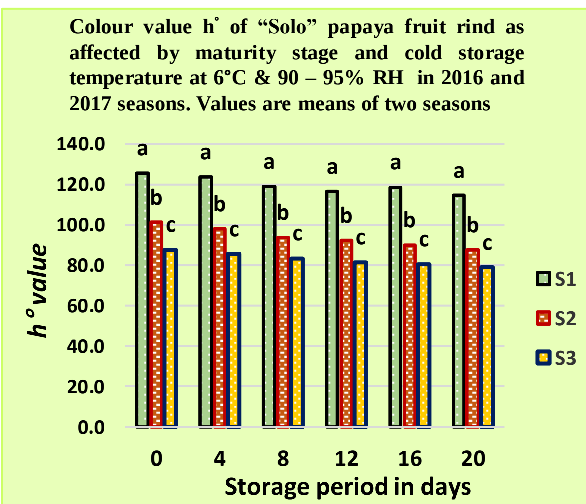

Fig. 6: Values followed by the same letter (s) are not significantly different at $P \leq 0.05$ according to the Duncan's multiple range test.

As shown in (Table 6), acidity of all stages of maturity was slightly increased with increasing storage period at 6°C till the first 12 days of cold storage. There was a slight difference (not significant) in titratable acidity between all stages of maturity during the rest of cold storage period.

There was an increment in percentages of Vitamin C% (ascorbic acid) along cold storage period independent of maturity stage. Fruits harvested at stage 3 had the highest significant ($p \leq 0.05$) concentration of ascorbic acid compared with fruits of the other stages (Table 7). These data were in consistent with those of **Pal *et al*. (1980) and Bron & Jacomino (2006).**

A slight increase was noticed in flesh total carotene content of papaya fruits during cold storage (Table 8). There was a significant ($p \leq 0.05$) difference among all stages of maturity in flesh total carotene content. As expected, the fruits of S3 always had the highest percentage of total carotene content till the end of storage period. In the same direction, **Bari *et al.* (2006)** found that the highest percentage of carotene was detected at the more advanced stage of maturity.

For sensory evaluation, the highest scores were attributed to fruit harvested at stages 2 and 3. Comparing the results obtained for sensory analysis (Fig. 7) with soluble solids percentages (Table 4), the panelists detected the differences found in soluble solids. Harvesting at early stage of maturity had no negative effect on fruit quality but the fruits were not acceptable for consumption.

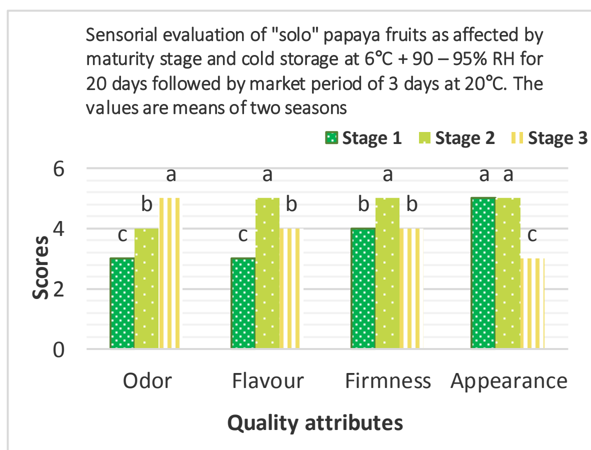

Fig.7: Scores: 1= very bad, 2= bad, 3= regular, 4= good and 5= excellent
Values followed by the same letter (s) are not significantly different at 5% level

ISSN:2572-3006(Print)2572-3111(Online)
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CONCLUSION

It is important to harvest papaya fruits at the proper maturity stage because the sugars content do not accumulate in the pulp after harvest. Non-destructive indices can be used to determine papaya harvest maturity, including the number of days from flowering, fruit size, and mesocarp colour. Destructive indices used for determining harvest maturity include internal flesh colour and soluble solids content. These indices are used to test randomly selected fruits in order to correlate fruit size with maturity. The internal mesocarp colour of mature papaya fruit changes from cream to yellow-orange as the external rind colour changes from green to yellow-orange during ripening. Soluble solids content of mature fruits should be at least 11.5%. Growers must use a combination of external and internal maturity indices to determine when to harvest. At the 50% yellow rind stage of papaya fruit the shelf life can be extended to 5 – 7. Cold storage is a likely solution for slowing the loss of firmness, keeping quality and extend marketing life.

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Table 1: Weight (g), firmness, SSC %, titratable acidity%, Vitamin C% and Total carotene of "Solo" papaya fruits at three maturity stages in 2016 and 2017 seasons

Attribute	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
	Season 2016			Season 2017		
Weight (g)	701.5	718.9	722.6	688.5	709.3	712.3
Flesh firmness (N)	77.5	46.5	22.8	77.0	55.5	21.6
SSC (%)	9.6	10.5	11.6	10.0	11.2	12.1
*Titratable acidity (%)	0.16	0.18	0.20	0.17	0.18	0.19
*Vitamin C (%)	83.5	92.9	102.8	81.3	91.3	99.8
* Total carotene (%)	1.20	1.45	1.93	1.15	1.44	2.00

*(mg/100 ml)

Table 2: Colour values (a*, L*, C* and h°) of "Solo" papaya fruit rind at three maturity stages in 2016 and 2017 seasons

Stages of maturity	Colour values			
	*a**	*L**	*C**	*h*°
		Season 2016		
1	-16.6 c	40.7 c	30.6 c	124.5 a
2	-9.8 b	55.6 b	46.7 b	100.9 b
3	4.7 a	62.5 a	61.2 a	87.3 c
		Season 2017		
1	-17.4 c	41.2 c	31.6 c	126.6 a
2	-10.4 b	57.3 b	48.9 b	101.6 b
3	3.8 a	64.4 a	62.0 a	88.2 c

Table 3: Weight loss %, Firmness (N) and colour values of "Solo" papaya fruits as affected by maturity stages and shelf life (5 days at 20 ±2°C) in 2016 and 2017 seasons

Stages of maturity	Weight loss (%)	Firmness (N)	Colour values			
			$^1a*$	$^2L*$	$^3C*$	$^4h°$
			Season 2016			
1	4.5 c	33.7 a	-9.6 c	54.7 c	40.6 c	100.2 a
2	6.8 b	19.2 b	-4.8 b	63.6 b	66.3 b	88.5 b
3	8.6 a	8.5 c	8.7 a	72.3 a	77.2 a	74.7 c
			Season 2017			
1	3.8 c	36.4 a	-9.8 c	51.4 c	41.3 c	100.5 a
2	6.6 b	18.6 b	-4.4 b	64.3 b	68.1 b	89.3 b
3	8.4 a	8.4 c	8.8 a	74.2 a	76.9 a	75.2 c

Values within each column with different letters are significantly different at P ≤ 0.05 according to the Duncan's multiple range test.
$^1a*$ (−) = green and (+) = red. $^2L*$ (brightness) 0 = black and 100 = white. $^3C*(a*^2 + b*^2)^{0.5}$ ^{4}*Hue angle h*° range (0 = Red, 90 = Yellow, 180 = Green-blue and 270° = Blue)

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Table 4: Soluble solids content SSC%, Titratable acidity, Vitamin C, Total carotene% and antioxidant activity of "Solo" papaya fruits as affected by maturity stages and shelf life (5 days at 20 ±2°C) in 2016 and 2017 season

Stages of maturity	SSC (%)	Acidity (%)	Vitamin C (mg/100 ml)	Total carotene (mg/100g f. w.)	EC50 values (mg mg−1 DPPH)
			Season 2016		
1	10.8 b	0.14 b	85.0 c	2.40 b	33.8 c
2	12.0 a	0.19 a	93.0 b	2.60 ab	43.3 b
3	12.6 a	0.19 a	108.0 a	2.70 a	63.2 a
			Season 2017		
1	10.4 b	0.14 b	86.0 c	2.37 a	36.3 c
2	11.8 ab	0.19 a	94.7 b	2.50 a	44.5 b
3	12.6 a	0.19 a	106.6 a	2.63 a	65.3 a

Values within each column with different letters are significantly different at P ≤ 0.05 according to the Duncan's multiple range test.

Table 5: Weight loss (%) of "Solo" papaya fruits as affected by maturity stage and cold storage at 6°C & 90 – 95% RH in 2016 and 2017 seasons

Stage of maturity	Storage period in days					
	0	4	8	12	16	20
			Season 2016			
1	0.00	1.00 c	1.6 c	2.5 c	3.6 c	5.9 c
2	0.00	1.40 b	2.4 b	4.8 b	5.6 b	7.8 b
3	0.00	1.80 a	2.8 a	5.5 a	7.2 a	9.3 a
			Season 2017			
1	0.00	1.1 c	1.4 c	2.3 c	3.3 c	5.5 c
2	0.00	1.5 b	2.6 b	4.6 b	5.4 b	7.6 b
3	0.00	2.0 a	3.1 a	5.8 a	6.8 a	9.0 a

Values within each column with different letters are significantly different at P ≤ 0.05 according to the Duncan's multiple range test.

Table 6: Titratable acidity (%) of "Solo" papaya fruits as affected by maturity stage and cold storage temperature at 6°C & 90 – 95% RH in 2016 and 2017 seasons

Stage of maturity	Storage period in days					
	0	4	8	12	16	20
			Season 2016			
1	0.16 b	0.18 b	0.17 a	0.20 a	0.18 a	0.18 a
2	0.16 ab	0.19 ab	0.18 a	0.19 a	0.18 a	0.18 a
3	0.20 a	0.19 a	0.17 a	0.19 a	0.19 a	0.19 a
			Season 2017			
1	0.17 b	0.18 a	0.18 a	0.18 a	0.18 a	0.18 a
2	0.18 ab	0.18 a	0.19 a	0.20 a	0.20 a	0.18 a
3	0.19 a	0.18 a	0.19 a	0.19 a	0.19 a	0.19 a

The values within each column with different letters are significantly different at P ≤ 0.05 according to the Duncan's multiple range test.

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Table 7: Vitamin C (%) of "Solo" papaya fruits as affected by maturity stage and cold storage temperature at 6°C & 90 – 95% RH in 2016 and 2017 seasons

Stage of maturity	Storage period in days					
	0	4	8	12	16	20
			Season 2016			
1	83.5 c	85.0 c	86.9 c	87.3 c	89.6 c	92.8 c
2	92.9 b	96.4 b	98.5 b	98.9 b	99.4 b	102.6 b
3	102.8 a	106 a	111 a	124 a	136 a	143 a
			Season 2017			
1	81.3 c	86.4 c	88.6 c	90.6 c	92.4 c	94.6 c
2	91.3 b	94.3 b	95.3 b	96.8 b	98.5 b	100 b
3	99.8 a	102 a	113.9 a	122.0 a	136 a	141 a

The values within each column with different letters are significantly different at $P \leq 0.05$ according to the Duncan's multiple range test.

Table 8: Total carotene content (mg / 100g fresh weight) of "Solo" papaya fruits as affected by maturity stage and cold storage temperature at 6°C & 90 – 95% RH in 2016 and 2017 seasons

Stages of maturity	Storage period in days					
	0	4	8	12	16	20
			Season 2016			
1	1.20 c	1.23 c	1.29 c	1.43 a	1.42 b	1.44 b
2	1.45 b	1.36 b	1.41 b	1.54 a	1.52 ab	1.56 b
3	1.93 a	1.55 a	1.60 a	1.63 a	1.70 a	1.78 a
			Season 2017			
1	1.15 c	1.22 c	1.35 c	1.42 a	1.48 b	1.47 b
2	1.44 b	1.40 b	1.50 b	1.55 a	1.60 ab	1.62 b
3	2.00 a	1.58 a	1.60 a	1.63 a	1.78 a	1.80 a

The values within each column with different letters are significantly different at $P \leq 0.05$ according to the Duncan's multiple range test.

ISSN:2572-3006(Print)2572-3111(Online)
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