



Postharvest management of papaya

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Abstract: Papaya (*Carica papaya* L.) is a delicious fruit widely cultivated in tropical and subtropical areas. India is first among papaya producing countries in the world producing around 5.2 million tons of papaya during 2012-2013. Papaya fruits are highly perishable in nature and postharvest losses of up to 75% have been reported to Hawaii shippers by mainland USA wholesalers and retailers. The present investigation was under taken at the Department of Processing Technology, College of Agriculture, Vellayani, during 2012-2014, with the objective to standardize postharvest practices for improved shelf life. The fruits harvested at ¼ maturity stage and were sanitized with hot water at 50° C for 20 minutes and warm sodium hypochlorite 150 ppm for 10 minutes. The fruits were sanitized and waxed and kept in corrugated fibre board boxes with ethylene absorbent potassium permanganate and kept under ambient temperature were studied. Fruits treated with hot water at 50° C for 20 minutes with waxing and with ethylene absorbent recorded highest shelf life of 11 days. Potassium permanganate reduces the autocatalytic process of ethylene during ripening and hence delayed the ripening process. In the present experiment all the treatments with waxing resulted in less mechanical damage suggests that waxing might have resulted in reducing the severity of bruises in the skin during transport.

Keywords: Papaya, Postharvest management, Surface sterilization, Waxing, Ethylene absorbent

Introduction

Papaya (*Carica papaya* L.) is a delicious fruit widely cultivated in tropical and subtropical areas. The cultivated papaya belongs to the family Caricaceae and is the most important economic species in Caricaceae (Paull and Duarte, 2011). Papaya with a world production of 12.6 million tons in 2012- 2013 is a major economic crop in tropical countries. India is first among papaya producing countries in the world producing around 5.2 million tons of papaya during 2012-2013 (NHB, 2014). The commercial varieties of papaya grown in India are Coorg Honeydew, Washington, Honey dew, Pusa delicious, Pusa nanha, Taiwan 786, Taiwan 785, Sunrise, Solo, CO-1, CO-7 and CO-3 respectively (Malabadi *et al.*, 2011). Papaya fruits are highly perishable and need to be handled with extreme care from the time they are harvested until they reach the consumer. The estimated post harvest losses of papaya fruits had been up to 75% have been reported to Hawaii shippers by mainland USA wholesalers and retailers. These losses are associated with mechanical injury, fruit ripening, chilling injury and postharvest diseases (Paull and Chen, 2014). The use of heat treatments in postharvest management is applied to many kinds of fruits to prevent fungal and insect eradication (Paull, 1994; Lurie, 1998). Heat treatments (hot water, hot air, vapour heat) may be used for disease control (such as anthracnose on mango and crown rot on banana) and for insect control to meet quarantine requirements for some commodities, such as mango and papaya (Kader, 2013).

Martins *et al.* (2010) reported that treatment of papaya fruit with hot water at 48-50° C for 20 minutes controlled the *Colletotrichum gleosporioides* and *Phoma caricae*. Kechinski *et al.* (2012) applied heat treatments with a hot water brushing system at temperatures of

45, 55 and 65° C in papaya fruits. No mould was observed under the wax film of fruits treated with hot water, ozonated water and wax, indicating that the combined treatment effectively disinfected the papaya fruits. Many studies have been conducted in order to understand the post-harvest factors that influence papaya quality. The high content of water, the softness of the fruit on ripening and the vulnerability of the fruit to many postharvest diseases altogether contribute to the substantial increase in postharvest losses. Thus an integrated approach controlling postharvest disease, mechanical damage and fruit ripening should be considered to extend the shelf life.

Materials and Methods

The present investigation was under taken, at the Department of Processing Technology, College of Agriculture, Vellayani, Kerala Agricultural University, Thrissur, during 2012-2014, with the objective to standardize postharvest practices for improved shelf life. Papaya variety Coorg Honeydew was used for the study. The fruits harvested at ¼ maturity stage and were sanitized with hot water at 50° C for 20 minutes and warm sodium hypochlorite 150 ppm for 10 minutes. The fruits were sanitized using sanitising agents and waxed and kept in corrugated fibre board boxes with ethylene absorbent and kept under ambient temperature were studied. The wax used was carnauba wax applied by hand with a sponge, and the papaya fruits were air-dried under the fan as previously described by Kechinski *et al.*, (2012). The ethylene absorbent used was KMnO₄ pallets taken in muslin cloth sachet of 1.5cm² at the rate of 8.0 g/ kg of fruit. These sachet were kept in corrugated fibre board packages containing papaya fruits.

Treatments: The fruits selected as the ¼ stage of harvest for local market was subjected to the following treatments.

T₁ - W_a + X₁ + E₁ (hot water @ 50° C for 20 minutes + waxing+ ethylene absorbent); T₂ - W_a + X₁ + E₂ (hot water @ 50° C for 20 minutes + waxing +without ethylene absorbent); T₃ - W_a + X₂ + E₁ (hot water @ 50° C for 20 minutes +without waxing+ ethylene absorbent); T₄ - W_a + X₂ + E₁ (hot water @ 50° C for 20 minutes +without waxing+ without ethylene absorbent); T₅ -W_b + X₁ + E₁ (warm sodium hypochlorite 150 ppm for 10 minutes + waxing+ ethylene absorbent); T₆ -W_b + X₁ + E₂ (warm sodium hypochlorite 150 ppm for 10 minutes+ waxing+ without ethylene absorbent); T₇ -W_b + X₂ + E₁ (warm sodium hypochlorite 150 ppm for 10 minutes+ without waxing+ ethylene absorbent); T₈ -W_b + X₂ + E₂ (warm sodium hypochlorite 150 ppm for 10 minutes+ without waxing+ without ethylene absorbent); T₉ - Control

Shelf Life: In each treatment, fruit at fully ripe stage was considered as the end of the shelf life in that particular treatment and expressed in days.

Percent leakage: The uniform sized fruit pieces were made into thin slices, immersed in 20 ml distilled water for three hours and absorbance was read in UV spectrophotometer at 273 nm. The immersed slices were heated in water bath at 100° C for 20 minutes, filtered, filtrate was made upto 20 ml and the absorbance was read in UV spectrophotometer at 273 nm. The loss of membrane integrity was expressed as per cent ion leakage. Percent leakage was calculated and expressed as percentage (Amith, 2012):

$$\text{Percent leakage} = \frac{\text{Initial absorbance of bathing medium}}{\text{Final absorbance of bathing medium}} \times \text{Dilution factor}$$

Mechanical damage: Skin injury was expressed as percent of fruit surface area affected. Severity of injury was estimated subjectively on a scale from zero to three (Quintana and Paull, 1993).

0-None; 1-Light green impact area; 2-Medium green 3-Dark green

Carotenoid: Carotenoids were estimated as per the procedure of Saini *et al.*, (2001) and expressed as mg/ 100. 0 g of treated fruit.

Total Soluble Solids (TSS): Total Soluble Solids (TSS) was recorded directly using Erma Hand refractometer (range 0 -32° brix) and expressed in degree Brix (°B).

Acidity: The titrable acidity was estimated as per the procedure described by Ranganna (1991) and expressed as per cent anhydrous citric acid.

pH: The pH was recorded using electronic pH meter (Saini *et al.*, 2001).

Statistical analysis: The observations were analyzed statistically in a Completely Randomized Design (CRD) and significance was tested using analysis of variance technique (Gomez and Gomez, 1984).

Results and Discussion

Shelf Life: The effect of pre storage treatments on shelf life of papaya var. Coorg Honeydew for local market is shown in Fig.1. Fruits treated with hot water 50° C for 20 minutes with waxing and with ethylene absorbent (T₁) recorded highest shelf life (11.00 days), which was on par with warm sodium hypochlorite 150 ppm for 10 minutes with waxing and ethylene absorbent (T₅) and warm sodium hypochlorite 150 ppm with waxing and without ethylene absorbent (T₆) treatments. (10.33 days). The control sample (T₉) had lowest shelf life (4.00 days). The treatments which was on par with warm sodium hypochlorite 150 ppm for 10 minutes without waxing and without ethylene absorbent, T₈ (5.67 days), was on par with hot

water treatment at 50° C for 20 minutes without wax and without ethylene absorbent (T₄) (6.67 days). The hot water treatment at 50° C for 20 minutes without waxing and with ethylene absorbent (T₃) (9.33 days) and hot water treatment at 50° C for 20 minutes with waxing and without ethylene absorbent, T₂ (9.67 days) and warm sodium hypochlorite 150 ppm for 10 minutes without waxing and with ethylene absorbent, T₇ (9.67 days) were on par. The best treatment (T₁) could produce variation in the shelf life from 4 to 11 days. This might be because of the delay in ripening process due to modified atmospheric condition brought about by waxing and ethylene absorbents and the less decay due to less microbial load in these treatments.

Potassium permanganate oxidises the ethylene produced by the fruit during ripening extends the pre-climacteric period and the postharvest life (Resende *et al.* 2001). The reduction in ethylene effected by addition of potassium permanganate subsequently forced to delay the ripening of many climacteric fruits was also reported by Wills and Warton (2004). Dikki *et al.* (2010) reported that postharvest treatment with 6.0 per cent wax coating and 250 ppm NAA resulted in extending the shelf life of papaya up to 15 days at room temperature as against the 7 days of shelf life of untreated fruits. Geetha and Thirumaran (2010) also observed one week and four week increase in shelf life in waxed vacuumed papaya fruits kept under room temperature and refrigeration process. The effect of KMnO₄ on the extension of postharvest life of 'Sunrise Golden' papaya stored under modified atmosphere and refrigeration was reported by Silva *et al.* (2009). The effectiveness of MgO and KMnO₄ in modified atmosphere package extended the postharvest life of papaya cv. Rathna (Jayathunge *et al.*, 2011).

Membrane Integrity: Fruits treated with hot water treatment at 50° C for 20 minutes with waxing and with ethylene absorbent (T₁) had least percent leakage (58.18 percent), which was on par with warm sodium hypochlorite 150 ppm for 10 minutes with waxing and with ethylene absorbent T₅ (59.05 percent). The control sample (T₉) had highest percent leakage (96.52 percent). These results suggest a strong association between membrane ion leakage and loss in weight.

These results suggest a strong association between membrane ion leakage and loss in weight. Walter *et al.*, (1990) found a relationship between increased water loss and increased membrane ion leakage. The loss of cell membrane integrity is known to cause ion leakage and unrestricted movement of fluids within cellular compartments a condition injurious to fruits (Maalekuu *et al.*, 2004). The high water loss rate also showed very high and positive correlation with membrane ion leakage (Parker and Maalekuu, 2013). The electrolyte leakage in the papaya fruit without KMnO₄ treatment was high and in treated fruit electrolyte leakage was low in present study. This is supported by the Silva *et al.*, (2009). The less loss in membrane integrity of treatment T₁ might be due to the intact membrane which resulted from the better treatments like hot water treatment coupled with waxing and ethylene absorbent application. The less loss in membrane integrity resulted in less physiological loss in weight also.

Carotenoids: Significant difference was noticed in carotenoid content between different treatments. Highest carotenoid content was exhibited by hot water treatment at 50° C for 20 minutes without

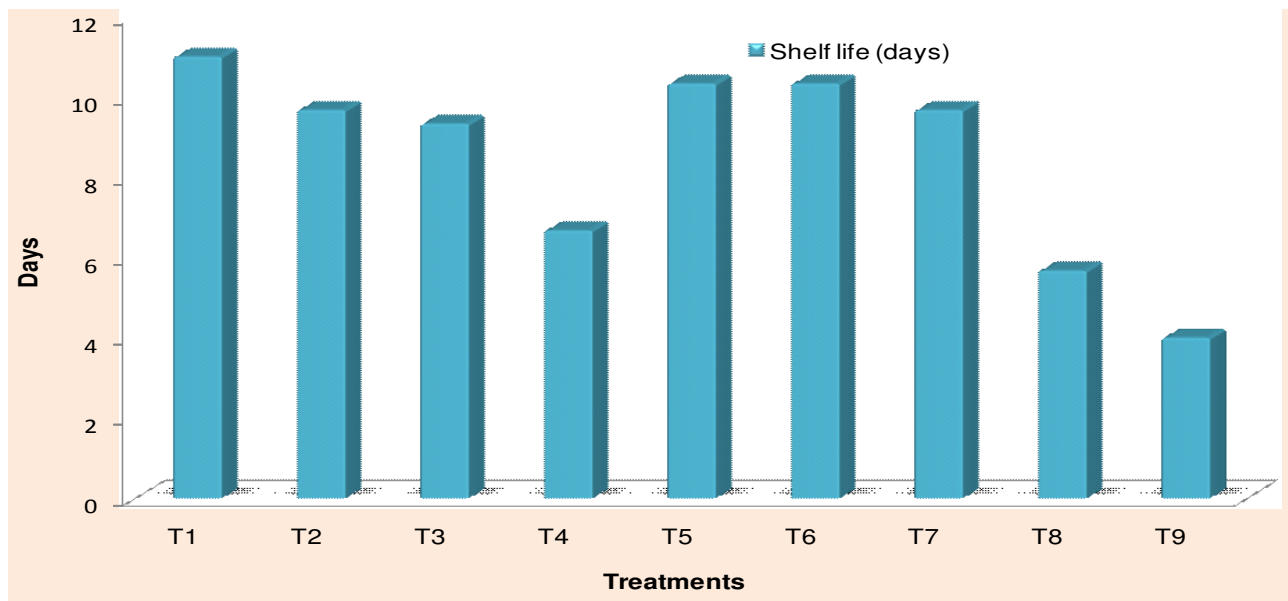


Fig. 1: Effect of pre storage treatments on shelf life of papaya var. Coorg Honeydew

Table-1: Effect of pre storage treatments on percent leakage, mechanical damage, carotenoids, TSS, acidity and pH of papaya var. Coorg Honeydew.

Treat-ments	Percent leakage	Mechanical damage	Carotenoids (mg/100g)	TSS ($^{\circ}$ Brix)	Acidity (%)	pH
T	58.18	0.33	2.68	12.66	0.15	5.56
T ¹	73.28	0.33	2.50	11.66	0.16	5.56
T ²	74.87	1.33	2.54	12.00	0.11	5.40
T ³	95.95	1.33	2.71	11.00	0.13	5.26
T ⁴	59.05	0.33	2.35	12.00	0.10	5.20
T ⁵	71.14	0.33	2.34	10.66	0.11	6.03
T ⁶	73.11	1.33	2.30	11.00	0.16	5.70
T ⁷	95.77	1.33	2.28	11.33	0.18	5.80
T ⁸	96.52	1.67	2.35	10.33	0.11	5.63
SE	2.519	0.333	0.101	0.415	0.031	0.142
CD(0.05)	7.485	0.990	0.302	1.2352	NS	0.4227

waxing and without ethylene absorbent, T₄ (2.71 mg/100g), which was on par with the hot water treatment at 50 $^{\circ}$ C for 20 minutes with waxing and with ethylene absorbent, T₁ (2.68 mg/100 g), hot water treatment at 50 $^{\circ}$ C for 20 minutes without waxing and with ethylene absorbent, T₃ (2.54 mg/100 g), hot water treatment at 50 $^{\circ}$ C for 20 minutes with waxing and without ethylene absorbent, T₂ (2.50 mg/100 g). Warm sodium hypochlorite, 150 ppm for 10 minutes without waxing and without ethylene absorbent (T₈) had recorded lowest carotenoid (2.28 mg/100 g), which was on par with the warm sodium hypochlorite, 150 ppm for 10 minutes without waxing and with ethylene absorbent, T₇ (2.30 mg/100 g), warm sodium hypochlorite, 150 ppm for 10 minutes with waxing with ethylene absorbent, T₆ (2.34 mg/100 g) and control sample, T₉ (2.35 mg/100 g).

The differences in carotenoid could be attributed to agricultural practices, sunlight exposure, production area, stage of ripeness, post harvest handling, and methodology used for analysis (Rosso and Mercadante, 2005; Paz *et al.*, 2008; Andersson *et al.*, 2009; Jeyakumar *et al.*, 2010; Sancho *et al.*, 2011). Leon *et al.* (2004) also observed that 1-MCP treatment inhibited ripening of a mountain papaya variety; thus the inhibition of ethylene production

could block normal fruit ripening including the synthesis of carotenoids (Gao *et al.*, 2007). The impairment of carotenoid accumulation in treated papaya fruit could be either by the consumption of their early precursors, such as geranylgeranyl diphosphate (GGDP), or by inhibiting phytoene synthase activity. In fact, a putative acetylCo-Acetyltransferase gene was down regulated after ethylene treatment and during ripening (Fabi *et al.*, 2010).

Total Soluble Solids (TSS): There was significant difference between treatments with regard to total soluble solids. Highest total soluble solids was recorded in fruits treated with the hot water treatment at 50 $^{\circ}$ C for 20 minutes with waxing and with ethylene absorbent, T₁ (12.66 $^{\circ}$ B), which was on par with the hot water treatment at 50 $^{\circ}$ C for 20 minutes without waxing and with ethylene absorbent, T₃ (12.00 $^{\circ}$ B), warm sodium hypochlorite 150 ppm for 10 minutes with waxing and with ethylene absorbent, T₅ (12.00 $^{\circ}$ B), the hot water treatment at 50 $^{\circ}$ C for 20 minutes with waxing and without ethylene absorbent, T₂ (11.66 $^{\circ}$ B). Lowest TSS was found in the control sample, T₉ (10.33 $^{\circ}$ B). TSS was found to be significantly highest in the waxed fruit; the result was in close confirmation with the finding of Dikki *et al.*, (2010).

Acidity: There was no significant difference between the treatments with respect to acidity. This shows that the treatments could not make any significant change in the acidity of the fruits.

pH: A significant difference in pH was noted between treatments. The highest pH was observed in warm sodium hypochlorite 150 ppm for 10 minutes with waxing and without ethylene absorbent, T₆ (6.03) which is on par with warm sodium hypochlorite 150 ppm for 10 minutes without waxing and without ethylene absorbent, T₈ (5.80), warm sodium hypochlorite 150 ppm for 10 minutes without waxing and with ethylene absorbent, T₇ (5.70). Lowest pH was recorded in warm sodium hypochlorite 150 ppm for 10 minutes with waxing and with ethylene absorbent, T₅ (5.20).

Shahid and Abbasi (2011) reported that in sweet orange cv. Blood Red treated with wax coating, change in pH during storage

period might be due to number of reasons; firstly, the alteration of biochemical condition of fruit due to treatments secondly, due to lower rate of respiration and metabolic activity. pH increase but at a slower rate particularly at the end of storage period, as there might be the saturation of atmosphere inside the pack with water vapours. **Mechanical Damage:** The fruits treated with hot water treatment at 50° C for 20 minutes with waxing and with ethylene absorbent (T₁), hot water treatment at 50° C for 20 minutes with waxing and without ethylene absorbent (T₂), warm sodium hypochlorite 150 ppm for 10 minutes with waxing and with ethylene absorbent (T₃) and warm sodium hypochlorite 150 ppm for 10 minutes with waxing and without ethylene absorbent (T₄) had less mechanical damage and control one had more mechanical damage.

Mechanical damage during harvesting, packaging and transport can result in a substantial reduction in quality. Ideally, such damage would be minimized through improved understanding of the mechanisms (Li and Thomas 2014). According to Quintana and Paull (1993) waxing reduced the severity of skin injury. New GMC (2004) reported that application of a surface wax on papaya fruit generally with carnauba or shellac based wax reduced shrinkage and gave the fruits a glossy appearance.

In India, huge postharvest losses have been reported especially in horticultural produce. Reducing post-harvest losses ensures sufficient food, both in quantity and in quality. Papaya var. Coorg Honeydew fruits treated with hot water 50° C for 20 minutes with waxing and with ethylene absorbent recorded highest shelf life of 11.00 days, by using ethylene absorbent (KMnO₄). In the present experiment all the treatments with waxing resulted in less mechanical damage suggests that waxing resulted in reducing the severity of bruises in the skin during the transport. Reduction of postharvest losses reduces cost of production, trade and distribution, lowers the price for the consumer and increases the farmer's income. It will further ensure higher level of income for the farmers and widen the market produce by taking them to remote areas of the country.

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