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Effect of pre-harvest treatments to enhance the post harvest quality and shelf Life of Papaya (*Carica papaya* L.) cv. Red Lady

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ABSTRACT

Papaya (*Carica papaya* L.) is one of the major fruit crops of India, which is the fifth most important fruit crop after banana in India. Red Lady is a high yielding dwarf variety of papaya, best suited and cultivated around Tamil Nadu. Although, Red Lady has gained much popularity in the domestic and export markets, there is always a difficulty in reaching the consumer hands with the good quality. So far, little attention has been paid to investigate the effect of pre-harvest chemicals on post-harvest quality of papaya. An experiment was conducted at a farmer's field, Ammampalayam, Attur taluk, Salem district during the year 2019-2020 in order to evaluate the effect of pre-harvest treatments to enhance the post-harvest quality and Shelf life of papaya fruits. Papaya plants were sprayed with NAA @ 100 ppm, Potassium chloride @ 1.5%, Potassium nitrate @ 1.5% (as source of potassium), Calcium chloride @ 1.5%, Calcium nitrate @ 1.5% and Calcium sulphate @ 1.5% (as source of calcium) and the combination of NAA @ 100 ppm with potassium and calcium sources at 1.5% were sprayed at 21 days after flower anthesis onto the fruits. Control was sprayed with plain water. Spray applications were repeated every two weeks for six times. Results revealed that the quality parameters of fruits, *viz*., fruit firmness (kg cm^{-2}), physiological loss (%), spoilage loss (%), percentage of marketable fruits (%) and Shelf life (Days) of the papaya were increased considerably with $CaCl_2$ @ 1.5%. Therefore, spraying with 1.5% calcium chloride to the fruits is suitable for better post-harvest quality.

Key words: *Papaya, Red lady, Pre-harvest treatment*

Introduction

Papaya is one of the major fruit crops of India, which is the fifth most important fruit crop of India. It was introduced to India in 16th century from Malacca (Kumar and Abraham, 1943). Papaya is scientifically known as *Carica papaya* L. belongs to the family Caricaceae, genus Carica and among 48 known species in Caricaceae family, *Carica papaya* L. is the only species of edible fruits (Chadha, 1992). It is native to tropical America but believed to have originated in Southern Mexico and neighbouring Central America. Papaya is an herbaceous perennial in the family Caricaceae. It is commonly referred to as a "tree", the plant is properly a large herb, sparsely branched tree with single hallow stem and palmately lobed, spirally arranged leaves confined to the top of the trunk. The flowers are mostly dioecious and gynodioecious and in some varieties hermaphrodite types are also recognized. Pre-harvest treatments have most important factor to increase the quality of the fruits and suitable treatments based on the crop before harvest will definitely increase the quality of fruits. Pre-harvest application of plant growth regulators, different mineral elements and fungicides controls the postharvest quality of the fruits (Zoffoli *et al*., 2009; Domínguez *et al*., 2012; Zhu *et al*., 2016). Although some of the similar effects may be generally noticeable for the pre-harvest sprays, some variability may exist across different fruit species or among different cultivars of the same species and hence, it is essential to confirm the suitability and to enhance the possible application protocols on fruit-by-fruit basis (Lara, 2013).

Materials and Methods

Research investigations were conducted at a farmer's field in Ammampalayam, Attur Taluk, Salem district, during 2022–2023. In this experiment, a randomized block design (RBD) was employed to assess the impact of different treatments on the growth and yield of the Red Lady papaya variety. The RBD consisted of 12 treatments replicated three times, with a total of 360 plants selected for the experiment. Spacing between plants was maintained at 2 × 2 meters to provide ample room for growth and development. The study involved preparing the desired concentrations of pre-harvest sprays, which were then applied 21 days after flower anthesis. Spraying was carried out every 2 weeks for a total of 6 times, with the final spray applied 4 days before fruit harvesting.

Results and Discussion

Significant differences were observed in fruit firmness and physiological loss (Table 1) in the weight of papaya fruits due to various pre-harvest treatments. Fruits treated with T_5 ($CaCl_2$ @ 1.5%) maintained the highest firmness levels, measuring 8.43 kg cm^{-2}, 6.37 kg cm^{-2} and 5.68 kg cm^{-2} on the 3^{rd}, 6^{th} and 9^{th} days of storage, respectively. followed by T_2 (NAA @ 100 ppm) showed firmness values of 8.21 kg cm^{-2}, 6.11 kg cm^{-2} and 5.36 kg cm^{-2} on the same respective days. In contrast, untreated fruits (T_1) exhibited the lowest firmness maintenance, with values of 6.5 kg cm^{-2}, 5.92 kg cm^{-2} and 3.36 kg cm^{-2} on the 3^{rd}, 6^{th} and 9^{th} days of storage. The firmness of the fruits decreased significantly during storage, from 7.27 kg/cm2 on the 3^{rd} day to 4.00 kg/cm2 on the 12^{th} day.

Pre-harvest calcium sprays improved cell-to-cell adhesion, as indicated by the higher contents of ionically bound pectins in treated fruit, leading to a higher fruit firmness level at commercial harvest (Ortiz *et al*., 2011).

Notably, T_5 ($CaCl_2$ @ 1.5%) exhibited the lowest percentage of physiological loss in weight throughout the storage period, with values of 3.56%, 6.34% and 8.46% on the 3^{rd}, 6^{th} and 9^{th} days, respectively. followed by T_2 (NAA @ 100 ppm) showed percentages of 3.73%, 6.55% and 8.72% on the same respective days. In contrast, untreated fruits (T_1) experienced the highest physiological loss in weight, with values of 5.45%, 8.62% and 11.37% on the 3^{rd}, 6^{th} and 9^{th} days of storage. Furthermore, there were significant variations observed in the physiological loss in weight among different storage durations, with the percentage increasing from 4.46% on the 3^{rd} day to 9.79% on the 9^{th} day.

The decrease in weight loss observed with calcium application can be attributed to its role in maintaining fruit firmness, slowing down respiratory rate and delaying senescence. Calcium treatments affect enzymes like peroxidase and catalase, delaying cell breakdown and preserving firmness, thus reducing weight loss during storage. These observations are in close agreement with the findings of Ramakrishna *et al*. (2001) in papaya, Yadav *et al*. (2009) in ber, Kirmani *et al*. (2013) in plum and Pradeep Kumar *et al*. (2017) in mango, respectively.

The data from Table 2 demonstrates notable differences in spoilage loss (%) and percentage of marketable fruits among the various pre-harvest treatments. Specifically, T_5 (CaCl2 @ 1.5%) exhibited the lowest levels of spoilage, recording 0%, 12.80% and 22.62% on the 3^{rd}, 6^{th} and 9^{th} days of storage, respectively. Similarly, T_2 (NAA @ 100 ppm) showed relatively low spoilage percentages of 0%, 14.90% and 26.02% on the same days. In contrast, the control group (T_1) experienced the highest spoilage percentages, reaching 0%, 36.84% and 62.35% on the 3^{rd}, 6^{th} and 9^{th} days, respectively. Spoilage rates increased steadily from the 3^{rd} day (0%) to the 9^{th} day (40.58%), underscoring the importance of effective pre-harvest treatments in preserving product quality during storage.

Calcium-treated fruits showed a significantly lesser extent of spoilage loss, which might be due to the higher fruit flesh and calcium content in the peel, which resulted in stronger intracellular organization and a rigidified cell wall. The present investigation is in conformity with the findings of Tsomu and Patel (2014) in sapota, Lal *et al.* (2011) in apricot and Pradeep Kumar *et al*. (2017) in mango.

Notably, T_5 (CaCl2 @ 1.5%) displayed the highest percentage of marketable fruits, with values of 100%, 87.20% and 77.38% on the 3rd, 6th and 9th days of storage, respectively. Following closely, T_2 (NAA @ 100 ppm) showed relatively high percentages of marketable fruits, recording 100%, 85.10% and 73.98% on the corresponding days. Conversely, the control group (T_1) exhibited the lowest percentage of marketable fruits, with values of 100%, 63.16% and 37.65% on the 3rd, 6th and 9th days of storage, respectively. Furthermore, significant variations were observed in the percentage of marketable fruits across the storage period. The percentage decreased progressively from the 3rd day (100%) to the 9th day (59.41%), indicating a decline in fruit quality over time.

Calcium decreases the spoilage of fruit by reducing the process of respiration, whereas calcium plays a number of roles, such as increasing fruit firmness, which leads to benefits like slower ripening and also increases the shelf life.

These findings are in accordance with the results obtained by Singh *et al*. (2012), Karemera and Habimana (2014), Bhusan *et al*. (2015) and Pradeep Kumar *et al*. (2017) in mango.

Table 1. Effect of pre-harvest treatments on firmness (kg cm^{-2}) and physiological loss in weight (%) of papaya fruits cv. Red Lady

Treatments	Firmness (kg cm^{-2})			Physiological loss in weight (%)		
	3rd day	6th day	9th day	3rd day	6th day	9th day
T_1 – Control	5.92	3.36	1.92	5.45	8.62	11.37
T_2 - NAA @ 100 ppm	8.21	6.11	5.36	3.73	6.55	8.72
T_3 - KCl @ 1.5%	6.76	4.42	3.29	4.90	7.96	10.37
T_4 - KNO_3 @ 1.5%	7.47	5.25	4.31	4.32	7.26	9.55
T_5 - $CaCl_2$ @ 1.5%	8.43	6.37	5.68	3.56	6.34	8.46
T_6 - $CaNO_3$ @ 1.5 %	7.70	5.52	4.64	4.13	7.03	9.29
T_7 - $CaSO_4$ @ 1.5 %	7.00	4.70	3.64	4.70	7.72	10.09
T_8 - (T_2 + T_3)	6.27	3.85	2.59	5.23	8.37	10.96
T_9 - (T_2 + T_4)	7.24	4.98	3.98	4.51	7.49	9.82
T_{10} - (T_2 + T_5)	7.98	5.84	5.03	3.90	6.76	8.98
T_{11} - (T_2 + T_6)	7.75	5.57	4.69	4.08	6.98	9.23
T_{12} - (T_2 + T_7)	6.52	4.14	2.94	5.06	8.17	10.66
Mean	7.27	5.00	4.00	4.46	7.43	9.79
S.Ed	0.104	0.125	0.156	0.078	0.135	0.176
C.D (p=0.05)	0.20	0.25	0.31	0.15	0.27	0.35

Table 2. Effect of pre-harvest treatments on spoilage loss (%) and percentage of marketable fruits of papaya fruits cv. Red Lady

Treatments	Spoilage loss (%)			Percentage of marketable fruits (%)			Shelf life
	3rd day	6thday	9th day	3rd day	6thday	9th day	(Days)
T_1 – Control	0	36.84	62.35	100	63.16	37.65	9.18
T_2 - NAA @ 100 ppm	0	14.90	26.02	100	85.10	73.98	14.43
T_3 - KCl @ 1.5%	0	28.62	48.57	100	71.38	51.43	10.93
T_4 - KNO_3 @ 1.5%	0	21.56	36.87	100	78.44	63.13	12.67
T_5 - $CaCl_2$ @ 1.5%	0	12.80	22.62	100	87.20	77.38	14.96
T_6 - $CaNO_3$ @ 1.5 %	0	19.31	33.17	100	80.69	66.83	13.26
T_7 - $CaSO_4$ @ 1.5 %	0	26.22	44.57	100	73.78	55.43	11.43
T_8 - (T_2 + T_3)	0	33.59	56.87	100	66.41	43.13	9.92
T_9 - (T_2 + T_4)	0	23.86	40.67	100	76.14	59.33	12.06
T_{10} - (T_2 + T_5)	0	17.06	29.52	100	82.94	70.48	13.88
T_{11} - (T_2 + T_6)	0	19.26	33.12	100	80.74	66.88	13.31
T_{12} - (T_2 + T_7)	0	31.09	52.67	100	68.91	47.33	10.41
Mean	0	23.75	40.58	100	76.24	59.41	12.20
S.Ed	0	1.001	1.655	1.745	1.001	1.655	0.240
C.D (p=0.05)	0	2.00	3.31	3.61	2.00	3.31	0.48

The influence of pre-harvest treatments on the shelf life of papaya fruits is depicted in Table 2. Specifically, T_5 ($CaCl_2$ @ 1.5%) was remarkably effective, boasting the longest shelf life of 14.96 days, followed by T_2 (NAA @ 100 ppm) with 14.43 days. In contrast, untreated fruits (T_1) exhibited the shortest shelf life, lasting only 9.18 days.

Calcium treatment significantly reduces the rate of the ripening process as a result of enhanced endogenous levels of auxin and cytokinin. Fruit treated with $CaCl_2$ solution retained cell wall integrity as a consequence of an influx of calcium that could have helped thicken calcium pectate in the cell wall and thus assisted in the prolonged shelf life. The present investigation is in conformity with the results reported by Mahajan and Sharma (2000) on peaches, El-Badawy (2012), Kirmani *et al*. (2013) on plums and Karemera and Habimana (2014) on mango.

Conclusion

These findings underscore the effectiveness of pre-harvest treatments, particularly T_5 ($CaCl_2$ @ 1.5%), in mitigating physiological weight loss and enhancing the storage stability of papaya fruits.

Conflict of Interest: None

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