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Effect of calcium and gibberellic acid on post-harvest behaviour of papaya cv. Co2

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ABSTRACT

A study was conducted in order to examine the efficacy four levels each of $CaCl_2$, $Ca(NO_3)_2$ (1%, 2%, 3% and 4% each) and GA_3 (50, 100, 150, and 200 ppm) on the post-harvest behaviour of papaya fruits. Uniformed size fruits were harvested at the physiological maturity and treated in various treatments for 5 min. at room temperature. The post-harvest treatment of papaya fruits in GA_3 @ 100 ppm and $CaCl_2$ @ 2% recorded significantly the lowest level of loss in fruit weight, ripening percentage and rate of decay and have registered high firmness, high TSS, high ascorbic acid content, titrable acidity and also higher score for sensory evaluation. The study suggests that both GA_3 @ 100 ppm and $CaCl_2$ at 2% as post-harvest dip could preserve the physiological changes and improve the shelf-life upto to nine days and the quality in papaya.

Key words: Papaya, post-harvest treatment, calcium, gibberellic acid.

INTRODUCTION

Papaya is one of the most important tropical fruit primarily cultivated in India. The fruits are very rich source of Vit. A and Vit. C. Despite the fact that the fruits are nutritionally rich, this crop could not be exploited at the large scale due to high perishability and poor post-harvest storage facilities. The shelf-life of papaya fruits is relatively shorter than other tropical fruits as a direct consequences of weak cell wall integrity. It was reported that the calcium chloride treatment of fruits protect them against post-harvest deterioration by binding with hydrolysis such as galacturonase and promote shelf-life. Further calcium has been shown to inhibit ethylene production and thus delay ripening (Al-Ani and Richardson, 2). It was observed that the fruits that are rich in calcium are more resistant to mechanical injury and post-harvest losses. The calcium treatment is known to prevent post-harvest losses in *ber* and pear (Siddiqui and Gupta, 13). In addition to this, there are few growth regulators believed to promote shelf-life of papaya fruits. Mehta *et al.* (10) suggested that GA_3 @ 100 ppm significantly suppress the succinate activities of malate-dehydrogenase during post-harvest ripening of papaya and thus retard ripening. Singh and Singh (14) observed minimum physiological loss in weight for mango fruits treated with GA_3 @ 50 ppm under ambient conditions. Therefore, an experiment was conducted to find out the effect of $CaCl_2$, $Ca(NO_3)_2$ and gibberellic acid on the storage behaviour of papaya.

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MATERIALS AND METHODS

The uniform sized, firm and good looking papaya cv. CO_2 which were harvested at proper physiological maturity from healthy plants from a commercial orchard, Periyakulam and were used for this study. The fruits were washed, graded by the density gradation method to select fruits having uniform maturity and only water sinkers were used for storage studies. The fruits were treated in different compounds, which consist four levels of each $CaCl_2$, $Ca(NO_3)_2$ (1, 2, 3 and 4 %) and GA_3 (50, 100, 150 and 200 ppm) along with a control. The total number of treatments were thirteen replicated five times in completely randomized block design (CRBD). The harvested papaya fruits were soaked in various treatment solutions for 5 min and kept for observations under ambient conditions. Each treatment had fifteen fruits and sampled periodically on 1, 3, 6 and 9 days after the treatment. The fruits were assessed for physiological loss in weight, firmness, rate of ripening, rate of decay, TSS, acidity, ascorbic acid and sensory evaluation on appearance. The fruit firmness was worked out by the method of Srivastava *et al.* (15). The total soluble solids of fruits were measured with the help of hand refractrometer. Titrable acidity and ascorbic acid were determined as per the AOAC (1). The appearance, taste, flavour and texture of each sample were evaluated organoleptically by a panel of five judges using nine point hedonic scale (Amerine *et al.*, 3).

RESULTS AND DISCUSSION

The fruit weight loss during the storage was significant regardless of soaking treatment in nutrient solutions and growth regulator (Table 1). The decline

Table 1. Effect of calcium and gibberellic acid dip on changes in fruit weight, PLW, fruit firmness and percentage of ripening in papaya during storage.

Treatment	Days after storage														
	Fruit weight				Physiological loss in weight (%)				Firmness of fruit (kg/ cm)				Percentage of ripening		
	1st	3rd	6th	9th	1st	3rd	6th	9th	1st	3rd	6th	9th	3rd	6th	9th
$CaCl_2$ 1%	1.46	1.40	1.31	1.20	4.30	6.70	8.52	17.77	8.20	4.00	2.00	1.40	20.50	64.50	94.50
$CaCl_2$ 2%	1.53	1.46	1.40	1.31	4.64	3.71	6.77	14.39	8.30	4.80	2.90	2.30	10.17	50.17	79.30
$CaCl_2$ 3%	1.37	1.22	1.11	1.03	11.42	8.62	7.10	24.81	7.90	3.83	2.10	1.60	24.30	64.50	94.30
$CaCl_2$ 4%	1.42	1.36	1.20	1.10	4.55	11.53	8.80	23.00	8.40	4.57	2.30	1.90	22.50	65.17	95.00
$Ca(NO_3)_2$ 1%	1.37	1.28	1.11	1.00	6.35	13.32	9.89	26.86	8.40	4.46	2.20	1.63	21.50	62.17	94.20
$Ca(NO_3)_2$ 2%	1.57	1.51	1.46	1.34	4.01	3.24	7.95	14.41	8.00	4.87	2.87	2.40	10.50	50.17	82.20
$Ca(NO_3)_2$ 3%	1.48	1.39	1.21	1.12	6.22	13.04	7.29	24.41	8.43	4.56	2.40	1.83	23.50	64.17	94.30
$Ca(NO_3)_2$ 4%	1.27	1.21	1.11	0.98	5.25	8.44	11.48	23.20	8.13	4.27	2.03	1.50	25.17	67.67	98.20
GA_3 50 ppm	1.43	1.35	1.27	1.16	5.25	5.99	8.42	13.44	8.03	3.96	1.93	1.33	25.50	64.50	98.20
GA_3 100 ppm	1.47	1.40	1.34	1.27	4.62	4.21	5.35	13.52	8.07	4.97	3.00	2.50	5.50	47.17	77.20
GA_3 150 ppm	1.62	1.55	1.47	1.35	4.38	5.29	7.70	16.42	8.23	4.56	2.50	1.90	22.33	60.17	77.20
GA_3 200 ppm	1.45	1.39	1.30	1.21	4.41	5.91	7.43	16.74	8.30	4.37	2.13	1.50	21.50	63.17	95.20
Control	1.33	1.25	1.11	0.97	5.57	11.64	12.45	26.95	8.30	4.26	1.27	0.70	40.50	100.00	-
CD (P = 0.05)	0.08	0.08	0.08	0.08	1.12	2.06	1.11	2.84	0.18	0.13	0.16	0.15	1.15	0.98	2.50

Table 2. Effect of calcium and gibberellic acid on healthy and decay per cent of fruits, TSS, titrable acidity and ascorbic acid of papaya during storage.

Treatment	Healthy fruits at 9th day (%)	Decayed fruits at 9th day (%)	Days after storage											
			TSS (°Brix)				Titrable acidity (%)				Ascorbic acid (mg/g 100 g)			
			1st	3rd	6th	9th	1st	3rd	6th	9th	1st	3rd	6th	9th
$CaCl_2$ 1%	81.0	19.0	6.83	8.40	11.40	9.60	0.12	0.11	0.09	0.06	21.76	28.72	35.72	41.67
$CaCl_2$ 2%	90.0	10.0	7.10	8.80	10.80	11.80	0.13	0.12	0.11	0.07	22.56	26.54	38.44	38.51
$CaCl_2$ 3%	72.0	28.0	6.90	8.60	12.10	9.60	0.13	0.13	0.12	0.06	22.39	28.15	33.27	41.53
$CaCl_2$ 4%	71.0	29.0	7.00	9.00	11.10	9.40	0.12	0.12	0.11	0.06	20.56	27.34	32.46	42.91
$Ca(NO_3)_2$ 1%	75.0	25.0	6.90	8.50	11.30	9.60	0.13	0.11	0.10	0.06	20.93	26.02	31.09	41.08
$Ca(NO_3)_2$ 2%	88.0	12.0	7.00	8.50	11.80	11.00	0.13	0.12	0.10	0.07	21.33	28.20	34.33	40.21
$Ca(NO_3)_2$ 3%	75.0	25.0	7.00	8.90	11.90	9.70	0.13	0.12	0.10	0.06	21.81	26.82	32.92	41.25
$Ca(NO_3)_2$ 4%	70.3	29.7	7.37	8.80	11.50	9.00	0.14	0.13	0.11	0.06	21.86	27.88	35.38	43.42
GA_3 50 ppm	75.3	24.7	7.30	9.00	11.50	9.60	0.12	0.11	0.10	0.06	23.65	30.47	37.50	42.05
GA_3 100 ppm	95.0	5.0	7.20	9.00	10.50	12.50	0.11	0.11	0.10	0.08	22.77	25.59	33.27	46.85
GA_3 150 ppm	80.0	20.0	7.20	8.80	11.80	10.10	0.12	0.11	0.10	0.07	22.61	27.61	34.63	40.63
GA_3 200 pm	78.0	22.0	7.00	8.70	11.70	9.70	0.12	0.11	0.10	0.06	22.36	28.46	36.12	41.13
Control	40.0	60.0	6.77	8.60	12.20	9.07	0.13	0.11	0.10	0.05	22.78	30.55	37.83	40.37
CD (P = 0.05)	2.7	2.7	0.29	0.34	0.37	0.47	0.003	0.003	0.22	0.002	1.24	0.96	1.78	0.66

in fruit weight during storage primarily attributed to the losses in moisture through physiological processes such as evaporation and transpiration (Roy and Pandey, 12). The post-harvest loss of fruit weight was significantly diminished by treating the fruit in growth regulator and calcium solution. Among the treatments, fruits treated with GA_3 @ 150 ppm for 5 min., had effectively reduced the moisture losses and maintained higher fruit weight even at 9 days of storage. This treatment was comparable to the fruits treated in 2% $CaCl_2$. The physiological loss in fruit weight was significantly circumvented by post-harvest treatments. On the 9[th] day of the storage, the fruits treated with 100 ppm GA_3 recorded the lowest cumulative physiological loss in weight and treatment was similar to soaking the fruits in 2% $CaCl_2$ solution. The data suggest that fruits treated in GA_3 or $CaCl_2$ had the reduced the rate of respiration and other degradative physiological processes that resulted in minimum loss of weight. Similiar findings were reported for mango by Moottoo (11).

The rapid loss in firmness during storage is usually associated with accelerated hydrolytic enzymes (Lazan *et al.*, 9). Post-harvest treatments assisted the papaya fruits to maintain firmness even after several days of storage (Table 1). Fruits treated in $CaCl_2$ solution @ 2% retained good cell wall integrity as a consequence of influx of calcium that could have helped in thickening of calcium pectate in the cell wall that assisted in prolonged shelf-life (Wills *et al.*, 1981). The data on ripening percentage increased linearly with the time of storage regardless of growth regulator or nutrient solution treatments. However, fruits treated in GA_3 @ 100 ppm or 2% $CaCl_2$ could delay the ripening process and extended the shelf-life of fruits even after 9 days of storage, while the untreated fruits reached the complete ripening within 6 days. Calcium is important in the maintenance of cell wall integrity in plants. Heavy influx of external or internal calcium results to inhibit the ripening process due to the reduction in enzymatic activity that are closely related to ethylene evolution. The data are in conformity with the findings of Conway (6) who suggested that calcium treatment significantly reduced the rate of ripening as a result of enhanced endogenous levels of auxin and cytokinin.

Percentage of decayed fruits were observed at the last day of storage. The percentage of decayed was significantly highest in the control as against the treated fruits in $CaCl_2$, $Ca(NO_3)_2$ or GA_3. The treated fruits were less vulnerable to physiological deterioration. Consequently spoilage of treated fruits was relatively lower and thus registered least percentage of decayed fruits. This result was in line with Singh and Singh (14).

During the ripening of fruits, the total soluble solids (TSS) enhanced with the progress of time as a consequence of conversion of starch into sugars (Khumbhar and Desai, 8). The TSS values increased linearly from 3[rd] day till the end of the experiment. However, the pattern of ripening differed significantly with post-harvest treatments (Table 2). Fruits treated in GA_3 @ 100 ppm and $CaCl_2$ @ 2% had maintained higher TSS during the storage. The maintenance of TSS in stored fruits may be due to the decline in hydrolytic enzymes that are associated with fruit ripening (Balakrishnan, 4).

Titrable acidity of papaya fruits decreased with the advancement of ripening process regardless of post-harvest treatments (Table 2). Fruits treated in GA_3 @ 100 ppm and $CaCl_2$ @ 2 % has maintained higher titrable acidity value at the end of 9[th] day. This suggest that post-harvest treatments with GA_3 or calcium could be ascribed for delay in the fruit deterioration process. Similar observations were reported for sapota by Gautam and Chundawat (7). Ascorbic acid content of the fruit increased as the period of storage also increased in all the treatments (Table 2). Fruits treated with GA_3 @ 100 ppm recorded the highest acidity, which indicates slow ripening. This was in line with the findings of Banik *et al.* (5) in sapota. Post-harvest treatments of fruits with GA_3 @ 100 ppm and $CaCl_2$ @ 2% had recorded the highest score for organoleptic evaluation, which influence the quality parameter such as colour, texture and thereby improved acceptability.

REFERENCES

1. A.O.A.C. 1975. *Official Methods of Analysis. Association of Analytical Chemists.* (11[th] Edn.), Washington, D.C.
2. Al-Ani, A.M. and Richardson, D.G. 1985. Effect of calcium and nitrogen on respiration and ethylene evolution of Anjour pear fruits. *Iraqui J. Agric. Sci. Zanco.* **3**: 81-95.
3. Amerine, M.A., Pangborn, R.M. and Rosscler, G.B. 1965. *Principles of Sensory Evaluation of Food.* Academic Press, London.
4. Balakrishnan, K. 1998. *Group Meeting of All India Coordinated Research Project on Post-harvest Technology of Horticultural Crops.* Vol.1. S.K.N. College of Horticulture, Rajasthan. Jan. 9-11.
5. Banik, D., Dutta, R.S., Ghosh, S.K. and Sen. S.K. 1988. Studies on extension of storage-life of sapota (*Achras sapota* L.). *Indian J. Hort.*, **45**: 241-48.
6. Conway, W.S. 1987. The effect of post-harvest infiltration of calcium, magnesium and strontium on decay, firmness, respiration and ethylene production in apples. *J. American Soc. Hort. Sci.* **112**: 300-3.

7. Gautam, S.K. and Chundawat, B.S. 1989. Post-harvest changes in sapota cv. Kalipatti. *Indian J. Hort.* **48**: 444-48.

8. Khumbhar, S.S. and Desai, M.T. 1986. Studies on shelf-life of sapota fruits. *J. Maharashtra Agric. Univ.* **11**: 184-86.

9. Lazan, H., Alid, Z.M. and Selamat, M.K. 1993. The underline biochemistry of the effect of modified atmosphere and storage temperature of firmness decrease in papaya. *Acta Hort.* **343**: 141-45.

10. Mehta, P.M., Raj, S.S. and Raju, P.S. 1986. Influence of fruit ripening retardants on succinate and malate dehydrogenase in papaya fruits with emphasis on preservation. *Indian. J. Hort.* **43**: 169-73.

11. Moottoo, A. 1991. Effect of post-harvest calcium chloride dips on ripening changes in 'Julie' mangoes. *HortSci.* **15**: **33-34**.

12. Roy, S.K. and Pandey, R.M. 1983. Effect of existing method of harvesting on ripening and storage of mango. *Silver Jubilee Celebration Seminar on Plant Physiology. Indian Soc. Plant Physiol.* Session 1, Abst. 1-22.

13. Siddiqui, S. and Gupta, O.P. 1989. Effect of post-harvest application of some chemicals on the shelf life of ber fruit. *Haryana. J. Hort. Sci.* **24**: 19-23.

14. Singh, B.K. and Singh, T.P. 1992. Effect of certain post-harvest treatments on the storage life and quality of mango cv. Zardalu. *Indian Food Packer,* **46**: 57-63.

15. Srivastava, M.P., Tandon, R.N., Bilgrami, K.S. and Ghosh, A.K. 1984. Studies on fungal diseases of some tropical fruits. *Phytopath.* **2-5**: 250-56.

16. Wills, R.H.H., Leo, T.H., Graham, D., Mc Glasson, W.E. and Hall, E.G. 1981. *Post-harvest - An Introduction to Physiology and Handling of Fruits & Vegetables.* The AVI Publishing Company, L.C. West Port. Conn.

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