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Effect of preharvest application of calcium on storage behaviour, ripening and shelflife of papaya (*Carica papaya* L.)

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ABSTRACT
An experiment was conducted inorder to study the effect of preharvest application of calcium on storage behaviour, ripening and shelf life of papaya using four levels (0.5, 1.0, 1.5, 2.0 %) each of $CaCl_2$ and Ca $(NO_3)_2$ along with a control in RBD design with five replication. The data indicated that preharvest spray off calcium compounds reduced physiological losses in weight, TSS, total sugars and total carotenoid content showed an initial increase and then declined as the storage period advanced. The firmness was increased as the concentration of calcium increased in the fruits and higher acidity was associated with longer shelf life. The $CaCl_2$ and Ca $(NO_3)_2$ solutions @ 2% spray was effective in delaying the colour development and enhanced shelf life of fruits upto 10 days.

Key words : Papaya, Calcium, Preharvest spray, Post harvest behaviour, Shelf life.

INTRODUCTION

Papaya is one of the most important tropical fruit primarily cultivated in India in an area of about 60,000 h.a with the productivity of 87 t ha^{-1}. 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 direct consequences of weak cell wall integrity (Lazan *et al.,* 1993). Appropriate technology to extend the shelf life and *corresponding author

reduce post harvest losses of papaya is therefore required. The possibilities for low temperature storage are limited by the high capital cost and susceptibility of papaya to chilling injury at low temperatures. Calcium is known to be essential plant nutrient involved in a number of physiological processes concerning membrane structure, function and enzyme activity (Jones and Lunt, 1967). Calcium chloride treatment of fruits protects them against post harvest deterioration by binding with hydrolysis such as galacturonase and promotes shelf life. Further calcium has been shown to inhibit ethylene production and thus delay ripening (Al-ani and Richardson, 1985). Calcium has shown promise in quality retention of fruits and vegetables through maintaining firmness, reducing respiratory rate and ethylene evolution (Poovaiah, 1986). The present study was undertaken to find out the effect of preharvest calcium sprays on various physico chemical changes and shelflife of papaya cv. CO2 during ripening and storage.

MATERIALS AND METHODS

Preharvest calcium chloride $CaCl_2$ and Ca $(NO_3)_2$ sprays were done on papaya fruits cv. CO2 in the orchard at Horticultural college and Research institute, Periyakulam. The $CaCl_2$ and $Ca(NO_3)_2$ solutions containing 0.5, 1.0, 1.5, and 2.0 per cent of calcium were sprayed 25 days before harvesting of fruits (approximately 110 – 115 days) from the date of anthesis. Uniform sized fruits on the lower row of fruits were selected for spraying. The fruits were thoroughly drenched with the solution using hand atomizer in the early morning hours. Teepol @ 0.1 %was used as surfactant. Fruits were harvested and lots of 20 – 25 fruits each were prepared and used for individual treatment. Five lots of fruits for each replication were stored at ambient temperature (30± 2°C) and relative humidity (70 – 75 %). The fruits were assessed for physiological loss in weight (%), firmness (Kg/cm), TSS(°Brix), acidity (%), total sugars (%), ascorbic acid (mg/100 g) and carotenoid content (mg/100g) at 3 days interval. The fruit firmness was worked out by the method of Srivastava *et al.* (1984) whereas TSS was estimated with hand refractometer. Acidity, ascorbic acid, total sugars and total carotenoids were estimated as per Ranganna (1986).

RESULTS AND DISCUSSION

The data on fruit weight measured at day 1, 3, 6 and 9 had shown that the fruit weight decreased with the time of exposure in storage condition (Table 1). The decline in fruit weight during storage primarily attributed the losses in moisture through physiological process such as evaporation and transpiration. This finding is in confirmation with the observation of Roy and Pandey (1983) who have shown decrease in moisture content during storage. Among the treatments fruits sprayed with $CaCl_2$ @ 2% has effectively reduced the losses in moisture and maintained higher fruit weight even at 9 days of storage. The physiological loss in weight among treatments increased as the storage period advanced. Lowest physiological loss (14.39) was observed in fruits sprayed with 2 % $CaCl_2$ followed by 2 % $Ca(NO_3)_2$ (14.5 %) and the control (26.95) recorded the maximum PLW (Table.1). The increased weight loss in untreated fruits might be due to increased storage breakdown associated with higher respiratory rate compared to calcium treated fruits sprayed with pre harvest $CaCl_2$ in mangoes (Mootto, 1991).

The firmness of papaya fruits as indicated by the resistance of the fruits to external pressure measured by penetrometer. The rapid loss in firmness during storage is usually associated with accelerated hydrolytic enzymes (Lazen *et al.,* 1993). It was also observed that preharvest spray with 2 % $CaCl_2$ and 2 % $Ca(NO_3)_2$ (2.30) showed higher retention of firmness compared to the control fruits (0.70). It was noticed that fruits having higher concentration of calcium compounds in preharvest sprays retained higher firmness. This was probably due to added calcium in peel and pulp that helped to maintain cell wall integrity as a consequence of influx of calcium that could have helped in thickening of calcium pectate in the cell wall and thus assist in prolonged shelf life. (Haribabu and Shanthakrishnamoorthy, 1993).

The acidity was significantly influenced by calcium compounds. It decreased gradually from the first day with the advancement of ripening (Table 2). The decline in acidity could be attributed to a decrease in citric acid during storage. Among all, $CaCl_2$(2 %) and $Ca(NO_3)_2$ (2 %) registered high titrable acidity (0.073) over the control (0.046). Similar increase in acidity due to calcium treatments as preharvest spray in Amrapali mangoes was reported by Singh *et al.* (1982).

During the ripening of fruits, the total soluble solids (TSS) enhanced with the progress of ripening as a consequence of conversion of starch into sugar (Khumbhar and Desai, 1986). TSS values increased linearly from 3rd day. However, the pattern of ripening differed significantly with different preharvest treatments. Fruits sprayed with 2 % $CaCl_2$ (2 %) and $Ca(NO_3)_2$ (2 %) had maintained higher TSS during the storage. The maintenance of TSS in fruits may be due to the decline in hydrolytic enzymes that are

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Table 1 : Effect of Ca on fruit weight (Kg), Physiological loss in weight (%) and fruit firmness (Kg/cm^2) during storage of papaya.

Treatment	Fruit weight (kg) Days after storage				Physiological loss in weight(%) Days after storage				Fruit firmness (kg cm^{-2}) Days after storage			
	1	3	6	9	1	3	6	9	1	3	6	9
$CaCl_2$ 0.5 %	1.463	1.400	1.315	1.213	4.30	6.70	8.52	17.77	8.200	4.00	2.00	1.40
$CaCl_2$ 1 %	1.374	1.217	1.112	1.033	11.42	8.62	7.10	24.81	7.900	3.83	2.10	1.60
$CaCl_2$ 1.5%	1.426	1.361	1.204	1.098	4.55	11.53	8.80	23.00	8.40	4.56	2.30	1.90
$CaCl_2$ 2%	1.528	1.457	1.403	1.308	4.64	3.71	6.77	14.39	8.30	4.80	2.90	2.30
Ca (NO_3) 0.5 %	1.370	1.283	1.112	1.002	6.35	13.32	9.89	26.86	8.40	4.46	2.20	1.63
Ca (NO_3) 1 %	1.275	1.208	1.106	0.979	5.25	8.44	11.48	23.26	8.00	4.86	2.86	1.80
Ca (NO_3) 1.5 %	1.479	1.387	1.206	1.118	6.22	13.04	7.29	24.41	8.43	4.56	2.40	1.83
Ca (NO_3) 2 %	1.571	1.508	1.459	1.373	4.01	3.24	7.95	14.51	8.13	4.26	2.85	2.20
Control	1.328	1.254	1.108	0.970	5.57	11.64	12.45	26.95	8.30	4.26	1.26	0.70
CD (5 %)	-	-	-	0.0813	-	-	-	2.84	-	-	-	0.15

Table 2 : Effect of Ca on Total soluble solids (^{0} Brix), Titrable acidity (%) and total sugars (%) during storage of papaya.

Treatment	Total soluble solids (^{0} Brix) Days after storage				Titrable acidity (%) Days after storage				Total sugars (%) Days after storage			
	1	3	6	9	1	3	6	9	1	3	6	9
$CaCl_2$ 0.5 %	6.83	8.40	11.40	9.60	0.121	0.119	0.093	0.059	3.00	4.30	7.20	5.70
$CaCl_2$ 1 %	6.90	8.60	12.10	9.40	0.126	0.133	0.117	0.058	3.10	4.50	7.80	5.70
$CaCl_2$ 1.5%	7.00	9.00	11.10	9.45	0.116	0.120	0.106	0.059	3.50	5.90	6.90	5.50
$CaCl_2$ 2%	7.10	8.80	10.80	11.80	0.135	0.122	0.107	0.073	3.30	4.70	6.66	7.30
Ca (NO_3) 0.5 %	6.90	8.50	11.30	9.60	0.127	0.115	0.099	0.060	2.90	4.33	7.23	5.50
Ca (NO_3) 1 %	7.00	8.90	11.90	9.70	0.128	0.17	0.100	0.057	3.20	4.40	7.60	5.70
Ca (NO_3) 1.5 %	7.36	8.80	11.50	9.00	0.139	0.128	0.112	0.059	3.10	4.40	7.30	5.10
Ca (NO_3) 2 %	7.00	8.50	11.80	11.00	0.131	0.119	0.103	0.073	3.20	4.40	7.60	5.70
Control	6.76	8.60	12.20	9.06	0.126	0.119	0.098	0.046	3.00	4.50	8.00	5.20
CD (5 %)	-	-	-	0.46	-	-	-	0.002	-	-	-	0.359

Table 3: Effect of Ca on Total carotenoids (mg/100g) and ascorbic acid content (mg/100g) during storage of papaya.

Treatment	Total carotenoids (mg/100g) Days after storage				Ascorbic acid content (mg/100g) Days after storage				
	1	3	6	9	1	3	6	9	Shelf life (Days)
$CaCl_2$ 0.5 %	0.78	1.79	1.50	1.53	21.76	28.72	35.72	41.67	6.0
$CaCl_2$ 1 %	0.81	1.26	1.54	1.58	22.38	28.15	33.29	41.53	6.8
$CaCl_2$ 1.5%	0.77	1.28	1.53	1.85	20.56	27.33	32.46	42.91	7.3
$CaCl_2$ 2%	0.67	1.19	1.31	1.40	22.53	26.53	33.44	38.51	10.0
Ca (NO_3) 0.5 %	0.69	1.55	1.89	1.53	20.93	26.02	31.09	41.08	7.3
Ca (NO_3) 1 %	0.66	1.42	1.47	1.50	21.81	26.82	32.92	41.25	7.0
Ca (NO_3) 1.5 %	0.79	1.48	1.53	1.62	21.86	27.87	35.58	43.42	8.0
Ca (NO_3) 2 %	0.77	1.31	1.49	1.38	21.33	28.19	34.33	40.21	9.5
Control	0.85	1.58	1.80	1.63	22.78	30.55	37.83	43.41	4.0
CD (5 %)	-	-	-	0.286	-	-	-	0.656	0.27

associated with fruit ripening (Balakrishnan, 1998).

The total sugar content of the papaya fruit, which represent in the form of reducing and non-reducing sugars increased as the process of ripening enhanced irrespective of the treatments. This is due to accumulation of total sugars during the process of ripening, as a consequence of starch hydrolysis. The maximum total sugar content (7.3) was found in sprayed fruits, while minimum total sugars content (5.20) was recorded in unsprayed fruits, after 9 days of storage. The drastic reduction in the total sugar may be due to utilization of sugars for respiration (Selvaraj *et al.* 1982).

The colour of the ripe papaya flesh is mainly due to the presence of carotenoid pigments. Progressive increase in carotenoid content was observed during ripening of fruits in storage (Selvaraj *et al.* 1982). This rate of increase in total carotenoids content was more in the control fruits compared to fruits sprayed with higher concentration of $CaCl_2$ and $Ca(NO_3)_2$ (2 %). This might be due to the effect of calcium on slow ripening of papaya fruits. Similar results on reduced carotenoid content due to calcium treatment in mango fruits were reported by Haribabu and Shanthakrishnamoorthy (1993).

Ascorbic acid content of the fruit increased as the period of storage increased in all the treatments except control. Sustained increase of ascorbic acid was noticed in treatments receiving higher concentration of $CaCl_2$ and $Ca(NO_3)_2$ (Table 3). The gradual increase in ascorbic acid during ripening may be due to the gradual changes in metabolishm of carbohydrate and biosynthesis of glucose. This was in line with the findings of Poovaiah *et al.* (1988).

It was also observed that papays fruits developed yellow patches on green background and orange yellow colour in flesh at edible ripe stage, which was sprayed with preharvest $CaCl_2$ and $Ca(NO_3)_2$. This could be due to the calcium effect which might have penetrated to the peel and pulp, and maintained the chlorophyll initially and fruits led to consistent development of carotenoid with the ripening process. The shelf life of untreated ruits was 5.0 days compared to 10 days of the fruits treated with 2% $CaCl_2$ and $Ca(NO_3)$

$_2$ as preharvest sprays. Similar findings were noticed by (Poovaiah *et al.* 1988).

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