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MH Khanvilkar
Depatrment of Horticulture, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

RA Kaushik
Depatrment of Horticulture, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

CD Pawar
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, dist. Ratnagiri, Maharashtra, India

UB Pethe
Depatrment of Horticulture, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

PM Talha
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, dist. Ratnagiri, Maharashtra, India

DK Sarolia
Depatrment of Horticulture, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

B Upadhyay
Depatrment of Horticulture, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

LN Mahawer
Depatrment of Horticulture, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Correspondence
MH Khanvilkar
Depatrment of Horticulture, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Response of post harvest treatments of various chemical and plant growth regulators on physical parameters of sapota fruits cv. Kalipatti

MH Khanvilkar, RA Kaushik, CD Pawar, UB Pethe, PM Talha, DK Sarolia, B Upadhyay and LN Mahawer

Abstract
Investigation was conducted to study the effect of post harvest treatments of chemical and plant growth regulators on physical characteristics of sapota fruits cv. Kalipatti. Fruits were treated with calcium chloride (5000 and 10000 ppm), calcium nitrate (2 and 4 %), gibberellic acid (200 and 400 ppm) benzyl adenine (75 and 150 ppm) and control (distilled water) and stored at ambient temperature. $CaCl_2$ (10000 ppm) was proved very effective in weight, PLW and registered high fruit firmness, increase shelf life and ripening period. There was significant increase in physiological loss in weight, spoilage with enhanced storage period irrespective of chemical and growth regulator treatments. Similarly decrease in weight, fruit firmness during storage of sapota fruit was noticed. The minimum physiological loss in weight, total spoilage were noticed under $CaCl_2$ 10000 ppm treated fruits. The study suggest that $CaCl_2$ 10000 ppm as post harvest dip improves the fruits firmness, shelf life and ripening period of sapota up to 12^{th} day of storage.

Keywords: sapota, calcium chloride, calcium nitrate, gibberellic acid, benzyl adenine, storage

Introduction
Sapota (*Manilkara achras* (Mill) Forsberg) is one of the prominent fruits belongs to family sapotaceae, is native to Tropical America. Being climacteric in nature sapota fruits need ripening treatments after full maturity. During ripening fruit passes through a series of changes in colour, texture and flavour indication that compositional changes are taking place. The ripe fruits have pleasant aroma and are excellent in sweetness without any astringency due to decrease in polyphenols with concurrent increase in sugars, production of ethylene, rate of respiration and catalyse activity (Shankaranarayanan *et al.* 2007). The post harvest losses are very high in tropical countries. Various chemicals and plant growth regulator have been used to hasten or delay ripening, to reduce losses and to improve and maintain colour and quality by slowing down the metabolic activities of fruits. These chemicals arrest the growth and spread of micro organism by reducing the shrivelling which ultimately leads to an increased shelf life and maintain the marketability of the fruits for a longer period. Therefore, the present investigation is carried out to evaluate the effect of post harvest treatments of chemical and plant growth regulators on quality of sapota fruits during storage.

Material and Methods
The present investigation was carried out at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during the year 2015-16 and 2016-17 after registering under Ph. D. Programme at Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India. The fruits of sapota cv. Kalipatti were harvested at optimum stage of maturity. The fruits were dipped for 10 min. in solution of calcium nitrate (2 and 4 %), calcium chloride (5000 and 10000 ppm) gibberellin acid (200 and 400 ppm), benzyl adenine (75 and 150 ppm) and in absolute control the fruits were dipped in distilled water.
The experimental data was analysed in Completely Randomized Design (CRD) with three replications. The fruits were then air dried and kept at ambient temperature during storage. The fruits were assessed at two days interval for weight, physiological loss in weight, fruit firmness and at alternate day for ripening and spoilage pattern.

Weight of fruit (g)
Individual fruit was weighed on monopan sensitive electronic balance. The weighing machine was calibrated by using standard weights before taking observation. Individual fruit was kept on machine and average weight of 10 fruits was recorded in grams (g).

Physiological loss in weight (PLW)
For studying the physiological loss in weight each fruit was marked. The progressive loss in weight was noted at an interval of two days and per cent loss in weight was calculated by using formula. Total 30 fruits were monitored for physiological loss in weight.

PLW (%) was calculated as follows –

$$\% \text{ PLW} = \frac{\text{Initial weight (g)} - \text{Final weight (g)}}{\text{Initial weight (g)}} \times 100$$

Fruit firmness (kg/cm^2)
Total 10 fruits per treatment were observed for fruit firmness and determined by using fruit pressure tester and recorded on kg/cm^2.

Shelf life (Days)
The shelf life of fruit was noted by keeping the fruits at ambient temperature and the days taken from harvesting to optimum eating stage

Spoilage of fruits (%)
The number of visibly shrivelled and diseased fruits were counted and expressed as percentage over the total number of fruits at every alternate days of storage.

Result and Discussion
The weight loss increased continuously throughout the storage irrespective of treatments and all the treatments differ significantly with respect to weight (Table 1). Average weight recorded by the sapota fruits at initial day of storage was 89.62 g and that at 12th day of storage it was 62.41 g. At 12th day of storage maximum weight was observed in fruits treated with $CaCl_2$ 10000 ppm (77.87g) and it was at par with $CaCl_2$ 5000 ppm (73.44 g). Minimum fruit weight was observed in the fruits treated with calcium nitrate 2 per cent (47.13 g). Similar findings were reported by Paralkar (1985), Raut (1999), Pawar (2009) in sapota.

Table 1: Effect of post harvest treatments of different chemicals and plant growth regulators on weight (g) of sapota fruits cv. Kalipatti

Treatments	Days of storage				
	0	3	6	9	12
Control (Distilled water)	94.28	91.02	83.22	77.39	69.99
Calcium nitrate 2 per cent	78.36	73.67	66.54	63.46	47.13
Calcium nitrate 4 per cent	79.17	75.28	69.34	66.60	50.87
Calcium chloride 5000 ppm	97.13	92.26	83.54	80.37	73.44
Calcium chloride 10000 ppm	103.45	96.15	87.63	84.85	77.87
Gibberellic acid 200 ppm	92.74	87.62	76.07	74.38	63.18
Gibberellic acid 400 ppm	92.95	88.61	80.31	75.74	66.65
Benzyl adenine 75 ppm	83.18	79.33	71.53	65.78	54.62
Benzyl adenine 150 ppm	85.37	82.52	74.14	71.63	57.90
Mean	89.62	85.16	76.92	73.35	62.41
SEm±1	3.18	3.16	2.86	2.76	2.28
CD (P=0.05)	9.13	9.05	8.22	7.92	6.54

The physiological loss in weight was significantly diminished by post harvest $CaCl_2$ treatment. The fruits treated with $CaCl_2$ (10000 ppm) recorded the lowest (21.10 %) loss in weight and it was at par with $CaCl_2$ (5000 ppm) treated fruits (22.07 %). The reduction in weight loss might be due to the calcium treatment which has been reported to be effective in terms of membrane integrity maintenance with lower losses of phospholipids and proteins and reduced ion leakages which could be responsible for the lower weight loss and retention of more moisture. The results obtained in the study agreed with the results of Gautam and Chundawat (1990) [2], Bharathi (2002) and Nikam (2008) [3] in Kalipatti variety of sapota.

Table 2: Effect of post harvest treatments of different chemicals and plant growth regulators on physiological loss in weight (%) of sapota fruits cv. Kalipatti.

Treatments	Days of storage				
	0	3	6	9	12
Control (Distilled water)	0.00	5.18	13.44	21.43	39.01
Calcium nitrate 2 per cent	0.00	4.56	8.95	16.10	31.01
Calcium nitrate 4 per cent	0.00	4.20	8.12	14.85	30.44
Calcium chloride 5000 ppm	0.00	2.40	5.47	10.99	22.07
Calcium chloride 10000 ppm	0.00	2.22	4.59	10.64	21.10
Gibberellic acid 200 ppm	0.00	3.11	7.01	11.65	27.51
Gibberellic acid 400 ppm	0.00	2.55	6.06	11.69	26.15
Benzyl adenine 75 ppm	0.00	3.54	7.76	14.37	30.01
Benzyl adenine 150 ppm	0.00	3.27	7.27	13.90	28.66
Mean	0.00	3.45	7.63	13.96	28.44
SEm±1	0.00	0.13	0.27	0.48	1.06
CD (P=0.05)		0.37	0.76	1.37	3.05

Fruit firmness during the storage is associated with acceleration of hydrolytic enzymes. Post-harvest treatments assisted sapota fruits to maintain fruit firmness up to the end of storage period. Fruits treated with $CaCl_2$ 10000 ppm showed the highest fruit firmness (0.80 kg./cm^2) in comparison to all other treatments (Table 3). Firmness in many fruits is an important characteristics that is used to determine stability and it is predominantly determined by cell wall composition and structure. Calcium treatments have been known to delay the softening and improve the fruit quality. Similar results were obtained by Tsomu and Patel (2014) [5] in Kalipatti variety of sapota.

Table 3: Effect of post harvest treatments of different chemicals and plant growth regulators on fruit firmness (kg/cm^2) of sapota fruits cv. Kalipatti.

Treatments	Days of storage				
	0	3	6	9	12
Control (Distilled water)	3.73	3.28	3.11	1.86	0.31
Calcium nitrate 2 per cent	3.72	3.23	2.78	1.74	0.40
Calcium nitrate 4 per cent	3.50	3.10	2.72	1.68	0.46
Calcium chloride 5000 ppm	2.86	2.56	2.14	1.09	0.74
Calcium chloride 10000 ppm	2.65	2.19	1.91	1.05	0.80
Gibberellic acid 200 ppm	3.15	2.78	2.35	1.27	0.61
Gibberellic acid 400 ppm	3.12	2.74	2.25	1.14	0.68
Benzyl adenine 75 ppm	3.33	3.05	2.64	1.55	0.50
Benzyl adenine 150 ppm	3.19	2.86	2.53	1.37	0.52
Mean	3.25	2.86	2.49	1.41	0.55
SEm±1	0.06	0.02	0.02	0.01	0.01
CD (P=0.05)	0.18	0.05	0.05	0.02	0.03

The spoilage per cent of sapota fruits was increased as the storage period increased, irrespective of treatments. Calcium treated fruits showed significantly lesser extent of spoilage,

followed gibbrillic acid. The fruits treated with calcium chloride 10000 ppm was found to be best for delaying ripening and spoilage. The results obtained in the study agreed with the results of Gautam and Chundawat (1990) [2], Bharathi (2002) and Nikam (2008) [3] in Kalipatti variety of sapota. The delaying ripening and spoilage of sapota fruits during storage could be due to slow release of free water on an effect of reduced metabolism and rate of transpiration in calcium treated fruits.

Table 4: Effect of post harvest treatments of different chemicals and plant growth regulators on spoilage (%) of sapota fruits cv. Kalipatti.

Treatments	Days of storage				
	0 to 4	6	8	10	12
Control (Distilled water)	0	13	50.34	66.0	100.0
Calcium nitrate 2 per cent	0	0	27.34	49.33	78.66
Calcium nitrate 4 per cent	0	0	31.34	47.66	77.00
Calcium chloride 5000 ppm	0	0	5.34	20.00	41.34
Calcium chloride 10000 ppm	0	0	10.34	15.66	39.00
Gibberellic acid 200 ppm	0	0	9.34	13.66	54.00
Gibberellic acid 400 ppm	0	0	8.00	18.68	45.34
Benzyl adenine 75 ppm	0	0	21.34	40.34	70.66
Benzyl adenine 150 ppm	0	0	22.33	45.66	68.34

The shelf life of fruits was prolonged due to chemical and growth regulators treatment over control. Among the different treatments tried, $CaCl_2$ 5000 ppm, $CaCl_2$ 10000 ppm, GA_3 200 ppm and GA3 400 ppm were found most effective to extend shelf life (8 days) of sapota fruits over control (Table 5)

Table 5: Effect of post harvest treatments of different chemicals and plant growth regulators on shelf life (days) of sapota fruits cv. Kalipatti

Treatments	Shelf life (days)
Control (Distilled water)	4.0
Calcium nitrate 2 per cent	6.0
Calcium nitrate 4 per cent	6.0
Calcium chloride 5000 ppm	8.0
Calcium chloride 10000 ppm	8.0
Gibberellic acid 200 ppm	8.0
Gibberellic acid 400 ppm	8.0
Benzyl adenine 75 ppm	6.0
Benzyl adenine 150 ppm	6.0

Conclusion

From the present study it is concluded that the fruit treated with $CaCl_2$ 10000 ppm help in maintaining highest fruit firmness, least spoilage and physiological loss in weight as compared to other post-harvest treatments.

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