International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(3): 2500-2503

Received: 13-03-2019
Accepted: 15-04-2019

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Influence of pre-harvest chemical treatments on physio-chemical characteristics and shelf life of Sapota [*Manilkara achras* (Mill.) Forsberg] var. PKM 1

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Abstract
The present investigation "Influence of pre-harvest chemical treatments on physio-chemical characteristics and shelf life of Sapota [*Manilkara achras* (Mill.) Forsberg] Var. PKM1" was conducted at Department of Fruit Crops, Horticultural college and Research Institute, Periyakulam during 2019. Pre harvest spraying of Calcium chloride (1.0% & 2.0%), Gibberellic acid (50ppm &100ppm) along with control (water) sprayed on 20 years old sapota tree at one month before harvesting stage. The fruits were stored at cold storage (14±1 °C, 90-95% RH) after harvest. Among these treatments, results proved that pre-harvest spraying of $CaCl_2$ 2.0% found to be most effective for maintaining titrable acidity (0.21%), ascorbic acid content (21.09 kg/100mg), minimum physiological loss in weight (7.72%), gradual increase in total soluble solids (20.45%), total sugars (11.32%), reducing sugars (6.50%), and increase in shelf life (28 days) of sapota as compared to untreated fruits (21.75days).

Keywords: Sapota, pre-harvest spray, calcium chloride, Gibberellic acid, shelf life

Introduction
Sapota [*Manilkara achras* (Mill.) Fosberg] belongs to the family Sapotaceae and commonly known as *chiku* is an evergreen fruit tree native of Tropical America. The total area, production and productivity of sapota in India is about 107.2 Thousand Ha with 1284.60 Thousand MT production and 12 mt/ha productivity respectively (NHB, 2017). Sapota fruit is highly perishable and impossible to store for longer period at ambient temprature and must be stored at cold conditions. Being a climatric fruit, sapota ripens within 4 to 7days after harvest at full ripened stage due to fast biochemical changes which reduced the shelf life of sapota.

Sapota fruit is usually consumed in the fresh form. However, the export of fresh Sapota has been restricted because of its perishability, difficult to handle and transport in fresh form due to quick ripening and fruit softening. Calcium supports to increase the shelf life of fruits by influencing the structural integrity of both the cell wall and plasma membrane. It involves in delaying ripening and senescence, increase in firmness, vitamin C and reduction in respiration and there by extending storage life which is due to reducing the incidence of physiological disorders and storage rots (Sharma *et al.*, 1996) [11].

Gibberellins are used for increasing fruit size and firmness. These plant growth regulators have also been found to decrease fungal infections, either by delaying ripening or senescence, or by altering the structure of the fruit. Hence, it becomes necessary to find out some suitable pre-harvest spray to improve the physico-chemical properties and to extend the shelf life of sapota.

Materials and Methods
The present investigation was carried out at the central block, Department of Fruit crops, Horticultural College and Research Institute, Periyakulam, Theni district during the year 2019. The experiment was laid out in Factorial Randomized Block design (FRBD) with four replication comprising three plants per treatment. 20 years old uniform trees of sapota var. PKM1 were marked and one month before harvest the selected trees were sprayed with different level of plant growth regulators (GA_3 @ 50ppm, GA_3 @ 100@ppm) and chemicals (Calcium chloride 1.0%, 2.0%) along with control (Water spray). The pre- harvest fruits were collected in plastic crates. Three kg fruits from each replication sof each treatment were stored under cold storage condition (14±1 °C, 90-95% Relative Humidity).

The observations like physiological loss in weight, TSS, titrable acidity, total sugars, reducing sugar, ascorbic acid content and shelf life fruits were assessed at 1st,10th 19th,28th days interval. The total soluble solids (TSS) were determined by using Erma Hand refractometer of 0-32^o Brix range following the procedure described in A.O.A.C. (1990) [1]. The physiological loss in weight (PLW), ascorbic acid content(kg/100mg), titrable acidity (%),Total sugars (%) and reducing sugars (%) were determined by adopting the A.O.A.C (1990) [1] method and expressed in percentage. The shelf life was determined by recording the number of days the fruits remained in markatable condition without spoilage in each replication during storage.

Results and Discussion

Physiological loss in weight (%)

The result presented in Table 1 showed that Minimum physiological loss in weight0.631, 4.581, 9.777 and 15.922%) was observed in T_5 ($CaCl_2$ @ 2%) followed by treatment T_4 ($CaCl_2$ @ 1%). i.e. 0.964, 6.062, 10.862 and 17.704%), while maximum physiological loss in weight (2.795, 13.776, 25.131 and 44.500%) was observed in treatment T_1 (control). The reduction in weight loss might be due to the maintenance of firmness of fruit by calcium which decreased the enzyme activity responsible for disintegration of cellular structure and decreases the gaseous exchange. Similar findings have been reported by Aradhya *et al*. (2006) [3] in sapota and Bhusan *et al.*, (2015) [5] in mango.

Total soluble solids (TSS) (^{0}Brix)

Data presented in Table 2 showed that gradual increase in total soluble solids (20.12, 20.21, 20.69, 20.76 ^{0}Brix) was recorded in T_5 ($CaCl_2$@2%) followed by treatment T_4($CaCl_2$@1%) i.e. 20.45, 20.53, 20.78, 20.86 ^{0}Brix), while rapid increase in total soluble solids (20.98, 21.34, 22.12, 22.67 ^{0}Brix) was observed in treatment T_1 (control).This may be due to the increase in soluble solids content and total soluble sugars caused by hydrolysis of polysaccharides like starch, cellulose and pectin sub-stances into simpler substances. Similar findings have been reported by Sudha *et al*., (2007) [12] in sapota.

Ascorbic acid content (mg/100 g pulp)

The result presented in Table 3 showed that gradual decrease of Ascorbic acid content (28.92, 24.9, 19.28 and 11.24 mg/100g pulp) was recorded in treatment T_5 ($CaCl_2$@2%) followed by treatment T_4($CaCl_2$@1%) i.e.(27.31, 20.88, 17.67 and 10.44 mg/100g pulp), while rapid decrease in Ascorbic acid content (24.9, 18.47, 10.44 and 2.41 mg/100g pulps) was observed in treatment T_1 (control). Calcium probably retarded oxidation process and hence the rate of conversion of L-ascorbic acid in to de-hydro ascorbic acid slow down. Similar findings have been reported by Desai (2016) [7] in sapota.

Titrable acidity (%)

The result presented in Table 4 showed that gradual decrease of titrable acidity (0.29, 0.27, 0.17, 0.13%) was recorded with T_5 ($CaCl_2$@ 2%) followed by treatment T_4 ($CaCl_2$ @ 1%) i.e. 0.28, 0.23, 0.16, 0.12%), while rapid decrease in titrable Acidity (0.24, 0.18, 0.13 and 0.08 %) was observed in treatment T_1 (control). The treatment with $CaCl_2$ recorded the maximum titrable acidity might be due to delayed respiration rate and conversion of organic acids into sugars. The similar result on acidity was also reported by Patel *et al*., (2017) [10] in sapota, Habimana (2014) in mango.

Total sugars (%)

The result presented in Table 5 showed that gradual increase total sugars (%) was observed (10.12,10.44,11.36 and 13.34%) in treatment T_5 ($CaCl_2$@2%) was followed by treatment T_4($CaCl_2$@1%) i.e. 10.31,10.76,12.13,13.79%), while rapid increase in total sugar content (11.18,11.78,13.12,14.87%) was observed in treatment T_1 (control). The gradual increase in total sugar during initial storage period might be due to the hydrolysis of starch into sugar as on complete hydrolysis of starch, no further increase occurs and subsequently a decline in total sugar is predictable. Similar findings have been reported by Tsomu and Patel (2014) [13] in sapota, Bisen *et al.* (2014) [6] in guava.

Reducing sugars (%)

The result presented in Table 6 showed that significantly gradual increase of reducing sugar (6.04, 6.27, 6.62, 7.05%) was observed with T5 ($CaCl_2$@ 2%) followed by treatment T_4 ($CaCl_2$@1%) i.e. 6.12, 6.48, 6.94, 7.45%), while (control) fruits presented the rapid increase total sugar content (6.32, 6.84, 7.47, 8.43%) in sapota fruits. The gradual increase of reducing sugar content by calcium application might be due to the less utilization of sugar in respiration and conversion of starch into sugar, while the subsequent decline was perhaps due to consumption of sugar for respiration during storage. Similar findings have been reported by Bhalerao *et al.* (2010) in sapota.

Shelf life (days)

The result presented in Table 7 showed that maximum shelf life (28 days) was observed in T_5 ($CaCl_2$ @ 2%) followed by treatment T_4 ($CaCl_2$ @ 1%).While minimum shelf life (21.75 days) was observed in treatment T_1 (control). Effect of calcium chloride was found to be most effective to prolong shelf life by decreasing the respiration rate and improving the shelf life. The similar result on shelf life was also reported by Amarjeet *et al*., (2016) [2] in sapota.

Tables

Table 1: Effect of pre harvest treatments of Physiological loss in weight (%) of sapota var. PKM 1 under cold storage

Treatments	Physiological loss in weight (%)				
	Days after Storage				
	3 DOS	11 DOS	20 DOS	28 DOS	MEAN
T_1-Control	2.80	13.78	25.13	44.50	21.55
T_2-GA_3@50ppm	1.86	16.31	30.32	35.67	21.04
T_3-GA_3@100ppm	1.55	6.45	12.67	18.48	9.79
T_4-$CaCl_2$@1%	0.96	6.06	10.86	17.70	8.90
T_5- $CaCl_2$@2%	0.63	4.58	9.78	15.92	7.73
Mean	1.56	9.43	17.75	26.46	
Source	Treatments(T)	Days of storage(D)		Interaction(TXD)	
SE(d)	0.130	0.118		0.264	
CD(p=0.05)	0.264	0.236		0.529	

Table 2: Effect of pre harvest treatments on Total soluble solids (TSS) (^{0}Brix) of sapota var. PKM 1 under cold storage

Treatments	**Total soluble solids (TSS) (ºBrix)**				
	Days after Storage				
	1st	**10th**	**19th**	**28th**	Mean
T_1-Control	20.98	21.34	22.12	22.67	21.78
T_2-GA_3@50ppm	20.67	20.75	21.14	21.45	21.00
T_3-GA_3@100ppm	20.56	20.76	21.12	21.37	20.95
T_4-$CaCl_2$@1%	20.45	20.53	20.78	20.86	20.66
T_5- $CaCl_2$@2%	20.12	20.21	20.69	20.76	20.45
Mean	20.56	20.72	21.17	21.42	
Source	Treatments(T)	Days of storage(D)		Interaction(TXD)	
SE(d)	0.132	0.147		0.295	
CD(p=0.05)	0.264	0.295		0.591	

Table 3: Effect of pre harvest treatments on Ascorbic acid content (mg\100g pulp) of sapota var. PKM 1 under cold storage

Treatments	**Ascorbic acid (mg\100g)**				
	Days after Storage				
	1st	**10th**	**19th**	**28th**	Mean
T_1-Control	24.9	18.47	10.44	2.41	**14.06**
T_2-GA_3@50ppm	24.9	19.28	13.65	4.02	**15.46**
T_3-GA_3@100ppm	25.7	20.08	16.87	8.84	**17.87**
T_4-$CaCl_2$@1%	27.31	20.88	17.67	10.44	**19.08**
T_5- $CaCl_2$@2%	28.92	24.9	19.28	11.24	**21.09**
Mean	26.346	20.722	15.582	7.39	
Source	Treatments(T)	Days of storage(D)		Interaction(TXD)	
SE(d)	0.116	0.130		0.260	
CD(p=0.05)	0.232	0.260		0.520	

Table 4: Effect of pre harvest treatments on Titrable Acidity (%) of sapota var. PKM 1 under cold storage

Treatments	**Titrable Acidity (%)**				
	Days after Storage				
	1st	**10th**	**19th**	**28th**	Mean
T_1-Control	0.24	0.18	0.13	0.08	0.158
T_2-GA_3@50ppm	0.25	0.20	0.13	0.09	0.168
T_3-GA_3@100ppm	0.27	0.21	0.14	0.11	0.183
T_4-$CaCl_2$@1%	0.28	0.23	0.16	0.12	0.198
T_5- $CaCl_2$@2%	0.29	0.27	0.17	0.13	0.215
Mean	0.27	0.22	0.15	0.11	
Source	Treatments(T)	Days of storage(D)		Interaction(TXD)	
SE(d)	0.0010	0.0012		0.002	
CD(p=0.05)	0.0021	0.0024		0.004	

Table 5: Effect of preharvest treatments on Total sugar (%) of sapota var. PKM 1 under cold storage

Treatments	**Total sugar (%)**				
	Days after Storage				
	1st	**10th**	**19th**	**28th**	Mean
T_1-Control	11.18	11.78	13.12	14.87	12.74
T_2-GA_3@50ppm	10.78	11.43	12.63	14.45	12.32
T_3-GA_3@100ppm	10.54	11.12	12.34	14.12	12.03
T_4-$CaCl_2$@1%	10.31	10.76	12.13	13.79	11.75
T_5- $CaCl_2$@2%	10.12	10.44	11.36	13.34	11.32
Mean	10.59	11.11	12.32	14.11	
Source	Treatments(T)	Days of storage(D)		Interaction(TXD)	
SE(d)	0.070	0.079		0.158	
CD(p=0.05)	0.141	0.158		0.316	

Table 6: Effect of preharvest treatments of Reducing sugars (%) of sapota var. PKM 1 under cold storage

Treatments	**Reducing sugar (%)**				
	Days after Storage				
	1st	**10th**	**19th**	**28th**	Mean
T_1-Control	6.32	6.84	7.47	8.43	7.27
T_2-GA_3@50ppm	6.24	6.69	7.12	8.02	7.02
T_3-GA_3@100ppm	6.2	6.57	7.1	7.78	6.91
T_4-$CaCl_2$@1%	6.12	6.48	6.94	7.45	6.75
T_5- $CaCl_2$@2%	6.04	6.27	6.62	7.05	6.50
Mean	6.18	6.57	7.05	7.75	
Source	Treatments(T)	Days of storage(D)		Interaction(TXD)	
SE(d)	0.044	0.049		0.098	
CD(p=0.05)	0.088	0.098		0.197	

Table 7: Effect of pre harvest treatments on Shelf life of sapota var. PKM 1 under cold storage

Treatments	Shelf life
T_1-Control	21.75
T_2-GA_3@50ppm	22.3
T_3-GA_3@100ppm	22.5
T_4-$CaCl_2$@1%	26.3
T_5- $CaCl_2$@2%	28.0
Mean	24.15
SE(d)	0.58
CD(p=0.05)	1.28

Conclusion

On the basis of findings, it can be concluded that preharvest (30 days before harvest) spraying of $CaCl_2$@2% found effective for gradual increase in shelf life gradual increase in total soluble solids, total sugars, reducing sugars, with maximum acidity, ascorbic acid content and minimum physiological loss in weight and in sapota fruits.

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