



# Effect of Calcium and Coating Materials on Quality and Shelf Life of Guava (*Psidium guajava* L.) Cv. Allahabad Safeda under Cold Storage Condition

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

An experiment was conducted to study the effect of calcium and coating materials on quality and shelf life of guava (*Psidium guajava* L.) cv. Allahabad Safeda under cold storage condition during Rabi-2020 at Horticultural Research Farm and P.G. Laboratory, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat. Freshly harvested uniform sized fruits at proper physiological maturity were subjected to treatments comprising of different calcium chemical concentration viz., CaCl<sub>2</sub> 1%, CaNO<sub>3</sub> 2% and No chemical and with different coating materials (Coconut oil, Arabic gum, Olive oil and No coating). Total numbers of treatments are twelve with CRD factorial design. Periodic observations on 4<sup>th</sup>, 8<sup>th</sup>, 12<sup>th</sup>, 16<sup>th</sup> and 20<sup>th</sup> day of storage periods were taken. The study results revealed that fruits treated with CaCl<sub>2</sub> 1.0% when coated with coconut oil coating resulted in prolonging shelf life up to 20 days with minimizing physiological loss in weight (1.88%), spoilage (6.63%), TSS (11.85) and firmness (7.35%) with maintaining higher level of acidity (0.733), ascorbic acid (237.5), total sugar (4.48), reducing sugar and non-reducing sugar as compared to the control (No chemical and No coating). In this investigation, application of CaCl<sub>2</sub> 1% with coconut oil coating is increase shelf life up to 20 days of guava under cold storage with maintained physiological and bio-chemical characters.

**Keywords:** Guava; shelf-life; CaCl<sub>2</sub>; CaNO<sub>3</sub>; coating materials and physiological loss in weight.

## 1. INTRODUCTION

Guava (*Psidium guajava*) is one of the most important fruits and it is considered as 'apple of tropics' and 'poor man's apple' which belong to Myrtaceae family. Along with a number of other fruits, Guava originated in Tropical America. Guava is now grown in India, Brazil, Mexico, Florida (USA), Peru, South Africa, Egypt, West Indies, China and Malaysia. In India guava cultivated in Uttar Pradesh, Madhya Pradesh, Gujarat, Karnataka, Odisha, Bihar, Kerala, Rajasthan, Andhra Pradesh and Maharashtra. Allahabad district of Uttar Pradesh is major producer of guava. In Gujarat it is grown in Bhavnagar, Amreli, Kutch, Junagadh, Anand, Dahod, Surat and Gandhinagar.

India produces large quantity of this fruit but a great proportion of it, is lost due to inadequate post-harvest management practices and extremely low level of processing infrastructure of this fruit in our country. There are a number of factors behind low level of processing in India. Poor domestic demand is one of the reasons for inadequate development of processing sector, since Indians are more habitual of fresh consumption of fruits. Moreover, there is a huge gap between the prices of fresh fruits and processed products, so later are thought to be costly affair. This processing sector, due to lack of proper infrastructure facilities, equipment, hygienic conditions and latest know how, is unable to produce good quality of product, resulting into low demand of processed items in the market.

Use of the various post-harvest treatment that should be used for maintain fresh-like quality and nutritional value. There are various types of post-harvest treatment like physical, chemical and gaseous treatment should be used. Shelf life of fresh fruits can be extended through low temperature storage, edible coating and treatments with chemicals. Estimated that at least 60 percent of  $Ca^{+2}$  in plant associated with cell wall fraction. Calcium is one of the cell wall components and plays an important role in forming cross-bridges between pectins, resulting in calcium pectate complexes. Thus, these structures confer resistance to the cell wall and prevent their degradation [1]. Pure coconut oil as edible coating of fruit has gaining interest for its anti-senescence property by controlling respiration rate, transpiration rate and binding of ethylene biosynthesis process. Keeping all this in view, the present experiment was aimed to evaluate the effect of different calcium and

coating materials on quality and shelf life of guava (*Psidium guajava* L.) cv. Allahabad Safeda under cold storage Condition.

## 2. MATERIALS AND METHODS

The research experiment was carried out during Rabi-2020 at Horticultural Research Farm and P. G. Laboratory, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand. Uniform sized fruits of Allahabad Safeda cultivar were selected at proper physiological maturity. The fruits were dipped for 15 minutes in calcium allied chemicals and after drying in shady condition for 5 to 10 minutes, fruits are coated with different coating materials using spongy object. Treated fruits were then placed in CFB boxes followed by storing them in cold storage. The experiment was laid out in Completely Randomized Design with Factorial concept (FCRD) having twelve treatments combination comprising of  $CaCl_2$  1.0%,  $CaNO_3$  2%, different coating (coconut oil, Arabic gum olive oil) and with control three replications.

Fruit samples were analysed for physio-biochemical changes like physiological loss in weight (%), spoilage (%), firmness ( $Kgcm^{-2}$ ), total soluble solids ( $^{\circ}Brix$ ), acidity (%), ascorbic acid (mg/100g pulp), total sugar (%), reducing sugar (%) and non-reducing sugar (%). Observations recorded at every four (4) days intervals (i.e., 4<sup>th</sup>, 8<sup>th</sup>, 12<sup>th</sup>, 16<sup>th</sup> and 20<sup>th</sup> days) up to 20<sup>th</sup> days during storage.

## 3. RESULTS AND DISCUSSION

### 3.1 Physiological Parameters

#### 3.1.1 Physiological loss in weight (PLW) (%)

The data present in Table 1 indicated that the physiological loss in weight during storage is increased day by day due to loss of moisture through transpiration and respiration. In this experiment minimum PLW % (0, 0.66, 1.35, 2.08 and 3.46%) was recorded in  $T_1$  ( $C_1M_1-CaCl_2$  1.0% with coconut oil coating) on 4<sup>th</sup>, 8<sup>th</sup>, 12<sup>th</sup>, 16<sup>th</sup> and 20<sup>th</sup> day of observation as compared to control. Fruits coated with pure coconut oil recorded the minimum weight loss in guava. The reduction in weight loss might also be due to the maintenance of firmness of fruits by Effect of Post-Harvest Chemicals on Storability of Sapota CV. Kalipatti calcium as it decreased the enzyme activity responsible for cellular structure, which decreased the gaseous exchange [2].

This may be due to anti senescence property present in pure coconut oil help to slow storage break down associated with low respiration rate, transpiration rate and binding of the ethylene biosynthesis process Bisen et al. [3].

### 3.1.2 Spoilage

Data in Table 1 showed that there was no spoilage in all the treatments up to 4<sup>th</sup> and 8<sup>th</sup> days of storage. After that fast spoilage observed in all the treatments with advancement of storage regardless of the treatments. Among all the treatments minimum spoilage % was observed in (4.33, 5.55 and 10.02%) T<sub>1</sub> (C<sub>1</sub>M<sub>1</sub>-CaCl<sub>2</sub> 1.0% with coconut oil coating) on 12<sup>th</sup>, 16<sup>th</sup> and 20<sup>th</sup> day of storage as compared to control. which was at par with treatments C<sub>1</sub>M<sub>3</sub> (CaCl<sub>2</sub> 1% with olive oil) on 12<sup>th</sup> day and C<sub>2</sub>M<sub>1</sub> (CaNO<sub>3</sub> 2% with coconut oil coating) on 12<sup>th</sup> and 16<sup>th</sup> day of storage. The hydrolysis of metabolites in the stored fruits with the time was also a reason for spoilage. Similar findings were reported by Srinu et al. [4] in papaya. The fruit coating with coconut oil reduces the chances of disease growth on the fruit surface by sealing the stomatal openings and preventing the entry of pathogens inside the fruit. Similar results are reported by Nasrin et al. [5].

### 3.1.3 Firmness (Kgcm<sup>-2</sup>)

Data in Table 1 revealed that all the treatments exhibited non-significant effect for fruit firmness up to 4<sup>th</sup> and 8<sup>th</sup> day of storage. The maximum firmness (7.54, 6.95, 5.85, 4.53 and 3.96 Kgcm<sup>-2</sup>) was recorded in treatment T<sub>1</sub> (C<sub>1</sub>M<sub>1</sub>-CaCl<sub>2</sub> 1.0% with coconut oil coating) on 12<sup>th</sup>, 16<sup>th</sup> and 20<sup>th</sup> as compare to control, which was at par with treatment C<sub>3</sub>M<sub>1</sub>. Calcium as it was a part of cell wall as calcium pectate and also prevented membrane deterioration by restricting rapid peroxidation and its autocatalytic production results are correlated with the findings of Srinu et al. [4] in papaya. The decrease in fruit texture with the storage periods might be due to breakdown of insoluble pectin to soluble form and also due to cellular disintegration leading to permeability of the cell membrane which ultimately helps in gaseous exchange Mahajan et al. [6].

## 3.2 Bio-chemical Parameters

### 3.2.1 Total soluble solids (<sup>0</sup>Brix)

The data presented in Table 2 indicated that TSS content was increased up to 12<sup>th</sup> days of storage after that declined at end of storage period. The

maximum TSS (11.85, 12.06, 12.39, 11.55, 10.54, 8.06 and 5.36 <sup>0</sup>Brix) was recorded with the treatment T<sub>1</sub> (C<sub>1</sub>M<sub>1</sub>-CaCl<sub>2</sub> 1.0% with coconut oil coating), which were at par with treatment T<sub>5</sub> (C<sub>2</sub>M<sub>1</sub>) on 8<sup>th</sup> day of storage. The above results might be attributed to the reason that CaCl<sub>2</sub> coating retarded the ripening and senescence processes and simultaneously reduced the conversion of starch into sugars Kumar et al. [7] in sapota fruits are also in line with the present results. Coconut oil coated TSS might increase due to loss of water or due to conversion of organic acids into sugary substrate Owolabi et al. [8].

### 3.2.2 Acidity (%)

The data presented in Table 2 indicated there was decrease in acidity at day-to-day level of storage period. On 4<sup>th</sup> day of storage found maximum acidity was founded in T<sub>1</sub> (C<sub>1</sub>M<sub>1</sub>-CaCl<sub>2</sub> 1.0% with coconut oil coating) treated fruits. Which was at par with treatment C<sub>1</sub>M<sub>2</sub> and C<sub>1</sub>M<sub>3</sub> on 4<sup>th</sup> day of storage. Decrease in acidity might be attributed to the conversion of acid into sugars during respiration Srinu *et al.* [4]. The decreased in acidity during storage may be due to the use of organic acid as respiratory substrate during storage and conversion of acid into sugar because of ripening process noticed by Jawandha et al. [9].

### 3.2.3 Ascorbic acid (mg/100g pulp)

Data pertaining to ascorbic acid in the fruit are presented in Table 2. Ascorbic acid content is decreased at the end of storage period. The maximum value of ascorbic acid was founded in T<sub>1</sub> (C<sub>1</sub>M<sub>1</sub>-CaCl<sub>2</sub> 1.0% with coconut oil coating) (237.50, 226.52, 201.50, 187.56, 170.55mg/100 g pulp) on 4<sup>th</sup>, 8<sup>th</sup>, 12<sup>th</sup>, 16<sup>th</sup> and 20<sup>th</sup> day of storage respectively, which was at par with C<sub>2</sub>M<sub>1</sub> on 12<sup>th</sup> day of storage. The higher ascorbic acid content observed in calcium chloride treated fruits might be due to the breakdown of physiological process Srinu et al. [4]. Pure coconut oil and castor oil helped in reducing the rate of ripening which results in dissolution of ascorbic acid to dehydro ascorbic acid during storage Bisen et al. [10].

### 3.2.4 Total sugar (%), Reducing sugar (%) and non-reducing sugar (%)

The data presented in Table 3 revealed that effect of treatments on total sugar and reducing sugar was significant. The total sugar and reducing sugar were increasing up to 16<sup>th</sup> days of storage after it was decrease. The maximum

**Table 1. Effect of calcium and coating materials on Physiological loss in weight (%), Spoilage (%) and Firmness (Kgcm<sup>-2</sup>) of guava (*Psidiumguajava*L.) cv. Allahabad Safeda under cold storage condition**

Treatment combinations	Physiological loss in weight (%)					Spoilage (%)					Firmness (Kgcm <sup>-2</sup> )				
	Storage period in days					Storage period in days					Storage period in days				
	4 <sup>th</sup>	8 <sup>th</sup>	12 <sup>th</sup>	16 <sup>th</sup>	20 <sup>th</sup>	4 <sup>th</sup>	8 <sup>th</sup>	12 <sup>th</sup>	16 <sup>th</sup>	20 <sup>th</sup>	4 <sup>th</sup>	8 <sup>th</sup>	12 <sup>th</sup>	16 <sup>th</sup>	20 <sup>th</sup>
C <sub>1</sub> M <sub>1</sub>	0	0.66	1.35	2.08	3.46	0	0	4.33	5.55	10.02	8.73	7.72	7.54	6.95	5.85
C <sub>1</sub> M <sub>2</sub>	0	3.78	6.38	8.22	11.49	0	0	17.00	19.18	54.15	8.66	7.69	5.4	5.05	4.71
C <sub>1</sub> M <sub>3</sub>	0	1.11	1.75	2.83	6.21	0	0	5.33	12.34	26.90	8.64	7.66	7.10	6.11	5.18
C <sub>1</sub> M <sub>4</sub>	0	5.82	8.79	12.59	-	0	0	29.33	30.79	-	8.65	7.63	4.95	4.60	-
C <sub>2</sub> M <sub>1</sub>	0	0.90	1.64	3.45	5.21	0	0	5.00	6.72	22.38	8.65	7.63	7.21	6.36	5.32
C <sub>2</sub> M <sub>2</sub>	0	5.54	8.59	11.45	-	0	0	27.00	32.41	-	8.66	7.59	5.21	4.78	-
C <sub>2</sub> M <sub>3</sub>	0	1.60	2.13	3.69	8.79	0	0	12.66	16.57	26.90	8.68	7.55	6.21	5.46	4.93
C <sub>2</sub> M <sub>4</sub>	0	5.86	9.49	12.82	-	0	0	40.00	52.30	-	8.56	7.53	4.73	4.56	-
C <sub>3</sub> M <sub>1</sub>	0	2.01	3.02	3.72	9.14	0	0	14.66	17.00	40.42	8.63	7.53	6.10	5.30	4.88
C <sub>3</sub> M <sub>2</sub>	0	4.76	7.86	10.83	12.89	0	0	18.66	19.60	69.95	8.41	7.58	5.34	4.93	4.63
C <sub>3</sub> M <sub>3</sub>	0	3.63	3.26	5.24	9.19	0	0	14.00	18.29	45.49	8.50	7.55	5.95	5.19	4.78
C <sub>3</sub> M <sub>4</sub>	0	7.09	11.37	14.22	-	0	0	48.00	-	-	8.63	7.57	4.51	4.12	-
S.Em. ±		0.017	0.021	0.021	0.017	-	-	1.02	0.50	0.014	0.130	0.112	0.017	0.018	0.014
C.D. at 5%		0.048	0.062	0.060	0.051	-	-	2.99	1.46	0.04	NS	NS	0.051	0.55	0.042
C.V. %		1.93	0.68	0.47	0.54	-	-	9.05	4.51	0.10	2.61	2.56	0.51	0.62	0.74

**Table 2. Effect of calcium and coating materials on Total Soluble Solids (°Brix), Acidity (%) and Ascorbic acid (mg/100 g pulp) of guava (*Psidiumguajava*L.) cv. Allahabad Safeda under cold storage condition**

Treatment combinations	Total Soluble Solids (°Brix)					Acidity (%)					Ascorbic acid (mg/100 g pulp)				
	Storage period in days					Storage period in days					Storage period in days				
	4 <sup>th</sup>	8 <sup>th</sup>	12 <sup>th</sup>	16 <sup>th</sup>	20 <sup>th</sup>	4 <sup>th</sup>	8 <sup>th</sup>	12 <sup>th</sup>	16 <sup>th</sup>	20 <sup>th</sup>	4 <sup>th</sup>	8 <sup>th</sup>	12 <sup>th</sup>	16 <sup>th</sup>	20 <sup>th</sup>
C <sub>1</sub> M <sub>1</sub>	11.85	12.06	12.39	11.55	10.54	0.733	0.719	0.715	0.711	0.705	237.50	226.52	201.50	187.56	170.55
C <sub>1</sub> M <sub>2</sub>	10.5	10.58	10.71	9.80	6.21	0.716	0.688	0.682	0.675	0.668	216.50	194.93	159.40	134.54	135.45
C <sub>1</sub> M <sub>3</sub>	10.94	11.71	11.40	11.22	9.37	0.730	0.712	0.710	0.704	0.698	225.29	206.53	176.32	150.36	128.76
C <sub>1</sub> M <sub>4</sub>	9.94	10.30	10.18	7.17	-	0.693	0.671	0.665	0.657	-	213.71	183.52	148.49	122.73	-
C <sub>2</sub> M <sub>1</sub>	11.65	11.98	11.94	11.34	10.40	0.730	0.716	0.712	0.706	0.700	231.68	214.67	195.64	179.39	158.23
C <sub>2</sub> M <sub>2</sub>	10.21	10.49	10.42	7.98	-	0.7067	0.676	0.674	0.669	-	214.67	186.37	153.64	128.43	-
C <sub>2</sub> M <sub>3</sub>	10.91	11.29	11.01	10.36	8.38	0.693	0.698	0.695	0.688	0.682	221.69	201.01	167.39	141.66	120.53
C <sub>2</sub> M <sub>4</sub>	9.7	9.81	10.24	6.92	-	0.696	0.664	0.680	0.654	-	212.32	178.31	145.39	119.42	-
C <sub>3</sub> M <sub>1</sub>	10.57	10.87	10.89	10.13	7.95	0.720	0.694	0.691	0.706	0.678	219.57	200.27	164.64	139.39	117.23
C <sub>3</sub> M <sub>2</sub>	10.23	10.56	10.65	8.12	5.84	0.706	0.684	0.680	0.669	0.66	215.67	191.43	156.46	129.38	109.92
C <sub>3</sub> M <sub>3</sub>	10.43	10.69	10.75	9.95	6.25	0.720	0.690	0.686	0.688	0.671	217.67	196.09	161.40	136.40	115.43
C <sub>3</sub> M <sub>4</sub>	9.52	9.72	9.87	6.81	-	0.683	0.67	0.651	0.654	-	202.08	180.06	140.43	115.44	-
S.Em. ±	0.010	0.034	0.048	0.020	0.013	0.006	0.002	0.002	0.685	0.002	1.861	2.761	2.556	2.420	1.911
C.D. at 5%	0.055	0.101	0.140	0.058	0.038	0.017	0.006	0.005	0.673	0.005	5.432	8.060	7.461	7.063	5.57
C.V. %	0.30	0.55	0.76	0.37	0.42	1.44	0.49	0.47	0.54	0.67	1.47	2.43	2.70	2.99	3.76

**Table 3. Effect of calcium and coating materials on Total sugar (%), Reducing sugar (%) and Non- reducing sugar (%) of guava (*Psidium guajava*L.) cv. Allahabad Safeda under cold storage condition**

Treatment combinations	Total sugar (%)					Reducing sugar (%)					Non- reducing sugar (%)				
	Storage period in days					Storage period in days					Storage period in days				
	4 <sup>th</sup>	8 <sup>th</sup>	12 <sup>th</sup>	16 <sup>th</sup>	20 <sup>th</sup>	4 <sup>th</sup>	8 <sup>th</sup>	12 <sup>th</sup>	16 <sup>th</sup>	20 <sup>th</sup>	4 <sup>th</sup>	8 <sup>th</sup>	12 <sup>th</sup>	16 <sup>th</sup>	20 <sup>th</sup>
C <sub>1</sub> M <sub>1</sub>	8.48	8.99	9.58	10.31	9.61	4.53	4.65	4.88	5.21	4.63	3.95	4.34	4.70	5.11	4.98
C <sub>1</sub> M <sub>2</sub>	7.83	8.16	8.59	9.31	8.77	4.30	4.41	4.66	4.76	4.39	3.51	3.75	3.93	4.55	4.38
C <sub>1</sub> M <sub>3</sub>	8.37	8.68	9.18	9.91	9.22	4.48	4.57	4.79	5.08	4.56	3.77	4.04	4.39	4.83	4.66
C <sub>1</sub> M <sub>4</sub>	7.54	7.68	8.03	8.33	-	4.08	4.14	4.45	4.58	-	3.46	3.54	3.58	3.75	-
C <sub>2</sub> M <sub>1</sub>	8.23	8.55	9.25	9.95	9.25	4.42	4.60	4.82	5.13	4.59	3.89	4.08	4.43	4.82	4.66
C <sub>2</sub> M <sub>2</sub>	7.65	7.88	8.24	8.85	-	4.32	4.24	4.56	4.62	-	3.46	3.64	3.68	3.93	-
C <sub>2</sub> M <sub>3</sub>	8.18	8.61	9.11	9.83	9.15	4.46	4.56	4.77	5.06	4.45	3.72	3.86	4.34	4.77	4.62
C <sub>2</sub> M <sub>4</sub>	7.39	7.61	7.93	8.14	-	4.03	4.11	4.38	4.42	-	3.34	3.50	3.55	3.72	-
C <sub>3</sub> M <sub>1</sub>	8.05	8.43	8.87	9.51	8.98	4.42	4.61	4.72	4.95	4.45	3.63	3.82	4.15	4.56	4.53
C <sub>3</sub> M <sub>2</sub>	7.80	8.12	8.56	9.26	8.75	4.19	4.38	4.63	4.73	4.54	3.50	3.74	4.04	4.53	4.21
C <sub>3</sub> M <sub>3</sub>	7.88	8.24	8.72	9.34	8.85	4.35	4.43	4.68	4.81	4.45	3.56	3.81	4.68	4.53	4.40
C <sub>3</sub> M <sub>4</sub>	7.21	7.39	7.71	7.89	-	4.05	4.08	4.16	4.22	-	3.18	3.31	3.55	3.67	-
S.Em. ±	0.054	0.022	0.020	0.021	0.012	0.021	0.022	0.019	0.019	0.015	0.021	0.020	0.018	0.016	0.011
C.D. at 5%	0.157	0.065	0.059	0.060	0.036	0.062	0.064	0.057	0.056	0.043	0.062	0.059	0.053	0.47	0.033
C.V. %	1.18	0.47	0.40	0.39	0.35	0.85	0.86	0.73	0.69	0.85	1.02	0.93	0.77	0.64	0.64

total sugar and reducing sugar recorded in T<sub>1</sub> (C<sub>1</sub>M<sub>1</sub>-CaCl<sub>2</sub> 1.0% with coconut oil coating) on 4<sup>th</sup>, 8<sup>th</sup>, 12<sup>th</sup>, 16<sup>th</sup> and 20<sup>th</sup> day of storage. The 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. The present investigation is in conformity with the results reported by Desai [11] concluded that total sugars showed a similar trend of increase up to 20 days from storage followed by a decrease [12]. This may be due to rapid conversion of polysaccharides into sugars in the earlier stage and later to utilization of sugars in respiration. Jawandha et al. [9].

#### 4. CONCLUSION

From results obtained in this research experiment, it can be concluded that CaCl<sub>2</sub> 1.0% (dipping for 15 minutes) along with coconut oil coating improves the quality and prolongs the shelf life of guava cv. Allahabad Safeda under cold storage condition. The result revealed that CaCl<sub>2</sub> 1.0% with coconut oil coated fruits decreased physiological loss in weight and spoilage % and increase fruit firmness, TSS, acidity, ascorbic acid and total sugar with 20 days of shelf life under cold storage condition.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

- Hocking B, Tyerman SD, Burton RA, Gilliam M. Fruit calcium: Transport and physiology. *Frontiers of Plant Science*. 2016;(7):569.
- Tsomu T, Patel HC. Effect of post-harvest treatments of chemical and plant growth regulators on physical parameters of sapota fruit cv. Kalipatti. *Journal Food Process Technol*. 2014;5:347–49.
- Bisen A, Pandey SK. Effect of post-harvest treatments on biochemical and organoleptic constituents of Kagzi lime fruits during storage. *J. Hort. Sci*. 2008;3:53–56.
- Srinu B, Rao MA, Joshi VK, Reddy NS, Sharma H. Effect of different post-harvest treatments on quality and shelf life of papaya. *Journal Pharmacognosy and Phytochemistry*. 2017;6:1788–792.
- Nasrin, TAA, Isalam MN, Rahman MA, Arfin MS, Ullah MA. Evaluation of postharvest quality of edible-coated mandarin at ambient storage. *Int. J. Agric. Res. Innov. Technol*. 2018; 8: 18-25.
- Mahajan BVC, Kumar D. Dhillon WS. Effect of different polymeric films on the shelf life and quality of pear fruits under supermarket conditions. *Indian Journal of Horticulture*. 2013;70:309-12.
- Kumar A. Chauhan AS, Ravi R, Kudachikar VB. Influence of pre-treatments and storage condition on the quality of sapota (*Achras zapota*) fruit and on its processed product marmalade. *Int. J. Curr. Sci*. 2016;19:133–45.
- Owolabi IO, Sumethee S, Narumol M. Combined impact of peppermint oil and lime oil on mangosteen (*Garcinia Mangostana*) fruit ripening and mold growth using closed system. *Postharvest Biology and Technology*. 2021;175: 111488.
- Jawandha SK, Randhawa JS, Gill PPS, Sing J. Effect of Post-Harvest Treatment on Storage Quality in 'Umran' Ber Fruit. *Journal of Horticultural Sciences*. 2008;3:48-52.
- Bisen A, Pandey SK, Patel N. Effect of skin coatings on prolonging shelf life of kagzi lime fruits (*Citrus aurantifolia* Swingle). *J. Food Sci. Tech*. 2012;49 (6):753–759.
- Desai VN. Influence of pre-harvest spraying treatments of chemicals and plant growth regulators on quality parameters and shelf life of sapota [Manilkara achras (Mill.) Forsberg] fruits cv. Kalipatti M.Sc. Thesis Submitted to Anand Agricultural University. Anand (Gujarat). 2016;109-111.
- Mitra SK, Bose TK. *Fruits Tropical & Sub-tropical*. Naya Udyog, Calcutta. 2001;610-611.

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