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Effect of Post-Harvest Treatments on Shelf Life and Quality of Guava (*Psidium guajava* L.) cv. Allahabad Safeda

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A B S T R A C T

The present investigation entitled "Effect of Post-Harvest Treatments on Shelf Life and Quality of Guava (*Psidium guajava* L.) cv. Allahabad Safeda" was conducted at Fruit Research Station, Emalia, Department of Horticulture, College of Agriculture, J.N.K.V.V., Jabalpur (M.P.) during the year 2018- 2019. The experiment was laid out in Complete Randomized Design with three replications. The experiment consist of 15 treatment T_0 (Control), T_1 (Calcium Chloride @ 1%), T_2 (Calcium Nitrate @ 1%), T_3 (Potassium Permanganate @ 1%), T_4 (Azadirachta Decoction @ 10%), T_5 (Calcium Chloride @ 2% + Carbendazim 0.1%), T_6 (Calcium Chloride @ 3%+ Carbendazim 0.1%), T_7 (Calcium Nitrate @ 2% + Carbendazim 0.1%), T_8 (Calcium Nitrate @ 3% + Carbendazim 0.1%), T_9 (Sodium Benzoate@ 500ppm), T_{10} (Boric acid @ 300ppm), T_{11} (NAA @ 300ppm), T_{12} (NAA@ 400ppm), T_{13} (Mustard oil), and T_{14} (Cow urine). On the basis of result obtained in the present investigation, it is concluded that application of various chemical alone or in combination may be used for extending post-harvest shelf life of guava. The treatment T_7 (calcium nitrate @ 2.0% + Carbendazim 0.1% has been proved to be best post-harvest treatment for safe storage of guava cv. Allahabad Safeda in respect to minimum loss in physiological weight (12.04%), minimum decay (16.66%) and maximum - fruit size {length-(5.36cm)& diameter- (6.40cm)}, fruit volume (110ml) and specific gravity (0.590g/ml). TSS/acid ratio (17.76), Further, this treatment also maintained the fruit quality in terms of maximum - total soluble solids (10.77°Brix), acidity % (0.67%), Ascorbic acid (176.00mg/100g), total sugars (7.23%), reducing sugar (3.63%), and non-reducing sugar (3.90%) during storage up to 12th day of storage at the ambient room temperature. The treatment T_6 (Calcium Nitrate @ 3.0% + Carbendazim 0.1%) was found next best treatment in improving the shelf life and quality of fruit.

Introduction

Guava (*Psidium guajava* L.) known as "apple of tropics" belongs to family Myrtaceae. It is one of the dominant fruit crops of tropical and subtropical regions of India which bears delicious fruits in three different seasons' viz., summer, rainy and winter crops having lots of nutritional value and processing potential. In India, guava is the fourth most important fruit

crop in area and production after mango, banana and citrus. The total area, production and productivity of guava in India are about 2.60-million-hectare area with 3826 metric tonnes production and 15.93 metric tonnes ha^{-1} productivity, respectively. In Madhya Pradesh, total area, production and productivity of guava is 28.44 thousand hectare, 990 thousand million tonnes and 34.81 metric tonnes ha^{-1} respectively (Anonymous 2017). It has good potential in the fruit industry of our country because of its ability to withstand climatic vicissitudes, hardiness and cheapness, usefulness as dessert, preserved fruit and delicious taste. The fruit is an excellent source of vitamin C and pectin but has low energy (66 cal/100g), protein content (1%) and has 17% dry matter and 83% moisture. The fruit is also rich in mineral like phosphorous (24-37mg/100g), calcium (14-30mg/100g) and iron (0.6-1.4mg/100g) as well as vitamins like niacin, panthotenic acid, thiamin, riboflavin and vitamin A (Mitra and Bose, 2001). Fruit is pleasantly sweet and refreshingly acidic in flavor and emits sweet aroma.

Several delicious preserved products like jam, jelly, cheese, puree, ice cream, canned fruit and RTS are prepared from fruits of guava. Juice wine and pulp wine are also prepared from guava fruits. The seeds yield 3 to 13% oil, which is rich in essential fatty acid and can be used as salad dressing (Adsule and Kadam, 1995). It is a highly perishable fruit due to high moisture content. The post-harvest losses can be minimized by extension of shelf life through checking the rate of transpiration and respiration, microbial infection and protecting membranes from disorganization (Bisen and Pandey, 2008). During storage, physico-chemical and biological changes affect the final texture and quality of fruits. Post-harvest dipping treatment increases the shelf life of the fruits by retaining their firmness and control of the decaying organism (Ahmead *et al.*, 2005).

Materials and Methods

The present study was carried out in the Department of Horticulture, College of Agriculture, JNKVV, Jabalpur, (M.P.) during 2018-19. The mature and uniform size of guava fruits was procured from the Fruit Research Station Imalia. The experiment consist of 15 treatment T_0 (Control), T_1 (Calcium Chloride @ 1%), T_2 (Calcium Nitrate @ 1%), T_3 (Potassium Permanganate @ 1%), T_4 (Azadirachta Decoction @ 10%), T_5 (Calcium Chloride @ 2% + Carbendazim 0.1%), T_6 (Calcium Chloride @ 3%+ Carbendazim 0.1%), T_7 (Calcium Nitrate @ 2% + Carbendazim 0.1%), T_8 (Calcium Nitrate @ 3% + Carbendazim 0.1%), T_9 (Sodium Benzoate@ 500ppm), T_{10} (Boric acid @ 300ppm), T_{11} (NAA @ 300ppm), T_{12} (NAA@ 400ppm), T_{13} (Mustard oil), and T_{14} (Cow urine).

Results and Discussion

Bio-chemical parameters

Physiological loss in weight (%)

The data presented in Table 1 indicated that the physiological loss in weight during storage is characterized by reduction in fruit weight by the way of loss of moisture through evaporation and/or transpiration. In general, physiological loss in weight increases with the advancement of storage period**.** In the present investigation, the minimum physiological loss in weight (12.05%) at 12^{th} day during storage was recorded with T_7 (calcium nitrate 2.0% + Carbendazim 0.1%) closely followed by T_6 (calcium chloride 3% + Carbendazim 0.1%) and T_5 (calcium chloride 2% + Carbendazim 0.1%) against the maximum (21.04%) physiological loss in weight under T_0 (control). The possible reason for reduced weight loss by chemical might be due to evaporation and transpiration processes. Calcium extends the shelf life of guava fruit

by maintaining their firmness and minimizing respiration rate, proteolysis and tissue breakdown. It also acts as an anti-senescence agent by preventing cellular disorganization by maintaining protein and nucleic synthesis. Hiwale and Singh (2003), in guava fruits and Mahajan *et al.,* (2008) reported that the highest weight loss of untreated fruits is due to increased storage break down associated with higher respiratory rate as compared to calcium nitrate treated aonla fruits.

Similar findings had also been reported by Hiwale and Singh (2003) in guava fruits, Mahajan *et al.,* (2008) in plum cv. Sutlej Purple, Reshi *et al.,* (2013) and Bhooriya *et al.,* (2018).

Total soluble solids (°Brix)

The data presented in Table 1 indicated that there was increase in total soluble solids content up to 6th day of storage in all the treatments including control and later on decreased as the storage processed. Among treatments, T_7 (calcium nitrate 2.0% + Carbendazim 0.1%) recorded maximum TSS content (10.77°Brix), whereas minimum (7.64°Brix) under T_0 (control) at the end of storage period.

The increase in TSS during the initial stage may be attributed to the conversion of starches and other polysaccharides into soluble forms of sugars. The subsequent decrease in TSS at advanced stage is owing to the increased rate of respiration in later stages of storage resulting in its faster utilization in oxidation process through Krebs cycle.

Similar improvement and retention of TSS has also been reported with Calcium nitrate by Yadav and Varu (2013), Selvan and Bal (2005), Rajput *et al.,* (2008), Gangwar*et al.,* (2012) and Bhooriya *et al.,* (2018) in guava.

Acidity (%)

The data presented in Table 1 indicated that the gradual and progressive decrease in acidity was observed under all the treatments during storage and this progressive decline might be due to utilization of acid in metabolism. The maximum (0.67%) acidity during storage was observed in fruits treated in T_7 (calcium nitrate 2.0% + Carbendazim 0.1%) followed by T_6 (calcium chloride 3.0% + Carbendazim 0.1%) against the minimum (0.43%) under control. The decrease in acidity with calcium nitrate and sago has also been reported in by Jawadagi*et al.,* (2013) and Gohlani and Bisen (2012).

TSS/acid ratio

The data presented in Table 2 indicated that theThe TSS/acid ratio increased with the advancement of storage period up to 12th day of storage. The minimum TSS/acid ratio 16.07 was observed with the treatment T_7 (calcium nitrate 2% + Carbendazim 0.1%) which is superior over rest of the treatments. While, the treatment T_6 (calcium chloride 3% + Carbendazim 0.1%) which were closely followed by the treatments T_5 (calcium chloride 2% + Carbendazim 0.1%). The maximum 17.76 was recorded in T_0 (control). Similar results on grape were obtained by Morga*et al.,* (1979), Hamid, (2000), Abdel-Hamid *et al.,* (2004).

Ascorbic acid (mg/100g)

The data presented in Table 2 indicated that the ascorbic acid content decreased under all the treatments with the advancement of storage period. At the end of storage period the maximum (176.00 mg/100 g) ascorbic acid significantly decreased by the treatment T_7 (calcium nitrate 2% + Carbendazim 0.1%)) and the minimum (101.33 mg/100 g) ascorbic acid was observed in T_0 (control). Calcium

nitrate treatments increased the ascorbic acid content of fruits compared to control fruits. This might be a result of continued synthesis of L- ascorbic acid from its precursor glucose-6- phosphate and additive effect of slow rate oxidation in respiration process. The decrease in ascorbic acid with calcium nitrate has also been reported in guava by Patra and Sadhu (1992). Similar findings had also been reported by Jayachandran *et al.,* (2004) and Mahajan *et al.,* (2003) and Jatinder *et al.,* (2017).

Total sugars (%)

The data presented in Table 2 indicated that the total sugar increased initially with the highest on the 6th day of storage and thereafter declined. This trend was seen in all the treated fruits of guava cv. Allahabad Safeda and control also. The initial rise may be due to water loss from fruits through evapo-transpiration and inhibition of activities of enzymes responsible for degradation of sugars, while the subsequent decline may be due to utilization of sugars in respiration. Fruits treated with T_7 (calcium nitrate 2% + Carbendazim 0.1%) recorded the highest total sugar content (7.23%) and lower total sugar content (5.71%) observed in T_0 (control) at the 12^{th} day of storage. This may be due to slow hydrolysis of starch to sugars and gradual build-up of sugars in calcium treated fruits may also be attributed to retarded ripening. Calcium nitrate has also been reported in guava by Patra and Sadhu (1992) and Jayachandran *et al.,* (2004). Similar findings had also been reported bySelvan and Bal (2005).

Reducing sugars (%)

The data presented in Table 3 indicated that the different chemicals showed significant effect on the accumulation of reducing sugar. The significantly maximum reducing sugar 4.25, 4.37, 4.45, 3.75 and 3.63 was observed with T_7 (calcium nitrate2% + Carbendazim 0.1%) at 0,3,6,9 and 12 day of storage period, respectively. Whereas, the minimum reducing sugars percentage 4.26, 4.04, 4.11, 3.52 and 3.19 were recorded under T_0 (control) at 0, 3, 6, 9 and 12 days of storage, respectively.

The 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 had also been reported by Singh *et al.,* (2008), Agrawal and Jaiswal (2012), Jatinder *et al.,* (2017).

Non-reducing sugars (%)

The data presented in Table 3 indicated that the non-reducing sugar was found significantly maximum with T_7 (Ca $(NO_3)_2$ 2% + Carbendazim 0.1%) i.e. 3.59, 4.08, 4.45, 4.15 and 3.90 per cent at 0, 3, 6, 9 and 12 day of storage period, respectively. While, at 12 day of storage period the significantly maximum non-reducing sugar (3.90%) was found with T_7 [(Ca $(NO_3)_2$ 2% + Carbendazim 0.1%].

The increase in non-reducing sugar during storage was due to the conversion of starch into sugar. While, decreased in sugar may be due to the consumption of sugar for respiration during storage period. The findings obtained in the present investigation can be compared to those obtained by Agrawal and Jaiswal (2012), and Jatinder *et al.,* (2017).

Decay loss (%)

The data presented in Table 3 indicated that the losses due to decay were observed from 6^{th}day onwards and found to be increased significantly up to 12^{th} day of storage.

Table.1 Effect of different post-harvest treatments on physiological loss in weight per cent (PLW%), fruit length (cm) and fruit diameter (cm) of guava cv. Allahabad Safeda during storage

Treatments	PLW (%)					Total soluble solids (°Brix)					Acidity (%)				
	0Day	3rdDay	6thDay	9thday	12thDay	0Day	3rdDay	6thDay	9thday	12thDay	0Day	3rdDay	6thDay	9thday	12thDay
T_0-Control (water dipping)	0.00	7.83	11.9	15.01	21.04	9.63	9.76	10.11	8.60	4.43	0.73	0.69	0.62	0.53	0.43
T_1-Calcium chloride @ 1%	0.00	4.54	7.61	11.11	15.07	10.23	10.53	10.77	10.10	5.14	0.74	0.70	0.64	0.60	0.55
T_2-Calcium nitrate @ 1%	0.00	4.62	7.40	11.60	15.42	9.76	10.10	10.40	10.01	5.20	0.74	0.70	0.64	0.61	0.56
T_3-Potassium permanganate@ 1%	0.00	4.61	8.10	10.32	14.80	9.83	10.03	10.65	10.10	5.15	0.74	0.70	0.66	0.62	0.58
T_4-Azadirachta decoction @ 10%	0.00	3.89	7.05	9.75	13.81	9.76	11.40	11.47	10.49	5.23	0.75	0.72	0.66	0.62	0.57
T_5-Calcium chloride @ 2% + Carbendazim 0.1%	0.00	4.52	7.60	10.91	13.75	9.83	10.33	10.64	9.99	5.13	0.73	0.70	0.63	0.59	0.55
T_6-Calcium chloride @ 3%+ Carbendazim 0.1%	0.00	3.80	6.88	9.63	13.67	10.70	10.83	11.61	10.57	5.30	0.75	0.73	0.70	0.67	0.65
T_7-Calcium nitrate @ 2% + Carbendazim 0.1%	0.00	3.41	6.70	9.23	12.05	11.63	11.86	12.14	11.70	5.36	0.75	0.74	0.71	0.68	0.67
T_8-Calcium nitrate @ 3% + Carbendazim 0.1%	0.00	4.61	7.81	11.07	15.17	10.20	10.30	10.52	10.07	5.22	0.75	0.71	0.66	0.62	0.57
T_9-Sodium benzoate@ 500ppm	0.00	4.60	7.70	11.02	14.57	10.22	10.60	10.83	9.95	5.23	0.74	0.70	0.65	0.61	0.55
T_{10}-Boric acid @ 300ppm	0.00	4.68	8.17	12.13	15.81	10.21	10.56	10.80	10.35	5.15	0.74	0.70	0.66	0.62	0.56
T_{11}-NAA @ 300ppm	0.00	4.61	8.20	11.21	15.13	10.02	10.30	10.58	10.07	5.10	0.74	0.70	0.65	0.61	0.56
T_{12}-NAA@ 400ppm	0.00	4.45	8.14	10.9	14.21	10.45	10.63	10.88	10.16	5.13	0.74	0.70	0.65	0.61	0.57
T_{13}-Mustard oil	0.00	4.52	7.79	11.11	15.07	9.97	10.66	10.40	9.71	5.10	0.74	0.70	0.66	0.61	0.60
T_{14}-Cow urine	0.00	4.62	7.65	11.95	15.42	10.70	10.83	10.96	10.46	5.13	0.74	0.71	0.66	0.61	0.57
SEm±	**0.00**	**0.006**	**0.25**	**0.23**	**0.018**	**0.21**	**0.26**	**0.23**	**0.24**	**0.12**	**0.008**	**0.01**	**0.009**	**0.008**	**0.01**
CD at 5% level	**0.00**	**0.018**	**0.74**	**0.67**	**0.052**	**0.61**	**0.76**	**0.69**	**0.72**	**0.37**	**0.02**	**0.02**	**0.02**	**0.02**	**0.03**

Table.2 Effect of different post-harvest treatments on fruit volume, fruit decay (%) and specific gravity of guava cv. Allahabad Safeda during storage

Treatments	TSS/acid ratio					Ascorbic acid (mg/100g)					Total sugars (%)				
	0Day	3rdDay	6thDay	9thday	12thDay	0Day	3rdDay	6thDay	9thday	12thDay	0Day	3rdDay	6thDay	9thday	12thDay
T_0-Control (water dipping)	13.19	14.14	16.30	16.22	17.76	243.00	211.00	195.66	170.33	101.33	7.35	7.05	7.40	7.12	5.71
T_1-Calcium chloride @ 1%	13.82	15.04	16.82	16.83	16.81	244.66	227.66	215.00	192.00	162.33	7.61	8.14	8.64	7.62	6.45
T_2-Calcium nitrate @ 1%	13.18	14.42	16.25	16.40	16.87	244.33	226.00	216.00	191.66	162.66	7.53	8.17	8.43	7.53	6.48
T_3-Potassium permanganate@ 1%	13.28	14.32	16.13	16.29	15.87	244.66	235.00	216.33	191.33	161.33	7.62	8.16	8.69	7.57	6.56
T_4-Azadirachta decoction @ 10%	13.01	15.83	17.37	16.91	16.91	245.66	225.00	211.00	191.66	160.66	7.35	7.76	8.45	7.55	6.61
T_5-Calcium chloride @ 2% + Carbendazim 0.1%	13.10	14.75	16.88	16.88	16.10	244.00	221.66	215.33	191.33	161.66	7.55	8.25	8.62	7.43	5.87
T_6-Calcium chloride @ 3%+ Carbendazim 0.1%	14.36	14.82	16.58	16.47	16.38	246.00	235.33	227.00	195.66	163.00	7.62	8.46	8.70	7.64	7.09
T_7-Calcium nitrate @ 2% + Carbendazim 0.1%	15.50	16.02	17.09	16.20	16.07	246.00	241.00	230.33	198.66	176.00	6.88	8.53	8.72	7.84	7.23
T_8-Calcium nitrate @ 3% + Carbendazim 0.1%	13.60	14.50	16.01	16.24	16.17	242.66	223.33	215.66	190.33	162.33	7.88	8.43	8.52	7.56	5.80
T_9-Sodium benzoate@ 500ppm	13.81	15.14	16.66	16.31	16.23	243.33	224.00	220.00	192.00	161.33	6.82	7.36	7.75	6.86	5.83
T_{10}-Boric acid @ 300ppm	13.79	15.08	16.36	16.69	16.98	244.66	225.66	215.33	191.33	159.00	7.25	7.65	8.50	7.46	6.48
T_{11}-NAA @ 300ppm	13.54	14.71	16.27	16.50	16.12	245.33	226.00	215.00	190.33	162.00	6.51	7.47	7.99	7.22	5.78
T_{12}-NAA@ 400ppm	14.12	15.18	16.73	16.65	16.15	244.33	224.33	215.66	191.66	161.33	7.26	7.57	7.89	7.26	6.81
T_{13}-Mustard oil	13.47	15.22	15.75	15.91	16.66	244.33	226.00	217.66	190.66	162.00	6.52	7.30	7.61	7.35	6.72
T_{14}-Cow urine	14.45	15.25	16.60	17.14	16.80	246.33	225.00	215.66	192.00	161.00	7.55	8.18	8.41	7.40	6.29
SEm±	**0.09**	**0.05**	**0.10**	**0.12**	**0.06**	**0.79**	**0.57**	**0.57**	**0.33**	**1.18**	**0.04**	**0.04**	**0.08**	**0.07**	**0.13**
CD at 5% level	**0.28**	**0.14**	**0.30**	**0.36**	**0.17**	**N/A**	**1.67**	**1.67**	**0.96**	**3.43**	**0.12**	**0.14**	**0.23**	**0.21**	**0.39**

Table.3 Effect of different post-harvest treatments on reducing sugars (%),fruit decay (%) and non-reducing sugars (%)of guavacv. Allahabad Safeda during storage

Treatments	Reducing sugars (%)					Non-reducing sugars (%)					Decay (%)				
	0Day	3rdDay	6thDay	9thday	12thDay	0Day	3rdDay	6thDay	9thday	12thDay	0Day	3rdDay	6thDay	9thday	12thDay
T_0-Control (water dipping)	4.26	4.04	4.11	3.52	3.19	3.25	3.35	3.45	3.28	2.74	0.00	0.00	33.33	66.66	91.66
T_1-Calcium chloride @ 1%	4.24	4.27	4.33	3.65	3.50	3.43	3.66	3.82	3.58	3.25	0.00	0.00	16.66	41.66	58.33
T_2-Calcium nitrate @ 1%	4.28	4.32	4.36	3.68	3.50	3.35	3.80	4.00	3.52	3.30	0.00	0.00	16.66	41.66	58.33
T_3-Potassium permanganate@ 1%	4.20	4.31	4.30	3.70	3.53	3.13	3.46	3.63	3.33	3.23	0.00	0.00	16.66	41.66	58.33
T_4-Azadirachta decoction @ 10%	4.25	4.29	4.36	3.69	3.54	3.47	3.79	3.93	3.57	3.22	0.00	0.00	25.00	50.00	75.00
T_5-Calcium chloride @ 2% + Carbendazim 0.1%	4.25	4.27	4.35	3.68	3.53	3.32	3.83	4.14	3.88	3.32	0.00	0.00	16.66	41.66	58.33
T_6-Calcium chloride @ 3%+ Carbendazim 0.1%	4.01	4.36	4.41	3.73	3.58	3.53	3.88	4.26	3.90	3.68	0.00	0.00	8.33	16.66	25.00
T_7-Calcium nitrate @ 2% + Carbendazim 0.1%	4.25	4.37	4.45	3.75	3.63	3.59	4.08	4.45	4.15	3.90	0.00	0.00	0.00	8.33	16.66
T_8-Calcium nitrate @ 3% + Carbendazim 0.1%	4.23	4.27	4.33	3.70	3.52	3.35	3.75	4.10	3.83	3.18	0.00	0.00	16.66	41.66	58.33
T_9-Sodium benzoate@ 500ppm	4.27	4.25	4.44	3.64	3.44	3.25	3.70	4.21	3.78	3.24	0.00	0.00	16.66	41.66	58.33
T_{10}-Boric acid @ 300ppm	4.25	4.30	4.41	3.61	3.44	3.35	3.40	4.05	3.76	3.17	0.00	0.00	25.00	50.00	75.00
T_{11}-NAA @ 300ppm	4.25	4.25	4.32	3.66	3.42	3.10	3.38	3.98	3.49	3.15	0.00	0.00	25.00	50.00	75.00
T_{12}-NAA@ 400ppm	4.23	4.28	4.34	3.68	3.31	2.98	3.45	4.22	3.71	3.19	0.00	0.00	25.00	50.00	75.00
T_{13}-Mustard oil	4.27	4.25	4.35	3.57	3.41	3.27	3.71	4.11	3.70	3.18	0.00	0.00	25.00	58.33	83.33.
T_{14}-Cow urine	4.26	4.33	4.36	3.57	3.34	3.51	3.35	4.04	3.49	3.11	0.00	0.00	25.00	58.33	83.33
SEm±	**0.02**	**0.03**	**0.03**	**0.04**	**0.06**	**0.07**	**0.04**	**0.18**	**0.10**	**0.04**	**0.00**	**0.00**	**0.00**	**1.41**	**2.64**
CD at 5% level	**0.06**	**0.10**	**0.11**	**0.11**	**0.17**	**0.21**	**0.14**	**0.49**	**0.31**	**0.13**	**0.00**	**0.00**	**0.00**	**3.87**	**7.92**

Table.4(a) Economics of treatments for improving shelf life and quality of guava fruits/Quintal

Name of Chemicals (Treatments)	Required quantity of chemicals for 1 litre solution(gm)	Required quantity of chemicals for 10 litre solution (gm)	Rate ofchemicals (Rs.)	Total cost of chemicals for 10 litre solution(Rs.)
T_0-Control (water dipping)	0	0	0	0
T_1-Calcium chloride @ 1%	10	100	Rs.170/500gm	34
T_2-Calcium nitrate @ 1%	10	100	Rs.248/500gm	49.6
T_3-Potassium permanganate@ 1%	10	100	Rs.670/500gm	134
T_4-Azadirachta decoction @ 10%	100	1000	Rs.30/500gm	60
T_5-Calcium chloride @ 2% + Carbendazim 0.1%	20 + 1	200 + 10	Rs.170/500gm + 870/500gm	85.4
T_6-Calcium chloride @ 3% + Carbendazim 0.1%	30 + 1	300 + 10	Rs.170/500gm + 870/500gm	119.4
T_7-Calcium nitrate @ 2% + Carbendazim 0.1%	20 + 1	200 + 10	Rs.248/500gm + 870/500gm	116.6
T_8-Calcium nitrate @ 3% + Carbendazim 0.1%	30 + 1	300 + 10	Rs.248/500gm + 870/500gm	166.2
T_9-Sodium benzoate@ 500ppm	0.5	5	Rs.450/500gm	4.5
T_{10}-Boric acid @ 300ppm	0.3	3	Rs.470/500gm	2.82
T_{11}-NAA @ 300ppm	0.3	3	Rs.770/100gm	4.62
T_{12}-NAA@ 400ppm	0.4	4	Rs.770/100gm	6.16
T_{13}-Mustard oil	500ml	5000ml	Rs.90/500ml	450
T_{14}-Cow urine	500ml	5000ml	Rs.10 /500ml	100

Table.4(b) Economics of treatments for improving shelf life and quality of guava fruits/Quintal

Name of Chemicals (Treatments)	Total cost of chemicals for 10 litre solution (Rs.)	Cost of guava fruits (1Q) at the rate of Rs.30/kg at 0 days (Fresh)	Decay fruit after 12th day (kg)	Marketable fruits after 12th day (kg)	Market value of the fruits (Rs.) (Round value)
T_0-Control (water dipping)	0	3000	91.66	8.34	250
T_1-Calcium chloride @ 1%	34	3000	58.33	41.67	1250
T_2-Calcium nitrate @ 1%	49.6	3000	58.33	41.67	1250
T_3-Potassium permanganate@ 1%	134	3000	58.33	41.67	1250
T_4-Azadirachta decoction @ 10%	60	3000	75.00	25.00	750
T_5-Calcium chloride @ 2% + Carbendazim 0.1%	85.4	3000	58.33	50.00	1500
T_6-Calcium chloride @ 3% + Carbendazim 0.1%	119.4	3000	25.00	75.00	2250
T_7-Calcium nitrate @ 2% + Carbendazim 0.1%	116.6	3000	16.66	83.34	2500
T_8-Calcium nitrate @ 3% + Carbendazim 0.1%	166.2	3000	58.33	41.67	1250
T_9-Sodium benzoate@ 500ppm	4.5	3000	58.33	41.67	1250
T_{10}-Boric acid @ 300ppm	2.82	3000	75.00	33.34	1000
T_{11}-NAA @ 300ppm	4.62	3000	75.00	33.34	1000
T_{12}-NAA@ 400ppm	6.16	3000	75.00	33.34	1000
T_{13}-Mustard oil	450	3000	83.33	16.67	500
T_{14}-Cow urine	100	3000	83.33	16.67	500

However, the result showed minimum decayed fruits (8.33 and 16.66%) at 9 and 12 day of storage were obtained under T_7 treatments (calcium nitrate 2% + Carbendazim 0.1%) than the others.

The decayed fruits were noted about 33.33, 66.66 and 91.66% in the T_0 (control) after 6, 9th and 12th days. Rotting caused due to infection, makes the fruit soft and affected fruits develop bad odour**.** The dipping guava fruits in calcium nitrate and calcium chloride decreased fruit rot and preserved storage quality also treated fruits received significantly higher quality ratings than untreated fruits (control).

The current study demonstrates that application of calcium nitrate 2% + Carbendazim 0.1% has merit in reducing spoilage in guava fruits which may be due to their positive role in delaying the senescence of fruits by maintaining cell wall integrity and thus lowering the spoilage. Beneficial effects of calcium against post-harvest decay have been shown for various fruit species. The role of post-harvest calcium application decreased decay incidence has been reported in guava by Reshi *et al.,* (2013) and Singh *et al.,* (2007) in fruits of strawberry.

Economics of the treatment on the basis of the marketable guava fruits

Data presented in Table 4 a & b showed that all the treatments significantly influenced the marketable fruits over control. The treatment T_7 (Calcium nitrate 2.0% + Carbendazim 0.1%) proved better having with 83.34kgavailablemarketable fruits worth Rs.2500after 12 days followed by T_6 (Calcium chloride @ 3% + Carbendazim 0.1%) with 75kg marketable fruits worth Rs.2250. While, the treatment T_0 (control) recorded the minimum 8.34kg marketable fruits worth Rs.250 at 12 days after storage respectively.

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