

Original Research Article

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## Postharvest Treatments on Storage Life of Guava (*Psidium guajava* L.) in Himalayan Terai Region of West Bengal, India

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### ABSTRACT

Guava (*Psidium guajava* L.) is the fifth most important fruit crop of India, has a limited postharvest shelf life. This study explored the use of some postharvest treatments to extend the shelf life, post-harvest disease incidence and to assess the physico-chemical changes of fruits during storage and to study the effect of seasonal variation on quality and storage life of guava fruits (cv.L-49). Fully mature but green guava fruits were treated with different edible coating materials, chemicals, powder formulation of bio-control agent, hot water, and control. On the rainy and winter season, retention percent was found maximum with paraffin liquid 10%. Physiological loss in weight was minimum with the guar gum 1% in rainy season, paraffin 5% and gum acacia 10% in winter season. Regarding other horticultural traits like total soluble solids, ascorbic acid, total sugar, reducing sugar, non-reducing sugar content etc. were recorded maximum with gum acacia 10% in rainy season and winter. From this experiment, it is concluded that winter season guava fruits could be stored well as compared to rainy season fruits. Edible coating materials showed the better results in terms of extending the shelf life of guava fruits (cv. L-49) in both rainy and winter season as well as to maintain the qualities than the other chemicals.

#### Keywords

Edible coatings, chemicals, bio-control agent, guava, Storage Life.

#### Article Info

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### Introduction

Guava (*Psidium guajava* L.), belongs to the family Myrtaceae, is the fifth most important fruits of India in terms of production during 2014-15. Guava is one of the commonest fruits liked by poor and the rich people and also known as “The Apple of Tropics” (Bose and Mitra, 2011). Guava is being grown all over the sub-tropical and tropical world due to its high dietary value and good flavor. It is a highly palatable fruit with a rich source of vitamin C (Pal *et al.*, 2004) and it is a

climacteric fruits (Akamine and Goo, 1979; Markado-silva *et al.*, 1998); ripen rapidly after the harvest and has a short shelf life. Therefore, guava fruits are required to be managed appropriately in order to get a regulated market supply through postharvest treatments to improve the storage life. Keeping these viewpoints, the study was conducted with objectives to extend the marketable shelf life and to assess the physico-chemical changes of fruits during

storage and to study the effect of seasonal variation on quality and storage life of guava fruits cv. L-49 treated with different edible coating materials (guar gum, gum acacia, chitosan), chemicals (calcium chloride, paraffin liquid), powder formulation of bio-control agent (*Pseudomonas*), hot water.

## Materials and Methods

To conduct the experiment, fully mature but green guava fruits (cv. L-49) of two successive seasons (rainy and winter) were collected from an private orchard of Coochbehar district, West Bengal, India during the year 2013 and immediately brought to the laboratory of the Department of Pomology and Postharvest Technology, at Uttar Banga Krishi Viswa vidyalaya, Pundibari, Coochbehar, West Bengal, India for storage after necessary treatments. The fruits after washing in running tap water dried in the shade for few minutes. The fruits were treated with T<sub>1</sub>- CaCl<sub>2</sub> 1% (Dip in aqueous solution of calcium chloride 1% for five minutes), T<sub>2</sub>- CaCl<sub>2</sub> 2% (Dip in aqueous solution of calcium chloride 2% for five minutes), T<sub>3</sub>- Paraffin liquid 5% (Dipped for 30 seconds in 5% aqueous emulsion of liquid paraffin), T<sub>4</sub>- Paraffin liquid 10% (Dipped for 30 seconds in 10% aqueous emulsion of liquid paraffin), T<sub>5</sub>- *Pseudomonas fluorescence* 1% (Dipped for 5 minutes in 1% (*Pseudomonas fluorescence*) aqueous solution of pseudomonas), T<sub>6</sub>- *Pseudomonas fluorescence* 2% (Dipped for 5 minutes in 2% (*Pseudomonas fluorescence*) aqueous solution of pseudomonas), T<sub>7</sub>- Hot water (45<sup>0</sup>±2<sup>0</sup>C) (Immersed into hot water for 8 minutes at 45<sup>0</sup>C± 2<sup>0</sup> C in hot water bath chamber and then were hydro cooled rapidly), T<sub>8</sub>- Hot water (35<sup>0</sup>±2<sup>0</sup>C) (Immersed into hot water for 8 minutes at 35<sup>0</sup>C ± 2<sup>0</sup>C in hot water bath chamber and then were hydro cooled rapidly), T<sub>9</sub>- Chitosan 0.5% (To prepare 500 mL of 0.5% (w/v) chitosan solution, accurate weight of 2.5 g of chitosan were dispersed in 50 mL

of glacial acetic acid), T<sub>10</sub>- Chitosan 1% (To prepare 500 mL of 1% (w/v) chitosan solution, accurate weight of 5 g of chitosan were dispersed in 50 mL of glacial acetic acid), T<sub>11</sub>- Guar gum 1% (1g guar gum powder was mixed with 100 ml of water for the preparation of 1% solution), T<sub>12</sub>- Guar gum 2% (2g guar gum powder was mixed with 100 ml of water for the preparation of 2% solutions respectively), T<sub>13</sub>- Gum acacia 10% (Dissolve 100 mg of gum acacia powder in 1000 mL water. The solution was stirred with low heat, 40 °C for 30 minutes), T<sub>14</sub>- Gum acacia 20% (Dissolve 200 mg of gum acacia powder in 1000 mL water. The solution was stirred with low heat at 40 °C for 30 minutes), T<sub>15</sub>- Control (Without treatment).

A number of observations were recorded during storage period at an interval of 2 days, i.e., physical parameters of fruits like retention percent of fruits, physiological loss in weight, fruit weight loss % = (fruit weight at initial period – fruit weight at sampling period)/fruit weight at initial period × 100, diseases incidence percent (percentage of darken fruits due to fungal and mould growth), and bio-chemical parameters of fruits like total soluble solid (TSS) (recorded with the help of handrefractometer, (Mazumdar and Majumder, 2003), total sugar and reducing sugar (AOAC, 1984), ascorbic acid (Rangana, 1977).

## Statistical analysis

Analysis of variance (one way classified data) for each parameter was performed using ProcGlm of Statistical Analysis System (SAS) software (version 9.3). Mean separation for different treatment under different parameter were performed using Least Significant Different (LSD) test (P ≤ 0.05). Data transformation is done by following Gomez and Gomez (Gomez and Gomez, 1983).

## Results and Discussion

### Percentage of retention

Observation during storage of rainy and winter season guava fruits revealed that the retention percent (Table 1) was decreased in all the treatments as the storage period progressed. In rainy season, on 10 days after treatment, the retention percent was found highest (80.33%) with paraffin liquid 10%, followed by paraffin liquid 5% (79%), whereas, it was minimum (42%) in control. However, in winter season, on 12 days after treatment, the retention percent was found highest (86%) with paraffin liquid 10%, followed by paraffin liquid 5% (85.67%) and statistically at par with the other chemicals, whereas, it was minimum (74.67%) in control. In winter season, 12 days after treatment, the chemical property of fruits of all treatments was better but marketable quality decreased. Treatment with hot water (Wang *et al.*, 1963) and coating with wax emulsion (Ayranci and Tunc, 2003) also increased the shelf life of mango fruits.

### Weight Loss Percentage

Weight loss percentage increased significantly with the prolongation of the storage period for all treatments. Normally, the weight loss occurs during the fruit storage due to its respiratory process, the transference of humidity and some processes of oxidation (Ayranci and Tunc, 2003). In rainy season on 10 days after treatment, the physiological loss in weight was found minimum (7.15%) with guar gum 1% and statistically at par with paraffin liquid 5% (7.39%), whereas, it was maximum (10.49%) in control. However, on 12 days after treatment, the physiological loss in weight was found lowest (5.60%) with both paraffin liquid 5% and gum acacia 10% and statistically at par with the paraffin liquid 10% (5.62%) and gum acacia 20% (5.62%),

whereas, it was maximum (8.00%) in control (Table 2). The reduction in weight loss was probably due to the effects of these coatings as a semi permeable barrier against oxygen, carbon dioxide, moisture and solute movement, thereby reducing respiration, water loss and oxidation reaction rates (Baldwin, 1999).

### Disease incidence percent

It was found that the postharvest disease of guava was mainly due to anthracnose diseases caused by *Gloeosporium psidii*. The disease incidence percent was studied by visual observation from infected guava fruits. Observation during storage of rainy and winter season guava fruits revealed that the disease incidence percent (Table III) was increased in all the treatments as the storage period progressed.

In rainy season, on 10 days after treatment, the disease incidence percent was found lowest (4%) with paraffin liquid 10% which was statistically at par with paraffin liquid 5% (5%), whereas, it was maximum (26%) under control. However, in winter season, on 12 days after treatment, the disease incidence percent was found lowest (5%) with paraffin liquid 10%, whereas, it was highest (22%) under control. Passam (Passam, 1982) also reported that 'Doodooth' mango was highly susceptible to anthracnose but when the fruits were treated with hot water ( $52 \pm 2^{\circ}\text{C}$ ) containing 500-1000 mg/l benomyl the incidence of diseases was reduced.

### Total soluble solids (TSS)

TSS content during winter months was higher in general as compared to fruits harvested during rainy season (Table 4). It was increased up to a certain period and there after decreased in all the treatments as the storage period progressed.

**Table.1** Effect of different treatments on fruit retention (percent)

TREATMENTS	Days after treatments										
	Rainy season					Winter season					
	2	4	6	8	10	2	4	6	8	10	12
T <sub>1</sub> - CaCl <sub>2</sub> 1%	95.00 (77.19) bc	80.66 (63.93) ef	70.66 (57.21) c	59.67 (50.57) cdef	52.67 (46.53) cd	95.00 (77.19) bc	92.33 (74.07) abcd	90.00 (71.7) abc	87.67 (69.54) abc	85.00 (67.28) a	81.33 (64.5) abc
T <sub>2</sub> - CaCl <sub>2</sub> 2%	97.00 (81.85) abc	84.00 (66.51) cde	70.66 (57.22) c	58.67 (50) def	51.67 (45.96) d	97.00 (81.85) ac	93.33 (75.1) abc	91.00 (72.59) abc	88.00 (69.77) abc	85.33 (67.5) a	82.00 (64.94) abc
T <sub>3</sub> - Paraffin liquid 5%	100.00 (90) a	94.66 (76.73) a	90.00 (71.56) a	85.67 (67.76) a	79.00 (62.74) a	100.00 (90) a	97.00 (80.12) a	94.67 (76.66) a	92.33 (73.93) a	89.00 (70.64) a	85.67 (67.76) a
T <sub>4</sub> - Paraffin liquid 10%	100.00 (90) a	96.00 (69.06) a	93.33 (62) a	87.33 (56.11) a	80.33 (51.74) a	100.00 (90) a	96.67 (79.66) ab	94.33 (76.27) ab	92.00 (73.59) ab	89.00 (70.64) a	86.00 (68.05) a
T <sub>5</sub> - <i>Pseudomonas fluorescense</i> 1%	95.33 (80.01) abc	88.33 (70.11) b	78.33 (62.47) b	69.00 (56.27) b	56.67 (48.84) bc	96.00 (78.46) ac	91.33 (72.9) cd	88.67 (70.35) cd	86.00 (68.04) de	83.00 (65.67) ab	80.00 (63.44) abc
T <sub>6</sub> - <i>Pseudomonas fluorescense</i> 2%	96.00 (78.46) abc	88.66 (70.38) b	76.33 (60.89) bc	65.00 (53.73) bc	54.00 (47.3) bcd	93.33 (77.71) bc	86.33 (68.32) d	83.33 (65.95) d	81.00 (64.19) d	78.00 (62.05) b	78.33 (62.46) bc
T <sub>7</sub> - Hot water (45 ± 2 °C)	95.33 (80.01) abc	85.33 (67.52) bc	70.66 (57.21) c	57.67 (49.41) ef	47.33 (43.47) e	95.33 (79.97) ac	92.00 (74.00) abcd	89.33 (71.14) bcd	86.33 (68.44) de	86.67 (69.24) a	82.33 (65.55) ab
T <sub>8</sub> - Hot water (35 ± 2 °C)	97.66 (84.89) ab	81.33 (64.46) de	71.66 (57.89) c	57.67 (49.41) ef	44.67 (41.94) ef	97.67 (84.89) ab	93.67 (75.7) abc	91.00 (72.73) abc	88.33 (70.11) abc	85.00 (67.27) a	81.00 (64.19) abc
T <sub>9</sub> - Chitosan 0.5%	91.00 (72.59) c	82.00 (64.97) de	71.66 (57.86) c	60.00 (54.1) bc	52.33 (46.34) d	97.67 (84.89) ab	94.00 (76.22) abc	91.33 (73.17) abc	89.00 (70.78) abc	86.00 (68.1) a	82.33 (65.18) ab
T <sub>10</sub> - Chitosan 1%	93.33 (77.7) bc	87.33 (69.21) bc	73.66 (59.15) bc	62.67 (52.34) cde	45.33 (42.32) ef	95.33 (80.01) ac	91.33 (73.6) bcd	89.00 (70.93) bcd	86.67 (68.99) bc	83.33 (66.26) a	80.67 (64.19) abc
T <sub>11</sub> - Guar gum 1%	96.66 (83.85) abc	90.66 (60.89) fg	76.33 (60.89) bc	64.67 (53.53) bcd	57.67 (49.41) b	96.67 (83.85) ac	93.00 (75.26) abc	90.00 (69.69) cd	87.33 (69.34) abc	84.00 (66.59) ab	81.66 (64.81) abc
T <sub>12</sub> - Guar gum 2%	98.66 (86.15) ab	93.00 (60.89) fg	76.33 (60.89) bc	65.66 (54.13) bc	57.67 (49.41) b	98.67 (86.15) ab	95.67 (78.23) abc	93.00 (74.82) abc	90.00 (71.62) abc	86.67 (68.6) a	84.00 (66.44) ab
T <sub>13</sub> - Gum acacia 10%	97.66 (84.89) ab	92.66 (59.38) g	74.00 (59.38) bc	63.33 (52.73) bcde	53.00 (46.72) cd	95.33 (80.01) ac	92.67 (75.13) abc	90.00 (71.95) abc	88.67 (70.66) abc	85.67 (67.89) a	82.33 (65.18) ab
T <sub>14</sub> - Gum acacia 20%	95.33 (80.01) abc	89.66 (59.38) g	74.00 (59.38) bc	60.00 (50.77) cdef	51.67 (45.95) d	96.00 (78.46) ac	93.33 (75.05) abc	90.67 (72.23) abc	87.67 (69.49) abc	85.00 (67.24) a	82.33 (65.18) abc
T <sub>15</sub> - Control	96.00 (78.46) abc	87.33 (57.89) g	71.66 (57.89) c	56.33 (48.64) f	42.00 (40.41) f	91.00 (72.56) c	86.67 (68.62) d	83.67 (66.17) d	80.67 (63.93) d	78.00 (62.03) b	74.67 (60) c
Least Significant Difference (P<0.05)	11.765	3.430	3.790	3.640	2.37	11.77	6.16	5.42	4.73	5.01	5.17

\*\*Means with the same letter are not significantly different

**Table.2** Effect of different treatments on physiological loss in weight (percent)

Treatments	Days after treatments										
	Rainy season					Winter season					
	2	4	6	8	10	2	4	6	8	10	12
T <sub>1</sub> - CaCl <sub>2</sub> 1%	2.32ab	3.22d	4.63de	6.52dcd e	8.11c	1.61b	2.46c	3.37c	4.36c	5.47b	6.75cde f
T <sub>2</sub> - CaCl <sub>2</sub> 2%	2.07bc d	3.07d e	4.48e	6.26cde f	8.06c	1.60b	2.44c	3.35c	4.33d c	5.43b	6.70cde f
T <sub>3</sub> - Paraffin liquid 5%	1.51e	3.08d e	4.62de	5.88ef	7.39de	1.31b c	2.39c	3.27c	4.23d c	5.30b	5.60g
T <sub>4</sub> - Paraffin liquid 10%	1.68dc	2.85e f	4.10f	5.97ef	7.65cd e	1.05c	2.40c	3.28c	4.24d c	5.32b	5.62g
T <sub>5</sub> - <i>Pseudomonas fluorescence</i> 1%	2.08bc	3.40c d	5.28b	6.97bc	8.99b	1.59b	2.43c	3.33c	4.31d	5.40b	6.66def
T <sub>6</sub> - <i>Pseudomonas fluorescence</i> 2%	1.66e	3.39c d	5.27b	6.97bc	8.98b	1.61b	2.46c	3.36c	4.36c	5.47b	6.75cde f
T <sub>7</sub> - Hot water (45 <sup>o</sup> ±2 <sup>o</sup> C)	2.22ab	3.70c b	5.03bc	6.98b	9.02b	1.59b	2.42c	3.31c	4.28d c	5.37b	6.62f
T <sub>8</sub> - Hot water (35 <sup>o</sup> ±2 <sup>o</sup> C)	2.11bc	3.89b	4.95bc d	7.11b	9.18b	1.59b	2.42c	3.32c	4.29d	5.38b	6.64ef
T <sub>9</sub> - Chitosan 0.5%	2.19ab	3.79b	4.84cd	6.94bcd	9.12b	1.59b	2.69b c	3.61b c	5.18b	6.38a	6.81bcd e
T <sub>10</sub> - Chitosan 1%	2.20ab	3.35c d	4.77cd e	7.01b	8.96b	1.59b	2.69b c	3.88a b	5.18b	6.38a	6.82bcd
T <sub>11</sub> - Guar gum 1%	1.40e	2.52f	3.75g	5.70f	7.15e	1.59b	2.43c	3.89a b	5.20a b	6.40a	6.84bc
T <sub>12</sub> - Guar gum 2%	1.78cd e	3.12d e	4.61de	5.89ef	7.85cd	1.60b	3.00a b	3.93a b	5.27a b	6.50a	6.95b
T <sub>13</sub> - Gum acacia 10%	2.25ab	3.17d e	4.76cd e	6.09ef	8.15c	1.08c	2.39c	3.29c	4.26d c	4.74c	5.60g
T <sub>14</sub> - Gum acacia 20%	2.24ab	3.30d	4.89cd	6.24def	8.15c	1.06c	2.39c	3.30c	4.27d c	5.35b	5.62g
T <sub>15</sub> - Control	2.54a	4.31a	6.31a	8.18a	10.49a	2.39a	3.27a	4.24a	5.30a	6.54a	8.00a
Least Significant Difference (P≤0.05)	0.40	0.36	0.35	0.71	0.60	0.38	0.50	0.43	0.10	0.25	0.17

\*\*Means with the same letter are not significantly different

**Table.3** Effect of different treatments on disease incidence (percent)

Treatments	Days after treatments										
	Rainy season					Winter season					
	2	4	6	8	10	2	4	6	8	10	12
T <sub>1</sub> - CaCl <sub>2</sub> 1%	1 (3.33)a	6 (14.2)a b	11 (19.62)a	16 (23.56) ab	21(27.2 6)ab	1(3.3 3)a	4(11. 74)ab cd	9(17.0 2)a	12(20. 51)ab	16(23 .83)a b	20(26.5 6)ab
T <sub>2</sub> - CaCl <sub>2</sub> 2%	1 (3.33) a	5(12.8) a	10(18.20 )ab	15(22.3 2)ab	20(26.4 5)ab	1(3.3 3)a	4(11. 77)ab cd	7(15.2 6)a	11(18. 86)abc	13(21 .30)a bc	16(23.4 9)bc
T <sub>3</sub> - Paraffin liquid 5%	0(0)a	0(0)e	0(0)c	1(3.33) e	5(12.8)e	0(0)a	0(0)f	0(0)d	1(3.33) f	4(10. 96)ef	7(15.18) fgh
T <sub>4</sub> - Paraffin liquid 10%	0(0)a	0(0)e	0(0)c	1(3.33) e	4(11.38) e	0(0)a	0(0)f	0(0)d	1(3.33) f	3(7.6 3)f	5(13.11) h
T <sub>5</sub> - <i>Pseudomonas fluorescence</i> 1%	0(0)a	2(4.73) cde	2(4.73)c	6(14.2) cd	10(18.4 4)d	0(0)a	0(0)f	2(6.65) bc	4(9.42) ef	7(15. 29)de	10(17.8 2)efg
T <sub>6</sub> - <i>Pseudomonas fluorescence</i> 2%	0(0)a	0(0)e	0(0)c	4(11.38 )d	10(18.2 0)d	0(0)a	0(0)f	0(0)d	1(3.33) f	4(10. 96)ef	7(14.90) gh
T <sub>7</sub> - Hot water (45 <sup>o</sup> ±2 <sup>o</sup> C)	0(0)a	2(6.65) abcd	5(12.78) b	11(19.6 2)bc	21(27.2 6)ab	0(0)a	2(6.6 5) cdef	5(12.7 8)ab	10(18. 42) abcd	15(22 .52) ab	18(24.8 7)abc
T <sub>8</sub> - Hot water (35 <sup>o</sup> ±2 <sup>o</sup> C)	1 (3.33)a	6(14.2) ab	11(19.62 )a	14(21.9 7)ab	22(27.9 3)ab	1(3.3 3)a	6(14. 2)ab	10(18. 58)a	13(21. 33)ab	16(23 .80)a b	19(26.1) abc
T <sub>9</sub> - Chitosan 0.5%	2 (6.65)a	5(12.7 8)abc	10(18.44 )ab	16(23.5 6)ab	23(28.6 3)ab	1(3.3 3)a	2(4.3 0)ef	2(4.73) cd	5(12.8) cde	8(16. 36)cd	11(19.2 2)de
T <sub>10</sub> - Chitosan 1%	1 (3.33)a	5(12.7 8)abc	10(18.44 )ab	15(22.7 6)ab	19(25.8 2)ab	0(0)a	0(0)f	0(0)d	4(11.3 8)dc	8(16. 6)cd	11(18.9 1)def
T <sub>11</sub> - Guar gum 1%	1(3.33) a	4(9.47) abcd	8(15.38) ab	13(20.9 0)ab	18(24.5 5)bc	1(3.3 3)a	3(7.6 3)bcd e	6(14.2) a	11(19. 09)abc	14(22 .14)a b	18(25.0 6)abc
T <sub>12</sub> - Guar gum 2%	1(3.33) a	2(4.73) cde	5(12.8)b	10(18.2 0)bc	17(23.8 5)bc	1(3.3 3)a	2(4.7 3)def	5(12.4 7)ab	10(17. 92)abc d	12(20 .5)bc d	16(23.5 9)bc
T <sub>13</sub> - Gum acacia 10%	0(0)a	5(12.7 8)abc	9(17.02) ab	13(21.0 7)ab	18(24.8 4)bc	1(3.3 3)a	5(12. 78)ab c	9(17.0 2)a	12(20. 23)ab	15(22 .75)a b	18(24.8 4)abc
T <sub>14</sub> - Gum acacia 20%	0(0)a	1(3.33) de	2(4.73)c	6(14.2) cd	12(20.4 1)cd	0(0)a	1(3.3 3)ef	2(4.73) cd	6(14.2) bcde	12(19 .89)b cd	15(22.4 7)cd
T <sub>15</sub> - Control	3 (6.15)a	7 (15.6)a	13 (20.79)a	20(26.5 2)a	26 (30.84)a	2(6.6 5)a	7(14. 93)a	11(19. 05)a	15(23. 04)a	19(26 .1)a	22(28.2) a
Least Significant Difference (P≤0.05)	-	8.27	6.59	6.07	5.17	-	7.21	6.64	7.15	5.34	4.00

\*\*Means with the same letter are not significantly different

**Table.4** Changes in total soluble solids (Obrix)

Treatments	Days after treatments										
	Rainy season					Winter season					
	2	4	6	8	10	2	4	6	8	10	12
T <sub>1</sub> - CaCl <sub>2</sub> 1%	6.86a bc	7.30de	6.43cdef	5.85bc d	5.29b c	9.96cdef	10.60c d	11.26c def	11.73de fg	10.73c de	10.33c d
T <sub>2</sub> - CaCl <sub>2</sub> 2%	6.77a bc	7.37cd e	6.43cdef	5.78cd	5.33b c	10.40ab c	10.73a bcd	11.12d ef	11.66ef g	10.40e	10.00 de
T <sub>3</sub> - Paraffin liquid 5%	7.19a	7.73ab	6.91abc	6.48a	5.86a	10.66ab	11.27a b	11.79a b	12.26ab c	11.90a	11.13a b
T <sub>4</sub> - Paraffin liquid 10%	7.16a	7.67ab c	6.78abc d	6.25ab	5.63a b	10.66ab	11.27a b	11.89a	12.40ab	11.93a	11.13a b
T <sub>5</sub> - <i>Pseudomonas fluorescence</i> 1%	7.01a b	7.30de	6.32def	5.97bc	5.19c	10.33ab cd	10.73a bcd	11.20c def	11.60fg	10.99c d	10.06 de
T <sub>6</sub> - <i>Pseudomonas fluorescence</i> 2%	6.94a bc	7.37cd e	6.54abc de	5.93bc	5.29b c	9.93cdef	10.40c d	10.84f	11.73de fg	11.12 bc	10.73 bc
T <sub>7</sub> - Hot water (45 <sup>o</sup> ±2 <sup>o</sup> C)	6.77a bc	7.16e	6.45bcd ef	5.74cd	5.29b c	10.06bc def	11.00a bc	11.34b cdf	11.60fg	10.60 de	9.86de
T <sub>8</sub> - Hot water (35 <sup>o</sup> ±2 <sup>o</sup> C)	6.54b c	7.06e	6.16ef	5.68cd	5.19c	9.53f	10.2dd	10.99ef	11.46g	10.53 de	9.80e
T <sub>9</sub> - Chitosan 0.5%	6.46c	7.27de	6.46abc def	5.88bc d	5.42b c	9.80cdef	10.53c d	11.34b cde	12.00bc def	11.20 bc	10.80 bc
T <sub>10</sub> - Chitosan 1%	6.86a bc	7.19e	6.63abc de	5.88bc d	5.36b c	9.67ef	10.40c d	11.12d ef	11.80cd efg	11.12 bc	10.73 bc
T <sub>11</sub> - Guar gum 1%	7.26a	7.84ab	6.96ab	6.51a	5.93a	10.20ab cde	10.67b cd	11.44a bce	12.13ab cde	11.79a	11.06a b
T <sub>12</sub> - Guar gum 2%	7.13a	6.54bc d	6.73abc d	6.00bc	5.59a b	10.13bc def	10.73a bcd	11.50a bcd	12.20ab cd	11.60a b	10.93 b
T <sub>13</sub> - Gum acacia 10%	7.28a	7.91a	6.91abc	6.53a	5.95a	10.80a	11.33a	11.90a	12.60a	12.00a	11.26a
T <sub>14</sub> - Gum acacia 20%	7.25a	7.90a	6.98a	6.48a	5.86a	10.33ab cd	11.00a bc	11.64a bc	12.33ab	11.89a	11.20a b
T <sub>15</sub> - Control	6.74a bc	7.07e	6.00f	5.51d	5.16c	9.73def	10.53c d	11.20d ef	11.60fg	10.93c d	10.33c d
Least Significant Difference (P≤0.05)	0.55	0.34	0.52	0.40	0.36	0.67	0.66	0.50	0.53	0.49	0.51

\*\*Means with the same letter are not significantly different

**Table.5** Changes in total sugar content (mg)

Treatments	Days after treatments										
	Rainy season					Winter season					
	2	4	6	8	10	2	4	6	8	10	12
T <sub>1</sub> - CaCl <sub>2</sub> 1%	4.33 cd	5.11 bc	4.27 d	3.76def	3.29d e	6.11f	6.56h	6.88f	7.17 bc	6.49e	6.04 g
T <sub>2</sub> - CaCl <sub>2</sub> 2%	4.27 de	5.17 b	4.30 cd	3.67ef	3.33d e	6.67bc d	6.94b cde	7.02d e	7.17 bc	6.69c de	6.29 de
T <sub>3</sub> - Paraffin liquid 5%	4.72 a	5.51 a	4.77 a	4.26ab	3.89a	6.75ab c	6.98a bc	7.17a b	7.27 a	6.95a b	6.60 ab
T <sub>4</sub> - Paraffin liquid 10%	4.66 ab	5.53 a	4.56 b	4.19abc d	3.69a b	6.92a	7.07a	7.23a	7.29 a	6.92a b	6.62 a
T <sub>5</sub> - <i>Pseudomonas fluorescence</i> 1%	4.49 bc	5.05 bc	4.23 d	3.83bcd ef	3.19d e	6.83ab	6.91b cde	7.08c de	7.18 bc	6.62c de	6.27 e
T <sub>6</sub> - <i>Pseudomonas fluorescence</i> 2%	4.38 cd	5.18 b	4.35 cd	3.81cde f	3.29d e	6.52d	6.84d ef	7.00e	7.15 cd	6.63c de	6.26 e
T <sub>7</sub> - Hot water (45 <sup>o</sup> ±2 <sup>o</sup> c)	4.10 e	5.07 bc	4.25 d	3.65ef	3.30d e	6.59cd	6.72g	7.07d e	7.25 ab	6.76b cd	6.41 cd
T <sub>8</sub> - Hot water (35 <sup>o</sup> ±2 <sup>o</sup> c)	4.33 cd	5.11 bc	4.31 cd	3.86abc def	3.16e	6.28ef	6.57h	6.89f	7.08 d	6.66c de	6.21 ef
T <sub>9</sub> - Chitosan 0.5%	4.33 cd	5.12 bc	4.44 bc	3.75def	3.43c d	6.60bc d	6.94b cd	7.05d e	7.14 cd	6.83a bc	6.46 c
T <sub>10</sub> - Chitosan 1%	4.40 cd	5.11 bc	4.50 b	3.74def	3.35c de	6.50bc de	6.83e fg	7.07d e	7.14 cd	6.74b cd	6.48 bc
T <sub>11</sub> - Guar gum 1%	4.78 a	5.61 a	4.80 a	4.30ab	3.93a	6.71ab cd	6.79f g	7.07d e	7.11 cd	6.82a bc	6.33 de
T <sub>12</sub> - Guar gum 2%	4.65 ab	5.49 a	4.58 b	4.07abc de	3.59b c	6.54cd	6.87c def	7.03d e	7.12 cd	6.65c de	6.40 cd
T <sub>13</sub> - Gum acacia 10%	4.78 a	5.60 a	4.81 a	4.30a	3.93a	6.93a	7.01a b	7.17a bc	7.28 a	6.98a	6.64 a
T <sub>14</sub> - Gum acacia 20%	4.70 a	5.61 a	4.80 a	4.25abc	3.89a	6.63bc d	6.94b cd	7.10b cd	7.24 ab	6.99a	6.66 a
T <sub>15</sub> - Control	4.25 de	5.00 c	4.26 d	3.60f	3.13e	6.54cd	6.89c def	7.01d e	7.12 cd	6.59d e	6.13f g
Least Significant Difference (P≤0.05)	0.18	0.15	0.14	0.45	0.25	0.23	0.11	0.09	0.07	0.22	0.12

\*\*Means with the same letter are not significantly different



**Table.6** Changes in reducing sugar content (mg)

Treatments	Days after treatments										
	Rainy season					Winter season					
	2	4	6	8	10	2	4	6	8	10	12
T <sub>1</sub> - CaCl <sub>2</sub> 1%	2.30c def	3.03d e	2.30 d	2.04 a	1.70d ef	3.15d ef	3.27ef	3.3 5a	3.21 e	3.07 d	3.01d
T <sub>2</sub> - CaCl <sub>2</sub> 2%	2.20d efg	3.10c de	2.37 cd	2.03 a	1.75c de	3.16c def	3.26ef	3.3 3b	3.20 e	3.11 cd	3.02c d
T <sub>3</sub> - Paraffin liquid 5%	2.57a	3.30a b	2.70 ab	2.36 a	1.96a b	3.23a b	3.33ab c	3.4 1a	3.33 b	3.26 a	3.18a
T <sub>4</sub> - Paraffin liquid 10%	2.53a b	3.30a b	2.53 bc	2.32 a	1.87a bc	3.24a b	3.33ab	3.4 2a	3.35 ab	3.26 a	3.17a
T <sub>5</sub> - <i>Pseudomonas fluorescence</i> 1%	2.31b cde	3.14c de	2.37 cd	2.03 a	1.56g	3.16c def	3.26f	3.3 3b	3.20 e	3.14 bc	3.07b
T <sub>6</sub> - <i>Pseudomonas fluorescence</i> 2%	2.30c def	3.10c de	2.36 cd	2.08 a	1.68e fg	3.13f	3.25f	3.3 3b	3.20 e	3.15 bc	3.07b
T <sub>7</sub> - Hot water (45 <sup>0</sup> ±2 <sup>0</sup> c)	2.08g	3.03d e	2.36 cd	2.09 a	1.74c de	3.15e f	3.26ef	3.3 3b	3.2e	3.13 bc	3.05c
T <sub>8</sub> - Hot water (35 <sup>0</sup> ±2 <sup>0</sup> c)	2.27c def	3.14c d	2.31 d	2.12 a	1.77c de	3.15d ef	3.27de f	3.3 3b	3.21 e	3.16 b	3.04b cd
T <sub>9</sub> - Chitosan 0.5%	2.09f g	3.07d e	2.43 cd	2.08 a	1.74c de	3.20b cde	3.30ab cde	3.3 5b	3.27 c	3.15 bc	3.05b c
T <sub>10</sub> - Chitosan 1%	2.20d efg	3.00e	2.50 c	2.09 a	1.74c de	3.22a bc	3.28de f	3.3 3b	3.26 cd	3.14 bc	3.05b c
T <sub>11</sub> - Guar gum powder 1%	2.59a	3.34a b	2.71 a	2.26 a	1.83b cd	3.23a b	3.29cd ef	3.3 4b	3.27 cd	3.15 bc	3.07b
T <sub>12</sub> - Guar gum powder 2%	2.42a bc	3.23b c	2.50 c	2.06 a	1.81b cde	3.20b cde	3.32ab cd	3.3 6b	3.27 cd	3.16 b	3.07b
T <sub>13</sub> - Gum acacia 10%	2.60a	3.37a	2.73 a	2.38 a	1.98a	3.26a b	3.34a	3.4 1a	3.35 ab	3.28 a	3.19a
T <sub>14</sub> - Gum acacia 20%	2.40a bcd	3.12c de	2.50 c	2.00 a	1.76c de	3.27a	3.33ab c	3.4 3a	3.36 a	3.27 a	3.18a
T <sub>15</sub> - Control	2.17e fg	3.02d e	2.30 d	2.01 a	1.58f g	3.21a bcd	3.29bc def	3.3 3b	3.25 d	3.13 bc	3.02c d
<b>Least Significant Difference (P≤0.05)</b>	<b>0.22</b>	<b>0.13</b>	<b>0.17</b>	<b>0.44</b>	<b>0.14</b>	<b>0.06</b>	<b>0.04</b>	<b>0.03</b>	<b>0.02</b>	<b>0.04</b>	<b>0.03</b>

\*\*Means with the same letter are not significantly different

**Table.7** Changes in ascorbic acid content (mg/100g of pulp)

Treatments	Days after treatments										
	Rainy season					Winter season					
	2	4	6	8	10	2	4	6	8	10	12
T <sub>1</sub> - CaCl <sub>2</sub> 1%	161.57f	154.21h	149.41ef	142.16e	135.24gh	248.36cdef	243.25cd	236.15e	230.45g	225.31de	220.61de
T <sub>2</sub> - CaCl <sub>2</sub> 2%	165.17cde	159.61de	152.34cd	147.00c	140.27de	253.16ab	248.61a	242.00b	236.16cd	230.34c	224.39c
T <sub>3</sub> - Paraffin liquid 5%	167.24bc	162.00bcde	157.18b	151.00b	145.32c	253.21ab	249.38a	245.32a	240.84a	236.51a	230.34ab
T <sub>4</sub> - Paraffin liquid 10%	167.00bc	163.14ab	158.34ab	152.24b	146.23bc	253.17ab	248.31a	244.16a	239.64ab	235.61ab	229.16ab
T <sub>5</sub> - <i>Pseudomonas fluorescens</i> 1%	164.00de	156.00gh	150.05def	144.31de	137.26fg	247.00ef	241.28cd	235.34ef	230.61fg	225.64de	219.61de
T <sub>6</sub> - <i>Pseudomonas fluorescens</i> 2%	163.42ef	156.65fgh	150.82cde	142.25e	135.21gh	248.21cdef	243.34bc	237.57d	231.04fg	226.54d	220.31de
T <sub>7</sub> - Hot water (45 <sup>0</sup> ±2 <sup>0</sup> c)	163.12ef	155.26h	148.21f	144.28de	138.00ef	245.62f	239.27de	233.64f	227.34h	222.61f	218.16ef
T <sub>8</sub> - Hot water (35 <sup>0</sup> ±2 <sup>0</sup> c)	166.00bcd	158.36efg	151.45cde	144.34de	135.42gh	251.00abc	245.31b	240.21bc	234.54de	229.61c	221.52cd
T <sub>9</sub> - Chitosan 0.5%	165.16cde	158.32efg	152.37cde	146.29cd	140.28de	247.00ef	241.31cd	235.00ef	230.61fg	224.35ef	219.61de
T <sub>10</sub> - Chitosan 1%	165.32cde	159.45ef	153.12c	147.26c	141.33d	250.31abcd	242.30c	236.31de	230.00g	223.00f	215.61f
T <sub>11</sub> - Guar gum 1%	168.05ab	162.31bcd	157.61b	151.34b	148.36ab	249.31cde	245.31b	239.13c	232.65ef	226.35d	222.31cd
T <sub>12</sub> - Guar gum 2%	167.27bc	163.19ab	158.27ab	152.34b	145.23c	247.61def	243.21bc	237.61d	231.26fg	225.13de	220.61de
T <sub>13</sub> - Gum acacia 10%	170.00a	165.31a	160.20a	155.15a	150.10a	250.15bcde	245.16b	241.31b	237.61bc	234.61b	229.00b
T <sub>14</sub> - Gum acacia 20%	168.05ab	163.00abc	158.34ab	152.00b	148.10ab	253.42a	249.61a	244.31a	240.31a	236.10ab	232.15a
T <sub>15</sub> - Control	167.19bc	160.18cde	152.61c	145.26cd	133.28h	246.00f	238.09e	230.61g	223.06i	218.00g	210.31g
Least Significant Difference (P≤0.05)	2.39	2.87	2.34	2.37	2.37	3.17	2.33	1.42	2.16	1.73	3.13

\*\*Means with the same letter are not significantly different

In rainy season, on 10 days after treatment, TSS was found maximum (5.95<sup>0</sup>brix) with gum acacia 10%, followed by guar gum 1% (5.93<sup>0</sup>brix) and statistically at par with paraffin liquid 5%, 10%, and gum acacia 20%, whereas, it was minimum (5.16<sup>0</sup>brix) under control. Similarly, in winter season, on 12 days after treatment, it was found maximum (11.26<sup>0</sup>brix) with gum acacia

10% which was statistically at par with the gum acacia 20%, paraffin liquid 5% and 10%. The increase in TSS and sugar content during storage may possibly be due to hydrolysis of starch into sugars as on complete hydrolysis of starch no further increase occurs and subsequently a decline in these parameters is predictable as they along with other organic acids are primary substrate for respiration

(Wills *et al.*, 1980). Kagzi lime fruits treated with coconut oil recorded minimum (8.4%) increase in TSS followed by (8.5%) liquid paraffin wax (Bisen *et al.*, 2012).

### **Total sugar (TS)**

In rainy season, on 10 days after treatment, total sugar (Table 5) content was found maximum (3.93) with guar gum 1% and gum acacia 10% and statistically at par with paraffin liquid 5% (3.89), gum acacia 20% (3.89) and paraffin liquid 10% (3.69), whereas, it was minimum(3.13) under control. However, in winter season, on 12 days after treatment, total sugar content was found maximum (6.66) with gum acacia 20% and statistically at par with gum acacia 10% (6.64), paraffin liquid 10% (6.62) and paraffin liquid 5% (6.60), whereas, it was minimum (6.04) with calcium chloride 1%.

### **Reducing sugar**

In rainy season, on 10 days after treatment, reducing sugar content (Table 6) was found maximum (1.98) with gum acasia 10% and statistically at par with paraffin liquid 5% (1.96%) paraffin liquid 10% (1.87). In winter season similarly, maximum (3.19)reducing sugar content was recorded with gum acasia 10% and it was statistically at par with paraffin liquid 5% (3.18), paraffin liquid 10% (3.17) and gum acasia 20%(3.18).

### **Ascorbic acid**

The ascorbic acid content (Table 7) was decreased in all the treatments as the storage period advanced. In rainy season, on 10 days after treatment, the ascorbic acid content was found highest (150.1 mg/100g of pulp) with gum acacia 10% and statistically at par with the guar gum 1% and gum acacia 20%, whereas, it was lowest (133.28mg/100g of pulp) under control. However, in winter season, on 12 days after treatment, it was

found maximum (232.15mg/100g of pulp) with gum acacia 20% and statistically at par with the paraffin liquid 5% (230.34mg/100g of pulp) and 10% (229.16mg/100g of pulp), whereas, it was minimum (210.31mg/100g of pulp) under control. The ascorbic acid content (5.81 mg/100g) was more in peach fruits treated with paraffin liquid (20%) as compared to fruits under control (2.81 mg/100g) (Elham and Sawsan, 2013).

In conclusion, the fruit retention percentage in both the rainy and winter season was found maximum with paraffin liquid 10%. Physiological loss in weight was minimum in fruits treated with the guar gum 1% in rainy season and paraffin 5% and gum acacia 10% in winter season. Disease incidence was found minimum in the fruits treated with paraffin liquid 5% in both the seasons. Regarding other horticultural traits like TSS, ascorbic acid, total sugar, reducing sugar, content were recorded maximum with gum acacia 10% in rainy season guava fruits and gum acacia10% and 20% in winter season, respectively. From this experiment, it is concluded that winter season guava fruits could be store well as compared to rainy season fruits. Edible coating materials showed the better results in terms of extending the shelf life as well as the qualities of guava fruits than the other chemicals in both rainy and winter season.

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