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# Response of Post Harvest Treatments on Shelf Life of Custard Apple (*Annona squamosa* L.) variety Arka Sahan during Storage

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**A B S T R A C T**

A laboratory experiment was conducted on "Study on the effect of post harvest treatments on shelf life of custard apple (*Annona squamosa* L.) variety Arka Sahan during storage'' at department of fruit science, college of horticulture, Mandsaur. Experiment was statistically designed in Complete Randomized Design (CRD) with three replications. There were three components with 13 treatment combinations i.e. Calcium chloride at 2%, 4%, 6%, Benzyl adenine at 50ppm, 100ppm, 150ppm, Chitosan at 0.5%, 1.0%, 1.5% and their combinations and control. Physical parameter (Fruit length, Diameter and Specific gravity), Marketable and Spoilage of fruit, Biochemical parameters i.e. Total Soluble Solids, Titrable acidity and Ascorbic acid were observed. The result concluded that the higher combination of treatments (chitosan 1.5 % + BA 150 ppm + $CaCl_2$ 6.0 %) was found to be the best for enhanced the shelf life of fruit upto 12 days with good quality and appearance of fruits as compared to control.

## Introduction

Custard apple (*Annona squamosa* L.) is one of the finest fruits introduced in India from Tropical America. The undomesticated form of this fruit can be found in many part of India. It is also known as various names like Sugar Apple, sitaphal, sweet sop and sharifa. Fruit ripening nature of custard apple is climacteric i.e. sharp rise in respiration after harvest. Custard apple is very high perishable fruit crop with very short life of storage (Wills *et al.,* 2001). The edible portion or pulp is a creamy and granular with a good blend of sweetness. It contains protein (1.6 g), fat (0.5-0.6 g), carbohydrate (23.5 g), crude fiber (0.9-6.6 g), calcium (17.6 g), phosphorus (47 mg), iron (1.5 g), thiamine (0.075-0.119 mg), riboflavin (0.086- 0.175 mg), ascorbic acid (15.0-44.4 mg) and nicotinic acid (0.5 mg) per 100g of edible portion (Mahadevbhai and Patel, 2018). Cold storage is not promising. Moreover if fruit is allowed to remain on the tree for prolonged period, the pericarp splits to open facilitating deterioration. Because of custard apple is highly perishable, the fruits could not be send to distant markets. Commercialization of custard apple (*Annona squamosa*, L) is the biggest hinder for the custard apple growers due to its highly perishable nature. On an average, the postharvest shelf life of this fruit is only three to four days at ambient temperature. Therefore, it can commercialize only in the domestic market. An immediate consequence is a raise of the product's price. Hence, it is mandatory to develop a technology which allows to increase the custard apple post harvest shelf life, available to consumers with good quality and reasonable prize. It is also necessary to develop a technology which enables to extend the sugar apple postharvest shelf life, reaching the consumer with good sensory qualities and available at compensatory prices. Among the different methods, fruit coatings are one such alternative as they do not only improve external appearance, but also modify the internal atmosphere of fruits (Trung *et al.,* 2011).

Use of semi-permeable coatings has gained importance in reducing the moisture loss, transpiration, respiration and microbial attack with maintaining firmness at ambient condition (Patel *et al.*, 2011). Coatings make good oxygen and lipid barrier at low to intermediate RH because the polymers can effectively make hydrogen bonds (Sihag *et al.*, 2005). For instance use of benzyl adenine (antioxidant) acts as antisenescent, stop the metabolic break down deterioration caused by various biochemical activities in the fruits (Bhardwaj *et al.*, 2005). Calcium chloride has found promising new technology in maintaining fruit quality during storage, which alternative to disinfestations of fruit and could modify its response to other stresses. Chitosan dissolved in diluted organic acids can be used as a casting fluid to form a preservative membranous coating on the fruits that have been successfully used to maintain the quality and shows antifungal activity against several fungi (Trung *et al.*, 2011; Li and Yu, 2001). An immediate consequence is a raise of the product's price. Hence, it is necessary to develop a technology which enables to extend the sugar apple postharvest shelf life, reaching the consumer with good sensory qualities and available at compensatory prices by the application of edible coatings.

## Materials and Methods

Custard apple fruits were obtained from a KVK of Chittaurgarh, Rajasthan. The full matured fruits were subjected to uniform manual grading and used for experiment in the laboratory of department of fruit science in plastic crates. The fruits were cleaned with running tap water to remove the adherent dirt material and then spread in room. The fruits were disinfected with 0.1 % (w/v) bavistin solution for 2 minutes then fruits were dipped in the coating solutions of 13 treatment combinations i.e. Calcium chloride at 2%, 4%, 6%, Benzyl adenine at 50ppm, 100ppm, 150ppm, Chitosan at 0.5%, 1.0%, 1.5% and their combinations and control.

The chitosan solution (1%, wt/vol) was prepared by dissolving 1 % acetic acid to accelerate the dissolution process. The pH of the chitosan solution was adjusted to 5.6 using I N NaOH. After applications of treatments fruits were kept in the room temperature in plastic trays. Determination of fruit length and diameter determined by using vernier caliper. The TSS content of fruit was determined by using a digital refractometer, Acidity and

Ascorbic acid were determined by the method of Ranganna (1996).

## Results and Discussion

### Physical Parameters

The observations were presented as initial value (before treatment), 0 day, $4^{th}$ day, $8^{th}$ day and $12^{th}$ day. Reduction of fruit length showed an increasing trend with the increasing period of storage. The significantly minimum reduction in fruit length (0.00 cm, 0.14 cm, 0.22 cm and 0.42 cm) was observed with application of treatment $T_{12}$ ($CaCl_2$ 6.0 % + BA 150 ppm + Chitosan 1.5 %) and it was significantly at par with $T_{11}$ (0.15 cm, 0.24 cm and 0.43 cm) on the 4, 8, 12 days of storage period, respectively. While, the maximum loss in fruit length found with $T_0$ (0.00 cm, 0.25 cm, 0.35 cm and 0.55 cm) at 0, 4, 8 and 12 days of storage period, respectively. The loss in size of fruit diameter increase significantly in respect of different postharvest treatments up to 12 days. $T_{12}$ ($CaCl_2$ 6.0 % + BA 150 ppm + Chitosan 1.5 %) exhibited significantly minimum loss in fruit diameter (0.00 cm, 0.15 cm, 0.26 cm and 0.45 cm) on 0, 4, 8 and 12 days of storage period. Treatment ($T_{11}$) statistically at par with the treatment $T_{12}$ (0.16 cm, 0.27 cm and 0.46 cm) at 4, 8, 12 days of storage period, respectively. While, the maximum loss of fruit diameter among all the treatments was found with the control $T_0$ (0.00 cm, 0.26 cm, 0.37 cm and 0.58 cm) on the 0, 4, 8, 12 days of storage life respectively. Post-harvest treatments of Chitosan, Benzyl adenine and $CaCl_2$ did not significant on specific gravity over control. Although, it was showed in decreasing trend under all the post harvest treatments (Table-1).

This may be due to the combined effect of chitosan, benzyl adenine and calcium chloride. Chitosan provided better way to reduce the evaporation and avoided shrinkage resulting minimum reduction in fruit length and diameter (Medlicott *et al.,* 1987). The maintenance of flesh firmness of chitosan coated fruits might be due to the antifungal activity of chitosan and formation of semi permeable barrier around the fruit surface, thereby reducing infection, gas exchange and other ripening processes during storage (Shiekh, *et al.,* 2013). BA has a free radical and to extinguish property which hinder ethylene biosynthesis, caused retardation of senescence and also reduced the shrinkage of fruits during storage period in mango (Thokchom and Mandal., 2019). Similar result obtained in mandarin cv. Nagpur Santra (Bhardwaj *et al.,* 2005). Calcium chloride at higher concentrations served as a semi-permeable membrane around the fruit-surface resulting in reduction in evapo-transpiration and in the rate of respiration (Lal *et al.,* 2011). The lower microbial growth and weight loss when the combined effect of calcium chloride with chitosan was applied over the mangoes (Chouhan, *et al.,* 2014). Similar findings also reported by (Abdel *et al.,* 2017) on shelf life of peach fruit.

### Marketable and spoilage parameters

The effect of various treatments on percentage of marketable fruits was observed significantly during storage of custard apple fruit at ambient temperature. The most of the marketable fruits were retained marketable till 4 to 8 days after storage without deteriorating their quality when fruits treated with different concentration of Chitosan, $CaCl_2$, Benzyl adenine. Among all the treatments effect of coating on the marketable and spoilage fruit revealed that higher combinations ($T_{12}$ -$CaCl_2$ -6.0% + BA- 150 ppm + Chitosan- 1.5%) performed well on marketable fruit recorded maximum (95.46%, 87.04% and 65.31 %). reducing loss of spoilage (4.54%, 12.96%, 34.69 %) on the days 4, 8, 12 of storage period respectively, over rest of treatments.

**Table.1** Effect of postharvest treatments on physical parameters of custard apple fruits

| Symbol | Treatment details | Initial Value | Reduction in Fruit length (cm) | | | | Initial Value | Reduction in Fruit diameter (cm) | | | | Initial Value | Specific gravity | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0 days | 4 day | 8 day | 12 day | | 0 days | 4 day | 8 day | 12 day | | 0 days | 4 day | 8 day | 12 day |
| **To** | **Control** | 5.33 | 0.00 | 0.25 | 0.35 | 0.55 | 5.77 | 0.00 | 0.26 | 0.37 | 0.58 | 1.23 | 0.00 | 0.07 | 0.06 | 0.05 |
| **$T_1$** | **$CaCl_2$ (2.0 %)** | 5.83 | 0.00 | 0.23 | 0.33 | 0.54 | 6.21 | 0.00 | 0.23 | 0.33 | 0.55 | 1.25 | 0.00 | 0.08 | 0.04 | 0.04 |
| **$T_2$** | **$CaCl_2$ (4.0 %)** | 5.54 | 0.00 | 0.17 | 0.28 | 0.47 | 5.90 | 0.00 | 0.19 | 0.30 | 0.51 | 1.25 | 0.00 | 0.06 | 0.06 | 0.04 |
| **$T_3$** | **$CaCl_2$ (6.0 %)** | 5.13 | 0.00 | 0.16 | 0.26 | 0.46 | 5.73 | 0.00 | 0.18 | 0.29 | 0.50 | 1.23 | 0.00 | 0.05 | 0.05 | 0.04 |
| **$T_4$** | **Benzyl adenine (50 ppm)** | 5.58 | 0.00 | 0.20 | 0.30 | 0.51 | 5.92 | 0.00 | 0.21 | 0.31 | 0.53 | 1.22 | 0.00 | 0.06 | 0.05 | 0.05 |
| **$T_5$** | **Benzyl adenine (100 ppm)** | 5.29 | 0.00 | 0.18 | 0.28 | 0.48 | 5.85 | 0.00 | 0.19 | 0.29 | 0.49 | 1.28 | 0.00 | 0.05 | 0.05 | 0.04 |
| **$T_6$** | **Benzyl adenine (150 ppm)** | 5.37 | 0.00 | 0.18 | 0.27 | 0.47 | 5.65 | 0.00 | 0.18 | 0.28 | 0.48 | 1.22 | 0.00 | 0.06 | 0.05 | 0.05 |
| **$T_7$** | **Chitosan (0.5 %)** | 5.38 | 0.00 | 0.19 | 0.29 | 0.50 | 5.66 | 0.00 | 0.21 | 0.32 | 0.51 | 1.21 | 0.00 | 0.05 | 0.05 | 0.04 |
| **$T_8$** | **Chitosan (1.0 %)** | 5.96 | 0.00 | 0.17 | 0.27 | 0.47 | 6.63 | 0.00 | 0.18 | 0.28 | 0.49 | 1.25 | 0.00 | 0.05 | 0.05 | 0.04 |
| **$T_9$** | **Chitosan (1.5 %)** | 5.53 | 0.00 | 0.16 | 0.26 | 0.46 | 6.00 | 0.00 | 0.17 | 0.27 | 0.47 | 1.26 | 0.00 | 0.04 | 0.04 | 0.03 |
| **$T_{10}$** | **$CaCl_2$ (2.0 %) +BA (50 PPM) +Chitosan (0.5 %)** | 5.56 | 0.00 | 0.17 | 0.27 | 0.47 | 6.01 | 0.00 | 0.21 | 0.30 | 0.50 | 1.24 | 0.00 | 0.04 | 0.03 | 0.03 |
| **$T_{11}$** | **$CaCl_2$ (4.0 %) +BA (100 PPM) +Chitosan (1.0 %)** | 5.53 | 0.00 | 0.15 | 0.24 | 0.43 | 5.93 | 0.00 | 0.16 | 0.27 | 0.46 | 1.26 | 0.00 | 0.04 | 0.04 | 0.03 |
| **$T_{12}$** | **$CaCl_2$ (6.0 %) +BA (150 PPM) +Chitosan (1.5 %)** | 5.53 | 0.00 | 0.14 | 0.22 | 0.42 | 5.98 | 0.00 | 0.15 | 0.26 | 0.45 | 1.24 | 0.00 | 0.03 | 0.03 | 0.02 |
| | SEm± | | 0.00 | 0.01 | 0.01 | 0.01 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.01 | 0.01 | 0.00 |
| | CD at 5 % | | 0.00 | 0.03 | 0.03 | 0.03 | | 0.00 | 0.01 | 0.01 | 0.01 | | NS | NS | NS | NS |

**Table.2** Effect of postharvest treatments on Marketable (%) and Spoilage (%) of custard apple fruits

| Symbol | Treatment details | Initial Value | Marketable fruit (%) | | | | Initial Value | Spoilage fruit (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0 days | 4 day | 8 day | 12 day | | 0 days | 4 day | 8 day | 12 day |
| To | Control | 100.00 | 100.00 | 91.47 | 39.54 | 29.31 | 0.00 | 0.00 | 8.53 | 60.46 | 70.69 |
| $T_1$ | $CaCl_2$ (2.0 %) | 100.00 | 100.00 | 92.12 | 63.52 | 48.03 | 0.00 | 0.00 | 7.88 | 36.48 | 51.97 |
| $T_2$ | $CaCl_2$ (4.0 %) | 100.00 | 100.00 | 92.26 | 73.55 | 52.61 | 0.00 | 0.00 | 7.74 | 26.45 | 47.39 |
| $T_3$ | $CaCl_2$ (6.0 %) | 100.00 | 100.00 | 93.14 | 80.12 | 60.06 | 0.00 | 0.00 | 6.86 | 19.88 | 39.94 |
| $T_4$ | Benzyl adenine (50 ppm) | 100.00 | 100.00 | 92.31 | 75.23 | 54.70 | 0.00 | 0.00 | 7.69 | 24.77 | 45.30 |
| $T_5$ | Benzyl adenine (100 ppm) | 100.00 | 100.00 | 92.99 | 80.04 | 59.55 | 0.00 | 0.00 | 7.01 | 19.96 | 40.45 |
| $T_6$ | Benzyl adenine (150 ppm) | 100.00 | 100.00 | 94.43 | 82.53 | 62.01 | 0.00 | 0.00 | 5.57 | 17.47 | 37.99 |
| $T_7$ | Chitosan (0.5 %) | 100.00 | 100.00 | 92.43 | 79.41 | 57.90 | 0.00 | 0.00 | 7.57 | 20.59 | 42.10 |
| $T_8$ | Chitosan (1.0 %) | 100.00 | 100.00 | 93.16 | 80.57 | 60.84 | 0.00 | 0.00 | 6.84 | 19.43 | 39.16 |
| $T_9$ | Chitosan (1.5 %) | 100.00 | 100.00 | 94.75 | 84.61 | 62.48 | 0.00 | 0.00 | 5.25 | 15.39 | 37.52 |
| $T_{10}$ | $CaCl_2$ (2.0 %) +BA (50 PPM) +Chitosan (0.5 %) | 100.00 | 100.00 | 92.77 | 79.65 | 59.22 | 0.00 | 0.00 | 7.23 | 20.35 | 40.78 |
| $T_{11}$ | $CaCl_2$ (4.0 %) +BA (100 PPM) +Chitosan (1.0 %) | 100.00 | 100.00 | 95.11 | 85.30 | 64.90 | 0.00 | 0.00 | 4.89 | 14.70 | 35.10 |
| $T_{12}$ | $CaCl_2$ (6.0 %) +BA (150 PPM) +Chitosan (1.5 %) | 100.00 | 100.00 | 95.46 | 87.04 | 65.31 | 0.00 | 0.00 | 4.54 | 12.96 | 34.69 |
| | SEm± | | 0.00 | 0.14 | 0.92 | 0.52 | | 0.00 | 0.14 | 0.92 | 0.52 |
| | CD at 5 % | | 0.00 | 0.40 | 2.66 | 1.52 | | 0.00 | 0.40 | 2.66 | 1.50 |

**Table.3** Effect of postharvest treatments on Biochemical parameters of custard apple fruits

| Symbol | Treatment details | Initial Value | TSS ($^0$B) | | | | Initial Value | Acidity % | | | | Initial Value | Ascorbic Acid (mg/100mg) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0 days | 4 day | 8 day | 12 day | | 0 days | 4 day | 8 day | 12 day | | 0 days | 4 day | 8 day | 12 day |
| **To** | **Control** | 18.56 | 0.00 | 0.75 | 4.36 | 0.07 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 23.26 | 0.00 | 5.39 | 3.87 | 1.64 |
| **$T_1$** | **$CaCl_2$ (2.0 %)** | 19.54 | 0.00 | 0.94 | 4.52 | 0.18 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 24.03 | 0.00 | 5.86 | 4.95 | 1.98 |
| **$T_2$** | **$CaCl_2$ (4.0 %)** | 19.64 | 0.00 | 1.07 | 5.23 | 0.96 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 25.97 | 0.00 | 6.25 | 5.42 | 2.35 |
| **$T_3$** | **$CaCl_2$ (6.0 %)** | 20.03 | 0.00 | 2.08 | 5.42 | 1.12 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 26.15 | 0.00 | 6.78 | 5.75 | 2.59 |
| **$T_4$** | **Benzyl adenine (50 ppm)** | 19.55 | 0.00 | 0.97 | 4.90 | 0.66 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 24.30 | 0.00 | 6.07 | 5.12 | 2.00 |
| **$T_5$** | **Benzyl adenine (100 ppm)** | 20.11 | 0.00 | 1.60 | 5.26 | 1.07 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 25.98 | 0.00 | 6.42 | 5.64 | 2.48 |
| **$T_6$** | **Benzyl adenine (150 ppm)** | 20.68 | 0.00 | 2.30 | 5.44 | 1.32 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 26.14 | 0.00 | 6.82 | 5.95 | 2.62 |
| **$T_7$** | **Chitosan (0.5 %)** | 19.73 | 0.00 | 0.99 | 4.96 | 0.92 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 24.78 | 0.00 | 6.14 | 5.38 | 2.08 |
| **$T_8$** | **Chitosan (1.0 %)** | 20.86 | 0.00 | 1.78 | 5.39 | 1.11 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 26.52 | 0.00 | 6.65 | 5.69 | 2.54 |
| **$T_9$** | **Chitosan (1.5 %)** | 20.98 | 0.00 | 2.92 | 5.53 | 1.40 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 27.02 | 0.00 | 6.83 | 6.05 | 2.62 |
| **$T_{10}$** | **$CaCl_2$ (2.0 %) +BA (50 PPM) +Chitosan (0.5 %)** | 21.02 | 0.00 | 2.99 | 5.55 | 1.38 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 26.15 | 0.00 | 6.14 | 6.10 | 2.09 |
| **$T_{11}$** | **$CaCl_2$ (4.0 %) +BA (100 PPM) +Chitosan (1.0 %)** | 21.21 | 0.00 | 3.05 | 5.60 | 1.42 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 28.20 | 0.00 | 6.86 | 6.08 | 2.93 |
| **$T_{12}$** | **$CaCl_2$ (6.0 %) +BA (150 PPM) +Chitosan (1.5 %)** | 21.73 | 0.00 | 3.07 | 5.67 | 1.50 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | 29.55 | 0.00 | 7.33 | 6.10 | 2.94 |
| | SEm± | | 0.00 | 0.32 | 0.14 | 0.16 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | | 0.00 | 0.19 | 0.15 | 0.14 |
| | CD at 5 % | | 0.00 | 0.94 | 0.41 | 0.47 | 0.00 | 6.55 | 7.06 | 5.60 | 0.00 | | 0.00 | 0.55 | 0.44 | 0.41 |

Although, it was significantly at par with $T_{11}$ in case of marketable fruits (95.11 %, 85.30 % and 64.90 %) and Spoilage fruits (4.89 %, 14.70 % and 35.10 %) on the days 4, 8, 12 of storage period, respectively. While, minimum marketable fruit recorded (91.47%, 39.54% and 29.31 %) and maximum spoilage fruit (8.53%, 60.46 and 70.69 %) were noticed at 4, 8, 12 days of storage period respectively over all the treatments (Table 2).

Increase the marketable quality and shelf life of the fruit due to the inhibit ethylene synthesis and reduce the respiration rate by the combined effect of chitosan, benzyl adenine and calcium chloride. Chitosan provided the lowest rotted aonla fruits might be due to inhibition of sporulation and spore germination of rot causing fungus by wax coating treatment (Jakhar and Singh, 2008). As for the combination of chitosan and calcium chloride, its potential as fungal decay inhibitors has been reported also by Munoz *et al.,* (2008). Similarly result showed by El-Badawy,(2012) on peach. Results of this study are in agreement with previous reports by Jayachandran *et al.,* (2007) in Guava, Chauhan, (2014) in mango, Reddy, (2007) in papaya and Elham *et al.,* (2007) in apricot.

## Biochemical parameters

The biochemical parameters significantly influenced by the application of individual and combination of coatings on fruits during investigation**.** The effect of $CaCl_2$, BA and Chitosan coating on rate of changes of biochemical parameters on the day of 0, 4, 8 and 12 days of storage period respectively (Table-3). The higher combinations ($T_{12}$ - $CaCl_2$ -6.0% + BA- 150 ppm + Chitosan-1.5%) recorded maximum total soluble solids (0.00 $^0$B, 3.07 $^0$B, 5.67 $^0$B and 1.50 $^0$B) on 0, 4, 8 and 12 days of storage period, respectively. Minimum acidity (0.00 %, 42.25%, 45.59% and 46.37 %) and maximum ascorbic acid (0.00 mg/100gm, 7.33 mg/100gm, 6.10 mg/100gm and 2.94 mg/100gm) were observed with the application of higher combination of treatments $T_{12}$ over all the treatment combinations at 4, 8 and 12 days of storage duration respectively. While lowest total soluble solids (0.00 $^0$B, 0.75 $^0$B, 4.36 $^0$B and 0.07 $^0$B), ascorbic acid (0.00 mg/100gm, 5.39 mg/100gm, 3.87 mg/100gm and 1.64 mg/100gm) were recorded on 0, 4, 8 and 12 days of storage period of duration, respectively. The maximum acidity % (10.03 %, 20.03 % and 22.70 %) was found with treatment $T_0$ at 4, 8, 12 days of storage period, respectively (Table 3).

The combined effect of chitosan, calcium chloride and benzyl adenine maintain the quality and biochemical parameters due to the changes brought about in total soluble solids of fruits during ripening are mainly due to degradation of starch and accumulation of sugar. Chitosan and calcium chloride coating with combinations improve the quality and shelf life of mango (Chauhan, *et al.,* 2014). These results are in accordance with the findings of Jholgiker and Reddy (2007) in custard apple and Reddy *et al.,* (2014) in guava.

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