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Effect of Edible Coatings Chitosan and Calcium Gluconate on Sugars and Ascorbic Acid Content of Mango (*Mangifera indica* L.)

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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 edible coatings chitosan and calcium gluconate on ascorbic acid and sugars of mango (*Mangifera indica* L.) at College of Horticulture-Rajendranagar, SKLTSHU, Siddipet district, Telangana. The experiment was conducted with

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Completely Randomized Design including six treatments with different concentrations of edible surface coatings and observations were recorded at every three days interval up to end of shelf life. Among different treatments highest total sugars (11.95 %) were recorded by T2 - dipping in 2% edible chitosan coating, followed by T1 - dipping in 1% edible chitosan with highest ascorbic acid content (31.22 mg 100g-1) and T6 – control (untreated fruits) recorded the rapid changes i.e., increase and decrease in sugars and ascorbic acid as it ripens fast. Post-harvest coating of mango fruits with chitosan has resulted in increased sugars and ascorbic acid content compared to calcium gluconate and control.

Keywords: Mango; edible coating; chitosan; calcium gluconate.

1. INTRODUCTION

Mango (*Mangifera indica* L.) is the king of fruits, and belongs to the family Anacardiaceae. It is considered one of the most important tropical fruit of the world, originated in South East Asia. Mango holds special importance in India due to its origin, attachment to culture, heritage, unique taste, exotic flavour, its nutrition and extensive cultivation and it also widely accepted by other parts of the world. It has good nutritional value and is grown in tropical and sub-tropical countries around the world.

“Mango is a climacteric fruit, so it is necessary to study and understand the shelf life of mango under different treatments to mitigate postharvest losses. The shelf life of mango indicates the period between the time of harvest and the time of start of the rotting of fruits. It is a determining factor for marketing and industrial processing. Due to mishandling, inadequate storage or lack of postharvest technical knowledge, producers and traders have to face about 27% losses” [1].

“The application of edible coatings is one of the most innovative methods to extend the commercial shelf life of fruits and vegetables which slow down fruit ripening or lengthen fruit storage period. One of the fruit coating agents, which currently has a promising prospect, is chitosan” [2]. Chitosan is a natural polymer obtained by deacetylation of chitin shells of shrimp and other crustaceans. Chitosan has several advantages such as bio-compatibility, bio-degradability and no toxicity over other polysaccharides.

“Chitosan and its derivatives increase the shelf life of a wide range of vegetables and fruits by inhibiting decay. So, one of the interesting applications of this biopolymer is product preservation because of its ability to be used as a coating material. The function of chitosan as an antimicrobial material is attributed to amino groups or hydrogen bonding between chitosan and extracellular polymers” [3]. As a biopolymer, chitosan has excellent film-forming properties and can form a semipermeable film on fruit which may modify the internal atmosphere, as well as decrease weight loss and shrivelling due to transpiration and improve overall fruit quality.

“Among various organic acids, gluconic acid is the major one produced by phosphate solubilization by gram-negative bacteria. Gluconic acid is produced by the oxidative metabolism of glucose by dehydrogenase enzyme through microbial fermentation with different types of *Aspergillus niger* strains. Gluconic acid and its salts (gluconates) are being used extensively as chelating micronutrient agents in agriculture presently as they are suitable for soil or foliar applications and also suitable for drip irrigation. The chelated micronutrients of gluconates are required in lower quantities as compared to inorganic compounds as they are completely assimilated by crops” Elisha *et al.*, [4] Prasanna *et al*., [5].

The use of chelated particles especially chelated gluconates is more easily absorbed by plant leaves or roots as they are rich in organic matter. In the process of chelation, the positive charge of micro-nutrients is removed and allows a neutral or slightly negative charged chelated to move through the leaf and root pores more rapidly. As these plant pores are charged negatively, positively charged micronutrients get attached at the pore entrance and becomes difficult to the plant for assimilation, when chelated micronutrients are used there will be no restriction barrier as they are neutral in charge. These micronutrient chelated gluconic acid are available in different forms like calcium gluconate, ferrous gluconate, potassium gluconate, zinc gluconate, magnesium gluconate, manganese gluconate and sodium gluconate.

Chitosan is a proven edible coating in improving the shelf life of mango Zhu *et al*., [6] and Zafrul *et al*., [1], research has also been done on use of calcium gluconates as edible coating in improving the quality and shelf life of guava [2]. In present study an effort has been made to compare chitosan and calcium gluconate as an edible surface coating to record its effect in improving shelf life and quality of mango.

2. MATERIALS AND METHODS

The experiment was conducted at College of Horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Telangana during the years 2021-22 and 20122-23. Mango fruits of variety "Banganpalli" were used for research were procured from Fruit Research Station-Sangareddy, Telangana.

The experiment was conducted in Completely Randomized Design with six treatments, three replications which includes T_1 - Dipping in 1% edible chitosan coating, T_2 - Dipping in 2% edible chitosan coating, T_3 - Dipping in 2% calcium gluconate, T_4 - Dipping in 1% edible chitosan coating + 2% calcium gluconate, T_5 - Dipping in 2% edible chitosan coating + 2% calcium gluconate, T_6 – Control.

2.1 Preparation of Chitosan Solution

For preparation of 1% and 2% chitosan solution dissolve 10g and 20g of chitosan powder in 0.1M 5.74ml acetic acid and 1 litre of distilled water respectively.

2.2 Preparation of Calcium Gluconate Solution

For the preparation of 1% and 2% calcium gluconate solution diluting 10ml and 20ml of calcium gluconate in 1 liter of distilled water respectively [1].

2.3 Methods of Application of Edible Coatings

For each treatment, seven fruits were selected and the fruits were washed thoroughly under running tap water to remove the adherent dirt material. Fruits were treated with 1% and 2% chitosan solution for 10 minutes and then allowed to air dry for 20-30 minutes in the shade, similarly, fruits were dipped in 1% and 2% calcium gluconate solution for 10 minutes and air-dried. The analysis of the fruits was done at every 3 days intervals. 3 fruits in each treatment were undisturbed for evaluation of physiological loss in weight, spoilage and shelf life. The remaining was used for analyzing the physical and quality parameters.

2.4 Total Sugars (%)

Total sugars were determined by Lane and Eynon [7] method. The clarified lead-free solution (50 ml) was taken into a 250 ml volumetric flask and to it 10 ml of HCl was added, mixed well and allowed to stand at room temperature for 24 hours. The solution after 24 hours was neutralized with NaOH using a drop of phenolphthalein as an indicator and volume was made up. The solution was taken into a burette and titration was carried out against standard Fehling's solution mixture of A and B (1:1) using methylene blue as an indicator and taking brick red colour as an endpoint.

$$\text{Total sugars (\%)} = \frac{\text{Factor x Volume made up}}{\text{Titre value x Weight of sample}} \text{ X } 100$$

2.5 Reducing Sugars (%)

Reducing sugars were determined by Lane and Eynon [7] method. Ten grams of fruit pulp was taken and ground well and transferred to a 250 ml volumetric flask, and 100 ml of water was added. Two ml of lead acetate solution (45%) was added and kept for 10 minutes for precipitation of colloidal matter. Potassium oxalate (22%) of 2 ml was added to remove the excess lead and the volume was made up to 250 ml and filtered through Whatmann No. 4 filter paper. The lead-free solution was filled into a burette and titrated against 10 ml of standard Fehling's solution mixture of A and B (1:1) using methylene blue as an indicator till the end point was indicated by the formation of a brick red precipitate. The titration was carried out by keeping Fehling's solution boiling on the heating mantle. The results were expressed as percent reducing sugar.

$$\text{Reducing sugars (\%)} = \frac{\text{Factor x Volume made up}}{\text{Titre value x Weight of sample}} \text{ x } 100$$

2.6 Non-Reducing Sugars (%)

Non-reducing sugars in a sample are obtained by subtracting reducing sugars from total sugars.

Non-reducing sugars (%) = Total sugars - Reducing sugars

2.7 Ascorbic Acid

Ascorbic acid was estimated by the Indophenol method [8]. Ten grams of fresh fruit pulp was ground well and blended with 3% Meta phosphoric acid (HPO_3) and the volume was made up to 100ml with HPO_3 solution. An aliquot of 10ml was taken and titrated against standard dye solution (2, 6 dichlorophenol indophenol dye) till light pink colour persist for at least 15 seconds. Standardization of dye (dye factor) was done by titrating it against standard ascorbic acid diluted in 3% HPO_3 solution. The ascorbic acid was calculated using the following formula and expressed as mg ascorbic acid per 100 g fresh weight.

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre x Dye factor x Vol. made up x 100}}{\text{Wt. of sample x Aliquot take}}$$

Dye factor = 0.5 / Titre value

3. RESULTS AND DISCUSSION

3.1 Total Sugars (%)

The synergistic effect of edible coating chitosan and calcium gluconate of mango on total sugars was presented in Table 1.

Initially total sugars increases along with storage period up to 9th day and later it reduces till the end of shelf life. All the treatments have significant difference with respect to total sugars.

On 3rd day of the storage highest total sugars was recorded by T_5 - dipping in 2% edible chitosan coating + 2% calcium gluconate (12.75 %) which was on par with T_1 - dipping in 1% edible chitosan coating (12.72 %) and lowest total sugars percentage was recorded by T_4 – dipping in 1% edible coating chitosan + 2% calcium gluconate (11.60 %) followed by T_2 - dipping in 2% edible chitosan coating (11.96 %).

On 6th day, highest total sugars percentage was recorded by T_6 – control (14.76 %) followed by T_3 - dipping in 2% calcium gluconate (13.94) which was on par with T_1 (13.82 %) and T_2 (13.70 %) and lowest total sugars was recorded by T_4 – dipping in 1% edible coating chitosan + 2% calcium gluconate (12.84 %) followed by T_5 - dipping in 2% edible chitosan coating + 2% calcium gluconate (13.06).

On 9th day, T_6 – control (15.90) recorded highest total sugars which was on par with T_3 (15.90 %), T_2 (15.84 %) and T_1 (15.83 %) and lowest total sugars was recorded by T_5 - dipping in 2% edible chitosan coating + 2% calcium gluconate (15.00).

On 12th day, of the storage T_1 - dipping in 1% edible chitosan coating (13.70 %) recorded the maximum total sugars percentage followed by T_2 - dipping in 2% edible chitosan coating (13.61 %) and lowest was recorded by T_3 - dipping in 2% calcium gluconate (12.03 %) followed by T_4 – dipping in 1% edible coating chitosan + 2% calcium gluconate (12.86 %). While T_6 – control shown end of shelf life.

On 15th day, highest total sugars was recorded by T_1 - dipping in 1% edible chitosan coating (11.95 %) followed by T_2 - dipping in 2% edible chitosan coating (11.72 %). While T_3, T_4 and T_5 shown end of shelf life.

Chitosan coated fruits showed maximum sugars compared with calcium gluconate coated fruits. Similar increase in sugars due to chitosan was reported by Zafrul et al. [1] in mango and Prashanth et al. [3]in dragon fruits. Chitosan treatments formed a semi-permeable film around the fruit which suppressed ethylene production and restored TSS content in the fruit. Suppression of respiration also slows down the synthesis and use of metabolites resulting in lower TSS due to the slower hydrolysis of carbohydrates to sugars.

3.2 Reducing Sugars (%)

Results on the effect of edible coating chitosan and calcium gluconate of mango on reducing sugars was presented in the Table 2. Reducing sugars increases along with storage period until fruit ripens i.e. 9th day and later it reduces till the end of shelf life. There was a significant difference among all the treatments with respect to reducing sugars percentage.

On 3rd day, the highest reducing sugars was recorded by T_3 - dipping in 2% calcium gluconate (5.13 %) followed by T_1 - dipping in 1% edible chitosan coating (4.93 %) and the least reducing sugars percentage was recorded by T_5 - dipping in 2% edible chitosan coating + 2% calcium gluconate (4.00 %) followed by T_4 – dipping in 1% edible coating chitosan + 2% calcium gluconate (4.16 %).

On 6th day, T_6 – control (5.92 %) recorded the maximum percentage of reducing sugars followed by T_3 - dipping in 2% calcium gluconate (5.81 %) and minimum percentage of reducing sugars was recorded by T_5 - dipping in 2% edible chitosan coating + 2% calcium gluconate (4.67 %) followed by T_4 – dipping in 1% edible coating chitosan + 2% calcium gluconate (4.92 %).

On 9th day of storage highest reducing sugars was recorded by T_6 – control (6.93 %) followed by T_3 - dipping in 2% calcium gluconate (6.70 %) which was on par with T_1 - dipping in 1% edible chitosan coating (6.69 %) and lowest reducing sugars was recorded by T_4 – dipping in 1% edible coating chitosan + 2% calcium gluconate (6.00 %) followed by T_5 - dipping in 2% edible chitosan coating + 2% calcium gluconate (6.10 %).

On 12th day, highest reducing sugars percentage was recorded by T_1 - dipping in 1% edible chitosan (5.72 %) followed by T_2 - dipping in 2% edible chitosan coating (5.57 %) and lowest was recorded by T_4 – dipping in 1% edible coating chitosan + 2% calcium gluconate (4.92 %) followed by T_3 - dipping in 2% calcium gluconate (4.99 %). While T_6 – control shows end of shelf life.

Table 1. Effect of edible coating chitosan and calcium gluconate on total sugars (%) of mango (*Mangifera indica* L.) Cv. Banganpalli

Total sugars (%)					
Treatments	**3rd Day**	**6th Day**	**9th Day**	**12th Day**	**15th Day**
T_1	12.72^{Aa}	13.82^{Cc}	15.83^{Ba}	13.70	11.95
T_2	11.96^{Cc}	13.70^{Cc}	15.84^{Ba}	13.61	11.72
T_3	12.11^{Bb}	13.94^{Bb}	15.90^{Aa}	12.03	*
T_4	11.60^{Dd}	12.84^{Ee}	15.10^{Cb}	12.86	*
T_5	12.75^{Aa}	13.06^{Dd}	15.00^{Dc}	12.92	*
T_6	12.05^{Bb}	14.76^{Aa}	15.90^{Aa}	*	*
SE.m±	**0.025**	**0.041**	**0.026**		
CD(p=0.05)	**0.079**	**0.128**	**0.079**		

** - end of shelf life; (Each data point is average of two years)*
T_1: Dipping in 1% ediblee coating chitosan
T_2: Dipping in 2% edible coating chitosan
T_3: Dipping in 2% calcium gluconate
T_4: Dipping in 1% edible coating chitosan + 2% calcium gluconate
T_5: Dipping in 2% edible coating chitosan + 2% calcium gluconate
T_6: Control

Table 2. Effect of edible coating chitosan and calcium gluconate on reducing sugars (%) of mango (*Mangifera indica* L.) Cv. Banganpalli

Reducing sugars (%)					
Treatments	**3rd Day**	**6th Day**	**9th Day**	**12th Day**	**15th Day**
T_1	4.93^{Bb}	5.70^{Cc}	6.69^{Bb}	5.72	4.79
T_2	4.61^{Cc}	5.55^{Dd}	6.41^{Cc}	5.57	4.65
T_3	5.13^{Aa}	5.81^{Ee}	6.70^{Bb}	4.99	*
T_4	4.16^{Ee}	4.92^{Ff}	6.00^{Dd}	4.92	*
T_5	4.00^{Ff}	4.67^{Aa}	6.10^{Dd}	5.03	*
T_6	4.44^{Dd}	5.92^{a}	6.93^{aA}	*	*
SE.m±	**0.011**	**0.030**	**0.037**		
CD(p=0.05)	**0.035**	**0.092**	**0.114**		

** - end of shelf life; (Each data point is average of two years)*
T_1: Dipping in 1% ediblee coating chitosan
T_2: Dipping in 2% edible coating chitosan
T_3: Dipping in 2% calcium gluconate
T_4: Dipping in 1% edible coating chitosan + 2% calcium gluconate
T_5: Dipping in 2% edible coating chitosan + 2% calcium gluconate
T_6: Control

On 15th day highest reducing sugars was recorded by T_1 - dipping in 1% edible chitosan coating (4.79 %) followed by T_2 - dipping in 2% edible chitosan coating (4.65 %). While T_3, T_4 and T_5 shows end of shelf life.

The raise in sugars may be due to conversion of starch into sugars during storage. This increase and decrease is delayed in chitosan treated fruits as it delays ripening process of fruits Mandal et al. [9]. Similar result was recorded by El Ghaouth et al. [10] in strawberry.

3.3 Non-Reducing Sugars (%)

Results on the effect of post-harvest application of chitosan and calcium gluconate of mango on non-reducing sugars was presented in the Table 3. Initially non-reducing sugars increases along with storage period and later starts decreasing till the end of shelf life.

On 3rd day of storage highest non-reducing sugars was recorded by T_5 - dipping in 2% edible chitosan coating + 2% calcium gluconate (8.75 %) followed by T_1 - dipping in 1% edible chitosan coating (7.79 %) and lowest was recorded by T_3 - dipping in 2% calcium gluconate (6.98 %) followed by T_2 - dipping in 2% edible chitosan coating (7.35 %).

On 6th day, T_6 – control (8.84 %) recorded the highest non-reducing sugars percentage followed by T_5 - dipping in 2% edible chitosan coating + 2% calcium gluconate (8.38 %) and lowest non-reducing sugars was recorded by T_4 – dipping in 1% edible coating chitosan + 2% calcium gluconate (7.92 %) followed by T_1 - dipping in 1% edible chitosan coating (8.11 %) which was on par with T_3 (8.13 %), T_2 (8.14 %).

On 9th day, highest non-reducing sugars was recorded by T_2 - dipping in 2% edible chitosan coating (9.43 %) followed by T_3 - dipping in 2% calcium gluconate (9.19 %) which was on par with T_1 (9.14 %) and T_4 (9.09 %) and lowest non-reducing sugars was recorded by T_6 – control (8.97 %) followed by T_5 - dipping in 2% edible chitosan coating + 2% calcium gluconate (8.89 %).

On 12th day, T_2 - dipping in 2% edible chitosan coating (8.04 %) recorded the highest non-reducing sugars followed by T_1 - dipping in 1% edible chitosan coating (7.98 %) and lowest was recorded by T_3 - dipping in 2% calcium gluconate (7.04 %) followed by T_5 - dipping in 2% edible chitosan coating + 2% calcium gluconate (7.89 %). While T_6 – control shows end of shelf life.

On 15th day, highest non-reducing sugars was recorded by T_1 - dipping in 1% edible chitosan coating (7.16 %) followed by T_2 - dipping in 2% edible chitosan coating (7.07 %). While T_3, T_4 and T_5 shows end of shelf life.

The increase of ascorbic acid during ripening might be delayed by chitosan and calcium coating due to delayed rapid oxidation of ascorbic acid. The highest retention of ascorbic acid during storage by calcium sprays might

Table 3. Effect of edible coating chitosan and calcium gluconate on non-reducing sugars (%) of mango (*Mangifera indica* L.) Cv. Banganpalli

Non-reducing sugars (%)					
Treatments	**3rd Day**	**6th Day**	**9th Day**	**12th Day**	**15th Day**
T_1	7.79^{Bb}	8.11^{Cc}	9.14^{Bb}	7.98	7.16
T_2	7.35^{De}	8.14^{Cc}	9.43^{Aa}	8.04	7.07
T_3	6.98^{Ef}	8.13^{Cc}	9.19^{Bb}	7.04	*
T_4	7.44^{Dd}	7.92^{Dd}	9.09^{Bc}	7.94	*
T_5	8.75^{Aa}	8.38^{Bb}	8.89^{De}	7.89	*
T_6	7.61^{Cc}	8.84^{Aa}	8.97^{Cd}	*	*
SE.m±	**0.025**	**0.025**	**0.026**		
CD(p=0.05)	**0.078**	**0.077**	**0.08**		

** - end of shelf life; (Each data point is average of two years)*
T_1: Dipping in 1% ediblee coating chitosan
T_2: Dipping in 2% edible coating chitosan
T_3: Dipping in 2% calcium gluconate
T_4: Dipping in 1% edible coating chitosan + 2% calcium gluconate
T_5: Dipping in 2% edible coating chitosan + 2% calcium gluconate
T_6: Control

be due to continue synthesis of its precursor like Glucose- 6-phosphate during conversion as starch into various sugars and slow rate of oxidation [11]. Similar results with ascorbic acid was noted by Eshetu *et al*. [12] by chitosan treated mango.

3.4 Ascorbic Acid Content (mg 100^{-1}g)

Results of ascorbic acid content of mango influenced by post-harvest application of chitosan and calcium gluconate is presented in Table 4 and Fig 1. Ascorbic acid content decreases with storage period until fruit starts ripening, when fruit ripens it increases and later decreases as storage proceeds.

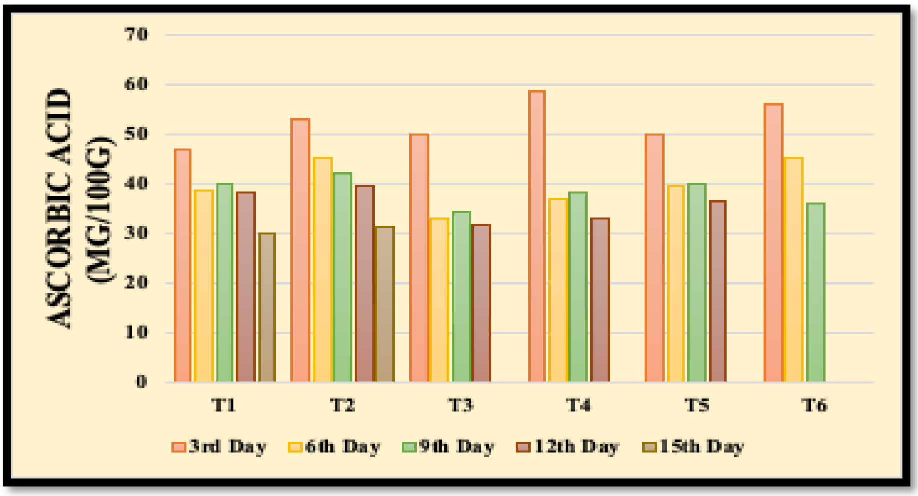
On 3rd day of the storage maximum ascorbic acid content was recorded by T_4 – dipping in 1% edible coating chitosan + 2% calcium gluconate (58.85) followed by T_6 – control (56.26 mg 100^{-1}g) and lowest ascorbic acid content was recorded by T_1 - dipping in 1% edible chitosan coating (47.16 mg 100^{-1}g) followed by T_3 - dipping in 2% calcium gluconate (50.01 mg 100^{-1}g)

On 6th day, maximum ascorbic acid content was recorded by T_2 - dipping in 2% edible chitosan coating (45.27 mg 100^{-1}g) followed by T_6 – control (45.08 mg 100^{-1}g) and minimum ascorbic acid content was recorded by T_3 - dipping in 2% calcium gluconate (33.28 mg 100^{-1}g) followed by T_4 – dipping in 1% edible coating chitosan + 2% calcium gluconate (36.88 mg 100^{-1}g).

On 9th day of the storage T_2 - dipping in 2% edible chitosan coating (42.13 mg 100^{-1}g) recorded the maximum ascorbic acid content followed by T_1 - dipping in 1% edible chitosan coating (40.27 mg 100^{-1}g) and lowest ascorbic content was recorded by T_3 - dipping in 2% calcium gluconate (34.54 mg 100^{-1}g) followed by T_6 – control (36.07 mg 100^{-1}g).

On 12th day, T_2 - dipping in 2% edible chitosan coating (39.58 mg 100^{-1}g) recorded the highest ascorbic content followed by T_1 - dipping in 1% edible chitosan coating (38.34 mg 100^{-1}g) and T_3 - dipping in 2% calcium gluconate (31.67 mg 100^{-1}g) recorded the lowest ascorbic acid content followed by T_4 – dipping in 1% edible coating chitosan + 2% calcium gluconate (33.33 mg 100^{-1}g). While T_6 – control shows end of shelf life.

On 15th day, the highest non-reducing sugars was recorded by T_2 - dipping in 2% edible chitosan coating (31.22 mg 100^{-1}g) followed by T_1 - dipping in 1% edible chitosan coating (30.03 mg 100^{-1}g). While T_3, T_4 and T_5 shows end of shelf life.



T_1: Dipping in 1% ediblee coating chitosan
T_2: Dipping in 2% edible coating chitosan
T_3: Dipping in 2% calcium gluconate
T_4:Dipping in 1% edible coating chitosan + 2% calcium gluconate
T_5: Dipping in 2% edible coating chitosan + 2% calcium gluconate
T_6: Control

Fig 1. Effect of edible coating chitosan and calcium gluconate on Ascorbic acid content (mg/100g) of mango (*Mangifera indica* L.) Cv. Banganpalli

Table 4. Effect of edible coating chitosan and calcium gluconate on acid content (mg/100g) of mango (*Mangifera indica* L.) Cv. Banganpalli

Ascorbic acid (mg/100g)					
Treatments	**3rd Day**	**6th Day**	**9th Day**	**12th Day**	**15th Day**
T_1	47.16^{Df}	38.68^{Dd}	40.43^{Bb}	38.34	30.03
T_2	53.02^{Cc}	45.27^{Aa}	42.13^{Aa}	39.58	31.22
T_3	50.01^{De}	33.28^{Ff}	34.54^{Df}	31.67	*
T_4	58.85^{Aa}	36.89^{Ee}	38.36^{Bd}	33.33	*
T_5	50.23^{Dd}	39.75^{Cc}	40.08^{Bc}	36.52	*
T_6	56.26^{Bb}	45.08^{Bb}	36.07^{Ce}	*	*
SE.m±	0.035	0.048	0.025		
CD(p=0.05)	0.108	0.148	0.078		

** - end of shelf life; (Each data point is average of two years*

Ascorbic acid increases during ripening but decreases during senescence. It has been observed that once the fruits have ripened, the ascorbic acid contents start to decline. Mango fruits coated with 1.0 and 2.0% chitosan showed a slower decrease in vitamin C [13]. Similar results were observed by Ali et al. [14] in dragon fruits coated with 1.0% and 1.5% chitosan concentrations which showed a slower initial increase in ascorbic acid, This suggests that the chitosan coating slowed down the loss of vitamin C during storage.

4. CONCLUSION

- The effect of edible coatings chitosan and calcium gluconate on sugars and ascorbic acid content was found significantly differed among the treatments.
- Changes in sugars and ascorbic acid content was slow in T_2 - dipping in 2% edible chitosan coating compared to T_6 – control in which changes are rapid during storage. Highest sugars (11.95 % total sugars, 4.79 % reducing sugars and 7.16 % non-reducing sugars) was recorded by T_2 - dipping in 2% edible chitosan coating and highest ascorbic acid content (31.22 mg/100g) was recorded by T_1 - dipping in 1% edible chitosan coating on 15th day of storage.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Zafrul H, Niaz Md, Amirul I Md, Hasibur RH Md and Kamrul H. Effect of different concentrations of chitosan on shelf life and quality of mango. Sustainability in Food and Agriculture. 2020;1(1):21-26.
2. Fekry OM. Effect of edible coating chitosan and calcium gluconate on maintaining fruit quality and marketability of guava (*Psidium guajava*) fruits during storage. Middle East Journal of Applied Science. 2018;8(4): 1046-1060.
3. Prashanth R, Kiran Kumar A, Rajkumar M and Aparna K. Studies on postharvest quality and shelf life of pink fleshed dragon fruit (*Hylocereus spp*.) coated with chitosan and stored at ambient temperature. Biological Forum – An International Journal. 2022;14(3):340-347.
4. Elisha P, Sharma RK and Varma V. Studies on organic acid-based biotech nutrients to enhance soil organic carbon (SOC) and grain yield in Maize (*Zea Mays*) crop. International Journal of Science Engineering and Advance Technology. 2014;2(10);532-541.
5. Prasanna Kumar N, Gouthami B, Joseph B, Raja Reddy A, Sreerama Reddy N, Prathiksha G, Lavanaya N, Ramohan N and Sparjanbabu S. Performance of gluconate and lactate based formulations on plant growth and yield attributes in Maize (*Zea mays* L.). International Journal of Environment and Climate Change. 2022;12(11)676-684.
6. Zhu X, Wang Q, Cao J and Jiang W. Effect of chitosan coating on post-harvest quality of mango (*Mangifera indica* L. Cv. Tainong) fruits. Journal of Food Processing and Preservation. 2008;32: 770–784.
7. AOAC. Associate of official Analytical chemists, Official methods of Analysis, AOAC, Washington DC; 1965.
8. Ranganna S. Hand Book of Analysis and quality control of fruit and vegetable

products. Tata McGraw Hill Publishing Co.Ltd., New Delhi; 1986.
9. Mandal D, Lalrinpuii S, Tridip KH and Amritesh CS. Effect of edible coating on shelf life and quality of local mango Cv. Rangkuai of Mizoram . Research on Crops 2018;19(3):419-424.
10. El-Ghaouth A, Ponnampalam R and Boulet M. Chitosan coating effect on storability and quality of fresh strawberries. Journal of Food Science. 1991;56:1618–621.
11. Pradeep Kumar V and Manu MM. Effect of preharvest application of different chemicals and plant growth regulators on biochemical parameters of mango (*Mangifera indica* L.) var. Amrapali. International Journal of Agricultural Sciences. 2018;14(1):92-96.
12. Eshetu A, Ali M I, Sirawdink F, Forsido CG and Kuyu. Effect of beeswax and chitosan treatments on quality and shelf life of selected mango (*Mangifera indica* L.) cultivars. Heliyon Article. 2018;01116: 2405-8440.
13. Hong K, Jianghui X, Lubin Z, Dequan S and Deqiang G. Effects of chitosan coating on postharvest life and quality of guava (*Psidium guajava* L.) fruit during cold storage. *Scientia horticulturae.* 2012;144: 172–178.
14. Ali A, Zahid N, Manickam S, Siddiqui Y, Alderson PG and Maqbool M. Effectiveness of submicron chitosan dispersions in controlling anthracnose and maintaining quality of dragon fruit. Postharvest Biology Technology. 2013;86: 147–153.

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