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Effect of Different Surface Coatings on Shelf Life and Quality of Guava (*Psidium guajava L.*) CV. Allahabad Safeda

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Authors' contributions

This work was carried out in collaboration among all authors. Authors SS, VJ and PP designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors VJ and AKK managed the analyses of the study. Authors SS and VJ managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To evaluate the potentiality of surface coatings for achieving extended shelf life with enhance fruit quality attributes in Guava under ambient storage condition.
Study design: The lab experiment conducted in complete randomized design three replications on Allahabad safeda of Guava.
Place and duration of study: The experiment was conducted during November 2019 at College of Horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad.
Methodology: Guava freshly harvested fruits were coated with three Surface coatings viz. Aloe vera (12.5%, 25% & 50%), Chitosan (0.5%, 1.0% & 1.5%), citric acid (1%, 2% & 3%). The coated fruits were stored at ambient room condition. Periodically effects of surface coatings were observed for physiological loss in weight, Shelf Life (days), Firmness (Kg/cm 2), Total Soluble Solids (%),

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Titrable Acidity (%), Ascorbic Acid (mg/100g), Total Sugars (%), Reducing Sugars (%), Non-Reducing Sugars (%).

Results: Surface coating physical parameters, fruits treated with T5-Chitosan (1%) showed minimum physiological loss in weight during storage, and least decay percentage. Among the treatments, highest shelf life (9.98 days), highest firmness (2.76 kg/cm2) was recorded in T5-Chitosan (1%) which was on par with T2-Aloe vera (25%) (9.67 days & 2.71 kg/cm2) while lowest shelf life was recorded in T10-Control (6.45 days). Among the treatments, T5- Chitosan (1%) recorded highest TSS (10.33 oB), highest ascorbic acid content (122.32 mg/100g), highest total sugar content, reducing sugar and least non reducing sugar content (9.72%, 6.02% & 2.84%) respectively followed by T2-Aloe vera 25% while least was noticed in T6-Chitosan 1.5% on 10th day of storage.

Conclusion: surface coating of Chitosan1% substantially improved the shelf life with retaining better fruit quality attributes under ambient conditions.

Keywords: Chitosan; aloe vera; citric acid; guava and surface coatings.

1. INTRODUCTION

Guava (*Psidium guajava* L.) a Myrtaceae member is one of the important commercial fruit crops in India. It is the fourth most important fruit crop of India after mango, banana and citrus. It can be grown in tropical and subtropical regions and is called as “Apple of Tropics”. It is originated from Tropical America and spread across the globe and was introduced to India in early 17th century.Surface coatings when applied to fruits help in extending the shelf life by acting as a barrier between atmosphere and fruit surface. The most common and widely used surface coatings are *Aloe vera* and Chitosan [1]. *Aloe vera* has the potential to be used as an edible coating for fresh cut fruits as it contains various polysaccharides [2]. *Aloe vera* is a well-known plant for its marvelous medicinal properties. It prolongs the conservation of fresh fruits. This natural product is a safe and environmentally friendly. *Aloe vera* forms a protective layer against the oxygen and moisture of the air and inhibits the action of micro-organisms that causes food borne illnesses through its various antibacterial and antifungal compounds, it also prevents loss of moisture, retains firmness, controls respiratory rate and maturation [3]. Chitosan has a chemical structure close to that of cellulose and has long been known to protect perishable produce from deterioration by reducing transpiration, respiration and maintaining the textural quality. Chitosan has been successfully tried and recommended for enhancing the shelf life of several fruits such as litchi, strawberry, mango, peaches, Japanese pears, and kiwi fruit. Indeed, chitosan is often considered to be the ideal preservative coating for fresh fruits because of its excellent film forming and biochemical properties.

2. MATERIALS AND METHODS

2.1 Experimental Location

The experiment was conducted at College of Horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad during the year 2019.

2.2 Collection of Guava

Guava fruits Cv. Allahabad Safeda used for research were procured from Fruit research station, SKLTSHU, Sangareddy.Guava fruits were selected for uniformity in size, shape and colour. Diseased, sunburn, bruised and injured fruits were discarded. The remaining fruits were randomized and divided into ten lots of 30 fruits for the following treatments in three replicates (each replicate contained 10 individual fruits).

2.3 Experimental Design and Treatments

The experiment was laid out in completely randomized design (CRD) with three repetitions and consisting of ten treatments comprising of surface coatings. Aloe vera (12.5%, 25% & 50%), Chitosan (0.5%, 1.0% & 1.5%), citric acid (1%, 2% & 3%) and control (without any coatings).In the experiment ten freshly harvested fruits were assigned per treatment per repetition. The fruits were stored at room temperature.

2.4 Collection of Plant Material and Preparation of Surface Coatings

Fresh Aloe Vera leaves collected from Medicinal and Aromatic Plants Research Station. The leaves were washed to remove the dust, aloe vera gel matrix was separated from the outer cortex of leaves using knife and then the

colorless hydro parenchyma was grinded in a blender and strained through muslin cloth to remove thick particles. Pectin 1 per cent was taken and mixed with water and in turn mixed with *Aloe vera* gel at different concentrations (12.5%, 25% & 50%) and heated to the required temperature to prepare the treatment solutions. The liquid obtained, constituted fresh Aloe vera (25%) and it was further diluted with distilled water in1:1 ratio (50% Aloe vera extract) and in 3:1 ratio (75% Aloe vera extract). Similarly, 0.5 per cent, 1 per cent and 1.5 per cent chitosan solution was prepared by dissolving 5g, 10g and 15g of chitosan powder in 1000ml of distilled water. Citric acid 1 per cent, 2 per cent and 3 per cent solution was prepared by dissolving 5g, 10g and 15g of citric acid in 1000ml of distilled water. Fruits were coated as per the treatments by dipping in treatment wise solution for 5-10 min. Coated fruits then allows for air drying at ambient conditions.

2.5 Data Collection

Physiological loss in weight during storage was calculated by subtracting the final fresh weight (10th day of storage) from the initial fresh weight (0 days of storage) of the fruits. Cumulative weight losses were expressed as a percentage loss of original weight. Shelf life of the fruits was determined by recording the number of days the fruits remained in good condition in storage. The stage where in more than 50 per cent of the stored fruits became unfit for consumption was considered as end of shelf life in that particular treatment and expressed as mean number of days [4]. Penetrometer was used to record the firmness of fruits and direct readings were obtained in terms of kg/cm^2. The sample fruits were subjected to penetrometer by pressing near the center of the fruit and direct reading on the scale was recorded at two days intervals.The total soluble solids of the fruits were determined with the help of Erma hand refractometer, Japan and expressed as [5]. Titratable Acidity (%) was observed Ten grams of sample was taken, ground well and transferred to volumetric flask and volume was made up to 100 ml with distilled water. The contents were filtered through Whatmann No.1 filter paper. An aliquot of 10 ml was taken into conical flask to which 2-3 drops of phenolphthalein indicator was added and titrated against 0.1 N NaOH till a pink color was obtained which persists at least for 15 seconds, as an end point [5].The reducing sugars were determined by the method of Lane and Eynon.Non reducing sugars were calculated from the calculated values of total and reducing sugars. Ascorbic acid was estimated by method outlined by Ranganna [5].

2.6 Data Analysis

The design adopted was (CRD) completely randomized design with and the data was processed at the Computer center, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad using the established statistical analysis as per the procedure (windowstat version 9.1) outlined by Murali Khetan [6]. Significance was tested by 'F' value at 5 percent level of significance.

3. RESULTS AND DISCUSSION

3.1 Physiological Loss in Weight (%)

The data are presented in Table 1. The percent PLW values showed an increasing trend from 2nd day to 10th day during storage. There was a significant difference observed among the treatments with respect to PLW at room temperature conditions. On 2nd day, T_5-Chitosan (1%) recorded least PLW (5.62) which was on par with T_2-Aloe vera 25% (5.66), T_6-Chitosan 1.5% (5.74),T_7-Citric acid 1% (5.80) while highest PLW was recorded in T_{10}- Control (8.69). Similar trend was observed on 4th day and 6th day respectively. On 4th day, lowest PLW was observed in T_5-Chitosan 1% (6.93) which was on par with T_2-Aloe vera 25% (7.13) and highest PLW was noticed in T_{10}- Control (11.11). Similar result was observed with respect to PLW on 6thday. On 8th day, treatments *viz*., T_3-Aloe vera 50%, T_8-Citric acid 2% & T_{10}-Control showed the end of shelf life and among the treatments, least PLW was recorded in T_5-Chitosan 1% (10.01) followed by T_2-Aloe vera 25% (10.22) and highest PLW was recorded in T_9- Citric acid 3% (12.43). On 10th day, except T_2, T_4, T_5, T_6, T_7 all other treatments showed the end of shelf life with T_5- Chitosan (1%) recorded least PLW (12.06) followed by T_2-Aloe vera 25% (12.74) and highest PLW was recorded in T_6-Chitosan 1.5% (14.56). Among all the treatments, fruits treated with chitosan (1%) showed minimum loss in physiological weight during storage compared to other treatments as chitosan coating reduces the water loss and respiration rate of fruits during storage by acting as a protective layer between fruit surface and

atmosphere. The results obtained in the present investigation are in close conformity with Manpreet et al. [7].

3.2 Shelf Life (Days)

The data pertaining to the Shelf life of guava fruits treated with surface coatings is presented in the Table 2. Highest shelf life of 9.98 days was recorded in T_5-Chitosan (1%) which was on par with T_2-Aloe vera 25% (9.67) and T_6-Chitosan 1.5% (9.55) while lowest shelf life was recorded in T_{10}-Control (6.45).Fruits treated with Chitosan (1%) recorded highest shelf life as chitosan coatings reduces shrinkage by reducing loss of moisture, transpiration and respiration losses thereby retains the freshness of the fruits [8]. The present results are in conformity with the findings of Sandeep and Bal [9], Sabir and Sabir [10]; Romanazzi et al. [11].

3.3 Firmness (Kg/cm2)

Table 3 depicts the data pertaining to the firmness of guava fruits as influenced by the application of surface coatings. Firmness of guava fruits showed a decreasing tendency with increase in storage period. On 2nd day, fruits treated with T_5- Chitosan (1.0%) recorded highest firmness (4.04) and was on par with T_2-Aloe Vera (25%) (3.93) and least firmness was recorded in T_{10} -Control (3.31). On 4th day, highest firmness was observed in T_5 - Chitosan 1.0% (3.69) which was followed by T_4- Chitosan @0.5% (3.60),T_8-Citric acid 2% (3.58) and T_2-Aloe Vera (25%) (3.56) whereas least firmness was recorded in T_{10} -Control (2.68). Similar result was observed on 6th day with respect to firmness of guava fruits. On 8th day, treatments *viz*., T_3-Aloe vera 50%, T_8-Citric acid 2% & T_{10}- Control showed the end of shelf life and among the

Table 1. Effect of different surface coatings on physiological loss in weight (%) of guava CV. Allahabad Safeda under ambient conditions

Treatments	Physiological loss of weight (%)				
	2nd Day	4th Day	6th Day	8th Day	10thDay
T_1- Aloe Vera (12.5%)	6.81	8.01	10.79	12.33	*
T_2 - Aloe Vera (25%)	5.66	7.13	8.47	10.22	12.74
T_3 - Aloe Vera (50%)	6.55	7.40	10.54	*	*
T_4- Chitosan (0.5%)	7.06	8.16	10.16	12.06	14.05
T_5 - Chitosan (1.0%)	5.62	6.93	8.03	10.01	12.06
T_6 - Chitosan (1.5%)	5.74	7.35	10.12	12.03	14.56
T_7- Citric acid (1%)	5.80	8.02	10.14	12.12	14.16
T_8 - Citric acid (2%)	5.93	7.73	10.21	*	*
T_9 - Citric acid (3%)	6.18	8.44	10.22	12.43	*
T_{10}- Control	8.69	11.11	13.02	*	*
SEm±	0.08	0.09	0.16	0.06	
CD 5%	0.22	0.28	0.48	0.17	

Table 2. Effect of different surface coatings on shelf life (days) of guava CV. Allahabad safeda under ambient conditions

Treatments	Shelf life (days)
T_1- Aloe Vera (12.5%)	8.37
T_2 - Aloe Vera (25%)	9.67
T_3 - Aloe Vera (50%)	7.52
T_4- Chitosan (0.5%)	9.31
T_5 - Chitosan (1.0%)	9.98
T_6 - Chitosan (1.5%)	9.55
T_7- Citric acid (1%)	9.48
T_8 - Citric acid (2%)	7.37
T_9 - Citric acid (3%)	8.41
T_{10}- Control	6.45
SEm±	0.15
CD 5%	0.46

**- End of the shelf life of fruits*

Table 3. Effect of different surface coatings on firmness (kg/cm^2) of guava CV. Allahabad Safeda under ambient conditions

Treatments	Firmness (kg/cm^2)				
	2nd Day	4thDay	6th Day	8th Day	10thDay
T_1- Aloe Vera (12.5%)	3.66	3.35	2.87	2.75	*
T_2 - Aloe Vera (25%)	3.93	3.56	2.88	2.77	2.71
T_3 - Aloe Vera (50%)	3.73	3.51	2.72	*	*
T_4- Chitosan (0.5%)	3.67	3.60	2.83	2.76	2.61
T_5 - Chitosan (1.0%)	4.04	3.69	3.08	2.96	2.76
T_6 - Chitosan (1.5%)	3.62	3.50	2.90	2.80	2.53
T_7- Citric acid (1%)	3.65	3.51	2.92	2.85	2.65
T_8 - Citric acid (2%)	3.84	3.58	2.79	*	*
T_9 - Citric acid (3%)	3.63	3.51	2.82	2.75	*
T_{10}- Control	3.31	2.68	1.51	*	*
SEm±	0.05	0.02	0.04	0.01	
CD 5%	0.17	0.06	0.12	0.03	

**- End of the shelf life of fruits*

treatments, highest firmness was recorded in T_5- Chitosan 1% (2.96) followed by T_7- Citric acid 1% (2.85) while least firmness was noticed in T_9- Citric acid 3% and T_1- Aloe. Vera (12.5%) (2.75). On 10th day of storage, except T_2, T_4, T_5, T_6, T_7 all other treatments showed the end of shelf life with T_5- Chitosan (1%) recorded highest firmness (2.76) followed by T_2-Aloe vera 25% (2.71) and were on par to each other, while least firmness was recorded in T_6-Chitosan 1.5% (2.53) .From the result, it is observed that highest firmness was observed with fruits treated with Chitosan (1.0%). The progressive loss of firmness is the result of a gradual transformation of protopectin in to pectin which is degraded by the enzyme poly galacturonate in the cell wall as reported by Hobson [12]. Maximum deterioration and minimal degree of firmness indicates the maximum quality degradation. Findings of present study are absolutely in accordance with that of Akhtar et al. [13] in non-climacteric fruit loquat.

3.4 Total Soluble Solids (°Brix)

The effect of surface coatings at ambient storage condition of guava on total soluble solids is presented in the Table 4.Total soluble solids increased with the storage period at room temperature from first day to tenth day. On 2nd day, highest TSS was recorded in T_5 - Chitosan 1% (9.28) which was followed by T_2- Aloe Vera (25%) and T_7- Citric acid 1% (9.22) while lowest TSS was noticed in T_{10} -Control (9.15). Similar trend was noticed with respect to TSS on 4th and 6th day respectively. On 8th day, treatments *viz*., T_3-Aloe vera 50%, T_8-Citric acid 2% & T_{10}- Control showed the end of shelf life and among the treatments, highest TSS was recorded in T_5- Chitosan 1% (10.30) followed by T_2- Aloe Vera (25%) (10.14) while least value was noticed in T_9- Citric acid 3% (10.04).On 10th day of storage, except T_2, T_4, T_5, T_6, T_7 all other treatments showed the end of shelf life with T_5- Chitosan (1%) recorded highest TSS value (10.33) followed by T_2-Aloe vera 25% (10.14) while least was noticed in T_6-Chitosan 1.5% (10.02).A large percentage of the soluble solids in grapes are sugars mainly glucose and fructose that are central sugars and are involved in cell respiration and synthesis and third sugar is sucrose that is non-reducing by nature and present relatively in smaller amounts with level not exceedingly more than one percent. From the above results, it can be concluded that the fruits treated with Chitosan (1%) showed superior over other treatments, this may be due to the fact that chitosan forms a semi permeable film and modifies the internal atmosphere, decreases transpiration losses and regulates the quality of the fruits as reported by Olivas et al. [14]; Sabir and Sabir [10].The increment in soluble solids is attributed towards rapid conversion of complex starch molecules in to simple sugars as reported by Gallo et al. [15]. Excess loss of water from the fruiting tissues may also be a valid reason behind this increment [16].

3.5 Titrable Acidity (%)

Results on titrable acidity of guava fruits stored at ambient temperature as influenced by surface coatings is presented in the Table 5. Acidity of a fruits decreased with the storage period. On 2nd day, lowest titrable acidity was recorded in T_5 -

Table 4. Effect of different surface coatings on TSS content (^{o}Brix) of guava CV. Allahabad safeda under ambient conditions

Treatments	TSS content (^{o}B)				
	2nd Day	4thDay	6th Day	8th Day	10thDay
T_1- Aloe Vera (12.5%)	9.20	9.87	10.06	10.10	*
T_2 - Aloe Vera (25%)	9.23	9.93	10.12	10.14	10.14
T_3 - Aloe Vera (50%)	9.21	9.84	10.01	*	*
T_4- Chitosan (0.5%)	9.21	9.81	10.08	10.11	10.11
T_5 - Chitosan (1.0%)	9.28	9.99	10.22	10.30	10.33
T_6 - Chitosan (1.5%)	9.22	9.88	9.93	10.01	10.02
T_7- Citric acid (1%)	9.23	9.86	10.09	10.10	10.11
T_8 - Citric acid (2%)	9.20	9.82	9.98	*	*
T_9 - Citric acid (3%)	9.21	9.79	9.99	10.04	*
T_{10}- Control	9.15	9.03	8.65	*	*
SEm±	0.01	0.03	0.01	0.01	
CD @5%	0.03	0.09	0.04	0.03	

**- End of the shelf life of fruits*

Table 5. Effect of different surface coatings on titrable acidity (%) of guava CV. Allahabad Safeda under ambient conditions

Treatments	Titrable acidity (%)				
	2nd Day	4thDay	6th Day	8th Day	10thDay
T_1- Aloe Vera (12.5%)	0.44	0.39	0.34	0.30	*
T_2 - Aloe Vera (25%)	0.40	0.36	0.33	0.31	0.29
T_3 - Aloe Vera (50%)	0.43	0.38	0.35	*	*
T_4- Chitosan (0.5%)	0.43	0.37	0.34	0.29	0.28
T_5 - Chitosan (1.0%)	0.35	0.34	0.32	0.31	0.27
T_6 - Chitosan (1.5%)	0.41	0.39	0.34	0.31	0.30
T_7- Citric acid (1%)	0.40	0.40	0.33	0.30	0.27
T_8 - Citric acid (2%)	0.42	0.36	0.34	*	*
T_9 - Citric acid (3%)	0.42	0.36	0.34	0.31	*
T_{10}- Control	0.49	0.45	0.40	*	*
SEm±	0.01	0.01	0.01	0.01	
CD @5%	0.03	0.05	0.03	NS	

**- End of the shelf life of fruits*

Chitosan 1% (0.35) which was followed by T_2- Aloe Vera 25% and T_7- Citric acid 1% (0.40) while highest titrable acidity was noticed in T_{10} - Control (0.49). Similar trend was noticed with respect to TSS on 4th and 6th day respectively. On 8th day, treatments *viz*., T_3-Aloe vera 50%, T_8-Citric acid 2% & T_{10}- Control showed the end of shelf life and among the treatments, non-significant result was noticed with respect to the titrable acidity. On 10th day of storage, except T_2, T_4, T_5, T_6, T_7 all other treatments showed the end of shelf life and with lowest acidity recorded in T_5 - Chitosan 1% (0.27) and highest in T_6 - Chitosan 1.5% (0.30) Titrable acidity of fruits decreases due to increase of soluble sugars during course of ripening. This decrease was observed less in fruits coated with surface coating compared to control due to edible coatings. T5-chitosan (1%) is the best treatment with least acidity, similar findings were reported by Baviskaret al. (1995) [17] in guava fruits were acidity decreased continuously towards the end of storage period regardless of post-harvest treatments and storage conditions.

3.6 Total sugars (%)

The effect of surface coatings on total sugars in guava fruit is presented in the Table 6. Total sugar content increased with the storage period at room temperature from first day to tenth day. On 2nd day, highest total sugar content was recorded in T_5 - Chitosan @1% (8.05) which was followed by T_2- Aloe Vera (25%) (7.82) and T_7- Citric acid 1% (7.71) while lowest total sugar content was noticed in T_{10} -Control (6.42). Similar trend was noticed with respect to total sugar content on 4th and 6th day respectively. On 8th

day, treatments *viz*., T_3-Aloe vera 50%, T_8-Citric acid 2% & T_{10}- Control showed the end of shelf life and among the treatments, highest total sugar content was recorded in T_5-Chitosan 1% (9.06) followed by T_2- Aloe Vera (25%) (8.73) while least value was noticed in T_9- Citric acid 3% (8.23) .On 10th day of storage, except T_2, T_4, T_5, T_6, T_7 all other treatments showed the end of shelf life with T_5- Chitosan (1%) recorded highest total sugar value (9.72) followed by T_2-Aloe vera 25% (9.06) while least was noticed in T_4-Chitosan 0.5% (8.68) T5-chitosan (1%) was the best treatment with maximum total sugars during storage period. The total sugars content increased during the storage period in all treatments. The raise in sugars may be due to conversion of starch into sugars. Similar observation was reported by Ramchandra and Ashok (1997) [18] in ber.

3.7 Ascorbic acid content (mg/100g)

Results of ascorbic acid content guava fruit influenced by surface coatings is presented in the Table 7. On 2nd day there was significant difference observed among the treatments with highest ascorbic acid content in T_5 - Chitosan 1% (179.23) which was followed by T_2- Aloe Vera (25%) (178.81) and T_7- Citric acid 1% (173.84) while lowest was noticed in T_{10} -Control (155.94). Similar trend was noticed with respect to ascorbic acid on 4th and 6th day respectively. On 8th day, treatments *viz*., T_3-Aloe vera 50%, T_8-Citric acid 2% & T_{10}- Control showed the end of shelf life and among the treatments, non-significant result was noticed with respect to the ascorbic acid content. On 10th day of storage, except T_2, T_4, T_5, T_6, T_7 all other treatments showed the end of shelf life with T_5- Chitosan (1%) recorded highest ascorbic acid content (122.32) followed by T_2-Aloe vera 25% (112.32) while lowest was noticed in T_6-Chitosan1.5% (109.92).

Among these treatments T_5-Chitosan 1% recorded significantly highest ascorbic acid content followed by T_2-Aloe vera 25%. The decrease trend of ascorbic acid is less in surface coated while it showed a rapid decrease in untreated fruits. This may be due to increase in total soluble sugars increases in the fruits. The results obtained were close to results of Jagtar Singh et al. (1978) [19]. In his studies on storage behaviour of guava fruits at room temperature.

3.8 Reducing sugars (%)

Results on the effect of surface coatings on reducing sugars of guava fruit is presented in the Table 8. On 2nd day, highest reducing sugar content was recorded in T_5 - Chitosan 1% (4.53) which was followed by T_2- Aloe Vera (25%) (4.33) while lowest content was noticed in T_{10} - Control (3.25). Similar trend was noticed with respect to reducing sugar content on 4th and 6th day respectively. On 8th day , treatments *viz*., T_3-Aloe vera 50%, T_8-Citric acid 2% & T_{10}- Control showed the end of shelf life and among the treatments, highest reducing sugar content was recorded in T_5-Chitosan 1% (5.82) followed by T_2- Aloe Vera (25%) (5.68) while least value was noticed in T_9- Citric acid 3% (5.12). On 10th day of storage, except T_2, T_4, T_5, T_6, T_7 all other treatments showed the end of shelf life with T_5-

Table 6. Effect of different surface coatings on ascorbic acid (mg/100 g) of guava CV. Allahabad Safeda under ambient conditions

Treatments	Ascorbic acid (mg/100 g)				
	2nd Day	4thDay	6th Day	8th Day	10thDay
T_1- Aloe Vera (12.5%)	173.44	157.75	136.28	118.36	*
T_2 - Aloe Vera (25%)	178.81	160.50	139.77	116.95	112.32
T_3 - Aloe Vera (50%)	174.71	159.76	133.27	*	*
T_4- Chitosan (0.5%)	171.78	155.64	138.17	118.25	111.23
T_5 - Chitosan (1.0%)	179.23	163.99	148.07	128.34	122.32
T_6 - Chitosan (1.5%)	168.90	156.90	135.97	116.25	109.92
T_7- Citric acid (1%)	173.34	158.59	137.59	118.96	112.23
T_8 - Citric acid (2%)	169.74	156.77	134.86	*	*
T_9 - Citric acid (3%)	167.70	153.25	135.75	112.12	*
T_{10}- Control	155.94	136.94	112.71	*	*
SEm±	2.23	1.44	1.30	1.10	
CD @5%	6.69	4.29	3.87	NS	

**- End of the shelf life of fruits*

Chitosan (1%) recorded highest reducing sugar content (6.02) followed by T_2-Aloe vera 25% (5.99) while least was noticed in T_4-Chitosan 0.5% (5.86). The total and reducing sugars were increased in all treatments. The raise in sugars may be due to conversion of starch into sugars during storage. Similar observation was reported by Ramchandra and Ashok [16] in ber.

3.9 Non-reducing Sugars (%)

The data pertaining to the effect of surface coatings on non-reducing sugars of guava fruit is presented in the Table 9. On 2nd day, lowest non reducing sugar content was recorded in T_2- Aloe Vera (25%) (3.49) which was followed by T_5 - Chitosan 1% (3.50) while highest content was noticed in T_{10} -Control (3.25). Similar trend was noticed with respect to non-reducing sugar content on 4th and 6th day respectively. On 8th day , treatments *viz*., T_3-Aloe vera 50%, T_8-Citric acid 2% & T_{10}- Control showed the end of shelf life and among the treatments, lowest non reducing sugar content was recorded in T_5-Chitosan 1% (2.91) followed by T_2-Aloe Vera (25%) (2.94) while highest value was noticed in T_9- Citric acid 3% (3.16) .On 10th day of storage, except T_2 ,T_4, T_5, T_6, T_7 all other treatments showed the end of shelf life with T_5- Chitosan (1%) recorded lowest non reducing sugar content (2.84) followed by T_2-Aloe vera 25% (2.94) while highest content was noticed in T_4-Chitosan 0.5% (3.05).

Table 7. Effect of different surface coatings on total sugar content (%) of guava CV. Allahabad safeda under ambient conditions

Treatments	Total sugar content (%)				
	2nd Day	4thDay	6th Day	8th Day	10thDay
T_1- Aloe Vera (12.5%)	7.42	7.67	7.94	8.26	*
T_2 - Aloe Vera (25%)	7.82	8.34	8.48	8.73	9.06
T_3 - Aloe Vera (50%)	7.52	7.83	7.84	*	*
T_4- Chitosan (0.5%)	7.48	7.86	7.99	8.29	8.68
T_5 - Chitosan (1.0%)	8.05	8.50	8.73	9.06	9.72
T_6 - Chitosan (1.5%)	7.50	7.66	7.88	8.34	8.83
T_7- Citric acid (1%)	7.55	8.06	8.07	8.62	8.76
T_8 - Citric acid (2%)	7.71	7.81	7.90	*	*
T_9 - Citric acid (3%)	7.50	7.84	8.02	8.23	*
T_{10}- Control	6.42	6.84	7.11	*	
SEm±	0.07	0.04	0.04	0.06	
CD @5%	0.21	0.12	0.11	0.18	

**- End of the shelf life of fruits*

Table 8. Effect of different surface coatings on reducing sugar content (%) of guava Cv. Allahabad safeda under ambient conditions

Treatments	Reducing sugar content (%)				
	2nd Day	4thDay	6th Day	8th Day	10thDay
T_1- Aloe Vera (12.5%)	3.88	4.08	4.84	5.04	*
T_2 - Aloe Vera (25%)	4.33	4.76	5.04	5.68	5.99
T_3 - Aloe Vera (50%)	3.92	4.18	4.84	*	*
T_4- Chitosan (0.5%)	3.79	4.19	4.73	5.23	5.86
T_5 - Chitosan (1.0%)	4.53	4.95	5.46	5.82	6.02
T_6 - Chitosan (1.5%)	4.01	4.27	4.79	5.36	5.92
T_7- Citric acid (1%)	3.87	4.19	4.83	5.16	5.90
T_8 - Citric acid (2%)	4.17	4.25	4.74	*	*
T_9 - Citric acid (3%)	3.83	4.20	4.83	5.12	*
T_{10}- Control	3.25	3.81	4.09	*	*
SEm±	0.04	0.05	0.05	0.01	
CD @5%	0.13	0.15	0.16	0.03	

**- End of the shelf life of fruits*

Table 9. Effect of different surface coatings on Non reducing sugar content (%) of guava Cv. Allahabad safeda under ambient conditions

Treatments	Non reducing sugar content (%)				
	2nd Day	4thDay	6th Day	8th Day	10thDay
T_1- Aloe Vera (12.5%)	3.51	3.48	3.16	3.06	*
T_2 - Aloe Vera (25%)	3.49	3.22	3.05	2.94	2.94
T_3 - Aloe Vera (50%)	3.60	3.72	3.18	*	*
T_4- Chitosan (0.5%)	3.69	3.55	3.27	3.12	3.05
T_5 - Chitosan (1.0%)	2.90	3.05	2.95	2.91	2.84
T_6 - Chitosan (1.5%)	3.51	3.45	3.15	3.05	2.99
T_7- Citric acid (1%)	3.69	3.54	3.05	3.03	3.01
T_8 - Citric acid (2%)	3.54	3.43	3.09	*	*
T_9 - Citric acid (3%)	3.50	3.59	3.18	3.16	*
T_{10}- Control	3.79	3.81	3.23	*	*
SEm±	0.02	0.03	0.02	0.03	
CD @5%	0.07	0.08	0.07	0.10	

**- End of the shelf life of fruit*

4. CONCLUSION

With respect to surface coatings, T_5-Chitosan (1%) recorded significantly superior results in terms of minimum PLW, decay percent and highest firmness, shelf life and quality parameter namely TSS, ascorbic acid content and benefit cost ratio and was followed by T_2-Aloe vera 25%.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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