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Influence of Edible Coatings with and without Calcium on Physico-chemical Characteristics of Guava (*Psidium guajava* L.) *cv.* Gwalior – 27 during Storage

Chythra Somanathan Nair*, Rajesh Lekhi, Dev Jatav and Jyoti Ahirwar

Department of Horticulture specialization in Fruit Science College of Agriculture, R.V.S.K.V.V., Gwalior, Madhya Pradesh, India

**Corresponding author*

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A B S T R A C T

The main objective of the experiment was to study the effects of different edible coatings like Aloe vera gel, Chitosan, Sodium alginate with and without Calcium gluconate on various physico- chemical characteristics of guava fruits. The trial was conducted at ambient storage temperature of 12-15 ºC at 75% RH in December, 2019. Different physico-chemical characteristics like physiological weight loss (%), decay (%),TSS (°Brix), Titrable Acidity (%), Vitamin C content(mg/100g) were recorded for 12days of storage at a regular interval of 3days (0th, 3rd, 6th, 9th and12^{th} day). Aloe vera 100% + Calcium gluconate 2% and Chitosan 2% + Calcium gluconate 2% showed the best results. It was concluded that Chitosan 2% + Calcium gluconate 2% was most effective in reducing the physiological loss in weight of fruits by inhibiting the ripening and decay, but Aloe vera gel 100% + Calcium gluconate 2% improved the quality of fruits better than the other coatings by maintaining higher levels of TSS and Titrable acidity throughout storage. However, Aloe vera gel due to its easy availability and low cost may be considered over Chitosan.

Introduction

Guava (*Psidium guajava* L.) also known as 'Apple of Tropics', is one of the most important commercial crop. It belongs to the family Myrtaceae and is considered superior to many of other fruits in terms of its nutritional and market value (Menzel, 1985). The fruits are rich source of Vitamin C (Ascorbic acid) and contains good amount of essential minerals like Calcium (14-30 mg/100g), Phosphorus (23.37 mg/100g), Iron (0.6-1.4mg/100g) (Bose *et al.*, 1999). It is popularly known as 'Poor man's apple' as it is no way inferior to apple in terms of its high nutritional value and is easily available in

market at a lower price (Sharma *et al.,* 1998). Guava fruits are climacteric in nature and it ripens rapidly. Hence it is highly perishable and has short shelf life up to 2-3 days when stored under room temperature (Krishna and Rao, 2014).

Quality of Guava fruits are highly affected by physical environmental factors. Physiological processes like ripening and production of other volatile compounds also depend on the environmental conditions. The process of ripening can be controlled in modified environmental conditions. Since the fruits are marketed under non-refrigerated condition, it is highly desirable to extend its shelf life under ambient condition.

An edible coating is a thin layer that is deposited on the surface of a fruit or vegetable and it can be consumed. It also acts as a barrier for microbial infections and results in delayed ripening and spoilage process.

The application of coating has gained importance in reducing the moisture loss and maintaining firmness (Farooqhi*et al.,* 1988 and Chauhan *et al.,* 2005). Coatings of Aloe vera gel, Chitosan and Sodium alginate have proved to be effective in improving the storage life of various fruits and vegetables. These control the permeability of fruits to gases like O_2 and CO_2 and the coating serve as a protective layer.

Coating of Calcium is effective in maintaining the textural quality of stored fruit and vegetable since calcium ions form cross-links or bridges between free carboxyl groups of the pectin chains which results in strengthening of the cell wall (Garcia *et al.,* 1996).

Post-harvest application of Calcium gluconate prior to storage has proved to be better in the retention of ascorbic acid. It attributes to the slow rate of oxidation in the respiration process. Hence, edible coatings delay the overall ripening and senescence of the stored fruit (Deepthi *et al.,* 2016).

The aim of the present investigation is to study the enhanced performance of different edible coatings in combination with Calcium gluconate on different post harvest quality parameters such as physiological weight loss, decay, Total Soluble Sugar, Titrable Acidity and Vitamin C content of Guava (*Psidium guajava* L. *cv*. Gwalior-27) fruits.

Materials and Methods

The experiment was conducted at Post-harvest Laboratory, College of Agriculture, R.V.S.K.V.V., Gwalior during the year 2019-20.

Fresh guavas of Gwalior-27 variety were harvested from the College Orchard. Sound fruits of uniform size and maturity were selected for the experiment. Ten fruits per treatment were selected and experimented in three replications.

Preparation of different coatings

Aloe vera Coating

Fresh Aloe vera leaves were cut and washed. The green skin along with spikes were removed to obtain the flesh.

The Aloe vera flesh was then washed and blanched in hot water for 4 min at 100°C. It was blended and filtered to obtain the clear gel.

Chitosan coating

Chitosan 2% coating was prepared by dissolving 20g of Chitosan in aqueous solution of glacier acetic acid (1% v/v). Tween 80 at 0.1% was added to enhance wettability.

Sodium alginate coating

Coating of Alginate 2% was prepared by dissolving 20g of Sodium alginate in 1 litre of sterilised distilled water. The solution was heated at 70°C until the solution became clear.

Calcium gluconate coating

2% of Calcium gluconate solution was prepared by dissolving 20g of Calcium gluconate in 1 litre of distilled water. 0.2ml of Tween 20 was added to improve wettability.

Coatings combined with calcium gluconate

Calcium gluconate 2% solution was added to prepared coatings of Aloe vera gel 100%, Chitosan 2%, Sodium alginate 2% in 1:1 ratio. Fruits were dipped in these solutions for 1 minute, drained and air dried.

The treated fruits were stored at ambient conditions of post-harvest laboratory having 12- 15°C temperature and 75% RH for 12 days.

Various physico-chemical characteristics were observed and noted at an interval of 3 days i.e. 0th, 3rd, 6th, 9th, 12th day of storage.

Quality attributes

Physiological Loss in Weight (PLW) of the stored fruits was determined by following equation [(initial weight of fruit – weight of fruit on the observation day) / initial weight of fruit] x 100.

Decay % of fruits were calculated by dividing the number of spoiled fruits with initial number of fruits multiplied by 100.

TSS of fruits was recorded by using digital Hand Refractometer of range 0-32 °Brix.

The titrable acidity in % and Vitamin C content in mg/100g were determined by Titration methods of Ranganna (1986).

Statistical analysis

The experiment was in completely randomised design with two factors (treatments and storage periods) and were analysed as per Snedecor and Cochran (1987). A significance level of 5% was used for all tests. The data are given in tables and graphs.

Results and Discussion

Physiological loss in weight

The data on effect of different edible coatings with and without Calcium on physiological loss in weight of guava under ambient storage conditions are given in Table 1. It was clear that minimum percentage of Physiological weight loss (3.39% and 4.65%) was observed in Calcium combined coatings of Chitosan 2% (T_6) followed by Aloe vera gel 100% (T_5) respectively. Maximum weight loss (13.62% and 12.04%) was observed in Control (T_0) followed by Calcium gluconate 2% (T_4) at the end of the storage period. Application of Chitosan protects the fruit from mechanical injuries and delays the loss of moisture and maintain tissue turgidity (Elsabee and Abdou, 2013). Aloe vera gel possess hygroscopic properties that reduces the moisture loss. Calcium is effective in membrane functionality and integrity maintenance by binding to the polar head group of the phospholipids. Thereby, the lower loss of phospholipids with reduced ion leakage could be responsible for reduced weight loss in Calcium applied fruits (Lester and Grusak, 1999). The mentioned results are similar to the findings of Fekry (2018) on effect of Chitosan and Calcium gluconate on maintaining quality of Guava during storage.

Decay (%)

The data on effect of different edible coatings with and without Calcium on Decay % of guava fruits during ambient storage conditions is presented in Table 2.

Chitosan 2% + Calcium gluconate 2% (T_6) and Aloe vera gel 100% +Calcium gluconate 2% (T_5) exhibited no decay till 3rd day of storage. Minimum percentage of Spoilage (1.73% and 2.58%) was observed in Calcium combined coatings of Chitosan 2% (T_6) followed by Aloe vera gel 100% (T_5) respectively.

Maximum rate of decay 28 (8.24% and 6.88%) was observed in Control (T_0) followed by Calcium gluconate 2% (T_4) at the end of the storage period. Chitosan is efficient in inhibiting decay and extending shelf life due to its bacteriostatic and fungistatic properties (Adetunji *et al.,* 2014). The presence of Calcium helped in increasing stability of the cell wall and middle lamella by forming new cross links between anionic homogalacturons, strengthening the cell wall and middle lamella. Thus, the fruit developed resistance to the fungal enzymes (Munoz *et al.,* 2008).

Chitosan combined with Calcium gluconate had enhanced resistance to infection and lesion development due to low respiration rate and delay of senescence (Wang *et al.,* 2014). The findings of this investigation is in line with the findings of Kumar *et al.,* (2017) and Fekry (2018) on Guava fruits

Total Soluble Solids (°Brix)

The data on effect of various edible coatings with and without Calcium on Total soluble solids of guava fruits under ambient storage conditions are presented in Table 3. Maximum Total Soluble Solids (10.65°Brix and 10.48°Brix) was observed in Calcium combined coatings of Aloe vera gel 100% (T_5) followed by Chitosan 2% (T_6) respectively. Minimum TSS (9.59°Brix and 9.68°Brix) was observed in Control (T_0) followed by Calcium gluconate 2% (T_4) at the end of the storage period. Aloe vera coating effectively maintained TSS because of its ability to lower the gas permeability, inhibiting the respiratory rates and retarding the metabolic activities of fruits. The present experimental results are in close conformity with observations of Chauhan *et al.,* (2014) who found that Aloe vera in combination with Calcium salt had better results on TSS and other physico-chemical parameters in Mango fruits.

Titrable Acidity (%)

The data on influence of different edible coatings with and without Calcium on Titrable acidity of guava fruits under ambient storage conditions are presented in Table 4. Highest percentage of Titrable acidity (0.38% and 0.37%) was recorded in Calcium combined coatings of Aloe vera gel 100% (T_5) followed by Chitosan 2% (T_6) respectively.

Higher retention of acidity in coated fruits is due to its ability to lower the respiration rates and delay the metabolic activities thereby, preventing the loss of organic acids during the storage (Munoz *et al.,* 2008).

Addition of Calcium maintains higher acidity in fruits during the storage due to its decreased hydrolysis of organic acids and subsequent accumulation of these acids that are oxidized at a slower rate because of low respiration rate (Gupta *et al.,* 2011).

The findings of the present investigation is in line with the observations reported by Kumar *et al.,*(2017) on guava fruits where Aloe vera followed by Chitosan had the maximum percentage of acidity at the end of the extended storage.

Table.1 Effect of different edible coatings without calcium on physiological weight loss % under ambient storage condition

Tr.No.	Treatments	Storage intervals (days)				Mean
		3	6	9	12	
T_0	Control	3.34	11.79	21.07	31.91	**13.62**
T_1	Aloe vera 100%	3.23	6.24	10.97	18.92	**7.87**
T_2	Chitosan 2%	0.81	5.53	10.10	15.96	**6.48**
T_3	Sodium alginate 2%	2.47	12.04	17.33	23.46	**11.07**
T_4	Calcium gluconate 2%	3.70	11.11	17.39	27.55	**12.04**
T_5	Aloe vera 100% + Calcium gluconate 2%	1.71	3.67	17.83	11.43	**4.66**
T_6	Chitosan 2% + Calcium gluconate 2%	0.72	2.70	6.47	8.83	**3.39**
T_7	Sodium Alginate 2% + Calcium gluconate 2%	2.13	5.04	4.69	15.51	**6.09**
Mean		**2.26**	**7.27**	**12.03**	**19.19**	
CD at 5% Treatments (T)		**1.51**	**2.39**	**1.94**	**1.67**	**0.89**
Storage intervals (S)		-	-	-	-	**0.63**
Interaction (TxS)		-	-	-	-	**1.79**

Table.2 Effect of different edible coatings with and without calcium on decay % under ambient storage condition

Tr.No.	Treatments	Storage intervals (days)				Mean
		3	6	9	12	
T_0	Control	3.75	6.97	12.00	18.48	**8.24**
T_1	Aloe vera 100%	2.05	2.86	6.55	10.06	**4.30**
T_2	Chitosan 2%	1.75	2.95	5.19	8.50	**3.68**
T_3	Sodium alginate 2%	2.45	5.14	8.37	13.98	**5.99**
T_4	Calcium gluconate 2%	2.50	5.90	10.50	15.50	**6.88**
T_5	Aloe vera 100% + Calcium gluconate 2%	0.00	2.40	3.75	6.75	**2.58**
T_6	Chitosan 2% + Calcium gluconate 2%	0.00	1.50	2.25	4.92	**1.73**
T_7	Sodium Alginate 2% + Calcium gluconate 2%	1.15	2.00	5.17	8.45	**3.35**
Mean		**1.71**	**3.71**	**6.72**	**10.83**	
CD at 5% Treatments (T)		**0.24**	**0.40**	**0.73**	**0.54**	**0.24**
Storage intervals (S)		-	-	-	-	**0.17**
Interaction (TxS)		-	-	-	-	**0.48**

Table.3 Effect of different edible coatings with and without calcium on total soluble solids (^{0} Brix) under ambient storage condition

Tr. No.	Treatments	Storage intervals (days)					Mean
		0	3	6	9	12	
T_0	Control	9.13	9.21	9.53	9.77	10.30	**9.59**
T_1	Aloe vera 100%	9.10	9.48	10.54	10.83	11.63	**10.32**
T_2	Chitosan 2%	9.13	9.26	9.64	10.27	10.67	**9.79**
T_3	Sodium alginate 2%	9.12	9.32	9.65	9.97	10.43	**9.70**
T_4	Calcium gluconate 2%	9.11	9.32	9.58	9.83	11.57	**9.68**
T_5	Aloe vera 100% + Calcium gluconate 2%	9.12	10.12	10.64	11.53	11.83	**10.65**
T_6	Chitosan 2% + Calcium gluconate 2%	9.11	9.56	10.68	11.43	11.60	**10.48**
T_7	Sodium Alginate 2% + Calcium gluconate 2%	9.13	9.48	10.52	11.37	11.50	**10.40**
Mean		**9.12**	**9.47**	**10.10**	**10.63**	**11.07**	
CD at 5% Treatments (T)		**NS**	**0.10**	**0.17**	**0.80**	**0.99**	**0.24**
Storage intervals (S)		-	-	-	-	-	**0.19**
Interaction (TxS)		-	-	-	-	-	**0.54**

Table.4 Effect of different edible coatings with and without calcium on titrable acidity (%) under ambient storage condition

Tr.No.	Treatments	Storage intervals (days)					Mean
		0	3	6	9	12	
T_0	Control	0.50	0.39	0.28	0.23	0.11	**0.30**
T_1	Aloe vera 100%	0.50	0.41	0.34	0.27	0.15	**0.33**
T_2	Chitosan 2%	0.50	0.38	0.33	0.24	0.14	**0.32**
T_3	Sodium alginate 2%	0.50	0.42	0.31	0.23	0.12	**0.32**
T_4	Calcium gluconate 2%	0.50	0.41	0.32	0.18	0.12	**0.31**
T_5	Aloe vera 100% + Calcium gluconate 2%	0.50	0.46	0.40	0.32	0.24	**0.38**
T_6	Chitosan 2% + Calcium gluconate 2%	0.50	0.45	0.39	0.30	0.23	**0.37**
T_7	Sodium Alginate 2% + Calcium gluconate 2%	0.50	0.43	0.36	0.24	0.22	**0.35**
Mean		**0.50**	**0.42**	**0.34**	**0.25**	**0.17**	
CD at 5% Treatments (T)		**NS**	**0.02**	**0.02**	**0.02**	**0.02**	**0.01**
Storage intervals (S)		-	-	-	-	-	**0.01**
Interaction (TxS)		-	-	-	-	-	**0.02**

Table.5 Effect of different edible coatings with and without calcium on Vitamin C content (mg/100g) under ambient storage condition

Tr. No.	Treatments	Storage intervals (days)					Mean
		0	3	6	9	12	
T_0	Control	255	210	182	137	95	**175.8**
T_1	Aloe vera 100%	260	233	192	144	117	**189.2**
T_2	Chitosan 2%	257	232	210	165	127	**198.2**
T_3	Sodium alginate 2%	257	239	183	143	125	**189.4**
T_4	Calcium gluconate 2%	260	226	189	147	116	**187.6**
T_5	Aloe vera 100% + Calcium gluconate 2%	258	238	215	173	133	**203.4**
T_6	Chitosan 2% + Calcium gluconate 2%	257	243	228	201	185	**222.8**
T_7	Sodium Alginate 2% + Calcium gluconate 2%	258	242	206	193	183	**216.4**
Mean		**257.8**	**232.88**	**200.63**	**162.63**	**135.13**	
CD at 5% Treatments (T)		**NS**	**14.33**	**14.93**	**9.38**	**12.60**	**5.24**
Storage intervals (S)		-	-	-	-	-	**4.14**
Interaction (TxS)		-	-	-	-	-	**11.72**

Vitamin C content (mg/100g)

The data on effect of various edible coatings with and without Calcium on Vitamin C content of guava fruits under ambient storage conditions are presented in Table 5.

Maximum Vitamin C content (222.8 mg/100g) was recorded in Chitosan 2% + Calcium gluconate 2% (T_6) and Minimum (175.5 mg/100g) was recorded in Control (T_0).

Chitosan coated fruits had a lower permeability to the gases which helped to inhibit the ripening process and reduce the activity of the enzymes involved in the oxidation of the Vitamin-C (Bal, 2013).

Calcium gluconate was effective in slowing down the rate of respiration, delaying the overall ripening and senescence which accounted to the maintenance of higher Vitamin C content in Calcium coated fruits (Deepthi *et al.*, 2016). These results are in agreement with the findings of Fekry (2018) and Chawla *et al.*, (2018) on Guava fruits.

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