Research Article

Effect of Herbal Edible Coatings on Quality Characteristics of Guava Stored Under Ambient Conditions

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Abstract

Guava being a climacteric fruit ripens rapidly and is highly perishable; its shelf-life period ranges from 3-4 days under ambient conditions. Thus, it makes transportation and storage difficult. Therefore, the main aim of the study was to assess the efficacy of different edible coating treatments like aloe vera gel and papaya leaf extract at varying concentrations of 5, 10, 15 and 20 per cent on the post-harvest quality attributes of fruits of guava cultivar 'Lucknow-49'. After treatment, fruits were kept under ambient conditions and analyzed for various physico-chemical and sensory parameters while the uncoated fruits served as control. Among all the treatments, minimum mean physiological loss in weight of 4.36 per cent, decay percentage of 4.09 per cent and TSS of 11.23°B were observed in T_5 (20% aloe vera gel) whereas, T_1 (Control) recorded maximum mean physiological loss in weight of 12.27 per cent, decay percentage of 13.28 per cent and TSS of 13.92°B. The lowest mean ascorbic acid content of 198.99 mg per 100g and highest total sugar (9.48%), reducing sugar (4.37%) content was recorded in T_1 (Control). Sensory evaluation of herbal coated guava fruits revealed that T_5 (20% aloe vera gel) recorded the highest mean score for overall acceptability (8.00). Hence, it was concluded that coating treatment of 20% aloe vera gel can be used for enhancing the shelf life and maintaining postharvest quality in fruits of guava cultivar 'Lucknow-49'.

Keywords: Guava, aloe vera, edible coatings, acidity, sensory parameters

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Introduction

Guava (*Psidium guajava* L.) is one of the important commercial fruits in India with annual production of 3.66 million tonnes [1]. The guava is rich in antioxidants like phenolics and carotene [2] and a source of minerals like iron, calcium, phosphorus as well as many vitamins like ascorbic acid, pantothenic acid, vitamin A and niacin [3]. It is a highly perishable fruit having high moisture content and intense metabolic activities which continues post-harvest, therefore loses its texture and quality during storage [4]. Marketable life is also significantly limited by the abrupt softening during post-harvest handling. Therefore, guava fruits are required to be managed appropriately through judicious use of post-harvest treatments [5].

Due to the economic impacts of spoiled foods and consumers' concerns over the safety of foods containing synthetic chemicals, a lot of attention has been paid to naturally derived compounds or natural products [6]. Edible coatings using natural biomaterials are being explored as a safer alternative to extend the shelf life of perishable food crops and improve food appearance [7]. Different compounds have been used as edible coatings to prevent commodity weight loss, including wax, milk proteins, celluloses, lipids, starch, zein and alginate [8].

Aloe vera gel has been identified as a novel coating agent with good antimicrobial properties [9]. In recent years, the use of A. vera gel has gained much attention for use as a safe and environment-friendly postharvest treatment. Aloe vera contains many beneficial complex components including glycoproteins, polysaccharides, salicylic acids, phenolic compounds, lignins, amino-acids, vitamins, saponins and enzymes which provide aloe vera its beneficial properties. The main component of aloe vera extract is "Aloin and Aloe-emodin". Aloe vera extract is used as anti-fungal, anti-bacterial, anti-inflammatory [10]. Aloe vera gel based edible coatings are good moisture and gas barrier.

On the other hand, plant extracts (neem, onion, garlic etc.) are widely popular as a postharvest treatment [11]. The antimicrobial activity of many plants against post-harvest pathogens has been demonstrated in mango and papaya [12]. Furthermore, papaya leaf contains bioactive compounds which have antifungal [13] activity. Moreover, plant extracts have the ability to decompose rapidly and do not cause any negative hazards to the environment unlike chemical pesticides [14]. Therefore, the objective of the present study was to evaluate the effect of these herbal edible coatings on the post-harvest shelf life and physico-chemical changes during storage of guava fruits cv. Lucknow-49 at ambient conditions.

Material and Methods

Preparation of herbal coatings

Aloe vera gel coating

Aloe vera gel was prepared according to the method of Ramachandra and Rao [15]. Whole leaves were washed with water and the base and tips of the leaves along with its spikes were removed. Aloe vera leaves must be processed within 2 hours of harvesting to prevent oxidation of the gel due to their exposure to air. Next, the skin was carefully separated from parenchyma to obtain aloe vera flesh. The flesh was then washed and blanched in hot water at 100ºC for 4 minutes. The blanched flesh was then blended and the aloe vera gel obtained was filtered through activated carbon to remove anthraquinones that have a laxative effect. Before pasteurization, the pH of the gel was adjusted to 3.0 by addition of citric acid to stabilize and prevent browning. The process was then continued with pasteurization at 85ºC for 1 minute. After pasteurization, the gel was quickly cooled to 5ºC or below. Finally, the aloe vera gel was filled into pre-sterilized, opaque glass bottles for storage in a chiller at 5ºC and 75-80% relative humidity.

Papaya leaf extract coating

To prepare papaya leaf extract, 500 g papaya leaves were first washed with running water. After that the leaf surface was sterilized using 0.1% mercuric chloride for 10 min. [16] and again washed thoroughly with sterile distilled water. Filtration was carried out to remove fibre.

Coating of guava fruits

Fresh and fully mature uniform sized and disease free guava variety Lucknow-49 was procured from RHRSS, Raya. The fruits were washed with tap water to remove the dirt and dust particles and dried at room temperature. The guava fruits were divided into requisite lots for different coatings. Accordingly, coatings of aloe vera gel and papaya leaf extract were made in 5, 10, 15, 20% with water. The treated and non-treated fruits were divided into different lots and were placed in ambient conditions in the laboratory. Fruits were dipped in these solutions for 1-2 minutes, drained and surface dried (**Figure 1**) by using procedure according to Hong *et al*. [17]. The observations on various physico-chemical attributes were studied on same day of harvest and after 7, 14 and 21 days of storage at ambient conditions (27-29ºC and 70-75% RH).

(a) (b)

Figure 1 Guava Fruits coated with aloe vera gel before (a) and after 21 days (b) of storage

Physical attributes

The physiological loss in weight (PLW) of the fruits was determined by using standard procedures according to AOAC [18]. Decay percentage of coated and uncoated fruit was calculated as the number of decayed fruit divided by initial number of all fruits multiplied by 100 [19] at subsequent intervals.

Chemical attributes

TSS of the fruits was measured with the help of hand held digital refractometer of 0-32°Brix range by using standard procedures according to AOAC [18]. The titratable acidity (expressed as citric acid %) was determined as per method of Ranganna [20]. Lane and Eynon [21] method as described by Ranganna [20] was used for determining total sugar, reducing sugar and non-reducing sugar and expressed in percentage.

Organoleptic evaluation

The organoleptic evaluation of guava fruits was performed by the panel of 10 judges based on the sensory attributes like colour, appearance texture, flavour, taste and overall acceptability. The evaluation was done on a nine point hedonic scale as described by Amerine *et al*. [22].

Statistical analysis

The data were analysed according to the procedure for analysis of two factorial completely randomized design. The overall significance of differences among the treatments was tested, using critical difference (C.D.) at 5% level of significance.

Results and Discussion

Data depicted in **Table 1** showed that all the treatments exerted a significant influence on physiological loss in weight. Minimum mean physiological loss in weight (4.36%) was recorded in 20% aloe vera gel coated fruits (T_5) followed by (4.52%) aloe vera gel coated fruits (T_4) and maximum (12.27%) was recorded in control (T_1) followed by (7.23%) in 5% papaya leaf extract treated samples (T_6). This might be due to the formation of water barrier between the fruit and the surrounding environment due to aloe vera gel, thus preventing its external transferences [23]. Loss of weight in fresh fruit is mainly due to the loss of water caused by transpiration and respiration processes [24]. Brishti *et al.* [25] also reported similar results that weight loss of uncoated fruit (sample) was significantly greater than that of aloe vera gel coated papaya fruit. At the end of the storage, control fruits showed 13.28% loss in weight, whereas the weight losses of samples coated with aloe vera gel (20%) was 4.09%.

Table 1 Effect of herbal edible coatings on Physiological Loss in weight and Decay percentage of stored guava fruits

Treatment	**Physiological Loss in Weight (%)**					**Decay (%)**				
	Storage period (days)					**Storage period (days)**				
	0	**7**	**14**	**21**	**Mean**	**0**	**7**	**14**	**21**	**Mean**
T_1 (Control)	0.00	9.82	16.78	22.50	12.27	0.00	9.40	17.26	26.45	13.28
T_2 (5% AG)	0.00	4.74	6.28	8.45	4.87	0.00	1.35	8.92	12.23	5.62
T_3 (10% AG)	0.00	4.43	6.04	8.26	4.68	0.00	0.00	8.47	11.51	4.99
T_4 (15% AG)	0.00	4.26	5.83	8.01	4.52	0.00	0.00	7.94	10.73	4.67
T_5 (20% AG)	0.00	3.95	5.62	7.88	4.36	0.00	0.00	6.70	9.67	4.09
T_6 (5% PLE)	0.00	6.85	9.82	12.24	7.23	0.00	6.80	11.31	15.90	8.50
T_7 (10% PLE)	0.00	6.62	9.67	12.09	7.09	0.00	6.48	11.10	15.35	8.23
T_8 (15% PLE)	0.00	6.31	9.41	11.85	6.89	0.00	6.25	10.26	14.82	7.83
T_9 (20% PLE)	0.00	6.00	9.13	11.62	6.69	0.00	5.73	9.88	14.37	7.49
Mean	0.00	5.89	8.73	11.43		0.00	4.00	10.20	14.56	
Effect	$CD_{0.05}$	$CD_{0.05}$								
Treatment	0.04	0.03								
Storage	0.03	0.02								
Treatment x Storage	0.08	0.07								
AG: Aloe vera Gel, PLE: Papaya Leaf Extract										

The data on effect of various treatments and storage periods on decay percentage of guava under ambient conditions are presented in Table 1. The data indicated that all the treatments exerted a significant influence on fruit decay percentage. No sign of decay were observed in Treatment T_3, T_4 and T_5 until 7 days of storage period. Control uncoated fruit showed maximum (13.28%) decay percentage during the entire storage period. Minimum fruit decay percentage (4.09%) was recorded in 20% aloe vera gel treated fruits (T_5) followed by (4.67%) in 15% aloe vera gel treated fruits (T_4). Storage period affected fruit decay percentage significantly which increased gradually irrespective of the treatment as the storage period progressed. Aloe gel and papaya leaf extract contain bioactive agents which mainly serve to prevent papaya fruit disease [26]. Aloe gel-based coating also retarded microorganism proliferation in sweet cherries [27].

The Total Soluble Solid content of guava fruit as affected by different coating material and storage duration is presented in **Table 2**. Both coating materials and storage intervals had significant on Total Soluble Solid of guava. Maximum TSS (13.92° Brix) was found in control fruits whereas, minimum TSS (11.23° Brix) was recorded in 20% aloe vera gel treated fruits (T_5). The increase in TSS of control fruits was mainly due to the progressive boost in free

sugars of fruit during storage periods, as reported by Cheour et al. [28]. Coated fruits retarded TSS development because aloe gel decreases the respiration and eventually catabolism of sugars. A similar result was found in Aloe gel-coated guava [29].

Table 2 Effect of herbal edible coating on Total Soluble Solids (TSS) and Titratable acidity of stored guava fruits

Treatment	TSS (^{o}B)					Titratable acidity (%)				
	Storage period (days)					Storage period (days)				
	0	7	14	21	Mean	0	7	14	21	Mean
T_1 (Control)	12.00	13.13	14.16	16.38	13.92	0.64	0.53	0.48	0.40	0.51
T_2 (5% AG)	12.00	12.16	12.65	13.10	12.48	0.64	0.55	0.51	0.47	0.54
T_3 (10% AG)	12.00	11.71	12.26	12.74	12.18	0.64	0.57	0.53	0.50	0.56
T_4 (15% AG)	12.00	10.68	11.68	12.37	11.68	0.64	0.58	0.56	0.53	0.58
T_5 (20% AG)	12.00	9.92	11.14	11.86	11.23	0.64	0.60	0.58	0.55	0.59
T_6 (5% PLE)	12.00	12.39	12.86	13.57	12.70	0.64	0.57	0.54	0.50	0.56
T_7 (10% PLE)	12.00	11.92	12.45	13.32	12.42	0.64	0.59	0.56	0.52	0.58
T_8 (15% PLE)	12.00	10.79	11.99	13.06	11.96	0.64	0.60	0.57	0.55	0.59
T_9 (20% PLE)	12.00	10.21	11.36	12.73	11.57	0.64	0.62	0.59	0.57	0.60
Mean	12.00	11.43	12.28	13.24		0.64	0.62	0.55	0.51	
Effect	$CD_{0.05}$	$CD_{0.05}$								
Treatment	0.05	0.04								
Storage	0.03	NS								
Treatment x Storage	0.18	0.07								
AG: Aloe vera Gel, PLE: Papaya Leaf Extract										

A gradual decrease in titratable acidity was found in both coated and uncoated guava fruits throughout the storage period (Table 2). Maximum fruit titratable acidity (0.60%) was recorded in T_9 (20% Papaya leaf extract) followed by (0.59%) in 20% aloe vera gel treated fruits (T_5) and T_8 (15% Papaya leaf extract) minimum (0.51%) was recorded in control (T_1). Slower decline in acidity in treated fruits compared to control might be due to delayed senescence and lower respiration rate in those fruits. This retention of TA content by coated guava fruits might also be due to the protective effect of aloe gel coating as a barrier to O_2 from the surrounding atmosphere [30] and reduction of respiration [31]. The titratable acidity was relatively high at harvest and then it decreased with advancement in storage period. The decrease in acid content of fruits with the increase in storage could be attributed to the use of organic acids in respiratory process by the fruit cells and conversion of acids into total sugars [32].

Total sugar content increased during storage in all the treatment (**Table 3**). Maximum total sugar content (9.48 %) was observed in T_1 (Control) followed by T_6 (5% Papaya leaf extract) and T_7 (5% Papaya leaf extract) whereas, minimum total sugar content (7.59%) was recorded in T_5 (20% Aloe vera gel) coated guava. The total sugar content was found to be higher in uncoated fruits which might be due to decrease in acidity as a result of physiological changes and rapid conversion of starch to sugars as a result of moisture loss [33]. In case of coated samples significantly slower increase in total sugar contents was observed as compared to control which might be due to slower ripening rate. Increase in total sugar during storage might be due to the hydrolysis of starch into sugar [34].

The data on effect of various treatments and storage period on reducing sugar content of guava fruits under ambient conditions is shown in Table 3. The data showed that all the treatments exerted significant effect on reducing sugars. Maximum reducing sugar content of 4.37 % was recorded in control followed by treatment T_6 (5% Papaya leaf extract). Storage period significantly affected reducing sugars which increased gradually irrespective of the treatment as the storage period progressed. The results further revealed that the rate of increase in reducing sugar content was significantly lower in coated samples as compared with control fruits which might be due to decrease in acidity as a result of physiological changes and rapid conversion of starch to sugars as a result of moisture loss[33]. In case of coated samples significantly slower increase in reducing sugar contents was observed as compared to control which might be due to slower ripening rate [34].

The perusal of data in **Figure 2** indicates that maximum overall acceptability of 8.10 was recorded in T_5 (20% Aloe vera gel) coated guava fruits followed by T_4 having overall acceptability of 7.91 after 21 days of storage. During storage the overall acceptability content decreased significantly irrespective of the treatments. Aloe vera coated fruits have higher retention of green colour and flavour was satisfactory, which means ripening was delayed in coated fruits. However, control fruits showed severe symptoms of dehydration during storage.

Table 3 Effect of herbal edible coating on Total sugar and Reducing sugar of stored guava fruits

Treatment	Total Sugar (%)					Reducing sugar (%)				
	Storage period (days)					Storage period (days)				
	0	7	14	21	Mean	0	7	14	21	Mean
T_1 (Control)	8.10	8.98	9.63	11.20	9.48	3.11	3.84	4.45	6.10	4.37
T_2 (5% AG)	8.10	7.86	8.48	10.54	8.75	3.11	3.26	3.93	4.28	3.64
T_3 (10% AG)	8.10	7.10	8.14	10.23	8.39	3.11	3.01	3.56	4.00	3.42
T_4 (15% AG)	8.10	6.82	7.77	9.61	8.07	3.11	2.75	3.11	3.67	3.16
T_5 (20% AG)	8.10	6.23	7.20	8.85	7.59	3.11	2.34	2.68	3.05	2.79
T_6 (5% PLE)	8.10	8.21	8.75	11.00	9.01	3.11	3.59	4.15	4.68	3.88
T_7 (10% PLE)	8.10	8.03	8.32	10.72	8.79	3.11	3.30	3.86	4.22	3.62
T_8 (15% PLE)	8.10	7.38	7.99	10.30	8.44	3.11	2.97	3.39	3.94	3.35
T_9 (20% PLE)	8.10	7.00	7.57	9.82	8.12	3.11	2.53	2.81	3.42	2.97
Mean	8.10	7.51	8.21	10.25		3.11	3.06	3.55	4.15	
Effect	$CD_{0.05}$	$CD_{0.05}$								
Treatment	0.03	0.06								
Storage	0.02	0.04								
Treatment x Storage	0.06	0.11								

AG: Aloe vera Gel, PLE: Papaya Leaf Extract

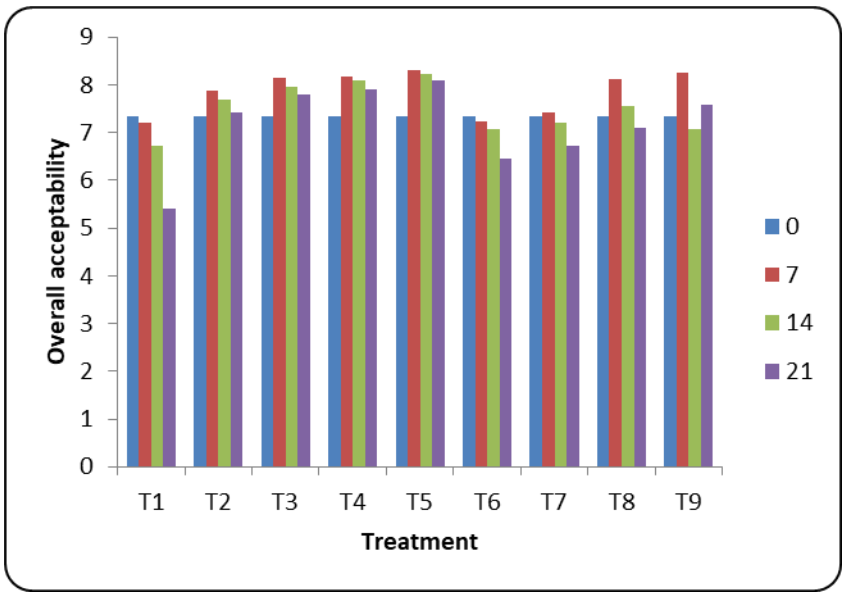

Figure 2 Effect of herbal edible coatings on Overall acceptability of guava fruits

Conclusion

From the overall observations of the experiment it was concluded that 20% aloe vera gel coated guava fruits was found most effective post-harvest treatment at ambient condition which enhanced the consumer acceptability, maintained the quality of fruits and caused minimum spoilage loss during storage. Aloe vera gel coated guava can be stored up to 21 days at ambient temperature without much nutritional deterioration. Hence this technology could be used to increase the shelf life and reduce the post-harvest losses of fruits to restrict use of harmful chemicals by the growers and traders.

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