Effect of leaf and seed powder based edible coating with beeswax and Clove essential oil on the shelf life of guava (*Psidium guajava*) cv. Allahabad Safeda

Abstract

The guava is thought to be India's most significant commercial fruit crop. Due to their high respiration rate, vulnerability to different pathogens, and mechanical damage that can quickly deteriorate the quality and concised its shelf life. Nonetheless, the purpose of the experiment was to investigate how guava's edible coatings affected its postharvest quality and shelf life. Guava fruits were treated by seven treatments of different concentrations of beeswax, guava leaf powder, neem leaf powder, tamarind seed powder, and clove oil with different combinations were used as edible coating. Various treatments were used to examine the impact of edible coating materials on the physical and chemical properties. Under ambient conditions, the variations in physiological and chemical parameters were seen. The findings of present study showed maximum fruit weight (120.29 g), highest vitamin C(163.19mg/100g), maximum acidity (0.49%)and antioxidantactivity (35.43%) obtained from T4 [Neem leaves powder (2%) + Beeswax (1%)+ clove oil (1%)] compared with untreated fruits. The result suggested that the applications of [Neem leaves powder @ 2%) + Beeswax @ 1% + clove oil @1%] as an edible coating material in guava fruit is more effective than other treatmentsto improve the shelf life of Guava.

Keywords: edible powder, beeswax,clove oil, storage

Introduction

The guava (*Psidium guajava L.*) is a well-known tropical and subtropical fruit that is grown all over the world. Guava belongs to the Myrtaceae family. More than 3800 different species of shrubs belong to the genus Psidium. Guava is a tropical fruiting tree that grows annually, is the toughest among tropical fruiting trees, and is the most tolerant of all environmental conditions (Jain*et al*., 2024).The guava fruit is rich in minerals and vitamins C, A, B1, and B2. The main components of red fleshed guava are the nutraceuticals, namely alpha-carotene, lycopene, and phenolic compounds along with high levels of vitamin C, all of which have antioxidant properties(Jumrah*et al*. 2024).The use of edible coatings is simple, inexpensive, and environmentally friendly**.** Biopolymers derived from natural sources, such as polysaccharides, proteins, lipids, or a multi-component mixture, are the basis for edible films and coatings (Basharat*et al*. 2024).These edible coatings serve as physical barriers on the surfaces of fruits and vegetables, reducing their permeability to O_2, CO_2, and water vapor, which lowers their respiration and transpiration rate. This is the main benefit of edible coatings, which has been shown in a wide range of fruits and vegetables, including apple, papaya, guava, plum, mango and apricot **(**Pillai*et al*. 2024).Beeswax is a natural glazing agent that can be used in food to stop water loss and offer protection while being stored. Beeswax's oxygen moisture barrier properties fall between low and high density polyethylene **(**Hosseini*et al*. 2023).A study revealed the effect of sodium alginate coating andcombination of Sodium Alginate (2%) and Neem Leaf Extract (20%) coatings which maintained the antioxidant capacity and overall physiochemical properties on kinnnow (Kaur*et al*. 2024).Post-harvest quality preservation of guava continues to be a production challenge because of the less post-harvest life due to its high rate of respiration, high ethylene rate, rapid firmness loss, and decay loss during storage. Due to the high level of postharvest losses in guava, innovative techniques were needed to preserve the fruit's quality through the prudent application of post-harvest treatments (Bisht*et al*. 2024).

A potential research gap to Examine these coatings affect the fruit's long-term physical and biochemical properties could be one area of unfulfilled research need. A dearth of studies investigating the long-term performance of these coatings may exist, despite the fact that many studies concentrate on their immediate impacts. Producers and consumers alike may benefit from knowing how long these coatings last and how effective they are over time, especially in areas where guava is a major agricultural crop and storage conditions might vary greatly. Further research may also be necessary to examine the scalability and economic viability of applying such coatings on a commercial basis.These approaches have shown promise as potential strategies to boost the profitability and shelf life of guava fruit with the help of edible coating.

MATERIALS AND METHODS

The Guava fruits with variety "Allahbadsafeda" were acquired from the local farmer of 'Punjab' of uniform size, color, free of physical damage and fungal infection were selected and washed with distilled water. The guava leaves and Neem leaves used in treatments were taken from the Herbal Garden of Lovely Professional University, Phagwara, Punjab and tamarind seeds from the local market of Phagwara, Punjab. About 294 fruits were taken for experiment for the analysis of chemical and physical properties with 7 treatments and their 3 replications. The coating of fruits were done with several combinations of Guava leaf powder, Neem leaf powder, Tamarind seed powder, Bees wax and clove oil by dipping the fruits for 5 minutes in solution. Samples of both treated and control were taken out on every 3, 6, 9, and 12 days at ambient temperature for phsyico-chemical analysis.

Preparation of coating materials

Tamarind seeds were soaked overnight in water (1:3 w/v) and washed using distilled water. The cleaned seeds were air-dried for 14 days. TSP was prepared by using a grinder. The powder was sieved through a 250 μm mesh and stored in an airtight container in a freezer at –18 ± 2°C before use. Preparation of tamarind (*Tamarindus indica*) seed powder with preserved antimicrobial activity was performed according to the method described by (Natukunda *et al*. 2016).

Mature Guava leaves were washed with distilled water. Then, the Guava and neem leaves were dried in a hot-air oven at the temperature of 343 K for 8 h and then ground to fine powder using grinder.The coating materials will be dissolved in appropriate amount of solvent and solution will be made by using homogenizer. The wax coating was made by dissolving 150g of bee wax in 10 ml of water on a hot plate and making sure that every part of the beeswax was completely hydrated.The melted bee wax solution was then added with 20 ml of oleic acid and 60 ml of triethanolamine (TEA). Finally, water was added until the solution reached a volume of 1 liter.

Applied treatments

T_0: control, T1: Guava leaf powder (1%) + Bees wax (1%) + clove oil (1%), T2: Guava leaf powder (2%) + Bees wax (1%) + clove oil (1%), T3: Neem leaf powder (1%) + Bees wax (1%) + clove oil (1%), T4: Neem leaf powder (2%) + Bees wax (1%) + clove oil (1%), T5: Tamarind Seed powder (1%) + Bees wax (1%) + clove oil (1%), T6: Tamarind Seed powder (2%) + Bees wax (1%) + clove oil (1%).

Physical parameters

Fruit weight (g) of selected fruit was weighed with the help of electronic balance; the average weight of fruit was calculated and expressed in grams.Fruit lengthof fruit was measured from calyx end to the pointed end or apex of the fruit with the help of vernier caliper and expressed in inch.Fruit Width of fruit was measured from the shoulders of the fruit with the help of vernier calliper and expressed in inch.
Decay Loss (%) was determined by taking spoiled fruit upon total number of fruits taken and expressed in percentage.

$$Decayloss(\%) = \frac{\text{Number of rotten fruits}}{Initialnooffruitstaken} \text{ X } 100$$

Fruit Firmness was analyzed with the help of Penetrometer. Firmness was measured as the maximum penetration force (N) reachedduring tissue breakage and determined with a 5 mm diameter flat probe. The penetration depth was 5 mm and cross head speed was 5 mm/s.

Chemical Parameters

For chemical analysis T.S.S (^{o}Brix), Titratable acidity (%), Ascorbic acid (mg/100g flesh), Reducing sugar (%), Non reducing sugar (%),Total sugar (%),Antioxidants activity (%) were measured with different methods.
The TSS of fruit was determined with the help of a digital refractometer (0-32 □brix) by putting a few drops of juice on the prism.
Acidity was determined by using the specified method (A.O.A.C, 1975) by titrating a known volume of fruit sample against 0.1N NaOH solutions using phenolphthalein as an indicator up to the end point (light pink colour). It is expressed in percent, as per formula given below:

$$\text{Acidity (\%)} = \frac{\text{Titre x Normality of NaOH x Vol. made up x Equivalent weight of acid x 100}}{\text{Volume of sample taken x Aliquot Taken x 100}}$$

Ascorbic acid was determined by using 2, 6-dichlorophenol-indophenol dye through visual titration method (Freed, 1966). Total sugars were estimated methods given by Lane and Eynon (1923). Antioxidant activity of fruit juice was determined on the basis of its radical scavenging effect on the DPPH free radical (Brand-Williams *et al*., 1995). Both DPPH reagent and sample were prepared in 70% methanol. In a test tube, 100 µl of sample was taken, to which 3.9 ml of DPPH was added and the optical density was measured at 517 nm.
The data obtained through Complete Randomized Design (CRD) techniqueswere subjected to statistical analysis of variance (ANOVA) and OPSTAT software was used for data analysis.

RESULTS AND DISCUSSION

Physical parameters

(1) Fruit weight (g): There was a decrease in fruit weight over time in all treatments, on the 6_{th} day the fruit weight of the untreated fruits was found to be lowest (116.94 g) in T_0 treatment, while the fruit weight of the T_4 treatment was the greatest (121.19 g) compared to the other treatments. In a similar way, the weight of uncoated guava fruits kept at room temperature dropped to 107.31 g on 12^{th} day as rather than T4 (114.43 g) on the same day for coated fruits as shown in (Table 1). Neem contains a number of active ingredients that are antibacterial and antifungal, including nimbidin, nimbin, and nimbidol. Neem leaf extracts may be a viable alternative in the fight against pathogens that cause guava to deteriorate. These results are consistent with those reported by (Freitas*et al*. 2018) who observed least reduction in fruit weight with neem leaf extract (5% and 10%) coatings during storage period of papaya fruit.

(2) Fruit Length (cm): The fruit lengthwas significantly affected both coating and non coated fruits. Fruits which are not treated gradually drop to (7.47 cm), whereas the T4 treatment shows a fall of (7.62 cm) on the 3rd day. In a similar vein, on the 12th day, the length of uncoated guava fruits kept at room temperature was shorter (6.04 cm) than that of T4 (7.13 cm)as described in (Table 1).This may be attributed tothe anti-senescent properties of coatings that hindered the production of ethylene,prevented the activity of enzymes necessary for cell maturation, and avoided celldegradation. These properties allow for decreased moisture loss and a decreasedtransfer of respiratory gas, which in turn slowed senescence and decreased thepercentage ofshrinkage.This was consistent to reportof Bee wax and essential oil coating useful in maintaining the fruit length of guava (Varma*et al*. 2022).

Table 1: Effect of edible coating on fruit weight (g), fruit length (cm), fruit width (cm) of guava cv. Allahabad Safeda

Treatments	Fruit weight (g)					Fruit length (cm)					Fruit width (cm)				
	Storage Days					Storage days					Storage days				
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
T_0	121.46	119.29	116.94	112.99	107.31	7.59	7.47	7.38	7.15	6.04	6.82	6.74	6.64	6.48	5.98
T_1	123.88	123.08	120.44	117.11	114.12	7.66	7.59	7.52	7.38	7.12	6.92	6.86	6.8	6.72	6.36
T_2	121.74	120.09	118.14	114.29	110.43	7.6	7.48	7.41	7.21	7.03	6.83	6.76	6.68	6.59	6.12
T_3	125.53	121.99	119.98	115.98	113.11	7.63	7.53	7.47	7.28	7.13	6.88	6.81	6.74	6.65	6.25
T_4	124.88	123.19	121.24	117.69	114.43	7.67	7.62	7.56	7.42	7.28	6.94	6.89	6.84	6.76	6.46
T_5	123.04	122.69	120.24	116.6	113.41	7.64	7.57	7.5	7.34	7.17	6.9	6.83	6.76	6.68	6.32
T_6	123.28	120.39	118.74	115.79	112.39	7.61	7.49	7.43	7.24	7.07	6.86	6.78	6.7	6.61	6.21
C.D	0.473	0.438	0.346	0.448	0.414	0.02	0.04	0.03	0.07	0.05	0.044	0.089	0.071	0.054	0.108
SE (m)	0.252	0.241	0.113	0.244	0.135	0.009	0.015	0.012	0.024	0.019	0.015	0.029	0.023	0.018	0.035

(3) Fruit Width (cm): As storage days increases the untreated fruits shows sudden decrease in fruit width as compared to treated fruit. The fruit width gradually reduced to 6.74 cm in the T_0 treatment on the 3rd day of storage, compared to 6.89 cm in the T_4 treatment. On the 12th day, the width of the uncoated guava fruits reduced to 5.98 cm, while the coated fruits showed a decline to T_4 (6.46 cm) and T_1 and T_5as mentioned in (Table 1). T_4 shows better results among all treatments.

(4)Firmness(kg/cm^2): The firmness of the uncoated fruits gradually reduces to (3.67 kg/cm^2) on the 6th day, as indicated in (Table 2), contrast to (4.86 kg/cm^2) in the T_4 treatment, followed by T_1 and T_5. Similar to T_4 (3.65 kg/cm^2) in coated fruits, the hardness of uncoated guava fruits kept at room temperature dropped to (1.9 kg/cm^2) on the 12th day. During storage, fruits that are coated maintain their firmness whereas uncoated fruits get softer.This demonstrates the effectiveness of coating treatments in delaying maturation and metabolic processes, and consequently, the decomposition of fruit pulp.It was justified with the report of(Seun*et al*. 2022) used guava leaf powder and aleoveraeffective in extending the shelf-life and firmness of orange fruits (Seun*et al*. 2022).

Table 2:Effect of edible coating on firmness (kg/cm^2) and decay loss (%) of guava cv. Allahabad Safeda

Treatments	**Firmness (kg/cm^2)**					**Decay loss (%)**				
	Storage Days					**Storage days**				
	0	**3**	**6**	**9**	**12**	**0**	**3**	**6**	**9**	**12**
T_0	5.19	4.36	3.67	2.65	1.9	0	0	4.24	6.41	11
T_1	5.34	5.14	4.81	4.24	3.53	0	0	0	0	0
T_2	5.27	4.89	4.53	4	3.41	0	0	0	0	2.34
T_3	5.25	4.68	4.44	3.8	3.36	0	0	0	0	0
T_4	5.39	5.21	4.86	4.48	3.65	0	0	0	0	0
T_5	5.32	4.92	4.74	4.22	3.47	0	0	0	0	0
T_6	5.29	4.75	4.58	4.07	3.44	0	0	0	0	2.28
C.D	0.09	0.36	0.31	0.45	0.41			0.07	0.11	2.62
SE (m)	0.03	0.11	0.10	0.17	0.13			0.023	0.038	0.857

(5)Decay loss (%): It shows significant differences among treatments during storage period. The decay loss (%) of the uncoated fruits and coating fruits did not show any spoilage up to 3rd day in all treatment. Maximum spoilage was shown in untreated fruit (4.24 %) on 6th day against other treatments which show no decay loss (%) up to 9 days. No decay loss (%) shown in T_1, T_3, T_4, T_5thanuncoated fruitsT_0(11%) shown decay loss followed by T_2 (2.34 %) and T_6 (2.28 %) at 12th day of storage at room temperature as shown in (Table 2). The lowest proportion of spoiling may be attributed to microbiological agent suppression and moisture prevention. On the other hand, low concentrations of oil preserve food during storage by preventing the spread of postharvest diseases such fruit rot. Similar findings of (Lakmali*et al*. 2019) used beeswax (1%) and essential oil which minimized the decay loss upto 12 days of storage period reported in guava fruit.

Chemical Parameters

(1) TSS (%): The total soluble solid of the uncoatedand coated fruitsincreased continuously up to 9 days of storage and then decreased in all treatments.On the 9th day, the TSS in uncoated treatments increases to (10.53 ^{o}Brix), which was still lower than in T_4 treatment (11.8 ^{o}Brix).TSS of uncoated guava fruits held at room temperature reached (8.66 ^{o}Brix), while T4 (10.63 ^{o}Brix) was recorded on the 12th day in coated fruits as discussed in (Table 3).The conversion of complex carbohydrates into water-soluble sugars causes a TSS rise in the ripening of climacteric fruits, indicating that the fruits are going through this process. Moreover, edible coating alters the fruit's internal environment by raising CO_2 levels, which inhibits the synthesis of ethylene and delays the ripening of the fruit. Reduced temperature slows down the ripening process, which in turn slows down the breakdown of starch into soluble sugars. The favorable effect of chitosan (1%) and thymol oil in increasing the TSS has been reported in Pomegranate fruit by (Malekshahi*et al*. 2021).

(2) Acidity (%): Acidity of guava fruits decreasedwith increase in storage periodup to 12 days. Coated fruits showed a slower decline in acidity than untreated fruits. The acidity of the uncoated fruits T_0 lowered to (0.58%) as rather than (0.69%) in T_4 treatment, followed by T_1 and T_5 on the 3rd day, as shown in Table 3. likewise, acidity of uncoated guava fruits held at room temperature declined up to (0.49%), compared to T_4 (0.56%) on the 9th day in coated fruits.Fruit cells use organic acids for respiration and convert acids into total sugars, which may explain why fruit acid content decreases as storage time increases.Similar reduction in acidity in guava is recorded with composite coating application of alginate (2%) and *Cycleabarbata* leaves powder (0.8%) by Utama*et al.* (2022).

Table 3: Effect of edible coating on TSS (^{o}Brix) and acidity (%)of guava cv. Allahabad Safeda on shelf life

Treatments	**TSS (%)**					**Acidity (%)**				
	Storage Days					**Storage days**				
	0	**3**	**6**	**9**	**12**	**0**	**3**	**6**	**9**	**12**
T_0	9.65	9.8	10.23	10.53	8.66	0.64	0.58	0.53	0.49	0.4
T_1	10.08	10.87	11.59	11.65	10.55	0.74	0.64	0.6	0.55	0.46
T_2	9.79	10.14	10.52	10.77	10.07	0.65	0.6	0.55	0.5	0.42
T_3	9.86	10.07	10.77	10.89	10.16	0.69	0.62	0.57	0.52	0.44
T_4	10.26	11.44	11.73	11.8	10.63	0.75	0.69	0.62	0.56	0.49
T_5	9.94	10.57	10.89	11.02	10.22	0.7	0.63	0.58	0.53	0.45
T_6	9.83	10.37	10.76	10.98	10.05	0.67	0.61	0.56	0.51	0.43
C.D	0.06	0.10	0.18	0.07	0.1	0.044	0.035	0.028	0.037	0.027
SE(m)	0.02	0.03	0.06	0.02	0.03	0.015	0.012	0.009	0.012	0.009

(3)Total Sugars (%): The total sugars in the uncoated fruits and coated fruit increased continuously up to 9 days of storage and then decreased in all treatments.The total sugars in uncoated treatments increase up to (9.52%)but minimumthanT_4(10.5 %) treatment on 9th day. In the same way thetotal sugars of uncoated guava fruits decreases to (8.56 %) in comparison with T_4 (9.52%) on 12th day in coated fruits as shown in (Table 4).As guava grew more mature, their total sugar content increased as a result of the starch being hydrolyzed into sugars. This increased sugar content peaked during the climacteric peak ripening stage, after which it was linked to an increase in the activity of the enzymes that hydrolyze starch and a decrease in the rate at which sugar degradation occurs through respiration.Murmu*et al.* (2018) found that similar differences in total sugars between coated and uncoated mandarin fruits with application of 1.5% sodium alginate, 0.7% citric acid and 1.0% sucrose ester.

(4) Reducing sugars (%): The data represented that the reducing sugars in the uncoated fruits and coated fruit increased continuously up to 9 days of storage and then decreased in all treatments. On the 9^{th} day, T4 had the highest decreasing sugar (5.76%), while uncontrolled treatment T_0 shown the lowest (5.06%) among all treatments as shown in (Table 4). After 9^{th} days there were decrease in reducing sugars,uncoated fruits have least T_0(4.36 %)andT_4 (5.17 %) have highest sugarson 12^{th} day in coated fruits.The climacteric fruits may exhibit a significant shift in decreasing sugar content as they mature, converting starch and sucrose into glucose.In addition (Murmu*et al.* 2018) successfully usedthe Arabic gum, 1% sodium caseinate, 1% cinnamon oil based coating reduced the loss of reducing sugar.

(5) Non reducing sugars (%): Different treatments had a substantial effect on non-reducing sugars (Table 4). Various edible coating treatments have a substantial effect on non-reducing sugars (%). After 9 days of storage, T4 had the highest non-reducing sugar content (4.74%) and T0 had the lowest (4.46%) in uncoated guava fruits held at room temperature. On the 12th day of storage, T4 had the highest non-reducing sugar percentage (4.39%) and T0 had the lowest (4.2%) across all treatments.Other studies showed the effective use of Chitosan edible coating on strawberry fruit reported by (Petriccione*et al.* 2015).

Table 4:Effect of edible coating on sugars (%) of guava cv. Allahabad Safeda

Treatments	**Total sugars (%)**					**Reducing sugars (%)**					**Non-reducing sugars (%)**				
	Storage Days					**Storage days**					**Storage days**				
	0	**3**	**6**	**9**	**12**	**0**	**3**	**6**	**9**	**12**	**0**	**3**	**6**	**9**	**12**
T_0	8.29	8.74	9.08	9.52	8.56	4.23	4.6	4.89	5.06	4.36	4.06	4.15	4.18	4.46	4.2
T_1	8.46	9.11	9.55	10.33	9.4	4.31	4.9	5.14	5.65	5.03	4.15	4.32	4.4	4.68	4.37
T_2	8.33	8.82	9.19	9.73	8.85	4.25	4.66	4.95	5.23	4.62	4.08	4.17	4.23	4.5	4.23
T_3	8.39	9.02	9.37	10.07	9.09	4.28	4.78	5.06	5.49	4.81	4.11	4.25	4.3	4.58	4.28
T_4	8.51	9.34	9.69	10.5	9.56	4.34	5.03	5.23	5.76	5.17	4.17	4.35	4.45	4.74	4.39
T_5	8.43	9.08	9.43	10.2	9.27	4.3	4.85	5.1	5.6	4.94	4.13	4.27	4.32	4.6	4.33
T_6	8.37	8.94	9.29	9.87	8.96	4.27	4.73	5.07	5.34	4.7	4.09	4.22	4.28	4.53	4.26

C.D	0.072	0.104	0.116	0.107	0.089	0.054	0.097	0.084	0.081	0.108	0.026	0.035	0.054	0.027	0.035
SE (m)	0.023	0.034	0.038	0.035	0.029	0.018	0.032	0.027	0.026	0.035	0.008	0.012	0.018	0.009	0.012

(6) Ascorbic acid(mg/100g): The data appeared shown the decrease in ascorbic acid with increase in storage period up to 12 days. On the 6th day of storage, as indicated in Table 5, the coated fruits of T_4 (227.19 mg/100g) were superior to the uncoated treatment T0 (195.85 mg/100g). Comparably, on the 12th day of storage at room temperature, ascorbic acid in T_0 steadily decreased to (101.52 mg/100g) as contrasted with T4 (163.19 mg/100g), which was followed by T1 and T5. One possible explanation for the decreased ascorbic acid loss in coated guava fruits could be the coatings' low oxygen permeability, which inhibits enzyme activity and hence stops ascorbic acid oxidation. Our results are in one line with findings ofMaftoonazad*et al.* (2019) usedpectin based coating maintained the ascorbic acid content in coated fruits that helps in maintaining the shelf life of the Lime fruit.

(7) Antioxidant activity(%): Itshows that the antioxidant content of guava fruit noticed a gradual reduction duringstorage for up to 12 days, with the loss of antioxidant content during storage was fasterin treatment T_0 (control). The result shows that treatment T_4 had the maximum antioxidant activity (39.45%) followed by T_1 (39.05%) and T_5 (38.35%) on the 6thdays of storage as discussed in (Table 5). The minimum values of antioxidant content (30.27%) were found in treatment T_0 (control) on the 12th days ofstorage among all tretaments.This could be due to coatings that form a barrier around the fruit surface, reducing the oxygen supply required for enzymatic oxidation of phenolics and retaining DDPH activity.The same tendency was observedby Kumar *et al.* (2023)in which mint leaves extract based coating maintained the antioxidant activity of Ber fruit.

Table 5: Effect of edible coating on ascorbic acid (mg/100g) and antioxidant activity (%)of guava cv. Allahabad Safeda on shelf life

Treatments	**Ascorbic acid (mg/100g)**					**Antioxidant activity (%)**				
	Storage Days					**Storage days**				
	0	**3**	**6**	**9**	**12**	**0**	**3**	**6**	**9**	**12**
T_0	243.19	211.19	195.85	170.52	101.52	42.71	39.39	36.02	33.83	30.27
T_1	244.85	235.19	216.52	192.19	162.52	45.32	40.99	39.05	38.16	33.62
T_2	244.52	226.19	215.19	190.44	160.31	43.18	38.59	36.62	35.36	31.32
T_3	244.85	221.85	215.52	191.52	161.52	44.25	40.03	37.79	36.66	32.27
T_4	246.89	235.52	227.19	195.85	163.19	45.91	41.36	39.45	38.6	35.43
T_5	244.19	227.85	216.19	191.85	161.85	45.91	40.41	38.35	37.36	32.3
T_6	244.85	225.19	211.19	191.52	160.85	43.36	39.56	37.52	36.46	31.61
C.D	0.316	0.319	0.317	0.305	0.297	0.099	0.301	0.398	0.257	0.294
SE (m)	0.103	0.104	0.103	0.099	0.097	0.032	0.098	0.130	0.084	0.096

Conclusion

It has been concluded that the application of Neem leavespowder (2%) + Bees wax (1%) + clove oil (%) on guava fruit is suitable to extend the shelflife as well as improving the overall quality parameters of the guava fruit. The Neem is anedible coating material which has many benefits for human health shows the best results as compared to other treatments. Coatings delayed the ripening process which protected thefruits from weight loss, maintained its antioxidant activity, TSS, and other physio- chemical parameters of guava fruit when compared to the uncoatedfruits, allowing up to 12 days of storage conditions suitable for consumption in higherproportion. Hence this study recommendstreatment(T_4)is very effective for edible coating material for extend the shelf life of guava under ambient condition.

References

1. A.O.A.C. 1975. Official method of analysisPublished by Agricultural Chemists.Washington, D.C
2. Basharat, Z., Ahmed, D., Tariq, M. R., Ali, S. W., & Pervaiz, M. U. (2024). Development of Edible Food Wrappers: An Eco-Friendly Approach Towards Sustainability. In Innovations in Engineering and Food Science (pp. 229-262). IGI Global.
3. Bisht, A., & Singh, S. P. (2024). Postharvest Losses and Management of Horticultural Produce: A Review. Journal of Scientific Research and Reports, 30, 305-320.
4. Brand-Williams, W., Cuvelier, M. E., & Berset, C. L. W. T. (1995). Use of a free radical method to evaluate antioxidant activity. LWT-Food science and Technology, 28(1): 25-30.
5. Chen, C., Peng, X., Zeng, R., Chen, M., Wan, C., & Chen, J. (2016). Ficus hirta fruits extract incorporated into an alginate-based edible coating for Nanfeng mandarin preservation. Scientia Horticulturae, 202: 41-48.
6. Freed, M. 1966. Methods of vitamin assay. Interscience Publishers.
7. Freitas, R. V. D. S., Souza, P. A. D., FERREIRA SENHOR, R. O. S. E. M. B. E. R. G., Moura, C. F. H., & Costa, F. B. D. (2018). Post-harvest storage of papaya fruits coated with extracts of leaves and fruits of Neem. Revista Caatinga, 31: 290-296.
8. Hosseini, S. F., Mousavi, Z., & McClements, D. J. (2023). Beeswax: a review on the recent progress in the development of superhydrophobic films/coatings and their applications in fruits preservation. Food Chemistry, 136404.
9. Jain, N. S., & Sankaran, K. M. Biodiversity and Conservation of Tropical Fruits in India. Sustainable Utilization and Conservation of Plant Genetic Diversity, 857.
10. Jumrah, E. (2024). Analysis of Vitamin Content in Tropical Fruits. Hayyan Journal, 1(1), 14-19.
11. Kaur, M., Gupta, N., Kaur Jawandha, S., & Kaur Grewal, S. (2024). Effect of Composite Coatings of Sodium Alginate and Neem Leaf Extract on Retention of Antioxidant Properties of Kinnow Mandarin under Low Temperature Storage. Journal of Agricultural Science and Technology, 0-0.
12. Kumar, P., Kumar, L., Tanwar, R., Singh, S., & Gaikwad, K. K. (2023). Active edible coating based on guar gum with mint extract and antibrowning agents for ber (Ziziphus mauritiana) fruits preservation. Journal of Food Measurement and Characterization, 17(1): 129-142.
13. Lakmali, H. M. K., Jayasinghe, C. V., & Jayasinghe, J. M. J. K. (2019). Effectiveness of a composite edible coating on the post-harvest conservation of guava (Psidium guajava L). International Journal of Postharvest Technology and Innovation, 6(4): 314-329.

14. Lane, J. H. (1923). Determination of reducing sugar by means of Fehling's solution with methylene blue as internal indicator. J. Soc. Chem. Ind., 17: 32-37.
15. Maftoonazad, N., & Ramaswamy, H. S. (2019). Application and evaluation of a pectin-based edible coating process for quality change kinetics and shelf-life extension of lime fruit (*Citrus aurantifolium*). Coatings, 9(5): 285.
16. Malekshahi, G., &ValizadehKaji, B. (2021). Effects of postharvest edible coatings to maintain qualitative properties and to extend shelf-life of pomegranate (Punica granatum. L). International Journal of Horticultural Science and Technology, 8(1): 67-80.
17. Murmu, S. B., & Mishra, H. N. (2018). The effect of edible coating based on Arabic gum, sodium caseinate and essential oil of cinnamon and lemon grass on guava. Food Chemistry, 245: 820-828.
18. Petriccione, M., Mastrobuoni, F., Pasquariello, M. S., Zampella, L., Nobis, E., Capriolo, G., &Scortichini, M. (2015). Effect of chitosan coating on the postharvest quality and antioxidant enzyme system response of strawberry fruit during cold storage. Foods, 4(4): 501-523.
19. Pillai, A. R., Eapen, A. S., Zhang, W., & Roy, S. (2024). Polysaccharide-Based Edible Biopolymer-Based Coatings for Fruit Preservation: A Review. Foods, 13(10), 1529.
20. Revathi, N., Varma, R., Singh, V., Johar, V., & Varma, S. (2023). The Effect of Edible Coating Material on Biochemical Factors of Guava (Psidium guajava L.) cv. L-49 Storage Life.
21. Seun, E.T., Omolade, A.K., Josephine, S.O., Iyamah, C.P.C., Olatunde, E.O., Lawrence, O.M., Adewumi, F. and Oke, O.A.(2022). Effects of Psidium guajava L. Leaf Powder and Aloe vcera L. Gel on Shelf Life of Citrus sinensis L. Fruits.
22. Utama, N. A., Pranata, I. A., &Pramesi, P. C. (2022). Maintaining physicochemical and sensory properties of guava var. Getas Merah using alginate and Cycleabarbataleaveas powder as edible coating. Advances in Horticultural Science, 36(2): 135-144.