RESEARCH ARTICLE Indian Journal of Agricultural Research, Volume 60 Issue 9: 1364-1370 (September 2026)

Influence of Post-harvest Application of Natural Coatings on Extending the Shelf Life of Guava (*Psidium guajava*) cv. Lucknow 49

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10.18805/IJARe.A-6586

ABSTRACT

Background: The research experiment aims to investigate the potential of different eco-friendly, plant-based and natural coatings, namely banana peel extract, pomegranate peel extract, jackfruit seed extract, aloe vera gel extract and konjac powder at 5% concentration levels, on the physicochemical qualities of the guava variety Lucknow 49.

Methods: The research experiment was conducted during 2025-2026 at the Fruit Science Laboratory, SRM College of Agricultural Sciences, Baburayanpettai, Tamil Nadu. The study was laid out in a completely randomized design (CRD) and different coating treatments were applied to evaluate their effects on the physicochemical properties and shelf life of guava under ambient storage conditions. Multivariate analyses, principal component analysis (PCA), were performed using R software version 4.5.2 to assess the interrelationships among the physicochemical attributes of guava during storage.

Result: The results revealed that the 5% concentration of pomegranate peel extract (T_2) has the potential to achieve the longest shelf life (8.67 days) by the ninth day of storage period; this treatment retains the higher fruit firmness (11.64 kg/cm^2), maximum amount of ascorbic acid (173.45 mg/100 g), while exhibit the low physiological loss in weight (13.55%) and also enhance the total soluble solids (TSS), total sugars in the treated fruits, which proves an effective semi-permeable membrane on the fruit surface, reducing physiological loss in weight (PLW) and reduce the metabolic rate of enzymatic processes. The experiment findings are the best potential of these plant-based extracts as an alternative source of food preservatives.

Key words: Extracts, Guava, Quality, Shelf-life.

INTRODUCTION

Guava (*Psidium guajava* L.) belongs to the family *Myrtaceae* and has a diploid chromosome number of 2n = 2x = 22. It is rich in Vitamin C, iron, calcium and phosphorus and it is a popular fruit crop in India (Butt *et al.*, 2025). Guava is considered a hardy crop, it is one of the most extensively cultivated fruit crops in tropical and subtropical regions worldwide (Afreen and Kamble, 2024). Guava is cultivated over an area of approximately 264.86 thousand hectares across the country, with Tamil Nadu accounting for the overall production of 155.06 thousand metric tons (National Horticulture Board, 2024).

The post-harvest losses of guava in developing countries ranged from 20-40% due to its highly perishable nature. In India, guava experiences significant post-harvest losses owing to physiological deterioration, microbial spoilage, improper handling, storage, packaging and transportation. In recent years, synthetic chemicals have been widely used to enhance the fruit quality and extend shelf life.

When compared to other plant materials, the following edible extracts of banana peel, pomegranate peel, jackfruit seed, aloe vera gel and konjac powder (Elephant foot yam) have shown considerable potential due to their richness in secondary metabolites and starch content. The starch and pectic components included in banana peels can create cohesive films that prevent moisture loss in fruit crops. Aloe vera gel is well known for its natural antibacterial properties and ability to form films (Anantharaman, 2025). The starches and proteins found in jackfruit seed extract can be used to make edible polymer matrices that enhance the strength and barrier qualities of coatings on the fruit

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How to cite this article: Agilan, S., Gopi, V., Prakash, K. and Mohanasundaram, S. (2026). Influence of Post-harvest Application of Natural Coatings on Extending the Shelf Life of Guava (*Psidium guajava*) cv. Lucknow 49. *Indian Journal of Agricultural Research*. **60(9):** 1364-1370. doi: 10.18805/IJARe.A-6586.

Submitted: 12-05-2026 **Accepted:** 03-07-2026 **Online:** 22-07-2026

surface (Kumar *et al.*, 2026). Pomegranate peel extract is rich in phenolics and tannins that have potent antibacterial and antioxidant properties that can inhibit oxidative browning and spoilage microorganisms (Kaur *et al.*, 2023). Konjac glucomannan (KGM) is a water-soluble polysaccharide known for its excellent film-forming and water-holding capacity under alkaline conditions Farswan *et al.* (2025). Using these inexpensive, locally available by-products promotes sustainable postharvest management practices in fruit crops. Therefore, the present study was undertaken to evaluate the effectiveness of selected plant-based edible coatings in maintaining the quality and extending the shelf life of the guava cv. Lucknow 49 under storage conditions.

MATERIALS AND METHODS

Sample collection, experimental material and design

The healthy, disease-free fruits of guava cv. Lucknow 49 were collected from the fruit orchard at SRM College of Agricultural Sciences, Chengalpattu, Tamil Nadu. The collected fruits are fully green and firm, indicating the physiological maturity that occurred just before ripening started. Fruits with uniform size and shape were manually harvested in August, 2025. The research has been conducted in the fruit science laboratory, Department of Fruit Science at SRM College of Agricultural Sciences. A Completely Randomized Design (CRD) was executed with three replications for each treatment. The treatment details, namely. T_1 - Banana peel extract at 5%, T_2 - Pomegranate peel extract at 5 %, T_3 - Jack fruit seed extract at 5%, T_4 - Aloe vera gel extract at 5%, T_5- Konjac powder extract at 5%, T_6 - Control (Water). Each treatment consisted of three replications, with three fruits per replication (nine fruits per treatment). The experimental followed for edible coating application and storage is illustrated in Fig 1. Briefly, physiologically mature and uniformly sized fruits were selected, immersed in the respective coating solutions for five minutes, air dried and stored under ambient (28±3°C temperature and 42 to 72 per cent relative humidity). The fruits were then arranged according to their treatment plan and observations were recorded on the 3rd, 6th and 9th days after treatment application to evaluate the effect of edible coatings on the shelf life and quality of guava fruits (Fig 1).

Preparation of extract

The following five extracts were prepared: Banana peel extract at 5%, pomegranate peel extract at 5%, jack fruit seed extract at 5%, aloe vera gel extract at 5%, konjac powder extract at 5% and control (Water).

Banana peel extract

Banana peels were collected and dried in a hot air oven at 55°C for 24 hours (Abdullah *et al.*, 2025). The dried peels were then powdered and 10 g of the powder was mixed with 140 ml ethanol and 60 ml distilled water in a conical flask to make 200 ml of extract. The mixture was shaken using a mechanical shaker for 78 hours at room temperature to obtain the extract.

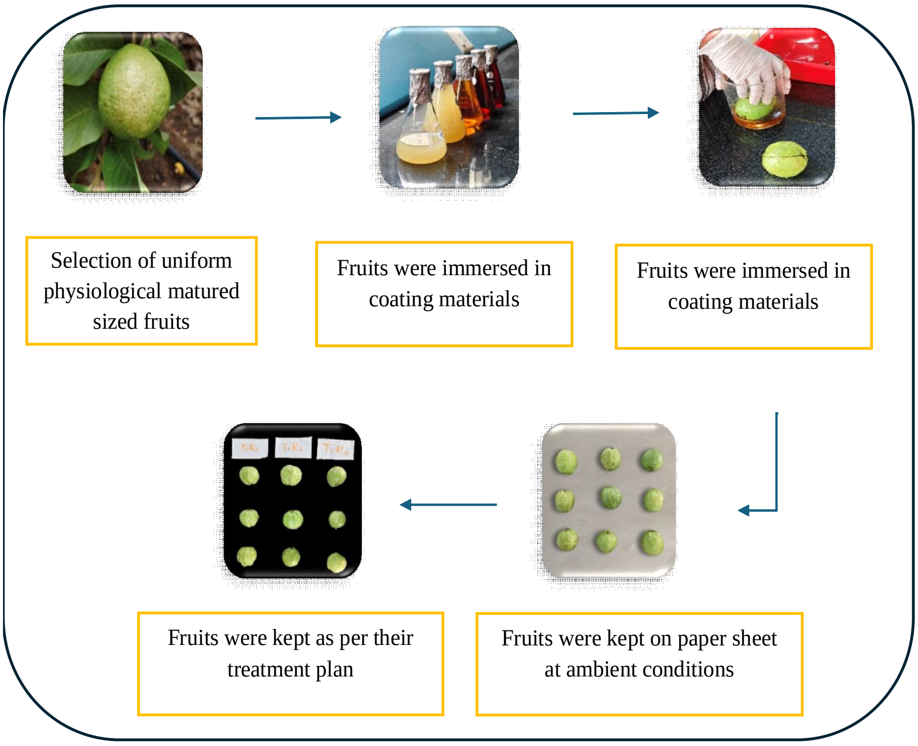

Fig 1: The flow chart of edible coating application and shelf life of guava.

Pomegranate peel extract

Mature pomegranate fruits were washed and manually peeled and the peels were air-dried for 48 hours in room temperature, then ground into a powder using a heavy duty kitchen grinder, sieved through fine mesh and stored at 18°C (Tarkhasi *et al.,* 2016); 10 g of the peel powder was then extracted with 140 mL ethanol and 60 mL distilled water for 200 ml in a conical flask and the mixture was shaken using a mechanical shaker for 78 hours at room temperature to obtain the extract.

Jackfruit seed extract

Jackfruit seeds were cleaned, cut into small pieces and blended. the supernatant was discarded and the precipitate was repeatedly washed with distilled water, filtered, air dried for 12 hours, re-blended and sieved through a mesh sieve then, 10 g of the powder was extracted with 140 mL ethanol and 60 mL distilled water in a conical flask to make 200 ml of extract and the mixture was shaken using a mechanical shaker for 78 hours at room temperature.

Aloe vera gel extract

Cut mature leaves from the plant base and keep them in an upright position for 15-20 minutes to drain the sap. Blend this matrix and sift the slurry through a thin, delicate cloth to eliminate fibers (Rehman *et al.*, 2020). This liquid contains fresh aloe vera gel. Finally, to make a 5% aloe vera gel solution, 10 g of gel was transferred into a volumetric flask and then distilled water was gradually added until the total volume reached 200 ml and the mixture was thoroughly mixed.

Konjac powder (or) elephant foot yam powder extract

Fresh, healthy konjac (Elephant foot yam) tubers were collected, thoroughly cleaned with distilled water, peeled and then tubers were cut into small, thin slices. The sliced pieces were then shade-dried. The dried material was then powdered and 10 g of the peel powder was extracted with 140 mL ethanol and 60 mL distilled water in a conical flask to make 200 ml of extract. The mixture was shaken using a mechanical shaker for 78 hours at room temperature to obtain the extract.

Quality parameters of the treated guava

Physiological loss in weight (PLW)

The weight of the guava samples was recorded before coating (Day 0) and after coating on Days 3rd, 6th and 9th. The weight reduction was calculated by comparing the initial and final weights and expressed as a percentage. The percentage weight reduction was determined using the following formula:

$$\text{Physiological weight loss (PLW)} = \frac{W1 - W2}{W1} \times 100$$

Where,
W1 = Initial weight of the sample.
W2 = Final weight of the sample.

Firmness (N)

The hardness of the guava was measured with a penetrometer. A 3.5 mm-diameter stainless-steel probe was inserted into the fruit three times for every sample. The firmness is used in the following formula:

$$\text{Firmness (kg/cm}^2\text{)} = (F/A)$$

Where,
F = Applied force (kg).
A = Cross-sectional area of the probe (cm^2), calculated as A = πr^2.

For a probe of 3.5 mm diameter, the radius (r) is 0.175 cm and the corresponding area (A) is approximately 0.096 cm^2.

Total soluble solids (TSS) °Brix

Total soluble solids (TSS) were measured using a digital refractometer and expressed as a °Brix.

Titratable acidity (%)

The titratable acidity (TA) was calculated using the method described by Labib *et al.* (2025). 10 g of guava pulp was blended with 90 ml of distilled water and the mixture was filtered through muslin cloth. A few drops of phenolphthalein indicator were added to determine the endpoint, which shows a pink colour. The solution was titrated against 0.1 N sodium hydroxide (NaOH) and the results were expressed as a percentage.

Ascorbic acid (mg 100 g^{-1})

The ascorbic acid concentration of guava was measured using the method described by Labib *et al.* (2025). In brief, a flask was filled with 10 mL of juice, then 0.4% oxalic acid was added to increase the volume to 100 mL. 2,6-dichloroindophenol was used for titration in a 5 ml aliquot. After that, the ascorbic acid content was obtained and expressed as mg/100 g.

Total sugar (%)

The total sugar content was determined following the hydrolysis of the extracted sample with hydrochloric acid (Rani *et al.*, 2025). The hydrolyzed material was then neutralized and titrated using Fehling's solution according to the Lane and Eynon method. The total sugar content was expressed as a percentage.

Reducing sugar (%)

Fehling's solution was provided in the Lane and Eynon titration method to measure the reduced sugar content of fruit pulp (Ayoub *et al.*, 2022). In order to titrate the sample extract against Fehling's solution, methylene blue was employed as an indicator. It was calculated and reported as the percentage of reduced sugar content.

Non-reducing sugar (%)

The percentage of non-reducing sugar was obtained by subtracting the reducing sugar from the total sugar using the following formula:

$$\text{Non reducing sugar (\%)} = \text{Total sugar} - \text{Reducing sugar.}$$

Disease incidence (%)

The fruits were visually inspected for signs of decay in order to record the disease incidence. At the third, sixth and ninth days of storage under ambient conditions. Fruits with surface lesions, soft rot, or visible signs of a fungal infection were considered infected. The percentage of disease incidence was measured using the following formula:

The disease incidence =

$$\frac{\text{Number of infected fruits}}{\text{Total number of fruits observed}} \times 100$$

Shelf life (days)

The shelf life of fruit was assessed by monitoring its marketability over time, focusing on visual spoilage, texture and overall market acceptability. Finally, the shelf life was expressed in days.

Statistical analysis

The data was generated using the R software (version 4.5.2) for statistical analysis. The critical differences in standard deviation were statistically significant at P= 0.05. Further principal component analysis (PCA) and Pearson correlation analysis were also investigated to assess the linkage and data trends.

RESULTS AND DISCUSSION

Physiological loss in weight (PLW)

Physiological weight loss (PLW) increased substantially ($p \leq 0.05$) with increased storage time for all the treatment groups. Fruits under the control treatment (T_6) had the highest PLW, which increased up to 24.23% by the end of the ninth day. On the other hand, the fruits that were treated with 5% pomegranate peel extract (T_2) had the lowest weight loss of 13.55% after the storage period (Table 1). The decrease in the physiological weight loss of the coated fruits could be attributed to the development of a semi-permeable membrane that reduces transpiration and moisture loss. Similar studies have conducted by Labib *et al.* (2025) in strawberry, applied on chitosan edible coatings can reduce the weight loss of treated fruits by acting as a physical barrier for the exchange of gases and moisture.

Total soluble solids (TSS)

The maximum total soluble solids (TSS) content was recorded from the control fruits on the 9th day of storage, which was 12.95°Brix. The lowest TSS content, T_2 - 9.42°Brix, was recorded for the pomegranate peel extract (Table 2). The gradual increase in TSS level in coated fruits shows that metabolic activity and carbohydrate conversion to soluble sugars are slow. Similar findings were reported by Algarni *et al.* (2022) in apricots treated with chitosan nanoparticles, where a gradual increase in TSS content was observed compared to control fruits.

Fruit firmness (N)

Fruit firmness decreased substantially during storage across all treatments. The control fruits (T_6) showed the least firmness, 7.11 kg/cm^2 on the 9th day. On the contrary, 5% of pomegranate peel extract (T_2) showed the maximum firmness of 11.64 kg/cm^2 during the entire 9th day of the storage period (Table 1). Similar findings were reported by Nasrin *et al.* (2025) on the effect of chitosan coating on the quality of fresh strawberries. The chitosan-coated fruits showed high firmness compared to the uncoated fruits.

Ascorbic acid content (mg 100 g^{-1})

Ascorbic acid (Vitamin C) content gradually decreased during their under-storage conditions. The controlled fruits (T_6) reduced drastically, 121.32 mg 100 g^{-1} on the 9th day. However, the fruits treated with 5% pomegranate peel extract (T_2) retained the highest amount of Vitamin C content. The content remained at 173.45 mg 100 g^{-1} on the 9th day of the storage period (Table 1). Similar findings were reported by Algarni *et al.* (2022) on apricot, which revealed the ascorbic acid content throughout the entire storage period.

Titratable acidity (%)

Titratable acidity (TA) showed a significant reduction during storage in all treatments, In this experiment, it was noticed that the uncoated control fruits showed the lowest acidity (0.50 per cent) on the 9th day of storage, whereas fruits coated with 5% pomegranate peel extract showed the highest acidity (0.76 per cent) (Table 1). By covering the fruits with a semi-permeable membrane, the acidity level reduces because the fruits ripen slowly. This study has also supported the findings of Labib *et al.* (2025).

Table 1: Effect of various treatments on PLW (%), firmness (N), ascorbic acid (mg 100 g^{-1}), titratable acidity (%) in guava cv. Lucknow 49.

Treatment	PLW (%)			Firmness			Ascorbic acid			Titratable acidity		
	3rd day	6th day	9th day	3rd day	6th day	9th day	3rd day	6th day	9th day	3rd day	6th day	9th day
T_1: Banana peel extract at 5%	16.62	18.03	19.25	10.79	9.85	8.09	162.48	150.66	132.76	0.81	0.68	0.57
T_2: Pomegranate peel extract at 5%	11.21	13.43	13.55	13.05	12.56	11.64	196.75	188.73	173.45	0.97	0.86	0.76
T_3: Jack fruit seed extract at 5%	13.09	15.73	16.96	10.55	8.81	7.89	154.57	142.60	125.60	0.92	0.83	0.63
T_4: Aloe vera gel at 5%	12.14	14.09	15.59	12.45	11.15	9.85	177.45	165.34	148.36	0.88	0.76	0.66
T_5: Konjac powder at 5%	12.27	15.92	18.68	11.97	10.21	9.15	170.53	158.50	140.36	0.89	0.72	0.61
T_6: Control	18.88	22.38	24.23	10.15	8.55	7.11	147.33	135.47	121.32	0.75	0.59	0.50
SE(d)	0.31	0.54	1.02	0.24	0.19	0.24	0.38	0.46	0.44	0.03	0.04	0.04
C.D.	0.98	1.67	3.15	0.76	0.59	0.76	1.19	1.42	1.36	0.11	0.14	0.13

Total sugars (%)

The total sugar content in all the treatments during storage. On the 9th day, the control fruits contained the highest total sugar content (9.51%), while the fruits treated with 5% pomegranate peel extract (T_2) maintained the lowest sugar content (7.62%) (Table 2). The previous experimental results are also compatible with those stated by Li *et al.* (2021), chitosan nano-material coatings used on blueberries effectively slow down the total sugar content by regulating the respiration.

Reducing augars (%)

Reducing sugars increased in all treatments over the period of storage conditions, Fruits under the control treatment accumulated the highest amount of reducing sugars, reaching 4.78% on the 9th day, while those treated with 5% pomegranate peel extract (T_2) accumulated reducing sugars at the lowest rate, reaching 4.17%. Fruits treated with aloe vera gel accumulated reducing sugars at a similar, although slightly higher, rate, reaching 4.19% (Table 2). These findings are in conformity with Parvin *et al.* (2023), who found that the coating of mangoes with chitosan effectively delays the increase of reducing sugars in mangoes during storage.

Non-reducing sugars (%)

In general, the non-reducing sugar content has been found to decrease with time, On the 9th day, treated pomegranate peel extract (T_2) recorded the lowest non-reducing sugar content (3.45%), while the control fruit showed a higher value (4.73%) (Table 2). This shows that the non-reducing sugar content was converted slowly into reducing sugar content. This study supports the findings by Labib *et al.* (2025) that the non-reducing sugar content could be affected by the treatment that the fruits receive after harvest.

Disease incidence (%)

The disease incidence gradually increased from the third to the ninth day of storage conditions. On the ninth day, T_2 showed the lowest disease incidence (4.65%), followed by T_4 (11.2%), while the control (22.45%) had the highest disease incidence (Fig 2). The antimicrobial properties of plant-based extracts and their ability to form protective coatings that restrict microbial development and delay deterioration.

These coatings also help regulate physiological processes, reducing respiration rate and maintaining fruit integrity during storage. The similar findings were reported by Gull *et al.* (2024), regulating the physiological, biochemical

Table 2: Effect of various treatments on TSS (°Brix), total sugar (%), reducing sugar (%), non-reducing sugar (%) in guava cv. Lucknow 49.

Treatment	TSS (°Brix)			Total sugar			Reducing sugar			Non-reducing sugar		
	3rd day	6th day	9th day	3rd day	6th day	9th day	3rd day	6th day	9th day	3rd day	6th day	9th day
T_1: Banana peel extract at 5%	9.55	10.58	12.05	7.37	7.84	8.25	3.46	3.70	4.26	4.00	4.14	3.99
T_2: Pomegranate peel extract at 5%	8.25	9.07	9.42	7.20	7.38	7.62	3.38	3.79	4.17	3.89	3.58	3.45
T_3: Jack fruit seed extract at 5%	9.21	10.48	11.29	7.58	8.33	8.68	3.48	3.64	4.25	4.10	4.69	4.43
T_4: Aloe vera gel at 5%	8.82	9.74	10.55	7.26	7.55	7.87	3.38	3.86	4.19	3.88	3.69	3.68
T_5: Konjac powder at 5%	9.05	10.01	11.15	7.44	8.07	8.53	3.38	3.92	4.33	4.05	4.15	4.20
T_6: Control	9.95	10.88	12.95	7.75	8.58	9.51	3.68	4.02	4.78	4.06	4.56	4.73
SE(d)	0.04	0.27	0.09	0.04	0.05	0.04	0.03	0.08	0.10	0.06	0.10	0.09
C.D.	0.13	0.86	0.28	0.14	0.18	0.13	0.10	0.24	0.30	0.18	0.33	0.27

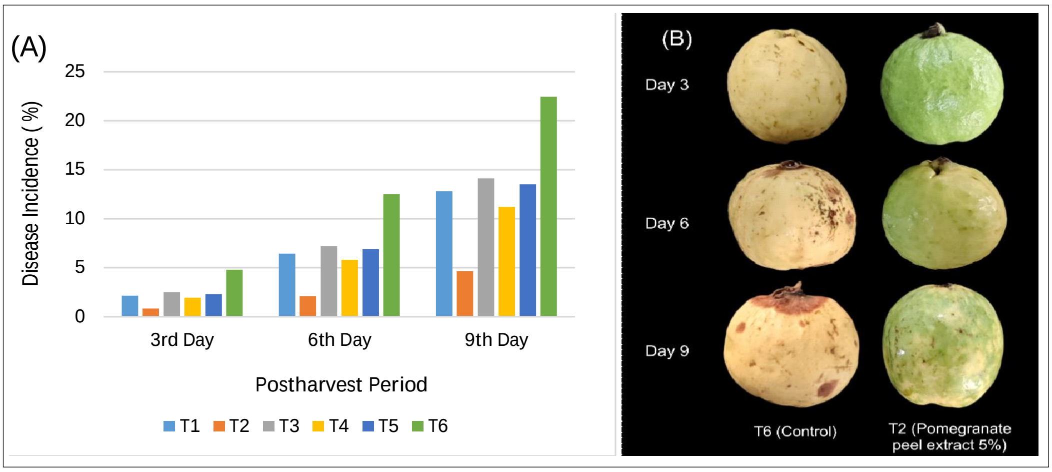

Fig 2: The impact of various edible coatings on disease incidence of guava (A), visual appearance of disease incidence in control (T6) vs pomegranate peel extract (T2).

processes used in edible coatings significantly reduces the incidences of bacterial infections and maintains the postharvest quality of guava.

Shelf life (days)

Studied all other treatments, the treatment T_2 revealed significant differences. The treatment (Pomegranate peel extract at 5%) had the longest shelf life (8.67 days), followed by T_4 - Aloe vera gel extract at 5% - 7.67 days. Uncoated fruits control (T_6) had a shorter shelf life (5.33 days) than the other treatments (Fig 3). The comparable findings were reported by Kumar *et al.* (2023), who demonstrated that by reducing respiration rate and preserving biochemical properties, the application of plant-based edible coatings significantly enhanced the shelf life and postharvest quality of "Surahi" guava.

Principal component analysis

PCA1 and PCA2 explain 85% and 9% of total variability, respectively, accounting for 94% of the total variation.

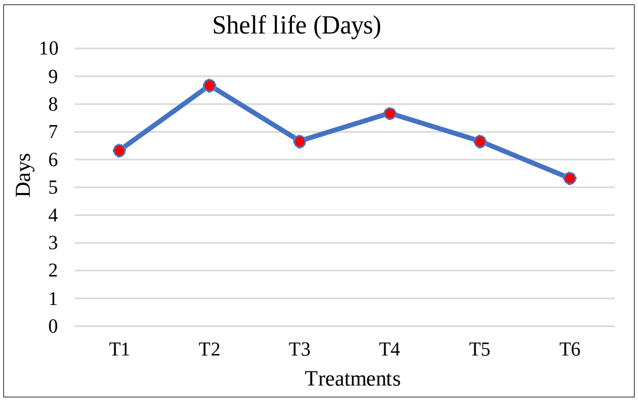

Fig 3: The impact of various edible coatings on the shelf life of guava.

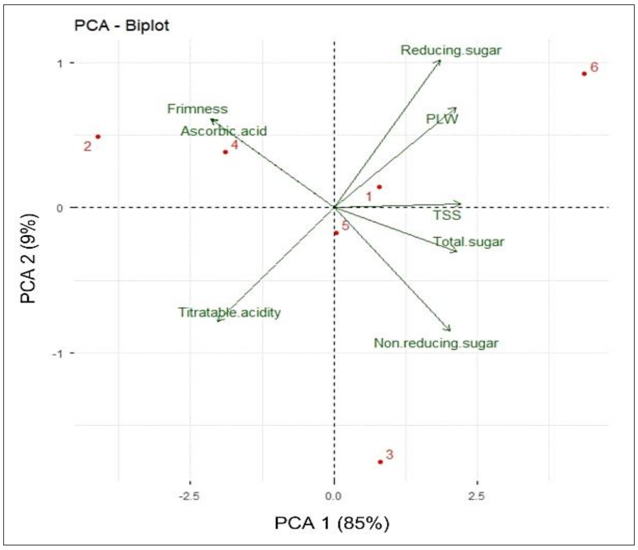

Fig 4: Principal component analysis (PCA) based on the biplot distribution of biochemical traits in Guava cv. Lucknow 49.

PCA1 was positively loaded with PLW, TSS, total sugar, reducing sugar and non-reducing sugar and had a negative association with firmness, ascorbic acid and titratable acidity, clearly representing the ripening and senescence pattern (Fig 4). Treatments positioned on the positive side of PCA1 were characterized by higher weight loss and sugar accumulation, whereas those on the negative side were associated with firmness and nutrient retention, indicating better storage stability (Labib *et al.*, 2025).

CONCLUSION

The current study concluded that plant-based edible coatings are a highly effective, eco-friendly way of extending the shelf life of the guava cv. Lucknow 49 stored under ambient conditions. Though all the studied treatments, including aloe vera gel, konjac powder and jackfruit seed extract, were found to be significantly superior to the control in terms of extending the shelf life, the 5% pomegranate peel extract (T_2) treatment is the most superior among all the treatments in widening the shelf life of the guava cv. Lucknow 49. On the 9th day of storage, the 5% pomegranate peel extract treatment has been found to possess the lowest weight loss of 13.55%, the highest fruit firmness of 11.64 kg/cm^2 and the maximum amount of ascorbic acid (173.45 mg 100 g^{-1}) and titratable acidity (0.76%). Furthermore, the T_2 treatment effectively minimized spoilage, recording the lowest disease incidence of (4.65%) compared to the control fruits, which have undergone senescence and quality loss during storage.

ACKNOWLEDGEMENT

The present study was supported by the Department of Fruit Science, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Baburayanpettai, Chengalpattu, Tamil Nadu, India.

Disclaimers

The opinions and findings presented in this article are the writers' own and may not necessarily reflect those of the organizations with which they are affiliated. The writers disclaim any liability for any direct or indirect losses resulting from the use of this content; they are accountable for the accuracy and completeness of the information presented.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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