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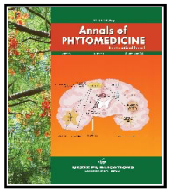

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Evaluation of natural edible coatings for enhancing the post-harvest quality and shelf life of guava (*Psidium guajava* L.) fruits

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Abstract

This study examined the impact of chitosan, gum tragacanth, aloe vera, and oxalic acid coatings on guava fruit storage. A comprehensive assessment was carried out on loss in weight, firmness, ascorbic acid concentration, total soluble solids (TSS) content, polygalacturonase (PG) activity, and overall acceptability over a 9 days storage period. Results demonstrated that all applied edible coatings significantly boosted shelf life to 9 days, and effectively mitigated weight loss compared to the control treatment. Notably, chitosan coatings at 1% and 2% concentrations exhibited the lowest physiological loss in weight (PLW), indicating their proficient moisture retention during storage. Moreover, chitosan-treated fruits displayed enhanced firmness, surpassing the control. Concerning ascorbic acid content, chitosan coatings at both concentrations effectively maintained elevated levels of this vital antioxidant relative to other coatings and the control. Nonetheless, gum tragacanth and aloe vera coatings also elicited favorable outcomes regarding overall acceptability ratings. Total soluble solids (TSS) remained relatively stable among treatments, exhibiting negligible variance. Noteworthy, chitosan coatings failed to significantly influence TSS values. Furthermore, all coated fruits showcased reduced polygalacturonase activity, signifying suppression of pectin degradation and fruit softening. Chitosan coatings consistently yielded the lowest PG activity, indicating their potential in preserving fruit texture and inhibiting decay. Overall, the application of edible coatings, particularly chitosan, gum tragacanth, and aloe vera, exhibited promising implications for enhancing the storage quality of guava fruits.

1. Introduction

Guava, formally identified as *Psidium guajava* L., is an esteemed tropical fruit commonly referred to as the "Apple of Tropics." It holds significant recognition within the scientific community as it belongs to the distinguished Myrtaceae family and possesses a chromosomal composition characterized by a diploid count of 2n = 22. It was brought to India in the 17th century and is now commonly grown commercially (Menzel, 1985). In terms of global fruit consumption, guava is the fifth most commonly consumed fruit, following citrus, banana, grapes, and apple. The majority of guava is consumed in its fresh form. Because of its elevated moisture content and intense metabolic activities, it is inherently prone to rapid deterioration and spoilage. As a result, guava can lose its texture and quality during storage, as noted by Kanwal *et al*. (2016). In developing countries, post-harvest losses of guava can reach 20-40% of the produce. Among fruits in India, guava has the highest post-harvest losses, accounting for approximately 18.1 % of the total. This includes losses of 4.1% during storage and 3.7% during packaging and transportation. However, implementing fruit processing methods can help reduce these losses to some extent (Verma *et al*., 2021). Post-harvest treatments are crucial for preserving guava fruit quality and extending its shelf-life. These treatments include the use of edible coatings. Edible coatings derived from plants offer a comparatively safer alternative, with minimal to no side effects, for the application of fruits. Additionally, these coatings are generally more cost-effective (Arif *et al*., 2022). Chitosan-based coatings inhibit microbial growth and, when combined with vitamins, minerals, and antimicrobial agents, enhance product shelf-life (Maan *et al.,* 2021). A multitude of pre-and post-harvest studies has consistently revealed the beneficial impact of chitosan treatment on the quality and shelf life of various fruit crops (Hajebi Seyed *et al.,* 2021). Aloe vera possesses a multitude of health-enhancing properties, such as antiviral and antibacterial effects, laxative properties, antioxidant and anti-inflammatory activities, anticancer potential, antidiabetic benefits, allergy-fighting properties, immune-stimulating effects, and UV-protection abilities (Vaidya *et al*., 2021). Plants and plant products serve as valuable reservoirs of natural antioxidants, containing a diverse array of essential compounds like vitamins, carotenoids, and phenolic compounds. The application of a coating made from aloe vera has been shown to reduce respiration rates and preserve quality characteristics in fruits, thus extending their shelf-life (Hamid *et al*., 2020). Gum tragacanth (GT) is a substance derived from the stems of certain species of Astragalus plants found in Asia (Armghan Khalid *et al.,* 2022). Gum tragacanth (GT) is widely and safely used as a food additive due to its ability to form films, emulsify, and encapsulate substances (El-Gioushy *et al.,* 2022). In the realm of food supplementation, plant extracts have gained prominence for their ability to enrich food products with bioactive compounds (Hamid *et al*., 2020). Furthermore, gum tragacanth shows promise as an edible protective coating that effectively prolongs the shelf-life of food

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items, such as pecan nuts, by addressing their oily and moist characteristics (Gupta *et al.,* 2022). Oxalic acid (OA) is an intrinsic organic acid naturally occurring in plants, playing multifaceted physiological roles. Research studies have unequivocally demonstrated the profound significance of oxalic acid (OA) in plant biology, as it orchestrates crucial functions such as orchestrating responses to environmental stress, instilling systemic resistance, and contributing to programmed cell death mechanisms (Jin *et al.,* 2014). In the modern context, the postharvest use of oxalic acid has gained significant attention, primarily because it can delay fruit ripening and act as an agent against senescence and browning, while also exhibiting strong antioxidant properties (Razzaq *et al.,* 2015).

2. Materials and Methods

2.1 Selection and harvest of fruits

Guava fruits were procured from a commercial orchard situated in Maheru village, Phagwara, Punjab. Following careful selection based on consistent size and appearance, the fruits were promptly packed in a carton and transported to the laboratory, covering a distance of 20-25 km using a well-ventilated vehicle. Any fruit exhibiting imperfections or indications of disease were diligently discarded during the selection process. The chosen fruits were then, washed and cleaned using double-distilled water (DDW) and subsequently air-dried. They were then subjected to different treatments, including immersion in DDW as a control (T_1), as well as treatments with Aloe vera at 50% (T_2) and 100% (T_8), gum tragacanth at 1% (T_9) and 2% (T_3), chitosan at 1% (T_5) and 2% (T_4), and oxalic acid at 2 mM (T_7) and 4 mM (T_6) concentrations. The fruits were immersed in the respective treatments for a duration of 15 min (Figure 1). To ensure precise and dependable results, three sets of control and treated fruits were meticulously arranged on a bench, maintaining a constant temperature of 24°C for each replicate. Upon the culmination of the ripening process, an extensive evaluation of diverse physicochemical attributes was performed for both the control and treated fruits. The calculation of the shelf-life of guava fruits entailed recording the duration in days, starting from the initiation of treatment and continuing until the final stage of ripening. This assessment was carried out until the fruits maintained their acceptability for commercial marketing.

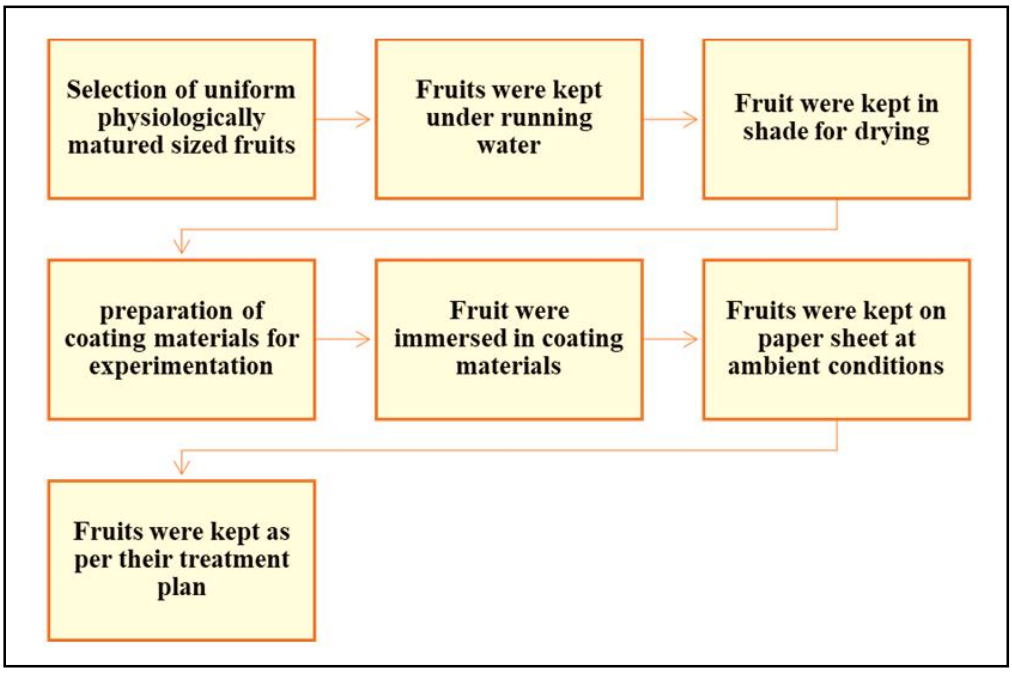

Figure 1: Flow chart of fruit coating.

2.2 Evaluation of physiological parameters in fruits

The per cent weight loss (PLW) was ascertained by computing the percentage difference between the initial weight and the final weight using the formula:

$$PLW\ (\%) = [(\text{Initial weight} - \text{Final weight}) / \text{Initial weight}] \times 100$$

This calculation enabled quantification of the weight reduction as a relative proportion of the initial weight.

To assess the firmness of guava fruits, a Texture Analyzer (Model TA. XT Plus, Godalming, Surrey, UK) with a robust platform and a 50 kg load cell was employed. The firmness of the fruits was measured in kilograms per square centimeter (kg/cm^2) using the following formula:

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

where, the area of the lower surface of the probe (πr^2). The force (F) was measured in kilograms, while the area (A) referred to the lower surface of the probe (πr^2), where π is a constant (approximately 22/7) and r represents the radius of the probe (0.25 cm). Furthermore, it should be noted that 1 Newton is approximately equivalent to 101.97162 kg/cm^2.

2.3 Quality parameter analysis of fruits

To measure the total ascorbic acid content of guava fruits, 2 g sample was homogenized using the manual grinding method. The homogenization process was carried out in a solution consisting of 500 ml of a 3% metaphosphoric acid solution. Following filtration,

the resulting mixture underwent the addition of the 2,6-dichlorophenol-indophenol color reagent. The addition continued until the appearance of a discernible and enduring pink coloration for a period of 15 seconds. The meticulous quantification of the recorded observations was conducted, and the results were expressed as milligrams per 100 grams of fresh weight (mg/100 g FW), following the methodology described by Akhtar *et al*. (2012). The precise quantification of ascorbic acid content in the guava fruit samples was achieved through a meticulous calculation using the formula:

Ascorbic acid content = (Titre value × dye factor × volume made up) / (Weight or volume of sample × volume of sample used) × 100

This rigorous approach ensured an accurate assessment of the ascorbic acid levels, reflecting the exact composition of the guava fruits.

To determine the total soluble solids (TSS) in guava fruits, a digital refractometer was utilized for accurate quantification. The acquired values were precisely documented in degrees Brix (°Brix), employing the methodology outlined by Athmaselvi *et al*. (2013). This rigorous approach ensured accurate measurement and reporting of the TSS content in the guava fruit samples.

Polygalacturonase (units g^{-1} FW) extraction was meticulously carried out following the precise protocol described by Singh and Singh (1993). A fruit sample weighing exactly 1.0 g was carefully extracted in a pre-chilled grinding apparatus, employing a 0.1 M sodium acetate buffer (pH 5.2) containing 0.02 M sodium metabisulphite and 10% (w/v) sodium chloride. This method ensured the successful extraction of polygalacturonase from the guava fruit samples while maintaining optimal pH and incorporating necessary components for stabilization and preservation. The resulting homogenate was subjected to a high-speed centrifugation step at 10,000 x g for 30 min at 4ºC, ensuring efficient separation of the supernatant. Subsequently, the obtained supernatant underwent meticulous dialysis against 0.01 M sodium acetate buffer (pH 5.2) for a duration of 4 h, with regular buffer changes performed hourly to maximize the efficiency of the dialysis process. To determine the enzyme activity, the assay method described by Ahmed and Labavitch (1980) was employed. This stringent methodology ensured accurate measurement of the enzyme activity in the guava fruit samples, facilitating comprehensive analysis of its functionality. The assay mixture, with a total volume of 1.0 ml, was precisely prepared by combining different components. This included 0.2 ml of the enzyme extract, 0.2 ml of sodium acetate buffer (0.1 M, pH 5.2) kept at a low temperature, 0.5 ml of a solution containing polygalacturonic acid (0.3% w/v), and 50 µl of a solution containing chloramphenicol and cycloheximide (125 µg each). The mixture was incubated at 37ºC for a duration of 20 h. To terminate the reaction, the tubes were subjected to a boiling water bath for 10 min. The resulting reducing sugars were quantified using galacturonic acid as a standard, with a range of 20-100 µg. Enzyme activity was defined as the quantity of enzyme needed to release 1 mg of galacturonic acid during a 20 h incubation at 37ºC. This rigorous assay methodology ensured an accurate assessment of the enzyme activity in the guava fruit samples.

2.4 Sensory evaluation of fruits

A collection of guava samples was randomly selected and subjected to scrutiny by a discerning panel of 10 partially trained judges. The panel meticulously assessed key characteristics encompassing appearance, color, flavor, texture, taste, and overall acceptability, culminating in a comprehensive evaluation of the guava samples. The sensory evaluation provided valuable insights into the guava samples' organoleptic characteristics. The sensory assessment was conducted at two-day intervals throughout the storage period. Each judge was provided with a sensory scorecard and instructed to rate their degree of liking or disliking each sensory attribute. The panel of judges utilized a 9-point Hedonic scale, spanning from 1 (strong dislike) to 9 (strong like), to articulate their preferences during the sensory evaluation process. The individual scores provided by the judges were averaged to derive the overall mean score for each sample, allowing for a comprehensive assessment of sensory preferences (Rangana, 1978).

2.5 Statistical analysis

The experimental treatments were replicated 3 times to ensure reliability. The data collected for each parameter were averaged to obtain the mean values, which were then subjected to statistical analysis. The analysis was conducted using a completely randomized design (CRD), and the critical difference (CD) was computed using the OPSTAT software (accessible online at www.hau.ernet.in). This approach offered valuable insights into the statistical significance of the results, aiding in the interpretation and understanding of the findings.

3. Results and Discussion

3.1 Physiological loss in weight (PLW) (%)

PLW, which stands for percentage of weight loss, quantifies the reduction in fruit weight resulting from respiration and transpiration processes. In Table 1, the influence of different edible coatings on the percentage of weight loss (PLW) during fruit storage is depicted. The table illustrates how the coatings affect the moisture loss in the fruits. The results indicated that at the beginning of the storage period, all treatments displayed 0% PLW, indicating the initial freshness of the fruits. However, on the third day of storage, the control treatment (T_1) showed the highest PLW percentage at 7.93%. while treatment T_4 (chitosan 2%) showed the lowest PLW (3.4%). On the 5th day, the trend continued, with the control group showing the highest PLW (14.28%), while T_5 (chitosan 1%) showed the lowest PLW (5.53%). The difference in PLW between treatment T_1 and treatment T_5 increased from 4.53% on the third day to 8.75% on the fifth day. On the 9th day, the PLW of all treatments increased compared to the 5th day. The control fruits not survived, while T_5 (chitosan 1%) showed the lowest PLW (9.32). Chitosan-based formulations (T_4 and T_5) demonstrated superior efficacy in reducing the weight loss of guava fruits compared to other treatments. This is consistent with previous studies by Saxena *et al.* (2020) that have demonstrated the effectiveness of chitosan in reducing PLW in various fruits and vegetables. The results also indicated a progressive increase in the difference in PLW between the control group and treatment T_5, from 4.53% on the third day to 8.75% on the fifth day. These findings imply that the impact of chitosan-based coatings on reducing the percentage of weight loss (PLW) becomes more pronounced with longer storage durations. These results align with a previous study conducted by Bhan *et al*. (2022), which also demonstrated an increased effectiveness of chitosan in reducing PLW in Kinnow mandarin fruits as the storage period progressed.

Table 1: Effect of various edible coatings on physiological loss in weight (PLW) (%) during storage

Treatment	Storage days				
	1st day	3rd day	5th day	7th day	9th day
T_1 (Control)	0.00	7.93	14.28	-	-
T_2 (Aloe vera 50%)	0.00	4.24	9.62	10.41	16.74
T_3 (Gum tragacanth 2%)	0.00	4.04	8.79	9.61	15.49
T_4 (Chitosan 2%)	0.00	3.40	6.64	8.47	13.04
T_5 (Chitosan 1%)	0.00	3.56	5.53	7.61	9.32
T_6 (Oxalic acid 4 mM)	0.00	7.41	14.27	18.41	-
T_7 (Oxalic acid 2 mM)	0.00	7.17	10.21	16.61	-
T_8 (Aloe vera 100%)	0.00	6.69	10.35	14.7	18.44
T_9 (Gum tragacanth 1%)	0.00	5.41	9.86	12.63	17.56
SE(m)	0.00	0.10	0.14	0.19	0.14
C.D.	0.00	0.31	0.43	0.57	0.43

Note: '-' denoted as fruits not survived.

3.2 Firmness (kg/cm^2)

A comprehensive analysis of the data provided in Table 2 provides insights into the influence of various edible coatings on the firmness of guava fruit throughout the storage period. On 1st day, all treatments showed similar initial firmness values, with no significant difference between them. However, on the 5th day, T_5 (chitosan 1%) treatment showed the highest firmness value of 4.3 kg/cm^2, followed by T_4 (chitosan 2%) treatment with 4.12 kg/cm^2, in contrast, the control treatment (T_1) exhibited the lowest firmness value of 3.07 kg/cm^2. On the 9th day, treatment (T_5) showed the highest firmness value of 2.71 kg/cm^2, followed by T_4 with 2.53 kg/cm^2, while T_8 (Aloe vera 100%) had the lowest value of 1.95 kg/cm^2. The study findings underscore the effectiveness of chitosan-based coatings in maintaining the firmness of guava fruit during storage. These results align with prior research that has similarly emphasized the capacity of chitosan coatings to delay fruit ripening, mitigate moisture loss, and prolong the shelf life of diverse fruit varieties while preserving their firm texture (Maringgal *et al.,* 2020). Chitosan can help to maintain the structural integrity of the fruit, thereby maintaining its firmness. In addition, chitosan has been shown to have an inhibitory effect on enzymes such as polygalacturonase and cellulase, which are responsible for the softening of fruits (Yan *et al.,* 2021). Conversely, the application of Aloe vera-based coatings did not demonstrate significant effectiveness in preserving the firmness of guava fruit. This outcome concurs with prior studies, which have suggested that Aloe vera-based coatings possess restricted capabilities in preserving fruit quality throughout the storage period (Mani *et al.,* 2017). This outcome could be attributed to the inadequate concentration of Aloe vera in the coating, which may not have been sufficient to achieve the intended effect.

Table 2 : Effect of various edible coatings on firmness (kg/cm^2) during storage

Treatment	Storage days				
	1st day	3rd day	5th day	7th day	9th day
T_1 (Control)	6.32	4.14	3.07	-	-
T_2 (Aloe vera 50%)	6.32	5.07	3.86	3.07	2.23
T_3 (Gum tragacanth 2%)	6.32	5.23	3.82	3.15	2.44
T_4 (Chitosan 2%)	6.32	5.28	4.12	3.26	2.53
T_5 (Chitosan 1%)	6.32	5.36	4.30	3.35	2.71
T_6 (Oxalic acid 4 mM)	6.32	5.17	3.42	2.44	-
T_7 (Oxalic acid 2 mM)	6.33	4.66	3.55	2.56	-
T_8 (Aloe vera 100%)	6.32	4.85	3.61	2.63	1.95
T_9 (Gum tragacanth 1%)	6.32	4.91	3.81	2.92	2.07
SE(m)	0.00	0.11	0.04	0.03	0.02
C.D.	0.01	0.33	0.13	0.08	0.07

Note: '-' denoted as fruits not survived.

3.3 Total ascorbic acid (mg/100g FW)

The data presented in Table 3 provide compelling scientific evidence regarding the influence of various edible coatings on the ascorbic acid concentration in guava fruit during storage. The findings underscore the prominent role played by both the coating type and the storage duration in shaping the ascorbic acid content. Remarkably, no significant variations were observed in the levels of ascorbic acid among the different treatments at the beginning of the storage period. Nevertheless, on the fifth day of storage, distinct variations in ascorbic acid levels were observed among the guava fruits treated with different coatings as it was seen that T_4 (chitosan 2%) exhibited the highest concentration of ascorbic acid at 171.3 mg/100g FW, followed by T_3 (gum tragacanth 2%) and T_4 (chitosan 1%). Similarly, on the ninth day of storage, T_5 (chitosan 1%) treatment resulted in the highest concentration of ascorbic acid at 134.46 mg/100g FW, followed by T_4 (chitosan 2%) and T_3 (gum tragacanth 2%). The findings of this study are consistent with prior research, providing further substantiation for the efficacy of edible coatings in preserving the optimal ascorbic acid levels in fruits and vegetables throughout the storage duration (Duguma, 2018). Chitosan has garnered significant acclaim for its exceptional efficacy in preserving the nutritional composition of fruits, thus upholding their superior quality during the storage period (Adiletta *et al.,* 2018). Chitosan acts as a shield, exerting a discernible protective effect on the ascorbic acid content in guava fruit through its ability to regulate gas exchange, inhibit enzyme activity, and maintain optimal pH conditions. This helps prevent excessive oxidation and degradation of ascorbic acid, ensuring its concentration remains stable during storage (Silva *et al.,* 2018). Gum tragacanth exhibits a notable capacity to protect the ascorbic acid content in fruits, such as strawberries, resulting in enhanced nutritional value and prolonged shelf life (Khodaei *et al.,* 2021).

Table 3 : Effect of various edible coatings on ascorbic acid (mg/100g FW) during storage

Treatment	Storage days				
	1st day	3rd day	5th day	7th day	9th day
T_1 (Control)	191.99	159.92	144.76	-	-
T_2 (Aloe vera 50%)	192.32	178.89	164.50	141.57	122.72
T_3 (Gum tragacanth 2%)	192.54	180.58	165.70	145.07	127.43
T_4 (Chitosan 2%)	192.36	182.11	171.30	147.18	130.33
T_5 (Chitosan 1%)	193.10	183.70	162.97	152.08	134.46
T_6 (Oxalic acid 4 mM)	195.17	163.95	140.82	127.10	-
T_7 (Oxalic acid 2 mM)	192.26	169.8	153.73	130.29	-
T_8 (Aloe vera 100%)	191.66	175.96	159.96	136.73	115.43
T_9 (Gum tragacanth 1%)	190.77	174.32	162.25	135.85	118.27
SE(m)	0.48	0.65	2.70	1.06	0.93
C.D.	1.42	1.96	8.09	3.21	2.90

Note: '-' denoted as fruits not survived

3.4 TSS (°Brix)

Analysis of the data presented in Table 4 reveals the impact of different edible coatings on the total soluble solids (TSS) of guava fruits during a 9-day storage period. Initially, all treatments exhibited similar TSS values, ranging from 9.08 to 9.98 °Brix. However, on the third day of storage, there was a general increase in TSS values, with no significant differences among treatments except for T_5 (chitosan 1%), which had a slightly lower TSS value of 9.98°Brix. On the fifth day of storage, there was a gradual increase in TSS values observed across all treatments as compared to the 3rd day. However, treatment T_6 (oxalic acid 4 mM) and T_7 (oxalic acid 2 mM) had significantly higher TSS values of 11.12 and 10.98 °Brix, respectively, as compared to the T_1 which had a TSS value of 11.22°Brix. The other treatments had TSS values ranging from 10.54 to 10.87°Brix, which were not significantly different from the control treatment. The findings of this study align with previous research indicating a rise in the TSS content of guava fruits during storage (Bashir *et al.,* 2003). Additionally, the higher TSS values observed in some treatments, such as treatments T_6 and T_7, could be attributed to the acidification of the fruit tissue caused by oxalic acid, which is known to promote sugar accumulation in fruits (Hazarika and Marak, 2022). Edible coatings maintain TSS in fruits by reducing water loss and preventing contamination. Chitosan, a commonly used coating, slows ripening by reducing respiration and ethylene production, preserving TSS. Edible coatings improve fruit quality and shelf-life, making them a valuable tool for fruit storage (Adiletta *et al.,* 2018). On the contrary, gum tragacanth has been documented to enhance fruit firmness and mitigate water loss, according to previous studies (Ali *et al.,* 2022).

3.5 Polygalacturonase (units g^{-1} FW)

The impact of different edible coatings on polygalacturonase (PG) activity during storage is illustrated in Table 5. PG is an enzyme that breaks down pectin, a crucial component of the cell wall in fruits and vegetables. High levels of PG activity may result in softening and decay of the product. On the initial day, there were no significant differences in PG activity among the treatments. However, on the third day of storage, the coated fruits demonstrated lower PG activity compared to the control. Chitosan-coated fruits, specifically those treated with 1% (4.01 units g^{-1} FW) and 2% (4.06 units g^{-1} FW) concentrations, exhibited the lowest levels of PG activity. By the fifth day, all the coated fruits exhibited elevated PG activity compared to the control treatment. Once again, the chitosan-coated fruits (T_5

and T_4) at both concentrations demonstrated the lowest PG activity levels, with values of 6.03 units g^{-1} FW (chitosan 1%) and 6.07 units g^{-1} FW (chitosan 2%), respectively. On the 9th day, some of the fruits did not survive, as denoted by a hyphen (-). Among the surviving fruits, all the coated fruits showed lower PG activity. Fruits coated with chitosan at 1% (8.05 units g^{-1} FW) and 2% (8.06 units g^{-1} FW) concentrations showed the lowest PG activity on the 9th day. The rise in PG activity over the storage period, regardless of the applied coatings, indicates that the coatings were only partially effective in inhibiting pectin degradation in the fruits. This suggests that while the coatings did contribute to reducing PG activity, they were unable to completely halt the enzymatic process throughout the storage duration. The findings presented in Table 5 support the effectiveness of edible coatings, specifically chitosan, in reducing the activity of polygalacturonase (PG) in fresh fruits during storage. These findings align with prior research indicating the effectiveness of chitosan coatings in maintaining fruit firmness and suppressing enzymatic activity (Qi *et al*., 2011). The diminished PG activity observed in chitosan-coated fruits can be attributed to the barrier properties of chitosan. By creating a physical barrier, chitosan limits the ingress of water and gases into the fruit, consequently retarding its metabolic processes. The barrier property of chitosan plays a crucial role in preserving the structural integrity of the fruit and suppressing the enzymatic activity of PG. Polygalacturonase is responsible for the degradation of pectin in the fruit, and by inhibiting its activity, chitosan helps to maintain the overall quality and firmness of the fruit (Shiekh *et al.,* 2013). This finding aligns with previous studies that have emphasized the diverse effects of edible coatings on enzymatic activity. The influence of coatings on enzyme activity can be influenced by various factors, including the composition and concentration of the coating material, as well as the unique properties of the fruit being coated (Yousuf *et al.,* 2021).

Table 4 : Effect of various edible coatings on TSS (^{0}Brix) during storage

Treatment	Storage days				
	1st day	3rd day	5th day	7th day	9th day
T_1 (Control)	9.98	10.21	11.22	-	-
T_2 (Aloe vera 50%)	9.12	10.02	10.68	11.20	10.22
T_3 (Gum tragacanth 2%)	9.11	10.02	10.61	11.21	10.21
T_4 (Chitosan 2%)	9.08	10.02	10.59	11.14	10.08
T_5 (Chitosan 1%)	9.11	9.98	10.54	11.12	10.00
T_6 (Oxalic acid 4 mM)	9.11	10.12	11.12	11.31	-
T_7 (Oxalic acid 2 mM)	9.22	10.11	10.98	11.33	-
T_8 (Aloe vera 100%)	9.11	10.06	10.87	11.23	10.32
T_9 (Gum tragacanth 1%)	9.21	10.05	10.79	11.22	10.23
SE(m)	0.01	0.01	0.01	0.01	0.01
C.D.	0.01	0.01	0.02	0.02	0.02

Note: '-' denoted as fruits not survive.

Table 5 : Effect of various edible coatings on polygalacturonase (units g^{-1} FW) during storage

Treatment	Storage days				
	1st day	3rd day	5th day	7th day	9th day
T_1 (Control)	2.02	4.23	7.21	-	-
T_2 (Aloe vera 50%)	2.04	4.13	6.35	9.15	8.15
T_3 (Gum tragacanth 2%)	2.08	4.11	6.16	9.18	8.13
T_4 (Chitosan 2%)	2.07	4.06	6.07	9.07	8.06
T_5 (Chitosan 1%)	2.02	4.01	6.03	9.04	8.05
T_6 (Oxalic acid 4 mM)	2.05	4.21	7.12	9.81	-
T_7 (Oxalic acid 2 mM)	2.08	4.21	6.96	9.68	-
T_8 (Aloe vera 100%)	2.05	4.18	6.78	9.45	8.57
T_9 (Gum tragacanth 1%)	2.04	4.14	6.55	9.24	8.37
SE(m)	0.01	0.01	0.01	0.02	0.02
C.D.	0.02	0.03	0.03	0.06	0.05

Note: '-' denoted as fruits not survived.

3.6 Overall organoleptic score

The data presented in Table 6 illuminates the influence of various edible coatings on the overall acceptability of fruits during storage. Notably, on the first day, all treatments exhibited similar scores for overall acceptability, indicating no significant divergence from the control treatment. However, on the 5th day, treatment T_4 - Chitosan 2% (7.85) and T_5 - chitosan 1% (7.88) had significantly higher overall acceptability scores than the control treatment. On the 9th day, treatment T_4 (6.99), and T_5 (6.85) treatment had higher overall acceptability scores compared to the control, where fruits did not survive. The data in Table 6 reveals the positive impact of edible coatings on fruit acceptability during storage. Gum tragacanth and chitosan coatings outperformed the control treatment, significantly improving overall fruit acceptability. The improved overall acceptability of fruits in this study can be attributed to the effective preservation of fruit quality achieved through the tested coatings. These coatings prevent water loss, delay ripening, and slow down senescence, resulting in a more desirable sensory experience and higher acceptability (El-Ghaouth *et al.,* 1991). Interestingly, the effectiveness of the coatings varied over time, with some coatings losing their effectiveness after a few days. For instance, on the 9th day, chitosan 1% had a lower overall acceptability score compared to the earlier days. This may be due to the deterioration of the coating over time, leading to decreased effectiveness in maintaining fruit quality. Therefore, it is important to carefully select the appropriate coating and concentration to ensure long-lasting effectiveness.

Table 6: Effect of various edible coatings on overall acceptability during storage

Treatment	Storage days				
	1st day	3rd day	5th day	7th day	9th day
T_1 (Control)	5.57	5.62	4.67	-	-
T_2 (Aloe vera 50%)	5.78	6.69	7.80	6.59	5.44
T_3 (Gum tragacanth 2%)	5.67	7.12	7.82	6.72	6.74
T_4 (Chitosan 2%)	5.46	7.28	7.85	7.13	6.85
T_5 (Chitosan 1%)	5.75	7.27	7.88	7.14	6.99
T_6 (Oxalic acid 4 mM)	5.75	7.32	7.72	7.25	-
T_7 (Oxalic acid 2 mM)	5.54	7.58	7.72	7.47	-
T_8 (Aloe vera 100%)	5.46	7.11	7.76	7.05	6.55
T_9 (Gum tragacanth 1%)	5.36	7.04	7.79	6.79	6.66
SE(m)	0.02	0.06	0.07	0.04	0.02
C.D.	0.05	0.18	0.21	0.13	0.06

Note: '-' denoted as fruits not survived.

4. Conclusion

To summarize, the utilization of edible coatings including chitosan, gum tragacanth, and aloe vera exhibited notable enhancements in preserving the storage quality of guava fruits. These coatings imparted substantial advantages by mitigating weight loss (PLW), sustaining fruit firmness, safeguarding ascorbic acid levels, and suppressing PG activity. The results of this study emphasize the effectiveness of edible coatings as a promising strategy to improve post-harvest qualities and prolong the shelf-life of guava fruits. Specifically, chitosan coatings at 1% concentration consistently exhibited superior performance in reducing PLW, maintaining firmness, and preserving ascorbic acid levels. Gum tragacanth and aloe vera coatings also showed positive effects on overall acceptability scores. The findings emphasize the effectiveness of using edible coatings to prolong the shelf life and improve the quality characteristics of guava fruits

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Conflict of interest

The authors declare no conflict of interest relevant to this article.

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