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IMPACT OF PRE-HARVEST FRUIT BAGGING ON BIOCHEMICAL ATTRIBUTES OF GUAVA (L-49)

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ABSTRACT

The present investigation entitled "Impact of Pre-Harvest Fruit Bagging on Biochemical Attributes of Guava (*Psidium guajava* L.) cv. L-49" was conducted during 2022–23 at the Instructional Farm, College of Horticulture, Banda University of Agriculture and Technology, Banda. The experiment was laid out in a Randomized Block Design with seven treatments comprising different bagging materials, namely newspaper, butter paper, transparent polythene, black polythene, yellow polythene, brown paper, non-woven bag, and an unbagged control. Fruits were bagged at the marble stage, and biochemical as well as organoleptic parameters were evaluated at maturity. The results revealed that pre-harvest fruit bagging significantly improved the biochemical composition and sensory quality of guava fruits compared to the control. Among treatments, the non-woven bag (T_7) proved most effective, recording the highest total soluble solids (13.70%), total sugars (10.25%), reducing sugars (6.11%), non-reducing sugars (4.13%), total phenols (154.83 mg/100 g), and superior sensory scores. It also exhibited the lowest titratable acidity (0.25%) and highest TSS: acid ratio (55.64). Yellow polythene (T_5) and brown paper bag (T_6) emerged as second-best treatments for several parameters. Ascorbic acid content was highest in black polythene bag (T_4). Bagging treatments enhanced pectin and crude fiber content, indicating improved textural quality and shelf life. Overall, fruit bagging created a favorable microenvironment that enhanced sugar accumulation, reduced acidity, and improved nutritional quality and consumer acceptability. The study demonstrates that pre-harvest bagging, particularly using non-woven material, is an effective and eco-friendly technique for improving the quality of guava cv. L-49.

***Keywords* :** Guava, Black polythene, Non-woven bag, Pectin, Fiber.

Introduction

Guava (*Psidium guajava* L.) is an economically important fruit crop widely cultivated in tropical and subtropical regions of the world, particularly in India, which is one of the leading producers. The fruit is highly valued for its exceptional nutritional composition, being rich in vitamin C, dietary fiber, sugars, and bioactive compounds such as phenolics and flavonoids that contribute to antioxidant activity and human health (Sharma *et al*., 2020). Owing to its high nutritive and medicinal value, improving the quality attributes of guava fruits has become a major focus in horticultural research. Despite its significance, guava production faces several challenges related to fruit quality deterioration during development. Fruits are highly prone to insect pests, diseases, sunburn, mechanical injuries, and environmental fluctuations, which adversely affect both external appearance and internal biochemical composition (Mitra & Bose, 2019). These factors often lead to reduced total soluble solids (TSS), imbalanced sugar-acid ratio, and degradation of ascorbic acid, ultimately lowering consumer acceptability and market value (Singh *et al*., 2022). In recent years, pre-harvest fruit bagging has emerged as an effective, eco-friendly, and residue-free technique to enhance fruit quality. This practice involves enclosing developing fruits in protective bags made of paper, polyethylene, or other materials to create a modified microenvironment. Bagging not only protects fruits from pests, pathogens, and physical damage but also alters light intensity, temperature, and humidity around the fruit, thereby influencing physiological and biochemical processes during fruit growth and maturation (Sharma *et al*., 2014).

Several studies have reported that pre-harvest fruit bagging significantly improves important biochemical attributes of fruits. In guava, bagging has been associated with increased total soluble solids, total sugars, reducing sugars, and ascorbic acid content, along with a reduction in titratable acidity, leading to an improved sugar-acid balance and enhanced palatability (Rahman *et al*., 2016). Similar findings have also been reported in other fruit crops such as mango, apple, and pomegranate, where bagging improved biochemical composition and reduced post-harvest losses (Sharma *et al*., 2014; Islam *et al*., 2019). These improvements are primarily attributed to the modification of the fruit microclimate, which influences photosynthate accumulation, respiration rate, and enzymatic activities involved in sugar metabolism and organic acid degradation. However, the effectiveness of fruit bagging depends on several factors, including the type of bagging material, timing of application, duration of bagging, and cultivar-specific responses. In the case of guava cv. Lucknow-49 (L-49), which is widely cultivated due to its high yield and consumer preference, limited systematic information is available regarding the influence of pre-harvest bagging on its biochemical attributes under different growing conditions. A deeper understanding of these biochemical changes is essential for optimizing bagging practices and enhancing fruit quality for both domestic consumption and export markets. Therefore, the present study was undertaken to evaluate the impact of pre-harvest fruit bagging on the biochemical attributes of guava (*Psidium guajava* L.) cv. L-49, with particular emphasis on parameters such as total soluble solids, sugars, titratable acidity, and ascorbic acid content.

Materials and Methods

The present investigation entitled "Impact of Pre-Harvest Fruit Bagging on Biochemical Attributes of Guava (*Psidium guajava* L.) cv. L-49" was conducted at Instructional Farm, College of Horticulture, Banda University of Agriculture and Technology, Banda during the year 2022–23. The experimental site falls under subtropical climatic conditions characterized by hot summers and mild winters, with temperature ranging from about 10°C in winter to 45°C in summer and relative humidity varying between 40–85% during the crop period. The soil of the experimental field was sandy loam in texture, well-drained, and moderately fertile, which is considered suitable for guava cultivation. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The treatments comprised different pre-harvest fruit bagging materials such as T_1: Newspaper bag, T_2: Butter paper bag, T_3: Transparent polythene bag, T_4: Black polythene bag, T_5: Yellow polythene bag, T_6: Brown paper bag, T_7: Non-woven bag, and T_8: Control (without bagging). Uniform and healthy guava trees of cv. L-49 were selected, and fruits were bagged at the marble stage of development according to the respective treatments, while fruits under control were left unbagged. All recommended cultural practices were followed uniformly for all treatments throughout the experimental period.

At physiological maturity, fruits were harvested manually from each treatment and brought to the laboratory for analysis. The fruits were washed thoroughly with clean water, and pulp was extracted manually. The pulp was homogenized and filtered through muslin cloth to obtain a clear juice sample for biochemical estimations. TSS was determined using a hand refractometer and expressed in ^{0}Brix. Titratable acidity was estimated by titrating a known volume of juice against standard sodium hydroxide solution using phenolphthalein as an indicator and expressed as percent citric acid. The TSS to acid ratio was calculated by dividing TSS by acidity. Total sugars were estimated by the Lane and Eynon method, while reducing sugars were determined by direct titration against Fehling's solution, and non-reducing sugars were calculated as the difference between total sugars and reducing sugars. Ascorbic acid content was determined using the 2,6-dichlorophenol indophenol dye method after extraction with metaphosphoric acid and expressed as mg per 100 g pulp. Total phenolic content was estimated using the Folin–Ciocalteau reagent method. Pectin content was determined as calcium pectate by precipitation with calcium chloride followed by drying and weighing, and crude fiber content was estimated through sequential acid and alkali digestion followed by drying and ashing.

Organoleptic evaluation of fruits was carried out by a panel of judges to assess sensory attributes such as taste, color, texture, and aroma using a 9-point hedonic scale, where a score of 1 indicated "dislike extremely" and 9 indicated "like extremely." The mean scores for each parameter were calculated, and higher values indicated better acceptability of fruits.

The data recorded on various parameters were subjected to statistical analysis using analysis of variance (ANOVA) appropriate for the Randomized Block Design as described by Panse and Sukhatme. The significance of differences among treatment means was tested by calculating the critical difference (CD) at 5% level of significance, and standard error of mean (SEm) was also computed to assess the variability among treatments.

Results and Discussion

The present study on the "Impact of Pre-Harvest Fruit Bagging on Biochemical Attributes of Guava (*Psidium guajava* L.) cv. L-49" clearly demonstrated that pre-harvest fruit bagging significantly improved the biochemical composition and organoleptic quality of fruits compared to the unbagged control (T_8). Among the bagging treatments (T_1–T_7), T_7 proved to be the most effective overall, while T_5 and T_6 emerged as strong second-best performers in several key parameters. This highlights the potential of specific bagging materials and timings to optimise fruit quality.

Biochemical Parameters

TSS increased markedly due to bagging (Table 1) with the highest value recorded in T_7 (13.70%), followed by T_5 (12.85%) as the second best. These were statistically superior to the control T_8 (9.52%) as per CD@5% (0.46). Titratable acidity was significantly reduced, recording the lowest value in T_7 (0.25%), which resulted in the highest TSS:acid ratio (55.64). T_5 again ranked second best with 0.29% acidity and 44.41 TSS:acid ratio. In contrast, the control T_8 showed the highest acidity (0.43%) and lowest ratio (22.21). These changes reflect the favourable micro-environment created inside the bags, which promotes the metabolic conversion of organic acids into sugars (Srivastava *et al*., 2023; Sharma *et al*., 2020). Total sugars, reducing sugars, and non-reducing sugars also exhibited substantial improvement. T_7 recorded the highest total sugars (10.25%), reducing sugars (6.11%), and non-reducing sugars (4.13%), followed by T_5 with 9.59%, 5.84%, and 3.75%, respectively. All these values were significantly higher than the control T_8 (6.82%, 4.18%, and 2.64%). The elevation in sugar content under bagging can be attributed to enhanced translocation of photosynthates from leaves to fruits and accelerated starch hydrolysis, facilitated by reduced light intensity and higher humidity inside the bags (Singh *et al*., 2021; Rawat *et al*., 2025). Such improvements directly contribute to better sweetness and consumer preference. The marked rise in TSS, total sugars, reducing and non-reducing sugars, along with the corresponding decline in titratable acidity, can be explained by the fact that bagging restricts excessive transpiration and photo-oxidative stress, thereby favouring the enzymatic breakdown of starch into soluble sugars and the utilisation of organic acids in respiratory and biosynthetic pathways (Singh *et al*., 2021; Rawat *et al*., 2025). Ascorbic acid content was highest in T_4 (230.97 mg/100g pulp), followed by T_5 (209.97 mg/100g) and T_7 (198.15 mg/100g), all markedly superior to the control T_8 (171.38 mg/100g). Bagging protected this heat and light-sensitive vitamin from photo-oxidative degradation while maintaining a stable humid microclimate (Saxena, 2020; Kumar *et al*., 2023).

Total phenol content reached its maximum in T_7 (154.83 mg/100g pulp), with T_6 emerging as the second best (148.13 mg/100g), significantly higher than the control T_8 (121.16 mg/100g). This increase is likely due to mild stress-induced activation of the phenylpropanoid pathway under the altered light spectrum inside the bags. Pectin content was highest in T_6 (1.86%), followed by T_5 as second best (1.80%), compared to the control (1.74%). Fibre content was maximum in T_5 (6.87%), followed by T_7 (6.57%), again significantly superior to T_8 (4.46%). These enhancements in pectin and fibre indicate better cell-wall integrity, improved textural firmness, and potentially longer shelf life of bagged fruits (Ali *et al*., 2021). Similarly, the higher retention of ascorbic acid, phenols, pectin, and fibre in bagged fruits (especially T_4, T_5, T_6, and T_7) highlights the protective role of bagging against direct solar radiation and biotic stresses. Phenolic compounds, being secondary metabolites, are upregulated under the mild abiotic stress created inside bags, contributing not only to antioxidant capacity but also to disease resistance and colour development (Ali *et al*., 2021; Saxena, 2020). Elevated pectin and fibre levels indicate stronger cell-wall structure, which translates into firmer texture and reduced susceptibility to bruising during handling and transport.

Table 1 : Biochemical composition of guava under different treatment

Treatments	TSS (^{0}Brix)	Titratable acidity (%)	TSS:Acid ratio	Total sugars (%)	Reducing sugar (%)	Non-reducing sugar (%)	Ascorbic acid (mg/100g pulp)	Phenol (mg/100g pulp)	Pectin (%)	Fiber (%)
T1	10.56	0.43	24.75	7.42	4.45	2.97	194.01	125.97	1.03	4.71
T2	11.12	0.38	29.09	7.93	4.75	3.18	168.41	127.16	1.25	5.33
T3	11.28	0.35	32.56	8.03	4.97	3.06	165.70	137.98	1.38	5.06
T4	12.18	0.31	39.24	8.58	5.32	3.26	230.97	143.23	1.56	6.13
T5	12.85	0.29	44.41	9.59	5.84	3.75	209.97	146.07	1.80	6.87
T6	11.77	0.33	36.94	8.33	4.99	3.34	190.12	148.13	1.86	5.54
T7	13.70	0.25	55.64	10.25	6.11	4.13	198.15	154.83	1.69	6.57
T8	9.52	0.43	22.21	6.82	4.18	2.64	171.38	121.16	1.74	4.46
SEm±	0.15	0.02	2.15	0.11	0.07	0.05	5.47	1.48	0.11	0.10
CD@5%	0.46	0.06	0.53	0.35	0.23	0.14	16.58	4.50	0.35	0.31

Organoleptic Evaluation

Sensory attributes evaluated on a 9-point hedonic scale (Table 2) confirmed the superiority of bagged fruits. Treatment T_7 obtained the highest scores for taste (8.33), colour (8.60), texture (8.50), and aroma (8.17). T_5 consistently ranked as the second-best performer with scores of 7.83 (taste), 8.23 (colour), and 8.00 (texture), while T_6 stood second best in aroma (7.53). All these values were statistically superior to the control T_8, which recorded the lowest scores (6.50, 7.00, 5.83, and 5.50 for taste, colour, texture, and aroma, respectively), with differences validated by their respective CD@5% values.

The superior organoleptic profile in T_7 and T_5 can be directly linked to their enhanced biochemical attributes such as higher TSS and sugars for sweetness, balanced acidity for pleasant taste, higher phenols and ascorbic acid for nutritional richness, and improved pectin and fibre for desirable texture and mouthfeel. The results conclusively establish that pre-harvest fruit bagging is an effective, non-chemical intervention for enhancing both internal quality and consumer acceptability of guava cv. L-49. The consistent outperformance of T_7, with T_5 and T_6 as close second-best treatments across multiple parameters, underscores the importance of selecting appropriate bagging material. These findings align well with previous reports on guava and other fruits where bagging created a modified microclimate, reduced light penetration (preventing sunburn and chlorophyll retention issues), elevated humidity, and protection from pests and mechanical damage, that collectively accelerated desirable ripening processes while minimizing quality losses (Sharma *et al.*, 2020; Srivastava *et al.*, 2023). In practical terms, the adoption of pre-harvest fruit bagging, particularly the superior T_7 regime offers multiple benefits for guava growers in India: reduced pesticide usage, lower post-harvest losses, higher nutritional value, and premium pricing due to attractive appearance and taste. The second-best treatments (T_5 and T_6) provide viable alternatives for growers seeking cost-effective options without compromising quality significantly. Overall, this eco-friendly technique not only elevates the biochemical and sensory profile of guava cv. L-49 but also supports sustainable horticulture by minimizing environmental impact and enhancing export potential.

Table 2 : Organoleptic Evaluation

Treatments	Taste	Colour	Texture	Aroma
T1	6.83	7.17	6.33	7.17
T2	7.00	7.43	6.50	7.33
T3	7.17	7.60	7.17	7.00
T4	7.67	8.20	7.50	7.00
T5	7.83	8.23	8.00	7.00
T6	7.33	7.63	7.83	7.53
T7	8.33	8.60	8.50	8.17
T8	6.50	7.00	5.83	5.50
SEm±	0.36	0.27	0.26	0.28
CD@5%	1.11	0.81	0.80	0.84

Conclusion

The present study clearly establishes that pre-harvest fruit bagging is an effective and sustainable technique for improving the biochemical and organoleptic quality of guava cv. L-49. Among the various treatments, the non-woven bag (T_7) consistently performed best by enhancing total soluble solids, sugar content, phenolic compounds, and sensory attributes while significantly reducing titratable acidity. Other treatments such as yellow polythene (T_5) and brown paper bag (T_6) also showed promising results and can be considered as viable alternatives. The improvement in fruit quality can be attributed to the modified microenvironment created by bagging, which favors metabolic activities such as sugar accumulation, organic acid degradation, and retention of sensitive compounds like ascorbic acid. Additionally, increased pectin and fiber content indicate better fruit texture and potential for extended shelf life. Thus, the adoption of suitable bagging materials, particularly non-woven bags, can help farmers enhance fruit quality, reduce dependence on chemical inputs, minimize post-harvest losses, and obtain better market value. This eco-friendly approach holds significant potential for improving the profitability and sustainability of guava cultivation.

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