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Guava leaf extract (*Psidium Guajava*) as organic preservatives for mangoes (*Mangifera Indica*)

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Abstract

This study examined the use of guava (Psidium guajava) leaf extract as a natural preservative to extend the shelf life and maintain the postharvest quality of mangoes (Mangifera indica). An experimental design was employed to test three extract concentrations—25%, 50%, and 75%—against an untreated control over a ten-day storage period. Observed parameters included weight loss, firmness, color retention, taste, odor, and microbial spoilage, which serve as indicators of fruit quality and consumer acceptability. Phytochemical analysis revealed tannins, flavonoids, saponins, alkaloids, and phenolic compounds as key bioactive constituents. These compounds contribute antimicrobial, antioxidant, and antifungal properties that collectively preserve fruit by reducing enzymatic activity, inhibiting microbial growth, preventing oxidation, and maintaining sensory attributes. Results indicated that mangoes treated with guava leaf extract showed slower weight loss, higher firmness, better color retention, preserved taste and odor, and lower microbial spoilage compared to the control. The 75% extract demonstrated the highest effectiveness, extending shelf life up to ten days, whereas untreated mangoes deteriorated after six days. ANOVA analysis confirmed significant differences among treatments ($p < 0.05$), demonstrating the concentration-dependent efficacy of the extract. In addition to its biological effectiveness, guava leaf extract provides economic advantages as a zero-cost, eco-friendly alternative to synthetic preservatives, which are costly and potentially harmful. The study highlights the potential of guava leaf extract as a sustainable, natural preservative that reduces postharvest losses, maintains fruit quality, and supports environmentally responsible agricultural practices. Future studies may optimize extraction

methods and application techniques to maximize its commercial viability in mango preservation.

Keywords: guava leaf extract, mango preservation, natural preservatives, phytochemicals, shelf life, postharvest quality

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1. Introduction

Mango (*Mangifera indica* L.) is one of the most important tropical fruits worldwide, highly valued for its exceptional flavor, nutritional content, and economic significance in global trade. In the Philippines, the Carabao mango is the leading variety, recognized for its sweetness, aroma, and superior eating quality. Declared the national fruit, it plays a vital role in rural livelihoods, providing income to thousands of farmers. Mango production significantly contributes to agricultural employment and export earnings, with major export destinations including Japan, South Korea, and countries in the Middle East (Sajise et al., 2019; FAO, 2023).

Postharvest Challenges - Despite its economic importance, the mango industry faces serious postharvest challenges. Mangoes are highly perishable fruits that undergo rapid ripening, softening, weight loss, and microbial spoilage after harvest. In the Philippines, approximately 30–40% of harvested mangoes are lost before reaching consumers (Nitu et al., 2025). Postharvest diseases such as anthracnose caused by *Colletotrichum gloeosporioides* and stem-end rot caused by *Lasiodiplodia theobromae* further contribute to these losses (Quintana et al., 2022).

Preservation Methods

Traditional Techniques - Various traditional postharvest techniques have been developed to slow down ripening and extend shelf life, including refrigeration, controlled atmosphere storage, hot water treatment, and irradiation (Saldaña et al., 2021). In addition, edible coatings derived from natural polymers such as chitosan, gum Arabic, and beeswax have shown potential in reducing moisture loss and delaying spoilage (Abdillah et al., 2021).

Synthetic Preservatives - Commercial postharvest management commonly employs synthetic chemicals such as fungicides (thiabendazole, carbendazim, benomyl, imazalil), sodium hypochlorite, sulfur dioxide fumigation, and wax coatings with chemical additives (Quintana et al., 2022; Ladaniya, 2020). Although effective in extending shelf life, these substances raise concerns regarding food safety, environmental pollution, and consumer health (Sharma et al., 2019; García-Barriga et al., 2021).

Natural Alternatives

Guava Leaf Extract - Guava (*Psidium guajava*) leaves are widely available and contain bioactive compounds such as flavonoids, tannins, phenolic acids, saponins, and terpenoids, which exhibit strong antimicrobial and antioxidant properties (Gutierrez et al., 2008; Uzor & Dick, 2023; Sukoco et al., 2024). Although these properties suggest strong potential for food preservation, the direct application of guava leaf extract on fresh mangoes remains insufficiently explored.

Research Rationale - This study addresses the need to reduce postharvest losses of mangoes while promoting safer and more environmentally friendly preservation methods. It specifically investigates guava leaf extract as a natural preservative alternative to synthetic chemicals. The study aims to:

- Provide a natural alternative to synthetic preservatives.
- Reduce postharvest losses and improve farmers' income and export potential.
- Promote sustainable and eco-friendly postharvest management practices.

Ultimately, this research may contribute to enhancing the global competitiveness of Philippine Carabao mangoes while supporting environmental protection and public health.

Statement of the Problem - The Carabao mango is one of the Philippines' most valuable agricultural products, yet its high perishability leads to significant postharvest losses. Although synthetic preservatives are widely used to extend shelf life, they pose potential risks to human health, the environment, and consumer acceptance. With increasing demand for safe and natural food preservation methods, there is a need to explore plant-based alternatives such as guava (*Psidium guajava*) leaf extract, which contains antimicrobial and antioxidant compounds. However, its effectiveness as a direct postharvest preservative for mangoes remains underexplored. This study seeks to address this gap by answering the following questions:

- What formulations of guava leaf extract can be used as postharvest mango preservatives?
- What is the level of effectiveness of different guava leaf extract formulations in terms of weight loss, taste, odor, color retention, firmness, microbial spoilage, and shelf life?
- Is there a significant difference in the effectiveness of guava leaf extract formulations in preserving mango quality?
- Which guava leaf extract formulation is most suitable for potential commercial application in postharvest mango preservation?

Objectives of the Study - This study aims to evaluate the potential of guava (*Psidium guajava*) leaf extract as an organic preservative for Carabao mangoes (*Mangifera indica*), particularly in maintaining fruit quality and extending shelf life under postharvest conditions. Specifically, it seeks to:

- Determine the effectiveness of different guava leaf extract formulations (25%, 50%, and 75%) in maintaining mango quality in terms of color, firmness, weight loss, and microbial load during storage.
- Compare the effectiveness of guava leaf extract-treated mangoes with untreated mangoes and those treated with synthetic preservatives.
- Determine whether there is a significant difference among the different guava leaf extract formulations in preserving mango quality.
- Identify the most suitable guava leaf extract formulation for potential commercial use.

Significance of the Study - This study is beneficial to the following stakeholders. **Local Mango Farmers** – Provides a cost-effective and safer alternative to synthetic preservatives, helping reduce postharvest losses and improve income. **Consumers** – Promotes safer fruit consumption by minimizing exposure to chemical preservatives. **Agricultural Researchers** – Contributes to the growing body of knowledge on plant-based preservatives in postharvest technology. **Department of Agriculture** – Offers scientific insights that may support policy formulation on sustainable postharvest practices. **Environmental Science Students and Educators** – Serves as a reference for studies on sustainable and eco-friendly agricultural innovations. **Government and Policymakers** – Supports the development of policies promoting natural and sustainable agricultural practices. **Environment** – Encourages reduced reliance on synthetic chemicals, contributing to environmental protection. **Mango Exporters** – Helps improve fruit quality retention during transport, enhancing global competitiveness.

Scope and Delimitations - This study focuses on the use of guava (*Psidium guajava*) leaf extract as an organic preservative for Carabao mangoes (*Mangifera indica*). It specifically examines three concentrations (25%, 50%, and 75%) and their effects on mango quality parameters, including color, firmness, weight loss, microbial load, and shelf life during storage. The study also compares treated mangoes with untreated samples and those treated with synthetic preservatives. Additionally, an economic assessment of the potential application of guava leaf extract is included. The research is limited to guava leaf extract and Carabao mangoes under controlled laboratory and storage conditions. Other fruit varieties, alternative plant extracts, and external environmental conditions are not included in the study.

Theoretical Framework - The study draws upon three major theoretical perspectives that explain the biochemical and physiological processes underlying fruit ripening, senescence, and preservation. The **Postharvest Technology of Horticultural Crops** by Kader (2002) emphasizes that fruit quality after harvest is shaped by genetic, hormonal, and environmental factors. Ethylene biosynthesis and perception are central to ripening regulation, while enzymes such as ACS, ACO, and ACC deaminase initiate changes in aroma, texture, color, and nutritional composition. Controlling ethylene activity is therefore crucial in delaying ripening and extending shelf life, which directly supports the use of guava leaf extract as a natural preservative for mangoes.

The **Yang Cycle of Ethylene Biosynthesis**, described by Yang and Hoffman (1984), outlines the biochemical pathway for ethylene production. Beginning with methionine, the cycle proceeds through S-adenosylmethionine (SAM) and 1-aminocyclopropane-1-carboxylic acid (ACC), with ACC synthase and ACC oxidase serving as critical control points. Ethylene produced through this cycle triggers ripening responses such as cell wall degradation and chlorophyll breakdown. In mango preservation, treatments that suppress ACS and ACO activity—such as guava leaf extract—can reduce ethylene levels, thereby delaying ripening and spoilage.

The **Oxidative Stress and Antioxidant Defense Theory** articulated by Halliwell and Gutteridge (1999) explains how reactive oxygen species (ROS) accelerate fruit deterioration by damaging lipids, proteins, and cell membranes. Antioxidants, including flavonoids and tannins found in guava leaves, neutralize ROS and protect fruit tissues from oxidative damage. Applying guava leaf extract to mangoes may therefore reduce oxidative stress, delay softening and discoloration, and enhance resistance to microbial spoilage. Together, these theories establish a comprehensive framework for understanding the preservative potential of guava leaf extract. By integrating ethylene regulation through the Yang Cycle with antioxidant defense mechanisms, this study positions guava leaf extract as a sustainable, natural alternative to chemical preservatives, aligning with consumer demand for eco-friendly postharvest practices.

2. Methodology

This section presents the research design and methods used in the study, including the population and sampling, data gathering procedures, and statistical treatment of data for analysis.

Research Design - This study uses an experimental research design to evaluate the effectiveness of guava (Psidium guajava) leaf extract as a natural preservative for extending the shelf life of mangoes (Mangifera indica). Mango samples are treated with the extract, and their postharvest quality—microbial load, weight loss, and sensory attributes—is compared to untreated control samples over a set storage period, allowing a controlled assessment of the extract's preservative effects.

Research Method - The research method in this study is experimental, using a controlled laboratory setup to investigate the preservative effects of guava leaf extract on mangoes. It involves preparing the extract, treating the mango samples, and monitoring changes in microbial growth, weight loss, and sensory qualities over time to provide measurable and reliable data.

Population and Sampling Design - The population of the study consists of mango fruits of uniform size and ripeness, purposively selected from a local orchard. A purposive sampling technique was used to ensure uniformity and minimize variability across samples. The mangoes were divided into four groups: three treatment groups dipped in guava leaf extract formulations (25%, 50%, and 75%) and one control group that remained untreated. All groups were stored under identical conditions to allow valid comparisons during the observation period.

Data Gathering and Procedures - The guava leaf extract is prepared by blending 500 g of fresh guava leaves with 2.5 L of distilled water until homogeneous, then filtering through a muslin cloth to obtain the stock extract (100%). From this, three formulations—25%, 50%, and 75%—are made by diluting with distilled water. Mangoes are divided into four groups: a control (untreated) and three treatment groups (25%, 50%, and 75% extract). Each treatment group is dipped in its respective formulation, while the control remains untreated. All groups are stored

under the same conditions, and observations are made at regular intervals to assess microbial growth, weight loss, and sensory qualities.

Statistical Treatment of Data - The collected data was analyzed using both descriptive and inferential statistics. Descriptive statistics was summarize the values obtained from the experiment, such as means and standard deviations. Inferential statistics, specifically analysis of variance (ANOVA), was applied to determine significant differences between the treated and untreated groups. A significance level of $p < 0.05$ was set to evaluate the results. Statistical software was used to ensure accurate processing and interpretation of the data collected.

3. Results and Discussion

This section presents the findings on the effectiveness of guava (**Psidium guajava**) leaf extract formulations in preserving the postharvest quality of Carabao mangoes (**Mangifera indica**) over a ten-day storage period. The discussion focuses on weight loss, sensory quality, microbial spoilage, shelf life, and overall preservation effectiveness.

3.1 Formulations of Guava Leaf Extract as Postharvest Mango Preservatives

Guava leaf extract was prepared in three concentrations (25%, 50%, and 75%) and applied to mango samples to evaluate preservation performance. Guava leaves contain flavonoids, tannins, and phenolic compounds with known antioxidant and antimicrobial properties. These bioactive compounds help slow ripening, reduce microbial activity, and minimize moisture loss in fruits.

Performance of Mangoes Treated with 25% Guava Leaf Extract - Mangoes treated with 25% extract showed gradual weight loss over ten days while maintaining acceptable sensory quality. However, minor softening and increasing microbial activity were observed toward the later storage period, indicating moderate preservation effectiveness.

Performance of Mangoes Treated with 50% Guava Leaf Extract - Mangoes treated with 50% extract exhibited improved preservation compared to the 25% treatment. Weight loss was reduced, sensory attributes remained stable, and microbial spoilage was lower throughout the storage period, indicating good preservation performance.

Performance of Mangoes Treated with 75% Guava Leaf Extract - Mangoes treated with 75% extract showed the highest preservation quality. Minimal weight loss, excellent sensory attributes, and very low microbial spoilage were observed, indicating superior effectiveness among all treatments.

3.2 Weight Loss of Mangoes During Storage

Weight Changes of Mangoes from Day 1 to Day 10 Across Treatments - All mango samples experienced gradual weight loss due to respiration and moisture evaporation. However, mangoes treated with higher concentrations of guava leaf extract consistently retained more weight compared to the control group. The 75% treatment showed the slowest rate of weight reduction, indicating better moisture retention and delayed deterioration.

3.3 Sensory Quality Assessment

Sensory Evaluation of Mangoes Treated with Guava Leaf Extract - Sensory evaluation showed progressive improvement in mango quality with increasing extract concentration. The control group exhibited poor sensory quality with visible spoilage, while 25% extract showed moderate improvement. The 50% treatment maintained good sensory quality, and the 75% extract consistently achieved excellent taste, odor, color retention, and firmness with minimal spoilage.

3.4 Effectiveness of Guava Leaf Extract Formulations

Shelf Life and Effectiveness of Different Guava Leaf Extract Concentrations - Results indicate increasing preservation effectiveness with higher extract concentration. The 25% formulation extended shelf life moderately, the 50% formulation showed better preservation performance, and the 75% formulation provided the longest shelf life and highest quality retention. The control group showed the fastest deterioration.

3.5 Statistical Analysis

ANOVA Results on Mango Preservation Treatments - The ANOVA results revealed a statistically significant difference ($p < 0.05$) among treatments. This indicates that guava leaf extract concentration has a significant effect on mango preservation in terms of weight loss, sensory quality, and microbial spoilage.

3.6 Cost Implications and Economic Benefits

Cost and Shelf Life Comparison of Preservation Methods - Guava leaf extract showed clear economic advantages over synthetic preservatives. While synthetic treatments incurred higher costs, guava leaf extract formulations (especially 50% and 75%) extended shelf life without additional material cost, making them more cost-effective and sustainable for postharvest use.

3.7 Commercializable Formulation

Based on the results, the 75% guava leaf extract formulation is identified as the most suitable for potential commercialization. It consistently provided the best preservation performance in terms of shelf life extension, sensory quality, microbial control, and weight retention.

3.8 Practical Implications

The findings support the potential of guava leaf extract as a natural and sustainable alternative to synthetic preservatives. Its application can help reduce postharvest losses, improve fruit quality, and promote environmentally friendly agricultural practices. It is also suitable as instructional material for agriculture, food science, and environmental studies.

4. Summary, Conclusion, and Recommendations

This section presents a summary of the study's findings, draws conclusions, and provides recommendations for practical applications and future research.

Summary of the Findings - The findings of the study reveal that guava leaf extract significantly contributes to the postharvest preservation of mangoes. Weight retention analysis indicated that mangoes treated with the 75% extract experienced the slowest decline in weight over the ten-day period, demonstrating that higher concentrations are more effective at minimizing moisture loss and delaying senescence. The 50% extract also improved weight retention compared to the 25% extract and untreated control, while the 25% extract showed only minor improvements. Firmness and color retention followed a similar trend, with the 75% extract maintaining the most desirable fruit texture and appearance, which are important quality attributes for consumers. Sensory evaluations further supported these findings, as mangoes treated with 75% extract scored highest in taste and odor, indicating that the extract not only preserves physical quality but also maintains the organoleptic properties that affect marketability.

The microbial spoilage assessment revealed that the 75% extract strongly inhibited bacterial and fungal growth, while the 50% extract provided moderate control and the 25% extract had limited effects. These observations confirm that guava leaf extract's preservative action is concentration-dependent and highlight the synergistic

effects of its bioactive compounds—tannins, flavonoids, saponins, alkaloids, and phenolic compounds—which collectively provide antimicrobial and antioxidant protection. The statistical analysis using ANOVA demonstrated that the differences in all measured parameters were significant. This verifies that the improvements in fruit quality were a direct result of the extract treatments rather than random variation. The SOP results collectively demonstrate that guava leaf extract can effectively delay ripening, reduce microbial growth, and maintain sensory and physical quality, making it a viable natural preservative for mangoes.

Conclusion - The study concludes that guava leaf extract is a highly effective natural preservative for mangoes, capable of maintaining postharvest quality across multiple parameters. All tested concentrations enhanced weight retention, firmness, color, taste, and odor compared to untreated mangoes, with higher concentrations producing superior results. The 75% extract emerged as the most effective treatment, significantly reducing microbial spoilage, maintaining firmness and color, and extending the shelf life of mangoes up to ten days. These results confirm that the preservative effect of guava leaf extract is concentration-dependent, with higher concentrations providing enhanced antioxidant and antimicrobial protection. The bioactive compounds present in guava leaves act synergistically to inhibit enzymatic browning, reduce microbial growth, and slow down senescence, thereby preserving both the physical and sensory qualities of mangoes. Beyond its preservative function, guava leaf extract offers practical advantages: it is cost-free, environmentally friendly, and accessible to small-scale farmers and local vendors. By replacing synthetic chemicals with natural plant extracts, this method contributes to sustainable agricultural practices and supports efforts to reduce postharvest losses, which are a significant concern in developing regions.

Recommendations - Based on the findings of the study and the SOP results, several recommendations are proposed to optimize the postharvest preservation of mangoes using guava (Psidium guajava) leaf extract. These recommendations are intended to guide practical applications, enhance storage and shelf life, and support sustainable postharvest practices. Each recommendation is based on observed improvements in weight retention, sensory quality, microbial control, concentration effectiveness, and practical implementation.

Weight Retention - The study's SOP results showed that mangoes treated with 75% guava leaf extract retained the highest weight over the ten-day observation period, indicating its superior ability to minimize moisture loss and slow the natural senescence process. Weight retention is a critical factor in postharvest fruit quality, as excessive moisture loss directly affects firmness, marketability, and overall consumer acceptance. Based on these findings, it is recommended that mangoes intended for both short- and long-term storage be treated with 75% guava leaf extract to achieve optimal moisture retention. The 50% extract may be used when moderate preservation is sufficient or when extract availability is limited, while the 25% extract was shown to be less effective in maintaining fruit weight. Proper application techniques, such as dipping or coating the mangoes evenly with the extract, are essential to ensure uniform protection and prevent localized weight loss. Additionally, careful handling during application will help maintain the extract's protective layer and further reduce postharvest deterioration.

Sensory Quality (Taste, Odor, Color, and Firmness) - Sensory quality is an important indicator of consumer acceptability, and the SOP findings demonstrated that mangoes treated with higher concentrations of guava leaf extract maintained superior taste, odor, color, and firmness compared to lower concentrations or untreated fruits. Mangoes treated with 75% extract scored the highest in sensory evaluations, retaining the natural flavor and appearance for the full ten-day period. Preserving these qualities is critical for commercial sales and long-distance transport, where visual and taste attributes strongly influence marketability. Therefore, it is recommended that mangoes, particularly those destined for markets, be treated with 75% guava leaf extract to ensure high-quality sensory characteristics. Consistent and uniform application, coupled with proper hygiene during extraction and treatment, is necessary to maintain these sensory attributes and prevent contamination that could affect taste, appearance, or texture.

Microbial Control - The SOP results indicated that microbial spoilage was most effectively inhibited by the 75% guava leaf extract, reflecting the strong antimicrobial properties of its phytochemicals, including tannins,

flavonoids, and phenolic compounds. Mangoes treated with this concentration experienced the lowest levels of bacterial and fungal growth, demonstrating the extract's potential to reduce spoilage and extend shelf life. Based on these findings, it is recommended that mangoes stored in warm or humid conditions be treated with 75% extract to minimize microbial contamination. Maintaining clean handling practices during extraction and application is crucial, as external contamination can reduce the effectiveness of the extract. Regular monitoring of storage conditions, combined with careful application, will ensure that the antimicrobial benefits observed in the SOP results are fully realized, thereby reducing postharvest losses and improving fruit safety.

Effectiveness of Different Concentrations - The SOP findings confirmed that the preservative effect of guava leaf extract is concentration-dependent. While the 25% extract provided minor improvements, the 50% extract offered moderate preservation, and the 75% extract consistently produced the most significant improvements across all parameters, including weight retention, sensory quality, and microbial control. It is therefore recommended that stakeholders choose the extract concentration based on storage needs, available resources, and desired shelf life. For short-term storage or resource-limited situations, 50% extract may suffice. However, for commercial or long-term storage purposes, 75% extract is recommended to ensure maximum preservation and maintenance of fruit quality. This approach allows users to balance cost, availability, and effectiveness while achieving the desired postharvest results.

Practical Application and Training: Adoption of PSIDRO PRO - The SOP results emphasized the importance of proper extraction, application, and handling practices to maximize the effectiveness of guava leaf extract. Farmers, cooperatives, and vendors should be trained on preparation techniques, correct concentration, uniform application, and hygiene practices to ensure consistent results. It is recommended that PSIDRO PRO, a standardized plant-based preservative from Psidium guajava (guava) leaves, be adopted for mango preservation. PSIDRO PRO extends shelf life, maintains weight, firmness, color, and taste, and inhibits microbial growth, providing a safe, natural, and cost-effective alternative to synthetic preservatives. Its adoption in commercial storage and distribution can improve fruit quality, reduce postharvest losses, and promote sustainable, eco-friendly practices.

Practical Educational Implications - The findings of this study provide meaningful educational and practical implications for students, teachers, researchers, and the agricultural community. The study demonstrates the potential of guava leaf extract (Psidium guajava) as an environmentally friendly and organic preservative for mangoes (Mangifera indica), promoting sustainable agricultural practices and reducing dependence on synthetic chemical preservatives. Educators may use this study as a reference material in teaching concepts related to environmental science, biology, chemistry, agriculture, and food preservation. Students may also gain awareness of the importance of natural resources and innovation in solving post-harvest problems through scientific research. Furthermore, schools and research institutions may encourage similar investigatory projects that promote eco-friendly technologies and sustainable food preservation methods. The study may also serve as a useful reference for future researchers who wish to further improve natural preservation techniques for agricultural products.

AI Declaration Statement - AI Use Disclosure. The authors used ChatGPT (OpenAI, 2026 version) for language refinement, grammar correction, organization of ideas, and manuscript improvement during the preparation of this study. All outputs generated by the AI tool were carefully reviewed, verified, validated, and edited by the authors. The authors assume full responsibility for the accuracy, integrity, and originality of the final manuscript. No confidential or personally identifiable information was entered into the AI system.

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