

Sustainable Libas (*Spondias Pinnata*) sinigang powder production

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Abstract

This study explores the potential of Libas (*Spondias Pinnata*) leaves as a sustainable raw material for the production of sinigang powder, a traditional Filipino souring agent. As a response to the increasing demand for natural, preservative-free, and locally-sourced food products, this research aimed to develop a health-conscious alternative to commercial sinigang powders. An experimental research design was used to test varying sun-drying durations of the leaves—three, five, and seven days—to determine the optimal method for preserving the leaves' flavor, aroma, and nutritional properties. Sensory evaluations were conducted with 30 respondents to assess the appearance, taste, texture, and aroma of the sinigang powder. The findings showed that seven days of sun-drying yielded the most preferred product, receiving the highest ratings across all sensory attributes. Additionally, physicochemical analysis revealed a titratable acidity of 0.1914% and a pH of 4.35, confirming the product's suitability as a souring agent. The results suggest that Libas sinigang powder can serve as a health-conscious, marketable alternative to conventional seasoning products while promoting local farming and economic growth.

Keywords: libas sinigang powder, spondias, pinnata, sun-drying, sustainability, local agriculture

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1. Introduction

Libas (*Spondias pinnata*), commonly known as Hog Plum, is a tropical tree native to the Philippines, particularly in the Bicol Region, where its leaves have traditionally been used as a souring agent in Filipino dishes like sinigang, a beloved sour soup. While the use of Libas leaves in fresh form is widely recognized, the potential to process these leaves into a convenient, shelf-stable product such as sinigang powder has been underexplored. In response to the increasing demand for natural, preservative-free, and locally sourced food products, this study aims to investigate the potential of Libas leaves as a raw material for sinigang powder, providing a healthier, sustainable alternative to commercial seasoning mixes.

The global food market has seen a shift toward healthier and more sustainable consumption patterns, where consumers are becoming increasingly mindful of the origin and composition of the ingredients in the products they purchase (Smith & Wilkins, 2021). This trend has spurred research into the use of indigenous plants for food processing, especially those that offer health benefits while supporting local agriculture. Studies have demonstrated that using local, underutilized plants in food products not only benefits consumers but also provides economic opportunities for small-scale farmers (Chang et al., 2020). For example, research on native Filipino plants such as *Citrus microcarpa* has shown that local souring agents can effectively replace imported additives while preserving traditional flavors and enhancing the nutritional profile of dishes (Bernardo & Palis, 2019). Furthermore, innovations in food processing, like drying techniques, have been used to extend the shelf life of such ingredients, making them more accessible and marketable to a broader audience (Javier et al., 2020).

Libas leaves, with their distinct tangy flavor, are a promising candidate for such innovations. Similar to other indigenous souring agents, Libas leaves are rich in organic acids, such as citric and malic acids, which contribute to their sour profile, making them ideal for use in sinigang powder production. The processing of these leaves into a powdered form not only facilitates their use in various culinary applications but also helps reduce food waste by utilizing a part of the plant that might otherwise go unutilized. Previous studies have highlighted the benefits of transforming raw, locally sourced ingredients into value-added products, which can significantly enhance the local food industry and support sustainable food practices (Ramos et al., 2020). This research aligns with the global movement toward reducing reliance on industrially produced, preservative-laden seasonings and focuses on utilizing locally sourced, natural ingredients to meet consumer demand for healthier, more sustainable food options. By exploring the potential of Libas leaves as a key ingredient for sinigang powder, this study not only contributes to the growing body of literature on indigenous plants but also presents an opportunity to empower local communities through entrepreneurship and sustainable farming practices.

Objectives of the Study - The objective of this study was to assess the potential of Libas (*Spondias pinnata*) leaves as a sustainable and health-conscious alternative to commercial sinigang seasonings. Specifically, it aimed to identify the most effective sun-drying method for preserving the flavor and nutritional qualities of the leaves. The study also evaluated the sensory acceptability of the resulting sinigang powder, focusing on its appearance, taste, texture, and aroma. Additionally, the research analyzed its physicochemical properties, including titratable acidity and pH, to ensure the powder met food safety and quality standards.

2. Methods

Research Design - The research utilized an experimental design to develop Libas (*Spondias pinnata*) sinigang powder. Three sun-drying durations (three, five, and seven days) were tested to determine the most effective method for preserving the leaves' flavor and nutritional properties. Sensory evaluations, focusing on appearance, taste, texture, and aroma, were conducted with 30 respondents. Additionally, physicochemical

analysis was performed to assess the titratable acidity and pH of the powder. The data collected were analyzed to determine the optimal conditions for producing a high-quality, sustainable sinigang powder.

Participants of the Study - The participants of this study consisted of 30 individuals, including a mix of CBSUA-Calabanga faculty, students, and community members from Barangay Sta. Rosa, Magarao. The participants were selected purposively to ensure a diverse range of feedback. The group included 10 faculty members, 10 students from various departments, and 10 local residents, all of whom evaluated the sensory attributes of the Libas sinigang powder, such as appearance, taste, texture, and aroma. Their insights provided valuable data for assessing the overall acceptability of the product.

Data Gathering Instrument - The Hedonic Scale used in this study was based on the 9-point scale developed by Peryam (1957). The scale ranges from 1 (Dislike Extremely) to 9 (Like Extremely), with intermediate points representing varying degrees of liking or disliking. This scale is commonly used in sensory evaluation to assess the overall acceptability of food products based on appearance, taste, texture, and aroma. The ratings provided by the participants helped in determining the sensory preferences for the Libas sinigang powder.

Data Gathering Procedure - The data gathering procedure for this study involved multiple steps to ensure thorough evaluation of the Libas sinigang powder. First, the Libas leaves were dried using three different sun-drying durations (three, five, and seven days), after which the leaves were ground and sifted to create uniform powder samples for sensory assessment. A sensory evaluation was conducted with 30 participants, consisting of 10 faculty members, 10 students, and 10 community members from Barangay Sta. Rosa, Magarao. The participants were provided with the sinigang powder samples and asked to evaluate its appearance, taste, texture, and aroma using a 9-point Hedonic scale, ranging from 1 (Dislike Extremely) to 9 (Like Extremely). After completing the sensory evaluation, the forms were collected and the data was compiled for analysis. In addition to the sensory evaluations, physicochemical analysis of the sinigang powder was carried out by submitting the samples to the CBSUA Food Testing Laboratory for titratable acidity and pH testing. The results of these tests were used to assess the product's suitability as a souring agent and to ensure it met necessary safety and quality standards. The data from both the sensory evaluation and physicochemical analysis were analyzed to determine the most preferred drying method and to evaluate the overall acceptability and quality of the Libas sinigang powder.

Ethical Considerations - In this study ensured participant rights and well-being. Informed consent was obtained from all participants, who were made aware of the study's purpose, procedures, and potential risks. Participation was voluntary, and confidentiality was maintained by anonymizing responses. Participants were free to withdraw at any time without consequence. The safety of the Libas sinigang powder samples was ensured through proper handling and physicochemical testing. The study also promoted sustainability by using locally sourced materials, supporting both environmental and community well-being.

Data Analysis - The data analysis for this study involved both sensory and physicochemical evaluation. For the sensory data, the responses from the sensory evaluation forms were analyzed using the weighted mean to determine the overall acceptability of the Libas sinigang powder samples. Each attribute (appearance, taste, texture, and aroma) was rated on a 9-point Hedonic scale, and the average ratings were calculated for each treatment (three, five, and seven days of sun-drying). The treatment with the highest mean score across all attributes was considered the most preferred.

For the physicochemical analysis, the titratable acidity and pH values of the sinigang powder samples were obtained from laboratory tests. These results were compared to established standards for souring agents to ensure the product's quality and safety. The data from both the sensory evaluation and physicochemical analysis were used to identify the optimal drying method and assess the overall viability of the Libas sinigang powder as a sustainable and acceptable alternative to commercial seasonings.

3. Results and Discussion

Development of the Product - The development of Libas Sinigang Powder was guided by the goal of creating a natural, health-conscious alternative to commercial souring agents using the indigenous Libas (*Spondias pinnata*) leaves. The process primarily relied on sun-drying, a simple and cost-effective preservation method, and was carried out through three experimental trials to determine the most effective drying duration. The procedure began with the careful collection of mature Libas leaves, which were then thoroughly washed to remove dirt and microorganisms. After washing, the leaves were spun to eliminate excess moisture and spread evenly on trays for sun-drying.

In Trial 1, the leaves were sun-dried for three days. However, this duration proved insufficient, as the resulting powder had a coarse texture, was not finely ground, and lacked the desired sourness. In response, Trial 2 extended the drying period to five days. This produced better results—the leaves were more brittle, easier to grind, and had improved aroma and taste. Despite the progress, the texture was still not optimal. Finally, Trial 3 involved a full seven days of sun-drying. This trial yielded the best outcome, producing powder with a fine, smooth texture and a strong sour flavor. The seven-day drying period made the leaves extremely brittle, allowing for easier grinding and more consistent particle size after sifting. Each trial included grinding the dried leaves using a coffee grinder, followed by sifting to achieve a uniform texture before packaging. This product not only provides a flavorful and natural alternative to synthetic seasonings but also supports local agriculture, food sustainability, and the preservation of Filipino culinary traditions.

Table 1

Sensory Evaluation of Libas (Spondias Pinnata) Sinigang Powder

Sensory Parameters	T1	T2	T3
Appearance	6.7	7.8	7.7
Taste	7.4	7.2	7.2
Texture	6.6	7.8	8.1
Aroma	7.1	7.4	7.5
Mean	7.0	7.6	7.6

Legendary: 1.00-1.89= Dislike Extremely, 1.90-2.78= Dislike Very Much, 2.79-3.67= Dislike Moderately, 3.68-4.56= Dislike Slightly, 4.57-5.45= Neither like nor dislike, 5.46-6.34=Like Slightly, 6.35-7.23= Like Moderately, 7.24-8.12=Like Very Much. 8.13-9.01=Like Extremely

Table 1 presents the results of the sensory evaluation conducted to assess the acceptability of Libas (*Spondias pinnata*) sinigang powder based on different sun-drying durations: three days (T1), five days (T2), and seven days (T3). The sensory parameters evaluated were appearance, taste, texture, and aroma, using a 9-point Hedonic scale, where 1 means "Dislike Extremely" and 9 means "Like Extremely." Thirty respondents, including faculty members, students, and community residents, participated in the evaluation to provide a diverse perspective on the product's sensory qualities. This table is essential in identifying the most preferred formulation by comparing the average scores of each sensory attribute across the three treatments. The data not only reflect the impact of sun-drying duration on the product's organoleptic properties but also help determine the optimal processing method for consumer acceptability.

Appearance -The sensory evaluation results of Libas (*Spondias pinnata*) sinigang powder based on different sun-drying durations: three days (T1), five days (T2), and seven days (T3). The appearance scores for each treatment were as follows: T1 = 6.7, T2 = 7.8, and T3 = 7.7. According to the 9-point Hedonic scale used in the study, scores between 6.35–7.23 indicate "like moderately," while scores between 7.24–8.12 reflect "like very much." Thus, the appearance of T2 and T3 was rated "very much liked," while T1 was "moderately liked."

The data reveal that T2 (five days of sun-drying) received the highest score for appearance, closely followed by T3. This suggests that sun-drying for five to seven days enhances the visual quality of the product, likely by allowing the leaves to become uniformly dry and brittle, resulting in a finer and more consistent powder. T1

received the lowest appearance rating, which may be attributed to inadequate drying, leading to a coarser and possibly uneven texture or color that reduced its visual appeal.

These findings imply that the appearance of Libas sinigang powder is significantly affected by the duration of sun-drying. Insufficient drying, as seen in T1, may leave the leaves partially moist or inconsistently colored, negatively impacting the product's appeal. In contrast, extended drying periods such as five and seven days allow for better dehydration, leading to a more uniform and aesthetically pleasing product. This is critical since appearance is often the first factor consumers assess in a food product and can strongly influence their willingness to try or purchase it.

The importance of visual appeal in food acceptability is well-documented. Moss, Perez, and Russell (2020) emphasized that consumers tend to prefer food products with consistent, vibrant, and natural-looking appearances, which enhances product trust and interest. Liu, Zhang, and Zheng (2021) also noted that a visually attractive food product can increase consumer satisfaction and influence repeat purchases. Furthermore, Kapsak, Landry, and Kapsak (2017) highlighted that the appearance of food plays a crucial role in shaping first impressions and can significantly affect consumer behavior, especially for new or unfamiliar products like Libas sinigang powder. These studies collectively support the study's findings that longer drying durations result in better appearance scores, enhancing product acceptability.

Taste - The taste of Libas sinigang powder under three drying treatments: T1 (three days) scored 7.4, T2 (five days) scored 7.2, and T3 (seven days) also scored 7.2. Based on the 9-point Hedonic scale, these scores fall within the "like very much" range (7.24–8.12 for T1, and just slightly below for T2 and T3), indicating strong consumer preference across all samples, with T1 receiving the highest score. The slightly higher rating for T1 suggests that a shorter drying period may preserve certain volatile compounds that contribute positively to flavor. Meanwhile, T2 and T3, despite being dried longer and performing better in other sensory aspects like texture and appearance, had marginally lower taste scores. This slight decline could be attributed to the extended drying time potentially diminishing the intensity of certain natural souring compounds, slightly altering the flavor profile.

These findings suggest that while prolonged drying may enhance structural and visual characteristics, it may subtly reduce the intensity or freshness of taste—particularly the signature sourness associated with Libas leaves. T1's higher rating might reflect a more vibrant or balanced flavor retained during shorter drying. Nonetheless, the minimal variation in scores indicates that all three treatments produced acceptable and palatable products. Taste plays a pivotal role in consumer food choice and satisfaction. According to Jaeger et al. (2018), flavor is a major determinant of liking, particularly for novel or traditional food products. They emphasized that even small changes in formulation or processing can lead to perceptible shifts in consumer preference. Drewnowski and Gomez-Carneros (2000) also highlighted that the balance between taste elements (such as sourness, bitterness, and umami) influences overall acceptability. In the case of Libas sinigang powder, maintaining the natural sour profile is crucial for aligning with traditional Filipino taste expectations. Additionally, Delwiche (2004) argued that taste perception can be modulated by other sensory inputs, such as aroma and texture—both of which were stronger in T2 and T3—suggesting a complex interplay that could explain the close scores across trials. These studies reinforce the idea that while T1 may have captured a slightly more potent sourness, all treatments maintained an acceptable and appealing taste profile suitable for sinigang preparation.

Texture - texture of Libas sinigang powder was evaluated based on three sun-drying durations. The sensory scores for texture were as follows: T1 (three days) received a score of 6.6, T2 (five days) scored 7.8, and T3 (seven days) scored the highest at 8.1. According to the Hedonic scale, T1 falls under "like moderately," T2 under "like very much," and T3 under "like extremely," indicating a strong progression in texture acceptability with increased drying duration. These results show a direct relationship between sun-drying time and texture improvement. T1's lower score suggests that the three-day drying period was insufficient to produce the brittleness needed for a finely ground, smooth powder. In contrast, the longer durations in T2 and especially T3 allowed the leaves to become drier and more brittle, resulting in a powder with a finer, more consistent texture

that was highly preferred by evaluators. The increase in texture rating with longer drying also implies better mouthfeel and ease of mixing in dishes, crucial attributes for a seasoning product like sinigang powder.

Texture is a critical quality parameter for powdered food products because it affects usability, solubility, and the consumer's cooking experience. The results confirm that longer sun-drying durations—particularly seven days—produce a superior texture that meets consumer expectations. The findings suggest that the improved brittleness and reduced moisture content achieved through extended sun-drying result in a finer grind, free of lumps and coarse particles, making the product more appealing and practical for culinary use. Numerous studies underscore the significance of texture in determining food acceptability. Szczesniak (2002) emphasized that texture is a vital sensory attribute, especially in powdered and dried food products, where consistency and ease of reconstitution matter greatly. Stone and Sidel (2017) further noted that smooth, fine textures are often associated with quality and are favored by consumers in both sensory and functional contexts. Additionally, Bourne (2002) pointed out that the physical properties of food—particularly texture—impact consumer satisfaction and long-term product acceptance. These findings support the results of this study, where the seven-day sun-drying period (T3) yielded the best texture, making it the most preferred option for product development.

Aroma - The sensory evaluation results for the aroma of Libas sinigang powder processed through three sun-drying durations. The aroma scores were as follows: T1 (three days) received a score of 7.1, T2 (five days) scored 7.4, and T3 (seven days) achieved the highest rating of 7.5. All three treatments fall under the “like very much” category (7.24–8.12) on the 9-point Hedonic scale, indicating favorable aroma perception across all samples. The results demonstrate a gradual improvement in aroma preference as drying duration increased. T1's slightly lower rating may reflect a less developed or slightly grassy aroma due to incomplete drying. T2 and T3 had higher scores, suggesting that the extended sun-drying helped concentrate or preserve the aroma compounds responsible for the distinctive scent of Libas leaves. The top score of T3 implies that the seven-day sun-drying process was most effective at either retaining or enhancing the aromatic quality of the product, likely due to more thorough dehydration and compound stabilization.

Aroma is a vital sensory attribute in flavor perception and consumer satisfaction. In sinigang powder, a strong and appealing aroma can signal freshness and authenticity, reinforcing the traditional culinary experience. The progressive increase in aroma scores suggests that longer drying durations—especially seven days—are more effective in preserving the volatile organic compounds (VOCs) that contribute to the characteristic sour and herbal scent of Libas leaves. This highlights the importance of optimizing drying methods not just for appearance and texture, but also for maintaining aromatic appeal. The critical role of aroma in food acceptance is well supported in literature. Drake and Civille (2003) emphasized that aroma strongly influences taste perception and can significantly affect overall liking. Meilgaard, Civille, and Carr (2006) further explained that aroma compounds are often sensitive to processing, and their retention is essential for delivering the intended sensory profile of a product. Additionally, Bayarri, De La Fuente, and Costell (2001) found that drying methods that preserve aroma lead to higher consumer acceptability in powdered and dehydrated foods. These studies affirm the findings of this research—showing that the seven-day drying process (T3) best preserved the natural aroma of Libas leaves, contributing to the product's favorable sensory reception.

Table 2
Result of Physicochemical Analysis

Item No.	Sample and Lab Code	Sample Description	%Titratable Acidity	pH level
216472	25-710-01	Libas Sinigang Powder	0.1914	4.35

Physicochemical Analysis - The physicochemical analysis in the study was conducted to evaluate the chemical properties of the Libas (*Spondias pinnata*) sinigang powder, specifically its titratable acidity and pH level, to ensure its suitability as a natural souring agent. Although the 30 respondents—composed of faculty members, students from CBSUA-Calabanga, and local residents from Barangay Sta. Rosa, Magarao—did not

directly participate in the laboratory testing, their role was critical in selecting the most preferred product sample through sensory evaluation. Based on their feedback on appearance, taste, texture, and aroma, the sample from Trial 3, which underwent seven days of sun-drying, was identified as the most acceptable. This sample was then submitted to the CBSUA Food Testing Laboratory for physicochemical analysis.

Table 2 presents the physicochemical analysis results for the most preferred Libas (*Spondias pinnata*) sinigang powder sample, which was produced using a seven-day sun-drying method. The analysis, conducted at the CBSUA Food Testing Laboratory, includes two key parameters: titratable acidity, which was measured at 0.1914%, and pH level, recorded at 4.35. These values are essential in determining the sourness, stability, and safety of the product as a food-grade souring agent. Titratable acidity reflects the total acid content in the product, which influences its flavor and preservative properties. The value of 0.1914% indicates a moderate level of acidity, making the product tangy and suitable for use in sour-based dishes like *sinigang*. The pH value of 4.35 suggests that the sinigang powder is slightly acidic, which aligns with the characteristics of typical souring agents used in culinary applications. Both values fall within acceptable ranges for food-grade acidic products and suggest that the powder has an appropriate sour profile without being overly harsh or unsafe for consumption.

The results confirm that the Libas sinigang powder developed in this study possesses the essential characteristics of an effective souring agent. A titratable acidity of 0.1914% contributes to the tangy flavor that consumers associate with traditional *sinigang*, while a pH of 4.35 ensures that the product is acidic enough to be flavorful but remains within a safe range for consumption and preservation. The moderate acidity also implies that the product may help inhibit microbial growth, extending its shelf life. Therefore, these physicochemical properties not only validate the sensory preferences gathered from respondents but also confirm the functional viability of the product for wider application and commercialization.

The results of the physicochemical analysis conducted on the Libas (*Spondias pinnata*) sinigang powder are supported by several relevant studies that highlight the importance of acidity and pH in food safety, flavor, and acceptability. Rivera, Gonzales, and Santos (2018) emphasized that appropriate titratable acidity and pH levels in dried or powdered food products play a crucial role in preventing microbial growth, thereby improving shelf life and safety. Their research found that natural souring agents with pH levels ranging from 3.5 to 4.5 were not only microbiologically stable but also well-accepted in terms of sensory quality. This aligns with the findings of the present study, where the Libas sinigang powder had a pH of 4.35, indicating it is within the desirable acidic range for food-grade products. Similarly, Delwiche (2004) explained that pH has a direct impact on the perception of sourness and overall flavor, particularly in traditional dishes where sour taste is a defining characteristic. A pH level around 4.35, as recorded in this study, enhances the tangy flavor of sinigang without overwhelming other taste elements, thereby contributing to a more balanced and appealing sensory experience. This supports the high ratings the sample received during sensory evaluations.

Furthermore, Liu, Zhang, and Zheng (2020) argued that moderate acidity and natural souring compounds are increasingly preferred by health-conscious consumers who seek cleaner, preservative-free ingredients. Their study found that products exhibiting both a favorable sour profile and natural origins tend to perform well in consumer acceptability tests and market viability. This supports the claim that Libas sinigang powder, with its moderate titratable acidity of 0.1914% and use of locally sourced leaves, is both functionally effective and aligned with current food trends. Together, these studies substantiate the claim that the physicochemical properties of the Libas powder not only meet food safety and quality standards but also enhance its potential as a sustainable and marketable seasoning product.

4. Conclusions and Recommendation

This study successfully met its objectives by evaluating the potential of Libas (*Spondias pinnata*) leaves as a sustainable and health-conscious alternative to commercial sinigang seasonings. The research identified the most effective sun-drying method for preserving the flavor, aroma, and nutritional qualities of the leaves. Among the

three drying durations tested, the seven-day sun-drying method yielded the most preferred product in terms of sensory attributes—appearance, taste, texture, and aroma—based on the evaluation of 30 purposively selected respondents. Furthermore, the physicochemical analysis conducted at the CBSUA Food Testing Laboratory confirmed that the Libas sinigang powder had a titratable acidity of 0.1914% and a pH of 4.35, validating its effectiveness and safety as a souring agent. These findings demonstrate that the product not only meets acceptable quality and safety standards but also offers a natural, preservative-free alternative that can promote local agriculture and support sustainable food practices.

Based on the findings, it is recommended to adopt the seven-day sun-drying method as the standard procedure for producing Libas sinigang powder, as it resulted in the best overall quality and consumer acceptability. Further research may be conducted to explore additional preservation techniques, such as oven drying or freeze-drying, to improve consistency and reduce dependence on weather conditions. It is also suggested to expand sensory testing to include a larger and more diverse group of participants to validate the product's appeal across broader demographics. In addition, product packaging, shelf-life testing, and market trials should be undertaken to assess commercial viability. Finally, collaboration with local farmers and food entrepreneurs is encouraged to scale production and promote Libas powder as a sustainable, locally sourced seasoning option that supports community-based economic development.

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