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UNLOCKING THE POTENTIAL OF POWDERED SOURSOP *(Annona muricata)*: A COMPREHENSIVE INVESTIGATION OF ITS UTILIZATION AS A NATURAL SOURING AGENT AND ITS ACCEPTABILITY IN VARIOUS RECIPES

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ABSTRACT

This study investigated the utilization of powdered soursop as a natural souring agent in Filipino cuisine, focusing on its incorporation into three sinigang recipes: Pork Sinigang, Fish Sinigang, and Beef Sinigang. Employing experimental and survey methodologies, the research explored the acceptability of powdered soursop across diverse groups (80 respondents) comprising children, teenagers, adults, and food experts. Through sensory evaluation and nutritional analysis, the study assessed the organoleptic qualities and nutritional composition of powdered soursop, highlighting its potential as a dietary protein and fiber source with low-fat content. Results indicate widespread acceptance of powdered soursop, with favorable ratings for appearance, aroma, and taste across all age groups and recipes tested. Statistical analysis reveals significant variations in acceptability for Fish Sinigang, emphasizing the influence of recipe choice on consumer perceptions. Furthermore, observations on the shelf-life of powdered soursop demonstrate its stability over extended periods, suggesting its suitability for commercialization and widespread adoption in both household and culinary settings. The study recommends further research, product refinement, and potential marketing initiatives to promote the use of powdered soursop as a natural souring agent in Filipino cuisine.

Keywords: *Powdered soursop, sinigang recipe, sensory evaluation, nutritional analysis, organoleptic qualities*

INTRODUCTION

Condiments play a crucial role in enhancing the flavors of various cuisines globally. They are essential components used to highlight or complement the taste of dishes, ranging from salts and spices to herbs and souring agents. With the increasing demand for instant and convenient food products, the significance of condiments in culinary practices has become even more pronounced (Mitra & Sharma, 2020). In today's fast-paced society, where time is a precious commodity, instant food items have gained popularity due to their quick preparation, catering to the needs of individuals balancing busy lifestyles (Ali & Ibrahim, 2018). However, despite the convenience offered by instant foods, flavor remains a critical factor in ensuring a satisfying culinary experience.

The manipulation of flavor through the use of condiments such as salt, sugar, or vinegar catalyzes enhancing the overall appeal and palatability of dishes (Vargas & Aggabao, 2022). These seasonings not only elevate the taste profile of food but also help cover undesirable flavors, contributing to a more enjoyable dining experience. Among the many fruits utilized as souring agents, soursop *(Annona muricata L.),* locally known as *Guyabano* in the Philippines, stands out for its distinctive sweet, tangy, or sour-sweet taste (Ngo, 2023). Widely cultivated and enjoyed across various regions, soursop is famous for its creamy white flesh, reminiscent of tropical flavors (Ajmera, 2023).

Beyond its culinary appeal, soursop possesses known nutritional and medicinal properties. Rich in essential nutrients such as potassium, vitamin C, and fiber, soursop offers a range of health benefits, including aiding metabolism and supporting overall well-being (Purdie, 2022). Moreover, soursop has garnered attention for its potential therapeutic applications, with studies highlighting its efficacy in addressing conditions such as diabetes, cancer, and oxidative stress (Afzaal et al., 2022). Additionally, research has explored the antimicrobial properties of soursop leaves, suggesting their potential use as natural food preservatives (Cruz et al., 2021).

Despite the extensive research on soursop's nutritional and medicinal attributes, limited studies have investigated its potential as a natural souring agent. This research gap prompted the present study, which aimed to explore the acceptability of powdered soursop as a natural souring agent. Given the abundance of soursop in the local area, particularly during peak seasons, there is an opportunity to harness its potential for culinary innovation. By developing powdered soursop and assessing its acceptability, this study seeks to contribute to the utilization of soursop as a sustainable and flavorful alternative to synthetic souring agents. Furthermore, the investigation of soursop's suitability as a natural food preservative adds another dimension to its culinary versatility, potentially extending its shelf life while retaining its nutritional value (da Costa et al., 2014).

To comprehensively address the research objectives, this study employed a multidisciplinary approach encompassing food science, sensory evaluation, and nutritional analysis. By elucidating the sensory attributes, nutritional composition, and

potential applications of powdered soursop, this research aims to provide valuable insights into its role in enhancing the safety, quality, and nutritional value of food products. Additionally, the findings of this study will pave the way for future research endeavors, exploring further innovations and applications of soursop in the food industry.

Research Questions

This study aimed to explore the utilization of powdered soursop (*Annona muricata*) as a natural souring agent to be used in different recipes.

Specifically, it sought answers to the following questions:

1. What are the processes involved in preparing powdered soursop (*Annona Muricata)* as a natural souring agent used in the following sinigang recipes:
   a. Pork Sinigang
   b. Fish Sinigang
   c. Beef Sinigang
2. What is the nutritive value of powdered soursop as a natural souring agent?
3. What is the level of acceptability of powdered soursop as a natural souring agent used in different recipes in terms of:
   a. Appearance/ Color
   b. Aroma
   c. Taste
4. What is the general level of acceptability of powdered soursop as a natural souring agent as evaluated by the different age groups?
   a. Children
   b. Teenagers
   c. Adults
   d. Food Experts
5. Is there a significant difference in the general level of acceptability of powdered soursop as a natural souring agent used in different recipes?
6. What is the shelf life of powdered soursop at room temperature?

METHODOLOGY

This study utilized the experimental research design to explore the utilization of powdered soursop (*Annona muricata*) as a natural souring agent to be used in three sinigang recipes, namely Pork Sinigang, Fish Sinigang, and Beef Sinigang. It also employed the survey method to determine the level of acceptability of the powdered soursop used in the recipes in terms of appearance/color, aroma, and taste. The general acceptability of the sinigang products was assessed by groups of respondents: children, teenagers, adults, and food experts. The nutritional contents of the powdered soursop were examined through laboratory tests by the Integrated Laboratory Division of the Department of Agriculture (DA) Regional Office 02. Finally, direct observation was employed by the researcher to determine the shelf-life of the developed product

Materials

To carry out the study, some equipment, materials, and tools were utilized. They were used for preparation, measurement, mixing, and cutting.

Table 1. Equipment and tools to be used in the preparation of Powdered Soursop as a Natural Souring Agent

DESCRIPTION			
Preparatory Tools	Measuring Tools	Cutting Tools	Equipment
Basin	Weighing Scale	Sterilized knife	Cabinet dryer or Fruit dryer
	Measuring spoons	Chopping Board	Miller

Ingredients

Table 2. Ingredients used in preparing powdered soursop as a souring agent.

Ingredients	Quantity
1. Soursop	10 kg (raw)=1000 g (powdered)
2. Garlic Powder	10 g
3. White pepper	10 g
4. Onion Powder	10 g
5. Iodized salt	5 g

Table 3. Recipes used in testing the soursop powder.

Pork Sinigang	Fish Sinigang	Beef Sinigang
1Kl Pork	1Kl Milkfish	1Kl Beef
40g Powdered Soursop Natural Souring Agent	40g Powdered Soursop Natural Souring Agent	40g Powdered Soursop Natural Souring Agent
Water Spinach	Water Spinach	Water Spinach
String beans	String beans	String beans
Green chili	Green chili	Green chili
Okra	Okra	Okra
Eggplant	Eggplant	Eggplant
Tomato	Tomato	Tomato
Taro		Taro

Table 4. Ingredients used in preparing Pork Sinigang, Fish Sinigang and Beef Sinigang

Pork Sinigang	Fish Sinigang	Beef Sinigang
1 kl pork, sinigang cut 2-3 cups kangkong leaves 5pcs long green chili pepper 2 ripe tomatoes, quartered 10 pieces string beans, cut into 2-inch length 1 large onion 1 piece taro 8 cups water 4 tablespoons fish sauce ¼ teaspoon ground pepper 40g Powdered soursop	1 kl Milkfish, sliced into 1 inch 2-3 cups kangkong leaves 5pcs long green chili pepper 2 ripe tomatoes, quartered 10 pieces string beans, cut into 2-inch length 1 large onion 8 cups water 4 tablespoons fish sauce ¼ teaspoon ground pepper 40g Powdered soursop	1 kl beef, sinigang cut 2-3 cups kangkong leaves 5pcs long green chili pepper 2 ripe tomatoes, quartered 10 pieces string beans, cut into 2-inch length 1 large onion 1 piece taro 8 cups water 4 tablespoons fish sauce ¼ teaspoon ground pepper 40g Powdered soursop

Development Procedure

The developmental procedure for creating powdered soursop as a natural souring agent for sinigang recipes began with carefully harvesting and washing ripe soursop fruits. Once cleaned, the fruits were sliced open, and their seeds were removed before drying, either in a cabinet or under the sun. After drying, the soursop pieces were cut into smaller segments to aid in further drying and then ground into a fine powder using a miller. The powdered soursop was sifted to remove coarse particles, ensuring a smooth consistency. Depending on requirements, the powder was mixed with other ingredients before being sealed in pouches for storage, ready for use in enhancing the flavor of sinigang dishes.

Data Gathering Procedure

Permission was sought to conduct the study through evaluation, targeting respondents composed of children, teenagers, adults, and food experts. Upon obtaining approval, the administration of questionnaires followed. The researcher personally briefed evaluators on questionnaire completion instructions. Completed questionnaire checklists were then collected from respondents. Sensory evaluation, facilitated by questionnaire checklists, was employed to gauge the organoleptic qualities of soursop as the primary ingredient in natural souring agents. Additionally, an observation method was utilized to track changes in powdered soursop, focusing on appearance, aroma, taste, and texture. It was done to determine the shelf-life of the developed product.

Sensory Evaluation

The sensory evaluation of the finished product involved eighty (80) evaluators representing diverse age groups: children (20), teenagers (20), adults (20), and food experts (20). These individuals were selected from specific locations in Baculud, City of Ilagan, Isabela, including Technical Education Skills Development Authority-ISAT, Calamagui 2nd, City of Ilagan, Isabela, and Naguilian National High School, Magsaysay, Naguilian, Isabela. They were purposively chosen and given proper orientation on how to evaluate the products using the provided evaluation instruments. The study was conducted during the second semester of the Academic Year 2023-2024. During the evaluation, the powdered soursop natural souring agent was compared to a commercially available souring agent. Each respondent was tasked with tasting samples of both products and providing feedback on appearance/color, aroma, taste, and texture. The collected data underwent statistical analysis using a quantitative approach. The acceptability of powdered soursop as a natural souring agent was assessed using a Four-point Likert Scale to gauge the respondents' level of satisfaction.

Liking Score	Numerical Value	Rating
4	3.25 – 4.00	Like a lot
3	2.50 – 3.24	Like a little
2	1.75 – 2.49	Dislike a little
1	1.00 – 1.74	Dislike a lot

RESULTS AND DISCUSSION

Product Development

The powdered soursop, developed as a natural souring agent, underwent various stages of development, including utilization in different recipes such as pork sinigang, fish sinigang, and beef sinigang. Throughout these stages, careful observation and analysis were conducted to refine the sinigang recipes, incorporating the powdered soursop as a key ingredient. The specific variety of soursop utilized in this study was Aguinaldo, chosen for its distinct flavor profile and suitability for culinary applications. The iterative process of experimentation and adjustment ultimately resulted in the creation of sinigang recipes with different variants, showcasing the versatility and efficacy of powdered soursop as a souring agent in Filipino cuisine

The process of preparing powdered soursop as a natural souring agent began with selecting high-quality soursop fruit, which was washed and sliced into quarters to remove the seeds. The fruit was then shredded and dried either in a Cabinet dryer for 8 hours or in a Fruit dryer for 15 hours to remove moisture. Once dried, the soursop was cut into smaller pieces and sun-dried until it was ready for pulverization. After grinding and sifting the dried fruit to achieve a fine powder consistency, 1 kilogram of powdered soursop was

measured and mixed with 5g of salt, 10g of garlic powder, and 10g of white pepper using a blender.

The final product was portioned into 40g quantities, sealed in pouches, and tested in recipes such as Pork Sinigang, Fish Sinigang, and Beef Sinigang to evaluate its effectiveness as a souring agent.

Figure 1. The Soursop Fruit *(Annona muricata)* also known locally as *Guyabano*

Figure 2. Sun drying soursop, until it can be pulverized, is a method employed in the study.

Figure 3. The Finished Product (Powdered Soursop as a Natural Souring Agent)

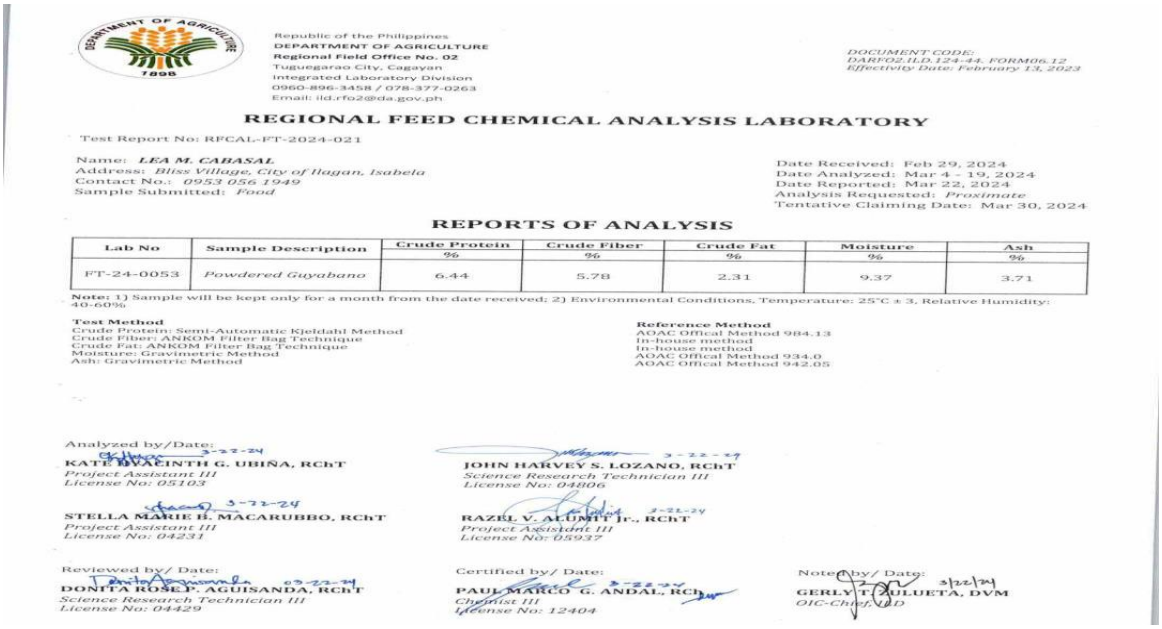
Nutritive Value of Powdered Soursop as a Natural Souring Agent

The reports of analysis (Figure 3) on the nutritive contents of powdered soursop from the Regional Feed Chemical Analysis Laboratory of the Department of Agriculture reveals the following nutritional composition per 100g: 6.44% crude protein, 5.78% crude fiber, 2.31% crude fat, 9.37% moisture, and 9.71% ash.

A protein content of 6.44% indicates a moderate protein level in powdered soursop, making it a potential dietary protein source. The presence of 5.78% crude fiber suggests a notable dietary fiber content, contributing to digestive well-being when part of a balanced diet. With only 2.31% crude fat, powdered soursop is relatively low in fat, which may suit those seeking low-fat dietary options. A moisture content of 9.37% indicates the retention of some water, affecting texture and shelf life. The high ash content (9.71%) suggests a relatively high mineral content in powdered soursop.

Duke (2014) highlights soursop's mineral-rich nature, further supported by its high ash content. Inkalaba, et. al. (2023) note the high-water content, which aligns with the observed moisture content.

Incorporating powdered soursop into a balanced diet may offer health benefits, particularly for digestive health and mineral intake. However, portion control and dietary balance are essential considerations for optimal nutrition.



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REGIONAL FEED CHEMICAL ANALYSIS LABORATORY

Test Report No: RFCAL-FT-2024-021

Name: LEA M. CABASAL
Address: Bliss Village, City of Ilagan, Isabela
Contact No.: 0953 056 1949
Sample Submitted: Food

Date Received: Feb 29, 2024
Date Analyzed: Mar 4 - 19, 2024
Date Reported: Mar 22, 2024
Analysis Requested: Proximate
Tentative Claiming Date: Mar 30, 2024

REPORTS OF ANALYSIS

Lab No	Sample Description	Crude Protein	Crude Fiber	Crude Fat	Moisture	Ash
		%	%	%	%	%
FT-24-0053	Powdered Guyabano	6.44	5.78	2.31	9.37	3.71

Note: 1) Sample will be kept only for a month from the date received; 2) Environmental Conditions, Temperature: 25°C ± 3, Relative Humidity: 40-60%.

Test Method
Crude Protein: Semi-Automatic Kjeldahl Method
Crude Fiber: ANKOM Filter Bag Technique
Crude Fat: ANKOM Filter Bag Technique
Moisture: Gravimetric Method
Ash: Gravimetric Method

Reference Method
AOAC Offical Method 984.13
In-house method
In-house method
AOAC Offical Method 934.0
AOAC Offical Method 942.05

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Figure 3. Reports of Analysis on the Nutritive Contents of Powdered Soursop

Level of Acceptability of Powdered Soursop as a Natural Souring Agent

Table 5. Assessment on the level of acceptability of powdered soursop as a natural souring agent in terms of appearance/color, aroma, and taste

Respondents	Characteristics	Pork Sinigang		Fish Sinigang		Beef Sinigang	
		Mean	Description	Mean	Description	Mean	Description
Children	Appearance/ Color	3.85	Like a Lot	3.60	Like a Lot	3.20	Like a Little
	Aroma	3.50	Like a Lot	3.45	Like a Lot	3.25	Like a Lot
	Taste	3.70	Like a Lot	3.55	Like a Lot	3.50	Like a Lot
Teenagers	Appearance/ Color	3.40	Like a Lot	3.50	Like a Lot	3.0	Like a Little
	Aroma	3.75	Like a Lot	3.55	Like a Lot	3.70	Like a Lot
	Taste	3.75	Like a Lot	3.50	Like a Lot	3.85	Like a Lot
Adults	Appearance/ Color	3.90	Like a Lot	3.90	Like a Lot	3.65	Like a Lot
	Aroma	3.65	Like a Lot	3.75	Like a Lot	3.80	Like a Lot
	Taste	3.75	Like a Lot	3.90	Like a Lot	3.90	Like a Lot
Food Experts	Appearance/ Color	3.60	Like a Lot	3.30	Like a Lot	3.60	Like a Lot
	Aroma	3.65	Like a Lot	3.30	Like a Lot	3.65	Like a Lot
	Taste	3.55	Like a Lot	3.40	Like a Lot	3.65	Like a Lot
Overall Mean		3.67	Like a Lot	3.56	Like a Lot	3.60	Like a Lot

The data provided indicates a widespread positive reception of powdered soursop as a natural souring agent in Filipino cuisine, as assessed across various age groups and levels of culinary expertise.

Children, teenagers, adults, and food experts alike rated powdered soursop favorably (like a lot) in terms of appearance/color, aroma, and taste when incorporated into traditional Filipino dishes such as Pork Sinigang, Fish Sinigang, and Beef Sinigang.

Children displayed particularly high enthusiasm, consistently awarding powdered soursop high ratings across all criteria. Although teenagers rated appearance/color slightly lower than children, they expressed strong approval for taste, especially in Beef Sinigang. Adults and food experts echoed these sentiments, providing consistently positive ratings across all aspects evaluated.

Additionally, the study by Eusala and Pendon (2016) reinforces these findings, highlighting that powdered soursop is exceptionally well-liked in sensory evaluations, particularly in sinigang recipes. This underscores the broad acceptance of powdered soursop as a natural souring agent, regardless of its application in cooking or baking.

In summary, the data suggests a widespread and consistent acceptance of powdered soursop as a valuable addition to Filipino cuisine, supported by positive perceptions across different demographic segments and culinary proficiency levels.

General Acceptability of the Powdered Soursop as a Natural Souring Agent across Age Groups

Table 6. The general level of acceptability of powdered soursop as a natural souring agent across age groups

Respondents	**Pork Sinigang**		**Fish Sinigang**		**Beef Sinigang**	
	Mean	Description	Mean	Description	Mean	Description
Children	3.68	Like a Lot	3.53	Like a Lot	3.32	Like a Lot
Teenagers	3.63	Like a Lot	3.62	Like a Lot	3.68	Like a Lot
Adults	3.77	Like a Lot	3.85	Like a Lot	3.78	Like a Lot
Food Experts	3.60	Like a Lot	3.33	Like a Lot	3.63	Like a Lot
Overall Mean	**3.67**	**Like a Lot**	**3.58**	**Like a Lot**	**3.60**	**Like a Lot**

The data presented reveals a widespread acceptance of powdered soursop as a natural souring agent among diverse age groups and food experts. Children, teenagers, and adults all rated powdered soursop favorably across various dishes, including Pork Sinigang, Fish Sinigang, and Beef Sinigang.

Children consistently expressed strong enjoyment of powdered soursop, with mean scores indicating high satisfaction. Similarly, teenagers demonstrated a keen liking for this natural souring agent, with their ratings closely resembling those of children.

Notably, adults showed the highest level of acceptability, indicating a preference for powdered soursop even more pronounced than that of younger age groups. Although food experts rated powdered soursop slightly lower than adults, their scores still reflect a positive outlook on its use in culinary applications.

Overall, the data suggests a robust acceptance of powdered soursop across different demographics and expertise levels, with mean scores consistently indicating strong favorability. This aligns with previous research by Cruz, et.al (2021), which suggests the potential of soursop as a natural alternative to synthetic souring agents and preservatives.

In summary, the findings underscore the widespread appeal of powdered soursop as a natural souring agent, highlighting its potential to enhance the flavor profile of various dishes.

Comparison in the General Acceptability of the Powdered Soursoup across Age Groups

Table 7. Comparison in the general acceptability of powdered soursop as a natural souring agent in different recipes as perceived by the respondents across age groups

Recipes	F-Value	ρ-Value	Decision	Remarks
Pork Sinigang	0.6084	0.6116	Accept H_0	Not Significant
Fish Sinigang	3.1683	0.0291	Reject H_0	Significant
Beef Sinigang	2.3407	0.0801	Accept H_0	Not Significant

The table presents the comparison on the of powdered soursop as a natural souring agent in different recipes as perceived by the respondents across age groups.
As presented in the table, for Pork Sinigang, the F-value is 0.6084, and the p-value is 0.6116. Since the p-value is greater than the typical significance level of 0.05, the decision is to accept the null hypothesis (H0). This means that there is no significant difference in the general acceptability of powdered soursop across different age groups for Pork Sinigang. In other words, respondents perceive powdered soursop similarly regardless of their age when it comes to Pork Sinigang.

For Fish Sinigang, the F-value is 3.1683, and the p-value is 0.0291. Since the p-value is less than 0.05, the decision is to reject the null hypothesis (H0). This indicates that there is a significant difference in the general acceptability of powdered soursop across different age groups for Fish Sinigang. In other words, respondents' perceptions of powdered soursop vary significantly depending on their age when it comes to Fish

Sinigang.

For Beef Sinigang, the F-value is 2.3407, and the p-value is 0.0801. Since the p-value is greater than 0.05, the decision is to accept the null hypothesis (H0). This means that there is no significant difference in the general acceptability of powdered soursop across different age groups for Beef Sinigang. Similar to Pork Sinigang, respondents perceive powdered soursop similarly regardless of their age when it comes to Beef Sinigang.

In summary, the powdered soursop's acceptability across age groups is consistent for Pork Sinigang and Beef Sinigang. However, there's a significant difference in acceptability across age groups for Fish Sinigang, indicating that respondents' perceptions vary depending on age for this recipe. These findings suggest that the choice of recipe influences how respondents perceive powdered soursop, with Fish Sinigang showing the most variation in acceptability across age groups.

The result of this study proves that powdered soursop can be used in different recipes which agrees with the findings of Eusala and Pendon (2016) that soursop could be used as a tart filling. Similarly, Pobar (2015) found that soursop could be made into candy. Based on the result of the study, powdered soursop is widely accepted for human consumption, and it is a good alternative to synthetic souring agents.

Shelf-life of Powdered Soursoup

The powdered soursop, carefully selected and processed to moderate the challenges associated with soursop fruit preservation, exhibits a stable shelf life when stored at room temperature.

Over the first week, rigorous daily observations revealed consistent quality, with no discernible changes in appearance, color, or texture. Importantly, there were no indications of molds or spoilage, affirming the effectiveness of the processing methods employed. Subsequent weekly observations corroborated these findings, though with the emergence of compaction in the powder, easily remedied by manual crushing to restore its original state.

Even after a month, the powdered soursop displayed remarkable resilience, retaining its quality and aroma while only experiencing a darkening in color, a common occurrence in dehydrated products. Into the second month, the powder remained devoid of spoilage or foul odors, maintaining its integrity and underscoring its viability for extended storage.

Despite the challenges inherent in preserving soursop, careful processing techniques have evidently yielded a product with a shelf life exceeding initial expectations, suggesting a potential duration of at least two months under ambient conditions.

Conclusions

The research findings presented in this study demonstrate the significant potential of powdered soursop as a natural souring agent in Filipino cuisine. Through meticulous product development, including the selection of high-quality Aguinaldo soursop and iterative recipe refinement, powdered soursop has been successfully integrated into traditional dishes such as Pork Sinigang, Fish Sinigang, and Beef Sinigang.

Analysis of the nutritional composition reveals powdered soursop to be a moderate source of protein and dietary fiber, with low fat content and a relatively high mineral content, making it a promising addition to balanced diets. Sensory evaluations conducted across diverse demographic groups and culinary expertise levels consistently indicate strong acceptance of powdered soursop in terms of appearance, aroma, and taste.

While acceptability remains high across age groups for Pork Sinigang and Beef Sinigang, variations are observed in perceptions of Fish Sinigang, highlighting the influence of recipe choice on acceptability. However, overall, powdered soursop emerges as a versatile ingredient with broad appeal in Filipino cuisine. Moreover, previous studies supporting the potential applications of soursop in various culinary contexts further reinforce the findings of this research, underscoring its versatility and acceptance.

Importantly, the stability of powdered soursop over extended shelf life, exceeding initial expectations, indicates its suitability for commercialization and widespread adoption in both household and culinary settings.

Recommendations

In view of the findings and conclusions of the study, the following recommendations are advanced:

1. Soursop fruit can be processed and recommended as a souring agent in cooking different sinigang recipes.
2. Further study into the different utilization of soursop fruit is recommended.
3. Processing of powdered soursop as a souring agent can be extended in the community and can serve as their income-generating activity.
4. Research on packaging materials should be conducted to maintain a better appearance and provide a longer shelf life of powdered soursop as a natural souring agent. Government agencies such as the Department of Science and Technology (DOST) and the Department of Trade and Industry (DTI) can be tapped to help in the further refinement of the product and for possible marketing.
5. A grinding machine is recommended to be used to obtain the finer result.
6. A study on maintaining the natural color of soursop is recommended.

Compliance with Ethical Standards

The researcher upheld ethical standards throughout the study, ensuring integrity, transparency, and respect for participants' rights. Informed consent was obtained from all participants before commencing the study, and measures were taken to safeguard their welfare. No conflicts of interest were present, and strict avoidance of plagiarism was maintained. The interpretation of findings remained unbiased, and the results were utilized solely for the study.

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