

Development Of Calamansi Zest Sweet Potato-Based Pastillas: Comparison Of Three Varieties

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ABSTRACT

This study focused on the development and evaluation of Calamansi Zest Sweet Potato-Based Pastillas, an innovative confection designed to enhance nutritional value while reducing food waste. By incorporating Calamansi (Citrus microcarpa) zest, a byproduct typically discarded, the research aligns with global sustainability trends and the Philippine Department of Science and Technology's advocacy for the use of indigenous materials. The research compared three sweet potato varieties to determine the optimal formulation based on sensory quality and financial viability. The sensory acceptability of the different treatments was evaluated by participants using a 9-point Hedonic Rating Scale, focusing on appearance, aroma, texture, and taste. Data were analyzed using frequencies, means, and repeated-measures multivariate analysis of Variance (MANOVA) to account for correlations among multiple sensory attributes. Results indicated that all treatments were successful and well-received by consumers, with Treatment 1 achieving the highest sensory acceptability and preference. Significant differences were observed across treatments, suggesting that the variety of sweet potato consistently influences consumer satisfaction. Economically, the product demonstrated financial viability with a positive return on expenditure. To ensure market readiness, the study recommends maintaining strict hygiene standards to sustain zero microbial growth and sourcing raw materials from diverse local regions to ensure sustainability. Ultimately, this research supports the commercialization of sweet potato-based pastillas as an affordable, health-conscious, and eco-friendly alternative in the functional food market.

Keywords: Calamansi, pastillas, indigenous materials, commercialization, food market

INTRODUCTION

In recent years, global interest in functional foods—foods that provide health benefits beyond basic nutrition—has encouraged researchers to explore locally available and underutilized ingredients. One promising ingredient is calamansi (*Citrus microcarpa*), a citrus fruit widely cultivated in the Philippines and known for its high vitamin C content, antioxidant properties, and distinct flavor. Studies by K. Venkatachalam and colleagues (2023) highlighted the antioxidant, anti-inflammatory, and commercial potential of calamansi, including the utilization of peels and processing by-products. Likewise, research by K.E.T. Abal et al. (2024) emphasized the nutritional composition and antioxidant properties of calamansi peels.

Despite its nutritional value, calamansi zest or peel is commonly discarded as waste. Globally, increasing attention has been given to transforming fruit by-products into value-added ingredients to reduce food waste and support sustainability. Fruit peels and zest have been used in food products such as candies, jams, and baked goods for their bioactive compounds and flavor-enhancing properties. This aligns with the Department of Science and Technology's advocacy for utilizing indigenous resources to develop functional food products.

Sweet potato (*Ipomoea batatas*) is another nutrient-rich crop containing carbohydrates, vitamins, minerals, and dietary fiber. Different varieties, such as yellow-, orange-, and white-fleshed sweet potatoes, vary in nutritional composition, sweetness, and texture. The combination of calamansi zest and sweet potato in pastillas offers an innovative approach to creating healthier, more sustainable confectionery products.

This study introduces Calamansi Zest Sweet Potato-Based Pastillas and compares three sweet potato varieties to determine differences in flavor, aroma, texture, color, and overall acceptability. The findings may provide valuable insights into food innovation and product standardization, and support local farmers and small-scale food producers.

Statement of the Problem

The study sought to assess the development and acceptability of Calamansi Zest Sweet Potato-Based Pastillas using three sweet potato varieties.

Specifically, it aimed to answer the following questions:

1. What is the level of sensory acceptability of the developed Calamansi Zest Sweet Potato-based Pastillas in terms of:
 - 1.1. Appearance
 - 1.2. Aroma
 - 1.3. Texture
 - 1.4. Taste
 - 1.5. Overall acceptability
2. Is there a significant difference in the sensory evaluation among the different treatments (T1, T2, and T3) of the development of calamansi zest sweet potato-based pastillas: Comparison of three varieties.
3. Which variety yields the most acceptable calamansi zest sweet potato-based Pastillas?
4. What are the microbial qualities in terms of bacterial and fungal count of the developed Calamansi zest Sweet Potato-Based Pastillas to ensure safety and sustainability for consumption?
5. What is the return on expenditure (ROE) for the production of Calamansi Zest Sweet Potato-Based Pastillas?
6. What instructional material can be proposed based on the findings of the study?

Scope and Delimitations

The study focused exclusively on the development of pastillas formulated from calamansi zest and three sweet potato varieties. Sensory evaluation covers appearance, aroma, texture, taste, and overall acceptability using a panel of evaluators. The researcher gathered thirty (30) respondent-evaluators composed of (5) TLE teacher, (5) Vendors of Sweet delicacies and (20) TLE students to evaluate the three (3) formulations of the developed calamansi zest sweet potato-based pastillas: comparison of three varieties, afterwards the best formulations underwent drying sweet potato-based pastillas and molded into oblong or round. A score card was used in indicating their sensory evaluation of the sweet potato. The study was conducted during the 2025-2026 school year.

Review of Related Literatures

Recent studies support the use of sweet potato in food processing and innovation. Research has shown that different sweet potato varieties vary in physical, chemical, and structural properties, affecting texture, flavor, color, sweetness, and nutritional value in processed products (Peng et al., 2024; Li et al., 2024; Xue et al., 2024). Improved processing techniques further enhance product quality and functionality (Xiong et al., 2024). Studies also indicate that sweet potato is

a sustainable and nutrient-rich crop with strong potential for value-added food development (Islam, 2024; Catangui & Arispe, 2025). Recent findings additionally reveal that storage conditions, sugar content, and dry matter influence the quality and acceptability of sweet potato-based products (Li et al., 2026).

Sensory evaluation remains essential in food product development as it measures consumer perception of appearance, aroma, taste, texture, and overall acceptability (Lawless & Heymann, 2018). Furthermore, microbial quality testing is important in ensuring safety and shelf stability, particularly for milk-based products susceptible to bacterial and fungal growth (Jay, 2019; Santos, 2020). Overall, previous studies support the development of calamansi zest sweet potato-based pastillas and highlight their potential as an innovative and acceptable food product.

Theoretical Framework

The study is theoretically grounded in the principles of functional food innovation and sustainable product development, which emphasize the transformation of locally underutilized agricultural materials into value-added goods. This framework draws on the nutritional synergy between sweet potato (*Ipomoea Batatas*), which provides a carbohydrate-rich base with high dietary fiber and antioxidants, and Calamansi (*Citrus Microcarpa*) Zest, which introduces aromatic essential oils and natural preservatives. Conceptually, the research utilized an Input-Process-Output (IPO) model. The Input phase consists of the three sweet potato varieties (Orange, Purple, and White-fleshed) and Calamansi Zest. The Process involves recipe standardization and sensory evaluation through a 9-point Hedonic Rating Scale to assess appearance, aroma, texture, and taste. The output is a standardized, highly acceptable, and financially viable Calamansi Zest Sweet Potato-Based Pastillas, intended for commercialization and for use as a resource in technology and home economics instruction.

Conceptual Framework

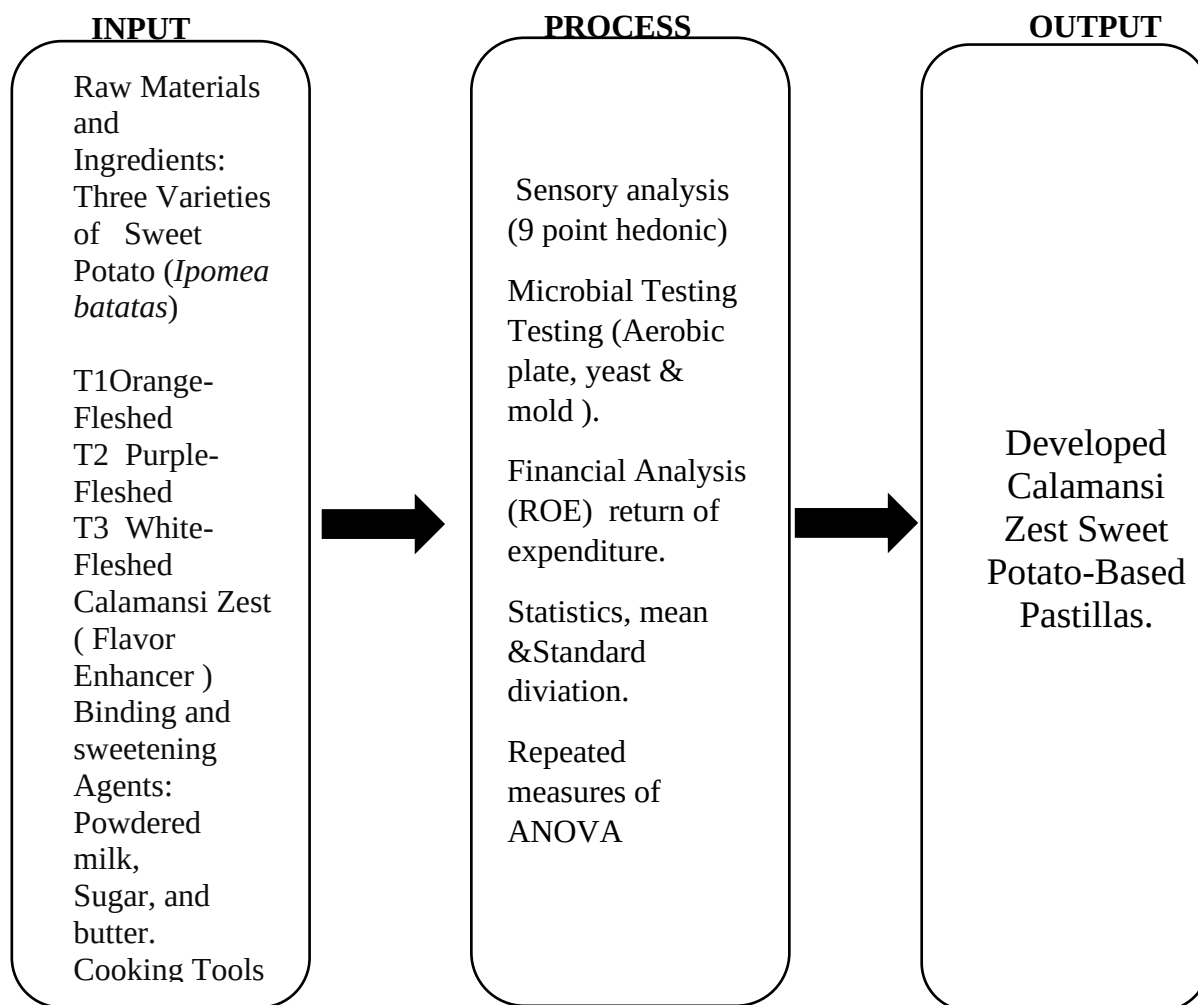


Figure 1: Conceptual Framework

The core of this research was a systematic Input-Process-Output (IPO) model that illustrates a systematic approach to developing and evaluating Calamansi Zest Sweet Potato-based Pastillas using three distinct varieties: orange-fleshed, purple-fleshed, and white-fleshed. The input phase established the foundational raw materials, specifically the sweet potato varieties (T1, T2, T3) and key additives such as calamansi zest for flavor, along with binding agents like powdered milk and sugar. The process phase involved the standardized preparation and cooking of these ingredients, followed by rigorous testing through sensory evaluation, microbial assessment, and economic analysis. Finally, the output represents the culmination of the study, a refined product and the identification of the superior sweet potato variety based on consumer acceptability and sensory characteristics.

METHODOLOGY

Research Design

This study utilized an Experimental Research Design, specifically a product Development and sensory evaluation approach, to develop and assess Calamansi Zest Sweet potato-based pastillas

using three different varieties of sweet potato. Three formulations were prepared: Three treatments (T1, T2, T3) containing calamansi zest combined with orange, purple, and white sweet potato varieties. The design enabled systematic comparison of sensory qualities, microbial safety, and standardization across treatments.

Research Locale

This study was conducted at San Felipe Integrated School in San Nicolas, Pangasinan. Sensory evaluations were conducted in the TLE Laboratory, and product storage tests were conducted under controlled room conditions (25-30 degrees Celsius).

Materials and Ingredients

This section presents the ingredients, tools, and equipment used to develop the three treatments for calamansi zest sweet potato-based pastillas. The materials were selected based on quality, availability, and sustainability for the development of standardized food products. The ingredients used in the development of pastillas were divided into base, variable, and enhancing ingredients. Base ingredients common to all treatments, these serve as the primary foundation for the pastillas mixture. Consistency. 3 cups of powdered milk adds body, firmness, and traditional pastillas texture. $\frac{1}{2}$ cup white sugar for rolling or adjusting sweetness. 2 tablespoons butter (Optional) adds smoothness and enhances mouthfeel. Variables: Ingredients (Per Treatment). These ingredients vary based on the sweet potato variety used, such as orange, purple, and white sweet potato.

Respondent of the Study

The development of Calamansi Zest Sweet Potato-Based Pastillas Underwent evaluation by a total of 30 respondent-evaluators. Among these evaluators, five (5) were Technology and Livelihood Education (TLE) teachers, and five (5) local consumers familiar with Filipino sweets delicacies. The remaining twenty (20) were students specializing in Technology and Livelihood Education (TVLE). This diverse group was selected as representatives of potential consumers and experts in the field, with TLE teachers offering professional insight and students providing perspective as future practitioners or consumers. Their evaluation served as a crucial step in Determining the acceptability of the developed products, offering valuable feedback on sensory attributes, overall quality, and potential market viability.

RESULTS AND DISCUSSION

SENSORY ACCEPTABILITY OF CALAMANSI ZEST SWEET POTATO-BASED PASTILLAS

Sensory evaluation refers to the method of judging the characteristics of a food product using the human senses. In this study, the developed calamansi zest sweet potato-based pastillas were evaluated by thirty (30) respondent-evaluators in terms of appearance, aroma, texture, and taste. Treatment 1 used the orange-fleshed sweet potato variety, Treatment 2 used the purple-fleshed variety, and Treatment 3 used the white-fleshed variety. The mean scores, standard deviations, and descriptive interpretations for each treatment are presented in Tables 1 to 4.

Characteristics of Calamansi Zest Sweet Potato-Based Pastillas in terms of Appearance

Table 1 presents the characteristics of calamansi zest sweet potato-based pastillas in terms of appearance.

Table 1

Characteristics of Calamansi Zest Sweet Potato-Based Pastillas in terms of Appearance

Treatment	Mean Value	Description	SD	Lowest	Highest
T1 – Orange	8.6	EL	0.62	7.0	9.0
T2 – Purple	8.33	VML	0.66	7.0	9.0
T3 – White	8.43	VML	0.9	5.0	9.0
AWM	8.45	VML			

Legend: AWM = Average Weighted Mean; EL = Extremely Liked; VML = Very Much Liked; ML = Moderately Liked; SL = Slightly Liked; NLDL = Neither Like nor Dislike; SD = Slightly Disliked; MD = Moderately Disliked; VMD = Very Much Disliked; ED = Extremely Disliked.

Table 1 shows that all three formulations of calamansi zest sweet potato-based pastillas were favorably accepted for their appearance. Treatment 1, using orange-fleshed sweet potato, obtained the highest mean rating and was described as extremely liked, while Treatments 2 and 3 were rated very much liked. The brighter color of the orange-fleshed variety may have contributed to its stronger visual appeal. Despite slight differences, all formulations were considered visually pleasing, indicating that the product has good potential as an improved traditional sweet. This supports the findings of Woolfe (2017), who emphasized that different sweet potato varieties provide natural pigments that enhance the appearance of food and its nutritional value. Similarly, Gomez (2020) highlighted the growing use of plant-based ingredients in healthier confectionery products.

Characteristics of Calamansi Zest Sweet Potato-Based Pastillas in terms of Aroma

Table 2 presents the characteristics of calamansi zest sweet potato-based pastillas in terms of aroma.

Table 2

Characteristics of Calamansi Zest Sweet Potato-Based Pastillas in terms of Aroma

Treatment	Mean Value	Description	SD	Lowest	Highest
T1 – Orange	8.73	EL	0.52	7.0	9.0
T2 – Purple	8.5	VML	0.68	7.0	9.0
T3 – White	8.43	VML	0.97	5.0	9.0
AWM	8.55	EL			

Legend: AWM = Average Weighted Mean; EL = Extremely Liked; VML = Very Much Liked; ML = Moderately Liked; SL = Slightly Liked; NLDL = Neither Like nor Dislike; SD = Slightly Disliked; MD = Moderately Disliked; VMD = Very Much Disliked; ED = Extremely Disliked.

Table 2 presents the acceptability of the developed pastillas in terms of aroma. All treatments were positively evaluated, with Treatment 1 receiving the highest mean score and rated as extremely liked, while Treatments 2 and 3 were rated very much liked. This suggests that the aroma of all formulations was generally acceptable, with Treatment 1 producing a more pleasant smell. The results indicate that calamansi zest contributed to a consistent citrus aroma, improving the product's sensory appeal. These findings support the study of Ana Carolina S. A. Silva (2022), which stated that citrus zest contains natural oils that enhance flavor and aroma in processed foods.

Characteristics of Calamansi Zest Sweet Potato-Based Pastillas in terms of Texture

Table 3 presents the characteristics of calamansi zest sweet potato-based pastillas in terms of texture.

Table 3

Characteristics of Calamansi Zest Sweet Potato-Based Pastillas in terms of Texture

Treatment	Mean Value	Description	SD	Lowest	Highest
T1 – Orange	8.57	EL	0.73	7.0	9.0
T2 – Purple	8.5	VML	0.68	7.0	9.0
T3 – White	8.57	EL	0.82	6.0	9.0
AWM	8.55	EL			

Legend: AWM = Average Weighted Mean; EL = Extremely Liked; VML = Very Much Liked; ML = Moderately Liked; SL = Slightly Liked; NLDL = Neither Like nor Dislike; SD = Slightly Disliked; MD = Moderately Disliked; VMD = Very Much Disliked; ED = Extremely Disliked

Table 3 shows the texture ratings of the calamansi zest sweet potato-based pastillas. Treatments 1 and 3 received the highest mean scores and were described as extremely liked, while Treatment 2 was rated very much liked. The overall weighted mean indicates that the texture was generally well accepted by the respondents. The findings suggest that all three sweet potato varieties produced a soft and acceptable texture suitable for pastillas. Since texture is an important quality attribute, the favorable ratings indicate that incorporating sweet potato did not negatively affect product quality. According to Huang and Liu (2021), the composition of sweet potato starch influences texture, making it suitable for confectionery applications.

Characteristics of Calamansi Zest Sweet Potato-Based Pastillas in terms of Taste

Table 4 presents the characteristics of calamansi zest sweet potato-based pastillas in terms of taste.

Table 4

Characteristics of Calamansi Zest Sweet Potato-Based Pastillas in terms of Taste

Treatment	Mean Value	Description	SD	Lowest	Highest
T1 – Orange	8.67	EL	0.55	7.0	9.0
T2 – Purple	8.57	EL	0.73	6.0	9.0
T3 – White	8.5	VML	0.78	6.0	9.0
AWM	8.58	EL			

Legend: AWM = Average Weighted Mean; EL = Extremely Liked; VML = Very Much Liked; ML = Moderately Liked; SL = Slightly Liked; NLDL = Neither Like nor Dislike; SD = Slightly Disliked; MD = Moderately Disliked; VMD = Very Much Disliked; ED = Extremely Disliked.

Table 4 presents the taste acceptability of the three pastilla treatments. Treatment 1 obtained the highest mean score and was rated as extremely liked, followed by Treatment 2 with the same rating, while Treatment 3 was rated very much liked. The findings indicate that all formulations were favorably accepted in terms of taste. Treatment 1 showed the highest acceptability, suggesting that its sweet potato variety blended effectively with the sweetness of the pastillas and calamansi zest. Overall, the results suggest strong consumer acceptance, with Treatment 1 showing the greatest potential in taste quality.

TEST OF SIGNIFICANT DIFFERENCES OF THE CHARACTERISTICS OF CALAMANSI ZEST SWEET POTATO-BASED PASTILLAS

To determine whether significant differences existed among the three treatments in terms of appearance, aroma, texture, and taste, analysis of variance was employed. The results are presented in Tables 5-8.

Comparison of the Appearance of Calamansi Zest Sweet Potato-Based Pastillas

Table 5 presents the comparison of calamansi zest sweet potato-based pastillas in terms of appearance.

Table 5

Comparison on the Appearance of Calamansi Zest Sweet Potato-Based Pastillas

Category	Mean	SD	F	Sig.
T1 – Orange	8.6	0.62	1.613	0.208
T2 – Purple	8.33	0.66		
T3 – White	8.43	0.9		

Table 5 compares the appearance ratings of the three treatments using analysis of variance. The result shows that there was no significant difference among the treatments because the p-value was greater than 0.05. This means that the respondents viewed the appearance of the three formulations as generally comparable.

Although Treatment 1 obtained the highest mean score, the statistical results indicate that its advantage over the other treatments was not statistically significant. Treatments 2 and 3 also received high ratings, which explains why the differences were small. In simple terms, all three varieties produced visually acceptable pastillas.

The finding implies that any of the three sweet potato varieties can be used without greatly affecting the appearance of the product. However, since Treatment 1 still had the highest mean score, it may be preferred when visual appeal is considered in product development. This supports its potential as the leading formulation while acknowledging that the other treatments were acceptable as well.

Comparison of the Aroma of Calamansi Zest Sweet Potato-Based Pastillas

Table 6 presents the comparison of calamansi zest sweet potato-based pastillas in terms of aroma.

Table 6

Comparison of the Aroma of Calamansi Zest Sweet Potato-Based Pastillas

Category	Mean	SD	F	Sig.
T1 – Orange	8.73	0.52	2.333	0.106
T2 – Purple	8.5	0.68		
T3 – White	8.43	0.97		

Table 6 presents the comparison of the three treatments in terms of aroma. Results showed no significant differences among the treatments, as the computed p-value was greater than 0.05, indicating that aroma ratings were not statistically different. Although Treatment 1 obtained the highest mean rating, the differences were minimal. This suggests that the calamansi zest provided a consistently pleasant aroma across all formulations, regardless of the sweet potato variety used. Therefore, all treatments were considered acceptable in terms of aroma.

Comparison of the Texture of Calamansi Zest Sweet Potato-Based Pastillas

Table 7 presents the comparison of calamansi zest sweet potato-based pastillas in terms of texture.

Table 7

Comparison on the Texture of Calamansi Zest Sweet Potato-Based Pastillas

Category	Mean	SD	F	Sig.
T1 – Orange	8.57	0.73	0.177	0.838
T2 – Purple	8.5	0.68		
T3 – White	8.57	0.82		

Table 7 presents the statistical comparison of the treatments in terms of texture. The result shows no significant difference among the three treatments because the significance value was greater than 0.05. This means that the respondents did not perceive a big difference in the texture of the pastillas made from the three sweet potato varieties.

Treatments 1 and 3 shared the highest mean score, while Treatment 2 followed closely. The small gap between the mean values indicates that all formulations produced a texture acceptable to the evaluators. This also suggests that the preparation and ingredient proportions provided a generally consistent texture.

The finding suggests that using sweet potato in pastillas can produce a desirable mouthfeel across varieties. Since texture is important in determining pastillas' quality, the lack of significant differences suggests the product can be standardized without major texture concerns. Treatment 1 remains a strong option, especially when considered alongside its ratings for other sensory attributes.

Comparison of the Taste of Calamansi Zest Sweet Potato-Based Pastillas

Table 8 presents the comparison of calamansi zest sweet potato-based pastillas in terms of taste.

Table 8

Comparison of the Taste of Calamansi Zest Sweet Potato-Based Pastillas

Category	Mean	SD	F	Sig.
T1 – Orange	8.67	0.55	1.0	0.374
T2 – Purple	8.57	0.73		
T3 – White	8.5	0.78		

Table 8 compares the taste ratings of the three treatments. Results showed no significant differences among the treatments, as the significance value exceeded the 0.05 level, indicating that all formulations were statistically comparable in taste acceptability. Treatment 1 obtained the highest mean score, followed by Treatments 2 and 3, although the differences were minimal. This suggests that respondents generally liked the taste of all formulations. The findings indicate that calamansi zest sweet potato-based pastillas have strong potential as a feasible and acceptable food product innovation.

OVERALL SUMMARY, MOST ACCEPTABLE VARIETY, AND STANDARDIZED RECIPE

The summary of the mean sensory scores of the three treatments is presented in Table 9. Since the available Excel dataset did not contain a separate overall acceptability column, the most acceptable treatment was identified through the composite mean of the measured sensory attributes.

Table 9

Overall Summary of Calamansi Zest Sweet Potato-Based Pastillas

Treatment	Appearance	Aroma	Texture	Taste	Composite Mean	Rank
T1 – Orange	8.6	8.73	8.57	8.67	8.642	1
T2 – Purple	8.33	8.5	8.5	8.57	8.475	3
T3 – White	8.43	8.43	8.57	8.5	8.483	2

Table 9 presents the sensory scores for the three treatments across appearance, aroma, texture, and taste. Based on the composite mean, Treatment 1 ranked highest, followed by Treatments 3 and 2, indicating that the orange-fleshed sweet potato formulation received the most favorable evaluation. Treatment 1 consistently performed well across sensory attributes, suggesting its suitability for further development and standardization. This finding supports the studies by Perez (2020) and Bautista (2022), which found that orange-fleshed sweet potato varieties were preferred for their better color and flavor characteristics.

STANDARDIZED RECIPE OF THE MOST ACCEPTABLE CALAMANSI ZEST SWEET POTATO-BASED PASTILLAS

Table 10 presents the standardized recipe of the most acceptable formulation based on the sensory evaluation results.

Table 10

Standardized Recipe of the Most Acceptable Calamansi Zest Sweet Potato-Based Pastillas

Item	Quantity	Unit
Orange-fleshed sweet potato	500	grams
Calamansi zest	4	grams
Powdered milk	200	grams
Sugar	150	grams
Butter	10	grams

Table 10 presents the standardized recipe of the most acceptable formulation of calamansi zest sweet potato-based pastillas. The recipe is based on Treatment 1, which used orange-fleshed sweet potato together with calamansi zest, powdered milk, sugar, and butter. This formulation was selected because it obtained the highest composite mean in the sensory evaluation. The listed quantities provide a practical guide for preparing the product consistently and to a high standard. The use of orange-fleshed sweet potato gives the product color and body, while calamansi zest contributes aroma and flavor. Powdered milk, sugar, and butter help maintain the familiar taste and texture expected from pastillas.

The standardized recipe is important because it translates the study's findings into a usable product formulation. It can serve as a basis for classroom activities, livelihood training, or small-scale food production. Since the recipe is anchored in the most widely accepted treatment, it may help ensure that future preparation of the product yields a similar sensory quality.

MICROBIAL QUALITIES OF THE DEVELOPED CALAMANSI ZEST SWEET POTATO-BASED PASTILLAS

The microbial analysis results for bacterial and fungal counts are still pending at the time of this chapter's preparation. The table below is provided as a placeholder for the laboratory findings and corresponding interpretation.

Table 11

Microbial Activities of the Developed Calamansi Zest Sweet Potato-Based Pastillas

Parameters	Test Method	Results
Total Coliform count, (CFU/g)	Pour plate	< 10 (Est.)
Aerobic Plate Count	Pour plate	< 10 (Est.)
Yeast and mold count	Spread plate	< 10 (Est.)
Salmonella detection (per 25g)	Conventional method	Negative

Note:CFU/g=ColonyForming ; unit per gram(Est.)=Estimated < Less than

Table 11 is intended to present the microbial qualities of the developed. Calamansi zest sweet potato-based pastillas. However, the table still contains placeholder entries because the bacterial and fungal count results were not yet available when the chapter was prepared. For this reason, no definitive interpretation of microbial quality can be drawn from the table.

The absence of completed values means that the discussion of this part should be treated as provisional. The table shows the expected format for reporting the results once laboratory findings are available. Until then, the sensory acceptability and standardized recipe results remain the main basis for evaluating the developed product.

Once the laboratory data are supplied, this table may help determine whether the product is suitable for safe consumption and possible storage. The results may also guide improvements in packaging, handling, and preparation procedures. Therefore, completing the table is important before making final claims about the product's quality beyond sensory acceptability.

Return of Expenditure for calamansi-zest, sweet potato-based pastillas: Comparison of Three Varieties.

The return on expenditure (ROE) of calamansi zest sweet potato-based pastillas was analyzed using key financial indicators, including total kilograms produced, mark-up pricing, gross income, net income, and overall profitability after expenses. These measures assessed production efficiency and financial viability.

Results showed that Treatment 1 (orange-fleshed sweet potato formulation) received the highest sensory acceptability and overall ranking. Its formulation consisted of 500 grams of orange-fleshed sweet potato, 4 grams of calamansi zest, 200 grams of milk powder, 150 grams of sugar, and 10 grams of butter.

Table 12

Return of Expenditure for Flavor Calamansi Zest Sweet Potato-Based Pastillas: Comparison of Three Varieties.

Item	Basis of Computation	Amount (Php.)	Remarks
Raw materials	Sweet potato, Calamansi zest, milk, sugar, and butter	240.00	Based on locally sweet potatoes
Packaging materials	Pouches, labels, seals, and other packaging needs	167.00	For 150 finished packs

Electricity/Gas Cost	Electric stove/Gas stove operation	50,00	Based on power use in boiling and gas use.
Labor	Washing, slicing, cooking, packaging and cleaning	100.00	Batch labor cost
Total Production Cost	Sum of all production expenses	Php. 557	TPC

Item	Basis of Computation	Amount (Php)	Remarks
Total Yield	150 packs of calamansi zest, sweet potato-based pastillas	_____	150 packs per batch
Cost per unit	₱ 557 ÷ 150 packs	3.71	Unit production cost
Selling Price	Cost per unit plus mark-up	5.00	Suggested selling price
Gross sales	₱ 5.00 × 150 packs	750.00	Projected sales
Net Income	₱ 750.00 – ₱ 557	193.00	Basis for ROE
Return on Expenditure	₱ 193 ÷ ₱ 750 × 100	25.33%	Positive ROE

Table 12 presents the financial returns of the Calamansi Zest Sweet Potato-Based Pastillas. The total production cost per batch is ₱557.00, producing 150 packs at a unit cost of ₱3.71 each. With a suggested selling price of ₱5.00 per pack, the projected gross sales reach ₱750.00, resulting in a net income of ₱193.00. Using the ROE formula, the return on expenditure is 25.33%, meaning every ₱100.00 invested may yield ₱25.33 in return. This indicates that the product has potential for classroom production, livelihood activities, and small-scale enterprise, subject to further validation of actual production conditions.

PROPOSED INSTRUCTIONAL MATERIALS BASED ON THE FINDINGS OF THE STUDY

Based on the findings, the proposed instructional materials for Calamansi Zest Sweet Potato-Based Pastillas aim to connect research with practical application for students and local entrepreneurs. The main output is a visual production guide that simplifies the process, particularly for the orange-fleshed sweet potato variety using a 500g sweet potato to 4g calamansi zest ratio, enabling easy replication of results. This guide is especially useful for TLE students, as it breaks down procedures from raw material preparation to pastilla molding.

A laboratory manual and entrepreneurial toolkit complement the guide by strengthening food safety, quality control, and business skills. It includes sensory evaluation sheets, microbial safety checklists, and financial insights, such as a 25.33% return on expenditure, to help users manage costs and assess profitability. It also promotes marketing the product as a functional food using indigenous ingredients.

Additionally, the materials include a sustainability module and video tutorial. The module emphasizes food waste valorization by repurposing calamansi zest, aligning with circular economy principles, while the video demonstrates key production steps, such as heating and

mashing. Together, these resources provide a practical, sustainable, and entrepreneurial learning package.

The proposed instructional material titled “***Production and Entrepreneurial Guide on the Development of Calamansi Zest Sweet Potato-Based Pastillas***” is designed for use in Technology and Livelihood Education (TLE), Home Economics, Food Technology, and community livelihood training. It is based on the study's findings, in which “Treatment 1” (500g orange-fleshed sweet potato, 4g calamansi zest, 200g milk powder, 150g sugar, and 10g butter) obtained the highest sensory acceptability score and was identified as the standardized formulation.

The material adopts a “brochure-type technology guide” format, presenting concise, visual learning content for easy understanding and self-learning. It introduces “Eco-Sweet Innovations”, which promotes food waste valorization by transforming calamansi peel and sweet potato into value-added confectionery products while supporting sustainable food practices and entrepreneurship.

The guide aims to help learners and community users determine the sensory acceptability of Calamansi Zest Sweet Potato-Based Pastillas using different sweet potato varieties. Specifically, it develops competencies in sensory evaluation, microbial safety assessment, product standardization, and entrepreneurial skills, including cost analysis, budgeting, pricing, and return on expenditure (ROE) calculation.

The instructional content includes the rationale of utilizing indigenous and recycled food resources, target users, objectives, learning concepts, required materials and equipment, standardized production procedures, safety and sanitation practices, learning activities, sensory evaluation tools, cost analysis worksheets, and assessment rubrics. Learners are expected to perform hands-on production activities, evaluate product quality using the 9-point hedonic scale, and apply business principles in product commercialization.

Overall, the instructional material bridges “food science, sustainability, and entrepreneurship”, enabling learners to transform agricultural by-products into market-ready, eco-friendly products while promoting economic self-reliance and livelihood opportunities.

BRUCHURE TYPE




DEVELOPED BY:
MARBELISA A. SAGUN

Experience a delightfully vibrant twist on a classic Filipino confection. This innovative snack marries the natural, earthy sweetness of smooth mashed sweet potatoes with the bright, citrusy punch of real calamansi zest. Perfectly chewy and thoughtfully crafted, it offers a healthier, uniquely refreshing treat that reimagines tradition in every bite.



**Sweet
Potato
Base**



**Zesty
Calamansi
Infusion**



**The Perfect
Sweet-Tangy
Balance**

OBJECTIVES

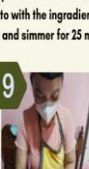
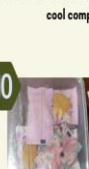
- ✓ To provide a nutritious, low-sugar pastillas alternative using a fiber-rich sweet potato base.
- ✓ To blend the natural sweetness of sweet potato with the sharp, refreshing contrast of calamansi zest.
- ✓ To elevate and market homegrown crops by utilizing locally sourced sweet potatoes and calamansi.

INGREDIENTS

Orange-fleshed Sweet Potato - 500g
Calamansi Zest - 4g
Milk powder - 200g
Sugar - 150g
Butter - 10g



PROCEDURE

- 
Do the Mise en place
- 
Washing the sweet potato.
- 
Place the sweet potatoes in a pot and boil them for 40 minutes. After 40 minutes, drain the water and transfer the sweet potato to a strainer.
- 
Place the sweet potatoes in a mixing bowl and mash it until it is smooth.
- 
Measure the dry ingredients.
- 
Grate the Calamansi Zest.
- 
Prepare a pan and cook the mashed sweet potato with the ingredients. Mix thoroughly and simmer for 25 minutes
- 
Transfer the mixture on a tray allow it to cool completely.
- 
Wrap the calamansi-zest sweet-potato pastillas in a plastic cellophane.
- 
Put the finished product in a plastic container seal and label.

SUMMARY

This study assessed the development and acceptability of calamansi zest-sweet potato-based pastillas using three sweet potato varieties. It specifically assessed sensory acceptability,

identified significant differences among treatments, determined the most acceptable variety, established a standardized recipe, and evaluated microbial quality.

Thirty (30) evaluators assessed appearance, aroma, texture, and taste. All treatments received positive ratings. Treatment 1 obtained the highest scores in appearance (8.60), aroma (8.73), and taste (8.67), while Treatments 1 and 3 shared the highest texture rating (8.57). Overall, Treatment 1 ranked highest with a composite mean of 8.642, followed by Treatment 3 (8.483) and Treatment 2 (8.475).

Analysis of variance showed no significant differences among treatments in appearance ($p = 0.208$), aroma ($p = 0.106$), texture ($p = 0.838$), and taste ($p = 0.374$), indicating comparable acceptability across varieties.

Treatment 1 (orange-fleshed sweet potato) emerged as the most acceptable formulation and served as the basis for the standardized recipe: 500 g orange-fleshed sweet potato, 4g calamansi zest, 200 g powdered milk, 150 g sugar, and 10 g butter.

Microbial testing results for bacterial and fungal counts are currently pending and will be included once laboratory analysis is completed.

CONCLUSIONS

Based on the study's findings, the researcher concludes that all three sweet potato varieties can be used to develop calamansi zest sweet potato-based pastillas, as all treatments received favorable sensory ratings from the respondents. However, Treatment 1, using orange-fleshed sweet potato, emerged as the most acceptable formulation, achieving the highest composite mean across the measured sensory attributes. The statistical analysis further shows that there were no significant differences among the treatments in appearance, aroma, texture, or taste. This indicates that the three varieties were generally comparable in acceptability, although Treatment 1 received the most favorable overall evaluation and is therefore recommended as the standardized recipe for the product. Regarding the microbial quality of the product, the laboratory results for the Total Coliform count (CFU/g) test method pour plate result, < 10 (est.), Aerobic plate count (CFU/g) test method: pour plate < 10 (est.) Yeast and mold count (CFU/g) test method result spread plate < 10 (est.) While Salmonella Detection (per 25g) test method results are negative for microbial. The product is economically feasible for small-scale livelihood projects or classroom-based production due to its positive ROE. The proposed brochure-type instructional materials, A comprehensive "Production and Entrepreneurial Guide," were developed, including a visual production manual, laboratory toolkit, and a food waste valorization module for use in TLE and Home Economics courses.

RECOMMENDATIONS

Based on the findings and conclusions of the study, the following recommendations are offered:

1. Treatment 1 using orange-fleshed sweet potato may be adopted as the standardized formulation for calamansi zest sweet potato-based pastillas.
2. Future researchers may include a direct measure of overall acceptability and flavor as separate variables to provide a more comprehensive sensory profile of the product.
3. Considered the most acceptable variety, based on the highest composite mean score of 8.642, Treatment 1 (orange-fleshed sweet potato) was identified as the most preferred formulation.
4. The microbial analysis of the developed product should be completed in order to establish its bacterial and fungal count, safety, and shelf-life potential.
5. A complete batch costing should be conducted to finalize the return on expenditure and determine whether production is feasible for classroom, community or small-scale enterprise use.

6. The proposed brochure-type instructional materials, A comprehensive "Production and Entrepreneurial Guide" was developed, including a visual production manual, laboratory toolkit, and a food waste valorization module for use in TLE and Home Economics courses.

Acknowledgment

AI Declaration Statement:

AI-supported tools helped with grammar and structure in creating this article. No AI tools were used to collect, analyze, or interpret data; all authors are credited for their academic contributions.

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APPENDIX G

PRIOR ART SEARCH (PAS) REPORT

BACKGROUND INFORMATION

Title of Invention	DEVELOPMENT OF CALAMANSI ZEST SWEET POTATO-BASED PASTILLAS	
Abstract	The utility model relates to the process of Development of Calamansi Zest Sweet Potato-Based Pastillas: Comparison of Three Varieties. Sweet Potato (<i>Ipomoea batatas</i>) are root crops that are high in beta-carotene. While Calamansi Zest (<i>Citrus Microcarpa</i>) serve as enhancing flavor in making sweet potato pastillas. The process involved preparing all the ingredients; Do the Mise en place; Washing the sweet potato; Place the Sweet potatoes in a pot and boil them for 40 minutes. After 40 minutes drain the water and transfer the sweet potato to a strainer; Place the sweet potato in a mixing bowl and mash it until it is smooth; Measure the dry ingredients; Grated the calamansi zest; Prepare a pan and cook the mashed sweet potato with the other ingredients; Mix thoroughly and simmer for 25 minutes; Transfer the mixture to a rectangular tray allow it to cool completely; wrap the calamansi-zest sweet-potato pastillas in a plastic cellophane; Put the finished product in a plastic container seal and label. It is good complement as your dessert after eating. The product can also be sold for a profit, providing extra income for your daily needs.	
Inventor(s)	MARBELISA A. SAGUN AMELITA DE VERA, PhD	
Applicant(s)	PANGASINAN STATE UNIVERSITY	
IPC: A23G 3/34; A23L 19/00; A23L 27/10; A23L 33/105; A23P 20/00 CPC: A23G 3/48; A23L 19/10; A23L 27/10; A23L 33/105; A23P 20/10; A23V 2002/00		
Keywords: calamansi zest pastillas, sweet potato pastillas, calamansi flavored confectionery, sweet potato milk candy, root crop confectionery product, citrus-flavored pastillas, <i>Ipomoea batatas</i>, confectionery, calamansi sweet product, fortified pastillas product, sweet potato dessert product		
Databases	Search String	Number of Hits

Espacenet	calamansi AND sweet potato	77 results
Espacenet	Calamansi zest	9 results
Google patent	"calamansi pastillas"	2 results
Google patent	(calamansi) and (sweet potato)	123 results
WIPO Patentscope	Pastillas calamansi	4 results
WIPO Patentscope	Sweet potato pastillas	0 results

Special Categories of Cited Documents:

- A** document defining the general state of the art which is not considered to be of particular relevance
- X** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone.
- Y** document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

DOCUMENTS CONSIDERED TO BE RELEVANT FOR INVENTION OR UTILITY MODEL

DOCUMENT 1

Patent Number/Title	PH22017000616U1 - PROCESS OF PRODUCING PASTILLAS FROM TURMERIC (Curcuma longa) AND CALAMANSI (Citrofortunella microcarpa)	
File/Document Type	UTILITY MODEL	
Filing Date	SEPTEMBER 13, 2017	
Inventors	GONZALES ROSELYN R. GONZALES GAMALIEL G. MONTE MARVEN G. PARAS GAY KAREL MAE L. UMPAD JUDY ANN G.	
Current Assignee	CEBU TECHNOLOGICAL UNIV DANA O CAMPUS [PH]	
Retrieved on	DECEMBER 15, 2017	
Category	Y	
Disclosure Elements		Prior Art Citations
This utility model discloses the composition of the sweet, yet healthy pastillas from turmeric (Curcuma longa) and calamansi (Citrofortunella microcarpa). It is usually consumed as a desert, or an alternative to a healthy snack. Composition includes honey, powdered milk, calamansi extract, boiled turmeric ginger, refined sugar (for coating) and water. Turmeric and calamansi are known for its health benefits, thereby promoting healthy diet, despite consuming desert or sweet food.		NONE

DOCUMENT 2

Patent Number/Title	RU2490926C1 - METHOD FOR PRODUCTION OF LAYERED FRUIT PASTILLE AND LAYERED FRUIT PASTILLE	
File/Document Type	UTILITY MODEL	
Filing Date	MARCH 28, 2012	
Inventors	ZHELNAKOV VIKTOR VASIL EVICH; SAAKJAN SAAK ARTJUSHOVICH	
Current Assignee	(INDIVIDUAL)	
Retrieved on	AUGUST 27, 2013	
Category	A	
Disclosure Elements	Prior Art Citations	
FIELD: food industry.SUBSTANCE: invention relates to the field of industrial-scale production of confectionery products. The method for production of layered fruit pastille includes apple fruits sorting and calibration, removal of mechanical impurities, cleaned fruits washing and baking on pans, baked fruits straining to produce puree, pastille mass preparation by way of beating up cooled puree with addition of sugar sand and/or sugar powder and egg albumen thereto, pastille mass pouring or laying out for drying, drying, slightly dried stratum cooling, formation of a twisted roll or a pie consisting of at least two layers with the adjacent strata of the roll or pie smeared with a filler, maintenance for impregnation with natural cooling, cutting to size, sprinkling with sugar powder and packaging for further storage and/or marketing. Apple fruits of sour varieties are used in the method. Fruits washing is performed in running water after preliminary soaking for 10-15 minutes. Then apples are laid onto baking pans with baking performed in a convective oven with forced circulation of hot air at a temperature of 190-260°C during 60-90 min. One performs forced cooling of naked fruits to a temperature of 2-7°C. Then one identifies a portion for further processing; straining is performed on sieves with mesh size equal to 1.25-2.25 mm. Pastille mass drying is performed at a temperature of 65-85°C during 20-40 hours. Further cooling of slightly dried strata is performed to a temperature of 18-30°C, with further maintenance of the pie (roll) performed at a temperature of 18-30°C during 18-30 hours. Layered fruit pastille is produced by this method.EFFECT: invention is aimed at creation of an industrial technology for production of layered pastille with improved taste indicators and extended storage life of natural products based on a traditional recipe; labour performance increase, reduction of labour manual component, increase of ready product yield, improvement and stabilisation of its quality and appearance.9 cl, 1 dwg, 2 ex		NONE

DOCUMENT 3

Patent Number/Title	PH2/2017/000605 - PASTILLAS FROM TURMERIC (CURCUMA LONGA) AND CALAMANSI (CITROFORTUNELLA MICROCARPA)	
File/Document Type	UTILITY MODEL	
Filing Date	SEPTEMBER 13, 2017	
Inventors	COSTAN, EMILY C. GONZALES, GAMALIEL G. GONZALES, ROSELYN R. ISIDTO, RENEEMAE DIANNE C. MATUGAS, KIMBERLY JAEN R.	
Current Assignee	CEBU TECHNOLOGICAL UNIVERSITY-DANAO CAMPUS	
Retrieved on	MAY 25, 2018	
Category	Y	
Disclosure Elements	Prior Art Citations	
This utility model discloses the composition of the sweet, yet healthy pastillas from turmeric (Curcuma longa) and calamansi (Citrofortunella microcarpa). It is usually consumed as a desert, or an alternative to a healthy snack. Composition includes honey, powdered milk, calamansi extract, boiled turmeric ginger, refined sugar (for coating) and water. Turmeric and calamansi are known for its health benefits, thereby promoting healthy diet, despite consuming desert or sweet food.		NONE

RECOMMENDATION:

The examiner further suggests the technology to be applied as a Utility Model due to its distinct formulation utilizing sweet potato and calamansi zest, as well as its potential industrial applicability as a value-added confectionery product.

Search and reviewed by:



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*Director, Innovations and
Technology Support Office*

Food Chemistry.