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ACCEPTABILITY OF ROOT CROP-JAMAICA CHERRY COOKIES

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Abstract: This study developed cookie with aratiles fruit filling, incorporating sweet potato, cassava, and taro flours as alternatives to wheat flour. The research aimed to evaluate the sensory qualities, consumer acceptability, and economic feasibility of these formulations while promoting the use of locally sourced ingredients. Specifically, the study assessed the appearance, aroma, taste, and texture, analyzed differences among treatments, and provided recommendations for future enhancements. An experimental research design to look into Jamaica cherry fruit filling in cookies made with different root crop flours, observing its effect on dependent variables design was used, formulating three cookie variations: sweet potato-based, cassava-based, and taro-based cookies. Sensory evaluation was conducted by semi-trained expert panelists, while general consumers participated in an acceptability test. Data were analyzed using statistical methods, and a cost analysis was performed to determine production feasibility. The findings revealed the differences in sensory qualities of cookies made with different root crop flours and Jamaica cherry fruit filling revealed significant variations in appearance, taste and texture. However, no significant difference was observed in aroma. Cassava and sweet potato flours enhanced the cookies' visual appeal and texture, while taro flour resulted in a denser and less desirable texture. The cassava-based cookies had the lowest production cost and highest profit margin, making them the most cost-efficient option. Shelf-life testing indicated that the cookies maintained their quality for several days before signs of spoilage appeared.Future research should enhance taro-based cookies' formulation, explore natural preservatives, enhance packaging, explore fruit-based fillings, and conduct nutritional profiling and consumer testing to boost commercial potential.

Keywords: Cookies, Jamaica Cherrt Fruit Filling, Root Crop Flour, Product Development

I. INTRODUCTION

Background of the Study

The increasing demand for healthier, gluten-free, and functional food products has prompted the food industry to seek innovative alternatives to traditional ingredients. This shift is driven by the rising prevalence of gluten intolerance and celiac disease, as well as a global trend toward health-conscious diets. Consequently, there's growing interest in using non-wheat flours and nutrient-rich fillings in baked goods.

In the Philippines, root crops like cassava and sweet potato are abundant, and indigenous fruits such as Jamaica cherry (Muntingia calabura) are widely available. However, these local, sustainable ingredients remain underutilized in mainstream food products. Cassava and sweet potato are often not maximized in commercial baked goods beyond traditional uses, and Jamaica cherry, despite its nutritional value, is largely untapped in processed forms like cookie fillings.

The heavy reliance on wheat flour in the baking industry poses challenges for individuals with gluten intolerance or celiac disease, as wheat-based products dominate the market, leaving limited options for those with dietary restrictions. Additionally, traditional cookie fillings tend to be high in sugar and processed ingredients, misaligning with the increasing demand for healthier alternatives.

A promising solution involves utilizing varied root crop flours, such as cassava and sweet potato, combined with Jamaica cherry fruit filling to create gluten-free, nutritionally enhanced, and sustainable sandwich cookies. Replacing wheat flour with root crop flours caters to individuals with gluten intolerance and offers additional health benefits, including higher fiber content and essential vitamins. Incorporating Jamaica cherry as a natural filling addresses the issue of excessive sugar in traditional cookie fillings while adding antioxidant and anti-inflammatory properties to the final product.

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Moreover, using locally sourced root crops and indigenous fruits supports sustainable agriculture and reduces the carbon footprint associated with imported ingredients. It also encourages the integration of underutilized crops into mainstream food production, contributing to local food security and economic development. This innovative approach not only addresses the health and dietary needs of consumers but also aligns with broader goals of sustainability and local economic growth.

Objectives of the Study

1. Describe the sensory qualities of cookies formulated with Jamaica cherry fruit filling and root crop flours (cassava, sweet potato, taro) in terms of appearance, aroma, taste and texture;
2. Determine the acceptability of the cookies based on sensory qualities such as appearance, aroma, taste, and texture;
3. Determine if there is a significant difference in the sensory qualities of the root crop-Jamaica cherry cookies in terms of appearance, aroma, taste and texture among three treatments;
4. Determine if there is a significant difference in the general acceptability of root crop-Jamaica cherry cookies;
5. Submit the best product for microbial and proximate analysis; and
6. Determine the shelf life of the cookies made from root crop flours and Jamaica cherry fruit filling as an innovative food product in terms of room and chilling temperature.

II. METHODOLOGY

The research utilized a Completely Randomized Design (CRD) for the experimental setup, as described by Montgomery (2020). This design allowed for the random assignment of cookie samples featuring various formulations of root crop flours combined with Jamaica cherry fruit filling. By employing CRD, the study minimized potential sources of bias and ensured that each treatment had an equal chance of being evaluated under the same conditions. This approach enhanced the reliability of the comparisons made across the different formulations, particularly in assessing their sensory attributes. Sensory evaluations were conducted by semi-trained panellists, who assessed the acceptability of each cookie formulation based on key sensory attributes such as appearance, aroma, taste, and texture. The use of a randomized design enhanced the validity of the findings, as it controlled for extraneous variables that could have influenced the sensory evaluations. This method provided a structured approach to gather data, enabling the researcher to draw meaningful conclusions regarding the impact of Jamaica cherry fruit filling on the overall quality and consumer acceptability of the root crop–Jamaica cherry cookies.

Proportion of ingredients for cookies with Jamaica cherry fruit filling.

Ingredients	Treatment A	Treatment B	Treatment C
flour Cassava flour	100g	-	-
Sweet potato	-	100g	-
Taro flour	-	-	100g
Sugar	70g	70g	70g
Butter	75g	75g	75g
Egg	57g	57g	57g
Vanilla extract	5g	5g	5g
Jamaica cherry fruit filling	50g	50g	50g

Experimental Procedure

The procedure for this study involved several key steps to prepare the root crop – Jamaica cherry cookies.

Step 1. Preparation of Raw Materials. All ingredients for the root crop–Jamaica cherry cookies were carefully measured and prepared according to the formulations outlined in Table 1. Fresh Jamaica cherry fruits were harvested, ensuring that only ripe and high-quality fruit was selected. The harvested Jamaica cherry fruits were then processed to create the filling, which included washing, pitting, and mashing the fruit to achieve the desired consistency.

Step 2. Preparation of Root Crop Flour. Fresh and mature root crops—such as sweet potato, cassava, taro, and yam—were cleaned, peeled, and sliced into uniform pieces. Depending on the crop, some slices were blanched to

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reduce browning and microbial load. The slices were then dried at 60°C for 8 to 10 hours until brittle, ground into fine flour, and sieved through a 60-mesh screen for uniformity. The resulting flours were stored in airtight containers in a cool, dry place for later use in cookie formulation

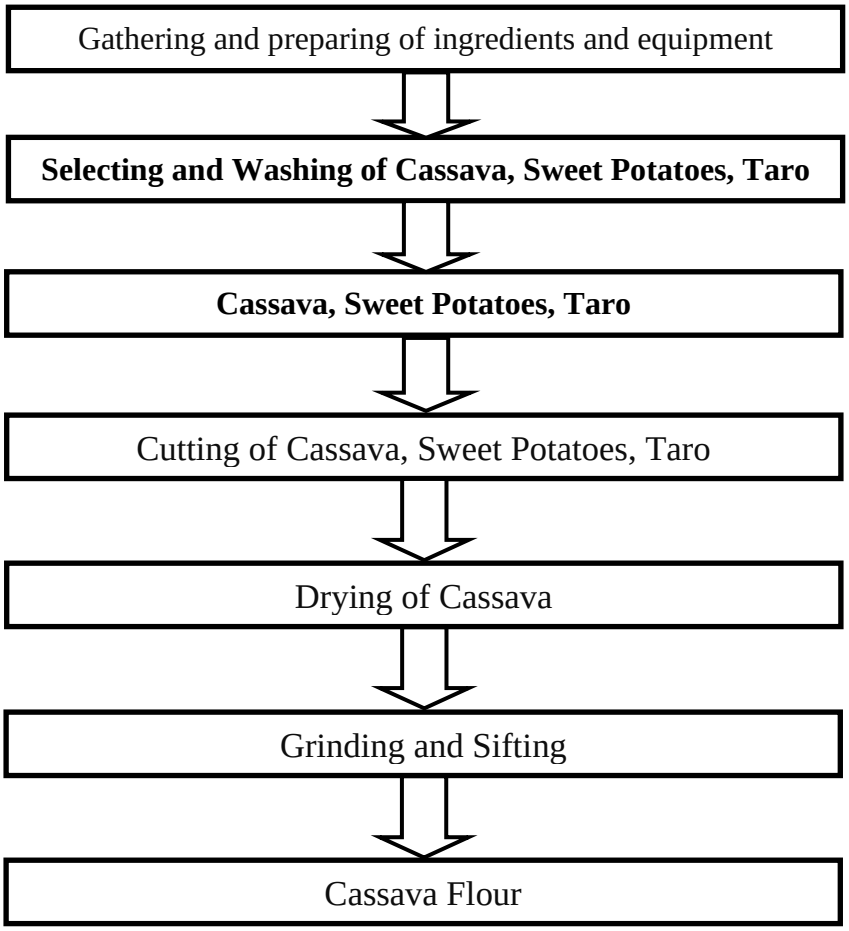

Figure 1. Flow chart of the process of making of varied root crop flours.

Step 3. Preparation of Jamaica Cherry Fruit Filling. The Jamaica cherry fruits were thoroughly washed to remove any dirt and impurities. After washing, the fruits were pitted to remove the seeds and then mashed until smooth. The mashed fruits were combined with sugar in a saucepan, and the mixture was cooked over low heat. This cooking process continued until the mixture thickened, which took approximately 30 minutes. Once thickened, the filling was set aside to cool, allowing the flavors to meld before it was used in cookie preparation.

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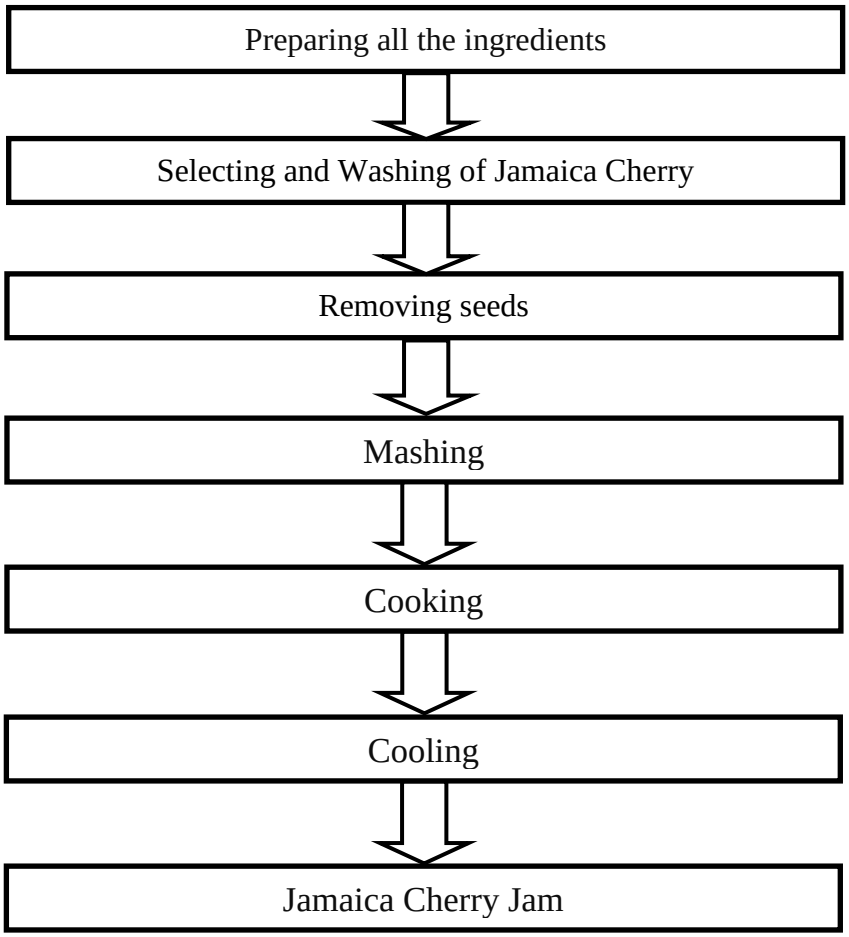

Figure 2. Flow chart showing the preparation of Jamaica Cherry Jam

Step 4. Preparation of Cookie Dough. In this step, flour and sugar were sifted into a mixing bowl to ensure even distribution of the dry ingredients. After achieving the desired consistency, eggs and vanilla extract were added to the mixture. The sifted dry ingredients were gradually mixed into the wet ingredients, forming a cohesive dough. This mixing process took approximately 15 minutes, resulting in a smooth cookie dough ready for shaping.

Step 5. Molding of Cookies. Small portions of the dough, each weighing about 20 grams, were rolled into balls and then flattened gently. These flattened dough pieces were arranged on a baking sheet. A spoonful of the prepared Jamaica cherry fruit filling was placed on top of half of the flattened dough circles. The remaining circles were then placed on top of the filled circles to form sandwiches. The cookies were baked in a preheated oven set at 180°C for 12 to 15 minutes, allowing them to rise and develop a golden-brown color.

Step 6. Cooling and Packaging. After baking, the cookies were removed from the oven and allowed to cool on a wire rack. This cooling process was essential to ensure the cookies set properly. Once cooled, the cookies were carefully packed in clean containers to maintain their freshness for sensory evaluation. These steps ensured that the cookies retained their quality and were ready for the next phase of the study.

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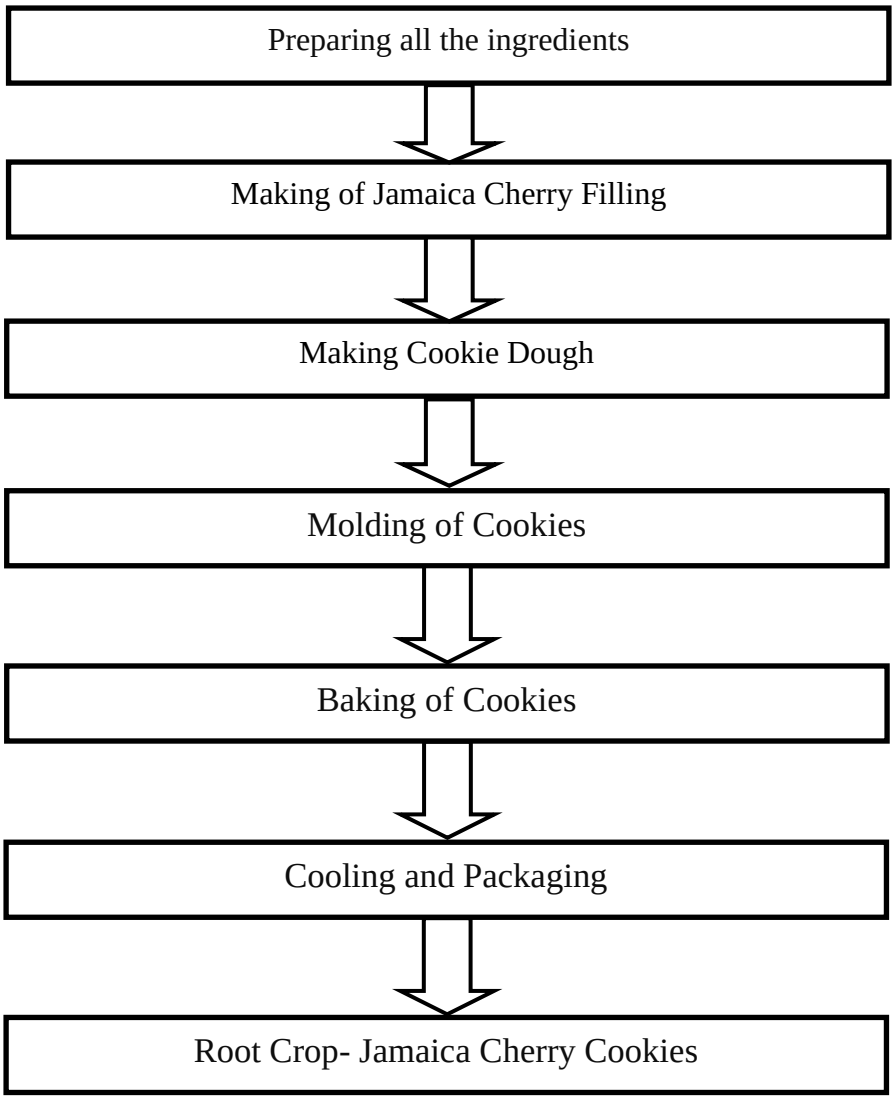

Figure 3. Flow chart showing the preparation of Root crop-Jamaica Cherry Cookies

Scoring of Variables

In scoring the variables, the researcher used the 9-point hedonic rating scale to rate the product. To have a better understanding of the result, the researcher gave the equivalent interpretation of each step in the scale. The categorizations of each variation were as follows:

Appearance

Score	Scoring Interval	Adjectival Description
9	8.12 – 9.00	Extremely Appealing
8	7.23 – 8.11	Very Much Appealing
7	6.34 – 7.22	Moderately Appealing
6	5.45 – 6.33	Slightly Appealing
5	4.56 – 5.44	Neither Appealing nor Unappealing
4	3.67 – 4.55	Slightly unappealing
3	2.78 – 3.66	Moderately unappealing
2	1.89 – 2.77	Very Much unappealing
1	1.00 – 1.88	Extremely Unappealing

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Aroma

Score	Scoring Interval	Adjectival Description
9	8.12 – 9.00	Extremely Pleasant
8	7.23 – 8.11	Very Much Pleasant
7	6.34 – 7.22	Moderately Pleasant
6	5.45 – 6.33	Slightly Pleasant
5	4.56 – 5.44	Neither Pleasant nor Unpleasant
4	3.67 – 4.55	Slightly Unpleasant
3	2.78 – 3.66	Moderately Unpleasant
2	1.89 – 2.77	Very Much Unpleasant
1	1.00 – 1.88	Extremely Unpleasant

Taste

Score	Scoring Interval	Adjectival Description
9	8.12 – 9.00	Extremely Delicious
8	7.23 – 8.11	Very Much Delicious
7	6.34 – 7.22	Moderately Delicious
6	5.45 – 6.33	Slightly Delicious
5	4.56 – 5.44	Neither Delicious nor Not Delicious
4	3.67 – 4.55	Slightly Not Delicious
3	2.78 – 3.66	Moderately Not Delicious
2	1.89 – 2.77	Very Much Not Delicious
1	1.00 – 1.88	Extremely Not Delicious

Texture

Score	Scoring Interval	Adjectival Description
9	8.12 – 9.00	Extremely crumbly
8	7.23 – 8.11	Very much crumbly
7	6.34 – 7.22	Moderately crumbly
6	5.45 – 6.33	Slightly crumbly
5	4.56 – 5.44	Neither crumbly nor Not crumbly
4	3.67 – 4.55	Slightly not crumbly
3	2.78 – 3.66	Moderately not crumbly
2	1.89 – 2.77	Very Much not crumbly
1	1.00 – 1.88	Extremely not crumbly

General Acceptability

Score	Scoring Interval	Adjectival Description
9	8.12 – 9.00	Liked Extremely
8	7.23 – 8.11	Liked Very Much
7	6.34 – 7.22	Liked Moderately
6	5.45 – 6.33	Liked Slightly
5	4.56 – 5.44	Neither Liked nor Disliked
4	3.67 – 4.55	Disliked Slightly
3	2.78 – 3.66	Disliked Moderately
2	1.89 – 2.77	Disliked Moderatelyp
1	1.00 – 1.88	Disliked Extremely

III. RESULTS AND DISCUSSION

Sensory Qualities of Cookies Formulated with Jamaica Cherry Fruit Filling and Root Crop Flours (Cassava, Sweet Potato, Taro)

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The sensory evaluation of brown rice chips infused with varying amounts of herbs (basil, onion leaves, and parsley) was The study evaluated the sensory qualities of cookies formulated with Jamaica cherry fruit filling and various root crop flours—cassava (Treatment A), sweet potato (Treatment B), and taro (Treatment C). Treatment A (cassava) achieved the highest mean scores across all sensory attributes, followed closely by Treatment B (sweet potato), while Treatment C (taro) received the lowest scores.

In terms of appearance, Treatment A scored 8.70, categorized as "Extremely Appealing," Treatment B scored 8.60 ("Extremely Appealing"), and Treatment C scored 7.90 ("Very Much Appealing"). For aroma, Treatments A and B scored 8.50 and 8.40 respectively, both classified as "Extremely Pleasant," whereas Treatment C scored 8.10 ("Very Much Pleasant"). Taste evaluations showed that Treatments A and B received scores of 8.70 and 8.60, both deemed "Extremely Delicious," while Treatment C scored 7.60 ("Very Much Delicious"). Regarding texture, Treatments A and B were rated as "Extremely Crumbly" with scores of 8.70 and 8.60, respectively, and Treatment C scored 7.80 ("Very Much Crumbly"). Overall sensory quality scores were highest for Treatment A (8.65), followed by Treatment B (8.55), and lowest for Treatment C (7.85).

These findings suggest that incorporating cassava and sweet potato flours into cookie formulations enhances consumer acceptability due to superior sensory attributes. The inclusion of Jamaica cherry fruit filling may have contributed to the pleasant aroma and enhanced taste of the cookies. Previous studies support these results; for instance, research has shown that fruit-based fillings improve the overall sensory profile of baked goods, and cassava and sweet potato-based baked products are favored for their natural sweetness, fine texture, and appealing color. The lower acceptability of taro-based cookies in Treatment C could be attributed to the inherent starch composition and texture of taro, which may result in a denser and less appealing cookie.

Table 3. Sensory qualities of cookie formulated with Jamaica cherry fruit filling and root crop flours (cassava, sweet potato, taro) in terms of aroma, appearance, taste and texture.

Quality Attributes	Treatment A (cassava)		Treatment B (sweet potato)		Treatment C (taro)	
	Mean	AD	Mean	AD	Mean	AD
Appearance	8.70	EA	8.60	EA	7.90	VMA
Aroma	8.50	EP	8.40	EP	8.10	VMP
Taste	8.70	ED	8.60	ED	7.60	VMD
Texture	8.70	EC	8.60	EC	7.80	VMC
Sensory Qualities	**8.65**	**EAc**	**8.55**	**EAc**	**7.85**	VMAc

Acceptability of the Root Crop
-Jamaica Cherry Cookies Based on Sensory Qualities such as Appearance, Taste, Aroma, and Texture

The sensory evaluation of cookies formulated with different treatments was conducted to assess their acceptability based on appearance, aroma, taste, and texture. The results revealed that Treatment B (sweet potato) received the highest mean scores across most attributes, followed closely by Treatment A (cassava), while Treatment C (taro) had the lowest ratings. In terms of appearance, Treatments A and B were rated as liked “Extremely Appealing, with scores of 8.50 and 8.60, respectively. Treatment C (taro), on the other hand, scored 7.93, which was classified as "Very Much Appealing" (VMA). Aroma evaluation showed that Treatment B (sweet potato) achieved the highest score of 8.63, categorized as "Liked Extremely Pleasant", (LE) while Treatment A (cassava) followed with 8.17, and Treatment C (taro) received a score of 7.83, considered as "Liked Very Much” (LVM)

As to taste, Treatment B (sweet potato) was rated the highest, with a mean score of 8.50, categorized as "Liked Extremely "(LE), followed by Treatment A (cassava) with 8.17 (ED). Treatment C (taro) scored 7.30, which was classified as "Very Much Delicious" (VM). Texture results indicated that Treatment B (sweet potato) was rated as "Extremely Crumbly" (LE) with a score of 8.10, while Treatment A (cassava) and Treatment C (taro) were both classified as "Liked Very Much “ (LVM), with scores of 7.70 and 7.90, respectively. In terms of general acceptability, Treatment B (sweet potato) attained the highest mean score of 8.46, categorized as "Liked Extremely Acceptable (LE), followed by Treatment A (cassava) with a score of 8.13 (LEA).

Meanwhile, Treatment C (taro), which scored 7.74, was classified as "Liked Very Much Acceptable" (LVM).The findings imply that optimizing ingredient composition in cookies formulations can significantly enhance

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sensory appeal and overall acceptability. The superior ratings of Treatment B (sweet potato) suggest that its formulation could be a promising option for commercial production or further product development. Furthermore, the findings suggest that the formulation used in Treatment B (sweet potato) resulted in the most favorable sensory qualities, particularly in terms of taste, aroma, and general acceptability. The high ratings in Treatment B (sweet potato) may be attributed to a well-balanced composition of ingredients, leading to enhanced flavor, appealing appearance, and desirable texture. Meanwhile, the lower acceptability of Treatment C (taro) indicates that the formulation used may have resulted in less desirable sensory characteristics, possibly due to variations in flour type or texture properties. Moreover, the results suggest that proper formulation and ingredient balance are crucial for developing cookie with high consumer acceptability.

The superior performance of Treatment B (sweet potato) indicates that a well-balanced combination of root crop flours and Jamaica cherry fruit filling can produce a product that is both nutritious and sensory-pleasing.

From a market perspective, the findings imply that Treatment B (sweet potato) could be a viable option for commercial production, particularly in the functional food sector, where consumers seek nutritious yet appealing snack options. Moreover, improving the formulation of Treatment C (taro) by adjusting ingredient ratios or modifying processing techniques could enhance its sensory qualities and overall acceptability, making it a more competitive product.

Additionally, the superior acceptability of Treatment B (sweet potato), which had the highest scores in appearance, aroma, taste, texture, and general acceptability, infers that its formulation provided an optimal balance of flavor and texture.

The results were consistent with previous studies. Hernandez et al. (2018), Mashayekh et al. (2019), and Olatunde et al. (2019) found that ingredient selection and formulation significantly impact consumer perception of baked products. Incorporating cassava and sweet potato flours enhances sensory appeal due to their naturally sweet taste and fine texture. The type and concentration of fruit influence overall sensory characteristics, as higher moisture content from fruit-based components can affect cookie texture

The results also supported the notion of Adebayo-Oyetoro et al. (2017), Adeola and Ohizua (2018), and Olatunde et al. (2019) that alternative flours can be successfully incorporated into bakery products without compromising quality when properly optimized. Cassava flour contributes to a desirable crispiness in baked goods, while sweet potato flour enhances natural sweetness and moisture retention, leading to better mouthfeel and flavor perception.

Ingredient selection, particularly the combination of root crop flours and fruit-based fillings, significantly impacts the sensory attributes of baked products, influencing consumer preference and acceptability. Taro flour, while nutritious, can contribute to a slightly earthy aftertaste and firmer texture, which might not be as well-received by consumers when used in high proportions.

Table 4. Acceptability of the cookies based on sensory qualities appearance, taste, aroma, and texture.

Quality Attributes	Treatment A (cassava)		Treatment B (sweet potato)		Treatment C (taro)	
	Mean	**AD**	**Mean**	**AD**	**Mean**	**AD**
Appearance	8.50	LE	8.60	LE	7.93	LVM
Aroma	8.17	LE	8.63	LE	7.83	LVM
Taste	8.17	LE	8.50	LE	7.30	LVM
Texture	7.70	LVM	8.10	LE	7.90	LVM
General Acceptability	**8.13**	**LEA**	**8.46**	**LEA**	**7.74**	**LVM**

Differences in Root Crop- Jamaica Cherry Cookies Fruit Filling

The statistical analysis of the sensory qualities of cookies formulated with different root crop flours (cassava, sweet potato, and taro) and Jamaica cherry fruit filling revealed significant differences in appearance, taste, and texture, while aroma differences were not statistically significant. The appearance ($z = 9.49$, $p = 0.009$), taste ($z = 14.58$, $p = 0.001$), and texture ($z = 9.81$, $p = 0.007$) showed significant differences, indicating that the type of root crop flour influenced these attributes. However, aroma ($z = 1.83$, $p = 0.401$) was not significantly different, indicating that the fruit filling likely contributed to a consistent aromatic profile across treatments. Taste differences were also highly significant ($p = 0.001$), suggesting that root crop flour selection significantly affects flavor perception. For texture, the significant variation ($p = 0.007$) indicates that the flour type influenced crispiness, smoothness, and mouthfeel.

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The null hypothesis stated that there were no significant differences in the sensory qualities of root crop–Jamaica cherry cookies made from cassava, sweet potato, and taro. However, results showed that the type of root crop used significantly influenced the cookies' appearance, taste, and texture, leading to the rejection of the null hypothesis for these attributes. Aroma was the only sensory quality where no significant difference was found. Pairwise comparisons revealed that taro-based cookies differed notably in appearance and aroma from the others. Overall, the findings indicated that the choice of root crop had a considerable impact on the sensory qualities of the cookies

The results imply the importance of selecting the appropriate root crop flour to achieve desirable sensory qualities in cookie. The significant differences in appearance, taste, and texture show that sweet potato and cassava flours may be more suitable for producing visually appealing, flavorful, and well-textured cookies. In contrast, taro flour might require formulation adjustments to enhance its sensory appeal. From a product development perspective, the findings also indicate that food manufacturers should optimize the ratio of root crop flours to achieve a balance between nutritional benefits and consumer acceptability. Additionally, non-significant differences in aroma indicates that the fruit filling played a dominant role in aromatic properties, which may allow for greater flexibility in flour selection without compromising this attribute. Since appearance, taste, and texture were significantly affected by the flour type, cassava and sweet potato flours are recommended for producing visually appealing, flavorful, and well-textured cookies. Taro flour, while nutritious, may require modifications, such as blending with other flours or adding sweeteners, to improve sensory acceptability. As aroma differences were not significant, manufacturers can confidently experiment with different flour combinations without negatively impacting aroma, as long as the fruit filling remains a consistent ingredient. This gives food developers more flexibility in formulation without compromising sensory appeal.

The result further imply that the Jamaica cherry fruit filling played a dominant role in determining aroma perception, overriding any differences caused by the root crop flours. Bakers and product developers can use different root crop flours without affecting the overall aroma, making formulation choices more flexible. Also, sweet potato and cassava flours enhance the sensory appeal of baked goods, making them more marketable for commercial production. While taro flour offers potential health benefits, it may require adjustments in formulation to improve overall acceptability. The findings also offer practical guidance for food manufacturers seeking to develop alternative flour-based products that meet consumer expectations while promoting sustainable, locally sourced ingredients.

The results aligned with findings from previous studies. Hernandez et al. (2018) found that different flour compositions impact the color, surface texture, and uniformity of baked goods. The type of flour used in baked goods significantly influences color, surface smoothness, and uniformity. Adebayo-Oyetoro et al. (2017) affirmed that sweet potato and cassava flours are known to produce lighter and more uniform baked products, whereas taro flour can result in darker hues and rougher textures due to its higher fiber content. High fiber content can reduce crispiness and increase chewiness, which may explain why cookies with taro flour scored lower in texture. According to Adeola and Ohizua (2018) cassava and sweet potato flours contain natural sugars that enhance sweetness, whereas taro flour has a more neutral or slightly earthy taste, which might explain its lower acceptability.

Moreover, Mashayekh et al. (2019) also asserted that the influence of Jamaica cherry fruit filling should also be considered, as fruit-based fillings contribute acidity and sweetness, potentially masking the more neutral taste of taro-based formulations. They found that fruit-based ingredients significantly influence the aroma of baked products, often masking the effects of different flour variations. According to Olatunde et al. (2019), cassava and sweet potato flours have been reported to create lighter and crispier textures, while taro flour contributes to a denser consistency due to its higher starch and fiber content. Fiber and starch composition influence texture in baked goods. Sweet potato and cassava flours are known to produce lighter and crispier textures, while taro flour, due to its higher fiber content, results in a denser and slightly chewier texture.

Table 5. Differences in the sensory qualities of the root crop–Jamaica cherry cookies

Quality Attributes		Z	p value	Remarks
Sensory Qualities	Appearance	9.49	0.009	s
	Aroma	1.83	0.401	ns
	Taste	14.58	0.001	s
	Texture	9.81	0.007	s

Legend: 0.01 = Level of Significance; s = significant; ns=not significant

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Differences in the General Acceptability of Root Crop-Jamaica Cherry Cookies

The general acceptability of cookies made from different root crop flours (cassava, sweet potato, and taro) combined with Jamaica cherry fruit filling was evaluated based on appearance, aroma, taste, and texture, as shown in Table 6. The results revealed significant differences in appearance, aroma, and taste, whereas texture differences were not statistically significant.

The study found a significant difference in the appearance of the cookies ($F = 9.226$, $p = 0.000$), indicating that the type of root crop flour significantly influenced the visual appeal of the cookies. The post-hoc comparison showed that Treatment A (cassava) (cassava) and Treatment B (sweet potato) (sweet potato) did not significantly differ ($p = 0.822$), but both were significantly different from Treatment C (taro) (taro) ($p = 0.003$ and $p = 0.000$), respectively.

Aroma was also significantly different among the treatments ($F = 8.216$, $p = 0.001$). Post-hoc analysis showed that Treatment A (cassava) (cassava) and Treatment B (sweet potato) (sweet potato) were not significantly different ($p = 0.197$), but both differed significantly from Treatment C (taro) (taro) ($p = 0.000$).

The study found no significant differences in texture among the treatments ($F = 2.019$, $p = 0.139$), suggesting that the type of flour did not heavily influence the mouthfeel and consistency of the sandwich cookies. The fiber and starch composition of all three root crop flours might have produced similar levels of firmness and crispness, leading to no major textural differences.

Taste exhibited the most significant variation ($F = 20.878$, $p = 0.000$), suggesting that the root crop flour had a direct impact on flavor perception. Post-hoc tests revealed that Treatment B (sweet potato) (sweet potato) and Treatment C (taro) (taro) differed significantly ($p = 0.000$), but cassava-based cookies (Treatment A (cassava)) were not significantly different from either ($p = 0.054$ and $p = 0.218$). The result showed that cassava and sweet potato flours produced more acceptable cookies in terms of appearance, aroma, and taste, while taro-based cookies were rated lower in acceptability due to color inconsistencies, earthy aroma, and reduced sweetness. Texture remained consistent across all treatments, suggesting flexibility in flour selection for this attribute.

The null hypothesis stated that there were no significant differences in the general acceptability of root crop–Jamaica cherry cookies in terms of appearance, aroma, taste, and texture. However, the analysis showed significant differences in appearance, aroma, and taste, indicating that the type of root crop used cassava, sweet potato, or taro had a notable impact on these attributes. The null hypothesis was accepted for texture, suggesting no significant variation in this quality among the different treatments. Overall, the findings revealed that the choice of root crop influenced most aspects of general acceptability, except for texture.

The results imply that cassava and sweet potato flours produced a more visually appealing cookie, while taro flour resulted in a less desirable appearance, likely due to its denser texture and darker color. Taro flour altered the aromatic properties of the cookies, likely due to its earthier, starch-heavy profile. Sweet potato enhanced sweetness, whereas taro reduced flavor acceptability due to its denser texture and slightly bland taste. Since appearance, aroma, and taste were significantly affected, cassava and sweet potato flours are better suited for producing highly acceptable cookies, while taro flour may require modifications (e.g., blending with other flours or sweeteners) to improve acceptability. Given the higher general acceptability of cassava and sweet potato-based cookies, these formulations have greater commercial potential.

Moreover, since texture differences were not significant, product developers have more flexibility in choosing root crop flours based on availability and nutritional benefits without compromising mouthfeel. This allows for cost-effective and innovative formulations in the baking industry. Future studies should explore nutritional composition, shelf stability, and consumer acceptability among different demographics. Additionally, sensory tests incorporating different ratios of flour combinations could help optimize product formulations for a wider market appeal.

The results agreed to what Hernandez et al. (2018) posited that cassava and sweet potato flours provide a lighter, more uniform color when baked, whereas taro flour often results in darker, uneven coloration due to its higher fiber and anthocyanin content. This validates the findings, indicating that cassava and sweet potato are better suited for achieving consumer-preferred appearance in baked products. According to Adeola and Ohizua (2018), sweet potato flour naturally enhances sweetness due to its higher sugar content, whereas cassava provides a neutral taste, allowing other ingredients to dominate. Taro, on the other hand, contains higher fiber and complex starches, which can slightly mask flavors and affect the final taste. These findings validate the study results, reinforcing that sweet potato flour is the most favorable in terms of taste enhancement.

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The results also supported the study of Mashayekh et al. (2019) that sweet potato and cassava flours contribute a mildly sweet and neutral aroma, while taro-based products often retain an earthy, slightly nutty scent. This validation confirmed that cassava and sweet potato flours enhance the overall aroma acceptability, making them preferable for use in cookie formulations. Olatunde et al. (2019) found that cassava, sweet potato, and taro flours all have comparable gelatinization properties, contributing to similar textural outcomes in baked products. This validation implies that all three root crops can be used interchangeably in formulations where texture is the primary concern. Studies by Falade and Christopher (2018), Ayo and Okaka (2020), and Bello et al. (2017) confirmed that alternative flour sources significantly impact sensory qualities, especially in appearance and taste. These findings suggest that root crop-based cookies, especially those using sweet potato and cassava, have the potential for wider consumer acceptance due to their desirable sensory properties.

Table 6. Difference in general acceptability of root crop-Jamaica cherry cookies.

Quality Attributes	SV	SS	Df	MS	F	P value	Remarks
Appearance	Between	7.756	2	3.878	9.226	0.000	s
	Within	36.567	87	.420			
	Total	44.322	89				
Aroma	Between	9.689	2	4.844	8.216	0.001	s
	Within	51.300	87	.590			
	Total	60.989	89				
Taste	Between	23.022	2	11.511	20.878	0.000	s
	Within	47.967	87	.551			
	Total	70.989	89				
Texture	Between	2.400	2	1.200	2.019	.139	ns
	Within	51.700	87	.594			
	Total	54.100	89				
General Acceptability	Between	25.980	2	12.990	26.536	0.00	s
	Total						
	Within Groups	145.390	297	0.490			
	Total	171.370	299				

Legend: 0.01 = Level of Significance; s = significant; ns=not significan

Microbial Analysis of Root Crop-Jamaica Cherry Cookies

The microbial analysis of the root crop-Jamaica cookies was conducted according to the criteria established by the Negros Prawn Producers Cooperative (NPPC) Analytical and Diagnostic Laboratory in Bacolod City and was compared with the Food and Drug Administration (FDA) approved standards for bread and pastries. The results confirmed that the bread met the safety standards, demonstrating proper hygiene, preparation, and handling procedure.

The aerobic plate count, which measures the total number of viable bacteria present, was recorded at less than 90 colony-forming units per gram (cfu/g). This was below the FDA approved limit of 10^3 cfu/g, confirming that the cookies were free from excessive bacterial contamination and safe for consumption. The 200g sample did not have a total coliform count, indicating that the cookies did not contain any coliform germs. The FDA states that coliform counts must be less than 10^2 cfu/g in order to be deemed safe. The sample's lack of coliform bacteria indicates that the water quality, food handling procedures, and raw materials all followed stringent sanitary regulations.

For salmonella test, there were no bacteria found in 25g of the root crop-Jamaica cherry cookies sample. This was in line with the FDA and NPPC requirements that salmonella be totally absent. This demonstrates that the cookies were devoid of this dangerous virus, proving that the right ingredients were chosen and that food safety procedures were followed.

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The yeast count was less than 10 cfu/g, which was significantly lower than the Food and Drug Administration (FDA) limit of 10^3 cfu/g. This suggests that the bread had minimal yeast contamination, reflecting good manufacturing practices and proper storage conditions. The mold count of 20 CFU/g was also considered low but should still be monitored. The absence of mold in the tested sample suggests that the bread was prepared and stored in an environment that prevented fungal contamination, reducing the risk of spoilage.

The results demonstrated that the root crop-Jamaica cherry cookies met all the microbiological standards required for bread and pastries under both NPPC and FDA regulations. The low microbial count suggests that the product was manufactured under hygienic conditions, used high-quality ingredients, and followed appropriate storage and packaging methods. These findings confirm that root crop-Jamaica cherry cookies can be used safely in bread-making without compromising food safety, provided that proper handling practices are maintained.

Table 7. Microbial analysis of root crop-Jamaica cherry cookies.

Sample Description	Parameter	DOST Result	FDA M	M
Root Crop-Jamaica Cherry Cookies 200g	Aerobic Plate Count (Petrifilm)	< 90 cfu/g sample	<10	10^3
	Total Coliform Count (3M Petrifilm)	< Not Detected at 10^1 cfu/g sample	<10	10^2
	Salmonella Count (Compact Dry Media)	<Absent in 25 grams cfu/g sample	Not Detected/ Absence	Not Detected/ Absence
	Yeast Count	<10 cfu/g sample	<10	10^3
	Mold Count	< 20 cfu/g sample	$<10^2$	10^3

Proximate Analysis of Root Crop-Jamaica Cherry Cookies

Table 10 shows the report of proximate analysis of root crop-Jamaica cherry cookies samples conducted by the Negros Prawn Producers Cooperative (NPPC) Analytical and Diagnostic Laboratory, Bacolod City with reference No. 25-84515, March 13, 2025 and was analyzed from March 21, 2025 to March 29, 2025 as attached in Appendix J.

The root crop-Jamaica cherry cookies with 200-gram sample in a resealable plastic container was subjected to moisture, protein, total fat content, carbohydrate, fiber and calories; moisture by gravimetric oven drying at 105°c; official methods of analysis of AOAC International (2019) 21st Ed. Official Method 925.10; crude protein by Kjeldahl Block Digestion Method and Steam Distillation.

For total fat by Soxhlet Method using Petroleum Ether with Acid Hydrolysis. Carbohydrate was computed by difference, (100-sum of moisture, ash, protein & fat); official methods of analysis of AOAC International (2019) 21st Ed. The total fat content obtained the result of 20.14. The value indicates the amount of fat present in the product, which implies that root crop-Jamaica cherry cookies had moderately high fat content while carbohydrates contained 52.9 grams per 200 grams represented the combined amount of moisture by oven method; official methods of analysis of AOAC International (2019) 21st Ed.; official method 925.10.

For ash by gravimetric method was official methods of analysis of AOAC International (2019) 21st Ed..; official method 923.03; for crude protein by Kjeldahl Block Digestion Method and Steam Distillation; for total fat by Soxhlet Method using Petroleum Ether with Acid Hydrolysis; for carbohydrate is computed by difference (100-sum of moisture, ash, protein and fat) was official methods of analysis of AOAC International (2019) 21st Ed., official method 986.25E; and for energy in kilocalories per 100 grams was the sum of protein, fat and carbohydrate multiplied by the general Atwater factors 4-9-4, respectively.

As shown in the result, root crop-Jamaica cookies had the moisture content of 5.75g/100g, crude protein of 1.61g/200g, total fat content of 20.14g/200g, carbohydrate of 52.9g/200g, fiber content of 3.26g/200g, and calories of 998 kcal/200g.

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The result given in the report were those obtained at the time of examination and referred only to the particular sample submitted.Conferring to the study of Majzoobi et al. (2016), incorporating by-products is a method to enhance the quality of gluten-free products, as these by-products served as a cost-effective source of functional components that may have abundant amounts of vitamins, antioxidants, protein, and dietary fiber.

Table 8. Proximate analysis of root crop-Jamaica cherry cookies.

Sample Description	Parameter	Result g/100mL
250g sample in a plastic food container labeled as: **Jamaica Cherry Cookie made of Sweet Potato Flour**	Fat	20.14g/200g
	Carbohydrate	52.9g/200g
	Moisture	5.75g/200g
	Fiber	3.26g/200g
	Protein	1.61g/200g
	Calories	998 kcal/200g

Shelf Life of the Cookies when Stored in Room and Chilling Temperature

The shelf life of the cookies is shown in Table 8. The shelf life was determined in terms of room temperature and chilling temperature. Results revealed that when the cupcake were stored at room temperature where the product was away from sunlight, with free passage of air, dry, normally lighted room, and covered with a screen for three days, on the first and second day, no changes occurred as to physical characteristics, indicating that its nutrients were intact. But on the third and fourth day, the product started to change its color, the molds developed and an unpleasant smell developed. The freshness of the product in general was lost.

Table 9. Shelf Life of the cookies when stored in room and chilling temperature.

	1 day (molds formation)	2 days (molds formation, slimy)	3-4days (molds formation, slimy, production of spot)
Room Temperature Cookies	-	-	-
Chilling Temperature Cookies	-	2 weeks -	After 2 weeks -

Legend: Negative (-) no mold formation Positive (+) mold formation is observed

IV. CONCLUSIONS

Based on the results and findings of the study, the following conclusions were drawn:

The cassava and sweet potato flours provide superior sensory characteristics, particularly in appearance, aroma, taste, and texture. Additionally, the Jamaica cherry fruit filling enhanced the cookies' aroma and taste, further contributing to their overall acceptability.

The sweet potato flour contributes to an optimal balance of flavor and texture, making it an excellent choice for cookie formulations. The results highlight the importance of ingredient selection in baked product development, as different root crop flours significantly influence consumer perception and preference.

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The type of root crop flour plays a crucial role in determining the cookies' visual appeal and mouthfeel, while the Jamaica cherry fruit filling provides a uniform aromatic profile across all treatments. Cassava and sweet potato flours create more desirable textures, while taro flour may require formulation adjustments to improve its sensory properties.

Cassava and sweet potato flours are more suitable for producing appealing and flavorful cookies, while taro flour may benefit from modifications such as blending with other flours or adding sweeteners to enhance its acceptability.

The based on the microbial and proximate analyses, the potential of root crop-based cookies for commercial production offers a safe and nutritious alternative to conventional baked goods.

The shelf life assessment highlights the importance of proper packaging and storage conditions in maintaining product quality .

Sweet potato-based cookies are the most suitable for commercial production, while cassava-based cookies also offer strong sensory appeal.

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