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Research Article

Assessing the sensory qualities and acceptability of sweet potato (*Ipomoea batatas*) and purple yam (*Dioscorea alata*) cookies: Opportunities for livelihood development

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Abstract

Malnutrition is a persistent challenge in the Philippines, with communities facing both nutrient deficiencies and overnutrition. Utilizing nutrient-rich root crops like sweet potato (*Ipomoea batatas*) and purple yam (*Dioscorea alata*) offers a practical approach to improving dietary intake and addressing these issues.This study evaluates the sensory qualities and acceptability of cookies made from sweet potato and purple yam as healthful snack options and potential sources of livelihood. To explore their integration into daily diets, three cookie formulations with varying proportions of these root crops were developed and assessed using a descriptive-quantitative approach. Sensory evaluation, employing a modified 5-point Likert scale, was conducted among faculty, bakers, and students at Cebu Technological University, Carmen Campus, and local bakeries.Statistical analysis revealed significant differences in sensory attributes. For appearance, the F-value was 23.02, showing notable differences between formulations, particularly F1 and F2. Aroma and texture were also significant (F-values: 37.38 and 42.07), with F2 consistently outperforming other groups. Sweetness exhibited the most variability (F-value: 162.62), reflecting clear preferences for the balanced formulation. Cookies with equal parts sweet potato and purple yam (F2) were significantly preferred for appearance, aroma, taste, sweetness, and texture. This success highlights the role of sensory evaluation in food development and the potential for local ingredients to enhance product appeal and support community income, addressing malnutrition and food security.

Keywords: Food product development, Malnutrition, Purple yam cookies, Sensory evaluation, Sweet potato cookies

INTRODUCTION

Public health is fundamental to the advancement and well-being of a nation. Healthy populations are more productive and better able to contribute to the workforce, enhancing economic growth and development. Human resource development, social stability, security, education, and productivity are all significantly impacted by good public health conditions (Satar *et al*., 2023). Basic health problems related to food consumption include malnutrition, which involves both undernutrition and overnutrition and chronic conditions such as diabetes, which is often influenced by dietary habits and excessive sugar intake (Lochs *et al.,* 2006).

The World Health Organization (2024) defines malnutrition as excesses, imbalances, or shortages in an individual's energy and/or nutrient consumption. Undernutrition, which includes wasting (low weight for height), stunting, and underweight, micronutrient-related malnutrition (a lack of essential minerals and vitamins), and overweight, obesity, and diet-related non-communicable diseases (such as heart disease, stroke, diabetes, and certain types of cancer) are the three main categories of conditions that fall under the umbrella term of malnutrition.

Malnutrition is still prevalent in the Philippines and has become a common hindrance for children. According to the United Nations Children's Fund (UNICEF, 2023), 95 children in the Philippines die from starvation daily. Furthermore, 27 Filipino children out of every 1,000 do not survive until their fifth birthday. One-third of Filipino children are stunted, indicating they are underweight for their age. Data from the Department of Education (2019) highlights the extent of the problem, reporting that 1,836,793 kindergarten to sixth-grade students were undernourished.The World Health Organization

(2024) underscores the importance of shifting from isolated interventions to integrated food system solutions. Their reports suggest transformative pathways that directly address the challenges posed by major drivers of malnutrition. These pathways emphasize the need for comprehensive investment strategies and policies to transform food systems, ensuring food security, improved nutrition, and access to affordable, healthy diets.

Root crops are a significant component of the Philippine agricultural landscape. Among the most prominent are sweet potatoes and purple yams. These crops are valued for their adaptability to local soil and climate conditions and versatility in various culinary applications (Octavio *et al.,* 2024). According to Padmaja (2009), Due to its starch roots, which can serve as a source of energy and nutrition, sweet potatoes (*Ipomoea batatas Lam.*) are grown extensively throughout the world's tropical and warm temperate zones. This edible tuberous root can be spherical, ovoid, or long and tapering. Its flesh can be white, pale cream, orange, or purple, while its skin can be brown, purple, or red. The green tops of the plant, which provide a concentrated source of numerous vital vitamins and minerals, are also highly prized. Despite its nutritional value, sweet potato remains underutilized in the Philippines, as noted by Gonzales et al. (2016). Alam (2021) further highlights the numerous health benefits of sweet potato, including its antioxidant properties and its roles in cardioprotection, anti-inflammation, anti-cancer, anti-diabetes, antimicrobial action, anti-obesity, and the prevention of vitamin A malnutrition through the consumption of different parts of the plant.

Purple yams, or "ube", are another essential root crop in the Philippines. They are known for their distinctive color and unique flavor, making them popular in various traditional and modern dishes. Ube is also rich in antioxidants and essential nutrients, contributing to overall health and well-being (Moriya *et al.,* 2015). Purple yam tubers represent an underutilized local natural source with significant potential. Purple yam (*Dioscorea alata L.)* is a plant that can withstand the conditions where it usually grows with minimal nutrients. Natural anthocyanins can be utilized as antioxidants and natural food coloring, can be found in purple yams, as Tomaroh *et al.,* (2021) noted. The Philippines has natural resources; sweet potato and purple yam have significant potential. When processed and utilized effectively, these flavors can be incorporated into cookies, transforming them into appealing snack items.

Various studies have widely employed sensory evaluation to determine consumer preferences (Drake, 2023; Fiorentini et al., 2021; Stone, 2020). The scientific field of sensory evaluation measures, analyses, and interprets consumer reactions to items using the senses of sight, smell, touch, taste, and hearing (Stone, 2020). Fiorentini *et al*. (2021) noted that sensory analysis assesses and measures a product's sensory attributes, including taste, smell, texture, and appearance. Keeping this in view, the present study aimed to evaluate the acceptability of sweet potato and purple yam cookies as a healthful snack alternative that could help alleviate malnutrition. The primary purpose of sensory evaluation was to provide a comprehensive interpretation of consumer responses by evaluating all sensory dimensions of a product to a specific objective.

MATERIALS AND METHODS

Research Design

The study employed a descriptive-quantitative research approach utilizing an experimental design to investigate the development of cookies made from Sweet Potato (*Ipomoea batatas*) and Purple Yam (*Dioscorea alata*) with various formulations. Laboratory techniques and procedures were applied to create and test these cookie formulations. Both descriptive and inferential statistical methods were used to analyze the acceptability of different formulations. The sensory attributes of the cookies were evaluated using a modified 5-point Likert scale (Likert, 1932), providing insights into significant differences in respondent preferences across the different cookie formulations.

Standard recipe and procedure

For Sweet Potato and Purple Yam Cookies, 1 cup of sweet potato (cooked and mashed) and 1 cup of purple yam (cooked and mashed) were combined with ½ cup all-purpose flour, 1 teaspoon baking soda, and ½ teaspoon salt in a mixing bowl. After mixing the dry ingredients, 2 tablespoons softened butter, 1 egg, 1 and ½ teaspoons vanilla extract, and 1 cup ube chips were added. A rubber scraper was used to agitate the mixture until it was thoroughly mixed. Next, mounds of cookie dough were scooped or spooned onto baking sheets lined with parchment paper. 350°F (175°C) was the preheated temperature of the oven. The cookies were baked in the oven for 8 to 10 minutes or until the edges were light brown. After baking, the cookies were allowed to stand on the baking sheet for 2 minutes before being transferred to a wire rack to cool completely. (Baldino *et. al.,* 2020)

Respondents

The study's respondents comprised faculty members from the Hospitality Management and Technology and Livelihood Education Departments, Bakers, Staff, and Hospitality Management and Technology and Livelihood Education students. The identified consumers were selected purposely at Cebu Technological University (CTU) Carmen Campus, Cebu, Philippines, and selected local bakeries in Carmen, Cebu. A total of 60 respondents participated: 20 individuals, including bak-

ers and faculty members from the HM and TLE programs, were purposively chosen as experts, while the remaining 40 respondents, consisting of students and staff, were selected through simple random sampling to represent the consumer perspective.

Methodology

This study employed an instrument adapted from the sensory evaluation framework that Singh-Ackbarali and Maharaj (2014) developed to evaluate the acceptability of innovative food products. The methodology was organized into three key components. Firstly, the questionnaire was used to assess the sensory attributes of commercial cookies. The second component focused on cookies incorporating 1 cup of mashed sweet potato and 1 cup of mashed purple yam, while the third component evaluated cookies with 1 and ¼ cups of mashed sweet potato and 1 and ¼ cups of mashed purple yam. Each segment was examined in appearance, aroma, taste, sweetness, and texture. Respondents rated the sensory characteristics of these various sweet potato and purple yam cookie formulations using a five-point hedonic scale presented in a rubric format. (Peryam *et al.,* 1952).

Data procedure

The Head of the Research and Development office and the Head of the Department of Hospitality Management granted approval to conduct the study. Additionally, ethical permission was obtained from the Campus Director. Three formulations (F_1 with ½ cup all-purpose flour, 1 cup ube chips, 1 tsp baking soda, ½ tsp salt, 1 pc egg, 2 tbsp melted butter and 1 ½ tsp vanilla essence, F_2 with ½ cup all-purpose flour, 1 cup ube chips, 1 cup mashed sweet potato, 1 cup mashed purple yam, 1 tsp baking soda, ½ tsp salt, 1 pc egg, 2 tbsp melted butter and 1 ½ tsp vanilla essence, and F_3 with ½ cup all-purpose flour, 1 cup ube chips, 1 and ¼ cups mashed sweet potato, 1 and ¼ cups mashed purple yam, 1 tsp baking soda, ½ tsp salt, 1 pc egg, 2 tbsp melted butter and 1 ½ tsp vanilla essence) were prepared in the cold kitchen laboratory of Cebu Technological University Carmen Campus, Cebu Philippines. Respondents were selected using purposive sampling techniques. Individuals were specifically chosen based on their relevance to the study and were approached individually to determine their willingness to participate in the tasting evaluation of sweet potato and purple yam cookies. Health protocols were strictly adhered to throughout the study to ensure the safe administration of the evaluation process and the collection of questionnaires. After distributing and administering the research technique to the participants, the questionnaires were meticulously collected and verified for accuracy. The responses from the participants were then painstakingly compiled and totalled in tables, laying the groundwork for in-depth data analysis and interpretation of the results.

Data analysis

Using the Statistical Package for the Social Sciences (SPSS) software, descriptive and inferential statistics were used to treat the data to get accurate and trustworthy results. A sensory evaluation of the purple yam and sweet potato cookies was conducted, focusing on texture, sweetness, taste, scent, and appearance. The sensory acceptability data, rated on a 5-point hedonic scale, were analyzed using weighted means. Additionally, the Analysis of Variance (ANOVA) by Roand (1925) was used to assess the statistical significance of mean differences among the various groups. Tukey's Honest Significant Difference (HSD) test (Tukey, 1953), which thoroughly comprehends the observed variances within the groups, was used to investigate further the significance of differences between pairs of group averages.

RESULTS AND DISCUSSION

Cookies are a popular snack enjoyed worldwide, and in many regions, they are the most consumed category of snack foods. Due to their abundance of fat, protein, and carbohydrates, cookies provide energy and serve as a valuable source of essential minerals (Saladino, 2023). The sensory evaluation of the three cookie formulations (F1 to F3) made from sweet potato (*Ipomoea batatas*) and purple yam (*Dioscorea alata*) provides valuable insights into consumer preferences. Root crops are important sources of energy and nutrients, offering essential fiber, calcium, iron, vitamins, and minerals. According to a review by Magbalot-Fernandez and Umar (2018), food innovations using root crops offer modern methods of preserving foods, ensuring a continuous supply through food processing. This aligns with the growing interest in developing instant foods that are healthy and made from natural ingredients. Recent studies have demonstrated that incorporating root crops into food products enhances nutritional value and sensory qualities (Morais, 2020). For instance, sweet potato-based baked goods are often preferred for their soft texture and mild sweetness, which aligns with the findings for F1 cookies in this study, where the sweet potato-based formulation achieved high acceptability for texture and flavor.

The potential of these root crops in food innovation presents a sustainable and health-conscious alternative, addressing the growing need for convenient, nutritious food options while contributing to food preservation efforts. The sensory evaluation of the three cookie formulations (Table 1, F1 to F3 made from sweet potato (*Ipomoea batatas*) and purple yam (*Dioscorea alata*) provides valuable insights into consumer preferences.

Table 1. Formulation for three different cookie recipes

Materials	Formulations of Purple Yam and Sweet Potato Cookies		
	F_1	F_2	F_3
All-purpose flour	½ cup	½ cup	½ cup
Ube chips	1 cup	1 cup	1 cup
Sweet potato (mashed)		1 cup	1 and ¼ cups
Purple yam (mashed)		1 cup	1 and ¼ cups
Baking soda	1 tsp	1 tsp	1 tsp
Salt	½ tsp	½ tsp	½ tsp
Egg	1 pc	1 pc	1 pc
Butter (melted)	2 tbsp	2 tbsp	2 tbsp
Vanilla essence	1 and ½ tsp	1 and ½ tsp	1 and ½ tsp

Table 2. Sensory analysis of F1 formulation

Attributes	Expert			Non-Expert		
	Mean	SD	VD	Mean	SD	VD
Appearance	3.85	0.95	Liked a Little	3.55	0.76	Liked a Little
Aroma	3.83	0.78	Liked a Little	3.15	0.59	Neither Liked nor Disliked
Taste	3.95	0.90	Liked a Little	3.00	0.79	Neither Liked nor Disliked
Sweetness	2.85	0.70	Neither Liked nor Disliked	3.80	0.52	Liked a Little
Texture	3.63	0.70	Liked a Little	3.90	0.45	Liked a Little

Legend: 1-1.80 Dislike a Lot; 1.81-2.60 Dislike a Little; 2.61-3.40 Neither Liked nor Disliked; 3.41-4.20 Liked a Little; 4.21-5.0 Liked a Lot; VD – Verbal Description; SD – Significant Difference

This data contributes to a deeper understanding of how these ingredients affect sensory attributes, which can be leveraged to generate new product ideas. These food innovations were based on the unique sensory properties of the ingredients or the distinct consumer segments identified through their sensory behaviours (Side et al., 1993). As Mihafu, Issa, and Kamiyango (2023) noted, sensory testing is vital for assessing consumer acceptability and designing quality systems, serving as key technical support for quality assurance in food production.

Table 2 shows the sensory evaluation results for the first formulation (F1), which was evaluated by both expert and non-expert groups. It generally received a "liked a little" rating for appearance, aroma, taste, sweetness, and texture. The experts rated the appearance with a mean score of 3.85 and the non-experts at 3.55, indicating that both groups perceived the product's visual appeal moderately. The aroma and taste received slightly higher ratings from experts, with a mean of 3.83 and 3.95, respectively, while non-experts provided lower scores for these attributes, particularly for taste (mean of 3.00), categorizing it as "neither liked nor disliked." However, the texture received positive feedback from both groups, particularly from non-experts (mean of 3.90), showing that the product's consistency was favorable. These outcomes echo the insights of Pinto *et al.*, (2021), which emphasize the significant role nutritional content plays in shaping consumer choices. Similarly, Peris *et al.*'s (2019) study, reinforces that consumers increasingly favour baked goods enriched with health-promoting ingredients. They highlighted that innovative, nutritious formulations can improve consumer acceptance by enhancing both the sensory qualities and health benefits of bakery products.

In comparison, the table 3 displays that the second formulation (F2) was significantly preferred, as indicated by higher mean ratings across all attributes. Both experts and non-experts rated F2's appearance, aroma, taste, sweetness, and texture as 'liked a lot,' with mean scores consistently above 4.70. For instance, the taste attribute scored 4.90 among both groups, illustrating strong positive feedback regarding flavor. This formulation's success could be attributed to the inclusion of mashed sweet potato (*Ipomoea batatas*) and purple yam (*Dioscorea alata*), which likely enhanced the overall sensory appeal of the cookies, especially in terms of appearance and texture. This finding is a testament to the power of sensory evaluation in understanding consumer preferences.

Its edge over other works and formulations lies in its nutrient-rich ingredients, which make it stand out as a healthier snack option. These cookies provide a substantial source of dietary fiber, vitamins, minerals, and antioxidants, all while delivering excellent sensory appeal. The vibrant, natural colors and inherent sweetness of sweet potato and purple yam not only enhance the product's visual and flavor profile but also elevate its overall quality, making it an ideal choice for health-conscious consumers seeking both nutrition and enjoyment in a snack.

Furthermore, the success of F2 underscores the importance of combining sensory and nutritional attributes in food product development. By meeting consumer demands for taste and health benefits, this study demonstrates the potential of sweet potato and purple yam cookies as a sustainable and innovative product.

Table 3. Sensory analysis of F2 formulation

Attributes	Expert			Non-Expert		
	Mean	SD	VD	Mean	SD	VD
Appearance	4.78	0.48	Liked a Lot	4.90	0.31	Liked a Lot
Aroma	4.83	0.50	Liked a Lot	4.85	0.37	Liked a Lot
Taste	4.90	0.38	Liked a Lot	4.90	0.31	Liked a Lot
Sweetness	4.70	0.56	Liked a Lot	4.75	0.55	Liked a Lot
Texture	4.83	0.38	Liked a Lot	4.70	0.57	Liked a Lot

Legend: 1-1.80 Dislike a Lot; 1.81-2.60 Dislike a Little; 2.61-3.40 Neither Liked nor Disliked; 3.41-4.20 Liked a Little; 4.21-5.0 Liked a Lot; VD – Verbal Description; SD – Significant Difference

Table 4. Sensory analysis of F3 formulation

Attributes	Expert			Non-Expert		
	Mean	SD	VD	Mean	SD	VD
Appearance	3.90	0.63	Liked a Little	4.15	0.49	Liked a Little
Aroma	3.88	0.56	Liked a Little	4.00	0.65	Liked a Little
Taste	3.95	0.60	Liked a Little	4.05	0.69	Liked a Little
Sweetness	4.08	0.28	Liked a Little	4.15	0.37	Liked a Little
Texture	4.00	0.66	Liked a Little	3.45	1.10	Liked a Little

Legend: 1-1.80 Dislike a Lot; 1.81-2.60 Disliked a Little; 2.61-3.40 Neither Liked nor Disliked; 3.41-4.20 Liked a Little; 4.21-5.0 Liked a Lot; VD – Verbal Description; SD – Significant Difference

Table 5. Significant differences in respondents' perception

Characteristics	F-Value	P-Value	Comparisons of Groups	Post-Hoc P-Value
Appearance	23.02	0.000	F1 vs F2	0.000**
			F2 vs F3	0.000**
			F1 vs F3	0.986
Aroma	37.38	0.000	F1 vs F2	0.000**
			F3 vs F2	0.000**
			F3 vs F1	0.629
Taste	15.25	0.000	F1 vs F2	0.000**
			F2 vs F3	0.000**
			F1 vs F3	0.642
Sweetness	162.62	0.000	F1 vs F2	0.000**
			F2 vs F3	0.000**
			F1 vs F3	0.000**
Texture	42.07	0.000	F1 vs F2	0.000**
			F2 vs F3	0.000**
			F1 vs F3	0.018**

*Significant at 0.05; **significant at 0.01

This aligns with efforts to utilize local, underutilized ingredients to create functional foods and livelihood opportunities for communities. This finding is a testament to the power of sensory evaluation in understanding consumer preferences. As Sidel and Stone (1993) emphasized, sensory evaluation plays a crucial role in food product development by providing key insights into consumer attitudes and perceptions. The food industry is constantly evolving, with growing competition and opportunities in global markets. To stay ahead, sensory evaluation must be leveraged as a passive tool and a proactive means to innovate, improve product quality, and meet consumer demands.

The success of F2 highlights the importance of incorporating consumer-driven sensory attributes into product development. It shows how effectively sensory evaluation can align product development with consumer preferences, pushing the food industry toward continued success through food innovation.

Table 4 reveals that the third formulation (F3), while not as highly rated as F2, still performed well. Both groups rated the appearance, aroma, taste, and sweetness as "liked a little," with mean scores close to 4.00, indicating a favorable but moderate reception. Notably, non-experts rated the texture slightly lower (mean of 3.45), which could suggest some variation in the product's mouthfeel or consistency that did not appeal as much to this group.

Table 5 shows that respondents' perceptions across different characteristics reveals several significant differences. For appearance, the F-value of 23.02 with a p-value of 0.000 indicates significant differences among

the groups. Specifically, there are notable differences between Groups F1 and F2, as well as between Groups F2 and F3. However, there is no significant difference between Groups F1 and F3. In terms of aroma, the F-value of 37.38 and a p-value of 0.000 suggest significant differences among the groups. Differences are significant between Groups F1 and F2, and between Groups F2 and F3, but not between Groups F3 and F1. For taste, the analysis shows an F-value of 15.25 with a p-value of 0.000, indicating significant differences between Groups F1 and F2 and between Groups F2 and F3. However, there is no significant difference between Groups F1 and F3.

Sweetness demonstrates the most pronounced variability, with an F-value of 162.62 and a p-value of 0.000. Significant differences are observed across all comparisons: F1 vs F2, F2 vs F3, and F1 vs F3. Finally, for texture, the F-value of 42.07 and a p-value of 0.000 suggest significant differences among the groups. Significant differences are found between Groups F1 and F2, and Groups F2 and F3, while a significant difference was also observed between Groups F1 and F3.These findings hold significant implications for both product development and consumer preferences. By understanding how various formulations affect sensory attributes, manufacturers can better design products that cater to consumer tastes and preferences. Identifying key factors influencing consumer preference, such as appearance, aroma, taste, sweetness, and texture, allows companies to adjust their recipes to align with consumer expectations and improve overall product acceptance.

Conclusion

The sensory evaluation of the three cookie formulations demonstrated that formulation F2 was significantly preferred, with both expert and non-expert panels rating its appearance, aroma, taste, sweetness, and texture as "liked a lot." The notably high ratings, especially for taste, suggest that including mashed sweet potato and purple yam greatly enhanced F2's sensory appeal. This study highlights the crucial role of sensory evaluation in aligning product development with consumer preferences. It provides valuable feedback for decision-making and guides the necessary modifications to improve food products, ensuring they meet consumer expectations and quality standards.

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Conflict of interest

The author declare that he has no conflict of interest.

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