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Economic Viability of Giant Swamp Taro (Cyrtosperma merkusii) as a Sustainable Ingredient for Sweet Halaya

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ABSTRACT

Giant swamp taro (Cyrtosperma merkusii), locally known as galyang, is a resilient and nutrient-rich root crop that remains underutilized in the Bicol Region. This study developed Sweet Halaya from giant swamp taro and determined the preparation process, the best formulation, the significance of differences among formulations, the level of acceptability in terms of color, taste, aroma, texture, appearance, and shelf-life, and the perceived economic viability of the product. Descriptive, experimental, and research and development methods were employed, with the Stage-Gate Framework guiding product development. Three formulations containing 1½ kg (Formulation 1), 1 kg (Formulation 2), and ½ kg (Formulation 3) of giant swamp taro, with all other ingredients held constant, were evaluated by 30 purposively selected evaluators composed of 10 teachers, 10 students, and 10 parents at Rodriguez National High School, Pili, Camarines Sur, using a four-point Likert-scale score sheet. Data were analyzed using the weighted mean, one-way analysis of variance (ANOVA), and the Tukey HSD test. Formulation 1 ranked first in overall acceptability (average weighted mean = 3.25), followed by Formulation 3 (3.10) and Formulation 2 (2.85), and the ANOVA showed a significant difference among the formulations, $F(2, 87) = 5.812$, $p = .004$. All formulations were rated Highly Acceptable in overall sensory quality (general average = 2.97), the product retained good quality for up to three days before spoilage set in on the fourth day, and all respondent groups rated its economic viability as Very Highly Acceptable. The study concludes that giant swamp taro is a viable ingredient for Sweet Halaya, with Formulation 1 recommended for production, and that improving shelf-life through preservation and packaging is needed before wider commercialization.

Keywords: *Giant Swamp Taro, Sweet Halaya, Product Development, Sensory Acceptability, Shelf-Life, Economic Viability*

INTRODUCTION

Sweet halaya, a beloved Filipino delicacy, traditionally depends on ingredients that can be both economically and environmentally challenging to source. Giant swamp taro (*Cyrtosperma merkusii*), a resilient and adaptable crop known for its large starchy corms, offers a promising alternative. In the Philippines, edible aroids include taro (*Colocasia esculenta*), yautia (*Xanthosoma sagittifolium*), giant taro (*Alocasia macrorrhiza*), giant swamp taro, and elephant foot yam (*Amorphophallus campanulatus*). Giant swamp taro is rich in carbohydrates, fiber, and essential minerals and thrives in marginal coastal and peatland areas (Englberger et al., 2008; Mendiondo et al., 2024), making it a resilient food source in the context of climate change and food security.

Globally, research emphasizes the potential of underutilized crops to enhance food security and nutrition. Hunter et al. (2020) advocate integrating neglected crops into mainstream diets to diversify food systems, and

ISSN: 3116-3475
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of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

Mendiondo et al. (2024) identified giant swamp taro as an underutilized wetland crop with potential for paludiculture in Southeast Asia. Taro starch and flour have favorable properties for a range of food products, including gluten-free options (Temesgen & Retta, 2015; Rashmi et al., 2018; Tosif et al., 2022). These efforts support Sustainable Development Goal 2 (Zero Hunger), which seeks to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture by 2030 (United Nations, n.d.).

In the Philippines, giant swamp taro, known as galyang or palawan, is increasingly recognized for its potential to address food security challenges. The Department of Science and Technology–PCAARRD reported that the crop showed potential as a supplemental food source in Agusan del Sur that can be processed into flour or starch (Maranan-Balbieran, 2022), and De Guzman et al. (2023) found giant swamp taro flour acceptable in pancake production. Republic Act No. 11148 (2018), the Kalusugan at Nutrisyon ng Mag-Nanay Act, further mandates an integrated national nutrition program that addresses hunger and malnutrition, a goal to which locally available, affordable, and culturally familiar foods can contribute. In Bicol, giant swamp taro has been used as a food supplement and as an ingredient in local dishes, and local studies have shown that taro and other root crops are acceptable substitutes in products such as polvoron (Garnce, 2017; Refardo et al., 2023).

Despite these developments, giant swamp taro remains underutilized because of limited processing knowledge and market appreciation, and its use in traditional Filipino desserts such as halaya, as well as the economic potential of such products, has not been established. By transforming giant swamp taro into Sweet Halaya, this study sought to add value to a locally abundant crop, promote agricultural diversification, enhance the availability of nutrient-rich foods, and generate income opportunities in rural communities.

This study determined the economic viability of giant swamp taro as a sustainable ingredient for Sweet Halaya at Rodriguez National High School, Pili, Camarines Sur. Specifically, it aimed to (1) determine the processes involved in the preparation of Sweet Halaya from giant swamp taro; (2) evaluate the best formulation in making Sweet Halaya from giant swamp taro; (3) determine whether there is a significant difference among the formulations; (4) evaluate the level of acceptability of giant swamp taro Sweet Halaya in terms of color, taste, aroma, texture, appearance, and shelf-life; and (5) analyze the economic viability of using giant swamp taro in Sweet Halaya production. The null hypothesis tested was that there is no significant difference among the formulations applied in making Sweet Halaya from giant swamp taro. The findings are expected to benefit Home Economics teachers and students, households and parents seeking income opportunities, farmers and entrepreneurs, and agencies promoting agricultural development and food security.

Literature Review

Giant Swamp Taro as an Underutilized Food Resource

Giant swamp taro is believed to be the largest edible corm-producing plant in the world and has long served as a staple in Pacific and Southeast Asian communities. Analyses of Micronesian cultivars showed that its corms contain carotenoids and minerals such as iron, zinc, and calcium, with considerable variation among cultivars (Englberger et al., 2008). Mendiondo et al. (2024) found that the crop's productivity is influenced by environmental and farming practices and highlighted its value as a wetland crop that can be grown in waterlogged areas where other crops perform poorly. Its starch has also been studied for food applications, with acid modification altering its physicochemical properties (Dompo et al., 2024).

Related studies on taro (*Colocasia esculenta*) affirm the nutritional and functional value of aroid crops. Temesgen and Retta (2015) and Rashmi et al. (2018) emphasized taro's nutritional potential and its versatile applications in food products, while Tosif et al. (2022) reviewed the extraction, composition, and health attributes of taro mucilage. Saklani et al. (2021) showed that taro enrichment affected the physicochemical and textural properties of cake, and Prasad and Bondy (2019) noted that dietary fiber and its fermentation products contribute to the prevention of human diseases. These studies collectively affirm the relevance of giant swamp taro and related root crops as sustainable and nutritious food sources.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

Food Security, Nutrition, and Policy Context

Food security is achieved when all people have consistent physical, social, and economic access to sufficient, safe, nutritious, and culturally acceptable food (Simelane & Worth, 2020). Sustainable Development Goal 2 targets ending hunger and achieving food security, improved nutrition, and sustainable agriculture by 2030 (United Nations, n.d.), while diversifying diets through neglected and underutilized species is viewed as essential to sustainable food systems (Hunter et al., 2020). In the Philippines, Republic Act No. 11148 (2018) supports an integrated national nutrition program, particularly for maternal, infant, and young child nutrition during the first 1,000 days of life.

Within this context, developing value-added products from locally abundant crops serves the dual purpose of improving access to nutritious food and creating livelihood opportunities. Initiatives in the Philippines, such as the identification of giant swamp taro as a supplemental food source and its processing into flour or starch (Maranan-Balbieran, 2022), illustrate how indigenous crops can be repositioned from subsistence foods into marketable commodities.

Alternative Ingredients in Food Product Development

Local studies have explored the feasibility of unconventional ingredients in food products, with a strong focus on sensory characteristics and overall acceptability. Alternative ingredients have been assessed in squash recipes (Castro, 2019), lubas fruit wine (Soverano, 2016), Indian mango wine (Lalugan, 2016), coconut meal cupcakes (Beatriz, 2019), coco-pili bars (Bantog, 2015), siling labuyo-flavored cakes and cookies (Angeles, 2018), eggplant pasta noodles (Hade, 2023), dragon fruit peel candy (Alano, 2023), and krill crackers (Coldas, 2023). These studies collectively highlight the importance of evaluating taste, aroma, texture, color, and appearance to ensure product acceptability while also considering processing techniques and economic advantages.

Several studies have determined optimal ingredient proportions in innovative food products, including sweet potato and malunggay in cupcakes (Casiro, 2025), nipa fruit in brownies (Cerbito, 2025), purple yam flour in baked products (Varde, 2024), lesser yam flour in food bars (Señar, 2025), avocado seeds in keto cookies (Arce, 2024), pili pulp in an all-purpose spread (Paral, 2025), and galyang flour in noodles (Galan, 2025). Root crop flours have also been found acceptable in pancakes (De Guzman et al., 2023) and polvoron (Garnce, 2017; Refardo et al., 2023). However, none of these studies examined giant swamp taro as the main ingredient of halaya or assessed the economic viability of such a product.

Theoretical Framework

The study was anchored on three theories. Schumpeter's Theory of Innovation holds that innovation drives economic growth through "creative destruction," in which new combinations of the factors of production replace old ones (Schumpeter, 2008). The study applied this principle by combining an abundant but underutilized indigenous crop with an established culinary method to create a value-added variant of a traditional dessert, representing innovation through a new raw material source, an improved product, and an optimized production method rather than through radical invention.

Food Acceptability Theory explains that acceptability results from the interaction of sensory attributes, consumer characteristics, and the emotional satisfaction derived from food (Maina, 2018). Sensory properties such as aroma, appearance, taste, and texture are fundamental determinants of acceptance, while knowledge, attitudes, and familiarity shape consumers' willingness to adopt novel foods. This theory served as the basis for evaluating the sensory attributes of the formulations. Finally, Food and Nutrition Security Theory emphasizes the availability, access, utilization, and stability of adequate, safe, nutritious, and culturally acceptable food (Simelane & Worth, 2020). The study applied this framework by developing an affordable and culturally familiar product from a locally abundant crop and by examining its shelf-life as an aspect of stability.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

Conceptual Framework

The study followed an Input–Process–Output paradigm, as shown in Figure 1. The input consisted of the raw material (giant swamp taro), other ingredients, and the utensils and equipment needed for production. The process was structured according to the Stage-Gate Framework (Cooper, 2019), which divides new product development into sequential stages separated by decision gates that evaluate technical, market, and financial criteria: Stage 0 (Discovery) and Gate 1 (Idea Screening), Stage 1 (Scoping) and Gate 2 (Second Screening), Stage 2 (Build Business Case) and Gate 3 (Go to Development), Stage 3 (Development) and Gate 4 (Go to Testing), Stage 4 (Testing and Validation) and Gate 5 (Go to Launch), Stage 5 (Launching), and the Post-Launch Review. The output was giant swamp taro Sweet Halaya.

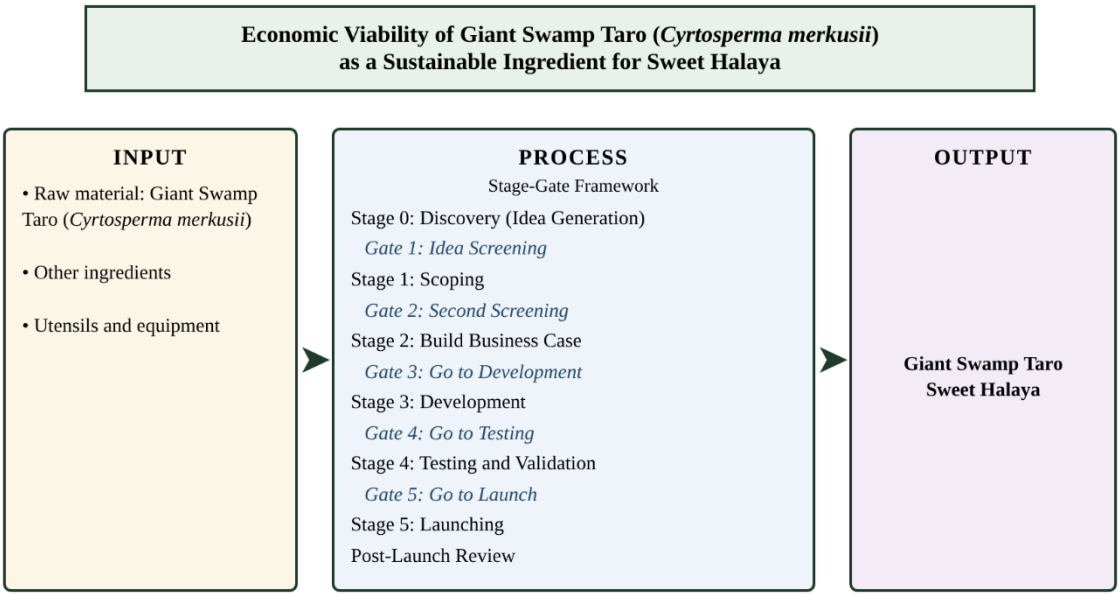


Figure 1. *Conceptual Paradigm of the Study*

METHODS

Research Design

The study employed descriptive, experimental, and research and development (R&D) methods. The descriptive method was used to document the collection and preparation of giant swamp taro and its transformation into Sweet Halaya. The experimental method was applied to the production of three formulations that differed only in the quantity of giant swamp taro, allowing the effect of the ingredient proportion on acceptability to be compared (Montgomery, 2017; Field, 2018). The R&D method guided the development and evaluation of the product across the three formulations, with the Stage-Gate Framework (Cooper, 2019) serving as the structure for moving the product from idea generation to testing.

Research Locale

The study was conducted at Rodriguez National High School in Barangay Cadlan, Pili, Camarines Sur, Philippines. The giant swamp taro used in the study was harvested in Barangay Cadlan, an area in the Bicol Region where the crop, locally called galyang, is abundant yet underutilized.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

Participants and Sampling

Thirty evaluators were selected through purposive sampling: 10 faculty teachers with experience in food testing, 10 junior high school students studying food processing, and 10 parents from the local barangay representing household consumers. This composition provided professional, younger-consumer, and household perspectives on the product's quality and market acceptability. The study used only the mature corm of the giant swamp taro; the leaves, stems, and roots were excluded.

Research Instrument

The study used a score sheet containing the evaluator's profile, items on the acceptability of the finished product in terms of color, taste, aroma, texture, and appearance, and a section for comments and suggestions. Ratings were made on a four-point Likert scale adapted from Galan (2025), and the score sheet was provided in a bilingual format. Table 1 presents the scale and the descriptors for each sensory attribute.

Table 1. *Scoring Scale for Evaluating the Finished Product*

Attribute	1.00–1.75 Less Acceptable (LA)	1.76–2.50 Moderately Acceptable (MA)	2.51–3.25 Highly Acceptable (HA)	3.26–4.00 Very Highly Acceptable (VHA)
Color	White	Light yellowish	Yellowish	Dark yellowish
Taste	Least sweet and creamy	Less sweet and creamy	Moderately sweet and creamy	Very sweet and creamy
Aroma	Least desirable	Odorless	Rancid	Highly rancid
Texture	Tough	Coarse	Fluffy	Soft and chewy
Appearance	Not attractive	Fairly attractive	Moderately attractive	Highly attractive

Data Gathering Procedure

The study proceeded in three phases: preliminary, experimental, and evaluation. In the preliminary phase, permission was secured from the school principal, the respondents were coordinated, and the raw materials, ingredients, tools, and equipment were prepared. The giant swamp taro was boiled for 30 to 45 minutes until soft but not mushy, cooled, peeled, and finely grated. In the experimental phase, three formulations were prepared: Formulation 1 with 1½ kg, Formulation 2 with 1 kg, and Formulation 3 with ½ kg of giant swamp taro. The other ingredients were held constant across all formulations: one can of coconut milk, ½ cup of brown sugar, 390 g of sweetened condensed milk, one cup of butter, 410 ml of evaporated milk, one teaspoon of vanilla extract, and one teaspoon of coconut oil.

All formulations followed the same standardized procedure. Butter was melted in a heavy-bottomed pan over medium heat; the prepared giant swamp taro, coconut milk, and evaporated milk were added and stirred until well combined; and the mixture was simmered over low heat with constant stirring for approximately 30 to 40 minutes. Sugar and vanilla extract were added once the mixture had thickened, stirring continued until the mixture reached a thick, pudding-like consistency that clung to the spoon, and coconut oil was added in the last few minutes of cooking for sheen. The halaya was then transferred into greased llanera molds or microwavable containers, cooled at room temperature, chilled for at least two hours to set, and packaged. In the evaluation phase, the evaluators rated the three formulations using the score sheet, and changes in the product's appearance, texture, odor, and taste were observed daily for six days to determine its shelf-life.

Data Analysis

The weighted mean was used to determine the level of acceptability of each formulation per sensory attribute and the respondents' ratings of economic viability, and the means were interpreted using the scale in Table 1. One-way analysis of variance (ANOVA) was used to determine whether the overall acceptability of the three formulations differed significantly, and the Tukey honest significant difference (HSD) test was used for pairwise comparisons following a significant result (Field, 2018). The level of significance was set at 0.05. The

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

shelf-life observations were described qualitatively, and the Stage-Gate Framework was used to document the development process.

Ethical Consideration

Informed consent was obtained from all respondents through forms written in English and Bikol that explained the purpose, procedures, voluntary nature, potential benefits, and minimal risks of the study, including possible sensory fatigue from tasting, as well as the right to withdraw at any time without consequence. No incentives that might bias responses were given. Coded identifiers were used in place of names, and anonymity was preserved in all results. All samples were prepared under hygienic and food-safe conditions, consistent with the principles of beneficence and social value under Republic Act No. 10532 (2013). Community members and local farmers with traditional knowledge of the crop were consulted, and the incorporation of giant swamp taro into halaya was framed as enriching rather than altering the tradition. An artificial intelligence tool (ChatGPT) was used only to refine the grammar and organization of the documentation and was not used in data collection, data handling, or statistical computation.

RESULTS AND DISCUSSION

Processes Involved in the Preparation of Sweet Halaya from Giant Swamp Taro

The development of giant swamp taro Sweet Halaya followed the Stage-Gate Framework shown in Figure 2. In Stage 0 (Discovery), the potential of giant swamp taro as a raw material was identified on the basis of its abundance and nutritional value, and Gate 1 (Idea Screen) validated the concept against existing research on indigenous ingredients. Stage 1 (Scoping) and Gate 2 (Second Screen) mapped supply sources in Camarines Sur and verified that harvesting and processing were hygienic. Stage 2 (Build Business Case) and Gate 3 (Go to Development) consolidated considerations of production cost, demand, and quality benchmarks. Stage 3 (Development) involved the preparation of the three formulations using the standardized procedure, and Gate 4 (Go to Testing) and Stage 4 (Testing and Validation) subjected the prototypes to sensory evaluation and shelf-life observation. Gate 5 (Go to Launch) confirmed the best formulation, while Stage 5 (Launch) and the Post-Launch Review provide for continuous refinement based on consumer response.

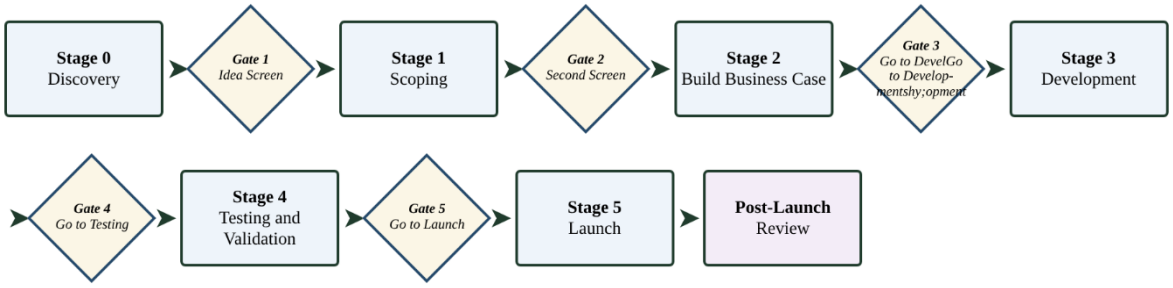


Figure 2. *Stage-Gate Process in the Development of Giant Swamp Taro Sweet Halaya*

The framework functioned as a risk-management and quality-assurance mechanism, translating broad objectives into manageable steps and requiring that technical, sensory, and economic considerations be satisfied before the product advanced to more resource-intensive phases (Cooper, 2019). This structured approach supports the view that innovation need not require radical invention but can arise from the systematic optimization of available resources, consistent with Schumpeter's (2008) concept of innovation as a new combination of resources, and it guided the development of a product aligned with the availability and access dimensions of food and nutrition security (Simelane & Worth, 2020).

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

Best Formulation of Giant Swamp Taro Sweet Halaya

Table 2 presents the overall acceptability of the three formulations as rated by the 30 evaluators. Formulation 1, containing 1½ kg of giant swamp taro, obtained the highest average weighted mean of 3.25 and ranked first, followed by Formulation 3 (½ kg) with 3.10 and Formulation 2 (1 kg) with 2.85.

Table 2. *Best Formulation of Giant Swamp Taro Sweet Halaya*

Formulation	Respondents	Average Weighted Mean	Rank
Formulation 1 (1½ kg)	30	3.25	1
Formulation 2 (1 kg)	30	2.85	3
Formulation 3 (½ kg)	30	3.10	2

These results indicate that the proportion of giant swamp taro influenced how the product was perceived and that Formulation 1 achieved the most favorable balance of characteristics expected of halaya. The identification of a single best formulation suggests that the inclusion level must be calibrated to retain the familiar qualities of the traditional dessert. This is consistent with Food Acceptability Theory, which holds that preference arises from the interaction of sensory attributes, familiarity, and perceived quality (Maina, 2018), and with local product-development studies that used formulation trials to identify the most acceptable proportion of an alternative ingredient (Varde, 2024; Arce, 2024; Casiro, 2025; Cerbito, 2025; Galan, 2025).

Significant Difference among the Formulations

Table 3 presents the results of the one-way ANOVA on the overall acceptability of the three formulations. The between-formulation variation was significantly greater than the within-formulation variation, $F(2, 87) = 5.812$, $p = .004$; thus, the null hypothesis was rejected.

Table 3. *One-Way ANOVA on the Acceptability of the Formulations of Giant Swamp Taro Sweet Halaya*

Source of Variation	SS	df	MS	F	p-value	Interpretation
Between Formulations	2.44	2	1.222	5.812	0.004	Significant
Within Formulations	18.29	87	0.210			
Total	20.73	89				

Note. Significant at $p < 0.05$. SS = sum of squares; MS = mean square.

The Tukey HSD test (Table 4) showed that Formulation 1 differed significantly from Formulation 2 ($Q = 4.778$, $p = .003$) and from Formulation 3 ($Q = 1.832$, $p = .043$), while Formulations 2 and 3 did not differ significantly ($Q = 2.947$, $p = .099$).

Table 4. *Tukey HSD Pairwise Comparison of the Formulations*

Paired Formulations	Q Statistic	p-value	Interpretation
Formulation 1 and Formulation 2	4.778	0.003	Significant
Formulation 1 and Formulation 3	1.832	0.043	Significant
Formulation 2 and Formulation 3	2.947	0.099	Not significant

Note. Significant at $p < 0.05$.

These results confirm that the quantity of giant swamp taro had a measurable effect on the acceptability of the product and that the differences in ratings were not due to chance. The relationship between ingredient proportion and acceptability was not linear, as the formulation with the intermediate amount (Formulation 2) received the lowest rating, which underscores the need for careful calibration in formulation development. The statistical evidence provided the basis required at the testing and launch gates of the Stage-Gate Framework (Cooper, 2019) for selecting the best formulation, and it supports Food Acceptability Theory in showing that variations in composition affect consumer perception (Maina, 2018).

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

Level of Acceptability of Giant Swamp Taro Sweet Halaya

Table 5 presents the acceptability of the three formulations by sensory attribute. All formulations were rated Highly Acceptable overall, with average weighted means of 3.08 for Formulation 1, 2.85 for Formulation 2, and 2.99 for Formulation 3 and a general average of 2.97. Color obtained the highest mean across formulations (3.26, Very Highly Acceptable), while taste (2.66) and texture (2.64) obtained the lowest, although both remained Highly Acceptable.

Table 5. *Level of Acceptability of Giant Swamp Taro Sweet Halaya by Sensory Attribute*

Attribute	F1 WM	Int	F2 WM	Int	F3 WM	Int	AWM	Int
Color	3.41	VHA	2.85	HA	3.53	VHA	3.26	VHA
Taste	2.89	HA	2.52	HA	2.57	HA	2.66	HA
Aroma	3.32	VHA	3.10	HA	3.27	VHA	3.23	HA
Texture	3.14	HA	2.76	HA	2.03	MA	2.64	HA
Appearance	2.63	HA	3.00	HA	3.57	VHA	3.07	HA
Average	3.08	HA	2.85	HA	2.99	HA	2.97	HA

Note. WM = weighted mean; AWM = average weighted mean; Int = interpretation; F1 = 1½ kg, F2 = 1 kg, F3 = ½ kg of giant swamp taro. 3.26–4.00 = Very Highly Acceptable (VHA); 2.51–3.25 = Highly Acceptable (HA); 1.76–2.50 = Moderately Acceptable (MA); 1.00–1.75 = Less Acceptable (LA).

Formulation 1 obtained the highest ratings for taste (2.89) and texture (3.14) and was rated Very Highly Acceptable for color and aroma, giving it the most balanced profile with no attribute falling below Highly Acceptable. Formulation 3, which contained the least giant swamp taro, received the highest ratings for color (3.53) and appearance (3.57) but the lowest rating for texture (2.03, Moderately Acceptable), making texture the most sensitive attribute to changes in formulation. Formulation 2 was rated Highly Acceptable across all attributes but did not excel in any. That all formulations remained acceptable confirms that giant swamp taro can be incorporated into halaya without compromising its overall appeal, while the differences across attributes indicate that the proportion of the crop must be calibrated to preserve the texture and taste expected of the traditional dessert. These findings support Food Acceptability Theory, which asserts that preference depends on the combined performance of appearance, aroma, taste, and texture (Maina, 2018), and they are consistent with studies showing that taro enrichment affects the textural properties of food products (Saklani et al., 2021).

Table 6 presents the shelf-life of the product based on daily sensory observation. The halaya maintained desirable qualities during the first three days, becoming thicker, smoother, more cohesive, and glossier as it set. Spoilage became evident on the fourth day through changes in smell and taste, the surface became watery and uneven with the onset of mold on the fifth day, and on the sixth day the product was soft, watery, and moldy, with an unpleasant odor and taste that made it unsafe to eat.

Table 6. *Shelf-Life of Giant Swamp Taro Sweet Halaya Based on Sensory Observation*

Day	Observation
Day 1	A thick, smooth, beige-colored paste with a slightly glossy texture, topped with a small mound of finely grated pale-yellow cheese.
Day 2	Thicker, smoother, and more settled, with a golden or light caramel color; the glossy surface and gelatinous texture indicate proper cooling and setting.
Day 3	Thicker, smoother, and more cohesive, with a glossy surface; firmer and more mature, showing improved consistency.
Day 4	Spoilage has begun based on smell and taste evaluation.
Day 5	The surface looks slightly watery and uneven, with changes in texture; spoilage has progressed and mold has started to develop.
Day 6	Spoiled: soft, watery, with white mold growth and an unpleasant odor and taste, making it unsafe to eat.

ISSN: 3116-3475
International Journal
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Volume 2 Issue 11 (November 2026)

The relatively short shelf-life reflects the natural spoilage of a moist, milk- and coconut-based product held without preservatives, and it indicates the need for further work on preservation techniques, such as permitted preservatives, vacuum sealing, or modified packaging, before wider distribution. The results also show the usefulness of regular sensory assessment in monitoring product quality and preventing the distribution of unsafe food, which relates to the stability dimension of food and nutrition security (Simelane & Worth, 2020).

Economic Viability of Giant Swamp Taro Sweet Halaya

Table 7 presents the respondents' ratings of the economic viability of the three formulations. All respondent groups rated the economic viability of the product as Very Highly Acceptable, with teachers giving the highest weighted mean (3.88), followed by students (3.56) and parents (3.42). Across the groups, Formulation 1 consistently obtained the highest ratings, Formulation 2 generally the lowest, and Formulation 3 intermediate values.

Table 7. *Economic Viability of Sweet Halaya Using Giant Swamp Taro*

Group	F1	F2	F3	Weighted Mean	Interpretation	Rank
Students	3.27	2.98	3.14	3.56	VHA	2nd
Parents	3.16	3.00	3.05	3.42	VHA	3rd
Teachers	3.33	2.80	3.32	3.88	VHA	1st

Note. 3.26–4.00 = Very Highly Acceptable (VHA); 2.51–3.25 = Highly Acceptable (HA); 1.76–2.50 = Moderately Acceptable (MA); 1.00–1.75 = Less Acceptable (LA).

The consistently favorable ratings indicate that the respondents perceived giant swamp taro as a cost-effective alternative ingredient capable of producing a product that offers good value relative to its expected cost and price. Teachers, who may have a broader view of product value and market positioning, gave the highest ratings, while parents, as primary household purchasers, also expressed confidence in the product's affordability and practicality. The superior rating of Formulation 1 suggests that it offered the best balance between input and perceived quality. These findings support Schumpeter's (2008) view that new combinations of resources can generate economic value, as an underutilized, low-cost raw material was transformed into a product perceived as marketable, and they correspond to the affordability and access dimensions of food and nutrition security (Simelane & Worth, 2020). Because the study did not include a detailed costing analysis, these results reflect the respondents' perceptions of economic viability rather than computed production costs and returns.

CONCLUSION

The Stage-Gate Framework effectively guided the development of giant swamp taro Sweet Halaya through structured stages and decision gates that supported quality, feasibility, and risk reduction. The proportion of giant swamp taro significantly affected the acceptability of the product, and Formulation 1, containing 1½ kg of giant swamp taro, was identified as the best formulation, ranking first in overall acceptability and differing significantly from the other formulations, while Formulations 2 and 3 did not differ significantly from each other. All formulations were acceptable, with Formulation 1 showing the most balanced sensory profile and texture emerging as the attribute most sensitive to the amount of giant swamp taro. The product retained good quality for up to three days, after which spoilage gradually set in. All respondent groups perceived the product as economically viable. Giant swamp taro is therefore a viable and sustainable ingredient for Sweet Halaya that can add value to a locally abundant crop, although improved preservation is needed before wider commercialization.

Recommendation

Food processors, entrepreneurs, and small-scale producers may adopt Formulation 1 for regular production and commercialization, as it demonstrated the best balance of sensory quality and consumer

acceptance. Food technologists and researchers may develop and test preservation techniques, such as the use of natural or permitted preservatives, vacuum sealing, or modified packaging, to extend the shelf-life of the product beyond three days. Local farmers and agricultural cooperatives may promote the sustainable cultivation and proper post-harvest handling of giant swamp taro. Local government units and agricultural extension offices may provide technical training, capacity building, and livelihood programs that assist communities in the production, processing, and marketing of giant swamp taro products. Home Economics teachers may use the product and its development process as instructional material for income-generating projects. Future researchers may develop other value-added products from giant swamp taro; conduct microbiological, moisture content, nutritional, and detailed cost-and-return analyses not covered in this study; and undertake larger-scale market studies to assess consumer demand, price competitiveness, and long-term economic viability.

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