

Utilization and Acceptability of Asian Swamp Eel (*Monopterus Albus*) and Cassava Based Sagip Powder as Ingredients in Siomai

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Article Details:

Received: 15 April 2026

Revised: 25 April 2026

Accepted: 30 April 2026

Published: 16 May 2026

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Recommended Citation:

Binag, K. J. D., Peñalber, M. R. (2026). Utilization and Acceptability of Asian Swamp Eel (*Monopterus Albus*) and Cassava Based Sagip Powder as Ingredients in Siomai. The International Review of Multidisciplinary Research. 1 (5), 640-650.
<https://doi.org/10.5281/zenodo.20229978>

Index Terms:

salary increase, teaching and learning focused, performance-based promotion, teaching excellence framework, state universities, faculty ranking, faculty promotion, education, political economy

Abstract. This study explored the utilization of Asian swamp eel (*Monopterus albus*) as food product innovation by developing a fortified siomai variant and evaluating its acceptability and nutritional value. It specifically aims to determine whether rice eel, combined with cassava-based Sagip Nutri-Powder, can serve as a viable, nutritious alternative to conventional meat-based siomai. A developmental and experimental research design was employed using four formulations with varying proportions of rice eel flesh and cassava-based fortification. Sensory evaluation was conducted with 75 panelists using a nine-point hedonic scale, while proximate analysis assessed crude protein, fat, fiber, moisture, and ash content. Data were analyzed using descriptive statistics and one-way ANOVA. Results revealed that Formulation II (900 g rice eel and 100 g cassava-based powder) consistently achieved the highest acceptability scores across all sensory attributes, with a general acceptability mean of 8.60 ("Like Extremely"). It also recorded the highest crude protein content (15.50%) and the lowest fat level (3.96%), indicating a favorable nutritional profile. Increasing cassava content improved fiber but slightly reduced protein and sensory ratings. These findings suggest that rice eel siomai fortified with cassava-based powder is both nutritionally beneficial and highly acceptable to consumers, supporting its potential as a sustainable food product. However, optimizing texture and formulation balance remains essential for broader market adoption and product consistency.

Introduction

In an area of food processing, there is always innovation and development. As years go by, many developments have been spotted in the different cuisines in the world. It is designed to serve newly developed or innovated food products. Culinary simply means cooking. But it has different kinds of techniques, strategies, and needs more skills to do some. It encompasses the art, science, and practice of preparing and presenting food. Most people loved to eat ready snack foods either foreign or locally made such as shanghai, lumpia, siomai, and more.

Siomai has been widely embraced in the Philippines, where it has been localized with various fillings such as pork, beef, and shrimp (Del Rosario, 2018). Filipino-style siomai is often served with calamansi and chili-garlic sauce, setting it apart from its Chinese counterpart. According to Choe and Kim (2019), food fusion enhances marketability by appealing to diverse taste preferences, making it an effective strategy in the competitive food industry. Studies suggest that incorporating local ingredients into foreign dishes enhances consumer acceptance and promotes cultural appreciation (Lee & Park, 2022).

The Asian swamp eels (*Monopterus albus*) which is locally known as Kolukol have been found to be occupying the rice fields of Barangay Remedios, Cervantes, Ilocos Sur. A study by Sibe (2014) Rice eel is rich in protein, contributing to muscle health and overall nutrition, low-fat content makes it a suitable choice for health-conscious individuals.

Rice eel fishing has the potential as an additional or alternative income for the farmers. Garcia, et al., (2023) conducted a study on food product development out of "Kolukols" to maximize the use of these eels in the locality. Asian swamp eels have a hidden hue that usually shows as dark brown or green tones all over their body. Usually, they have one V-shaped gill opening located behind their neck. Apart from having two rows of mandible teeth, people have reduced eye structures and

a thin membrane over their eyes. Usually, they lack scales or fins. Skin glands throughout the body produce protective mucus that helps one move in dirty surroundings. Though they had gills, these eels might meet up to 25% of their oxygen needs via cutaneous breathing. Often known as the Asian swamp eel, *Monopterus albus* is a type of eel native to the Oriental area, ranging from Southeast Asia to East Asia. Found on all three Greater Sunda Islands, the Malay Peninsula, and the Indochinese Peninsula, Asian swamp eels... As far west as eastern India, they might be found. Located in the eastern part of their range, they might be found in Shanghai, Taiwan, and the Miyako Islands of Japan. From Beijing, China, this species ranges to Malaysia, the Philippines, and Indonesia in the southern hemisphere (Matsumoto et al., 2010; Shafland et al., 2010).

Municipalities in the Philippines with notable prevalence of "*Monopterus albus*" have been reported and validated (BFAR R02 2017) in provinces of Cagayan Valley (Region 02): Alcala, Amulung, and Solana in Cagayan; Cauayan City, San Isidro, and Alicia in Isabela; Maddela, Diffun, and Cabarroguis in Quirino; and Solano, Bagabag, and Quezon in Nueva Vizcaya. Every municipality defined experimental areas (EA) as three rice plots spanning 500 m² each. With a water level under 15 cm, the rice fields are irrigated and accessible. It is in areas where rice eel infection is very common (Ame EC, Mayor AD., 2021). This study aims to tackle various global issues in support with the Sustainable Development Goals (SDGs) set forth by the United Nations. Rice Eel Siomai aligns perfectly with the goals of the global community aimed at eradicating poverty in all its forms, as outlined in Sustainable Development Goals (SDG) Number 1. It also addresses the elimination of hunger, achievement of food security, enhancement of nutrition, and promotion of sustainable agriculture in line with SDG Number 2. Furthermore, it supports the assurance of healthy lives and well-being for individuals of all ages, as per SDG Number 3. The initiative fosters sustained, inclusive, and sustainable economic growth, alongside full and productive employment and decent work for all, as stated in SDG Number 8. It guarantees sustainable consumption and production patterns, as indicated in SDG Number 12, and reinforces the means of implementation while revitalizing global partnerships for sustainable development, as articulated in SDG Number 17. This study aims to assess the acceptance of Asian Rice Eel (*Monopterus albus*) Siomai enhanced with cassava-based Sagip Nutri-Powder, utilizing rice eel meat as a substitute for pork, poultry, beef, and vegetables.

In addition, this research-based product is in partnership with the Barangay Integrated Development Approach for Nutrition Improvement (BIDANI) recognizing the significant malnutrition challenges facing 14 communities, as highlighted by National Nutrition Council data, Isabela State University's College of Education introduces a nutritional intervention. The distribution of Rice Eel Siomai Fortified with Cassava-Based Sagip Nutri-Powder through the BIDANI network, directly targeting children suffering from underweight, stunting, and wasting.

This research seeks to bridge the gap on the utilization of Asian swamp eel on innovating food products, specifically on the process of incorporating the flesh of Asian swamp eel in making siomai. By using the raw material rice eel as the main ingredient, it seeks to evaluate the level of acceptability of Rice Eel Siomai Fortified with Cassava Based Sagip Nutri-Powder and investigate the nutritive composition through laboratory proximate analysis with Department of Agriculture, Tuguegarao City, develop model recipe using the formulations.

Statement of the Problem

This study generally aims to produce and determine the acceptability of Asian swamp eel (*Monopterus albus*) fortified with Cassava-Based Sagip Nutri-powder through Siomai and its potential benefits. Specifically, it aims to answer the following questions:

1. What is the level of acceptability among the 4 formulations in terms of:
 - a. color/ appearance;
 - b. odor/ aroma;
 - c. taste/ flavor;
 - d. texture; and,
 - e. general acceptability?
2. What is the most acceptable formulation among four formulations?
3. What are the nutritive characteristics of Asian swamp eel (*Monopterus albus*) siomai as determined by both proximate analysis and nutrition facts labelling?
4. What significant differences exist in the level of consumer acceptability among the four Asian Swamp eel Siomai formulations in terms of appearance, aroma, taste, texture, and general acceptability?

Methodology

This study utilized experimental methods to develop a fortified siomai variant utilizing Asian swamp eel (*Monopterus albus*) as main ingredients fortified with cassava-based Sagip Nutri-Powder and evaluate its acceptability and nutritional value. The primary materials used included rice eel flesh, cassava-based Sagip powder, onion, leeks, garlic, egg, sesame oil, black pepper, salt, oyster sauce, and molo wrapper, with different formulations designated as formulation F2 to F4. Each

formulation varied in cassava-based Sagip powder and rice eel flesh. Specifically, the proportion was 900g rice eel flesh and 100g cassava-based Sagip Nutri powder (F2), 800g rice eel flesh and 200g cassava-based Sagip Nutri-powder (F3), and 700g rice eel flesh and 300g cassava-based Sagip Nutri-powder (F4). The Asian swamp eel used in this study was sourced from Municipality of Roxas, Isabela.

In preparing the Asian Swamp eel Siomai fortified with Cassava-Based SAGIP Nutri-Powder, all tools and equipment were sanitized thoroughly. In the process of making Asian swamp eel siomai starting from preparing and gathering rice eel as main ingredients. Using salt and ash for scrubbing the rice eel will help to remove the slime all over the body. Pre-washing and removal of the internal organs, head, and spinal and bones. Another set of washing to remove the remaining blood. Next, soak the dressed rice eel in a brining solution consist of 10% solution with water, salt, black pepper, and bay leaf. Brine the rice eel flesh for at least 30 minutes to 1 hour. Next, grind the rice eel flesh. In mixing bowl, add the ground rice eel flesh, onion, leeks, carrots, garlic, chopped, egg, sesame oil, celery powder, black pepper, salt, oyster sauce thoroughly mix until well blended. Then siomai mixture will be proportioned to 10 grams each piece in molo wrapper. Using steamer, bring water to boil before putting siomai pieces. Slightly greased the steamer tray with oil and then steam for 25 - 30 minutes. After steaming, the siomai will be removed, cool down and transfer for packing, refrigerated until needed for sensory evaluation. Various tools and equipment were used throughout the process including measuring spoon, measuring cup (liquid and dry), utility knife, chopping board, rubber scraper, strainer, colander, mixing bowl, spoon, portioning bowl, grater, peeler, steamer, chopper/grinder, timer, weighing scale, and hand gloves.

To determine the product's nutritional content the sample was submitted at the Department of Agriculture Regional Field Office No. 02. Each sample treatment of Asian Swamp eel siomai was analyzed for its nutritional content such as crude proteins, crude fiber, crude fat, moisture and ash content. The sensory evaluation was conducted to identify the potential areas of improvement and its market appeal and determine the level of acceptability of different treatments in terms of appearance/color, aroma/odor, taste/flavor, firmness/texture, general acceptability. The instrument used for data gathering was a score sheet using the Nine-point Hedonic Scale. The sensory panel was composed of 75 members randomly chosen from students, professionals, faculty and staff of Muñoz National High School and Isabela State University-Echague Campus. The panelist is chosen accordingly with healthy condition, non-smoker, non-alcoholic intake.

The treatment samples were prepared, coded, and subjected to sensory evaluation. There were four (4) formulations in the study (F1, F2, F3, and F4), which were assigned randomly to the experimental units. Each panelist was given a set of coded samples arranged on a plate. Each panelist rated the sample as to its appearance, aroma, taste, texture, and general acceptability. They are instructed to rinse their mouth before and after tasting each item to avoid combination of taste. To ensure the conduct of this sensory evaluation and maintain trust and cooperation from the participants, ethical measures were put in place including safety and hygiene, informed consent, confidentiality, respect for diversity, and professional conduct.

In the data analysis of these Asian swamp Eel Siomai experiment, descriptive statistics, including mean and standard deviation was employed to provide a clear summary of the central deviation in sensory attribute scores for each siomai concentration. In addition, Inferential statistics were applied and analyze using One-way Analysis of Variance (ANOVA). This tool was used to determine significant difference among treatment including appearance/color, aroma/odor, taste/flavor, texture, general acceptability across the four distinct treatment groups of rice eel siomai.

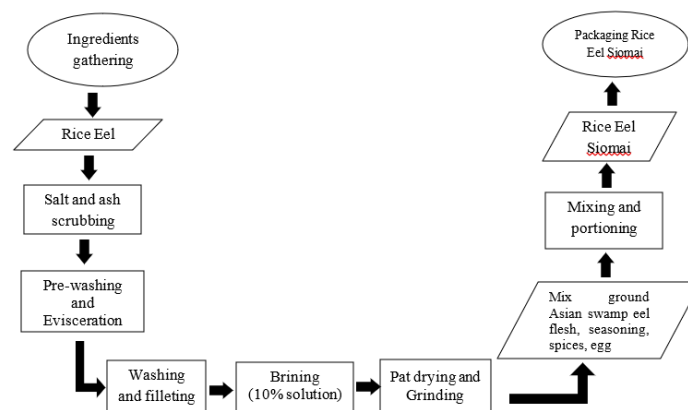


Figure 1. Flow chart for making Asian Swamp Eel Siomai

Results and Discussion

This section presents the analysis and interpretation of data gathered from the foregoing study Utilization and acceptability of Asian swamp eel (*monopterus albus*) and cassava based sagip powder as ingredients in siomai.

Level of Acceptability of the Four Formulations

The level of acceptability of the four formulations in terms of color/appearance, odor/aroma, taste/flavor, texture, and general acceptability is presented in Table 1.

Sensory Attribute	Formulation I	Formulation II	Formulation III	Formulation IV
Color/Appearance	7.96	8.25	7.36	6.93
Odor/Aroma	7.80	8.27	7.51	7.04
Taste/Flavor	7.72	8.21	7.01	5.99
Texture	7.60	8.28	7.20	6.55
General Acceptability	8.01	8.60	7.15	6.63

Table 1. Level of acceptability among the four formulations

As shown in the Table 1, the results show, the color/appearance of Formulation II obtained the highest mean score of 8.25, which corresponds to the descriptive rating of "Like Extremely". This indicates that the respondents highly favored the visual characteristics of this formulation. Color and appearance are considered important sensory attributes because they serve as the initial indicators of product quality and influence consumer expectations prior to tasting (Spence, 2021).

Meanwhile, Formulation I and Formulation III obtained mean scores of 7.96 and 7.36, respectively, both interpreted as "Like Very Much". These results suggest that the respondents also found the color and visual presentation of these formulations highly acceptable. Variations in color intensity, uniformity, and ingredient composition may influence consumer perception and overall product attractiveness (Motoki *et al.*, 2021).

On the other hand, Formulation IV recorded the lowest mean score of 6.93, corresponding to "Like Moderately". Although still within the acceptable range, the lower rating may indicate that the color or visual appeal of this formulation was less attractive compared to the other samples. Previous studies have shown that even slight differences in food color can significantly affect consumer preferences and perceived product quality (Jha *et al.*, 2022; Wang & Spence, 2023). The findings suggest that color/appearance significantly contributed to the acceptability of the formulations, with Formulation II demonstrating the most preferred visual attributes among the samples evaluated. According to research, consumer preferences are greatly influenced by the visual appeal of food products; foods that are more appealing and colorful are frequently accepted more readily (Tiwari & Bhandari, 2021).

The sensory profile of a product, particularly its odor and aroma, serves as a primary determinant of consumer choice and initial product acceptance. The mean scores for the level of acceptability of the four formulations in terms of odor. Based on the results, Formulation II earned the highest mean score of 8.27, qualitatively described as "Like Extremely". The superior performance of Formulation II suggests that its specific aromatic profile resonates most effectively with the olfactory preferences of the evaluators. Odor is a critical sensory attribute because it is often the first characteristic perceived by the consumer, significantly influencing the "halo effect" where a pleasant scent can positively bias the perception of other attributes (Smith & Jones, 2022).

Formulations I and III also received favorable evaluations and were classified under descriptive rating of "Like Very Much" category, with mean scores of 7.80 and 7.51 respectively. On the other hand, Formulation IV recorded the lowest mean score of 7.04, which corresponds to the descriptive rating of "Like Moderately". Although it received the lowest score among the samples, the result still indicates a favorable level of acceptance. The findings shown in table suggest that all formulations were positively perceived by the panelists in terms of odor, although variations in ingredient composition influenced the degree of acceptability.

Aroma is a critical determinant of food acceptability, serving as a primary sensory cue that guides food choice, stimulates appetite, and regulates intake behavior (Forde & de Graaf, 2022). According to the results of earlier research on the significance of aroma in food acceptability, the Formulation 2 were rated as having the noticeable aroma among the Rice eel Siomai fortified with cassava-based Sagip powder in this study.

While odor serves as the initial “gatekeeper” for product selection, the taste and flavor profile is the primary determinant of consumption satisfaction and repeat purchase intention. The mean scores for the level of acceptability of the four formulations in terms of taste and flavor.

As shown in Table 1, Formulation II consistently outperformed the other variants with a mean score of 8.21, described as “Like Extremely”. This signifies its high performance in the odor/aroma category suggesting a strong sensory congruence between how the product smells and how it tastes. Research indicates that such harmony between aroma and taste is critical, as consumers often experience “flavor” as a unified perception of both olfactory and gustatory cues (Chen & Wang, 2021).

Formulation I, which scored 7.72 with the descriptive rating “Like Very Much” while Formulation III which scored 7.01 also kept a good rating of “Like Moderately”. In contrast, Formulation IV received the lowest score of 5.99, falling into the “Like Slightly” category. This significant drop from its odor rating suggests that while the scent was moderately acceptable, the actual palate experience did not meet the panelists’ expectations. According to Bawajeeh *et al.*, (2020) and Elimelech *et al.*, (2024), taste is often regarded as the most decisive factor in food evaluation because it represents the immediate sensory judgment of quality. The lower rating in Formulation IV may be due to an imbalance in flavor intensity or a lingering aftertaste that was not apparent in the aroma phase. Furthermore, Hasan *et al.*, (2023) emphasize that taste consistency is the foundation of consumer loyalty. Thus, the superior and consistent “Extremely Like” ratings of Formulation II across both odor and taste make it the most viable candidate for final product development.

Texture in food refers to the sensory qualities perceived through touch, movement, and sound—primarily in the mouth (mouthfeel) but also by hand. Table 1 shows the mean acceptability scores of the four formulations based on texture. The results show that Formulation II achieved the highest mean score of 7.04, described as “Like Moderately” closely followed by Formulation I and Formulation IV, both also in the moderate acceptance range. Formulation III received the lowest rating of 5.99, labeled as “Like Slightly”.

Remarkably, the texture scores across all samples were notably lower than the scores for odor in Table 2 and taste in Table 3. While Formulation II was “Extremely Liked” for its flavor, its texture only reached a “Moderate” level of acceptance. This difference suggests a sensory decoupling, where the physical properties of the product did not fully match the high quality of its aromatic and gustatory profiles. Research study indicates consumers often prioritize flavor, but a suboptimal texture can limit the overall premium perception of a product Santagiuliana *et al.*, (2021).

Additionally, Nguyen *et al.*, (2023) note that in new product development, achieving a “Like Extremely” rating in texture often requires specialized stabilizers or specific processing temperatures that might not have been fully optimized in this stage. Despite these lower scores, Formulation II remains the most consistent, maintaining the lead in all sensory categories, thereby solidifying its position as the preferred formulation. The sensory evaluation results show a high level of consumer acceptability for Rice Eel Siomai fortified with varying levels of Cassava-Based Sagip Nutri Powder, with most panelists expressing positive preference across all formulations.

General acceptability reflects the overall consumer judgment, integrating all sensory inputs into a single preference rating. The above table shows the mean scores for general acceptability of the four formulations. Formulation II achieved the highest general acceptability score of 8.60 with the descriptive rating of “Like Extremely”. Followed by Formulation I with mean score of 8.01, with the corresponding rating of “Like Very Much”, while Formulations III and IV were rated as “Like Moderately”, with mean score of 7.15 and 6.63, respectively.

The outstanding performance of Formulation II in general acceptability reflects its superior scores in odor/aroma with mean score of 8.27 and taste/flavor with mean score of 8.21, indicating that its highly appealing flavor profile effectively compensated for the more moderate texture. Research note that general acceptability is strongly influenced by taste and aroma, which often serve as the primary determinants of overall liking in sensory evaluations Li *et al.*, (2021).

The notable gap between Formulation II and Formulation IV underscores the importance of achieving sensory balance. While Formulation IV was moderately liked, it lacked the “Extremely Like” ratings observed in the leading sample’s flavor profile. According to Maina (2025), a new product must achieve a general acceptability score of at least 8.00 on a 9-point Hedonic scale to ensure successful market penetration and consumer retention. Accordingly, Formulation II is the only variant surpassing this benchmark, positioning it as the most commercially viable prototype. This conclusion aligns with Torrico *et al.*, (2023), who emphasize that high general acceptability scores are strong predictors of real-world product success.

Most Acceptable Formulation

General acceptability reflects the overall consumer judgment, integrating multiple sensory cues into a single measure of product success. The evaluation of Rice Eel (*Monopterus albus*) Siomai with Cassava based sagip powder across four formulations indicates that Formulation II appears as the most preferred among the panelists as presented in Table 2.

Formulation	General Acceptability
	Mean
Formulation I	8.01
Formulation II	8.60
Formulation III	7.15
Formulation IV	6.63

Table 2. Most acceptable formulation among four treatments

Formulation II achieved the highest mean score of 8.60 with descriptive rating of "Like Extremely", followed by Formulation I with the mean score of 8.01 with the descriptive rating of "Like Very Much". Formulations III and IV were rated lower, with the mean score of 7.15 and 6.63 respectively, corresponding to "Like Moderately".

The performance of Formulation II is driven by its high odor with the mean score of 8.27 and taste/flavor with the mean score of 8.21, indicating strong sensory comparison between aroma and taste. Chen and Wang (2021) note that harmonized taste and aroma create a dominant "flavor" perception, often outweighing attributes such as texture in determining overall liking, explaining why Formulation II remains the clear favorite despite a moderate texture mean score of 7.04.

According to Maina (2025), a score above 8.00 on a 9-point Hedonic scale is a critical benchmark for market readiness and consumer retention. Formulation II surpasses this level, holding a 0.59-point advantage over Formulation I, which reinforces its commercial viability. On the other hand, the lower acceptability of Formulation IV with the mean score of 6.63 highlights how weak flavor intensity or a descriptive rating of "Like Slightly". The taste rating with the mean score of 5.99 can diminish overall perception, regardless of odor or appearance. Torrico *et al.*, (2023) emphasize that general acceptability reflects the dominant sensory cues; in this study, the superior flavor profile of Formulation II was the primary driver of its success.

Nutritive Characteristics of Asian Swamp Eel Siomai in terms of Proximate Composition and Nutrition Facts

	Crude Protein	Crude Fiber	Crude Fat	Moisture	Ash
	%	%	%	%	%
900g Rice Eel flesh,100g Cassava-Based Nutri Powder, F2	15.50	0.58	3.96	67.43	1.79
800g Rice Eel flesh,200g Cassava-Based Nutri Powder, F3	15.41	0.59	4.41	64.99	1.85
700g Rice Eel flesh,300g Cassava-Based Nutri Powder, F4	13.13	1.14	4.79	59.85	2.03

Table 3. Proximate Composition of the Asian Swamp Eel Siomai

As presented in the table, Formulation 2 registered the highest crude protein content at 15.50%, followed by Formulation 3 with 15.41%, and Formulation 4 with lowest crude protein content with 13.13%. Research indicates that the rice eel is a lean, high-protein food source. The precise composition can vary based on the part of the fish analyzed such as protein that has typical protein levels in the raw body range from 18.2% to 18.4% (Djabir *et al.*, 2025; Safitri *et al.*, 2025).

In terms of crude fiber content, Formulation 4 obtained the highest value at 1.14%, followed by Formulation 3 with 0.59%, and Formulation 2 registered with the lowest value of 0.58%.

With the crude fat content, Formulation 4 recorded the highest percentage at 4.79%, followed by Formulation 3 with 4.41%, and Formulation 2 registered the lowest percentage with 3.96%. In terms of moisture content, Formulation 2 registered the highest at 67.43%, Formulation 3 listed 64.99%, and Formulation 4 has the lowest at 59.85%. Therefore, this implies that Lipids (Fats) is generally a low-fat species, with lipid content typically measured between 2.3% and 4.2% (Rosli & Sarbon, 2015).

Finally, in terms of ash content, Formulation 4 showed the highest percentage of 2.03%, followed by Formulation 3 with 1.85%, and Formulation 2 registered the lowest percentage with 1.79%. This result indicates that the rice eel is a lean, high-protein food source. The precise composition can vary based on the part of the fish analyzed such as protein that has typical protein levels in the raw body range from 18.2% to 18.4% (Djabir et al., 2025; Safitri et al., 2025). As the result of the Ash and moisture content of this study it has a good result when it is cooked. On the contrary, the study of the raw muscle typically contains approximately 9.0g/100g of ash and moisture levels ranging from 12.2% to 70.3% depending on whether the sample is raw or dried (Rosli & Sarbon, 2015).

Nutrition Facts Result of the Most Acceptable Formulation

Nutrition Facts		
No. of servings per container: 24		
Serving size: 10g		
Amount per Serving		%RENI
Energy (kcal)	18	1%
Energy from fat (kcal)	4	
Total Fat (g)	0	
Total Carbohydrates (g)	2	
Crude Fiber (g)**	0	
Total Protein (g)	1	2%
*Percent %REI/RNI values are based on 2015 PDRI reference male adult requirement of 19-29 years old.		

Figure 2. Nutrition Facts Result

Based on the nutritional facts, it offers a quantitative profile of a food product’s chemical composition per standard unit of consumption. This analysis is essential for evaluating its contribution to daily dietary requirements and its potential role in health and wellness interventions. This justifies the study of Asian swamp eel for its high protein content, low lipid profile, and richness in bioactive compounds, making it a valuable resource for both dietary therapy and commercial aquaculture (Lei et al., 2023; Safitri et al., 2025).

The nutritional profile of the sample indicates a low-density energy source, providing 18 kcal per 10g serving, which represents only 1% of the Recommended Energy and Nutrient Intake (%RENI) for a reference adult male (19–29 years old). The total caloric content, approximately 22% is derived from fat (4 kcal), though the total fat content per serving is negligible at 0g. The carbohydrate component is measured at 2g, with no detectable crude fiber, while the protein content stands at 1g, contributing 2% toward the daily recommended intake. These findings indicates that the product is a light, low-protein, and low-carbohydrate food item, likely functioning as a supplement or a minor dietary component rather than a primary source of macronutrients.

Significant Differences among Four Formulations

Sensory Attribute	Color/ Appearance	Odor/ Aroma	Taste/ Flavor	Texture	General Acceptability
Formulation I	7.96	7.80	7.72	7.60	8.01
Formulation II	8.25	8.27	8.21	8.28	8.60
Formulation III	7.36	7.51	7.01	7.20	7.15

Formulation IV	6.93	7.04	5.99	6.55	6.63
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Table 4. Differences among Four Formulations

The data reveals distinct variations across the four formulations, highlighting a clear preference for Formulation II as the superior variant across all parameters. Formulation II consistently achieved the highest scores, peaking in General Acceptability (8.60) and maintaining strong performance in texture (8.28) and odor (8.27). This suggests that the specific ratio of ingredients in this formulation optimized the synergistic relationship between visual appeal and palatability. In contrast, Formulation I served as a strong secondary performer, maintaining stable scores in the 7.60 to 8.01 range, indicating a reliable but less preferred sensory profile compared to Formulation II.

A significant decline in sensory quality is observed in Formulation III and Formulation IV, with the latter receiving the lowest scores across all categories. The most notable disparity is found in the Taste/Flavor attribute, where Formulation IV dropped to a score of 5.99, a sharp contrast to Formulation II's 8.21. This downward trend suggests that the modifications made in Formulation IV—likely an over-concentration or dilution of key components—negatively impacted the organoleptic properties, particularly texture (6.55) and color (6.93). Ultimately, the data indicates that while Formulations I and II are highly acceptable, Formulation IV fails to meet the sensory threshold for general consumer preference, establishing a clear hierarchy in product quality.

Conclusion and Recommendations

Based on the results of the study, the level of acceptability of the four Asian Swamp eel siomai formulations varied in terms of appearance, aroma, texture, flavor and general acceptability. Formulation II emerged as the most preferred product across all sensory attributes, receiving “Like Extremely” ratings in color, aroma, taste, and overall acceptability. Its strong visual appeal and pleasant aroma positively influenced consumer perception, resulting in high flavor satisfaction. In contrast, Formulation IV showed weaker taste performance, indicating possible flavor imbalance. Although texture ratings were generally lower for all formulations, Formulation II still led in this aspect.

Among the four formulations, Formulation II, was identified as the most acceptable formulation based on its highest general acceptability score. The inclusion of Cassava-Based Sagip Nutri-Powder not only serves as a functional binder but also enhances the overall general acceptability of the product, making it a “Like Extremely” rated food item.

The phytochemical analysis revealed that among all four formulations of the Asian swamp eel siomai, formulation II has the highest crude protein and moisture content. On the other hand, the presence of crude fiber, crude fat, and ash content is registered the lowest percentage. Meanwhile, the nutritional profile of the sample indicates a low-density energy source, providing 18 kcal per 10g serving, which represents only 1% of the Recommended Energy and Nutrient Intake (%RENI) for a reference adult male (19–29 years old). The total caloric content, approximately 22% is derived from fat (4 kcal), though the total fat content per serving is negligible at 0g. The carbohydrate component is measured at 2g, with no detectable crude fiber, while the protein content stands at 1g, contributing 2% toward the daily recommended intake. These findings suggest that the product is a light, low-protein, and low-carbohydrate food item, likely functioning as a supplement or a minor dietary component rather than a primary source of macronutrients. It also emphasizes the health benefits of the siomai, the presence of beneficial phytochemicals, and the importance of supporting local farmers and sustainable agriculture in the Philippines

Considering the findings, the study recommends among the four formulations, Formulation II is the most recommended formulation for livelihood and consumption, as it achieved the highest level of holistic sensory evaluation. Future studies may perform shelf-life and microbial analysis to determine the product's storage stability and safety for commercial distribution. May include potato as source of fat to improve the texture of the product. Perform longer time of steaming to achieve the desired softness. Utilize all edible parts of the Asian Swamp eel specially the spinal cord and skin. The Local government units (LGUs) and entrepreneurs may consider adopting the IEC materials developed in this study to promote Asian Swamp Eel as a sustainable livelihood and a nutritious food solution for commercialization. Government agencies and community organizations may promote the utilization of Asian Swamp eel and cassava-based Sagip powder as alternative food resources to support food security and local livelihood development.

Acknowledgement

The completion of this endeavor, like any significant undertaking, is rarely the result of solitary effort. This acknowledgement serves as a heartfelt expression of gratitude to the numerous individuals and entities whose invaluable

support, guidance, and contributions have been instrumental in bringing this work to completion. Their assistance, in its various forms, has been deeply appreciated and has shaped the outcome in profound ways.

The author therefore wishes to express his praises to the almighty GOD for his continuous blessings, guidance, and providing his hope, courage, and strength physically and spiritually that enriched his years of education and spiritual living. The author wishes to convey his profound warm appreciation and heartfelt gratitude to the people who extended and shared their support that inspired him during the conduct of the study.

Prof. MARTINA DELOS REYES-PEÑALBER, EdD, his thesis adviser, for her invaluable guidance, encouragement, and continuous support throughout the conduct of this research. Her expertise, patience, and constructive suggestions greatly contributed to the successful completion of this study.

Prof. HAZEL BETH M. BAUTISTA, EdD, for their time, expertise, and insightful comments that helped improve the quality of this research

Dr. NIKKI JOYCE C. CURAN, EdD, for her insightful comments, valuable feedback and recommendations during the evaluation of this study.

Prof. MYLEEN R. CORPUZ, PhD, External Evaluator, and MARINEL P. DAYAWON, PhD, Dean, College of Education for their professional insights and support in the improvement of this research.

MARIO P. TAMANA, PhD, Program Chair of the Central Graduate School, and FLORENDA B. TEMANEL, PhD, Dean of the Central Graduate School, for their leadership, encouragement, and commitment to academic excellence which greatly supported the completion of this study.

MA. CORAZON M. VERBO, for her untiring concern and repeated follow-ups throughout the duration of the study. Profound thanks are given to the respondents of this study for their cooperation, for without them this study would not have been completed.

Special thanks to INOFEMIA G. GUADO, EdD, Principal II for her unending support throughout the duration of this study.

To his loving mother, MARILYN D. BINAG, for her endless sacrifices, guidance, and understanding, which served as a constant source of strength and inspiration. To his father, DANILO T. BINAG, for his steadfast support, wisdom, and motivation that helped them persevere in times of difficulty. To his cherished siblings, ANTONIO D. BINAG II and MATT DARYL D. BINAG, for their encouragement, companionship, and for always believing in their capabilities.

Funding

This research received no external funding from any public, commercial, or not-for-profit funding agency, and no organization provided financial support for the conduct of the study, authorship, or publication of this article.

Competing Interests Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study; all data used were obtained from previously published sources as cited in the reference list.

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Appendices

No appendices are attached to this study.