

Production of Tugi-Based Noodle

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ABSTRACT: This study investigated the production and acceptability of noodles made from Tugi (*Dioscorea esculenta*), an indigenous tuber in the Philippines. The research involved two phases: preparation of Tugi flour and formulation of tugi-based noodles. Physicochemical and nutritional analyses were conducted. The sensory evaluation was performed among 60 respondents: 30 consumers and 30 food experts. The noodles were evaluated in terms of appearance, aroma, taste, and texture across three treatments: Treatment 1 (100% Tugi flour), Treatment 2 (70% Tugi flour and 30% all-purpose flour), and Treatment 3 (50% Tugi flour and 50% all-purpose flour). Results revealed that Treatment 3 achieved the highest acceptability ratings, with respondents describing it as “Like Extremely” across most sensory attributes, closely comparable to the standard recipe made from 100% all-purpose flour. Treatment 2 was rated “Like Very Much,” showing improved sensory qualities compared to pure tugi flour, while Treatment 1 was moderately acceptable. Statistical analysis confirmed no significant difference in general acceptability between consumer and food expert, reinforcing the consistency of the findings. Cost-benefit analysis indicated economic viability, and shelf-life testing demonstrated stability under room temperature storage. Overall, the study highlights that partial substitution of wheat flour with Tugi flour—particularly at a 50:50 ratio—produces noodles that are nutritious, acceptable, and culturally relevant. These findings underscore the potential of Tugi-based noodles to support healthier diets, sustainable agriculture, local entrepreneurship, and the preservation of indigenous food heritage.

KEYWORDS: Tugi Flour, Tugi-based Noodle, Sensory Evaluation, Physicochemical and Nutritional Analysis

INTRODUCTION

The Philippines is well known for its rich cultural heritage, which presents a melting pot of flavors and textures that inspire culinary innovation (Dionio, 2022). Among the many dishes that grace Filipino tables, *pancit*—the Filipino term for noodles—holds a special place. These noodle dishes are woven into the fabric of Filipino life, from celebratory *pancit palabok* to everyday *pancit canton*. However, beneath the familiar strands of wheat flour lies an opportunity to reconnect with indigenous ingredients that have sustained communities for generations.

Noodles are popular food products worldwide (Triwara et al., 2023), with global production reaching 14 million tons annually. Their convenience and versatility have driven this popularity (Roobab et al., 2023). Noodles are especially favored because they are easy to cook, inexpensive, and have a long shelf life. However, their practicality is often offset by health concerns. Most noodles are made from wheat flour, which is low in protein and nutrients and offers limited functional health benefits (Zang et al., 2022). Wheat flour has also been linked to health issues such as a high glycemic index and gluten intolerance (Ang et al., 2020). As consumers increasingly prioritize health, there is growing interest in enriching noodles with nutritious ingredients and using alternative flours, such as gluten-free and high-protein seed flours (Obadi et al., 2021). Most commercially available noodles do not meet the body’s balanced nutritional needs, and instant noodles are often considered unhealthy (Ko et al., 2022), opening up opportunities to develop healthier options.

In recent years, the culinary landscape has seen a rise in fused cuisines, where traditional recipes are reimagined to cater to evolving palates and dietary preferences. One of the most promising alternative ingredients is root crops and tubers. In the Northern Philippines alone, indigenous communities have identified more than 20 roots and tubers, including 10 cultivated species and over 10 wild varieties (Gayao et al., 2016). Among these is *Tugi* (*Dioscorea esculenta*), commonly referred to as lesser yam or Asiatic yam—an underutilized yet nutritionally rich tuber native to the Philippines. It has high starch content, which makes it an excellent energy source, and its abundance of essential vitamins and minerals, including dietary fiber, potassium, and vitamin C. It thrives in the mountainous regions of Luzon, particularly in provinces such as Pangasinan, La Union, Bataan, Cagayan, and Benguet, where it has traditionally been cultivated by local farmers.

Despite its nutritional value and adaptability, *Tugi* remains underutilized in mainstream food innovation—such as noodle formulations. This gap in research and development highlights a missed opportunity to elevate indigenous crops in modern culinary

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applications. There is limited scientific literature on its functional properties, processing potential, and consumer acceptability when used in value-added products like noodles. Additionally, few studies have examined its economic viability or its role in promoting food security and sustainable agriculture.

This research aimed to address these gaps by exploring *Tugi* as a primary ingredient in noodle production, assessing its nutritional benefits, processing characteristics, and market potential. By doing so, the study not only contributes to the diversification of healthier noodle options but also helps invigorate the local agricultural market. Promoting *tugi* as a viable commercial crop can encourage farmers—especially in mountainous regions of Luzon—to cultivate it more consistently, helping reduce its scarcity and create new livelihood opportunities.

Moreover, by integrating *Tugi* into modern food systems, this study supports the preservation of indigenous knowledge and biodiversity. It empowers local communities by recognizing the value of their traditional crops and aligning them with current health and sustainability trends. Ultimately, this research bridges the gap between heritage and innovation, offering a pathway toward inclusive, nutritious, and culturally rooted food solutions.

This study is aligned with several Sustainable Development Goals (SDGs) that support health, sustainability, and food security. It addresses SDG 2: Zero Hunger by promoting the use of locally available and nutritious ingredients like *Tugi*, thereby improving access to healthy food. It contributes to SDG 3: Good Health and Well-being by offering a nutrient-rich alternative to conventional noodles, thus helping improve diets and overall wellness. For SDG 8: Decent Work and Economic Growth, the study encourages local farming and food entrepreneurship, supporting livelihoods and community-based agricultural practices. SDG 9: Industry, Innovation and Infrastructure is also reflected in the development of innovative food products that integrate indigenous ingredients into modern culinary applications. Lastly, SDG 12: Responsible Consumption and Production is supported by encouraging the use of sustainable, locally sourced ingredients.

Addressing the underutilization of *Tugi* is crucial for a more sustainable and health-conscious future. This study explored its untapped potential to reduce food waste while offering a nutritious and cost-effective alternative to traditional noodle. It aimed to demonstrate that *Tugi*-based flour can meet the demands of health-conscious consumers and support the development of healthier noodle using locally grown crops.

STATEMENT OF THE PROBLEM

This study aimed to develop and determine the acceptability of Tugi-based noodle. Specifically, it sought to answer the following questions:

1. What are the processes involved in the preparation of Tugi flour and Tugi-based noodle?
2. What is the physicochemical analysis and nutritive value of the developed Tugi flour and Tugi-based noodle?
3. What is the level of acceptability of the Tugi-based noodle, in terms of sensory evaluation, among the three treatments as evaluated by the different groups of respondents?
 - a. Appearance
 - b. Aroma
 - c. Taste
 - d. Texture
4. What is the general level of acceptability of the developed Tugi-based noodle as evaluated by the different groups of respondents?
 - a. Consumer
 - b. Food Experts
5. Is there a significant difference in the general level of acceptability of the Tugi-based noodle as evaluated by the different groups of respondents?
6. What is the cost benefit analysis of the developed Tugi-based noodle?
7. What is the shelf life and storage stability of Tugi flour and Tugi-based noodles at room temperature?

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TUGI (*Dioscorea esculenta*)



Fig. 1: Photo of Tugi

According to an article produced by Specialty Produce (n.d.), Tugi is a small to large tuber, averaging 15 to 20 centimeters in length and 6 to 8 centimeters in diameter, depending on growing conditions. It has a bulbous, slender, and oblong shape with slightly tapered to blunt, curved ends. The tubers range from 250 to 1,000 grams in weight and have thin, rough, textured skin that varies from pale brown to dark brown. The surface is often covered in tiny root hairs, giving it a hairy, shaggy appearance. Underneath the skin, the flesh is ivory to cream-colored, dense, and starchy. Once cooked, the flesh develops a soft, tender, fluffy, chewy, and thick consistency. *Tugi* is typically consumed after cooking and has a nutty, starchy, mild, and sweet flavor. The tubers are generally sweeter than potatoes and possess a subtle chestnut-like taste.

Nutritional Value

Tugi is a source of calcium to build strong bones and teeth, potassium to balance fluid levels within the body, iron to develop the protein hemoglobin for oxygen transport through the bloodstream, magnesium to control nerve functions, and other nutrients, including zinc, B vitamins, manganese, and other antioxidants. The tubers are known for their anti-inflammatory properties and are topically applied to swellings, boils, rashes, and other skin irritations.

Applications

Tugi has a neutral, mild, subtly sweet, and starchy taste suited for cooked preparations, especially when boiled, roasted, fried, or steamed. The tubers are typically cooked and peeled, revealing a soft flesh popularly dipped in sugar and eaten as a snack. Tugi is also sliced and fried into chips, cooked in methods used to prepare potatoes, or boiled and served with black coffee. In the Philippines, Tugi is cooked in coconut milk or simmered into a vegetable soup known as buridibod or buridibud. This soup has many variations with ingredients such as spinach, winged beans, fried fish, edible flowers, and herbs. Tugi pairs well with aromatics such as garlic, ginger, and onion, tomatoes, moringa leaves, beans, drumsticks, meats including poultry, pork, and beef, and seafood such as fish, shrimp, and clams. Whole, unwashed, and uncooked Tugi will keep for several weeks to months when stored in a cool, dry, and dark place.

Current Facts

Tugi, botanically classified as *Dioscorea esculenta*, is a tropical species belonging to the Dioscoreaceae family. The tubers develop on a perennial vining plant extending over 2.4 meters in length, and the vines are spiny and climbing, creeping over trees, rocks, walls, and trellises. The vines bear distinct heart-shaped leaves, and each plant can grow anywhere from 20 to 50 tubers per season. Tugi is the name for the species in Tagalog, a language spoken in the Philippines, and the Southeast Asian plant is also known by other names, including Apali, Cheru Kizhangu, Nana Kizhangu, Kaate Kanaga, Potato yam, Lesser yam, Asiatic yam, Siruvalli Kilangu. There are two main types of Tugi, cultivated and wild varieties, and the cultivated plants are grown on a small scale through specialty farms and in home gardens. Tugi is not as widespread as other commercial tubers, but the species has remained a secondary crop valued for its extended storage capabilities, nutritional content, and hardness. The species is traditionally cooked and consumed in a wide array of sweet and savory preparations.

Ethnic/Cultural Information

In the Philippines, Tugi is a traditional food served during the annual Fiesta de La Purisima Concepcion. The celebration is held in Santa Maria in Bulacan on a Thursday in February and features several customary masses and events that Santa Maria residents participate in as a community. Cooked Tugi is one of the most popular items sold through street vendors during this festival and is

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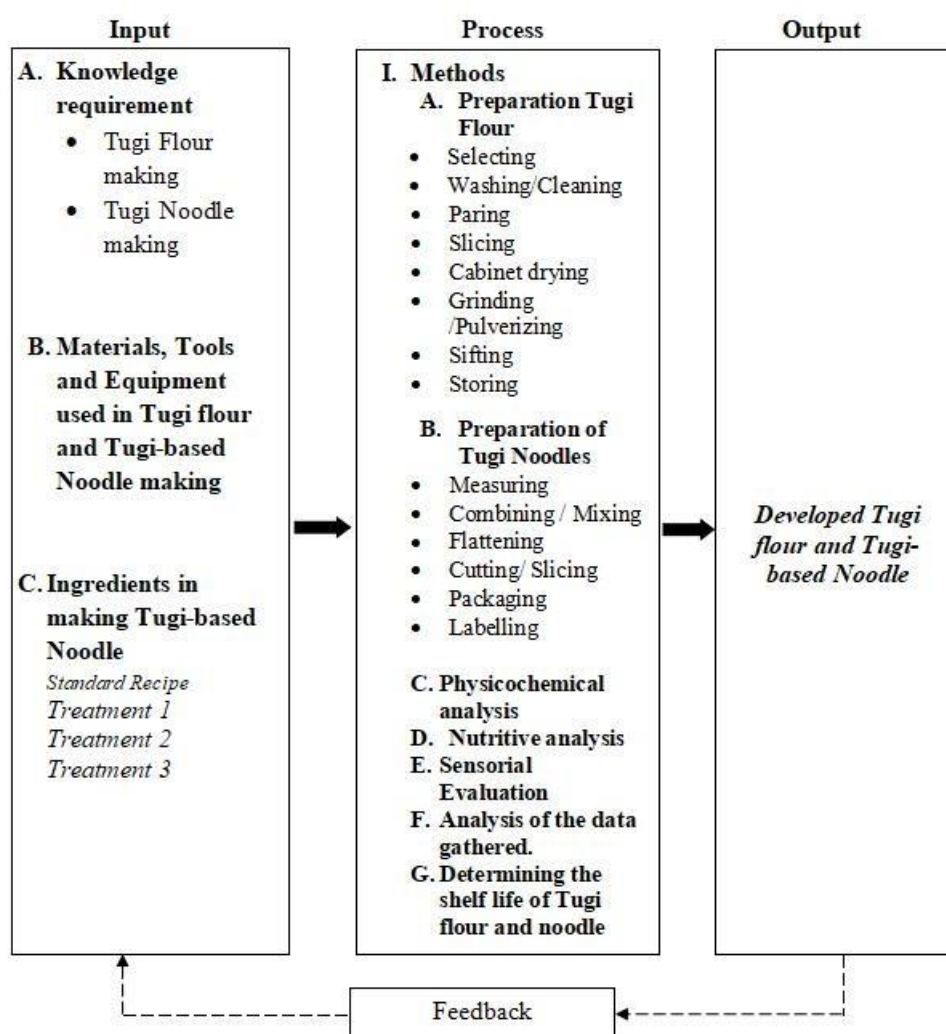
considered a delicacy. The tubers are delicately stacked in baskets and sold cooked and ready to eat just outside of the town's central church, also known as La Purisima Concepcion. Local legends throughout the town claim that visions of Saint Mary have been seen walking through the plots of Tugi tubers that are being grown for the festival, and the plants are specifically sown beside villages for the sole purpose of selling during the festival. Tugi is considered a food closely associated with Saint Mary and the cooked tubers are given as an offering at the annual celebration.

Flour Production in the Philippines

Flour production in the Philippines has a long history that reflects both industrial growth and agricultural dependency. The industry began in 1958 with the establishment of Republic Flour Mills (RFM), marking the country's entry into large-scale flour milling. Over the decades, the sector expanded significantly, with more than 21 flour mills operating nationwide today, concentrated in Metro Manila, Bulacan, Batangas, Cebu, Iloilo, Iligan, and Davao. These mills supply flour primarily for bakeries, noodle manufacturers, and food processors, making flour one of the most essential commodities in the Philippine food system. However, the country remains heavily dependent on imported wheat, as the tropical climate does not support large-scale wheat cultivation.

Conceptual Model of the Study

On the basis of the previous concepts, theories and findings in the related literature and studies, a conceptual model was developed as shown below:



The conceptual model, as illustrated above shows the different stages of the processes involved in order to answer the problem in the study.

The input stage includes the necessary knowledge about Tugi flour making and Tugi-based noodle making, along with the materials, tools, and ingredients required for noodle preparation.

The process stage involves the preparation and processing of Tugi flour which includes the following steps selecting, washing, peeling, slicing, drying, grinding, sifting, storing. This is followed by the preparation of Tugi flour into noodle including steps such as measuring, combining / mixing, flattening and cutting / slicing, packaging and labelling. A physicochemical and nutritional

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assessment were done to ensure the quality and health benefits of the product. Followed by sensory evaluation, data analysis and determining the shelf life of the product at room temperature.

Finally, the output stage consists of evaluating the acceptability of the developed noodle based on appearance, texture, taste, and overall sensory attributes. This thorough assessment helped to determine the feasibility and consumer preference for Tugi-based noodle. The study focused on ensuring nutritional value, sensory quality, and economic practicality in developing an alternative noodle option.

MATERIALS

Table 1. Tools and Equipment Needed in the Preparation of Tugi Flour and Tugi Noodle

TOOLS, MATERIALS AND EQUIPMENT USED					
Preparatory Tools	Measuring Tools	Mixing Tools	Cutting Tools	Cooking Tools	Equipment
Flour Sifter Utility Tray	Measuring Spoons	Mixing Bowls	Wire Dough Cutter	Wok	Dough Roller
Chopping board	Measuring Cups	Whisk	Knife	Casserole	Gas Range
Rolling Pin	Weighing Scale	Spoon	Grater		Dehydrator
Spatula					Pulverize Machine
Bowl					
Plate					
Basin					
Kneading Table					

Ingredients

Table 2. Raw Materials Used in the Preparation of Tugi Flour

Raw Ingredient (g)	Fresh weight (g)	Powder Yield (g)
1,000 grams Tugi tuber	800 grams Tugi tuber	Proximately 250 grams of Tugi flour

Table 3. Proportion of Ingredients Used in the Preparation of Tugi-based Noodle

Ingredients	Standard Recipe	Treatment 1	Treatment 2	Treatment 3
Tugi Flour	0 g 560 g	560 g	390 g	280 g
All-purpose Flour		0 g	170 g	280 g
Egg	6 pcs	6 pcs	6 pcs	6 pcs
Salt	25 g	25 g	25 g	25 g
Cooking Oil	30 g	30 g	30 g	30 g

Developmental Procedures

This study utilized Tugi flour which is produced through a series of carefully executed steps. The process began with the selection of high-quality Tugi crops, which are then dried, finely ground, and sifted to create smooth, refined Tugi flour. Once the flour is prepared, the next stage involved making Tugi-based noodles. The entire process is visually represented in Figure 3.

Preparation of Tugi Flour

The preparation of Tugi flour began in selecting quality tubers, washing, paring, and slicing them. The slices are dried in a cabinet dryer, ground into powder, sifted for smoothness. Finally, the processed flour is properly stored, packed and labelled maintaining its quality for future use.

Preparation of Tugi Noodle

The production of Tugi-based noodles started with accurately measuring of all needed ingredients. Once measured, it was kneaded into a smooth, elastic dough. Upon reaching the ideal texture and consistency, the dough was carefully rolled into a thin sheet, then cut into uniform portions according to the desired noodle size. The prepared noodles were packed, properly labelled then ready for cooking, ensuring a high-quality final product.

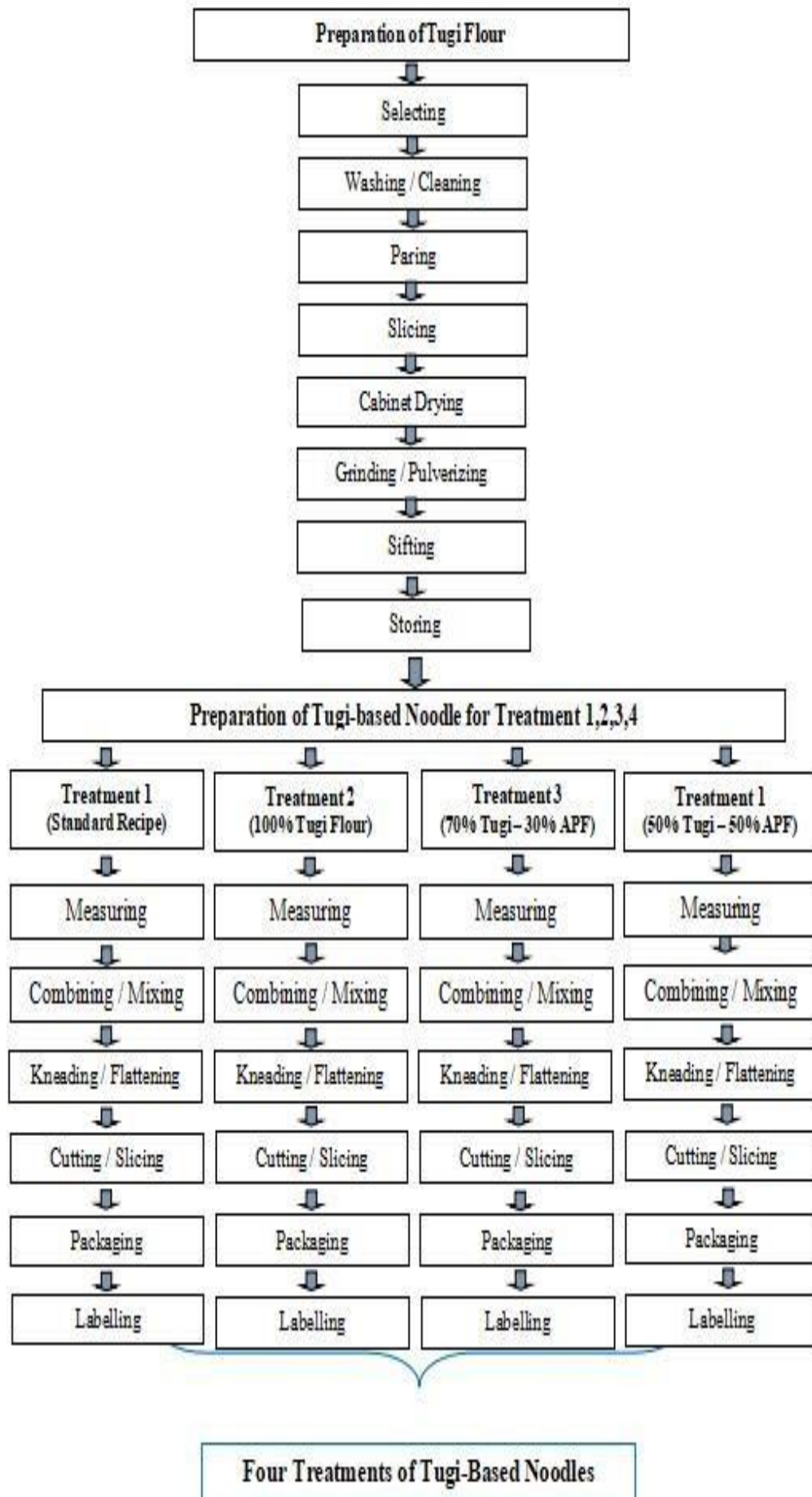


Figure 3. The Flow Diagram of the Procedure for Tugi-based Noodle

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Sensory Evaluation

The products were subjected to sensory evaluation by sixty (60) evaluators from varied groups, including consumers (30), and food experts (30). The 30 consumers were housewives, local farmers and regular costumers of the different panciteria in the City of Ilagan. The 30 food experts were food technology teachers from the different schools of San Antonio region and food technology teachers from Isabela State University – City of Ilagan campus and panciteria owners or workers from the City of Ilagan.

These evaluators were purposively selected and properly oriented on how to evaluate the products using standardized evaluation instruments. The study was conducted in the second semester of Academic Year 2025–2026. The different noodles were prepared using Tugi flour. Each respondent was asked to taste the samples of each product. Data on the appearance, aroma, taste, and texture of each product were collected and subjected to statistical analysis.

The evaluation was conducted using evaluation cards through a quantitative analysis method to determine the level of acceptability of the product. The acceptability of the Tugi-based noodle in terms of appearance, aroma, taste, and texture was assessed using a nine-point Hedonic scale, as follows:

Scale	Numerical Rating	Descriptive Rating
9	8.12 – 9.00	Like Extremely (LE)
8	7.23 – 8.11	Like Very Much (LVM)
7	6.34 – 7.22	Like Moderately (LM)
6	5.45 – 6.33	Like Slightly (LS)
5	4.56 – 5.44	Neither Like nor Dislike (Neutral) (NL)
4	3.67 – 4.55	Dislike Slightly (DS)
3	2.78 – 3.66	Dislike Moderately (DM)
2	1.89 – 2.77	Dislike Very Much (DVM)
1	1.00 – 1.88	Dislike Extremely (DE)

RESULT AND DISCUSSION

Product Development

Table 4. Processes Involved in Developing Tugi Flour

INGREDIEN/SM	Measurement After Paring	Measurement After Drying
Tugi	800 grams	Proximately 250 grams
Yield: 250 grams of Tugi Flour		

Table shows the measurement, ingredients and yield proximate of more than 250 grams of Tugi flour. In order to produce a high quality of a Tugi flour, the process started with selecting good quality of Tugi tubers, washing the Tugi tubers, paring, slicing, placing the Tugi in a dehydrator for about 5-8 hours (depending on the desired dryness you want), pulverizing, sifting and storing.



Figure 4

Table 5. Proportion of Ingredients and Process Involved in the Preparation of the Tugi-based Noodle

Ingredients	Standard Recipe	Treatment 1	Treatment 2	Treatment 3
Tugi Flour	0 g	560 g	390 g	280 g
All-purpose Flour	560 g	0 g	170 g	280 g
Egg	6 pcs	6 pcs	6 pcs	6 pcs
Salt	25 g	25 g	25 g	25 g
Cooking Oil	30 g	30 g	30 g	30 g
Yield (Noodle): 1, 050 grams		1,030 grams	1,000 grams	1, 050 grams

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The table presents the formulation and preparation process of the tugi-based noodle across treatments, showing how ingredient proportions affect yield and production. In the standard recipe, noodles were prepared using 560 grams of all-purpose flour, six eggs, 25 grams of salt, and 30 grams of cooking oil, producing a yield of 1,050 grams. Treatment 1 replaced all-purpose flour entirely with 560 grams of tugi flour, maintaining the same amounts of eggs, salt, and oil, resulting in a slightly lower yield of 1,030 grams.

Treatment 2 blended 390 grams of tugi flour with 170 grams of all-purpose flour, while keeping the other ingredients constant, producing 1,000 grams of noodles—the lowest yield among the treatments. Treatment 3 balanced the formulation with equal portions of tugi flour and all-purpose flour (280 grams each), alongside the same fixed amounts of eggs, salt, and oil, yielding 1,050 grams, equal to the standard recipe.

The process of making the noodles began with accurately measuring of all needed ingredients. Once measured, dry ingredients were mixed thoroughly until well combined followed by adding the wet ingredients into the mixture. It was kneaded into at least 5 to 10 minutes until the desired smoothness; elasticity of the dough is achieved. Upon reaching the ideal texture and consistency, the dough was carefully rolled into a thin sheet, then cut into uniform portions according to the desired noodle size. The prepared noodles were packed, properly labelled then ready for cooking, ensuring a high-quality final product.

Table 6. Report on Physicochemical Analysis and Nutritive Value of the Developed Tugi Flour and Tugi-based Noodle

Parameters	Pure Tugi Flour	T1: 100% Tugi	T2: 70% Tugi / 30% APF	T3: 50% Tugi / 50% APF
Moisture Content	6.83	30.50	31.93	32.59
Total Ash	2.00	1.20	1.30	1.40
Total Lipid	0.80	8.50	9.20	10.00
Total Protein	6.00	10.50	11.80	13.00
Total Fiber	8.50	6.50	5.20	4.00
Total Carbohydrates	75.87	42.80	40.57	39.01
TOTAL	100	100	100	100
Metabolized Energy (kcal/3g)	10.67	12.33	12.82	13.31

Table presents the proximate composition of Tugi Flour and the developed Tugi-based noodles across three treatments: T1 (100% Tugi flour), T2 (70% Tugi / 30% all-purpose flour), T3 (50% Tugi / 50% allpurpose flour) Moisture content was retained as measured, while other components were proportionally expressed to total 100%.

The proximate analysis of pure Tugi flour revealed that it is predominantly composed of carbohydrates (75.87%), making it a rich source of energy. The flour also contained appreciable amounts of dietary fiber (8.50%), which suggests potential health benefits in terms of digestive regulation and satiety. Protein content was measured at 6.00%, indicating moderate contribution to nutritional quality, while lipid content was relatively low (0.80%), supporting its classification as a low-fat food product. The ash value (2.00%) reflects the presence of essential minerals, while the moisture content (6.83%) suggests good storage stability when properly handled. The calculated metabolized energy was 3.55 kcal per gram, aligning with its high carbohydrate composition. These highlight Tugi flour as a carbohydrate-dense, fiber-rich ingredient with moderate protein levels, suitable for food innovation aimed at enhancing nutritional value while maintaining functional properties.

The results indicate that increasing substitution of all-purpose flour (APF) significantly influenced the nutritional profile of Tugi-based noodles. Moisture content increased from T1 (30.50%) to T3 (32.59%), suggesting that APF contributes to higher water retention capacity. In contrast, Pure Tugi flour exhibited significantly lower moisture (6.83%), reflecting its raw, unprocessed state. Ash content, an indicator of mineral composition, slightly increased with APF incorporation, with the highest value observed in pure Tugi flour (2.00%). This suggests that Tugi flour is inherently rich in minerals. Lipid content increased progressively from T1 (8.50%) to T3 (10.00%), indicating that blending with APF enhances fat retention or absorption during processing. However, pure Tugi flour showed minimal lipid content (0.80%).

Protein content followed an increasing trend, with T3 having the highest (13.00%). This implies that partial substitution with APF improves protein availability, likely due to gluten contribution. Fiber content decreased as APF increased, confirming that Tugi flour is a superior source of dietary fiber. Pure Tugi flour recorded the highest fiber (8.50%), reinforcing its functional food potential. Carbohydrates decreased from T1 to T3 but were highest in pure Tugi flour (75.87%), indicating that pure Tugi flour is carbohydrate-dense but less balanced nutritionally compared to blended formulations. Metabolized energy values increased with APF incorporation, with T3 having the highest energy (4.44 kcal/g), suggesting improved caloric density in blended formulations.

The result as per analyzed by the Laboratory technician and analyst of Quirino State University – Diffun Campus, Sir Denson M. Liday found out that result of the developed Tugi-based noodles is safe for human consumption.

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Table 7.1. Level of Acceptability of the Developed Tugi – Based Noodle in Terms of Sensory Evaluation

Indicators	Mean	Sd	Description
Standard Recipe (100% All-purpose Flour)			
APPEARANCE			
1.Pleasing combination of colors and forms.	8.32	1.05	Like Extremely
2.Rich, vibrant and visually appealing.	8.22	1.14	Like Extremely
3.The noodle looks appetizing and inviting.	8.32	1.10	Like Extremely
Average	8.28	1.05	Like Extremely
AROMA			
1.The aroma of the noodle is pleasant.	7.97	1.02	Like Very Much
2.The aroma of the noodle compliments the ingredients used.	7.93	1.01	Like Very Much
3.The aroma of the noodle stimulates appetite.	7.97	0.97	Like Very Much
Average	7.95	0.97	Like Very Much
TASTE			
1.A balanced, well-blended; all ingredients complement each other.	7.97	1.09	Like Very Much
2.The noodle is highly nutritious and delicious.	8.02	1.08	Like Very Much
3.The flavor profile has a smooth and pleasing aftertaste.	7.98	1.02	Like Very Much
Average	7.99	1.02	Like Very Much
TEXTURE			
1.Soft and slightly chewy texture.	8.18	1.16	Like Extremely
2.The noodle is pleasant in the mouth.	8.23	1.11	Like Extremely
3.The noodle complements its appearance.	8.35	1.05	Like Extremely
Average	8.25	1.07	Like Extremely
Overall Average	8.12	0.91	Like Extremely

The table presents the level of acceptability of the Tugi-based noodle using the standard recipe made from 560 grams of all-purpose flour, as evaluated by the respondents in terms of appearance, aroma, taste, and texture.

In terms of appearance, the noodle obtained very high mean scores ranging from 8.22 to 8.32, with an average of 8.28 described as “Like Extremely,” indicating that respondents found the product visually appealing, with a pleasing combination of colors and an appetizing look. For aroma, the noodle received slightly lower but still favorable ratings, with mean scores between 7.93 and 7.97 and an average of 7.95 interpreted as “Like Very Much,” suggesting that the smell of the noodle was pleasant and effectively stimulated appetite. In terms of taste, the product also performed well, with mean values ranging from 7.97 to 8.02 and an average of 7.99 described as “Like Very Much,” reflecting that respondents appreciated its balanced flavor and satisfying aftertaste. Meanwhile, texture received some of the highest evaluations, with mean scores from 8.18 to 8.35 and an average of 8.25 interpreted as “Like Extremely,” indicating that the noodle’s softness and chewiness were highly preferred. Overall, the standard recipe achieved an overall mean of 8.12, described as “Like Extremely,” demonstrating that it is highly acceptable to the respondents across all sensory attributes.

The standard recipe achieved the highest acceptability, with appearance and texture rated “Like Extremely” and aroma and taste rated “Like Very Much.” Respondents found the noodles visually appealing, aromatic, flavorful, and pleasantly chewy. This outcome reflects the established sensory dominance of wheat flour. Huang et al. (2021) showed that wheat noodles fortified with isomaltodextrin retained excellent sensory qualities and texture during storage, confirming wheat’s strong gluten network as the basis for elasticity and chewiness. Likewise, Jia et al. (2025) emphasized that wheat flour’s protein and starch composition directly governs noodle springiness and mouthfeel, explaining the superior ratings in your standard recipe.

In summary, the standard recipe is highly acceptable in all sensory aspects, particularly in appearance and texture, which were rated “Like Extremely,” while aroma and taste were rated “Like Very Much.” This indicates that the product is well-received by respondents and serves as a strong basis for comparison with other formulations.

Table 7.2. Level of Acceptability of the Developed Tugi – Based Noodle in Terms of Sensory Evaluation

Indicators	Mean	Sd	Description
Treatment 1 (100% Tugi Flour)			
APPEARANCE			
1.Pleasing combination of colors and forms.	6.72	1.40	Like Moderately
2.Rich, vibrant and visually appealing.	6.68	1.50	Like Moderately
3.The noodle looks appetizing and inviting.	6.70	1.54	Like Moderately
Average	6.70	1.45	Like Moderately

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AROMA

1.The aroma of Tugi noodle is pleasant.	7.13	1.37	Like Moderately
2.The aroma of Tugi noodle compliments the ingredients used.	7.13	1.32	Like Moderately
3.The aroma of Tugi noodle stimulates appetite.	7.13	1.37	Like Moderately
Average	7.13	1.33	Like Moderately

TASTE

1.A balanced, well-blended; all ingredients complement each other.	6.83	1.45	Like Moderately
2.The noodle is highly nutritious and delicious.	7.10	1.47	Like Moderately
3.The flavor profile has a smooth and pleasing aftertaste.	6.75	1.32	Like Moderately
Average	6.89	1.35	Like Moderately

TEXTURE

1.Soft and slightly chewy texture.	6.42	1.36	Like Moderately
2.The noodle is pleasant in the mouth.	6.48	1.45	Like Moderately
3.The noodle complements its appearance.	6.43	1.43	Like Moderately
Average	6.44	1.38	Like Moderately
Overall Average	6.79	1.28	Like Moderately

The table presents the level of acceptability of the Tugi-based noodle under Treatment 1, which utilizes 100% Tugi flour (560 grams), as evaluated by the respondents in terms of appearance, aroma, taste, and texture.

In terms of appearance, the noodle received mean scores ranging from 6.68 to 6.72, with an average of 6.70 described as “Like Moderately,” indicating that respondents found the product somewhat acceptable visually but less appealing compared to other formulations. For aroma, all indicators consistently obtained a mean of 7.13 with an average also described as “Like Moderately,” suggesting that while the aroma was acceptable, it was not particularly strong or highly appealing to the respondents. In terms of taste, the noodle recorded mean scores between 6.75 and 7.10, with an average of 6.89 interpreted as “Like Moderately,” reflecting that the flavor was acceptable but lacked the richness or balance that could make it more desirable. Meanwhile, texture received the lowest ratings among the sensory attributes, with mean scores ranging from 6.42 to 6.48 and an average of 6.44 described as “Like Moderately,” indicating that the mouthfeel and chewiness of the noodle were less preferred. Overall, Treatment 1 obtained an overall mean of 6.79, interpreted as “Like Moderately,” showing that the product is generally acceptable but does not achieve a high level of preference among respondents.

The 100% tugi flour noodle was rated only “Like Moderately” across all sensory attributes, with texture receiving the lowest scores. Respondents found the product acceptable but less appealing compared to wheat-based noodles. This aligns with findings that exclusive use of non-wheat flours reduces sensory quality. Wahjuningsih et al. (2022) reported that noodles made solely from sorghum and mung bean flours had weaker mouthfeel and higher cooking loss compared to wheat noodles. Similarly, Ayustaningwarno et al. (2025) found that taro–gembus flour noodles, while nutritionally beneficial, showed reduced sensory scores at higher substitution levels, particularly in texture. Likewise, Santiago and de la Cruz (2018) noted that while mung bean flour is rich in protein, products made solely from it often faced challenges in texture and mouthfeel, with blending proving essential to improve acceptability.

In summary, the 100% Tugi flour noodle is moderately acceptable in all sensory aspects, with relatively lower ratings in texture and appearance. This suggests that while pure Tugi flour can produce an acceptable noodle, it may require improvement or blending with other ingredients to enhance its overall sensory quality and increase consumer preference.

Table 7.3. Level of Acceptability of the Developed Tugi-Based Noodle in Terms of Sensory Evaluation

Indicators	Mean	Sd	Description
Treatment 2 (70% Tugi Flour and 30% All-purpose Flour)			
APPEARANCE			
1.Pleasing combination of colors and forms.	7.28	1.25	Like Very Much
2.Rich, vibrant and visually appealing.	7.28	1.35	Like Very Much
3.The noodle looks appetizing and inviting.	7.20	1.26	Like Moderately
Average	7.25	1.26	Like Very Much
AROMA			
1.The aroma of Tugi noodle is pleasant.	7.47	1.25	Like Very Much
2.The aroma of Tugi noodle compliments the ingredients used.	7.47	1.23	Like Very Much
3.The aroma of Tugi noodle stimulates appetite.	7.27	1.71	Like Very Much
Average	7.40	1.33	Like Very Much
TASTE			
1. A balanced, well-blended; all ingredients complement each other.	7.32	1.10	Like Very Much

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2.The noodle is highly nutritious and delicious.	7.50	1.21	Like Very Much
3.The flavor profile has a smooth and pleasing aftertaste.	7.25	1.17	Like Very Much
Average	7.35	1.10	Like Very Much
TEXTURE			
1.Soft and slightly chewy texture.	6.95	1.39	Like Moderately
2.The noodle is pleasant in the mouth.	7.02	1.63	Like Moderately
3.The noodle complements its appearance.	7.18	1.45	Like Moderately
Average	7.04	1.45	Like Moderately
Overall Average	7.26	1.20	Like Very Much

The table presents the level of acceptability of the Tugi-based noodle under Treatment 2, which consists of a 70% Tugi flour and 30% all-purpose flour blend (390 grams Tugi flour and 170 grams allpurpose flour), as evaluated by the respondents in terms of appearance, aroma, taste, and texture.

In terms of appearance, the noodle obtained mean scores ranging from 7.20 to 7.28, with an average of 7.25 described as “Like Very Much,” indicating that respondents generally found the product visually appealing, although one indicator fell slightly lower under “Like Moderately.” For aroma, the product received consistently favorable ratings, with mean scores between 7.27 and 7.47 and an average of 7.40 interpreted as “Like Very Much,” suggesting that the noodle’s smell was pleasant and effectively complemented its ingredients. In terms of taste, the noodle also performed well, with mean values ranging from 7.25 to 7.50 and an average of 7.35 described as “Like Very Much,” reflecting that respondents appreciated its balanced flavor and overall palatability. However, texture received comparatively lower ratings, with mean scores between 6.95 and 7.18 and an average of 7.04 interpreted as “Like Moderately,” indicating that while acceptable, the mouthfeel and chewiness were not as preferred as the other attributes. Overall, Treatment 2 achieved an overall mean of 7.26, described as “Like Very Much,” demonstrating that the product is generally well-accepted by respondents.

These findings from Treatment 2—using 70% Tugi flour blended with 30% all-purpose flour— showed clear improvements in appearance, aroma, and taste compared to noodles made solely from Tugi flour. This aligns well with recent research on composite flour formulations, which consistently demonstrates that blending indigenous or non-wheat flours with wheat enhances sensory qualities. For instance, Alim et al. (2024) reported that combining wheat flour with psyllium husk and peanut not only improved nutritional composition but also boosted taste and aroma compared to pure wheat or alternative flours. Similarly, Quintal and San Juan (2024) showed that mungbean–taro composite flour noodles achieved sensory scores comparable to wheat noodles, especially in aroma and taste, reinforcing the value of blending indigenous flours with wheat, which explains why texture in Treatment 2 was only moderately acceptable despite gains in other sensory aspects.

In summary, the 70% Tugi and 30% all-purpose flour noodle is highly acceptable in terms of appearance, aroma, and taste, while texture remains moderately acceptable. This suggests that blending Tugi flour with all-purpose flour improves the overall sensory quality compared to using pure Tugi flour, making Treatment 2 a more preferred formulation among the respondents.

Table 7.4. Level of Acceptability of the Developed Tugi-Based Noodle in Terms of Sensory Evaluation

Indicators	Mean	Sd	Description
Treatment 3 (50% Tugi Flour and 50% All-purpose Flour)			
APPEARANCE			
1.Pleasing combination of colors and forms.	8.12	0.85	Like Extremely
2.Rich, vibrant and visually appealing.	8.15	0.82	Like Extremely
3.The noodle looks appetizing and inviting.	8.15	0.88	Like Extremely
Average	8.14	0.80	Like Extremely
AROMA			
1.The aroma of Tugi noodle is pleasant.	8.22	1.03	Like Extremely
2.The aroma of Tugi noodle compliments the ingredients used.	8.20	1.05	Like Extremely
3.The aroma of Tugi noodle stimulates appetite.	8.20	1.07	Like Extremely
Average	8.20	1.02	Like Extremely
TASTE			
1. A balanced, well-blended; all ingredients complement each other.	8.15	1.07	Like Extremely
2.The noodle is highly nutritious and delicious.	8.17	0.98	Like Extremely
3.The flavor profile has a smooth and pleasing aftertaste.	8.03	1.12	Like Very Much
Average	8.12	1.01	Like Extremely
TEXTURE			
1.Soft and slightly chewy texture.	8.03	1.21	Like Very Much
2.The noodle is pleasant in the mouth.	8.12	1.12	Like Extremely

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3.The noodle complements its appearance.	8.10	1.04	Like Very Much
Average	8.08	1.10	Like Very Much
Overall Average	8.14	0.89	Like Extremely

The table presents the level of acceptability of the Tugi-based noodle under Treatment 3, which consists of a 50% Tugi flour and 50% all-purpose flour blend (280 grams each), as evaluated by the respondents in terms of appearance, aroma, taste, and texture. In terms of appearance, the noodle obtained high mean scores ranging from 8.12 to 8.15, with an average of 8.14 described as “Like Extremely,” indicating that respondents found the product highly attractive, with a pleasing combination of colors and an appetizing visual appeal. For aroma, the product also received consistently excellent ratings, with mean scores between 8.20 and 8.22 and an average of 8.20 interpreted as “Like Extremely,” suggesting that the noodle’s aroma was very pleasant and effectively stimulated appetite. In terms of taste, the noodle performed very well, with mean values ranging from 8.03 to 8.17 and an average of 8.12 described as “Like Extremely,” indicating that respondents appreciated its wellbalanced flavor and satisfying aftertaste, although one indicator was slightly lower at “Like Very Much.” Meanwhile, texture also received high ratings, with mean scores from 8.03 to 8.12 and an average of 8.08 interpreted as “Like Very Much,” showing that the noodle’s mouthfeel and chewiness were generally wellliked, though slightly lower compared to appearance, aroma, and taste. Overall, Treatment 3 achieved an overall mean of 8.14, described as “Like Extremely,” demonstrating that the product is highly acceptable to the respondents across all sensory attributes. These results are strongly supported by both international and local literature on composite flour noodle development and sensory evaluation. Mepba et al. (2021) reported that noodles made from 50% root crop flours (cocoyam, acha, Bambara groundnut) and 50% wheat flour achieved strong sensory appeal, particularly in appearance and flavor. Optimization studies published in *Food Chemistry Advances* (2025) confirmed that balanced blends such as wheat-cassava-mango peel-soybean improved nutritional composition while maintaining high sensory acceptability. Locally, Mba Ogbonnaya et al. (2025) reported that instant noodles made from wheat, rice, and water yam blends were not significantly different from 100% wheat noodles in sensory properties, highlighting the ability of local flours to match traditional formulations and underscoring the potential of indigenous crops like tugi when blended. In summary, the 50% Tugi and 50% all-purpose flour noodle is highly acceptable in all sensory aspects, particularly in appearance, aroma, and taste, which were rated “Like Extremely,” while texture was rated “Like Very Much.” This indicates that Treatment 3 provides the most balanced and preferred formulation among the treatments, offering enhanced sensory qualities and greater overall acceptability. This highlights the broader significance of using indigenous flours like Tugi in noodle production, offering sustainable and nutritious alternatives without sacrificing consumer preference.

Table 8. General Level of Acceptability of the Developed Tugi-Based Noodle as Evaluated by the Groups of Respondents

Indicators		Consumer		Food Experts	
Mean		Description		Mean	
Standard Recipe (100% All-purpose Flour)					
560 grams All-purpose Flour					
Appearance	8.42	Like Extremely		8.14	Like Extremely
Aroma	8.00	Like Very Much		7.91	Like Very Much
Taste	8.03	Like Very Much		7.94	Like Very Much
Texture	8.37	Like Extremely		8.14	Like Extremely
Overall Mean	8.20	Like Extremely		8.03	Like Very Much
Treatment 1 (50% Tugi Flour) 560 grams Tugi Flour					
Appearance	6.58	Like Moderately		6.82	Like Moderately
Aroma	7.24	Like Very Much		7.02	Like Moderately
Taste	6.98	Like Moderately		6.81	Like Moderately
Texture	6.43	Like Moderately		6.45	Like Moderately
Overall Mean	6.80	Like Moderately		6.77	Like Moderately
Treatment 2 (70% Tugi Flour and 30% All-purpose Flour) 390 grams Tugi Flour – 170 grams All-purpose Flour					
Appearance	7.42	Like Very Much		7.09	Like Moderately
Aroma	7.62	Like Very Much		7.18	Like Moderately
Taste	7.35	Like Very Much		7.36	Like Very Much
Texture	7.18	Like Moderately		6.90	Like Moderately
Overall Mean	7.39	Like Very Much		7.13	Like Moderately
Treatment 3 (50% Tugi Flour and 50% All-purpose Flour) 280 grams Tugi Flour – 280 grams All-purpose Flour					
Appearance	8.25	Like Extremely		8.02	Like Very Much

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Aroma	8.43	Like Extremely	7.98	Like Very Much
Taste	8.34	Like Extremely	7.89	Like Very Much
Texture	8.24	Like Extremely	7.92	Like Very Much
Overall Mean	8.31	Like Extremely	7.95	Like Very Much

The table presents the general level of acceptability of the developed Tugi-based noodle as evaluated by two groups of respondents, namely consumers and food experts, across four variants and in terms of appearance, aroma, taste, and texture.

For the standard recipe, both groups gave consistently high ratings, with consumers rating appearance and texture as “Like Extremely” and aroma and taste as “Like Very Much,” while food experts showed a similar pattern, indicating strong agreement on its high acceptability. In Treatment 1, which used 100% Tugi flour, both consumers and food experts rated most attributes as “Like Moderately,” although consumers rated aroma slightly higher as “Like Very Much,” suggesting that this formulation is acceptable but less preferred compared to the standard. Treatment 2 showed improved ratings, with consumers generally evaluating all attributes as “Like Very Much,” while food experts gave slightly lower ratings in appearance and aroma, described as “Like Moderately,” though both groups agreed on the taste being “Like Very Much.” In Treatment 3, both groups recorded the highest levels of acceptability among the developed formulations, with consumers rating all attributes as “Like Extremely,” while food experts rated them mostly as “Like Very Much,” indicating strong but slightly more conservative evaluations.

The sensory evaluation results of the developed Tugi-based noodles clearly show that blending Tugi flour with all-purpose flour improves overall acceptability, particularly at a 50:50 ratio. Consumers rated Treatment 3 highest across all attributes, describing appearance, aroma, taste, and texture as “Like Extremely,” while food experts gave slightly more conservative but still favorable ratings, mostly “Like Very Much.” In contrast, noodles made with 100% Tugi flour (Treatment 1) received the lowest scores, especially in texture, which was only “Like Moderately.” These findings highlight the importance of composite flour formulation in achieving desirable sensory qualities.

Recent studies strongly support these results. Agiriga et al. (2021) reported that noodles produced from blends of wheat, acha, Bambara groundnut, and cocoyam maintained strong sensory appeal while improving nutritional quality, showing that composite flours enhance both health and consumer preference. Mir, Naseem, and Wani (2024) further emphasized that noodles made from composite cereal flours retained better sensory quality during storage, with higher consumer acceptability in flavor and appearance, which parallels the improved ratings of Treatments 2 and 3 in this study. Ross (2020) explained that springiness, chewiness, and cohesiveness are critical noodle qualities, clarifying why texture in pure Tugi flour noodles was less acceptable compared to blended formulations.

Local research also validates these findings. Quintal and San Juan (2024) demonstrated that mungbean-taro composite flour noodles achieved sensory ratings comparable to all-purpose flour noodles, particularly in aroma and flavor, underscoring the viability of indigenous flours like Tugi. Similarly, Alviola and Monterde (2018) showed that selected Philippine flours could be incorporated into noodles without compromising sensory quality, supporting the conclusion that Tugi flour blends yield highly acceptable products.

Overall, both consumers and food experts agreed that the standard recipe and Treatment 3 were the most acceptable, while Treatment 1 was least preferred. This pattern is consistent with literature on food formulation and innovation, which highlights that incorporating root crops into noodles enhances nutritional value and sustainability, but optimal blending ratios are essential to maintain sensory appeal. The study therefore confirms that a balanced flour blend-particularly the 50:50 Tugi and all-purpose flour formulation produces noodles that are both nutritious and highly acceptable to consumers and experts alike, and that there is general agreement between the two groups regarding the sensory quality of the different formulations.

Table 9. Significant difference on the Level of Acceptability of the Developed Tugi- based Noodles as Evaluated by the Different Groups of Respondents

Treatment	t-value	p-value	Comparison	Decision	Remarks
Standard Recipe	0.51	0.48	p-value > 0.05	accept Ho	not significant
Treatment 1	0.01	0.93	p-value > 0.05	accept Ho	not significant
Treatment 2	0.72	0.40	p-value > 0.05	accept Ho	not significant
Treatment 3	2.58	0.11	p-value > 0.05	accept Ho	not significant

The table presents the results of the statistical analysis determining whether there is a significant difference in the general level of acceptability of the Tugi-based noodle as assessed by the different groups of respondents, specifically consumers and food experts. The computed t-values and corresponding p-values for the standard recipe and all three treatments show that all p-values (0.48, 0.93, 0.40, and 0.11) are greater than the 0.05 level of significance. This indicates that for each treatment, the null hypothesis (Ho) is accepted. The results consistently reveal that there is no statistically significant difference between the evaluations of the two groups

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across all variants. Although slight differences in mean ratings may exist between consumers and food experts, these differences are not large enough to be considered statistically meaningful.

These results are supported by recent studies in food product development and sensory evaluation. Lazaro et al. (2025) reported that both experts and student respondents rated a newly developed noodle product positively, and although minor variations in preferences were observed, statistical analysis showed no significant differences between groups. This consistency across respondents mirrors your results, where consumers and food experts evaluated Tugi-based noodles similarly. Likewise, Jacinto (2023) examined the acceptability and marketability of Makonbati noodles and found that while ratings varied among age groups, statistical tests such as ANOVA and Tukey comparisons confirmed that these differences were not significant enough to affect the overall conclusion of broad acceptability. In Tanzania, a study conducted by Mpalanzi et. al (2023) on noodles enriched with moringa leaf and sardine powders revealed that lower concentrations of added powders were more acceptable, but overall differences in acceptability across respondent groups remained minimal. The researchers concluded that while formulation influenced sensory attributes like texture and flavor, the general level of acceptability was consistent across evaluators.

In summary, there is no significant difference in the general level of acceptability of the Tugi-based noodle as assessed by consumers and food experts for all treatments. This suggests that both groups have comparable perceptions and evaluations of the product, reinforcing the consistency and reliability of the acceptability results across different types of respondents.

Table 10. Summary of Cost Benefit Analysis of the Developed Tugi-based Noodle

Item Description	Ingredients	Quantity	SR	T1	T2	T3
Tug Flour		T1 – 560 g		224.00	156.00	112.00
		T2 – 390 g				
		T3 – 280 g				
All-purpose Flour		SR - 560 g	28.00		8.50	14.00
		T2 -170 g				
		T3 – 280 g				
Eggs		6 pcs	60.00	60.00	60.00	60.00
Salt		25 g	1.00	1.00	1.00	1.00
Cooking Oil		30 g	3.00	3.00	3.00	3.00
Additional Expenses						
Container			10.00	10.00	10.00	10.00
Label			2.00	2.00	2.00	2.00
Labor Cost			17.00	17.00	17.00	17.00
Operating Expenses						
Electricity			10.00	10.00	10.00	10.00
Fare			20.00	20.00	20.00	20.00
Miscellaneous Cost			20.00	20.00	20.00	20.00
Tear and Wear of Tools and Equipment			5.00	5.00	5.00	5.00
Cost of Money (3% of Capital)			5.28	11.16	9.375	8.22
TOTAL PRODUCTION COST (Php)			181.28	383.16	321.87	282.22

The cost-benefit analysis of the developed tugi-based noodles highlights several important considerations in terms of labor, equipment depreciation, and capital charge. The expected wage per treatment, derived from a daily wage of ₱400, amounts to approximately ₱16.67 for every 20 minutes of work, which aligns closely with the ₱17 labor cost reflected in the table. For equipment depreciation, the tear and wear of tools and materials is calculated by dividing the original purchase cost of ₱25,000 by the estimated useful life in hours. Assuming a lifespan of around 5,000 hours, the resulting value is approximately ₱5 per hour, which corresponds to the figure included in the table. Meanwhile, the cost of money is computed by adding the recipe cost and additional expenses, then multiplying the sum by 30%. This explains the values shown: ₱5.28 for the standard recipe, ₱11.16 for Treatment 1, ₱9.38 for Treatment 2, and ₱8.22 for Treatment 3.

The table shows the comparative production costs of noodles prepared using different formulations, namely the standard recipe (SR) and three treatments (T1, T2, and T3) with varying proportions of tugi flour and all-purpose flour. The standard recipe, which relies solely on all-purpose flour, records the lowest production cost at ₱181.28, making it the most economical option and serving as the baseline for comparison. Treatment 1, which uses 100% tugi flour, shows the highest production cost at ₱383.16 due to the relatively expensive price of tugi flour, highlighting its limited economic viability despite its nutritional and cultural value. Treatment 2, with a 70% tugi and 30% all-purpose flour blend, reduces the cost to ₱321.87, while Treatment 3, with a 50–50 blend, further lowers the cost to ₱282.22. These blended formulations demonstrate that partial substitution of tugi flour is more sustainable than full replacement, as they balance innovation with affordability. Among the treatments, Treatment 3 emerges as the most practical option

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for commercialization, offering a compromise between cost efficiency and product differentiation. Overall, the analysis underscores that raw material cost is the primary driver of production feasibility, and blended formulations provide a more competitive pathway for introducing tugi-based noodles into the market.

Table 11. Summary Computation of Return and Investment.

PARTICULARS	TREATMENTS			
	SR	T1	T2	T3
Total Production Cost (Php)	181.28	383.28	321.87	282.22
Unit Cost (Total Production Yield) SR=1,050 grams, T1=1,030 grams, T2=1,000 grams, T3=1,050 grams	181.28	383.28	321.87	282.22
Mark Up (Production Cost x 30%)	54.384	114.984	96.561	84.666
Selling Price (Production Cost + Mark Up)	235.664	498.264	418.431	366.886
ROI (Income x 100/Total Production Cost)	30.00%	30.00%	30.00%	30.00%

The table presents the comparative production costs, mark-ups, selling prices, and return on investment (ROI) for noodles produced using different formulations. The standard recipe (SR), which uses 100% all-purpose flour, has the lowest production cost at ₱181.28. With a 30% mark-up, its selling price reaches ₱235.664, making it the most affordable option among all treatments. Treatment 1 (100% tugi flour) records the highest production cost at ₱383.28, resulting in a selling price of ₱498.264. This reflects the significant impact of tugi flour's high raw material cost, which limits its economic feasibility despite its potential nutritional benefits. Treatment 2 (70% tugi flour and 30% all-purpose flour) shows a production cost of ₱321.87 and a selling price of ₱418.431, while Treatment 3 (50% tugi flour and 50% all-purpose flour) reduces the cost further to ₱282.22 with a selling price of ₱366.886. All treatments maintain a uniform ROI of 30%, indicating that profitability is consistent across formulations when the same mark-up rate is applied. However, the absolute income varies, with SR offering the lowest selling price and T1 the highest.

In summary, this analysis underscores that while tugi flour enhances product innovation, its high cost significantly raises the selling price. Blended formulations, particularly Treatment 3, strike a more practical balance between affordability and innovation, making them more viable for commercialization compared to the costly full substitution in Treatment 1.

Table 12. Shelf-life and Storage Stability of Tugi flour

Days of Observation	Observation Result
Day 1	The appearance, aroma and texture of Tugi flour did not change.
Day 2-7	The appearance, aroma and texture of Tugi flour remained the same.
Day 8 – 21	The Tugi flour is the same in appearance, aroma and texture.
Day 22-60	For over 2 months, there is no notable changes occurred in the appearance, aroma and texture of the Tugi flour - if stored in a dry and well-sealed container.

Table shows the data on the shelf-life and storage stability of tugi flour. The flour demonstrates that the product maintains consistent quality over an extended period when stored properly. On Day 1, the flour showed no changes in appearance, aroma, or texture, establishing its initial stability. From Days 2 to 7, these attributes remained unchanged, indicating that short-term storage does not affect its sensory qualities. This stability continued through Days 8 to 21, further confirming that the flour retains its desirable characteristics for at least three weeks. Most notably, from Day 22 up to Day 60, the flour exhibited no notable changes in appearance, aroma, or texture, provided it was kept in a dry and well-sealed container.

This finding suggests that tugi flour has a shelf-life of at least two months under proper storage conditions, making it a viable ingredient for both household use and commercial applications. The absence of deterioration in sensory qualities highlights its potential for longer-term storage and distribution, which is essential for product commercialization. In the context of the research, this stability supports the feasibility of tugi flour as a sustainable raw material, ensuring that its nutritional and cultural value can be preserved without compromising quality during storage. Overall, the results emphasize that appropriate storage practices, particularly dryness and airtight sealing, are critical factors in maintaining the integrity of tugi flour over time.

Table 13. Shelf-life and Storage Stability of the Developed Tugi-based Noodle

Days of Observation	Observation Result
Day 1	The appearance, aroma, taste and texture of the product was the same as newly made noodle.
Day 2	The appearance, aroma, taste and texture of the product was the same.
Day 3	The appearance of the noodle starts to get darker, a slight change in amora was also observed and the texture got a little dryer particularly in treatment 1 - 100% Tugi Flour but nothing changed in its taste.

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Day 4-6	A noticeable change in appearance was observed particularly in treatment 3. A strong change in aroma was also noticed, and the texture of all the treatments are getting dryer.
Day 7-10	Molds are starting to appear in all treatments especially in treatment 3 with the highest moisture level; aroma was so strong than before and the texture of the noodles in all treatments are dry - a strong indication that the noodles are no longer edible.

The shows the shelf-life and storage stability of the developed tugi-based noodles. On Day 1, the noodles retained the same appearance, aroma, taste, and texture as when freshly prepared, indicating initial stability. By Day 2, these qualities remained unchanged, suggesting that the product can maintain its desirable sensory attributes for at least 48 hours under normal storage conditions. However, by Day 3, early signs of deterioration were observed, particularly in Treatment 1 (100% tugi flour), where the noodles began to darken in appearance, showed slight changes in aroma, and developed a drier texture, though taste remained unaffected. This indicates that pure tugi flour formulations may be more prone to early quality changes compared to blended treatments.

From Days 4 to 6, more noticeable changes occurred, especially in Treatment 3, where appearance and aroma were strongly affected, and all treatments exhibited increasing dryness in texture. By Days 7 to 10, molds began to appear across all treatments, with Treatment 3 showing the most rapid spoilage due to its higher moisture content. At this stage, the noodles developed a strong aroma and excessively dry texture, clear indicators that the product was no longer edible.

Overall, the findings suggest that the shelf-life of tugi-based noodles is limited to approximately 2–3 days under typical storage conditions before significant sensory changes occur, and by one-week, microbial growth renders the product unsafe for consumption. This emphasizes the importance of proper packaging, moisture control, and possibly the use of preservatives or drying techniques to extend storage stability. From a research perspective, these results highlight that while tugi flour can be successfully incorporated into noodle formulations, its high susceptibility to moisture and microbial growth requires further technological interventions to ensure commercial viability and consumer safety.

SUMMARY OF FINDINGS

1. The production of Tugi flour involved selecting good quality tubers, washing, paring, slicing, dehydrating for 5–8 hours, pulverizing, sifting and storing. This flour was then used to prepare noodles under three treatments: 100% Tugi flour (T1), 70% Tugi flour with 30% all-purpose flour (T2), and 50% Tugi flour with 50% all-purpose flour (T3). Each formulation followed a standard noodle-making process of measuring, mixing, kneading, rolling, cutting, packaging, and labelling, yielding approximately 1.0–1.05 kg of noodles per batch.

2. Pure Tugi flour was found to be carbohydrate-rich (75.87%) and high in dietary fiber (8.50%), but relatively low in protein (6.00%) and fat (0.80%). When processed into noodles, nutritional values shifted depending on the proportion of all-purpose flour. Protein and lipid content increased with higher APF substitution, while fiber decreased. Treatment 3 (50% Tugi flour and 50% APF) recorded the highest protein (13.00%) and metabolized energy (13.31 kcal/3g), while pure Tugi flour remained the best source of dietary fiber.

3. The sensory evaluation revealed that the standard recipe prepared with 100% all-purpose flour (APF) received the highest overall acceptability, being rated “Like Extremely,” particularly for its appearance and texture. In contrast, the formulation using 100% Tugi flour was only moderately acceptable, with notably lower scores in texture and appearance. However, partial substitution of APF with Tugi flour improved consumer perception: the 70% Tugi / 30% APF blend was rated “Like Very Much,” showing marked enhancements in appearance, aroma, and taste compared to pure Tugi flour. Most notably, the 50% Tugi / 50% APF treatment achieved “Like Extremely” ratings across nearly all sensory attributes, rendering it comparable to the standard recipe. These results suggest that while Tugi flour on its own may reduce product quality, a balanced substitution—particularly at 50%—can deliver sensory qualities comparable to traditional formulations, making it a promising option for enhancing nutrition without sacrificing consumer acceptance.

4. Sensory evaluation across appearance, aroma, taste, and texture showed that standard recipe and Treatment 3 were highly acceptable to respondents, while Treatment 2 was moderately high, and Treatment 1 was only moderately acceptable. This indicates that blending Tugi flour with all-purpose flour enhances consumer preference.

5. There was no significant difference in the general level of acceptability of the developed noodles from Tugi flour across different groups of evaluators. All computed p-values (0.48, 0.93, 0.40, and 0.11) were greater than the 0.05 level of significance, indicating that the null hypothesis was accepted for each treatment.

6. Cost analysis showed that the standard recipe using 100% all-purpose flour was the least expensive to produce at ₱181.28, with a selling price of ₱235.664 for 1,050 grams of noodles. In comparison, noodles made entirely from Tugi flour had the highest cost at ₱383.28, leading to a selling price of ₱498.264 despite a slightly lower yield. Blended formulations reduced expenses: the 70% Tugi–30% APF mix cost ₱321.87 with a selling price of ₱418.431, while the 50% Tugi–50% APF blend cost ₱282.22 and sold

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at ₦366.886, maintaining the same yield as the standard recipe. These findings highlight that while pure Tugi flour is economically challenging, partial substitution—especially the 50–50 blend—offers a more practical balance of affordability, yield, and product innovation.

7. Tugi flour, when properly dehydrated and stored, remains stable for extended periods. However, noodles prepared with Tugi flour require careful packaging to maintain quality. Moisture content increases with higher APF substitution, which may affect storage stability. While the study confirmed safety for consumption, further research is needed to determine the exact shelf-life of Tugi-based noodles under different storage conditions.

CONCLUSIONS

Based on the findings, the study concludes that the production of tugi flour and its subsequent incorporation into noodle formulations was successfully achieved, resulting in three distinct treatments with varying proportions of tugi flour and all-purpose flour. The nutritional analysis revealed that blended formulations provided a more balanced profile, with higher protein and energy values compared to noodles made entirely from tugi flour. Sensory evaluation further demonstrated that partial substitution with tugi flour improved consumer perception, with the 50% tugi–50% all-purpose flour blend achieving ratings comparable to the standard recipe, thereby confirming that balanced substitution enhances acceptability without compromising quality.

Across sensory attributes of appearance, aroma, taste, and texture, Treatment 3 was rated highly acceptable, Treatment 2 moderately high, and Treatment 1 only moderately acceptable, reinforcing the conclusion that blending tugi flour with all-purpose flour improves consumer preference. Statistical analysis using ANOVA showed no significant difference in the general level of acceptability between consumers and food experts, as all computed p-values were greater than 0.05, leading to the acceptance of the null hypothesis for each treatment.

The cost-benefit analysis revealed that noodles made entirely from tugi flour were the most expensive to produce, while the standard recipe using 100% all-purpose flour was the least costly. Blended formulations, particularly the 50% tugi–50% all-purpose flour mix, offered a more practical balance of affordability, yield, and product innovation. Finally, storage stability tests indicated that tugi flour remained stable when properly dehydrated and stored, but noodles prepared with it required careful packaging to maintain quality. Moisture content was found to increase with higher all-purpose flour substitution, which may affect storage stability. Overall, these conclusions highlight that blended formulations, especially the 50–50 mix, are the most viable option for commercialization, balancing nutritional value, consumer acceptability, cost efficiency, and storage feasibility.

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