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Sensory Acceptability and Characterizationof Giant Swamp Taro (*Cyrtospermamerkusii)* Pasta Enhanced with Malabar Spinach(*Basella alba)*

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Abstract: *This study aimed to develop an innovative pasta product using giant swamp taro enriched with Malabar spinach. Specifically, it assessed the sensory attributes in terms of appearance, aroma, taste, and texture of three pasta formulations, and examined whether significant differences existed in the sensory ratings among the formulations. The study also analyzed the nutritional composition of the most preferred formulation. A descriptive developmental research design was employed, involving 120 selected respondents composed of TVL/TLE students and food experts. Appropriate statistical tools were used, including mean, standard deviation, MANOVA and post hoc tests. Findings revealed that among the three formulations, Formulation C consistently received the highest acceptability scores across all sensory attributes and was significantly preferred over Formulations A and B. Nutritional analysis showed that the preferred formulation is a moderate-calorie, low-fat, low-sodium, carbohydrate-rich product. The study concludes that Malabar spinach effectively enhanced the sensory and nutritional quality of giant swamp taro pasta, offering a promising alternative for health-conscious consumers.*

Keywords: *Malabar spinach, giant swamp taro, pasta development, sensory evaluation, nutritional analysis*

I. INTRODUCTION

Developing innovative pasta formulations represents a sustainable approach to addressing the growing demand for healthier, diverse food options. One notable innovation is pasta enhanced with Giant Swamp Taro (Cyrtospermamerkusii) flour and Malabar Spinach (Basella alba), offering a unique blend of local ingredients that promote better nutrition and agricultural sustainability.

Giant Swamp Taro, a nutrient-dense root crop traditionally grown in wetland regions, provides a gluten-free, high-quality alternative to wheat flour, rich in carbohydrates, fiber, and essential minerals (Sjögersten et al., 2023; Ferdaus et al., 2023). Malabar Spinach, a fast-growing leafy vegetable, enhances the pasta's nutritional value with antioxidants, iron, and calcium while adding vibrant color (Santonia et al., 2022).This innovation aligns with the United Nations Sustainable Development Goals (SDGs), including SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), and SDG 12 (Responsible Consumption and Production). By utilizing nutrient-rich, locally sourced ingredients, it addresses food security and promotes sustainable agricultural practices, supporting SDG 13 (Climate Action) by minimizing environmental impact.Aligned with Ambisyon Natin 2040, this initiative fosters economic opportunities for smallholder farmers and leverages underutilized local crops to create a resilient, sustainable food system. The development of Giant Swamp Taro and Malabar Spinach-enriched pasta highlights the fusion of tradition and innovation, promising a nutritious, environmentally sustainable addition to modern culinary choices while contributing to national and global goals.

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II. LITERATURE REVIEW

Giant Swamp Taro (*Cyrtospermamerkusii*)

Giant Swamp Taro (Cyrtospermamerkusii) exhibits a promising nutritional profile that may help address micronutrient deficiencies, particularly in regions like the Philippines. It contains significant amounts of beta-carotene and vitamin C, especially in its wild variety, which surpasses the cultivated form in these nutrients (Santonia et al., 2022). Additionally, the cultivated variety is notably higher in essential minerals such as iron, zinc, and calcium, which are critical for combating deficiencies (Santonia et al., 2022) (Millena et al., 2024). The taro's high dietary fiber content (48% of the recommended intake) and its intermediate glycemic index (64-70) further enhance its potential as a staple food that supports digestive health and sustained energy release (Millena et al., 2024). Furthermore, the mineral bioavailability of zinc and manganese from Giant Swamp Taro is significant, making it a valuable dietary component for improving overall nutrition (Millena et al., 2024). Thus, incorporating Giant Swamp Taro into diets could effectively contribute to alleviating micronutrient deficiencies in vulnerable populations.

Giant Swamp Taro (*Cyrtospermamerkusii*) Sources

Giant swamp taro (Cyrtospermamerkusii), locally known as Dalugha, is a vital staple food in the Sangihe Islands of North Sulawesi, Indonesia, where it plays a significant role in food security, particularly in the face of climate change and rising sea levels (Rotinsulu et al., 2024). This underutilized crop thrives in wetland conditions, demonstrating resilience and adaptability, making it suitable for cultivation in marginal coastal areas and peatlands (Sjögersten et al., 2023). The starch extracted from its corms has diverse applications, including food products and bioplastics, with modifications enhancing its physico-chemical properties for various uses ("Effect of Acid Modification on the Physico-Chemical Properties of North Sulawesi's Giant Swamp Taro (GST) Starch (Cyrtospermamerkusii)", 2024). Morphological studies reveal distinct characteristics of Dalugha across different islands, indicating potential for further research and cultivation improvements (Pangemanan et al., 2023). Overall, C. merkusii's nutritional value and adaptability underscore its importance in local diets and agricultural practices (Rotinsulu et al., 2024) (Sjögersten et al., 2023). In the Philippines, particularly in regions like Bohol, swampy coastal areas are often home to various wild edible plants that serve as emergency food sources during times of scarcity. This practice is part of a broader cultural phenomenon known as "pantawid-gutom," which refers to the use of certain foods and practices to bridge periods of hunger, providing temporary relief and hope for better meals in the future (Lasco & Mendoza, 2024). It is also found in Surigao del Norte and it is common name is "Payaw" where a lot of Surigaonons use this crop as alternative for rice.

Malabar Spinach (*Basella Alba*)

Malabar spinach (Basella alba), also known as Indian spinach, is recognized for its impressive nutritional profile, which includes high levels of protein, vitamins A and C, and essential minerals such as calcium, iron, magnesium, and potassium (Chaurasiya et al., 2021). Recent studies highlight its rich content of bioactive compounds, including carotenoids and flavonoids, which contribute to its antioxidant, anti-inflammatory, and antimicrobial properties (Chaurasiya et al., 2021). The incorporation of Malabar spinach into food products, such as instant soup mixes, has been shown to enhance nutritional quality, with formulations containing up to 7.65% protein and 5.89% fiber (Singh & Sonkar, 2024). Additionally, the plant's adaptability to various soil conditions and its resilience in hot climates make it a valuable crop for improving dietary diversity and nutritional security, particularly in developing regions. Overall, Malabar spinach serves as a nutritious alternative to conventional leafy greens, offering both health benefits and culinary versatility (Chaurasiya et al., 2021).

Malabar Spinach (*Basella Alba*) Sources

Malabar spinach (Basella alba), a fast-growing vine, is primarily found in tropical and subtropical regions, thriving in warm climates. It is cultivated extensively in Southeast Asia, particularly in countries like India, where it is valued for its nutritional and medicinal properties (Khoi, 2024) (Madhavi et al., 2023). The plant is known for its rich content of vitamins, minerals, and phytochemicals, which contribute to its health benefits, including antioxidant and anti-

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inflammatory effects (Madhavi et al., 2023). Additionally, Malabar spinach is utilized in various culinary applications, such as instant soup mixes, enhancing both flavor and nutritional value (Singh & Sonkar, 2024). Its adaptability to different soil types, especially when supplemented with organic amendments like biochar and compost, further supports its cultivation in diverse agricultural settings (Khoi, 2024). Overall, Malabar spinach is not only a staple in local diets but also a subject of research for its potential health benefits and agricultural optimization (Shende et al., 2023). Malabar spinach (Basella alba) is widely cultivated in the Philippines, particularly in lowland tropical regions, where it thrives as a heat-tolerant, fast-growing perennial vine suitable for home and market gardens (Chaurasiya et al., 2021). This vegetable is not only popular for its nutritional benefits, similar to those of regular spinach, but also for its medicinal properties, which have been recognized in traditional practices (Chaurasiya et al., 2021). Research indicates that optimizing agricultural practices, such as the application of biochar and compost, can enhance the growth and quality of Malabar spinach, making it a sustainable crop choice for local farmers (Khoi, 2024). Overall, Malabar spinach is an integral part of the agricultural landscape in the Philippines, valued for both its culinary and health benefits (Savin, 2022).

Varieties of Pasta

Since 2020, the variety of pasta has expanded significantly, driven by innovations in ingredients and production techniques aimed at enhancing nutritional value, sustainability, and sensory qualities. Recent developments have focused on incorporating health-promoting substances and functional ingredients into pasta, transforming it into a carrier for specific physiological benefits("Innovative Pasta with High Nutritional and Health Potential", 2023). For instance, the use of highland barley flour and green leafy vegetables has been explored to enrich pasta with proteins and liposoluble compounds, improving its nutritional profile(Arcangelis & Romano, 2023). Additionally, the substitution of traditional wheat with local high-carbohydrate ingredients like pumpkin has been investigated, showing potential in maintaining desirable textural properties while reducing cooking loss and enhancing rehydration capacity(Sari &Siqhny, 2022). The introduction of new wheat varieties, such as Durum-21, has also contributed to the diversification of pasta types, offering high yield and quality traits suitable for industrial pasta production (Ahmad et al., 2023). Furthermore, the integration of aquatic fern powder and Pangasius protein isolate into pasta formulations has been studied to improve sustainability and nutritional quality, reflecting a broader trend towards health-based pasta innovations (Arcangelis & Romano, 2023). These advancements underscore a shift in the pasta industry towards products that not only meet consumer demands for taste and convenience but also align with health and environmental considerations.

Flours

In the Philippines, wheat flour remains the predominant choice for various culinary applications, particularly in baked goods, pastries, and noodles, with all-purpose flour being favored for its versatility. However, the growing awareness of health issues related to gluten, such as celiac disease and gluten sensitivity, has prompted research into alternative flours derived from sustainable sources. These alternatives, including amaranth, barley, and rice flour, not only reduce gluten content but also enhance the nutritional profile of baked products by increasing dietary fiber and protein levels (Siddiqui et al., 2022). Innovative flours, such as those made from potato and grape seeds, are being explored for their bioactive components, which can improve the organoleptic properties of foods like bread and pizza (Novitasari et al., 2023). Furthermore, advancements in flour classification using deep learning techniques have improved the identification of various wheat flour types, ensuring better quality control in production (Wang et al., 2024). Overall, the diversification of flour sources in the Philippines reflects a response to both health concerns and culinary versatility.

III. METHODOLOGY

This study is a descriptive developmental research method. This method allowed researcher to analyze the innovative pasta development made from giant swamp taro pasta enhanced with Malabar spinach. The goal of the study is to determine how much Malabar spinach is use to balance the taste of the innovative pasta. The objective of the study was

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to analyze the quantitative characteristics of innovative pasta made with giant swamp taro flour enhanced with Malabar spinach which consist of different varying amount of Malabar spinach from 50g to 100g. All the set-ups is evaluated for this quantitative characteristics such as appearance, aroma, taste and texture. However, descriptive research method was also used to obtain data to find out the acceptability of the finished product by the consumer and determine the acceptability of innovative pasta made from giant swamp taro flour prepared at different amount of Malabar spinach. The sensory evaluation utilized a 9-point hedonic scale to measure consumer acceptability across attributes such as appearance, taste, texture, and overall satisfaction, ensuring a comprehensive understanding of the product's market potential and nutritional contribution.The respondents of this study are the TVL/TLE students and TVL/TLE Teachers/Food experts of Amando A. Fabio Memorial National High School, Sta. Cruz, Placer, Surigao del Norte.Mean and Standard Deviation were used to determine the acceptability of the giant swamp taro pasta enriched with malabar spinach as to appearance, aroma, flavor/taste, and texture.Multivariate Analysis of Variance (MANOVA) for Repeated Measures and Bonferroni's Testwere used to compare the three formulations of giant swamp taro pasta enriched with malabar spinach in terms of the four sensory attributes: appearance, aroma, taste, and texture.

IV. RESULTS AND DISCUSSION

Table 1 presents the acceptability ratings of the appearance of Giant Swamp Taro Pasta enriched with Malabar Spinach across three different formulations, based on sensory evaluation.

Formulation A recorded an overall average mean of 5.47, corresponding to a descriptive rating of "Neither Like Nor Dislike" (NLND). Among the five appearance-related statements, the highest mean was observed in the item, "The color of the product is suitable for its type", with a mean of 5.72, interpreted as "Like slightly" (LS). This suggests that raters found the appropriateness of the color more acceptable than other aspects. On the other hand, the lowest mean was seen in the statement, "The color of the product looks appealing", with a score of 5.12, still within the NLND range, indicating neutrality or indifference in visual appeal for Formulation A.Formulation B achieved a significantly higher overall mean of 7.41, which falls under the category of "Like moderately" (LM). The most favored appearance attribute in this formulation was "The product's color matches my expectations for this type of product", with a mean score of 7.59, closely followed by "The color of the product is suitable for its type" at 7.55. Both of these statements received a "Like very much" (LVM) rating, implying strong visual appeal. The lowest-rated attribute, though still favorable, was "The color of the product looks appealing", which scored 7.19, indicating that even the least liked aspect still fell within the LM category.Formulation C received the highest acceptability ratings in terms of appearance among the three formulations, with an impressive average mean of 8.41, corresponding to "Like very much" (LVM). The highest individual item score was 8.56, which appeared in both "The product's color matches my expectations for this type of product" and "The color of the product is suitable for its type". These were interpreted as "Like extremely" (LE), suggesting exceptional visual appeal and appropriateness. The lowest mean for Formulation C was recorded in "The color of the product looks appealing", with a still very favorable score of 8.23, maintaining the LVM rating.

TABLE 1: ACCEPTABILITY OF APPEARANCE OF THE GIANT SWAMP TARO PASTA ENHANCED WITH MALABAR SPINACH

Statement	Formulation A			Formulation B			Formulation C		
	M	SD	*D*	M	SD	*D*	M	SD	*D*
1. The color of the product looks appealing.	5.12	1.11	***NLND***	7.19	0.96	***LM***	8.23	0.60	***LVM***
2. The color is vibrant and fresh.	5.38	0.99	***NLND***	7.28	0.93	***LM***	8.30	0.63	***LVM***
3. The product's color is consistent and uniform.	5.59	0.97	***LS***	7.44	0.85	***LM***	8.43	0.66	***LVM***
4. The color of the product is suitable for its type.	5.72	0.94	***LS***	7.55	0.83	***LVM***	8.55	0.66	***LE***

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5. The product's color matches my expectations for this type of product.	5.56	1.03	***LS***	7.59	0.82	***LVM***	8.56	0.65	***LE***
Average	**5.47**	**0.85**	***NLND***	**7.41**	**0.84**	***LM***	**8.41**	**0.57**	***LVM***

Table 2 presents the acceptability ratings of the aroma of Giant Swamp Taro Pasta enriched with Malabar Spinach across three formulations.

TABLE 2: ACCEPTABILITY OF AROMAOF THE GIANT SWAMP TARO PASTA ENHANCED WITH MALABAR SPINACH

Statement	Formulation A			Formulation B			Formulation C		
	M	**SD**	***D***	**M**	**SD**	***D***	**M**	**SD**	***D***
1. The product has an appealing odor.	5.26	1.27	***NLND***	7.29	0.76	***LM***	8.27	0.60	***LVM***
2. The product's odor is pleasant and not overpowering.	5.59	1.15	***LS***	7.42	0.69	***LM***	8.33	0.61	***LVM***
3. The product has a natural odor.	5.77	0.99	***LS***	7.54	0.65	***LVM***	8.42	0.63	***LVM***
4. The odor of the product is pleasant enough to encourage consumption.	5.80	1.00	***LS***	7.53	0.66	***LVM***	8.56	0.66	***LE***
5. The product's odor is consistent with its intended flavor.	5.56	1.09	***LS***	7.57	0.66	***LVM***	8.58	0.62	***LE***
Average	**5.60**	**0.99**	***LS***	**7.47**	**0.64**	***LM***	**8.43**	**0.55**	***LVM***

Formulation A garnered an average mean of 5.60, corresponding to the descriptor "Like slightly" (LS). Among the five aroma-related statements, the highest mean was observed in "The odor of the product is pleasant enough to encourage consumption" with a score of 5.80, followed closely by "The product has a natural odor" at 5.77, indicating a mild favorability toward the pasta's aroma. The lowest mean was found in "The product has an appealing odor" with a score of 5.26, which only falls under the "Neither Like Nor Dislike" (NLND) category. This suggests that while Formulation A was generally acceptable in aroma, it did not evoke strong positive impressions.Formulation B showed improved results, with an overall average mean of 7.47, which translates to "Like moderately" (LM). The highest mean scores were for "The product's odor is consistent with its intended flavor" (7.57) and "The odor of the product is pleasant enough to encourage consumption" (7.53), both of which were interpreted as "Like very much" (LVM). These results indicate that the aroma of Formulation B met the expectations of the evaluators, aligning well with its intended sensory experience. The lowest-rated item was "The product has an appealing odor" at 7.29, though this still maintained a LM rating, suggesting a generally favorable but slightly less enthusiastic response to that specific characteristic. Formulation C received the highest ratings in aroma acceptability, with an average mean of 8.43, which corresponds to "Like very much" (LVM). The two highest scoring statements were "The product's odor is consistent with its intended flavor" (8.58) and "The odor of the product is pleasant enough to encourage consumption" (8.56), both of which were interpreted as "Like extremely" (LE). These ratings strongly suggest that the aroma of Formulation C was not only pleasant but also compelling enough to promote consumption. The lowest mean for this formulation was 8.27 in the statement "The product has an appealing odor", which still remained within the LVM category.

Table 3 presents the acceptability ratings of the taste of Giant Swamp Taro Pasta enriched with Malabar Spinach, evaluated across three formulations using a 9-point hedonic scale.

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TABLE 3: THE ACCEPTABILITY OF TASTEOF THE GIANT SWAMP TARO PASTA ENHANCED WITH MALABAR SPINACH

Statement	Formulation A			Formulation B			Formulation C		
	M	SD	*D*	M	SD	*D*	M	SD	*D*
1. The taste is delicious and well-balanced, enhancing the overall dish.	5.83	1.51	***LS***	7.46	0.73	***LM***	8.43	0.59	***LVM***
2. The taste is neutral and does not stand out in the dish.	5.81	1.33	***LS***	7.53	0.69	***LVM***	8.48	0.55	***LVM***
3. The taste of the product is unique and refreshing.	5.85	1.10	***LS***	7.60	0.64	***LVM***	8.52	0.62	***LE***
4. The product has the appropriate level of starch and saltiness.	5.93	1.18	***LS***	7.63	0.62	***LVM***	8.64	0.61	***LE***
5. The aftertaste of the product is pleasant.	5.86	1.17	***LS***	7.64	0.62	***LVM***	8.65	0.59	***LE***
Average	**5.86**	**1.13**	***LS***	**7.57**	**0.63**	***LVM***	**8.54**	**0.52**	***LE***

Formulation A received an overall average mean of 5.86, corresponding to “Like slightly” (LS). This indicates that while the taste of this formulation was generally acceptable, it did not elicit strong positive responses from the raters. The highest mean was observed in the statement “The product has the appropriate level of starch and saltiness”, which scored 5.93, suggesting that this aspect was slightly more appreciated than the others. The lowest mean was 5.81, noted in “The taste is neutral and does not stand out in the dish”, which implies a rather plain flavor profile. Across all items, Formulation A remained consistently within the LS range, reflecting mild favorability without strong distinction.Formulation B showed a marked improvement, with an overall average mean of 7.57, interpreted as “Like very much” (LVM). This suggests that the raters found the taste of Formulation B to be appealing and flavorful. The highest rating was found in “The aftertaste of the product is pleasant” with a mean of 7.64, closely followed by “The product has the appropriate level of starch and saltiness” at 7.63. Both items suggest that Formulation B was well-seasoned and left a positive final impression. The lowest mean, though still favorable, was 7.46 in the statement “The taste is delicious and well-balanced, enhancing the overall dish”, which was rated “Like moderately” (LM). This indicates that while the taste was accepted and enjoyed, some improvement could still be made in enhancing overall flavor harmony.Formulation C achieved the highest acceptability among all three variants, with an impressive average mean of 8.54, corresponding to “Like extremely” (LE). This reflects a very strong positive reception from the raters. The highest mean of 8.65 was recorded in “The aftertaste of the product is pleasant”, followed closely by “The product has the appropriate level of starch and saltiness” at 8.64. These ratings indicate that Formulation C not only delivered a desirable initial taste but also left a satisfying aftertaste, reinforcing the quality of its flavor profile. The lowest mean, albeit still very high, was 8.43 for “The taste is delicious and well-balanced, enhancing the overall dish”, which received a “Like very much” (LVM) rating.

Table 4 summarizes the acceptability ratings of the texture of Giant Swamp Taro Pasta enriched with Malabar Spinach across three formulations.

TABLE 4: ACCEPTABILITY OF TEXTURE OF THE GIANT SWAMP TARO PASTA ENHANCED WITH MALABAR SPINACH

Statement	Formulation A			Formulation B			Formulation C		
	M	SD	*D*	M	SD	*D*	M	SD	*D*
1. The texture of the product is soft and noticeable when eaten.	5.16	1.30	***NLND***	7.32	0.80	***LM***	8.27	0.62	***LVM***

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2. The product has a noticeable chewy texture.	5.56	1.07	***LS***	7.41	0.74	***LM***	8.36	0.56	***LVM***
3. The texture is consistent throughout the product.	5.59	0.92	***LS***	7.54	0.67	***LVM***	8.43	0.60	***LVM***
4. The texture makes the product enjoyable to eat.	5.57	0.97	***LS***	7.57	0.66	***LVM***	8.58	0.62	***LE***
5. The texture is suitable for the type of product.	5.55	0.96	***LS***	7.62	0.65	***LVM***	8.58	0.60	***LE***
Average	**5.49**	**0.90**	***NLND***	**7.49**	**0.66**	***LM***	**8.44**	**0.54**	***LVM***

Formulation A received an overall mean score of 5.49, which falls under "Neither Like Nor Dislike" (NLND). This indicates that the respondents felt neutral toward the texture of this formulation. Among the individual statements, the highest mean was recorded in "The texture is consistent throughout the product" at 5.59, while the lowest was 5.16 in "The texture of the product is soft and noticeable when eaten". The rest of the texture attributes scored in the "Like slightly" (LS) range, suggesting mild favorability but with room for improvement. These findings indicate that while Formulation A was not negatively received, it failed to impress the raters in terms of mouthfeel and consistency.Formulation B demonstrated significantly better ratings, with an average mean of 7.49, interpreted as "Like moderately" (LM). The highest score was 7.62, found in "The texture is suitable for the type of product", reflecting a strong alignment between expected and actual mouthfeel. The lowest score, though still favorable, was 7.32 for "The texture of the product is soft and noticeable when eaten". Other statements like "The texture is consistent throughout the product" and "The texture makes the product enjoyable to eat" scored between 7.41 and 7.57, indicating that the textural experience was generally well received and enhanced the overall appeal of the product.Formulation C achieved the highest ratings among the three variants, with an overall average mean of 8.44, falling within "Like very much" (LVM). Two statements, "The texture makes the product enjoyable to eat" and "The texture is suitable for the type of product", received the highest scores at 8.58, which corresponds to "Like extremely" (LE). These results indicate that Formulation C provided a highly satisfying textural experience that enhanced the overall eating quality. The lowest score for this formulation was 8.27 for "The texture of the product is soft and noticeable when eaten", which remained within the LVM category.

Tables 5 and 6 present the inferential statistical analysis conducted to determine whether there were significant differences in the sensory attributes of the Giant Swamp Taro Pasta enriched with Malabar Spinach across the three formulations.

TABLE 5: SIGNIFICANT DIFFERENCE ON THE ACCEPTABILITY OF THE SENSORY ATTRIBUTES OF THE THREE FORMULATIONS OF THE GIANT SWAMP TARO PASTA ENHANCED WITH MALABAR SPINACH

Attribute	F	p	Decision on Ho	Interpretation
Appearance	622.46	<0.01	Rejected	Significant
Aroma	614.88	<0.01	Rejected	Significant
Taste	510.02	<0.01	Rejected	Significant
Texture	839.43	<0.01	Rejected	Significant

Wilks' Lambda Λ= 0.075, F=155.98, p<0.01

Table 5 shows the results of the Multivariate Analysis of Variance (MANOVA) used to assess overall differences across formulations for each sensory attribute. All attributes yielded highly significant F-values, with appearance (F = 622.46), aroma (F = 614.88), taste (F = 510.02), and texture (F = 839.43), all reporting p-values less than 0.01. These results lead to the rejection of the null hypothesis in all four cases, indicating that there are statistically significant

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differences among the three formulations in terms of each sensory characteristic. The Wilks' Lambda value of 0.075, F = 155.98, $p < 0.01$, further confirms the multivariate significance, indicating that the overall sensory profiles of the three formulations differ significantly.To identify where these differences lie, Table 6 presents the results of the pairwise comparisons among the three formulations for each sensory attribute. For appearance, Formulation C (M = 8.41) was significantly higher than both B (M = 7.41) and A (M = 5.47), while Formulation B was also significantly better than A, with all comparisons yielding $p < 0.01$. This pattern holds consistently for aroma, taste, and texture, where Formulation C received the highest mean ratings, followed by Formulation B, and lastly Formulation A. Each pairwise difference was statistically significant, with p-values less than 0.01, and the null hypotheses were uniformly rejected across all comparisons.These findings confirm that Formulation C was significantly superior in all sensory aspects, supporting its status as the most acceptable variant among the three.

TABLE 6: PAIRWISE COMPARISON ON THE SENSORY ATTRIBUTES OF THE THREE FORMULATIONS OF THE GIANT SWAMP TARO PASTA ENHANCED WITH MALABAR SPINACH

Attribute	Formulation (Mean)		p	Decision on Ho	Interpretation
Appearance	A (M=5.47)	B (M=7.41)	<0.01	Rejected	Significant
	A (M=5.47)	C (M=8.41)	<0.01	Rejected	Significant
	B (M=7.41)	C (M=8.41)	<0.01	Rejected	Significant
Aroma	A (M=5.6)	B (M=7.47)	<0.01	Rejected	Significant
	A (M=5.6)	C (M=8.43)	<0.01	Rejected	Significant
	B (M=7.47)	C (M=8.43)	<0.01	Rejected	Significant
Taste	A (M=5.86)	B (M=7.57)	<0.01	Rejected	Significant
	A (M=5.86)	C (M=8.54)	<0.01	Rejected	Significant
	B (M=7.57)	C (M=8.54)	<0.01	Rejected	Significant
Texture	A (M=5.49)	B (M=7.49)	<0.01	Rejected	Significant
	A (M=5.49)	C (M=8.44)	<0.01	Rejected	Significant
	B (M=7.49)	C (M=8.44)	<0.01	Rejected	Significant

Table 7 outlines the nutritional composition of the most preferred formulation of Giant Swamp Taro Pasta enriched with Malabar Spinach, Formulation C, based on the results of a chemical analysis.

TABLE 7: NUTRITIONAL CONTENTS OF FORMULATION "C"OF THE GIANT SWAMP TARO PASTA ENHANCED WITH MALABAR SPINACH

Food Nutrient	Result of Chemical Analysis (per 100g)	Amount of Food Nutrient per Serving Size (Rounded Value)	% Daily Value (based on 2000 Calorie Diet, Rounded Value)	% RENI (based on FNRI reference adult requirement of males 19–29 years old)
Calories	302.03	150		6
Calories from Fat	86.31	45		
Total Fat (g)	9.59	5	6	
Sodium (mg)	99.08	50	2	
Total Carbohydrates (g)	51.73	26	9	
Protein (g)	2.2	1	2	<2

*Based on the Report of Chemical Analysis

% Daily Value is based on the New Nutrition Facts Label finalized May 20, 2016

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The data are presented per 100 grams, per serving size (rounded values), and as a percentage of the recommended daily values based on a 2,000-calorie diet and the Recommended Energy and Nutrient Intake (RENI) for Filipino males aged 19–29 years, according to the Food and Nutrition Research Institute (FNRI).Per 100 grams, the pasta provides 302.03 calories, with 86.31 calories derived from fat. A single serving yields approximately 150 calories, contributing about 6% of the recommended daily caloric intake. This suggests that the product can serve as a moderate energy source within a balanced diet.In terms of macronutrients, the product contains 9.59 grams of total fat per 100 grams, or around 5 grams per serving, which is equivalent to 6% of the Daily Value (DV). This indicates that the pasta is relatively low in fat. The sodium content is also low, with 99.08 mg per 100 grams (about 50 mg per serving), contributing just 2% of the DV, making it suitable for those monitoring sodium intake.Total carbohydrates are the most abundant macronutrient, measured at 51.73 grams per 100 grams and 26 grams per serving, accounting for 9% of the DV. This reflects the pasta's role as a carbohydrate-rich food source, which is typical for pasta products. The protein content, however, is relatively low, with only 2.2 grams per 100 grams, or 1 gram per serving, translating to 2% of the DV and less than 2% of the RENI for adult males. This suggests that while the product is rich in energy and carbohydrates, it would need to be paired with protein-rich foods to contribute meaningfully to daily protein requirements.

V. CONCLUSION

Among the three formulations, Formulation C was the most acceptable in all sensory attributes, indicating that the highest level of Malabar Spinach enrichment effectively enhanced the appearance, aroma, taste, texture, and overall appeal of the Giant Swamp Taro Pasta.The significant differences found among the three formulations confirm that Formulation C is most preferred by the participant.The most preferred formulation is nutritionally characterized as a moderate-energy, low-fat, low-sodium, carbohydrate-rich product, making it a potentially health-conscious alternative for consumers seeking plant-based pasta options.

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