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FORMULATION, ANALYSES, AND ACCEPTABILITY OF TOFU-TARO EMBUTIDO WITH GREEN AMARANTH LEAVES

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Abstract: This experimental-development research was conducted during school year 2024-2025 aimed to formulate study formulated the tofu-taro embutido with green amaranth leaves to evaluate the sensory and acceptability qualities in terms of appearance, aroma, taste, and texture. Significant differences in sensory qualities and acceptability were also determined. The products were submitted for proximate analysis of the best treatments. The research employed a Completely Randomized Design (CRD), with four replications, and involved the evaluation of one final product by 100 tasters to gauge consumer preference. Data collection utilized scorecards with 9-Point Hedonic Scale. Statistical tools employed included the mean, Analysis of Variance, and post-hoc test. Results from sensory evaluations revealed that Treatment B (85 grams of taro flour and 15 grams of green amaranth leaves) received the highest ratings from semitrained panelists, described as extremely appealing, pleasant, delicious and firm. Treatment B was highly preferred by consumers and was liked extremely. Statistical analysis indicated a significant difference in appearance, taste, aroma, and texture based on sensory qualities, in the acceptability of the products. There was a significant difference as to consumers' preference in favor of Treatment B (85 grams of taro flour and 15 grams of green amaranth leaves). The shelf-life analysis showed that the product remained acceptable up to two days at room temperature, after which they began to lose freshness. The microbial analysis revealed that the product complied with safety standards. Proximate analysis confirmed that the product contained nutrients good for the health of the consumers. These findings indicated that the incorporation of green amaranth leaves with taro flour in embutido formulation enhanced the sensory qualities and increased consumer acceptability.

Keywords: Formulation, Analyses, Acceptability, Microbial and Proximate Analysis, Tofu, Taro, Embutido, Green Amaranth Leaves

I. INTRODUCTION

The global landscape of food production is undergoing a transformative shift, with an increasing recognition of the importance of embracing indigenous plant-based ingredients. Indigenous communities around the world have sustained themselves for centuries by harnessing the rich biodiversity of their environments. The utilization of native flora not only reflects a deep connection to the land but also offers a plethora of benefits that extend beyond mere sustenance Vijayan et al., (2022).

The likes of *Colocasia esculenta*, commonly known as *gabi tsina* (a.k.a taro), and *Amaranthus viridis*, known as *kulitis* in Capiz and green amaranth in English, are considered as valuable plants that have been cultivated and consumed by various communities around the world for centuries. Taro and *kulitis* are particularly prominent in Asia where it holds cultural significance and serves as a staple food Lim, (2015).

Both the taro and green amaranth leaves are rich in minerals and nutrients, the former being packed with complex carbohydrates, primarily in the form of starch, while the latter comes with fiber. This makes it an excellent energy source, providing sustained and slow-release energy, which is beneficial for maintaining stable blood sugar levels. Taro contains a significant amount of dietary fiber, promoting digestive health and contributing to a feeling of fullness. The fiber content also supports the prevention of constipation and other digestive issues. It is also a good source of essential vitamins such as vitamin C, vitamin A, and various B vitamins. It also contains minerals like potassium, magnesium, and iron, contributing to overall nutritional well-being. Likewise, it is a staple in many traditional diets, often used as a primary source of carbohydrates in various forms, including boiled, steamed, or fried. With this, the taro offers a versatile and nutritious base for various culinary creations, and one such application is its use in the preparation of embutido Axe, (2023).



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The study generally aims to formulate and determine the acceptability of tofu-gabi taro embutido with green amaranth leaves. Specifically, it aimed to describe the sensory qualities and the general acceptability of tofu-gabi taro embutido with green amaranth leaves in terms of appearance, aroma, taste and texture. Likewise, the study investigated if there are significant differences among treatments. The shelf like of the product placed in room and in chilling condition were also determined.

II. METHODS AND MATERIALS

The study was experimental-developmental research. It aimed to develop a nutritious embutido utilizing tofu- gabi taro and green amaranth leaves. Aside from introducing a tangible product, the study aimed to come up with a standardized recipe based on the taster's evaluation results.

The study employed a Completely Randomized Design (CRD), involving four Treatments A, B, C and D each with three replications. Each treatment consisted of varying proportions of a primary source which is tofu. The primary flour sources used was taro. The product for each treatment were evaluated by the semi-trained panelists in terms of their sensory attributes to determine which treatment within each product group has the best appearance, aroma, taste and texture. After which, the treatment with the highest score based on the ratings and feedback of the evaluators were mass-produced and were subjected to further evaluation by a separate set of evaluators to assess their overall acceptability.

The materials used in the study were the following chef's knife, chopping board, set measuring cup, measuring glass, ladle, utility bowls, spoons, plates, casserole, weighing scale and gas stove.

Tofu -Taro Embutido with Green Amaranth Leaves Treatments formulation

Table 1 presents the treatments in preparing the tofu- taro embutido with green amaranth leaves. After the evaluation of the semi-trained panelist. The chosen products in each treatment were as follows: Treatment A-90g taro flour and 10 g green amaranth leaves; Treatment B 85g taro flour and 15 g green amaranth leaves; Treatment C 80g taro flour and 20 g green amaranth leaves; and Treatment D 75g taro flour and 25g green amaranth leaves. These formulations with other ingredients in making the embutido were followed for the products' mass production to be evaluated by 100 consumers.

Ingredients	Treatment A	Treatment B	Treatment C	Treatment D
Taro Flour	90g	85g	80g	75g
Green Amaranth Leaves	10g	15g	20g	25g
Tofu	50g	50g	50g	50g
Eggs	200g	200g	200g	200g
Carrots	5g	5g	5g	5g
Pickles	5g	5g	5g	5g
Salt	1g	1g	1g	1g
Onion	5g	5g	5g	5g
Garlic	3g	3g	3g	3g
Cheese	5g	5g	5g	5g
Raisins	5g	5g	5g	5g
Black Pepper	2g	2g	2g	2g
Bell Pepper	10g	10g	10g	10g
Green Peas	5g	5g	5g	5g
Hotdog	4g	4g	4g	4g
Sugar	5g	5g	5g	5g

Table 1. Treatments in preparing tofu-taro embutido with green amaranth leaves.





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Experimental procedure

A. Procedure in Preparing Taro Flour and Green Amaranth Leaves

1. Preparation of Taro Flour

One (1) kilo of taro was brought from well-known root crops dealer at Sigma Public Market, Sigma, Capiz to ensure quality and food safety. Then, the taro was washed thoroughly and peeled. Next, the researcher thoroughly drained and grated the taro. Using a cheesecloth, the grated taro was squeezed to remove the extract and was dried under the heat of the sun for three (3) days. Subsequently, the dried taro was ground using a food processor into a fine flour texture. Finally, the prepared taro flour was placed in a clean container and set aside for future use.

2. Procedure in Preparing Green Amaranth Leaves

Good quality of green amaranth leaves was selected, then washed with running mineral water. The tough stems of green amaranth were trimmed. The green amaranth leaves were chopped into small pieces. Then, they were incorporated into the embutido mixture.

3. Procedure in Making Tofu-Taro Embutido with Green Amaranth Leaves

The tools and equipment needed were prepared. Then, the dry ingredients (taro flour) were sifted. Next, in a separate bowl, the embutido was prepared by combining the following ingredients in a large mixing bowl: tofu, onion, carrot, raisins, cheese, eggs, pickles, salt, green amaranth, red pepper, green peas, and ground black pepper. All ingredients were mixed well until they were blended. After that, all ingredients were weighed using a weighing scale. The bread crumbs were added then and mixing continued until well blended. Then, a cup of embutido mixture was scooped and placed over a sheet of pre-cut aluminum foil (12×10 inches). The mixture was then molded to form a cylindrical shape. The foil was rolled and secured both edges then was set aside. This was repeated until all the embutido mixture was consumed. After that, the wrapped embutido were arranged in a steamer. Next, the water was poured in the steamer, let boiled, and steamed (in medium heat) for 60 minutes. The steamed tofu-taro embutido was then removed from the steamer, cooled down, and chilled in the refrigerator for 2 hours. They were sliced and arranged in a serving plate. It could also be fried.

Collection of Data

An evaluation score card was used by the semi-trained panelists in evaluating the sensory quality attributes of the product in terms of appearance, aroma, taste, and texture The semi-trained panelists evaluated product before the researcher conducted the full-fledged large-scale consumer trials. The semi-trained panelists consisted of 25-30 members. Hence, in selecting those who would qualify as semi-trained panelists, the researcher selected Food Technology professors of Capiz State University, given their experience and expertise in evaluating food products. They were invited to serve as the evaluators for the sensory quality attributes of the product. The 100 evaluators of the study for the general acceptability consisted of 25 food establishment owners; 25 food technology students of Aglalana Integrated School; 25 housewives; and 25 consumers.

After the evaluation, the evaluation sheets were gathered, tallied, summarized, and prepared for statistical computation. The mean was used to determine the level of acceptability of tofu-taro embutido with green amaranth leaves in four treatments.

Statistical Tools

The data were tabulated and statistically analyzed using the Statistical Package for Social Sciences (SPSS) software using the Arithmetic Mean and the Analysis of Variance (ANOVA). The Arithmetic Mean was used to determine the sensory qualities and acceptability of the product among the four trials, while, ANOVA was used to determine the significant difference in the sensory qualities of the product in terms of appearance, aroma, taste, and texture as well as the differences among the four treatment level of significance was set at.01 alpha.





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III. RESULTS AND DISCUSSIONS

Sensory Qualities of Tofu-Taro Embutido with Green Amaranth Leaves

Table 4 presents the product formulations of tofu-taro embutido with green amaranth leaves and their corresponding sensory qualities in terms of appearance, aroma, taste, and texture. The sensory qualities evaluation was conducted by the semi-trained panelists who assessed the four different treatments, Treatment A (90g of taro flour, 10 grams of green amaranth leaves), Treatment B (85g of taro flour, 15g of green amaranth leaves), Treatment C (80g of taro flour and 25g of green amaranth leaves), and Treatment D (75g of taro flour and 25g of green amaranth leaves). Each treatment was evaluated based on appearance, aroma, taste, and texture to determine the most acceptable formulation of tofu-taro embutido with green amaranth leaves.

In terms of appearance, the result showed that Treatment B (85g of taro flour, 15g of green amaranth leaves) got the highest mean score of 8.30, described as "Extremely Appealing". This was followed Treatment A (90g of taro flour, 10 grams of green amaranth leaves) with the mean score of 8.10, described as "Extremely Appealing," Treatment C (80g of taro flour and 25g of green amaranth leaves) got the mean score of 7.90, described as "Very Much Appealing," and Treatment D (75g of taro flour and 25g of green amaranth leaves) with the mean score of 7.20, described as "Moderately Appealing". This implies that only Treatments B and A were extremely appealing and Treatment C was very much appealing; however, Treatment D was moderately appealing due to the increase amount of green amaranth leaves.

The result aligned with that of Jang and Lee (2024) that while incorporating green vegetables into tofu-based meat analogs improved the nutritional profile, higher concentrations altered visual and textural characteristics, sometimes resulting in lower acceptability scores for appearance. These findings suggested that an optimal balance of taro flour and green amaranth leaves was crucial to maintain both the aesthetic appeal and health benefits in plant-based products like embutido.

In terms of aroma, the result showed that Treatment B (85g of taro flour, 15g of green amaranth leaves) and Treatment C (80g of taro flour and 25g of green amaranth leaves) got the highest mean score of 8.20, described as "Extremely Pleasant". This was followed by Treatment A (90g of taro flour, 10 grams of green amaranth leaves) with the mean score of 8.00, described as "Very Much Pleasant," and Treatment D (75g of taro flour and 25g of green amaranth leaves) with the mean score of 7.30, described as "Very Much Pleasant". This implies that Treatments B and C of embutido was extremely pleasant. The aroma compound of green amaranth leaves notably had a green grassy aroma, contributing to the unique aroma of the embutido.

The result of the study aligned with that of Mburu et al., (2020) that moderate incorporation of green leafy vegetables like amaranth enhanced the aroma, attributing this to the release of natural volatile compounds, such as hexanal and (Z)-3-hexenal, which contribute a fresh, green, and slightly grassy scent. These aroma compounds, when balanced with other ingredients, were shown to improve overall aroma acceptability in plant-based dishes.

In terms of taste, the result showed that Treatment B (85g of taro flour, 15g of green amaranth leaves) got the highest mean score of 8.60, described as "Extremely Authentic". This was followed by Treatment C (80g of taro flour and 25g of green amaranth leaves), described as "Extremely Authentic," Treatment A (90g of taro flour, 10 grams of green amaranth leaves) with the mean score of 7.90, described as "Very Much Authentic," and Treatment D (75g of taro flour and 25g of green amaranth leaves) with the mean score of 7.50, described as "Very Much Authentic". This implies that Treatments B and C got a closer result due to the incorporation of taro and green amaranth leaves.

The result of the study was parallel to that of Mesinas et al., (2021) that the incorporation of green amaranth leaves into siomai taro wrappers enriched the taste of food product.

In terms of texture, the result showed that Treatment B (85g of taro flour, 15g of green amaranth leaves) got the highest mean score of 8.60, described "Extremely Firm". This was followed by Treatment C (80g of taro flour and 25g of green amaranth leaves) with the mean score 8.50, described as "Extremely Firm," while Treatment A (90g of taro flour, 10 grams of green amaranth leaves) got the mean score of 7.90, described as "Very Much Firm," and Treatment D (75g of taro flour and 25g of green amaranth leaves) got the mean score of 7.50, described as "Very Much Firm," This implies that Treatment B got the highest mean score due to the effect of taro starch as a binding property leading to better textural qualities.



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This result aligned with that of Dela Cruz and Marquez, (2019). They investigated the functional properties of taro flour, focusing on its water-holding capacity and gelatinization behavior. Their findings revealed that taro flour could effectively act as a natural binder and moisture retainer in plant-based meat substitutes, thereby improving texture and structural integrity-critical aspects in embutido formulations.

In general, the taste of tofu- taro embutido with green amaranth leaves received the highest ranking, followed by texture, then appearance, and lastly aroma, as evaluated by the 10 semi-trained panelists.

Sensory Qualities	Treatment A (90g taro flour and 10g green amaranth leaves)		Treatment B (85g taro flour and 15g green amaranth leaves)		Treatment C (80g taro flour and 20g green amaranth leaves)		Treatment D (75g taro flour and 25g green amaranth leaves)	
	Mean	AD	Mean	AD	Mean	AD	Mean	AD
Appearance	8.10	EA	8.30	EA	7.90	VMA	7.20	MA
Aroma	8.00	VMP	8.20	EP	8.20	EP	7.30	VMP
Taste	7.90	VMA	8.60	EA	8.50	EA	7.50	VMA
Texture	7.80	VMF	8.40	EF	8.30	EF	7.30	VMF

Table 4. Sensory qualities of tofu-taro embutido with green amaranth leaves.

Legend. Auje	cuvai Description (AD)		
Score	Appearance	Aroma	Taste
8.12 – 9.00	Extremely Appealing (EA)	Extremely Pleasant (EP)	Extremely Authentic (EA)
7.23 – 8.11	Very Much Appealing (VMA)	Very Much Pleasant (VMP)	Very Much Authentic (VMA)
6.34 – 7.22	Moderately Appealing (MA)	Moderately Pleasant (MP)	Moderately Authentic (MA)
5.45 - 6.33	Slightly Appealing (SA)	Slightly Pleasant (SP)	Slightly Authentic (SA)
Score	Texture		
8.12 - 9.00	Extremely Firm (EF)		

General Acceptability Tofu-Taro Embutido with Green Amaranth Leaves as Evaluated by Consumers

Slightly Firm(SF)

Very Much Firm(VMF)

Moderately Firm (MF

and Adjactinal Description (AD)

7.23 - 8.11

6.34 - 7.22

5.45 - 6.33

Table 5 reveals the results in the general acceptability of tofu-taro embutido with green amaranth leaves as evaluated by consumers, considering the four (4) treatments from the 100 participants. The assessment of appearance, aroma, taste, and texture showed that the tofu-taro embutido with green amaranth leaves was "Liked Very Much" even in different proportions of the amount of taro flour and green amaranth leaves, such as Treatment B (mean = 8.12), Treatment A (mean = 7.62), Treatment C (mean = 7.52), and Treatment D (mean = 7.33). This implies that the four (4) treatments in making tofu-taro embutido with green amaranth leaves found to be similar as a whole, regardless of the variations in the amount of taro flour and green amaranth leaves. This result conformed that the taro flour and green amaranth leaves have considerable effects on improving texture enhancement, flavor, and aroma, and the acceptability improvement that could appeal to health-conscious consumers looking for a plant-based, fiber – rich and protein -enhanced alternatives to the traditional embutido.

This result of the study supported the study of Lin and Huang, (2021), who highlighted the tofu-based meat analogs fortified with green vegetables. They found that tofu contributes to a soft, meat-like texture, while the inclusion of leafy greens added the depth of flavor and nutritional value. The combination resulted in improved overall sensory scores, reinforcing the viability of such combinations in meatless product development.



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 Table 5. General acceptability of tofu-taro embutido with green amaranth leaves as evaluated by consumers.

Sensory Qualities	Treatment ATreatment BT(90g taro flour(85g taro flour(8and 10g greenand 15g greenaamaranth leaves)amaranth leaves)a		Treatment C (80g taro flour and 20g green amaranth leaves)		Treatment D (75g taro flour and 25g green amaranth leaves)			
	Mean	AD	Mean	AD	Mean	AD	Mean	AD
Appearance	7.64	LVM	8.16	LE	7.76	LVM	7.51	LVM
Aroma	7.84	LVM	8.30	LE	7.66	LVM	7.49	LVM
Taste	7.56	LVM	8.07	LVM	7.31	LVM	7.19	LM
Texture	7.50	LVM	7.86	LVM	7.21	LM	7.17	LM
General Acceptability	7.62	LVM	8.12	LVM	7.52	LVM	7.33	LVM
nd: Adjectival Description (AD)								

Score General Acceptability 6.34 – 7.22 ⁸ 12 0.00 Libed Extramely (LE) 5.45 6.32

 8.12 - 9.00
 Liked Extremely (LE)
 5.45 - 6.33

 7.23 - 8.11
 Liked Very Much (LVM)

Liked Moderately (LM) Liked Slightly (LS)

Difference in the Sensory Qualities of Tofu-Taro Embutido with Green Amaranth Leaves

Table 6 shows that there was a significant difference in appearance, aroma, taste and texture among four (4) treatments of tofu-taro embutido with green amaranth leaves as evaluated by the semi-trained panelists.

The result revealed that in terms of appearance, there was a significant difference (F-ratio = 6.111, p-value = .002). This implies that the visual appeal of the tofu-taro embutido with green amaranth leaves differed in all treatments, likely due to the increasing or decreasing amounts of the main ingredients- taro flour and green amaranth leaves, which affected the appearance, uniformity, and overall presentation of the product in favor of Treatment B (85g of taro flour, 15g of green amaranth leaves), which was rated the most visually appealing by the semi-trained panelists due to its balanced proportion of ingredients that contributed to a more desirable and appetizing appearance.

The result supported Mesinas et al., (2021), who found that incorporating green amaranth leaves in food products like siomai wrappers significantly influenced their visual attributes. Their study emphasized that moderate inclusion levels enhanced appearance and consumer appeal, while excessive amounts negatively affected color and uniformity, which was similar to the findings in tofu-taro embutido.

The result of the study also revealed a significant difference in aroma among the four (4) treatments (F-ratio = 4.940, p-value = 0.006). This implies that the varying proportions used in preparing the tofu-taro embutido with green amaranth leaves affected the aromatic quality of the product. The difference in aroma may be attributed to the distinct earthy and grassy scent of green amaranth leaves, which became more prominent as the amount increased in favor of Treatment B (85g of taro flour, 15g of green amaranth leaves), which was found to have the most balanced and pleasant aroma as evaluated by the consumers.

The result also supported Onyeoziri et al., (2017), who found that increasing portion of green amaranth in food formulations contributed to a stronger earthy and grassy aroma. However, moderate amounts enhanced overall aroma perception, while excessive levels reduced acceptability due t overbearing vegetal notes.

The result of the test of difference among the products in terms of taste revealed a significant difference (F-ratio= 5.945, p-value = 0.002). This result implies that the taste varied significantly depending on the proportion of taro flour and green amaranth leaves formulation. The combination of ingredients influenced the flavor profile, particularly the balance between the mild taste of tofu, the earthy flavor of taro, and the slightly bitter notes of green amaranth leaves in favor of Treatment B (85g of taro flour, 15g of green amaranth leaves), which was rated the most authentic and pleasant in taste by the semi-trained panelists.



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This result aligned with the findings of Lin and Huang, (2021). They found that tofu-based meat analogs enriched with leafy vegetables had enhanced flavor when the green component was added in moderate amounts. They emphasized that while tofu offers a neutral base, leafy greens can complement it well when balanced properly, avoiding overly bitter or grassy notes.

Likewise, the test of difference in terms of texture also showed a significant difference (F-ratio = 5.704, p-value = 0.003). This implies that the firmness and mouthfeel of the embutido were affected by the varying ratios of tofu, taro flour, and green amaranth leaves in favor of Treatment B (85g of taro flour, 15g of green amaranth leaves), which achieved the ideal firmness and consistency as perceived by the panelists, offering a texture closest to traditional meal-based embutido.

This result supported Dela Cruz and Marquez, (2019) who reported that taro flour, due to its high water-holding and gelatization properties, contributes significantly to the firmness and cohesiveness of plant-based meat products. Its binding capacity enhanced the texture, making it a suitable substitute in meat analog formulations like embutido.

Since there was no significant difference in the sensory qualities of the tofu-taro embutido with green amaranth leaves in terms of appearance, aroma, taste, and texture in four treatments, the null hypothesis was rejected.

Table 6. Difference in the sensory qualities of tofu- taro embutido with green amaranth leaves.

Sensory Qualities	Sum of Squares	Df	Mean Square	F- value	P- value	Remarks
	6.875	3	2.292	6.111	.002	S
Appearance	13.500	36	.375			
	20.375	39				
	5.475	3	1.825	4.940	.006	S
Aroma	13.300	36	.369			
	18.775	39				
Taste	8.075	3	2.692	5.945	.002	S
Taste	16.300	36	.453			
	24.375	39				
Texture	7.700	3	2.567	5.704	.003	S
	16.200	36	.450			
	23.900	39				

Legend: p-value > .01, not significant at p-value < 0.01, significant at .01 alpha

Difference in the General Acceptability of Tofu-Taro Embutido with Green Amaranth Leaves

The data on the difference in the general acceptability of the tofu-taro embutido with green amaranth leaves is shown in Table 7. The result revealed the F-ratio of 35.861 with p-value of 0.00, which was less than the 0.01 alpha levels. This implies that there was a highly significant difference in the acceptability of tofu-taro embutido with green amaranth leaves.

In terms of appearance, the result revealed that there was a significant difference among the four (4) treatments of tofutaro embutido with green amaranth leaves, (F-ratio =15.187, p-value = 0.000) in favor of Treatment B (85g of taro flour, 15g of green amaranth leaves). This means that the result was statistically significant at the 0.01 level. The result indicated that the appearance of the product varied when the amount of green amaranth leaves was increasing in favor of Treatment B (85g of taro flour, 15g of green amaranth leaves), which obtained the highest mean score for appearance. The result further implies that this specific proportion was visually more appealing to the panelists. Furthermore, it indicated that the appearance of the product varied with the increasing amount of green amaranth leaves, possibly due to changes of texture or consistency that became less desirable at higher concentration.



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This result supported Mesinas et al., (2021) who explored the use of amaranth leaves in developing siomai wrappers. The study demonstrated that incorporating fresh amaranth leaves improved the nutritional value and sensory attributes of the wrappers, making them more acceptable to consumers. This supported the inclusion of green amaranth leaves in embutido to enhance its nutritional profile and consumer appeal.

In terms of aroma, the result revealed that there was a significant difference among the four (4) treatments of tofu-taro embutido with green amaranth leaves, as reflected by the F-ratio = 17.606 and the p-value = 0.000. This result implies that the aroma of the product varied when the amount of green amaranth leaves was increasing in favor of Treatment B (85g of taro flour, 15g of green amaranth leaves), which received the highest aroma rating, suggesting that the balance of 85g taro flour and 15g green amaranth leaves produced a more pleasant and appealing aroma to the panelists. It was also observed that the aroma of the product varied as the quantity of green amaranth leaves increased, potentially due to its distinct scent becoming more prominent or overpowering in higher concentrations.

The result supported Onyeoziri et al., (2017) who found that incorporation of green leafy vegetables, such as amaranth significantly influenced the aroma of food products. Amaranth contributed a distinct grassy and earthy aroma, which could enhance or overpower a product's sensory profile depending on the concentration used.

Consequently, the result of the test on taste also revealed a significant difference among the treatments (F-ratio = 32.407, p-value = 0.000). This again favored Treatment B, which obtained the highest taste acceptability score. The result implies that variations in the proportions of taro flour and green amaranth leaves significantly affected the taste of the embutido. In favor of Treatment B, it can be inferred that the formulation achieved a more balanced flavor profile, which the mild earthiness of taro and the subtle bitterness of green amaranth complemented the tofu base, enhancing the overall taste experience.

The result supported Dela Cruz et al., (2023) who evaluated the sensory attributes of polyoron made from blended taro and sweet potato. The combination of these root crops influenced the product's palatability, texture, and overall acceptability.

The result further revealed that there was a significant difference in the texture of tofu-taro embutido with green amaranth leaves as indicated by the F-ratio = 25.910, p-value = 0. 000. This implies that the variations in the amounts of taro flour and green amaranth leaves across the four (4) treatments significantly affected the texture of the product. This was in favor of Treatment B, which received the highest texture rating, suggesting that this particular ratio of 85g taro flour and 15g green amaranth leaves produced the most desirable mouthfeel among the samples. The embutido from this treatment likely achieved a balanced consistency, firm enough to hold its shape, yet soft and smooth enough to be palatable, making it more acceptable to the sensory panel. The differences in texture among treatments may be attributed to the gelling or binding properties of taro flour and the fibrous content of green amaranth leaves, which varied with each formulation.

This result aligned with the study of Moorthy, (2022). It was reported that taro, particularly its starch composition and water-holding capacity, contribute to its effectiveness as a natural binder. The findings showed that taro flour improved cohesiveness and moisture retention, the key qualities for meat substitutes, aiming to replicate the texture of traditional embutido.

Since there was no significant difference in the acceptability of tofu-taro embutido with green amaranth leaves in terms of its appearance, aroma, taste, and texture in four treatments, the null hypothesis was rejected.

Sensory Qualities	Sum of	Df	Mean	F	Р	Remarks
	Squares		Square			
	23.668	3	7.889	15.187	.000	S
Appearance	205.710	396	.519			
	229.378	399				
	36.528	3	12.176	17.606	.000	S
Aroma	273.870	396	.692			
	310.398	399				
Teste	45.648	3	15.216	32.407	.000	S
Taste	185.930	396	.470			

Table 7. Difference in the general acceptability of tofu- taro embutido with green amaranth leaves.



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	231.578 30.570	399 3	10.190	25.910	.000	s
Texture	155.740	396	.393			
	186.310	399				
General Acceptability	33.938	3 11	.313	35.861	.000	s
	124.921	396 .31	5			
	158.859	399				

Legend: p-value > .01, not significant at p-value < 0.01, significant at .01 alpha

Shelf Life of Tofu-Taro Embutido with Green Amaranth Leaves at Room and Chilling Temperature

The tofu-taro embutido was stored at room and chilling temperature to observe its shelf life.

Table 8 presents the observed shelf life of tofu-taro embutido with green amaranth leaves sealed when stored at room and chilling temperature, away from water and sunlight. The observation of the shelf life was done every day to examine if the product was of good quality or if there were any changes taking place in the tofu-taro embutido with green amaranth leaves.

Room Temperature. The result revealed that when the product was stored at room temperature, away from sunlight, with free passage of air, dry, normally lighted room for 6 days, on the first and second day, there were no changes occurred as to the physical characteristics, indicating that its nutrients were intact. But on the start of third to 6 days, the product started to change its aroma, appearance, and texture, and the molds were already present. The spoilage of the product was visible. Freshness of the product in general was lost.

Chilling. The tofu-taro embutido with green amaranth leaves were stored as chilling/fridge temperature for 6 days. The refrigerator temperature was monitored and kept between $32^{\circ}F - 40^{\circ}F$. The observation found no changes took place within 4 days. Nevertheless, after 6 days, the appearance of the product remained the same. Molds were not evident.

Freezing Temperature. The tofu-taro embutido with green amaranth leaves was stored at freezing temperature (at or below $32^{\circ}F - 0^{\circ}C$) for 1 month. Freezing effectively inhibits microbial growth and significantly slows down enzymatic and chemical reactions, making it suitable method for long-term preservation. After one month of frozen storage, the product maintained its appearance, texture and odor, with no signs of spoilage such as discoloration, off-odor, or freezer burn. This indicates that freezing is a viable method for extending the shelf life of plant based embutido without negatively affecting its sensory quality.

Table 8. Shelf life of tofu-taro embutido with green amaranth leaves when stored at room and chilling temperature.

Tofu- Taro Embutido with Green Amaranth Leaves	2 days (molds formation)	4 days (molds formation, lumpiness)	6 days (molds formation, lumpiness, production of spot)	1 Month (molds formation, lumpiness, production of spot)
Room Temperature			• <i>i</i>	• ·
Treatment B	-	+	+	+
Chilling Temperature				
Treatment B	-	-	-	+
Freezing Temperature Treatment B	_	_	-	_



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Legend: Negative (-) no mold formation Positive (+) mold formation is observed

Microbial Analysis of Tofu-Taro Embutido with Green Amaranth Leaves

Table 9 shows the microbial report analysis of tofu-taro embutido with green amaranth leaves samples conducted by the Negros Prawn Producers Cooperative Analytical and Diagnostic Laboratory, Bacolod City with LSO No. 25-84614. This was submitted on March 15, 2025 and was analyzed from March 15, 2025 to March 24, 2025 as attached in Appendix M.

The tofu-taro embutido with green amaranth leaves with two (2) packs at 250grams per pack were subjected to Aerobic Plate Count using AOAC International Official Method of Analysis, Total Coliform and E. Coli, using 3M Petrifilm E. Coli. Count, Salmonella using Compact Dry Media and Yeast Count using 3M Petrifilm.

As shown in the result in the Table 8, the tofu-taro embutido with green amaranth leaves has the Aerobic Plate Count of 40 cfu/g sample based on the BFAD reference criteria for Aerobic Plate Count, which M in level of rejection and m for an acceptable level. For molds and yeast count it had the result of <10 cfu/g sample with the BFAD reference criteria, which was both acceptable in m and M. The total Coliform got the result of <10 cfu/g sample based on the BFAD reference criteria, which was both acceptable in m and M. The total Coliform got the result of <10 cfu/g sample based on the BFAD reference criteria for total coliform, which followed the standard on category of baked goods which was both acceptable in m and M rejection. The result given in this report was during the time of examination and referred only to the particular sample submitted. Passing the microbial analysis confirmed that the food was free from harmful levels of microorganisms, reducing the risk of foodborne illnesses for consumers.

It also indicated that the food met quality standards, as excessive microbial growth could lead to spoilage, affecting the taste, firmness, and overall quality of the product. Meeting the microbial safety standards ensured that the food complies with regulatory requirements set by food safety authorities, demonstrating that the researcher, who formulated and processed the product understood the commitment to food safety regulations. Consumers were more likely to trust and purchase foods that have passed microbial analysis, knowing that they have been rigorously tested for safety. By ensuring low microbial counts, the food is less likely to spoil quickly, potentially extending its shelf life and reducing food waste. Lastly, by passing the guidelines for food standard it reduces the risk of foodborne illnesses caused by harmful microorganisms such as bacteria, viruses, and parasites. This protection safeguards individuals from the physical discomfort, pain, and potential long-term health consequences associated with foodborne diseases.

Sample Description	Parameter	NPPC	FDA Standards		
		m	Μ		
Tofu-Taro Embutido with Green Amaranth Leaves, 200g	Aerobic Plate Count	40 cfu/g sample	10 ⁴	10 ⁶	
(2 nacks @ 250g/nk·	Total Coliform	<not 10<sup="" at="" detected="">1</not>	10 ²		
MFD:03/14/2025	Mold and Yeast Count Salmonella	<10 cfu/g sample. Absent in 25 grams	50	10 ⁴ 10 ³	

Table 9. Microbial analysis of tofu-taro embutido with green amaranth leaves.

Legend: m - acceptable level of microorganism determined by a specified method: values are generally based on levels that are achievable under GMP

M – level which when exceeded in one or more samples would cause the lot to be rejected as this indicates a potential health hazard or imminent spoilage.



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Proximate Analysis of Tofu-Taro Embutido with Green Amaranth Leaves

Table 10 shows the report of proximate analysis of tofu-taro embutido with green amaranth leaves samples conducted by the Negros Prawn Producers Cooperative Analytical and Diagnostic Laboratory in Bacolod City with LSO No. 25-84514, which was submitted and analyzed on March 15, 2025, and reported on March 26, 2025, as attached in Appendix L.

The tofu-taro embutido with green amaranth leaves with two 250-gram sample in a plastic container was subjected to fat, carbohydrates, moisture, protein, ash and calories., for fat by Soxhlet Extraction Method, carbohydrates by Phenol Sulfuric Acid Method, moisture by Gravimetric Oven Drying at 105°C, protein Kjeldahl Method, ash by Oxidation at 550°C, and calories/ 100g

As shown in the result, tofu-taro embutido with green amaranth leaves had fat of 6.29/250grams, carbohydrates of 45.82/250grams, moisture of 40.2/250 grams, protein of 6.06/250grams, ash of 1.32/250grams, and calories 264/250grams.

The results given in the report were those obtained at the time of examination and referred only to the particular sample submitted.

The results imply that the tofu-taro embutido with green amaranth leaves is a nutrient-dense, plant-based alternative to traditional meat embutido, offering a balanced composition of macronutrients-notably moderate fat and protein content, high carbohydrate and moisture levels, and low ash (mineral) content per 250 grams. With 264 calories per serving, the product provides sufficient energy while remaining relatively low in fat and cholesterol, making it a health-conscious option for consumers seeking fiber-plant-protein-rich-foods. The high moisture content (40.2), also contributed to the product's tender texture and juiciness, while the combination of tofu, taro flour, and green amaranth leaves offered functional benefits, such as improved binding, flavor and nutritional enhancement.

The result supported Abdul et al., (2024) who conducted a proximate analysis to assess the levels of moisture, protein, fat, ash and carbohydrate content in commercially and experimentally produced embutido. The findings provided essential insights for improving the product's nutritional profile while maintaining its sensory and microbial quality.

Sample Description	Parameter	Result g/100mL
	Fat	6.29/250g
	Carbohydrates	45.82/250g
	Moisture	40.2/250 g
Tofu-Taro Embutido with Green Amaranth Leaves (250g)	Protein	6.06/250g
	Ash	1.32/250g
	Calories	264/250g

Table 10. Proximate analysis of tofu-taro embutido with green amaranth leaves.

IV. CONCLUSIONS

Taro (*gabi tsina*) can be processed into flour and effectively used as a main ingredient in making embutido. Tofu can serve as a healthy substitute for traditional meat components while enhancing the nutritional profile of the dish. The combination of taro flour and green amaranth leaves contributes positively to the sensory qualities of the product, making it a standout choice among the tested formulations. The sensory qualities of tofu-taro embutido with green amaranth leaves, specifically its appearance, aroma, taste, and texture, vary significantly across the different treatments. However, Treatment B (85g taro flour and 15g green amaranth leaves) stands out as the most favorable option. These findings highlight the positive impact of this particular formulation on the sensory appeal and consumer preference for



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the product. Taro flour and green amaranth leaves have shown great potential as a value-added ingredient in all food products, especially in food products such as embutido. The taro flour and green amaranth leaves are safe for human consumption as the results of microbial analysis of the product and is based on the BFAD standard for microbiological tests standard for food products.

V. RECOMMENDATION

Based on the established conclusions, the following recommendations are suggested:Tofu-taro embutido with green amaranth leaves is recommended as a viable alternative to traditional meat-based embutido. The incorporation of tofu and green amaranth has shown promising results in terms of sensory qualities and overall acceptability among consumers. The use of taro flour as a binder has proven effective in maintaining the desired structure and texture of the embutido. It is recommended to further optimize its concentration for consistent product quality in future formulations.

Promoting tofu-taro embutido in health-focused food events, vegetarian expos, and school food fair is encouraged. Its plant-based ingredients, combined with the nutritional value of green amaranth and taro, give it a unique appeal that aligns with current trends in healthy and sustainable eating. To maintain product freshness and safety, proper packaging, preferably vacuum-sealed or tightly sealed containers, is recommended. This will help extend the shell life and allow for wider distribution without compromising quality.

Future researchers are encouraged to explore other locally available binders, flavor enhancements, or preservation techniques that could further improve the product's stability and acceptability. Additionally, a shelf life study and nutrient analysis may provide valuable insights for commercial production. By applying these recommendations, stakeholders and future innovators can maximize the potential of tofu-taro embutido with green amaranth leaves as a nutritious, sustainable, and appealing meat alternative.

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