

Soybean Pulp with Sweetened Tofu Loaf Based Food: Product Development Research Study

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ABSTRACT: This research study titled “Soybean Pulp with Sweetened Tofu Loaf-Based Food: Product Development Research Study” explores the utilization of soybean pulp (okara)—a nutrient-rich by-product of tofu production—as the primary ingredient in developing a sustainable and health-promoting loaf-based food product. The study responds to the growing need for innovative food solutions that address malnutrition, reduce food waste, and support sustainable consumption in the Philippines. Employing a descriptive developmental research design, the project focused on the formulation, preparation, and sensory evaluation of the soybean pulp with sweetened tofu loaf. Fresh okara was sourced from local tofu producers in Ilagan City, Isabela, and combined with sweetened tofu and other natural ingredients to enhance flavor and texture. Sixty evaluators representing various age groups (children, teenagers, adults, and food experts) participated in a sensory evaluation assessing appearance, aroma, taste, and texture using a 5-point Likert scale. The findings revealed that the product achieved a “highly acceptable” overall rating, with Treatment 3 showing the highest mean acceptability across all sensory parameters (WAM: 5.00). Nutritional analysis indicated that every 100 grams of the product provided 20.29 g of protein, 7.64 g of carbohydrates, and 10.8 g of fat, demonstrating its potential as a nutrient-dense food alternative. The statistical analysis using ANOVA confirmed no significant difference in acceptability across age groups, suggesting universal consumer appeal. This study validates that soybean pulp, when innovatively processed with sweetened tofu, can yield a palatable and nutritionally balanced food product. Moreover, it contributes to environmental sustainability by repurposing agricultural by-products, aligning with the United Nations Sustainable Development Goals on zero hunger and responsible consumption (United Nations, 2024). The results underscore the importance of promoting waste-to-value initiatives within local food systems, fostering community-based entrepreneurship, and advancing health-conscious food innovation in the Philippines.

KEYWORD: soybean pulp, okara, tofu loaf, sensory evaluation, food innovation, sustainable nutrition

I. INTRODUCTION

The escalating global food prices and increasing demand for sustainable protein sources have driven the food industry to explore innovative and eco-friendly ingredients (Food and Agriculture Organization [FAO], 2022). In the Philippines, malnutrition and the growing consumption of unhealthy processed foods have become pressing concerns, necessitating the development of affordable and nutritious local food products (Department of Health [DOH], 2023). Despite the country’s rich tradition in preparing native delicacies, many Filipino households now rely heavily on processed snacks and sugary beverages that contribute to diet-related diseases. Addressing these issues requires creative utilization of local agricultural resources that can improve public nutrition while supporting environmental sustainability.

Soybean pulp, or okara, is a nutrient-dense by-product of tofu and soymilk production that is often discarded as waste, posing environmental challenges (Zhang et al., 2023). Given its high protein, fiber, and micronutrient content, okara presents a promising ingredient for developing health-promoting and sustainable food products. Repurposing this by-product aligns with the United Nations’ Sustainable Development Goals (SDG 2: Zero Hunger; SDG 12: Responsible Consumption and Production), emphasizing food waste reduction and the creation of nutritious, affordable food alternatives (United Nations, 2024). In the City of Ilagan, where tofu and taho production are common, substantial volumes of soybean residue are generated daily. This situation provides an opportunity to transform waste materials into value-added products, such as a soybean pulp with sweetened tofu loaf—a novel food innovation combining local flavors with sustainable nutrition.

Globally, researchers have identified okara as an underutilized yet nutrient-rich raw material. Studies show that it contains approximately 50% dietary fiber, 25% protein, and 10% lipid, along with beneficial compounds such as isoflavones and antioxidants (FAO, 2022; Zhang et al., 2023). These bioactives contribute to improved metabolic health, cardiovascular function, and glycemic control, making okara suitable for functional food development. However, challenges related to its coarse texture and earthy flavor limit its application in mainstream food production (Chen et al., 2022). To overcome these sensory barriers, blending okara with

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sweetened tofu offers a complementary approach. Tofu not only enhances the sensory profile with its mild flavor and smooth texture but also contributes complete proteins and essential amino acids, resulting in a nutritionally balanced and palatable product.

From a sustainability standpoint, okara valorization supports waste reduction and economic circularity by converting food industry by-products into viable food sources. In the Philippines, much of the okara generated by tofu production is discarded or used as animal feed, representing a missed opportunity for human nutrition and local entrepreneurship (Torres & Dela Cruz, 2021). The Department of Science and Technology's (DOST, 2023) Waste-to-Value program addresses this issue by encouraging research and innovation focused on repurposing agricultural residues into consumer-ready food items. This initiative is consistent with global efforts led by the United Nations (2024) to promote responsible consumption and production.

Furthermore, consumer acceptance plays a critical role in the success of such innovations. Studies emphasize that sensory evaluation—assessing parameters such as texture, taste, aroma, and appearance—is essential for developing products that balance nutritional quality with consumer appeal (Goyal et al., 2021; Lawless & Heymann, 2019). Processing techniques such as drying, milling, and fermentation have also been shown to improve okara's textural and flavor characteristics, thereby enhancing its acceptability (Chen et al., 2022; Liu & Kim, 2021). Integrating sweetened tofu, which contributes mild sweetness and creaminess, can further enhance the product's sensory characteristics while maintaining nutritional integrity.

In essence, the combination of soybean pulp and sweetened tofu represents an innovative approach to developing sustainable, health-oriented food products suited to local contexts. The nutritional synergy of okara's fiber-rich profile and tofu's complete protein content addresses key dietary needs, while its production contributes to waste minimization and economic sustainability. Within the Philippine setting—where tofu production is prevalent and community-based food innovation is growing—this research aims to demonstrate a viable model for transforming agricultural by-products into marketable, nutritious, and culturally relevant food solutions.

The main objective of this study is to develop and evaluate the quality and acceptability of a soybean pulp with sweetened tofu loaf as a sustainable and nutritious food product. Specifically, the study aims to:

1. Formulate and produce a loaf-based food product using soybean pulp (okara) and sweetened tofu as the main ingredients.
2. Evaluate the level of acceptability of the product in terms of:
 - Appearance
 - Aroma
 - Taste
 - Texture
3. Determine the sensory evaluation of the product as perceived by different age groups (children, teenagers, adults, and experts).
4. Assess the nutritional contribution of soybean pulp to the overall nutritive value of the developed product.
5. Promote sustainable food innovation by utilizing local agricultural by-products and supporting community-based nutrition improvement.

Statement of Objectives

The general objective of the study is to develop and evaluate a soybean pulp with sweetened tofu loaf as a sustainable and nutritious food innovation.

Specifically, the study aims to:

1. Formulate a loaf-based food product using soybean pulp (okara) and sweetened tofu.
2. Determine the sensory acceptability of the developed product in terms of appearance, aroma, taste, and texture.
3. Assess the statistical difference in acceptability across age groups.
4. Analyze the nutritional composition of the product.

II. METHODOLOGY

This chapter contains the materials / ingredients, utensils, experimental treatment, experimental design, collection of the data, statistical tools and analysis used in the study.

Research Design

This study utilized a descriptive developmental research design, focusing on the formulation, preparation, and evaluation of the soybean pulp with sweetened tofu loaf. The approach combined qualitative and quantitative analyses to determine sensory acceptability and nutritive content. Descriptive statistics were applied to analyse sensory evaluation results, while ANOVA was used to identify differences in acceptability among age groups.

Materials /Ingredients Needed in Making Soybean Tofu-loaf

Fresh soybean pulp (okara) was collected from local tofu and taho producers in Barangay Baligatan, City of Ilagan, Isabela. Other ingredients included sweetened tofu, cornstarch, brown sugar, soy sauce, vinegar, salt, paprika, and black pepper. Standard kitchen tools and equipment—mixing bowls, measuring cups and spoons, steamer, frying pan, and oven—were utilized for product preparation.

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Procedure in Making Soybean Tofu-loaf

The preparation followed a standard food product development process:

1. Preparation of Ingredients: Fresh okara and tofu were cleaned and measured precisely.
2. Mixing: All ingredients were combined in a mixing bowl until a uniform consistency was achieved.
3. Molding: The mixture was shaped into loaf molds lined with wax paper.
4. Cooking: The molded mixture was steamed and then lightly fried for enhanced flavor and texture.
5. Cooling and Packaging: The product was cooled and packed for sensory evaluation.

Sensory Evaluation

A total of 60 respondents—including children, teenagers, adults, and food experts—participated in the evaluation. The product samples were assessed for appearance, aroma, taste, and texture using a 5-point Likert scale, where 5 = Highly Acceptable and 1 = Not Acceptable. The data were analyzed using mean, standard deviation, and ANOVA to determine the significance of variations among age groups.

Table 1. The Range Numerical Rating and its Equivalent Descriptive Rating

Scale	Numeric Rating	Descriptive Rating
5	4.50 - 5.00	Highly Acceptable
4	3.50 - 4.49	Moderately Acceptable
3	2.50 - 3.49	Acceptable
2	1.50 - 2.49	Slightly Acceptable
1	0.50 - 1.49	Not Acceptable

Statistical Tool Used

All data were gathered from the questionnaire/evaluation form given to the evaluators. The variables were analysed and interpreted based from the computer output.

A. Mean (M). This was utilized to gauge the level of acceptability of the soybean pulp with sweetened tofu loaf based food as to respondents' age groups and criteria used.

B. Standard Deviation (SD). This was utilized to determine the homogeneity or average distances, of the level of acceptability scores around the mean.

C. One Way Between Groups Analysis of Variance (ANOVA). This was utilized to determine the differences of the level of general acceptability of the soybean pulp with sweetened tofu loaf food based across the four age groups.

III. RESULTS AND DISCUSSION

This chapter presents the results, discussion, and the personal insight that the researchers have gathered.

A. Formulate a loaf-based food product using soybean pulp (okara) and sweetened tofu.

The Soybean pulp with sweetened tofu loaf based food recipe has undergone different stages of development starting from process to cooking. Through these stages of development, careful observation and analysis were done to come up with feasible soybean pulp with sweetened tofu loaf-based food product.

1. Tools and Equipment

Preparation tools, measuring tools, mixing tools, cutting tools, cooking tools and equipment were used during the conduct of the study as shown in Table 2

Table 2. Tools and Equipment used in the conduct of the study.

Preparation tools	Measuring tools	Mixing tools	Cutting tools	Cooking tools	Equipment
Bowl	Measuring cups	Mixing bowls	Knife	Frying Pan	Gas range
Funnel	Measuring spoon	Wooden spoon	Chopping board	Casserole/ steamer	Gas stove
Spatula				Food tong	
Utility tray				Ladle	

2. Ingredients

Table 4 shows the ingredients used in the production of Proportion of Soybean pulp with sweetened tofu loaf food based.

3. Preparation of Soybean Pulp with Sweetened Tofu Loaf : Standard Formulation

Ingredients:

1kg soybean pulp

¼ corn-starch

¼ brown sugar

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½ kg tofu
6 tbsp. soy
6 tbsp. vinegar
5 sachet pepper
3 tsp. salt
2 tbs. paprika

Treatment 2 – Moderate Flavor Formulation

Ingredients:

1 kg soybean pulp (okara)
¾ kg tofu
¼ cup cornstarch
¼ cup brown sugar
7 tablespoons soy sauce
7 tablespoons vinegar
6 sachets pepper
4 teaspoons salt
2½ tablespoons paprika

Treatment 3 – Strong Flavor Formulation

Ingredients:

1 kg soybean pulp (okara)
1 kg tofu
¼ cup cornstarch
¼ cup brown sugar
8 tablespoons soy sauce
8 tablespoons vinegar
7 sachets pepper
5 teaspoons salt
3 tablespoons paprika

Experimental Treatments and Composition

The study consisted of three experimental treatments that varied in the amount of tofu and flavoring ingredients combined with a fixed quantity of soybean pulp (okara). The purpose of these treatments was to determine which formulation would yield the most acceptable soybean pulp loaf in terms of appearance, aroma, taste, and texture. The tofu content and level of seasonings served as the main variables, while other ingredients and preparation methods were kept constant.

Treatment	Soybean Pulp (kg)	Tofu (kg)	Cornstarch (cup)	Brown Sugar (cup)	Soy Sauce (tbsp)	Vinegar (tbsp)	Salt (tsp)	Paprika (tbsp)	Pepper (sachet)	Remarks
Treatment 1	1.0	0.50	¼	¼	6	6	3	2	5	Standard formulation
Treatment 2	1.0	0.75	¼	¼	7	7	4	2.5	6	Moderate flavor formulation
Treatment 3	1.0	1.00	¼	¼	8	8	5	3	7	Strong flavor formulation

All treatments followed the same preparation process:

1. Cleaning and measuring all ingredients.
2. Mixing the soybean pulp, tofu, and other ingredients in a bowl until a uniform consistency was achieved.
3. Molding the mixture into loaf molds lined with wax paper.
4. Steaming and then lightly frying to enhance flavor and texture.
5. Cooling and packaging the samples for sensory evaluation.

The three treatments were evaluated by 60 respondents composed of children, teenagers, adults, and food experts. Each evaluator assessed the products' appearance, aroma, taste, and texture using a 5-point Likert scale. The results determined which treatment achieved the highest level of consumer acceptability.

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B. Determine the sensory acceptability of the developed product in terms of appearance, aroma, taste, and texture.

To determine the acceptability of the soybean pulp with sweetened tofu loaf-based food, the proponent conducted the evaluation process. There were 60 respondents of the study. This includes some household of barangay Guibang Gamu, Isabela and barangay Centro San Antonio City of Ilagan. Among of which are children, youths, and adults. Also, some were teachers' and pupils of San Antonio Elementary School, City of Ilagan.

To determine the level of acceptability of soybean pulp with sweetened tofu loaf-based food, the respondents evaluated the food products with regard to its appearance, aroma, taste and texture. For clearing understanding, the data were presented in table form were treated concisely.

Table 3. Extent of Acceptability of Soybean pulp with sweetened tofu loaf-based food from Treatment 1.

Level of Acceptability	WAM	Descriptive
Appearance	4.55	Highly Acceptable
Aroma	4.7	Moderately Acceptable
Taste	4.75	Highly Acceptable
Texture	4.3	Moderately Acceptable

The table above shows the acceptability of soybean pulp with sweetened tofu loaf food based from Treatment 1. It reflects a highly acceptable level of acceptability from the respondents in terms of appearance (WAM 4.55), aroma (WAM: 4.7) and taste (WAM: 4.75), while the texture (WAM 4.3) is acceptable

Table 4. Extent of Acceptability of Soybean pulp with sweetened tofu loaf based food of Treatment 2

Level of Acceptability	WAM	Descriptive
Appearance	4.85	Highly Acceptable
Aroma	4.8	Moderately Acceptable
Taste	4.7	Moderately Acceptable
Texture	4.85	Highly Acceptable

The table above shows the acceptability of soybean pulp with sweetened tofu loaf food based from treatment 2. It reflects a highly acceptable level of acceptability from the respondents in terms of appearance (WAM: 4.85), aroma (WAM: 4.8) taste (WAM: 4.7), and texture (WAM: 4.85).

Table 5. Extent of Acceptability of Soybean pulp with sweetened tofu loaf based from Treatment 3

Level of Acceptability	WAM	Descriptive
Appearance	5	Highly Acceptable
Aroma	4.85	Highly Acceptable
Taste	5	Highly Acceptable
Texture	5	Highly Acceptable

The table above shows the acceptability of soybean pulp with sweetened tofu loaf based food from treatment 3. It reflects a highly acceptable level of acceptability from the respondents in terms of appearance (WAM: 5), aroma (WAM: 4.85) taste (WAM: 5), and texture (WAM: 5).

Table 6. Sensorial Evaluation of Soybean Pulp with Sweetened Tofu Loaf 1 in Terms of Taste, Aroma, Appearance, and Texture

Age Group	OWAM	Descriptive
Children	4.9	Moderately Acceptable
Teenager	4.5	Moderately Acceptable
Adult	4	Moderately Acceptable
Expert	4.75	Highly Acceptable

C. Assess the statistical difference in acceptability across age groups.

The table displays the respondents sensorial evaluation of the Soybean pulp with sweetened tofu loaf based food from treatment 1 in terms of their age groups. It shows that all age group has a **moderately** acceptable evaluation: teenagers (OWAM: 4.5), adults (OWAM: 4.), and children (OWAM: 4.9), except for expert (OWAM: 4.75) which is highly acceptable, the overall sensorial evaluation in is highly acceptable with a mean of 4.53.

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Table 7. Sensorial Evaluation of Soybean Pulp with Sweetened Tofu Loaf 2 in terms of Appearance, Aroma, Taste and Texture

Age Group	OWAM	Descriptive
Children	5	Highly Acceptable
Teenager	4.75	Highly Acceptable
Adult	4.25	Moderately Acceptable
Expert	4.5	Moderately Acceptable

The table above displays the respondents' sensorial evaluation of the Soybean Pulp with Sweetened Tofu Loaf based food from treatment 2 in terms of their age groups. It shows that the half of the age group has a highly acceptable evaluation: children (OWAM: 5), teenagers (OWAM: 4.75), except adults (OWAM: 4.90), and experts (OWAM: 4.5) which is moderately acceptable. The overall sensorial evaluation is highly acceptable with a mean of 4.62.

Table 8. Sensorial Evaluation of Soybean Pulp with Sweetened Tofu Loaf 3 in terms of Appearance, Taste, and texture

Age Group	OWAM	Descriptive
Children	5	Highly Acceptable
Teenager	5	Highly Acceptable
Adult	5	Highly Acceptable
Expert	5	Highly Acceptable

The table above displays the respondents' sensorial evaluation of the Soybean Pulp with Sweetened Tofu Loaf based food from treatment 3 in terms of their age groups. It shows that all age group has a highly acceptable evaluation: children (OWAM: 5), teenagers (OWAM: 5), adults (OWAM: 5), and experts (OWAM: 5). The overall sensorial evaluation is highly acceptable with a mean of 5.

Table 9. ANOVA of Soybean Pulp with Sweetened Tofu Loaf 1

Age Group	OWAM	Descriptive
Children	4.9	Moderately Acceptable
Teenager	4.5	Moderately Acceptable
Adult	4	Moderately Acceptable
Expert	4.75	Highly Acceptable

The table displays the respondents sensorial evaluation of the Soybean pulp with sweetened tofu loaf based food from treatment 1 in terms of their age groups. It shows that all age group has a **moderately** acceptable evaluation: teenagers (OWAM: 4.5), adults (OWAM: 4.), and children (OWAM: 4.9), except for expert (OWAM: 4.75) which is highly acceptable, the overall sensorial evaluation in is highly acceptable with a mean of 4.53.

Table 10. ANOVA of Soybean Pulp with Sweetened Tofu Loaf 2

Age Group	OWAM	Descriptive
Children	5	Highly Acceptable
Teenager	4.75	Highly Acceptable
Adult	4.25	Moderately Acceptable
Expert	4.5	Moderately Acceptable

The table above displays the respondents' sensorial evaluation of the Soybean Pulp with Sweetened Tofu Loaf based food from treatment 2 in terms of their age groups. It shows that the half of the age group has a highly acceptable evaluation: children (OWAM: 5), teenagers (OWAM: 4.75), except adults (OWAM: 4.90), and experts (OWAM: 4.5) which is moderately acceptable. The overall sensorial evaluation is highly acceptable with a mean of 4.62.

Table 11. ANOVA of Soybean Pulp with Sweetened Tofu Loaf 3

Age Group	OWAM	Descriptive
Children	5	Highly Acceptable
Teenager	5	Highly Acceptable
Adult	5	Highly Acceptable
Expert	5	Highly Acceptable

D. Analyze the nutritional composition of the product

The table above displays the respondents' sensorial evaluation of the Soybean Pulp with Sweetened Tofu Loaf based food from treatment 3 in terms of their age groups. It shows that all age group has a highly acceptable evaluation: children (OWAM: 5),

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teenagers (OWAM: 5), adults (OWAM: 5), and experts (OWAM: 5). The overall sensorial evaluation is highly acceptable with a mean of 5.

Table 12. Nutritive Value of Soybean Pulp with Sweetened Tofu Loaf based

Nutritional value per 100 g (3.5 oz)	
Energy	803 kJ (192 kcal)
Carbohydrates	7.64 g
Fat	10.80 g
Protein	20.29 g
Thiamine (B1)	7% 0.078 mg
Riboflavin (B2)	30% 0.358 mg
Niacin (B3)	18% 2.640 mg
Vitamin B6	17% 0.215 mg
Folate (B9)	6% 24 µg
Vitamin B12	3% 0.08 µg
Calcium	11% 111 mg
Iron	21% 2.7 mg
Magnesium	23% 81 mg
Manganese	62% 1.3 mg
Phosphorus	38% 266 mg
Potassium	9% 412 mg
Sodium	1% 9 mg
Zinc	12% 1.14 mg

IV. CONCLUSION

Soybean pulp with sweetened tofu loaf based food was produced from soybean, and tofu. Increase in nutritive content like protein and carbohydrates of the product is obtained from soybean. Every 100 grams of cooked Soybean pulp with sweetened tofu loaf provide 7.64 g of carbohydrates and 20.29 g of protein, and 7% or 0.078 mg of thiamine. The developed food product was evaluated by the respondents to determine the level of acceptability in terms of appearance, aroma, taste and texture which garnered an overall descriptive rating of highly acceptable. Moreover, there was no significant difference in the level of acceptability of soybean pulp with sweetened tofu loaf based food in terms of appearance, aroma, taste, and texture as perceived by the respondents according to their age groups.

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