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PURPLE SWEET POTATO FLOUR SUBSTITUTION IN MAKING STEAMED BAKED CUISINE (*BOLUKUU*) AS A HIGH-FIBER PRODUCT FOR Z GENERATION

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ABSTRACT

The development of value-added bakery products using functional local ingredients has gained increasing attention due to growing consumer demand for nutritionally improved foods. Steamed sponge cake represents a widely consumed traditional bakery product that can be reformulated through partial substitution with purple sweet potato flour, a source of dietary fiber. Nevertheless, product development requires systematic evaluation of formulation performance, packaging suitability, consumer acceptance, nutritional characteristics, and economic feasibility. This study aimed to develop and evaluate a steamed sponge cake product (*Bolukuu*) formulated with purple sweet potato flour, assess Generation Z consumer acceptance, analyze dietary fiber content and nutritional value, and determine appropriate packaging and pricing strategies.

A Research and Development (R&D) approach was applied using four sequential stages: define, design, develop, and disseminate. The study was conducted in the Culinary Laboratory and Chemistry Laboratory of the vocational Culinary Arts learning Program, Yogyakarta States University, with consumer acceptance testing carried out at the Pedestrian Area of the Karangmalang Rectorate. Product validation involved expert assessors, followed by sensory evaluation using a hedonic Likert scale with expert panelists, 31 semi-trained panelists in a limited-scale test, and 80 Generation Z consumers in a large-scale test. Data analysis was conducted through descriptive statistics and paired-sample t-tests, and scoring analysis.

The results demonstrated that the optimal formulation consisted of a 40% substitution of purple sweet potato flour. Packaging evaluation identified a gold-colored mica box with a floral cupcake base as the most suitable option. Findings from the sensory analysis showed a high degree of acceptance among consumers, with a mean hedonic score of 4.61 among Generation Z participants. Nutritional analysis revealed that a 45 g serving of *Bolukuu* provides 100 kcal of energy and 2.4 g of dietary fiber, indicating its potential contribution to digestive health. Economic analysis established a selling price of IDR 10,000 per package, with a break-even point of eight units. Overall, the findings confirm that *Bolukuu* represents a nutritionally enhanced bakery product with favorable sensory acceptance and economic feasibility.

Keywords:

steamed sponge cake, purple sweet potato flour, obesity, Generation Z, dietary fiber

Pengembangan produk bakery bernilai tambah dengan memanfaatkan bahan lokal berpotensi meningkatkan kualitas gizi dan daya tarik konsumen, khususnya Generasi Z. Bolu kukus merupakan produk bakery tradisional yang dapat dikembangkan melalui substitusi tepung ubi ungu sebagai sumber serat pangan. Namun, pengembangan produk memerlukan evaluasi terhadap formulasi, kemasan, tingkat penerimaan konsumen, kandungan gizi, serta kelayakan ekonomi. Penelitian ini bertujuan untuk mengembangkan produk bolu kukus (Bolukuu) dengan substitusi tepung ubi ungu, menentukan kemasan yang sesuai, menganalisis tingkat penerimaan konsumen Generasi Z, mengetahui kandungan serat dan nilai gizi, serta menetapkan harga jual produk.

Penelitian ini menggunakan **pendekatan penelitian dan pengembangan** yang dilaksanakan melalui tahapan define, design, develop, dan disseminate, yang dilaksanakan di Laboratorium Boga dan Laboratorium Kimia Program Studi D4 Tata Boga Fakultas Vokasi Universitas Negeri Yogyakarta, serta uji penerimaan konsumen di area Pedestrian Rektorat Karangmalang. Hasil penelitian menunjukkan bahwa formulasi optimal Bolukuu menggunakan substitusi tepung ubi ungu sebesar 40% dengan kemasan kotak mika berwarna keemasan. Produk Bolukuu memperoleh tingkat penerimaan tinggi oleh Generasi Z dengan nilai rata-rata 4,61. Analisis gizi menunjukkan bahwa Bolukuu dengan takaran saji 45 gram mengandung energi sebesar 100 kkal dan serat pangan sebesar 2,4 gram. Harga jual produk ditetapkan sebesar Rp10.000 per kemasan dengan titik impas sebanyak 8 buah, sehingga produk ini layak dikembangkan secara gizi dan ekonomi.

1. Introduction

Generation Z exhibits consumption behaviors that are strongly shaped by intensive digital media exposure and the Fear of Missing Out (FOMO) phenomenon, which significantly influences food preferences and purchasing decisions. This demographic tends to favor snack foods and ready-to-eat products that are high in energy and sugar yet low in dietary fiber. When coupled with low levels of physical activity, these dietary patterns contribute to inadequate fiber intake and elevate the risk of early-onset obesity. In Indonesia, average daily fiber consumption is estimated at only 5.7 g, substantially below the recommended Dietary Reference Intake of 29–37 g per day, indicating a pronounced imbalance in nutrient intake among young populations [1], [2].

Alongside these nutritional concerns, wheat flour consumption in Indonesia continues to rise, with domestic demand relying heavily on imported wheat as the primary raw material. Per capita wheat flour consumption has reached 2.94 kg per year, while national wheat imports amounted to 7.13 million tons in 2025 [3], [4]. This high level of import dependency reflects the underutilization of local food resources. Consequently, the development of diversified food products based on locally sourced ingredients with enhanced nutritional quality, particularly those rich in dietary fiber, represents a strategic approach to strengthening national food security and improving dietary patterns [5].

Purple sweet potato (*Ipomoea batatas* L.) is a local food commodity characterized by high carbohydrate and dietary fiber content, offering considerable potential as a partial substitute for wheat flour. Despite Indonesia being one of the world's leading producers of sweet potatoes, their utilization remains predominantly limited to traditional processing methods [6]. Converting purple sweet potatoes into flour presents opportunities for the development of value-added food products

with functional properties, particularly in increasing dietary fiber content and supporting healthier food alternatives [7].

This study focuses on the development of a steamed sponge cake product formulated with purple sweet potato flour substitution (*Bolukuu*). Steamed sponge cake was selected due to its high acceptance among Generation Z and its formulation flexibility. However, commercially available steamed sponge cakes are generally low in dietary fiber, high in sugar, and lack adequate nutritional labeling. Therefore, this study aims to develop a high-fiber steamed sponge cake formulation based on purple sweet potato flour, evaluate consumer acceptance among Generation Z, determine appropriate packaging, and analyze pricing and the break-even point (BEP) to produce a functional snack product based on local food resources that is both nutritionally valuable and economically feasible.

2. Method

2.1. Types of research

This study employed a Research and Development (R&D) methodology aimed at developing and producing a product through a systematic and structured process. The R&D approach comprises stages of needs identification, design, development, and product validation to ensure that the resulting product meets established quality standards, as well as criteria of effectiveness and efficiency [9].

The development model applied in this study was the 4D model, which consists of the Define, Design, Develop, and Disseminate stages. The Define stage focused on problem analysis and needs identification, while the Design stage involved product planning and formulation. The Develop stage encompassed product manufacturing, expert validation, and product testing, whereas the Disseminate stage aimed to distribute products that had been deemed feasible for use. The validation and testing processes played a critical role in ensuring product quality and enhancing the reliability of the research data [10], [11].

2.2. Place and Time of Research

The development study of steamed sponge cake with purple sweet potato flour substitution was conducted at the Culinary Laboratory and Chemistry Laboratory of the Applied Culinary Arts Study Program, Faculty of Vocational Studies, Universitas Negeri Yogyakarta (UNY), Wates Campus, Kulon Progo; the Faculty of Engineering, Universitas Negeri Yogyakarta; and the Pedestrian Area of the Rectorate Building, Karangmalang, Universitas Negeri Yogyakarta, Special Region of Yogyakarta. Laboratory analyses were carried out at Che-Mix Pratama Laboratory, Banguntapan, Bantul, Special Region of Yogyakarta. The research activities were conducted from 3 December 2024 to 12 January 2026.

2.3. Research Subjects

The research subjects consisted of expert evaluators, semi-trained panelists, and untrained panelists. The semi-trained panelists comprised 31 Culinary Arts students representing a limited-scale evaluation, while the untrained panelists consisted of 80 Generation Z participants involved in a large-scale consumer acceptance test.

2.4. Method

Data analysis in this study was conducted using both descriptive and inferential statistical approaches. Descriptive analysis was employed to summarize the results of the sensory acceptance test and the nutritional composition of the product using statistical measures including means, standard deviations, frequency distributions, and percentages. Furthermore, inferential analysis was performed using a paired sample *t*-test to identify differences between two related samples in terms of sensory acceptance parameters, nutritional composition, and key nutritional attributes. All statistical analyses were conducted using SPSS software as the data processing tool.

3. Results and Discussion

3.1. Result

The process of making Bolukuu uses the Research and Development (R&D) method, with a model consisting of define, design, develop and disseminate.

a. Define

The Define stage was conducted by identifying and analyzing three steamed sponge cake formulations through preliminary trials involving the academic supervisor and three panelists to determine a reference formulation that met the established product criteria. The selected formulation was subsequently used as the basis for product development through purple sweet potato flour substitution in the following stages.




Table 1. Define Phase Recipe

No.	Material	Unit	acuan I	acuan II	acuan III
1	Wheat Flour	Gram	20	150	250
2	Sugar	Gram	26	125	200
3	Egg	Item	1	1	1
4	SP	Gram	1	-	1
5	Baking powder	Gram	0,5	-	1
6	Coconut milk	ml	20	-	250
7	Water	ml	-	-	200
8	vanilla essence	ml	1	1	1
9	Salt	Gram	-	0,5	0,5
10	Food Coloring	drop	3	4	5
11	Milk	ml	-	150	-

Source: Wibowo [12], Junita [13], and Perkasa [14].

After the formulations were analyzed, here are the figure result of define phase product wih recipe 1, recipe 2 and recipe 3.

Table 2. Reference product results

Recipe 1	Recipe 2	Recipe 3
		

Recipe analysis is then continued by determining the sensory properties, namely shape, size, color, texture, taste, aroma and overall. The results of the analysis of the three recipes can be expressed in the form of sensory parameters down below.

Table 3. Reference Characteristics

NO	Sensory Parameters	Sample		
		R1	R2	R3
1.	Shape	Rose	Rose	Rose
2.	Size	6 x 2,5 cm	6 x 3 cm	6 x 3 cm
3.	Color	Yellowish white	Pale white	White
4.	Flavor	Egg-like	Milky	Vanilla and milk
5.	Taste	Sweet	Sweet	Sweet and savory
6.	Texture	Soft,pliable, lightweight and porous	Firm, compact, dry, and slightly wavy	Soft, fluffy, full-bodied, and porous
7.	<i>Overall</i>	Good	<u>Poor</u>	Excellent

The three reference recipe products were tested for their sensory characteristics by five trained panelists. The average sensory test results at the definition stage are shown in the table below.

Table 4. Average Results of Reference Products

NO.	Parameter Sensory	Mean		
		R1	R2	R3
1.	Shape	2,6	4	4,3
2.	Size	4,3	4,6	4,6
3.	Color	3	4	5
4.	Flavor	5	4	5
5.	Taste	3	3	4,6
6.	Texture	4,6	2,3	4
7.	<i>Overall</i>	3,6	3,3	4,6

Based on the analysis results, the R3 recipe sourced from Eliza Perkasa's YouTube channel was determined as the reference recipe in the product development design stage.

b. *Design*

The reference formulation at the design stage was prepared with purple sweet potato flour substitutions of 30%, 40%, and 50% respectively.

Table 5. Comparison of Reference Recipe with Development Recipe

No.	Item	Reference	Develop		
			P1 30%	P2 40%	P3 50%
1.	Egg (item)	1	1	1	1
2.	Wheat Flour (g)	250	175	150	125
3.	Purple Sweet Potato Flour (g)	-	75	100	125
4.	Sugar (g)	150	150	150	150
5.	SP (teaspoon)	1	1	1	1
6.	Vanilla essence (teaspoon)	1/4	¼	1/4	¼
7.	Baking Powder (teaspoon)	1/4	¼	1/4	¼
8.	Coconut milk (ml)	30	30	30	30

The selected recipe then enters the manufacturing stage, the product manufacturing results are then analyzed for sensory parameters to determine the quality of the product. The results can be reviewed in the table below.

Table 6. Development Characteristics

NO.	Parameter Sensory	Sampel		
		P1 (30%)	P2 (40%)	P3 (50%)
1.	Shape	Rose	Rose	Rose
2.	Size	6 x 2,5 cm	6 x 3 cm	6 x 3 cm
3.	Color	Light brown	purplish	Brownish
4.	Flavor	Milky, slight purple sweet potato	purple potato, vanilla milk	Strong purple sweet potato
5.	Taste	Sweet, slight purple sweet potato	Sweet purple sweet potato	Bitter
6.	Texture	Soft and fluffy	Soft, slightly sandy, fluffy, and dense	Crumbly, watery, and sandy
7.	Overall	Good	Very Good	Poor

The results of the form and visual analysis can be seen in the table 7.

Table 7. Product Development Results



. Based on these sensory parameters, the results of P1 showed a good shape. The purple sweet potato flour content was not optimal and could be improved. The results of P2 produced a fluffy sponge cake with a strong purple sweet potato aroma and flavor. The results of P3 had a watery texture and did not expand perfectly

Table 8. Comparison of Reference Recipe with Development Recipe

NO.	Parameter Sensory	Mean		
		P1 (30%)	P2 (40%)	P3 (50%)
1.	Shape	4	4	3,3
2.	Size	3,6	4	3,3
3.	Color	3,3	4	3
4.	Flavor	4	4,3	2,3
5.	Taste	4	4	2
6.	Texture	3,6	3,6	2,3
7.	Overall	3,6	4	3

Based on the evaluation results, formulation P2 with a 40% substitution of purple sweet potato flour was selected, as it provided an optimal balance between the level of substitution and sensory acceptance. The addition of fermented cassava (*tape singkong*) was applied to improve batter structure, resulting in a steamed sponge cake with a softer texture, better volume expansion, and a non-gritty mouthfeel.

c. Develop



Formulation P2 with a 40% substitution of purple sweet potato flour was established as the development formulation; however, it still exhibited limitations in texture, characterized by a light and slightly gritty crumb. The purple sweet potato steamed sponge cake was filled with vanilla-flavored custard cream (*vla custard*) to enhance sensory quality. The formulation of the custard cream filling is presented in the following section.

Table 9. Filling vanilla custard recipe

No.	Item	Quantity
1.	RAP powder	50 g
2.	Milk powder	27 g
3.	water (cold)	200 ml

The sensory parameter results represent the quality of the product. The results are in the form of an objective assessment looking at the shape, size, color, aroma, taste and overall product, which can be seen in the table below.

Table 10. Product P3 with *Bolukuu*

NO.	Parameter Sensory	P3	Develop
1.	Shape	Rose, slightly sandy	Rose, well-defined
2.	Size	6,5 cm x 2,5 cm	6,5 cm x 2,6 cm
3.	Color	Dark red velvet	Light red velvet
4.	Flavor	Purple sweet potato flour	Purple sweet potato flour, vanilla, milk, creamy
5.	Taste	Sweet	Sweet
6.	Texture	Moist and expanded	Firmer, more fluffy, softer
7.	Overall	Good	Very good
8.	results		

The test results indicated that the *Bolukuu* product received positive consumer acceptance, accompanied by feedback for further improvement. Therefore, the study was continued to the Disseminate stage through a limited-scale evaluation involving at least 30 semi-trained panelists.

d. Disseminate

Following the completion of the product development stage, a large-scale preference test was conducted involving 80 untrained panelists. The evaluation was carried out at the Pedestrian Area of the Rectorate Building, Karangmalang. The panelists consisted of Generation Z participants without formal training in sensory evaluation.

The evaluation process was performed by providing assessment forms to the panelists to record their perceptions and hedonic scores after tasting the product samples. The tested samples comprised the reference product and the developed product, namely *Bolukuu*. Panelists were instructed to evaluate all samples and complete the provided evaluation forms. The collected data

were subsequently analyzed using a paired sample *t*-test, with untrained panelists representing general consumer preferences.

1). Packaging



Fig 1. Packaging *Bolukuu*

Source: Ajeng (2026)

The innovative steamed sponge cake product formulated with purple sweet potato flour substitution was designated as *Bolukuu*. The product was shaped in a Rose form and exhibited a magenta coloration. *Bolukuu* was individually packaged in a mica box with a gold-colored base measuring 6 × 6 cm, covered with a transparent plastic lid (6 × 6 × 3 cm) and securely sealed. The packaging was supplemented with a sticker displaying the product name and nutritional information.

For presentation, *Bolukuu* was arranged in a compartmentalized cardboard box with a floral motif containing six pieces, complemented by a maroon chiffon ribbon as an aesthetic element.

2). Proximate Analysis and Nutritional Value

After obtaining the proximate test results from the development product, the nutritional value information is then calculated based on the net weight per packaging unit.

Table 11. Nutrition Value *Bolukuu*

Nutrition Value			
Serving Size	44 g		
SERVINGS PER PACK	1		
Total Energy		100 cal	
Fat Energy		7 cal	
			%AKG
Ash	1g		1%
Total Fat	1g		2%
Protein	2g		3%
Carbs	21g		48%
Total Fiber	3g		5%

* Percent AKG based on 2150kcal energy requirement.

Your energy needs may be higher or lower.

3). Selling Price and BEP

The product results (*BOLUKUU*) that have been determined are obtained by using recipe 3, then searching for the nutritional label number with the superior nutritional content, namely fiber

of 3g, the process is continued by calculating the selling value of bolukuu and also calculating the break-even point down below. This is intended to determine the appropriate product price to be marketed to consumers with the value that the product has provided. The calculation results are explained in the table 12.

Table 12. Calculation of Selling Price

No.	Information	Price
1.	Total Raw Material Costs (A)	Rp. 28.770,
2.	Packaging and Labeling Costs (B)	Rp. 27.000
3.	Total Fixed Costs (C)	Rp. 16.710
4.	Distribution Cost (D)	Rp. 5.000
5.	Production Cost (A+B+C+D)	Rp. 77.480/pcs
6.	Profit Margin 85% then mark-up = 85% x Rp. 5165,33 = Rp. 4.390,53	
	Selling Price	Rp. 9.556,86 round Rp. 10.000
	$BEP = \frac{77.480}{10.000} = 7,74$ or round 8 pcs.	8 pcs

3.2. Discussion

Purple sweet potato flour is a semi-finished raw material in the food industry that has the potential to be used as a substitute component for wheat flour. According to Lestari *et al.* [15], the dietary fiber content of purple sweet potato flour reaches 12.9 g per 100 g, indicating a relatively high fiber level. The utilization of purple sweet potato flour as a substitute for wheat flour aims to reduce dependence on wheat flour in food product formulations.

Bolukuu is a developed steamed sponge cake product formulated through partial substitution of wheat flour with purple sweet potato flour and filled with custard cream. The product is designed in the form of a Rose flower, selected as a visual representation of aesthetic value in food presentation. The formulation consists of 40% purple sweet potato flour and 60% wheat flour, aiming to enhance nutritional quality while maintaining acceptable sensory characteristics.

The production process employs the *sponge method*, involving the mixing of eggs, sugar, and emulsifier until a stable, thick batter is formed, followed by the gradual incorporation of dry ingredients, flavoring, and coloring agents. The batter is steamed in stages with the addition of custard filling at the center during partial cooking. The resulting product exhibits a distinctive purple sweet potato aroma combined with a mild milky note, a soft and compact texture, and a creamy, sweet custard filling, indicating favorable physical and sensory attributes.

Bolukuu is presented using a floral-patterned parchment paper cup and individually packaged in a transparent plastic box with a gold-colored base measuring 6 × 6 cm and a total volume of 6 × 6 × 3 cm, ensuring airtight sealing. The product, shaped as a magenta Rose, is labeled with a sticker containing the product name and nutritional information. For final presentation, Bolukuu is arranged in a floral-patterned pink cardboard box containing six pieces and finished with a maroon chiffon ribbon, enhancing the aesthetic appeal and perceived product value.

4. Conclusions

Based on the results of research, analysis and information data in the process of making Bolukuu products, based on the results obtained, the research conclusions are summarized as follows:

1. The selected and refined Bolukuu formulation employed a 40% substitution of purple sweet potato flour. The ingredients used in the production of Bolukuu included purple sweet potato flour, wheat flour, eggs, granulated sugar, coconut milk, emulsifier (SP), baking soda, and flavoring. The processing method applied was the sponge method, with steaming used as the cooking technique.
2. Bolukuu was packaged using a gold-colored mica box with a cupcake base that supported the Rose-shaped structure of the product, thereby enhancing its aesthetic value.
3. Hedonic testing indicated that the Bolukuu product was well accepted by Generation Z consumers. Sensory evaluation was conducted by expert evaluators, 31 semi-trained panelists in a limited-scale test, and 80 adolescent participants in a large-scale test. The results demonstrated positive acceptance, with mean hedonic scores of 4.06 for the reference product and 4.12 for the developed product.
4. The serving size of Bolukuu was 45 g per portion, providing an energy content of 100 kcal and a dietary fiber content of 2.4 g per serving. The dietary fiber present in Bolukuu contributes to supporting digestive health.
5. The selling price of Bolukuu was set at IDR 10,000 per package, with a break-even point (BEP) of eight units.

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