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The Effect of Porang (*Amorphallus O.*) Flour and Red Bean Substitution on Pancake Acceptability

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ABSTRACT

Background: The dietary habits of urban college students, characterized by frequent consumption of energy-dense fast food and inadequate fiber intake, may contribute to an increased risk of obesity.
Objective: This study aimed to evaluate the acceptability of pancake formulations substituted with porang flour (*Amorphophallus oncophyllus*) and served with red kidney bean paste as a low-energy snack option for obese college students.
Methods: This experimental study employed a Completely Randomized Design with three formulations: F0 (control), F1 (20 g porang flour), and F2 (40 g porang flour), each served with 15 g of red kidney bean paste. Acceptability was evaluated using a 5-point hedonic scale for color, aroma, texture, and taste. Data were analyzed using the Kruskal–Wallis test followed by the Mann–Whitney post-hoc test.
Results: Significant differences were found in color and taste acceptability ($p < 0.05$). Formula F2 showed significantly lower acceptability than the control in terms of color ($p < 0.001$) and taste ($p = 0.009$), mainly due to reduced crust brightness and the characteristic aftertaste of porang flour.
Conclusions: Substitution with porang flour and red kidney bean paste significantly affected the color and taste acceptability of pancakes. Formula F2, representing the highest substitution level, significantly altered panelists' preferences.
Keywords: Acceptability; obesity; pancakes; porang flour; red kidney bean paste.

Cite this Article

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INTRODUCTION

Food diversification plays an important role in improving nutritional status and developing high-quality human resources. Food diversification refers to the process of selecting foods that do not rely on a single food source but instead utilize a variety of food commodities in terms of production, processing, distribution, and household consumption. Food diversification can help overcome nutritional imbalances resulting from unhealthy dietary patterns. Nutritional imbalance may affect individuals of all ages, including university students. According to Maria A. [1], the prevalence of central obesity among students of the Faculty of Medicine, Universitas Nusa Cendana (FK Undana), was 29.3%, with this nutritional problem attributed to limited nutrition knowledge and unbalanced dietary patterns.

One of the most common health problems among university students is obesity, which occurs across nearly all age groups [2]. The causes of obesity are highly complex. One of the contributing factors among university students is their eating behavior. The prevalence of obesity based on body mass index (BMI) ≥25–27 kg/m² and BMI ≥27 kg/m² among individuals aged ≥15 years was 35.4%, while the prevalence of obesity with BMI ≥27 kg/m² alone was 21.8% [3]. Furthermore, the prevalence of obesity was higher in urban areas (25.1%) than in rural areas (17.8%).

Fast food has become widely available and increasingly popular in major cities, including Surabaya. Ready-to-eat snacks are also widely consumed in Surabaya, most of which consist of sweet and spicy foods that rarely contain vegetables, fruits, legumes, or tubers. As a result, the consumption of vegetables, fruits, legumes, and tubers in Indonesia remains relatively low.

According to the 2018 Basic Health Research (Riskesdas), the proportion of Indonesians consuming legumes was 2.27% in urban areas and 2.63% in rural areas. Meanwhile, tuber consumption accounted for 2.31% in urban areas and 1.28% in rural areas. The proportion of the Indonesian population consuming tubers other than sago, cassava, potatoes, and sweet potatoes was only 0.8%.

Legumes are an easily accessible source of plant-based protein. Red kidney beans contain 314 kcal of energy, 22.1 g of protein, 1.1 g of fat, 56.2 g of carbohydrates, and 4 g of dietary fiber per 100 g. red kidney beans have been utilized in various food products, one of which is as a substitute ingredient in cupcake production. According to Asih et al. [4], red kidney bean cupcakes with the best formulation, consisting of 50 g red kidney beans and 50 g wheat flour, achieved acceptability scores of 3.48 for color, 3.32 for taste, 3.40 for aroma, and 3.24 for texture.

Indonesia is also rich in tuber crops, one of which is porang (Amorphophallus oncophyllus). However, processed porang products are still rarely available on the market. Therefore, innovation is needed to encourage the consumption of alternative tuber-based products, such as porang. This is because most harvested porang is exported to Japan for processing into konjac flour [5]. In addition, porang can be processed into porang flour, which can subsequently be used in the production of various food products.

Porang tubers contain 83.38% water, 3.58% glucomannan, 7.65% starch, 0.92% protein, 0.02% fat, and 2.50% crude fiber per 100 g. Due to its low caloric content, porang flour is suitable for developing snack products for individuals with obesity. One potential application is its use as a substitute ingredient in pancake production. Therefore, this study aimed to evaluate the acceptability of pancake formulations substituted with porang flour and red kidney beans as a low-energy snack for university students with obesity.

METHOD

This study employed both true experimental and quasi-experimental designs. The true experimental design was conducted during the pancake formulation development stage, while the quasi-experimental design was used to evaluate product acceptability through organoleptic testing. A Completely Randomized Design (CRD) was applied in this study. The research was conducted from January to February 2026 at the Organoleptic Laboratory, Faculty of Public Health, Universitas Airlangga, Surabaya.

The preliminary study involved a limited sensory evaluation conducted by three panelists. Five pancake formulations (F0, F1, F2, F3, and F4) were evaluated during this stage. Based on the results of the preliminary study, three formulations were selected for the subsequent hedonic test, consisting of one control formula and the two best-performing formulations. The organoleptic quality of pancakes substituted with porang flour and red kidney bean paste was evaluated using a hedonic preference test involving both limited panelists and untrained panelists. The evaluation included color, aroma, texture, and taste using a five-point hedonic scale (1–5) for each formulation. Each panelist received two pancakes (60 g) from each formulation accompanied by 15 g of red kidney bean paste as the filling.

Table 1
Pancake Formulations with Porang Flour and Red Kidney Bean Paste Substitution

F	Substitution	Other Ingredients
0	-	Wheat flour (100 g), margarine (30 g), liquid skim milk (100 g), egg (40 g), baking powder (3 g), salt (1.5 g), granulated sugar (40 g), peanut paste (15 g).
1	Porang flour (20 g) and red kidney bean paste (15 g)	Wheat flour (80 g), margarine (30 g), liquid skim milk (100 g), egg (40 g), baking powder (3 g), salt (1.5 g), granulated sugar (40 g).
2	Porang flour (40 g) and red kidney bean paste (15 g)	Wheat flour (60 g), margarine (30 g), liquid skim milk (100 g), egg (40 g), baking powder (3 g), salt (1.5 g), granulated sugar (40 g).
3	Porang flour (60 g) and red kidney bean paste (15 g)	Wheat flour (40 g), margarine (30 g), liquid skim milk (100 g), egg (40 g), baking powder (3 g), salt (1.5 g), granulated sugar (40 g).
4	Porang flour (80 g) and red kidney bean paste (15 g)	Wheat flour (20 g), margarine (30 g), liquid skim milk (100 g), egg (40 g), baking powder (3 g), salt (1.5 g), granulated sugar (40 g).

Sumber: data olahan

RESULT

Table 2
Distribution of Limited Panelists' Organoleptic Quality Evaluation of Pancakes with Porang Flour and Red Kidney Bean Substitution

F	Organoleptic Quality Evaluation				Median	Rank
	Aroma	Texture	Color	Taste		
1	3	3	3	4	3	2
2	5	5	4	5	5	1
3	4	2	2	3	2,5	3
4	4	2	2	3	2,5	2

Table 2 presents the distribution of the limited panelists' evaluation of the organoleptic quality of pancakes, including aroma, texture, color, and taste. Based on the median values, formulation 2 (F2) was the most preferred by the limited panelists, with a median score of 5 and ranked first. Meanwhile, formulation 1 (F1) obtained a median score of 3 and ranked second. Formulations 3 (F3) and 4 (F4) obtained the same median score of 2.5 and therefore ranked lowest. These findings indicate that formulation 2 (F2) had better organoleptic quality than the other formulations according to the limited panelists' evaluation.

Table 3
Kruskal–Wallis Test Results for Pancake Acceptability

Characteristic	Formulation	*Asymp.Sig*	Interpretation
Aroma	F0, F1, F2	0,613	No significant difference
Texture	F0, F1, F2	0,315	No significant difference
Color	F0, F1, F2	<0,001	Significant difference
Taste	F0, F1, F2	0,045	Significant difference

The Kruskal–Wallis test results presented in Table 3 indicate that there were no significant differences among F0, F1, and F2 in terms of aroma and texture, as the significance values were greater than 0.05 ($p \geq 0.05$). In contrast, significant differences were observed for the color and taste parameters among the three formulations. Therefore, the Mann–Whitney test was performed to determine which formulations differed significantly.

Table 4
Mann–Whitney Test Results for Pancake Color

Formulation	*Asymp.Sig.*	Interpretation
F0-F1	0.071	No significant difference
F0-F2	<0.001	Significant difference
F1-F2	0.026	Significant difference

As shown in Table 4, the Mann–Whitney test demonstrated that formulation variation significantly affected the color characteristics of the pancakes. The comparison between the control formulation (F0) and F1 yielded an *Asymp. Sig.* value of 0.071 ($p > 0.05$), indicating no statistically significant difference in color between the two formulations. In contrast, significant differences were observed in the other comparisons. The comparison between F0 and F2 produced an *Asymp. Sig.* value of <0.001 ($p < 0.05$), while the comparison between F1 and F2 yielded an *Asymp. Sig.* value of 0.026 ($p < 0.05$). These findings indicate that formulation F2 produced a significant change in pancake color compared with both F0 and F1.

Table 5
Mann–Whitney Test Results for Pancake Taste

Formulation	*Asymp.Sig.*	Interpretation
F0-F1	0.488	No significant difference
F0-F2	0.009	Significant difference
F1-F2	0.129	No significant difference

Based on Table 5, the Mann–Whitney test results for the taste parameter showed varying levels of significance among the formulations. The comparison between the control formulation (F0) and F1 produced an Asymp. Sig. value of 0.488 ($p > 0.05$), while the comparison between F1 and F2 yielded an Asymp. Sig. value of 0.129 ($p > 0.05$), indicating no significant differences in taste. A significant difference was observed only between the control formulation (F0) and F2, with an Asymp. Sig. value of 0.009 ($p < 0.05$). These findings indicate that the formulation used in F2 significantly altered the taste characteristics of the pancakes compared with the control formulation (F0).

DISCUSSIONS

Color is one of the earliest sensory attributes determining the quality and consumer acceptability of food products. This visual attribute plays a crucial role in creating the first impression and works simultaneously with shape, taste, texture, and aroma to influence consumer preference [6]. Based on the Mann–Whitney test results presented in Table 4, variation in porang flour substitution significantly affected the acceptability of pancake color. The comparison between the control formulation (F0) and the first treatment formulation (F1) yielded an *Asymp. Sig.* value of 0.071 ($p > 0.05$), indicating no significant difference in color acceptability between the two formulations. This finding suggests that the level of porang flour substitution in F1 did not produce a sufficiently noticeable color change to be distinguished by the panelists, resulting in preference scores comparable to those of the control formulation.

In contrast, significant differences in color acceptability were observed between the control formulation (F0) and F2 ($p < 0.001$), as well as between F1 and F2 ($p = 0.026$). These statistical results ($p < 0.05$) indicate that the higher level of porang flour substitution in F2 produced a significant change in the color pigments of the pancakes. This visual difference was clearly perceived by the panelists.

The decline in panelists' preference for pancake color with increasing levels of porang flour substitution was closely related to the physicochemical characteristics of porang flour. Enita et al. reported that the addition of porang flour in pie crust production reduced the lightness value of the final product, resulting in a darker appearance. This phenomenon is attributed to the natural yellowish-brown color of porang flour itself [7]. Furthermore, the post-hoc analysis in their study demonstrated a trend similar to the present study, showing that higher proportions of porang flour resulted in lower panelist preference for product color.

More specifically, the dark color characteristic of porang flour is associated with its intrinsic components. Mahirdini and Afifah [8] reported that the brownish color is caused by the presence of polyphenol oxidase (PPO) and tannins, which are naturally occurring phenolic compounds. Consequently, porang flour has a relatively low whiteness value of only 46.24% compared with wheat flour, which has a whiteness value of 74.7% [9].

Therefore, when wheat flour was substituted with a higher proportion of porang flour, as in formulation F2, the predominance of phenolic compounds and the inherent color characteristics of porang flour significantly reduced the brightness of the batter after baking. The darker and duller brown color of the pancake surface likely contributed to the lower color preference scores assigned by the panelists compared with the control formulation (F0), which was prepared entirely with wheat flour.

Taste is the most critical organoleptic attribute influencing consumer acceptance of a new food product. Based on the Mann–Whitney test results presented in Table 5, substitution of porang flour combined with red kidney bean paste produced varying effects on pancake taste acceptability. No significant differences in taste acceptability were found between the control formulation (F0) and F1 (p = 0.488; $p > 0.05$), or between F1 and F2 (p = 0.129; $p > 0.05$). These findings indicate that the initial substitution level in F1 was still able to maintain a taste profile comparable to that of the control, while the difference in taste between F1 and F2 was not sufficiently pronounced to be distinguished by the panelists.

However, a statistically significant difference in taste acceptability was observed between the control formulation (F0) and F2 (p = 0.009; $p < 0.05$). This result indicates that the higher level of porang flour substitution in F2 produced a distinct taste sensation compared with conventional pancakes without porang flour substitution.

The decrease in panelists' preference for taste with increasing levels of porang flour substitution is consistent with the inherent sensory characteristics of porang. Similar findings have been reported in bakery products containing porang flour. Wulandari [10] found that increasing the proportion of porang flour in soft cookies resulted in progressively lower taste acceptability scores. This finding is supported by Mahirdini and Afifah [8], who reported that high levels of porang flour in biscuit or cookie formulations tended to reduce panelist acceptance of the resulting taste profile.

More specifically, the decline in taste preference at the higher substitution level observed in formulation F2 may be attributed to residual chemical compounds remaining in porang flour after processing. Setiavani and Ikram [11], in their study on sweet bread made with porang flour, reported that high proportions of porang flour could produce a gritty sensation and a distinctive aftertaste that reduced consumer acceptability.

This gritty sensation and characteristic aftertaste are thought to originate from residual oxalic acid compounds present in the porang flour matrix. Calcium oxalate crystals or oxalic acid naturally present in porang may produce slippery, bitter, and itchy sensations on the tongue during mastication and swallowing [11].

In the present study, the red kidney bean paste was applied separately as a spread after the pancakes were cooked. At the lower substitution level (F1), the sweet and savory flavor of the red kidney bean paste likely masked the slightly bitter taste of porang flour. However, at the higher substitution level in F2, the accumulation of residual oxalic acid compounds and the characteristic flavor of porang became more dominant during mastication. This resulted in a stronger flavor release, intensifying the itchy sensation and distinctive porang aftertaste. Consequently, panelists assigned the lowest taste preference scores to formulation F2 compared with the control formulation (F0) and F1.

This study offers a meaningful contribution to the field of functional food science by exploring the diversification of snack products, specifically pancakes, formulated from a blend of porang flour and red bean paste. It establishes scientific reference on the sensory tolerance limits of panelists toward porang glucomannan substitution, while also shedding light on how flavor release interactions occur between high-fiber dough and legume-based spreads. Moreover, the findings serve as foundational data for developing locally-sourced, fiber- and protein-rich food formulations with promising potential as low-calorie functional food alternatives for future advancement.

CONCLUSIONS

This study can be concluded that substituting wheat flour with porang flour combined with red kidney bean paste significantly affected the color and taste acceptability of pancakes, particularly at the higher substitution level (F2). The Mann–Whitney test indicated that formulation F1 did not differ significantly from the control (F0) in color ($p = 0.071$) or taste ($p = 0.488$), whereas F2 showed significant differences in both color ($p < 0.001$) and taste ($p = 0.009$). These changes were attributed to the reduced brightness caused by the glucomannan-rich properties of porang flour and the combined bitter aftertaste of porang with the natural sweet-savory flavor of red kidney bean paste.

CONFLICT OF INTEREST

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AUTHOR CONTRIBUTIONS

The Author designed the study, conducted the experimental research and organoleptic evaluation, analyzed the data, and wrote the manuscript.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE

The authors used ChatGPT (OpenAI, version GPT-5) to assist in improving the language and grammar of the manuscript. The authors reviewed and verified the content to ensure accuracy and integrity.

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