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The Effect of Mung Bean Flour Addition on the Organoleptic Properties, Nutritional Content, and Acceptability of Mung Bean Cassava Cake (Bosikajo) as a Snack for People with Type 2 Diabetes

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ABSTRACT

Background: *The use of local foods in the development of functional foods is crucial for promoting food diversification and managing degenerative diseases, such as type 2 diabetes. A combination of mung bean flour and cassava flour can produce products with a low glycemic index and high fiber and protein content..*

Research Methods: *This experimental study used a one-factor completely randomized design (CRD) with five treatments (addition of mung bean flour at 25 g, 50 g, 75 g, 100 g, and 125 g) and three replicates. A total of 25 semi-trained panelists were involved in the organoleptic testing, while nutrient content analysis was conducted using the proximate method, and acceptability testing was performed on 30 patients with type 2 diabetes aged 50–64 years.*

Research Results: *The results show that treatment t3 (75 g mung bean flour) had the highest hedonic scores (color 4.1; aroma 4.2; taste 4.3; texture 4.4). The nutritional content of treatment T3 cake per 100 g is as follows: energy 286 kcal, protein 9.15%, fat 9.20%, carbohydrates 43.13%, fiber 4.82%, moisture 29.35%, and ash 2.35%. The acceptability rate reached 86.7% and falls into the "good" category.*

Conclusion: *The addition of 75 g of mung bean flour produces a cake with the best organoleptic and nutritional quality and is acceptable to patients with type 2 diabetes as a healthy and functional snack.*

BACKGROUND

Diversifying local food sources is a strategic effort to improve the utilization of domestic food resources and promote the principles of balanced nutrition. One local food commodity with potential to be developed as an alternative to wheat flour is cassava, which is known to have higher levels of complex carbohydrates and fiber. Furthermore, the glycemic index of cassava flour (GI 40) is lower than that of wheat flour (GI 70), making it more suitable for managing blood sugar levels and thus more suitable for people with diabetes mellitus. However, the main drawback of cassava flour is its low protein content. Therefore, it is necessary to add a protein source, particularly from legumes such as mung bean flour. The high protein content (22.9 g/100 g), dietary fiber (4.3 g/100 g), and relatively low fat content (1.5 g/100 g), along with the unsaturated fatty acids and bioactive compounds found in mung beans, are known to offer health benefits, particularly for people with diabetes.Previous studies have shown that substituting green bean flour in cassava-based processed products can increase protein content and improve the product's organoleptic and " " properties. The production process for green bean flour is carried out without soaking; instead, roasting is used to maintain low moisture content and enhance shelf life.

Steamed sponge cake is a food or snack that is widely enjoyed by people of all ages. Therefore, the cassava and mung bean sponge cake (bosikajo) was developed as a snack that is low in glycemic index, high in fiber, and low in fat, and is suitable for patients with type 2 diabetes.

The objective of this study is to examine the effect of adding mung bean flour on the organoleptic properties, nutritional content, and acceptability of mung bean cassava cake as a safe and nutritious snack for people with type 2 diabetes mellitus.

RESEARCH METHODS

This study is an experimental study using a one-factor completely randomized design (CRD), namely the addition of mung bean flour with five treatments, namely 25 g, 50 g, 75 g, 100 g, and 125 g, with three replicates.

The formulation of the green bean cassava cake is shown in Table 1.

Name of Food Ingredient	Treatment Level				
	t1	t2	t3	t4	t5
Cassava Flour (g)	50	50	50	50	50
Mung bean flour (g)	25	50	75	100	125
Eggs (g)	150	150	150	150	150
Oil (ml)	65	65	65	65	65
Corn sugar (g)	40	40	40	40	40
Coconut milk (ml)	50	50	50	50	50
Baking powder (g)	1	1	1	1	1
Salt (tsp)	½	½	½	½	½
Vanilla (g)	1	1	1	1	1
Pandan Food Coloring	1	1	1	1	1

The parameters observed were color, aroma, taste, and texture. The organoleptic properties were evaluated using a hedonic method with a 5-point numerical scale, conducted by 25 semi-trained panelists. After that, the selected best formula was subjected to a nutritional value test using the proximate analysis method, with the parameters tested being moisture content (gravimetric), ash content (gravimetric), protein content (Kjeldahl), fat content (Soxhlet), carbohydrate content (by difference), and crude fiber content. Acceptability testing was then conducted by 30 diabetic patients aged 50–64 years by calculating the difference between the product served and the portion not consumed. Data processing and analysis of organoleptic properties were performed by testing data normality using the Shapiro-Wilk test (data with a non-normal distribution), followed by the non-parametric Kruskal-Wallis statistical analysis, with a follow-up Mann-Whitney test. Meanwhile, the analysis of nutritional content and acceptability used univariate analysis, the results of which were then presented descriptively using tables.

RESULTS

Organoleptic Properties of Cassava and Mung Bean Cake:

The normality test results showed that the color and taste parameters had a p-value <0.05, indicating that the data were not normally distributed; therefore, further nonparametric analysis using the *Kruskal-Wallis* method was required to identify differences in each parameter

Table 2. Significance of the Effect of Flour Addition on the Organoleptic Properties of Cassava and Mung Bean Cake (Bosikajo)

Parameter	P (Value)	Notation
Color	0.001	S
Aroma	0.195	NS
Taste	0.002	S
Texture	0.104	NS

The differences between treatment levels for each organoleptic trait, aroma, taste, and texture after conducting the Mann-Whitney test are shown in Table 3.

Table 3. Mean Values and Significance of the Organoleptic Test Results for Cassava and Mung Bean Cake

Treatment	Parameter			
	Color	Aroma	Taste	Texture
t1	2.60±1.000[a]	3.08 ± 1.056	3.12 ± 1.054 [ab]	2.76 ± 1.012
t2	3.32 ± 0.852 [ab]	3.32 ± 1.030	2.64 ± 0.952 [a]	3.00 ± 1041
t3	3.36 ± 0.810 [ab]	3.60 ± 0.816	3.36 ± 0.638 [ab]	3.24 ± 0.831
t4	3.52 ± 0.714 [b]	3.64 ± 0.860	2.80 ± 0.866 [a]	3.40±1000
t5	3.84 ± 1.028[b]	3.76 ± 0.926	3.64 ± 0.952[ab]	3.52 ± 1.085

Nutritional Value of Cassava Cake with **Mung Beans**: The results of the nutritional analysis of Cassava Cake with the addition of 75 g of mung bean flour in Table 3.

Table 3. Nutritional Content of Cassava Cake in Treatment t3 (75 g)

Parameter	Unit	Method	Average	Results of Yanti's Research	SNI 1996
Moisture content	%	Gravimetric	46.9	47.38	Max. 40%
Content	%	Dry ash	0.02	0.82	Max. 3
Protein	%	Kjeldahl	10.7	4.07	Max. 9*
Fat	%	Soxhlet	8.9	2.39	Max. 3*
Carbohydrate	%	By difference	32.2	45.35	Max. 55*
Crude Fiber Content	mg	-	1.2		-

Acceptability of Cassava and Mung Bean Cake: Data on the acceptability test results for Cassava and Mung Bean Cake (Bosikajo), as shown in Table 4

Table 4. Acceptance Test Results for Bosikajo

Acceptability Categories	n	Percentage	AKG Category	n	Percentage
Good	21	70%	Met	22	73%
Insufficient	9	30%	Not Met	8	27%
Total	30	100%		30	30%

Acceptability was determined by comparing the weight of the served portion minus the leftover weight divided by the weight of the served product. The served portion of bosikajo was 85 g per person. Of the 30 consumer panelists (DM patients), 21 patients (70%) had good acceptability and 9 patients (30%) had poor acceptability. However, 22 patients (73%) met the RDA requirements, while 8 patients (27%) did not meet the RDA requirements.

DISCUSSION

Organoleptic Properties of Cassava and Mung Bean Cake

Color

Based on Table 2, the results of the nonparametric test using the Kruskal-Wallis method show that bosikajo has a significant effect on the color of bosikajo. The color in treatments t1 and t2 is green, in t3 it is greenish-brown, while the color in t4 and t5 is brownish. The difference in bosikajo color is due to the addition of mung bean flour and pandan leaf water to enhance the color of the bosikajo; the higher the percentage of mung bean flour used, the darker the resulting cake color. This color change is associated with the amylose content in mung beans.

Aroma

Based on Table 2, the results of the nonparametric test using the Kruskal-Wallis method indicate that bosikajo has no significant effect on the aroma of bosikajo. The aroma in treatments t1 and t2 was the characteristic aroma of mung beans but not overly dominant; the characteristic aroma of mung beans from

treatment t3 was more pronounced; and in treatments t4 and t5, the characteristic aroma was very strong due to the addition of mung bean flour and the presence of *volatile compounds* during the steaming process.

Taste

Based on Table 2, the results of the non-parametric test using the Kruskal-Wallis method indicate that there is a significant effect on the taste of bosikajo. The taste of bosikajo in treatment t1 is savory with a distinct flavor from the dominant cassava flour; in t2, the savory taste remains balanced as a blend of mung bean flour and cassava flour; in t3, the savory taste persists but the mung bean flour flavor begins to dominate; and in t4 and t5, the savory taste remains but the mung bean flour flavor is very strong.

Texture

Based on the results of the Kruskal-Wallis test, the texture parameters showed $p > 0.05$, meaning there were no significant between treatments t1 through t5 regarding the texture of the cassava and mung bean cake. This is consistent with (Pakhri & Suaib, 2020) , which states that the comparison of mocaaf with mung bean flour had no significant effect ($p > 0.05$) on the texture of *the sponge cake* (texture scoring test).

Nutritional Content of Bosikajo

Moisture Content

Based on Table 3, the results of the proximate analysis of moisture content in the bosikajo product from the best treatment—namely treatment T3, which involved the addition of 75 g of mung bean flour—showed a moisture content of 46.92%. This indicates that the moisture content of the bosikajo exceeds the maximum moisture content requirement specified in SNI 01-4309-1996 , which sets the maximum moisture content at 40%.

Ash Content

The ash content of the bosikajo from the best treatment—namely treatment T3, which involved the addition of 75 g of mung bean flour—was 0.023%, which is still within the normal range according to SNI No. 01-4309:1996, which sets a maximum ash content limit of 3%. The content and composition depend on the type of material and the calcination process used. The mineral composition of a material is indicated by its ash content; the higher the ash content, the more minerals are contained in the material**.**
(Muchtadi, 1989 in (Yanti, 2019)).

Protein

The protein content in the Bosikajo product from the best treatment—namely, treatment T3 with the addition of 75 g of mung bean flour—is 10.74%, which complies with SNI 01-4309 1996, which sets a maximum protein content limit of 9%. In this product, the protein is derived from the addition of mung bean flour, eggs, and milk, with mung beans themselves containing approximately 22 grams of protein. (Yanti, 2019) . This aligns with the research (Pakhri & Suaib, 2020) The higher the substitution of mung bean flour, the higher the protein content in Provita cookies.

Fat Content

Proximate analysis of the fat content in the bosikajo product from the best treatment—namely treatment T3, which involved adding 75 g of mung bean flour—revealed a fat content of 8.92%, which falls into the high category because it exceeds the maximum fat limit set by SNI 01-4309:1996, which specifies a maximum fat content of 3%. The fat contained in steamed sponge cake comes from the addition of coconut milk and oil during the manufacturing process to provide a savory taste and make the texture softer.

Carbohydrates

Based on the carbohydrate analysis of the steamed cake with the best treatment (t3), which involved the addition of 75g of mung bean flour, the result was 32.18%, which falls into the “moderate” category according to SNI 01-4309 1996, with the required maximum carbohydrate content being 55%.

Fiber

Proximate analysis of the fiber content in the bosikajo product from the best treatment—namely treatment T3, which involved adding 75 g of mung bean flour—showed a fiber content of 1.20%. According to the **American Diabetes Association (ADA)** recommendations**,** the fiber requirement for people with diabetes is approximately **14 g per 1,000 kilocalories,** or ranging from **20–35 g of fiber per day,** depending on individual energy intake (ADA, 2019; Almatsier, 2009).

Energy

Based on the results of the calorie calculation for Bosikajo, which was determined by summing the protein, fat, and carbohydrate content, the energy content is 252.01 kcal per 100 g. This value aligns with the maximum limit set by SNI, which is 283 kcal per 100 g. Additionally, this energy content also meets the energy requirements for a snack for patients aged 50–64 years, which range from 180–215 kcal (RI, 2019)

Bosikajo Acceptability

An acceptability test of 85 g of bosikajo conducted on 30 panelists—patients with uncomplicated diabetes—yielded data on the level of acceptability of the tested product. The percentage of panelists in the "good" category who accepted bosikajo was 70% (21 people), while 30% (9 people) were categorized as having "poor" acceptability. Based on the acceptability test results, those with good acceptability reported liking the product's color, aroma, taste, and texture. Meanwhile, those in the poor acceptability category provided various reasons: 6 people reported a lack of appetite, and 3 people could not finish the product because they felt nauseous. Based on the analysis of meeting the Recommended Dietary Allowances (RDAs), the snack requirement falls within the range of 10–15% of their total daily needs. For patients aged 50–64 years, the snack requirement is approximately 180–215 kcal, 6–6.5 g of protein, 5–6 g of fat, and 28–34 g of carbohydrates. The amount of bosikajo needed to meet these requirements ranges from 71–80 g. In the acceptability test, 22 patients met their snack requirements because the amount of bosikajo they consumed remained within the recommended range. However, 8 patients consumed less than 71 g, resulting in insufficient nutrient intake and their acceptability being categorized as poor.

CONCLUSIONS

Cassava and mung bean cake has the following organoleptic properties: a brownish-green color, a distinctive mung bean aroma, a savory taste, and a soft texture. The addition of mung bean flour had a significant effect on the color and taste ($p<0.05$) of the cake, but not on the aroma and texture ($p>0.05$). The best results were obtained with the addition of 75 g of mung bean flour (t3). The nutritional values of product t3 include energy 252 kcal, protein 10.7%, fat 8.9%, carbohydrates 32.2%, moisture content 46.9%, ash content 0.02%, and fiber 1.2 mg. The acceptance rate of Bosikajo among patients aged 50–64 years was 70% (21 patients) with good acceptance and 30% (9 patients) with poor acceptance.

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