



## **Dried noodles with red bean flour substitution (*Vigna angularis*): Low glycemic index food alternative**

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### **ABSTRAK**

**Latar Belakang:** Rekomendasi asupan diet pada penderita Diabetes Melitus yang perlu diperhatikan yaitu mengonsumsi makanan yang mengandung indeks glikemik (IG) rendah. Mie kering dengan substitusi tepung kacang merah dapat menjadi pilihan dalam menu makanan penderita DM

**Tujuan:** Penelitian ini bertujuan untuk menganalisis uji daya terima, kandungan gizi dan indeks glikemik (IG) pada formulasi mie kering dengan substitusi tepung kacang merah.

**Metode:** Penelitian adalah eksperimen dengan 3 perlakuan formula mie kering substitusi tepung terigu dan kacang merah (F1 = 80%: 20%; F2 = 60%;40%; F3 = 40%:60%). Data yang dikumpulkan yaitu uji daya terima menggunakan uji hedonik pada 30 responden dan uji kandungan gizi menggunakan analisis uji proksimat yang kemudian dianalisis untuk menentukan formulasi terbaik dengan analisis ANOVA. Analisis nilai indeks glikemik pada 9 responden dengan metode IAUC.

**Hasil:** Mie kering substitusi tepung kacang merah berpengaruh signifikan pada hasil uji daya terima (warna, dan tekstur) dan kandungan gizi makro (protein, lemak) ( $p < 0,005$ ). Formulasi terbaik adalah F1 dengan substitusi tepung kacang merah 20% dengan nilai IG = 42,08%.

**Kesimpulan:** Mie dengan substitusi 20% tepung kacang merah memiliki indeks glikemik yang termasuk dalam golongan rendah, yaitu 42,08%.

**KATA KUNCI:** abetes melitus; indeks glikemik; kacang merah; mie kering; protein



## ABSTRACT

**Background:** Dietary recommendations for Diabetes Mellitus patients are consuming foods with a low glycemic index (GI). According to the results, dried noodles substituted with red bean flour is one of the foods recommended, considering the high protein and fiber content of red beans which are classified as low GI foods.

**Objectives:** This study aimed to analyze the acceptability, nutritional content, and glycemic index (GI) of dried noodle formulations with red bean flour substitution.

**Methods:** This was an experimental study with 3 treatments of dried noodle formulations substituting wheat flour and red beans (F1 = 80%: 20%; F2 = 60%; 40%; F3 = 40%: 60%). The data collected were acceptability tests using hedonic tests on 30 respondents and nutrient content tests (carbohydrates, protein, and fat content) utilizing proximate analysis which was then analyzed to determine the best formulation using Analysis of Variance (ANOVA). Analysis of the glycemic index in 9 respondents using the IAUC method.

**Results:** Dried noodles with red bean flour substitution had a significant effect on the results of the acceptability test (color and texture) and macronutrient content (protein, fat) ( $p < 0.005$ ). The best formulation was F1 with 20% red bean flour substitution with a GI value of 42.08%.

**Conclusions:** Dried noodles with 20% red bean flour substitution have a glycemic index classified as low, specifically 42.08%..

**KEYWORDS:** diabetes mellitus; dried noodles; glycemic index; protein; red beans

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## INTRODUCTION

Instant noodle consumption in Indonesia is very popular among people of all ages, from children to the elderly (1,2). Noodles are food products made from wheat flour, an imported ingredient with steadily increasing demand each year (2). Around 14.26 billion servings/packages were consumed by Indonesians in 2022, and this is an increase of about 7.46% compared to the previous year, which was 13.27 billion servings/packages (3).

The government has undertaken various initiatives to promote the use of local food ingredients, such as substituting wheat flour in noodles with rice to produce rice noodles or with sago to produce sago noodles. However, consumers prefer noodles made from wheat flour due to their taste and lower price. Substituting wheat flour with red bean flour in noodle production has shown positive results in several studies over the past 10 years and contributes to efforts to diversify flour substitutes (4). Red beans are rich in fiber, protein, and flavonoids and belong to the low glycemic index food group, making them suitable for people with Diabetes Mellitus (DM) (5-12).

Diabetes Mellitus is a non-communicable disease that can develop into a complicated

disease if not treated promptly. Its prevalence in 2025 showed that Indonesia ranked 5th in the world with the highest number of DM patients (20.4 million) and is the only Southeast Asian country in the top 10 worldwide (11). According to data obtained from the Ministry of Indonesia Health's Basic Health Research in 2024, the rate of prevalence increased by 1,7% in the country and Central Sulawesi Province has a prevalence rate of 1.7% (13).

Diet plays a significant role in the development of DM, and proper dietary management is essential for DM patients to prevent complications (14). People with DM must carefully monitor their dietary intake to maintain stable blood sugar levels. According to the results, noodles can serve as a suitable alternative to rice (15). While most market noodles, derived from wheat, are problematic for blood sugar control in diabetics, red bean-based noodles offer a superior alternative. Their lower GI and higher fiber content make them an excellent option for better blood sugar management and increased dietary pleasure.

Several studies have been conducted on dried noodles, such as the study by Siahaan et al. (2020) which produced dried noodles with the

addition of red bean flour and purple sweet potato extract. The results showed that dried noodles with a 20% substitution of red bean flour were preferred in terms of color and taste, with a protein content of 18.86%, fat content of 3.18%, and carbohydrate content of 71.35% (7). Another study that produced dried noodles with red bean flour substitution and beet extract resulted in a selected formulation of 15% red bean flour substitution with 50% beet extract, with a protein content of 15.66% and an overall acceptance score of 3 (8). Furthermore, a study on the production of dried noodles using only red bean flour substitution without any other additions resulted in a selected formulation of 10% red bean flour substitution with a protein content of 7.62%, fat content of 1.01%, and carbohydrate content of 80.04% (10).

Based on the explanation, the researcher is interested in further analyzing dried noodles with red bean flour substitution. Previous studies primarily focused on analyzed acceptability and nutritional content, while GI has not been further investigated, thereby there is a need to analyze whether dried noodles with the addition of red bean flour fall into the low GI category. Therefore, this study aimed to analyze the GI of dried noodle with red bean flour substitution.

## MATERIALS AND METHODS

This study used an experimental design with a completely randomized design (CRD) conducted from August to October 2024. Hedonic testing was carried out on 30 semi-panelists,

consisting of at least third-year or fifth-semester nutrition students who had taken courses related to organoleptic. The testing was conducted at the Organoleptic Laboratory of Widya Nusantara University, Palu City, Central Sulawesi. Nutritional content analysis was conducted at the Integrated Food/Beverage Nutrition Testing Laboratory of Tadulako University, Palu City, Central Sulawesi. GI analysis of the selected formulation was conducted at the Integrated Laboratory of Widya Nusantara University.

The selected formulation was determined using an effectiveness index method with a weighting process, based on the results of hedonic and nutritional content analysis. After the selected formulation was determined, GI analysis was conducted on 9 respondents who met the following criteria: at least 18 years old, normal body mass index (BMI) of 18.5-22.9 kg/m<sup>2</sup>, normal fasting glucose (60-110 mg/dL), no diagnosis of DM or prediabetes, not currently taking medications, not smoking, not currently on a special diet, no history of chronic diseases (liver and kidney), and no family history of DM (17,18). This study obtained ethical approval with number 2082/UN.414/TP/01/02/2024 from the Faculty of Public Health, Hasanuddin University. The initial stage involved creating dried noodle formulations with red bean flour substitutions at three ratios of wheat flour to red bean flour: F1 = 80% (wheat flour): 20% (red bean flour); F2 = 60%: 40%; and F3 = 40%: 60%, as presented in **Table 1**. The next stage involved conducting hedonic testing and nutritional content analysis with two replications.

**Table 1. Dried noodle formulation with red bean flour substitution**

Materials	F1	F2	F3
	(80%:20%)	(60%:40%)	(40%:60%)
Wheat flour	80 g	60 g	40 g
Red bean flour	20 g	40 g	60 g
Egg	30 mL	35 mL	40 mL
Water	15 mL	20 mL	30 mL
Palm oil	5 g	5 g	5g
Salt	1 g	1 g	1 g

*modification of formulation based on the study by Widiawati et.al (2022).*

The production of red bean flour began with the purchase of local red beans from Sigi, Central Sulawesi. The red beans were weighed and soaked for 12 hours. After soaking, they were drained and boiled for 5 minutes, then the red

bean skins were removed. Furthermore, the skinless red beans were dried in an oven at a temperature of 60°C for approximately 8 hours. Once dried, they were ground using a grinder and sieved using an 80-mesh sieve, resulting in ready-

to-use red bean flour for making dried noodles (5,10,19).

The production of dried noodle formulations with red bean flour substitution started with weighing the ingredients listed in **Table 1**. After weighing, the ingredients were placed in separate containers according to the formulation, and all ingredients were mixed until a dough was formed. The noodle dough was rolled out using a noodle maker until it formed noodles. After becoming noodle strands, the next step was weighing, shaping, and steaming for 10 minutes at 100°C and cooling at room temperature. The next step was the drying process using an oven at a temperature of 160°C for 15 minutes (10).

The hedonic test was used to assess the acceptability of the product by 30 semi-trained panelists, who evaluated the taste, color, aroma, and texture. The criteria of the hedonic panelist are (1) aged > 17 years; (2) physically and mentally healthy; (3) not allergic to red beans, gluten and eggs; (4) able to attend at the scheduled time and willing to participate in the entire series of test until completion; (5) currently/have taken a food trial course; (6) ensure a 1-2 hour interval before or after heavy meal. The results of the acceptability level used a Likert scale, with a score of 1 = strongly dislike; 2 = somewhat dislike; 3 = neutral; 4 = like; 5 = strongly like. The tools used were a hedonic test questionnaire, a pen, and mineral water for neutralization during the hedonic test.

The nutritional content analysis, which consisted of moisture content using the thermogravimetric method, ash content using the gravimetric method, carbohydrates using the UV-Vis method, protein using the Kjeldahl method, and fat using the Soxhlet method (5,10). The selection of the best formulation was determined using the effectiveness index method with a procedure involving the following steps value: (1) determining the value of each parameter by considering the impact on the glycemic index with a value of 0-1; (2) determining the Effectiveness Value (EV) using the formula:

$$EV = \frac{TV - WTV}{BTV - WTV} \quad [1]$$

Explanation: TV = Treatment Value; WTV = Worst Treatment Value; BTV= Best Treatment Value; (3) then the Product Value (NP) is calculated by multiplying the Effectiveness Value by the Weight Value using the formula: NP = NE x Weight; (4) The product values of all parameters of each group are summed up. The selected formulation is determined based on the highest Product Value (18).

The GI test used a standard food (25 gr pure glucose) and a test food (the selected formulation, which is F1 with 20% red bean flour substitution) (17,20). The method for determining the glycemic index value used the IAUC (Incremental Area Under the Blood glucose Curve) method. Respondents were asked to fast for approximately 10 hours (except for water). Finger-prick capillary blood samples were taken at the 0th minute (when fasting and before being given the reference/test food), then blood was taken again at the 30th, 60th, 90th, and 120th minutes. The interval between tests was 2 days, then the blood glucose values (at each blood glucose sampling time) were plotted on the x-axis (time) and y-axis (blood glucose) using a graph. GI value was determined by calculating the ratio of the area under the curve of the test food compared to the area under the curve of the reference food (17,18,20,21).

Organoleptic and nutrient content analyses were conducted using ANOVA with a significance level of 0.05, followed by post-hoc comparisons using the Duncan test. GI analysis was performed using a paired test by comparing the blood glucose response after consuming the test food with that of a standard food. The resulting data are presented descriptively in the form of graphs and tables.

## RESULTS AND DISCUSSIONS

### Acceptability and nutritional analysis test

The results of the acceptability test analysis on dried noodle formulations with red bean flour in **Table 2** show a significant difference in the organoleptic evaluation of color ( $p = 0.003$ ) and texture ( $p = 0.000$ ), but there is no significant difference in aroma ( $p = 0.810$ ), taste ( $p = 0.432$ ), and overall ( $p = 0.014$ ). This indicates that the lower the amount of red bean flour, the higher the acceptance level (color and texture). The highest acceptance level (aroma and texture) was found

in F1, with a 20% substitution of red bean flour. The acceptability test of dried noodles with red bean flour substitution involved the assessment of color, texture, aroma and taste in three noodles formulations (**Table 2**). Formulation F1, with a 20% substitution of red bean flour, obtained the highest average score for overall acceptability. Meanwhile, there were significant differences in color and texture among the three formulations, but no significant differences in aroma and taste. These results are similar, which found that color had a significant difference in dried noodle formulations with red bean flour substitution, while texture, aroma, and taste did not show significant differences (10). Color is an assessment made by panelists based on visual perception. The addition

of red bean flour to dried noodles imparts a brownish hue, with intensity of the color increasing in proportion to the amount of red bean flour used (12). This color change occurs due to the protein content in red bean flour, leading to browning (Maillard reaction) at high temperatures during noodle drying (8, 22). Texture is an assessment involving both the senses of touch and sight to evaluate size, quantity, and shape. The results of the texture assessment are consistent with previous research, which explained that the less red bean flour used, the more preferred it is. The higher the amount of red bean flour used, the tougher or harder the texture becomes, thereby the most preferred texture was F1 with the lowest substitution of red bean flour (5).

**Table 2. Results of acceptability test and nutritional analysis on dried noodle formulations with red bean flour.**

Organoleptic	Formulations Mean $\pm$ SD			p value <sup>4</sup>
	F1 <sup>1</sup>	F2 <sup>2</sup>	F3 <sup>3</sup>	
Color	3.80 $\pm$ 1.06 <sup>a</sup>	3.47 $\pm$ 1.07 <sup>b</sup>	2.83 $\pm$ 1.14 <sup>c</sup>	0.003
Texture	4.00 $\pm$ 1.34 <sup>a</sup>	3.10 $\pm$ 1.21 <sup>b</sup>	2.73 $\pm$ 1.28 <sup>c</sup>	0.000
Aroma	3.40 $\pm$ 1.13 <sup>a</sup>	3.30 $\pm$ 0.84 <sup>a</sup>	3.39 $\pm$ 0.99 <sup>a</sup>	0.810
Taste	3.40 $\pm$ 1.04 <sup>a</sup>	3.03 $\pm$ 1.07 <sup>a</sup>	3.27 $\pm$ 1.20 <sup>a</sup>	0.432
Carbohydrates (%)	46.52 $\pm$ 15.70 <sup>a</sup>	58.11 $\pm$ 57.60 <sup>a</sup>	66.13 $\pm$ 41.29 <sup>a</sup>	0.041
Protein (%)	10.03 $\pm$ 2.17 <sup>a</sup>	13.61 $\pm$ 3.09 <sup>b</sup>	14.20 $\pm$ 3.11 <sup>c</sup>	0.000
Fat (%)	7.60 $\pm$ 6.30 <sup>a</sup>	8.76 $\pm$ 5.64 <sup>b</sup>	11.15 $\pm$ 1.27 <sup>c</sup>	0.003
Moisture (%)	14.91 $\pm$ 3.21 <sup>a</sup>	24.72 $\pm$ 7.19 <sup>b</sup>	22.03 $\pm$ 3.95 <sup>c</sup>	0.000
Ash (%)	2.70 $\pm$ 0.14 <sup>a</sup>	2.85 $\pm$ 0.77 <sup>a</sup>	2.95 $\pm$ 0.35 <sup>a</sup>	0.006

<sup>1</sup>F1 = a ratio of 80% (wheat flour) : 20% (red bean flour); <sup>2</sup>F2 = a ratio of 60% (wheat flour) : 40% (red bean flour); <sup>3</sup>F3 = a ratio of 40% (wheat flour) : 60% (red bean flour); <sup>4</sup>Anova p < 0.005 with difference text using Duncan test<sup>a,b,c</sup>

The results of the nutritional analysis on dried noodle formulations with red bean flour in Table 2 show significant differences in carbohydrates (p 0.041), protein (p = 0.000), fat (p = 0.003), moisture content (p = 0.000), and ash content (p = 0.006). This indicates that the higher the amount of red bean flour, the higher the nutritional content (carbohydrates, protein, fat, and moisture content). The highest values for carbohydrates, protein, fat, and moisture content were found in F3 with a 60% substitution of red bean flour.

The nutritional content assessed included carbohydrate, protein, fat, moisture, and ash content. The results showed that carbohydrates, protein, fat, moisture and ash content differed significantly among the three formulations with red bean flour substitution (Table 2). The increase in

carbohydrate content in the dry noodles with red bean flour substitution occurs because both ingredients have a high carbohydrate content, and the calculation method is based on the by difference approach. The final result is significantly influenced by the chemical composition of the raw materials and changes in the levels of other components such as protein, fat, and ash (10). This study is in line with previous studies indicating that dried noodles with a 10% substitution of red bean flour have a protein content of 7.62% (10). Meanwhile, the results of this study for a 20% substitution of red bean flour showed a protein content of 10.03%. These results comply with the Indonesian National Standard (SNI) No 01-2974-1992, which sets a minimum protein content of 8% for dried noodles

(23). The decreasing protein content in red beans can be attributed to the soaking process during red bean flour production for 12 hours (24). The fat content of the selected formulation with a 20% substitution of red bean flour was 7.6%. This result differs from a previous study that reported a fat content of 1.01% (10). However, SNI No 01-2974-1992 does not regulate fat content (23). This difference can be attributed to the addition of 5

grams of cooking oil during the production of dried noodles and the use of high-protein wheat flour. High-protein wheat flour has a relatively high fat content of 2.29%. Meanwhile, red beans, in addition to being high in protein, also have a fairly high fat content of around 15.80% (25). Moreover, 100 grams of red bean flour contains 4.11% fat (26). Thus, the higher the amount of red bean flour used, the higher the fat content.

**Table 3. Product and Effectiveness Product of Dried Noodle Formulations with Red Bean Flour**

Paramater	Value	Formulations					
		F1 <sup>1</sup>		F2 <sup>2</sup>		F3 <sup>3</sup>	
		EV <sup>4</sup>	PV <sup>5</sup>	EV <sup>4</sup>	PV <sup>5</sup>	EV <sup>4</sup>	PV <sup>5</sup>
Color	0.08	1	0.08	0.64	0.05	0	0
Texture	0.08	1	0.08	0.31	0.02	0	0
Aroma	0.08	1	0.08	0	0	0.8	0.008
Taste	0.08	1	0.08	0	0	0	0
Carbohydrate	0.24	1	0.24	0.41	0.08	0	0
Protein	0.23	0	0	0.85	0.17	1	0.21
Fat	0.21	1	0.21	0.55	0.08	0	0
Total	1		<b>0.77</b>		0.4		0.218

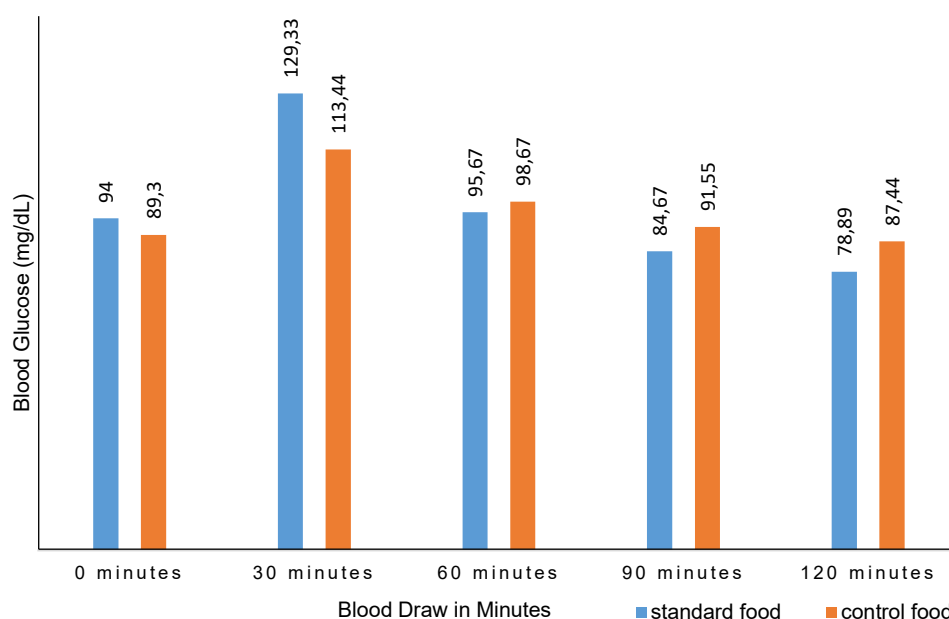
<sup>1</sup>F1 = a ratio of 80% (wheat flour) : 20% (red bean flour); <sup>2</sup>F2 = a ratio of 60% (wheat flour) : 40% (red bean flour); <sup>3</sup>F3 = a ratio of 40% (wheat flour) : 60% (red bean flour); <sup>4</sup>EV = Effectiveness Value; <sup>5</sup>PV = Product value

The moisture content of the selected formulation with a 20% substitution of red bean flour was 14.91%. This result differs from previous studies that reported a moisture content of 10%, and according to the SNI, the standard moisture content of dried noodles is 10% (10, 23). This higher value compared to the SNI and previous studies can be attributed to incomplete drying of the noodles. Additionally, the moisture content of red beans is generally higher than that of other legumes, such as red beans and green beans, which are 8.35% and 7.21%, respectively (8, 22). The higher the amount of red bean flour used, the higher the moisture content. The drying process also influenced the moisture content, resulting in a value that did not meet the SNI standard for dried noodles. The ash content analysis results show that all three formulations fall within the SNI standard for dry noodles, which is a maximum of 3% (23).

**Glycemic Index**

Before determining the GI of the dried noodles, the first step was to select the optimal formulation as shown in **Table 3**. The selected formulation

was determined using the effectiveness index method by considering the highest product value (PV) as shown in **Table 3**. This method showed that the selected formulation was F1 with the highest product value of 0.77, which was subsequently used for the glycemic index test. **Figure 1** shows the comparison of average glucose levels after consuming a standard food (25g pure glucose) and a test food (selected dried noodle formulation with 20% red bean flour substitution). The administration of the selected formulation, with a 20% substitution of red bean flour, resulted in a lower glucose response in the subjects compared to the administration of 25g pure glucose. The results showed that the selected dried noodle formulation with a 20% red bean flour substitution, equivalent to 25 grams of pure glucose carbohydrates (53.74 grams), had a glycemic index value of 42.08%, which is categorized as low. These results are presented in **Table 4**. Glycemic Index how rapidly a food raises blood sugar levels. Analysis of the selected dried noodle formulation, containing a 20% red bean flour substitution yielded a value of 42.08%, categorized as low (27).



**Figure 1. Blood glucose response of participants (9 respondents) after the treatment of consume dried noodles formulation with red bean flour**

**Table 4. Glycemic index of the selected dried noodle formulation with 20% red bean flour substitution**

Formulation	Amount of sample equivalent to 25 g pure glucose (g)	Glycemic index (%)
Dried noodle formulation with 20% red bean flour substitution	53.74	42.08

Subsequently, the blood glucose response increased at the 30-minute mark and then decreased slightly, but remained higher compared to the control food. These results are consistent with previous studies carried out on flakes with added red bean flour, which also exhibited a low GI and a similar blood glucose response (28,29).

#### CONCLUSION AND RECOMMENDATION

In conclusion, the formulation of dried noodles with red bean flour substitution has a significant difference in terms of acceptability (aroma and texture), protein content, fat content, and moisture content. The selected formulation is dried noodles with a 20% substitution of red bean flour with an IG value of 42.08%, which is categorized as low IG and can be recommended as a food choice for DM patients. Further study should consider the use of seasonings in noodles

to ensure safety for consumption and remain a recommendation for DM patients, as well as the chewiness of dried noodles and the shelf life.

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