



# Acceptability and Nutritional Profile of Pigeon Pea Snack Bars for Adolescents

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<p><b>Track Record Article</b></p> <p>Revised: 08 January 2026 Accepted: 15 March 2026 Published: 31 March 2026</p> <p><b>How to cite:</b> Purnaningsih, S., Nafi'a, Z. I., &amp; Ridha, A. (2026). Acceptability and Nutritional Profile of Pigeon Pea Snack Bars for Adolescents. <i>Contagion: Scientific Periodical Journal of Public Health and Coastal Health</i>, 8(1), 444–452.</p>	<p style="text-align: center;"><b>Abstract</b></p> <p><i>Adolescents commonly exhibit unhealthy snacking behaviors characterized by high-energy and low-fiber food consumption, contributing to various nutritional problems such as obesity and micronutrient deficiencies. This study aimed to evaluate the acceptability and nutritional composition of a pigeon pea (<i>Cajanus cajan</i>)–based snack bar developed as a high-fiber alternative snack for adolescents. A Research and Development (R&amp;D) approach using the 4D model (Define, Design, Develop, and Disseminate) was employed. Product acceptability was assessed through a hedonic test involving 80 untrained adolescent panelists using a 5-point scale (1 = strongly dislike to 5 = strongly like). Sensory attributes evaluated included color, aroma, taste, texture, and overall acceptance. Proximate composition and dietary fiber were analyzed according to AOAC standard methods. Energy values were calculated using Atwater conversion factors. Differences between the developed product and the control snack bar were analyzed using independent sample t-tests (<math>p &lt; 0.05</math>). The developed pigeon pea snack bar demonstrated significantly higher acceptance scores than the control product across all sensory attributes (<math>p &lt; 0.05</math>), with a mean overall liking score of <math>4.7 \pm 0.41</math>. Per 30 g serving, the snack bar contained 4.2 g protein, 4.2 g fat, 15.4 g carbohydrates, and 5 g dietary fiber and provided 134.1 kcal of energy. Approximately 83% of panelists rated the product <math>\geq 4</math>, indicating high consumer acceptance. In conclusion, pigeon pea–based snack bars are highly acceptable and nutritionally dense, suggesting strong potential as a locally sourced, high-fiber snack alternative for adolescents.</i></p> <p><b>Keywords:</b> Pigeon Pea, Sensory Evaluation, Proximate Analysis, Product Development, Adolescent Nutrition.</p>
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## INTRODUCTION

Nutritional problems among adolescents in Indonesia remain a major public health concern, largely associated with unhealthy dietary behaviors, including inadequate intake of energy, protein, and dietary fiber. These conditions contribute to obesity, chronic energy deficiency, and micronutrient deficiencies. Adolescents experience increased nutritional requirements due to rapid physical growth, while low consumption of fruits and vegetables negatively affects nutritional adequacy and overall quality of life (Dewi et al., 2025).

Adolescents also tend to develop habitual snacking behaviors characterized by frequent consumption of energy-dense and nutrient-poor foods. Combined with reduced physical activity, this pattern significantly increases the risk of overweight and obesity. Therefore, providing healthier snack alternatives is essential to support adolescent nutritional status (Almoraie et al., 2021; Hasibuan & Sahriani, 2024).

Current adolescent snacking patterns are dominated by high-calorie foods with low nutritional value. Snacks are generally defined as foods consumed between main meals, while healthy snacks are expected to provide essential nutrients and remain low in added sugar, salt, and saturated fat. Snack bars represent a practical snack option with relatively complete nutritional value and extended shelf life, making them suitable for adolescent consumption (Ulfa et al., 2024). Previous studies have reported that cereal bars formulated with pulse or legume flours show improved protein and dietary fiber content with acceptable sensory quality (Maia et al., 2021).

Legume-based flours offer promising potential as local food resources for snack bar development due to their high protein and dietary fiber content. Composite snack bars formulated from cereal and legume flours have been shown to improve nutritional quality and function as healthier snack alternatives for adolescents (Ulfa et al., 2024). Pigeon pea (*Cajanus cajan*), locally known as kacang gude, remains underutilized in Indonesia despite its nutritional value and gluten-free characteristics. Recent studies demonstrated that pigeon pea flour contributes significantly to protein, dietary fiber, and antioxidant content in processed food products (Irwan et al., 2024).

Several recent studies have explored the application of pigeon pea in bakery and snack products. Incorporation of pigeon pea flour has been reported to enhance protein and fiber content while maintaining acceptable sensory characteristics. However, research specifically focusing on pigeon pea-based snack bars targeted for adolescent consumption remains limited (Chinedum et al., 2025).

Previous snack bar studies in Indonesia have mainly utilized other legumes and local ingredients such as mung beans, rice bran, and millet. These formulations demonstrated increased dietary fiber and consumer acceptability but did not address pigeon pea as a primary ingredient (Ulfa et al., 2024). Therefore, a clear research gap exists regarding the development and evaluation of pigeon pea snack bars as high-fiber snack alternatives for adolescents.

Global nutrition research increasingly recognizes legumes as nutrient-dense foods that support both diet quality and sustainability (Torheim & Fadnes, 2024). Population-based evidence further demonstrates that higher pulse consumption is associated with improved nutrient intake profiles and better alignment with recommended healthy dietary patterns (Kaimila et al., 2024). Building on this nutritional foundation, recent product development studies show that incorporating legume ingredients into snack formulations can enhance nutritional value while maintaining consumer acceptability among younger populations (Duguma & Argessa, 2025). Collectively, these findings support the development of pigeon

pea-based snack bars as a relevant strategy to improve nutrient intake and dietary quality among adolescents.

This study aims to evaluate the acceptability and nutritional composition of pigeon pea-based snack bars through sensory evaluation, proximate analysis, and dietary fiber testing. The findings are expected to support the development of locally sourced, nutrient-dense snack products that contribute to improving adolescent dietary quality.

## **METHODS**

This study employed the Research and Development (R&D) method using the 4D model, which includes Define, Design, Development, and Disseminate (Mulyatiningsih, 2019). The research stages were also complemented by nutritional analysis. The data obtained were presented descriptively in the form of mean values and accompanied by standard deviations.

### **Define and Design**

The define stage aimed to identify an appropriate base formulation for developing a pigeon pea snack bar by comparing three reference recipes with different ingredient compositions. The use of three recipes was intended to explore variations in texture, flavor, and overall acceptability and to determine the most suitable formulation for substituting soybean flour with pigeon pea flour. Recipe 1 consisted of soybean flour, palm sugar, butter, egg yolk, and milk powder with a composition ratio of 2:1:1. In Recipe 2, soybean flour was replaced with pastry flour, palm sugar was substituted with granulated sugar, and the number of eggs was doubled to produce a softer texture. Recipe 3 used oatmeal and granola as the main components, combined with vegetable oil and palm sugar, representing a cereal-based snack bar formulation. These variations were designed to provide different structural and sensory characteristics, serving as comparative references in selecting the most appropriate base recipe. Soybean flour was initially used as a reference ingredient because it is commonly applied in legume-based snack bar products and has well-established nutritional properties. However, pigeon pea (*Cajanus cajan* L.) was introduced as a substitute due to its comparable protein content and its higher dietary fiber content, as well as its status as an underutilized local legume. Although both soybeans and pigeon peas are rich in protein, pigeon peas contain lower fat and higher complex carbohydrates, making them potentially more suitable for high-fiber snack development for adolescents. Therefore, soybean flour served only as a benchmark, while pigeon pea flour was evaluated as a functional alternative ingredient.

During the design stage, all three reference recipes were subjected to preliminary sensory evaluation by panelists and validation by two food experts to determine the most

acceptable base formulation. The selected formulation was then modified by replacing soybean flour with pigeon pea flour. The snack bar production process is illustrated in Figure 1. Egg yolks and palm sugar were first mixed using a mixer until creamy and homogeneous. Pigeon pea flour was then added gradually and mixed with a spatula, followed by the addition of melted margarine and further mixing until fully incorporated. The batter was poured into a baking tray lined with parchment paper and baked at 180°C for 20 minutes.



**Figure 1. The Production Process of Gude Bean Snack Bar**

### **Development**

The development stage involved validation testing conducted by two experts in the field. The experts' assessments were used to improve the product. Once the validation results demonstrated satisfactory quality, the process proceeded to the disseminate stage. The evaluation was carried out through two rounds of validation, each conducted by two experts. The results from Validation 1 were used to refine the product for Validation 2, while the results from Validation 2 served as the basis for product improvement before being tested by the panelists.

The evaluation was performed by having the experts taste the prepared product and assess it based on nine parameters (shape, size, color, aroma, texture, overall presentation, and packaging), using a scoring system of 1 = strongly dislike, 2 = dislike, 3 = like, and 4 = strongly like. The assessment was also accompanied by comments on the evaluated product.

### **Disseminate Stage**

In the dissemination stage, sensory acceptability testing was conducted involving 80 untrained adolescent panelists recruited from SMKN 3 Sukoharjo. Panelists were selected using convenience sampling based on the following inclusion criteria: aged 15–18 years, willing to participate, in healthy condition, and having no known food allergies to the product ingredients. All participants were regular snack consumers.

The panelists evaluated the developed pigeon pea snack bar using a hedonic preference test, in which they provided subjective ratings based on personal liking (David & David, 2020). Sensory attributes assessed included aroma, color, texture, and taste. A four-point hedonic scale was applied (1 = strongly dislike, 2 = dislike, 3 = like, and 4 = strongly like). Responses were recorded using standardized scoring forms.

## **Nutritional Content Analysis**

The nutritional content analysis consisted of proximate testing and dietary fiber analysis, each conducted in two replications. The proximate test included the assessment of moisture content, ash content, fat, protein, and carbohydrates.

The initial part of the method describes the research design, location, and duration in sequential order, followed by an explanation of the research subjects/samples and the sampling method. If the research was conducted in a laboratory, it should then include a detailed description of the materials and equipment used. The next section outlines the data collection procedures or laboratory research steps. Finally, the data processing and analysis methods used in the study should be explained. The number and arrangement of paragraphs may be adjusted according to the needs of the research presentation.

## **RESULTS**

### **Product Development and Formulation**

Three initial formulations were prepared as reference recipes to determine the most appropriate base for snack bar development. Preliminary sensory evaluation conducted by trained panelists indicated that Reference Recipe 1 achieved the highest overall acceptance, particularly in terms of taste, texture, and aroma. The other formulations were less preferred due to excessive sweetness and crumbly texture. Therefore, Reference Recipe 1 was selected as the base formulation and subsequently modified by substituting soybean flour with pigeon pea flour. Further adjustments were made based on expert feedback to improve portion size and flavor balance.

At the design stage, pigeon pea flour was incorporated at levels of 35%, 40%, and 50%. Based on validation by trained panelists, the formulation containing 40% pigeon pea flour was selected as the optimal product. Initial trials indicated excessive saltiness, which was corrected by removing salt from the formulation. The final formulation consisted primarily of pigeon pea flour, soybean flour, mung bean flour, butter, palm sugar, egg yolk, milk powder, raisins, and spices.

Validation by two food product experts showed that the developed snack bar achieved “good” sensory quality, particularly in color, aroma, texture, and overall acceptance. The product was formed into bar shapes measuring approximately  $7 \times 3$  cm, consistent with conventional snack bar dimensions.

## Acceptability Test

Acceptability testing was conducted with 80 untrained adolescent panelists using a 5-point hedonic scale. The results are presented in Table 1.

**Table 1. Adolescents' Acceptability Test Results**

Sensory Attributes	Control (Mean ± SD)	Developed Product (Mean ± SD)	p-value
Color	3.4 ± 0.49	4.68 ± 0.49	0.05
Aroma	3.6 ± 0.49	4.62 ± 0.48	0.00
Taste	3.7 ± 0.46	4.66 ± 0.47	0.34
Texture	3.4 ± 0.49	4.70 ± 0.44	0.02
Overall acceptance	3.6 ± 0.50	4.70 ± 0.41	0.00

The developed snack bar demonstrated significantly higher scores for color, aroma, texture, and overall acceptance compared to the control ( $p < 0.05$ ). Approximately 83% of panelists rated the product  $\geq 4$ , indicating high consumer acceptance.

## Nutritional Content

Proximate analysis showed that the moisture content of the snack bar was 10.71%, indicating a dry product. The protein content reached 14.25%, fat 20.55%, and carbohydrates 51.34%, with an average energy value of 447.31 kcal per 100 g. Each 30 g serving provided approximately 117 kcal and 5 g of dietary fiber.

The nutritional labeling indicated that the snack bar contributes meaningfully to daily energy and macronutrient intake. Based on acceptability testing and nutritional analysis, the pigeon pea snack bar demonstrated strong potential as a nutritious and acceptable alternative snack for adolescents.

## DISCUSSION

The results of this study align with previous research indicating that legume flour incorporation enhances snack bar nutritional quality. Enrichment with pulse flours significantly increases protein and dietary fiber content while maintaining sensory acceptability (Escobedo & Mojica, 2021). Enhanced fiber content may support metabolic health benefits relevant to adolescent populations (Edwards et al., 2015; WHO, 2020). These findings support the use of pigeon pea flour as a functional ingredient for developing nutritious snack products targeted at adolescents.

The hedonic test showed significantly higher scores for color, aroma, texture, and overall acceptance in the developed product compared with the control. This indicates that pigeon pea flour can be successfully incorporated into snack bar formulations without negatively affecting consumer preference. The brownish color and distinctive aroma were

likely influenced by the natural pigments and bioactive compounds in pigeon peas, which intensify during thermal processing and contribute to product appeal.

Texture acceptability may be attributed to the interaction between the protein and starch components of the mixed flours, which affect moisture retention and structural integrity. Previous studies have reported that legume-based formulations improve texture and nutritional quality due to their high protein and complex carbohydrate content. Protein also plays a role in water binding, contributing to a softer and more desirable texture.

From a nutritional perspective, the developed snack bar contained 14.25% protein, 20.55% fat, and 51.34% carbohydrates, with an energy value of 447.31 kcal per 100 g. In addition, each 30 g serving provided approximately 5 g of dietary fiber, supporting its potential as a high-fiber snack alternative. This composition aligns with adolescent nutritional needs, particularly in addressing low fiber intake and reliance on energy-dense, nutrient-poor snacks.

The high acceptance rate (83%) indicates that adolescents are receptive to snack products formulated with locally sourced legumes. This finding supports the utilization of pigeon pea as an underused food resource with potential applications in functional snack development. Incorporating pigeon pea flour into snack products may contribute to improving dietary quality among adolescents while promoting sustainable use of local agricultural commodities.

## CONCLUSIONS

The pigeon pea-based snack bar developed in this study demonstrated high acceptability among adolescent panelists, with an overall liking score of 4.7 and an acceptance rate of 83%. The product was characterized by a pleasant taste, soft texture, appealing brown color, and distinctive aroma.

Nutritional analysis showed that the snack bar contained 14.25% protein, 20.55% fat, and 51.34% carbohydrates and provided 447.31 kcal per 100 g, with approximately 5 g of dietary fiber per 30 g serving. These results indicate that pigeon pea snack bars can serve as a nutritious, high-fiber alternative snack for adolescents. The utilization of pigeon pea flour also supports the development of functional foods based on local legumes and may contribute to improving adolescent dietary quality.

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