

Development of a Red Bean and Soybean Based Snack Bar as a Natural Source of B-Complex Vitamins

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ABSTRACT

Vitamin B deficiency remains a nutritional issue in Indonesia, particularly among adolescents and young adults, leading to anemia and reduced productivity. Snack bars are among the most popular ready to eat foods consumed by this demographic, yet many lack balanced nutritional quality. This study aimed to develop a red bean and soybean based snack bar as a natural source of B-complex vitamins through descriptive observation and formulation analysis. The research was conducted qualitatively by outlining the formulation process, observing sensory characteristics such as color, texture, taste, and aroma, and reviewing relevant scientific literature regarding the nutritional potential of the selected ingredients. The formulation combined red beans and soybeans to explore their effects on product texture and flavor balance. Observations indicated that the combination produced a compact, cohesive bar with a pleasant nutty flavor and slightly dense texture. Literature analysis supported that both legumes naturally contain B vitamins, including thiamine and folate, which are essential for energy metabolism and red blood cell production. Overall, this study provides a descriptive understanding of how red beans and soybeans can be formulated into a functional snack bar with improved sensory appeal and potential nutritional benefits. The findings offer a conceptual basis for future development of plant-based snack products enriched with natural sources of B-complex vitamins.

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1. INTRODUCTION

Vitamin B deficiency continues to be a nutritional concern in developing countries, including Indonesia, particularly among adolescents and young adults (World Health Organization [WHO], 2023; Ministry of Health of Indonesia, 2022). Inadequate intake of B-complex vitamins such as thiamine (B1), riboflavin (B2), niacin (B3), and folate (B9) can lead to anemia, fatigue, and impaired metabolic function (Ribaya Mercado & Blumberg, 2020). Meanwhile, snack foods have become increasingly popular due to their convenience, but many commercial snack products lack adequate micronutrient content and rely heavily on refined carbohydrates and fats (Kaur & Singh, 2019; Rahmawati et al., 2021). Thus, developing a nutrient rich, plant based snack product that utilizes local ingredients could contribute to improving dietary quality and addressing micronutrient deficiencies.

Red beans (*Phaseolus vulgaris* L.) and soybeans (*Glycine max* L.) are legumes known for their high protein content, fiber, and essential micronutrients, including B-complex vitamins (Costa et al., 2020; Kim et al., 2022). Studies have shown that red beans contain thiamine and folate, while soybeans are rich in riboflavin and niacin, making them promising raw materials for developing functional foods (Iqbal et al., 2021; Kusnadi et al., 2020). Furthermore, the increasing demand for plant-based and functional snack products aligns with the global shift toward sustainable nutrition (Aschemann Witzel et al., 2021). However, despite these potentials, limited studies have explored the combination of red beans and soybeans in snack bar formulations, particularly regarding sensory quality and consumer acceptability.

This study aims to develop a red bean and soybean-based snack bar as a natural source of B-complex vitamins, emphasizing formulation design and sensory observation through a qualitative descriptive approach. The research describes the formulation process, observes key sensory characteristics such as color, texture, taste, and aroma and reviews relevant scientific literature on the nutritional potential of the ingredients. The combination of red beans and soybeans in varying proportions is expected to produce differences in texture and flavor balance, thereby offering insights into the development of functional snack bars with enhanced sensory appeal and nutritional value. By integrating local legume ingredients into snack bar formulations, this study contributes to the growing field of sustainable and health-oriented food innovation in Indonesia.

2. METHODS

This study employed a qualitative descriptive approach focusing on the formulation process, sensory observation, and theoretical review of the nutritional potential of red bean (*Phaseolus vulgaris L.*) and soybean (*Glycine max L.*) as natural sources of B-complex vitamins. The research aimed to describe and analyze the characteristics of a red bean and soybean-based snack bar in terms of color, texture, taste, and aroma. No laboratory chemical analysis was conducted; instead, qualitative assessment and literature review were used to support the sensory findings and theoretical formulation.

2.1 Material

The primary ingredients used in the formulation were red bean flour, soybean flour, oat flakes (rolled oats), roasted almonds, chia seeds, raisins, honey, margarine, fresh milk, and salt (Table 1). All ingredients were sourced from local markets in Denpasar, Indonesia, ensuring their availability and affordability for small-scale food innovation.

Table 1 Formulation of Red Bean and Soybean Flour-Based Snack Bar

No.	Main Ingredients	Treatments		
		F1	F2	F3
1	Red Bean Flour	90 gr	80 gr	70 gr
2	Soybean Flour	60 gr	70 gr	80 gr
3	Oat Flakes	15 gr	15 gr	15 gr
4	Roasted Almond	10 gr	10 gr	10 gr
5	Raisins	20 gr	20 gr	20 gr
6	Honey	12 ml	12 ml	12 ml
7	Margarine	15 gr	15 gr	15 gr
8	Freshmilk	5 ml	5 ml	5 ml
9	Salt	<2 gr	<2 gr	<2 gr

2.2 Formulation Process

The snack bar formulation procedure was adapted from Kaur and Singh (2019) and Wani et al. (2022), with modifications to the ratios of legume flours. The process consisted of four main stages:

1. Preparation of flours
Dried red beans and soybeans were cleaned, soaked for 8 hours, drained, oven-dried at 60°C, and ground into fine flour (60 mesh). The flours were stored in airtight containers to prevent moisture absorption.
2. Mixing of dry ingredients
Red bean flour, soybean flour, oat flakes, roasted almonds, and salt were mixed evenly in a stainless-steel bowl.
3. Incorporation of wet ingredients
Honey, margarine (melted at 40°C), fresh milk, and raisins were gradually added to the dry mix and stirred until a homogenous dough was obtained.
4. Molding and baking
The dough was pressed into a rectangular mold lined with baking paper and baked at 150°C for 20 minutes. After cooling for 30 minutes at room temperature, the snack bar was cut into 4×10 cm bars. The overall process is illustrated in Figure 1, showing the sequence from ingredient preparation to baking and cooling.

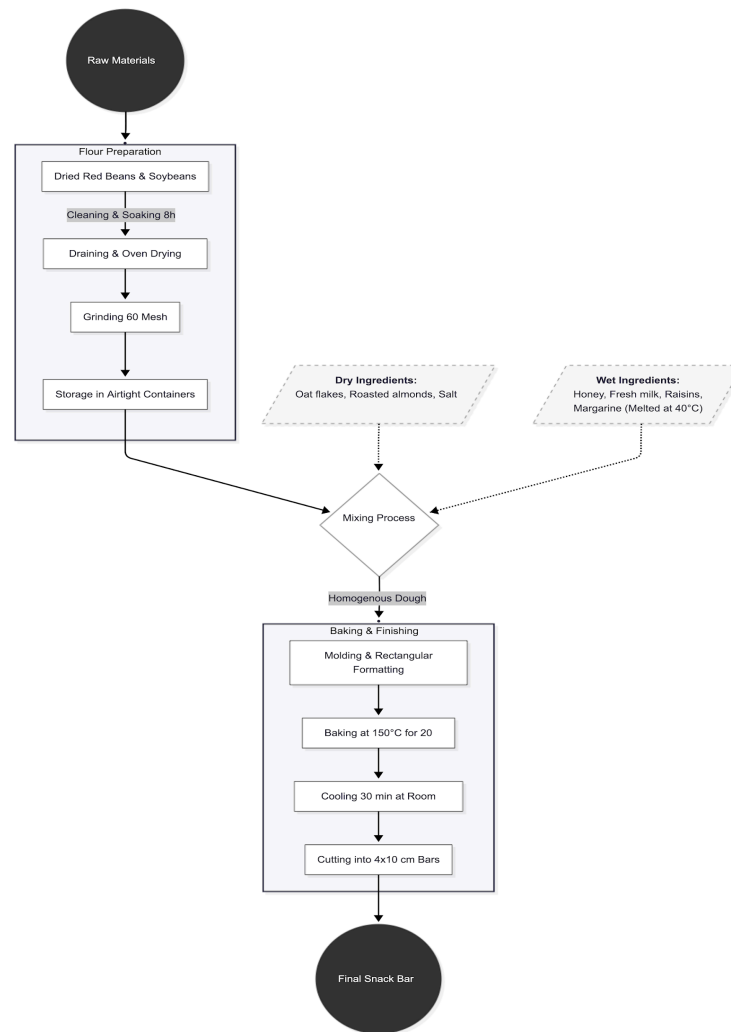


Figure 1 Flowchart SnackBar Production

2.3 Sensory Observation

The sensory evaluation was conducted qualitatively to describe the observable characteristics of the snack bar formulations, focusing on color, texture, aroma, and taste. Five trained evaluators from the Department of Food Technology, BIM University, participated in the assessment. The samples were evaluated immediately after cooling at room temperature to ensure consistent conditions. Descriptive terminology was employed to characterize the sensory attributes of each formulation, including color (uniform light brown), texture (firm and slightly chewy), aroma (mild roasted nut aroma), and taste (savory with balanced sweetness). Observations were independently recorded by each panelist. The qualitative nature of the evaluation aligns with the study’s exploratory objective; therefore, no numerical scoring or hedonic scale was applied. Instead, the evaluators’ descriptive notes were compiled and synthesized to identify common sensory patterns and differences across formulations.

2.4 Data Analysis

The collected sensory descriptions were analyzed through descriptive qualitative analysis. The process involved identifying recurring sensory themes, comparing variations among the three formulations, and interpreting these findings within the context of food science theory. The interpretation emphasized the functional roles of proteins, carbohydrates, and lipids in influencing the snack bar’s texture, flavor, and overall acceptability.

Additionally, the sensory outcomes were integrated with relevant literature on legume-based snack development to support theoretical validation and ensure scientific relevance (Costa et al., 2020; Kim et al., 2022; Wani et al., 2022). This analytical framework allowed for a contextual understanding of how formulation ratios between red bean and soybean flours contribute to the sensory quality of the final product.

3. RESULTS AND DISCUSSION

The sensory characteristics of the red bean and soybean-based snack bars were evaluated qualitatively based on color, texture, aroma, and taste. Observations revealed distinct variations among the three formulations due to differences in the proportions of red bean flour and soybean flour. These results are summarized in Table 2.

Attribute	F1 (90:60)	F2 (80:70)	F3 (70:80)
Color	Dark reddish brown; uniform appearance	Light brown; most appealing color	Pale yellowish brown; slightly oily surface
Texture	Dense and slightly hard	Compact, soft, and chewy	Softer and slightly greasy
Aroma	Mild nutty with red bean notes	Balanced roasted aroma	Pronounced beany aroma from soybeans
Taste	Sweet and mild with bean flavor	Harmonious sweet and nutty flavor	Savory and slightly bitter aftertaste

Table 2 Qualitative sensory characteristics of red bean and soybean based snack bar formulations

3.1 Color

Color is the main visual attribute that determines initial consumer acceptance and is an indicator of chemical reactions during baking. Observations of this color parameter were conducted qualitatively and descriptively through direct visual observation to identify differences in hue between formulations comparatively, in order to maintain methodological consistency in observational studies.

The results of the observation showed a clear color gradation, moving from dark reddish brown in Formulation 1 (90g red beans: 60g soybeans) to a lighter yellowish brown in Formulation 3 (70g red beans: 80g soybeans). Formulation 2 (80g red beans: 70g soybeans) produced a golden brown color that was considered the most appealing. Scientifically, the formation of dark colors in red bean-dominant formulations (F1) was caused by complex interactions between natural pigments and non-enzymatic browning reactions. Red bean flour has a high carbohydrate (starch) and protein content, where when baked, the reducing sugars from the hydrolyzed starch react with the free amino groups from the protein through the Maillard reaction, producing a brown pigment polymer called melanoidin (Putri Dewi & Mastina, 2025). Additionally, red bean skins contain anthocyanins that give a dark red hue and tend to become more intense when exposed to high temperatures (Fahira et al., 2022).

In contrast, the lighter color in Formulation 3 (F3) is due to the high proportion of soybean flour, which has a yellowish isoflavone base pigment (Alwi et al., 2021). The high fat content in soybeans also limits direct heat access to proteins, thereby slightly inhibiting the intensity of the Maillard reaction compared to high-starch-based products (Wulandari & Prambandita, 2024). Formulation 2 (F2) is considered to have the best color because this balanced ratio allows for the formation of a golden brown color that indicates optimal maturity without any signs of charring.

3.2. Texture

Texture plays a crucial role in determining the mouthfeel of snack bars. Texture evaluation in this study was conducted by trained panelists using specific descriptive terminology to explore the physical characteristics of the product in depth.

The results of the analysis show that an increase in soybean flour substitution correlates directly with the softness of the product's texture. Formulation 1 (F1) produced the hardest texture due to the high amylose content in red bean starch, which underwent retrogradation (recrystallization) after cooling, forming a rigid structure (Putri Dewi & Mastina, 2025; JIPANG, 2025). Conversely, Formulation 3 (F3) tends to be softer due to the role of soybean fat as a shortening agent that lubricates the gluten

structure or starch matrix (Alwi et al., 2021). Formulation 2 (F2) produced a texture described as ideal. The term ideal in this context refers to general sensory preferences for the snack bar category, namely having sufficient density so that it does not crumble easily but remains chewy when chewed, rather than a universal standard. In F2, red bean starch provides a sturdy structural framework, while soybean fat provides the right amount of softness.

3.3. Aroma

The aroma profile of the product is dominated by the interaction between the natural aroma of the raw materials and the volatile compounds resulting from baking. The main challenge in using soybean flour is the beany flavor, which is quite strong in Formulation 3. In contrast, Formulation 1 is dominated by a nutty aroma, and Formulation 2 produces a harmonious baked aroma.

The beany flavor in products with a high soybean content (F3) is caused by enzymatic activity. The lipoxygenase enzyme naturally present in soybeans catalyzes the oxidation of polyunsaturated fatty acids, producing volatile compounds such as hexanal and hexanol, which are responsible for the beany flavor (Dewi et al., 2022; Alwi et al., 2021). Although the roasting process can inactivate some of the enzymes, the high concentration of soybean flour still leaves an aftertaste of this aroma.

In Formulation 2, an effective masking phenomenon occurs. The pleasant roasted aroma (roasted nutty flavor) produced by the Maillard reaction in red bean flour is able to mask the lingering rancid aroma of soybeans. Heat treatment of red beans is known to increase the release of preferred aromatic pyrazine compounds (Fahira et al., 2022). Thus, F2 offers the most balanced aroma profile: sufficiently nutty to stimulate the appetite, yet free from the pungent off-flavor.

3.4. Taste

Flavor is the most complex hedonic parameter. Organoleptic results show a shift in flavor profile from predominantly sweet in F1 to intensely savory in F3. This savory flavor is associated with high levels of glutamate and aspartate amino acids in soy protein (Putri Dewi & Mastina, 2025). However, the excessive soybean concentration in F3 tends to produce a bitter taste if not balanced with sufficient sweeteners.

Formulation 2 successfully created optimal flavor synergy, where the complex carbohydrates in red beans provided a natural sweetness that balanced the savory taste of soy protein. The right proportion of ingredients is crucial to prevent the dominance of one flavor that is off-flavor (Alwi et al., 2021). The flavor balance in F2 indicates that this formulation has the potential for good acceptance if further developed and tested on a wider range of consumers, considering that quantitative hedonic testing was not conducted at this stage.

3.5. Interpretasi

Based on the synthesis of all organoleptic parameters, Formula 2 (80 g red beans : 70 g soybeans) was determined to be the best formulation because it successfully balanced the physicochemical characteristics between the raw materials.

Functionally, the selection of F2 as the best formulation was supported by a literature review that showed its potential nutritional value. Based on theoretical studies, legume-based snack bars rich in protein, fiber, and iron theoretically have the potential to support health, such as helping to improve the menstrual cycle and prevent anemia (Putri Dewi & Mastina, 2025; Dewi et al., 2022). Additionally, formulations with high nutrient density are crucial in the development of healthy snacks (Wulandari & Prambandita, 2024). Thus, Formulation 2 represents a composition capable of maintaining the potential of macro and micro nutrients for optimal health benefits based on existing theoretical foundations.

4. CONCLUSIONS

This study concludes that local food diversification based on red bean flour and soybean flour can be formulated into snack bar products with balanced sensory characteristics. The most significant finding of this study was the discovery of a physicochemical equilibrium point in Formulation 2 (ratio of 80 g red beans : 70 g soybeans), which proved capable of overcoming the main obstacles in legume-based products, namely overly hard texture due to starch retrogradation and a beany flavor due to enzymatic oxidation, without eliminating the distinctive characteristics of the raw materials.

The main contribution of this research lies in the development of a formulation that successfully synergizes the macronutrient profile to create harmonious organoleptic characteristics (golden brown color, chewy texture, and savory-sweet taste). The implications of these findings offer a strong theoretical basis for the development of functional foods for adolescent nutritional intervention, where Formulation 2 has the potential to be further developed as a well-accepted natural source of vitamin B complex.

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