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Acceptability and Iron Content of Beanka Crackers (Mung Bean Crackers and Kale Leaf Powder) Potential for Anemia Prevention in Adolescent Girls

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ABSTRACT

Iron deficiency anemia is a nutritional problem often affecting adolescent girls, leading to decreased concentration, fatigue, and developmental disorders. This study aimed to evaluate the acceptability and iron content of Beanka Crackers as an alternative nutritious snack for anemia prevention. An experimental design with three formulations was used: BKC0 (75 g wheat flour), BKC1 (45 g wheat flour, 25 g mung bean flour, 5 g kale leaf powder), and BKC2 (30 g wheat flour, 35 g mung bean flour, 10 g kale leaf powder). Acceptability was tested with 30 panelists using a hedonic scale to assess color, taste, aroma, and texture. Iron content was analyzed with Atomic Absorption Spectroscopy (AAS). Data were evaluated using the Kruskal-Wallis and Mann-Whitney tests. Results showed significant differences ($p < 0.05$) in color, taste, and texture, but not aroma. BKC1 achieved the highest overall acceptability (3.84) and texture score (4.07), compared with BKC0 and BKC2. BKC1 also contained the highest iron concentration at 0.0457 mg/g. In conclusion, BKC1 demonstrated the best acceptability and potential as an iron-rich snack for adolescents. Further product refinement is recommended to enhance sensory quality and strengthen its application as a functional food for anemia prevention.

INTRODUCTION

Iron deficiency anemia is one of the most serious health problems globally, especially among adolescent girls aged 10 to 19, characterized by low levels of hemoglobin in the blood1[1]. In the short term, anemia can weaken the immune system, reduce physical ability, and disrupt metabolism, making it easy to get sick, feel tired, lethargic, and have difficulty concentrating [2]. In the long term, anemia can decrease the ability to work and function of the brain, resulting in reduced productivity and academic potential [3].

Based on statistical data from the World Health Organization (WHO) in 2021, the incidence of anemia in women aged 15 to 49 years worldwide reached 29.9% in 2019 [4]. In Indonesia, the prevalence of anemia in women aged 15 to 29 years is recorded at 15.5% based on 2023 data [5]. Although the prevalence of anemia in women aged 15-29 years shows a decrease compared to the 2018 Riskesdas data which recorded a figure of 32% [6], while in the age group of 15-24 years, the incidence rate of anemia in East Java Province is still relatively high, with 42% of adolescent girls reported to have anemia [7].

The main cause of anemia in adolescent girls is *Iron Deficiency Anemia* (IDA) deficiency. The high prevalence of anemia in adolescent girls is influenced by various factors, including low iron intake, inefficient iron absorption, blood loss due to menstruation, and increased iron needs during the growth period [8,9]. Symptoms of anemia in adolescent girls are generally characterized by easy weakness and fatigue, pale face, frequent dizziness or headaches, and shortness of breath when performing light activities [10]. In addition, complaints can arise such as heart palpitations, difficulty concentrating, cold hands and feet, and brittle nails [11,12]. Anemia in adolescent girls can cause several side effects, such as decreased productivity of cognitive function, development, and increased susceptibility to infectious diseases [13,14].

Efforts to prevent anemia in adolescent girls can be done through feeding foods high in iron [9]. Research shows that mung bean drinks with inulin can support the effectiveness of iron [15] tablets. In addition, other studies have shown that boba made from katuk leaves and mung beans also has the potential to be a healthy snack for adolescents with anemia [16]. In addition, fresh kale leaves contain 1.6 mg of iron per 100 grams [17], and kale leaf powder has a higher content, which is 10.6 mg per 100 grams [18] With its high iron content, kale leaf powder offers potential for functional food development. Therefore, this study aimed to evaluate the acceptability and iron content of Beanka Crackers formulated with mung bean flour and kale leaf powder as an alternative iron-rich snack to prevent anemia in adolescent girls.

MATERIALS AND METHODS

This study employed an experimental design with three formulations of Beanka Crackers, namely BKC0 (control) consisting of 75 g of wheat flour, BKC1 with a composition of wheat flour, mung beans, and kale leaf powder in a ratio of 45:25:5, and BKC2 with a ratio of 30:35:10. Two types of tests were carried out in this study: a subjective acceptability test and an objective iron content test. The acceptability test involved 30 untrained female adolescent panelists who evaluated the color, taste, aroma, and texture of the product using a 5-point hedonic scale, while the iron content was analyzed using the Atomic Absorption Spectroscopy (AAS) method. Panelists were selected based on inclusion criteria, namely healthy individuals aged 18–25 years who were willing to participate and able to consume the product, while exclusion criteria included allergies to wheat, mung beans, or kale, smoking or consuming strong-flavored food or beverages within 30 minutes before the test, the use of strong fragrances, and illness during the test.

The research was conducted between January and May 2025, with product processing and acceptability tests carried out at the Nutrition Laboratory of Poltekkes Kemenkes Surabaya, and iron content analysis performed at the Energy and Environment Laboratory, Institut Teknologi Sepuluh

Nopember (ITS) Surabaya. Ethical approval was obtained from the Health Research Ethics Committee of Poltekkes Kemenkes Surabaya, and all procedures were conducted in accordance with ethical standards. Data from the acceptability test were analyzed using the Kruskal–Wallis test followed by the Mann–Whitney test for post-hoc comparisons, while the results of iron content analysis were presented descriptively based on AAS measurements. All statistical analyses were performed using SPSS software with a significance level of $\alpha = 0.05$.

RESULT

Table 1. Beanka Crackers Formulation

Indicator	Flour	Mung Bean	Kale Leaf Powder
BKC0	75 gram	-	-
BKC1	45 gram	25 gram	5 gram
BKC2	30 gram	35 gram	10 gram

Source: Primary Data, 2025

There are 3 formulations of Beanka Crackers, in the BKC0 formulation only 75 grams of wheat flour is used. The BKC1 and BKC2 formulations use a combination of all three ingredients (wheat flour, mung beans, and kale leaf powder) but with different ratios. BKC2 formulations tend to have more mung beans and kale leaf powder compared to BKC3, which has more mung beans and kale leaf powder.

Table 2. Characteristics of Beanka Crackers

Indicator	Formula		
	BKC0	BKC1	BKC2
Color	Yellowish brown	Greenish brown	Greenish brown
Taste	salty and savory from milk and butter	salty and savory from milk, butter, and kale powder	salty with a slight bitterness from kale powder
Aroma	milky and buttery	slight aroma of kale powder	strong aroma of kale powder
Texture	dense and crunchy	crisp and crunchy	crisp and crunchy

Source: Primary Data, 2025

Based on the characteristics of Beanka Crackers, there is a significant difference in the characteristics of each indicator. In terms of color, BKC0 has a yellowish brown appearance, while BKC1 and BKC2 show a greenish brown color due to the addition of kale leaf powder. The aroma in BKC0 is dominated by the salty and savory flavors that come from milk and butter. In BKC1, the savory aroma is still felt, but the light aroma of kale leaf powder begins to appear. In contrast to BKC2, the aroma is stronger and more pungent, with a slight bitterness from the more widely used kale leaves. In terms of taste, BKC0 gives a milky and buttery taste, while BKC1 has started to show the distinctive taste of kale powder. The BKC2 formulation has a slightly bitter taste due to the addition of kale leaf powder. BKC0 has a dense and crispy texture, while BKC1 and BKC2 have a crisp and

crunchy texture that is likely influenced by the combination of mung beans and kale leaf powder in the dough.

Table 3. Beanka Crackers Acceptability Test Score

Indicator	Formula		
	BKC0	BKC1	BKC2
Color	4.27	3.93	3.67
Taste	3.80	3.73	3.27
Aroma	3.83	3.63	3.40
Texture	3.07	4.07	3.80
Total	14.97	15.36	14.14
Mean	3,74	3.84	3.53

Source: Primary Data, 2025

Based on the table of Beanka Crackers acceptability test scores, it shows the results of panelists' assessments of four indicators, namely color, taste, aroma, and texture, in three product formulations, BKC0 (control), BKC1, and BKC2. Based on the results of the acceptability test, the BKC1 formulation obtained the highest average score of 3.84, compared to BKC0 (3.74) and BKC2 (3.53). The highest score on BKC1 was on the texture indicator with a score of 4.07, indicating that the panelists preferred the texture of crackers in this formulation over the other two formulations.

Table 4. Kruskal-Wallis Test Results

No.	Indicator	Kruskal-Wallis Test Value
1.	Color	0.022
2.	Taste	0.039
3.	Aroma	0.098
4.	Tekstur	0.000

Source: Primary Data, 2025

Based on the Kruskal-Wallis test results table, significant differences in color, taste, and texture between BKC0, BKC1, and BKC2 formulations are shown, but not in aroma. The colors of BKC1 and BKC2 appear darker due to the addition of green beans and kale leaf powder, in contrast to the lighter colors of BKC0. BKC0 has a neutral flavor of milk and butter, while BKC1 and BKC2 show a more complex flavor due to the addition of mung beans and kale leaf powder. Apart from the addition of ingredients, there was no significant difference in the aroma. In terms of texture, BKC1 dan BKC2 tastes crispier than BKC0, which has a denser texture. Overall, the addition of mung beans and kale leaf powder significantly affects the indicators of color, aroma, texture, but does not significantly affect the aroma.

Table 5. Mann-Whitney Test Results

No	Indicator	Mann Whitney Test Scores		
		BKC0: BKC1	BKC0: BKC2	BKC1: BKC2
1.	Color	0,066	0,010	0,0255
2.	Taste	0,0541	0,017	0,059
3.	Aroma	0,191	0,041	0,304
4.	Tekstur	0,000	0,002	0,119

Source: Primary Data, 2025

Based on the table of Mann-Whitney test results, significant differences were found in several acceptability indicators between the formulations of Beanka Crackers. For color indicators, there were statistically significant differences between BKC0 and BKC2 formulations (p = 0.010), as well as between BKC1 and BKC2 (p = 0.0255), suggesting that the addition of higher amounts of kale leaf powder in BKC2 affected panelists' color perception. For taste, only BKC0 and BKC2 showed a significant difference (p = 0.017), while the rest of the comparison showed no significant difference. In the aroma indicator, only significant differences occurred between BKC0 and BKC2 (p = 0.041), which suggests that aroma was also affected by the addition of higher amounts of ingredients. Meanwhile, the texture indicator showed a very significant difference between BKC0 and BKC1 (p = 0.000) and BKC0 and BKC2 (p = 0.002), but no significant difference between BKC1 and BKC2. The results of this study show that the addition of mung beans and kale leaf powder can significantly affect sensory characteristics, especially texture, and BKC1 formulations are the most preferred formulations.

Table 6. Iron Content Test Results of Beanka Crackers

Formula	Fe (mg / g)
BKC0	0,0421
BKC1	0,0457

Source: Primary Data, 2025

Based on the results of the iron content test, it is known that the BKC1 formulation has a higher iron (Fe) content compared to the BKC0 formulation. In the BKC0 (control) formulation, the iron content was 0.0421 mg/g, while in the BKC1 formulation containing additional mung beans and kale leaf powder, the iron content increased to 0.0457 mg/g.

DISCUSSION

The results of the acceptance test showed that the BKC1 formulation was the most acceptable to the panelists. BKC1 obtained the highest average score (3.84) compared to BKC0 (3.74) and BKC2 (3.53), with texture being the most preferred attribute (4.07). This indicates that the addition of 25 g of mung beans and 5 g of kale leaf powder produced the most desirable texture, characterized by greater crispiness and a balanced structure. In contrast, BKC2, which contained higher proportions

of mung beans and kale leaf powder, showed lower acceptability scores, particularly in taste and aroma. The stronger, slightly bitter aftertaste of kale powder and its earthy aroma may have reduced panelists' preference. Meanwhile, BKC0, the control formulation with only wheat flour, had a lighter color and a more neutral flavor but lacked the nutritional advantage of added ingredients. These differences indicate that formulation directly influences both sensory and nutritional characteristics of the product.

The Kruskal–Wallis test results confirmed significant differences in color ($p = 0.022$), taste ($p = 0.039$), and texture ($p = 0.000$), while aroma showed no significant difference ($p = 0.098$). The lighter appearance of BKC0 may be attributed to the dominance of refined wheat flour, which results in a paler product. In contrast, the addition of mung beans and kale leaf powder in BKC1 and BKC2 produced a slightly darker greenish-brown color due to natural pigments such as chlorophyll from kale and polyphenols from mung beans. The significant differences in taste were mainly associated with the more pronounced flavor of kale powder in BKC2, which tended to overpower the product, while BKC1 maintained a more balanced profile. Texture differences were most notable, with BKC1 achieving higher crispiness as mung beans contributed starch and protein that interacted with gluten to create a desirable crunchy structure. Aroma differences were less noticeable because the predominant aromas came from basic ingredients such as butter and milk, which contain volatile compounds like diacetyl and short-chain fatty acids that mask or balance the distinctive smell of mung beans and kale powder.

The Mann–Whitney test further revealed significant pairwise differences. BKC2 differed significantly in color from both BKC0 and BKC1, confirming the impact of kale powder addition on darker color perception. For flavor, only BKC0 and BKC2 were significantly different, highlighting the stronger kale flavor in BKC2. Texture differences were observed between BKC0 and both BKC1 and BKC2, while no significant difference was found between BKC1 and BKC2, suggesting that mung beans and kale powder contributed similarly to increased crispiness. Aroma differences were only significant between BKC0 and BKC2, likely due to the higher kale content in BKC2. Overall, these findings suggest that the addition of mung beans and kale leaf powder significantly affects color, taste, and texture, while aroma remains less affected.

The results of the iron content test using the Atomic Absorption Spectroscopy (AAS) method showed that BKC1 contained 0.0457 mg/g of iron, slightly higher than BKC0 (0.0421 mg/g). Although the difference was relatively small, it confirmed that the addition of mung beans and kale leaf powder contributed to iron enrichment. Mung beans are known as a source of plant-based iron, containing about 7.5 mg/100 grams [of 20]. In addition, mung beans contain vitamin C, which serves to help increase the absorption of non-heme iron in the body [21,22]. Meanwhile, kale leaves in powder form containing 10.6 mg/100 grams of iron also contribute to iron intake [18]. The findings in this study support the

results of previous studies that showed that supplementation with mung beans can increase the iron content of food products[by 23–25]. Therefore, the combination of mung beans and kale leaves in the formulation can be considered an effective approach to enrich food products with iron.

Based on these results, it can be concluded that H0 was rejected, meaning that the addition of mung beans and kale leaf powder significantly affected both sensory properties and iron levels of Beanka Crackers. The BKC1 formulation was proven to be the most optimal, combining the highest acceptability with increased iron levels. Considering that adolescent women need 15 mg of iron per day. If one serving of snacks can meet 10% of the daily requirement, then about 1.5 mg of iron [26] is needed. Beanka Crackers (BKC1) can contribute effectively. With approximately 1.59 mg of iron in 7 pieces (35 g), this product meets the target and may serve as a functional food alternative for anemia prevention.

Despite these promising results, potential biases in this study should be noted. The acceptability test relied on subjective evaluation from untrained adolescent female panelists, which may not fully represent broader consumer preferences. In addition, sensory perception can be influenced by individual cultural and dietary backgrounds, potentially affecting panelists' judgment. Another source of bias is the lack of randomization in sample presentation order, which could have influenced scoring through panelist fatigue or adaptation.

This study also has several limitations. The analysis was limited to sensory attributes and iron content, without evaluating other nutritional components such as protein, fiber, or bioavailability of iron. The study was conducted on a relatively small sample of 30 panelists, all within the same age group and gender, which may limit the generalizability of findings. Furthermore, the research did not assess the long-term stability of crackers or consumer acceptance under real market conditions. Future research should include a more diverse panel, larger sample size, and additional analyses of nutrient bioavailability to strengthen the evidence for Beanka Crackers as a functional food.

CONCLUSIONS

Based on a study of Beanka Crackers with the addition of mung beans and kale leaf powder for the prevention of anemia in adolescent girls, the BKC1 formulation showed the highest level of preference with an average value of 3.84 in all sensory aspects. Statistical analysis showed significant differences in color, taste, and texture, but not in aroma, confirming that BKC1 was the most preferred formulation. In addition, the iron level in BKC1 was recorded at 0.0457 mg/g, higher than BKC0 which was only 0.0421 mg/g. These findings support the development of locally-sourced, iron-rich snacks to help combat adolescent anemia in Indonesia. For practical application, adolescent girls need 15 mg of iron per day. If one serving of snack fulfills 10% of the daily requirement, then about 1.5 mg of iron is needed. The BKC1 formulation is able to achieve this, as 7 pieces (35 g) contain about 1.59

mg of iron. Researchers are advised to focus further development on enhancing aroma and taste, and incorporating other nutrient-rich ingredients. Institutions are encouraged to promote Beanka Crackers as a local nutritional intervention.

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