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Snack bar formulation with beetroot (*Beta vulgaris. L*) flour as iron sources for adolescent girls

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ABSTRAK

Latar Belakang: *Prevalensi anemia di Indonesia pada remaja putri meningkat dari 37.1% menurut Riskesdas 2013 menjadi 48.9% pada tahun 2018. Snackbar merupakan cemilan yang digemari oleh remaja. Penambahan tepung umbi bit pada snackbar sebagai sumber zat besi diharapkan menjadi alternatif cemilan sehat bagi remaja putri.*
Tujuan: *Tujuan dari penelitian ini adalah untuk mengembangkan formula snack bar.*
Metode: *Penelitian ini menggunakan desain eksperimental. Formulasi terdiri atas dua tahap yaitu tahap pertama menentukan formula terbaik tanpa penambahan tepung umbi bit. Tahap kedua yaitu formulasi dengan penambahan tepung umbi bit dengan tiga taraf yang berbeda yang terdiri atas F1 40 gram, F2 50 gram, F3 60 gram. Analisis kandungan zat gizi dilakukan melalui uji proksimat dan spektrofotometri.*
Hasil: *Formula terbaik adalah F1 dengan penambahan tepung umbi bit sebanyak 40 gram. F1 mengandung 11,99% protein; 10,62% lemak; 53,04% karbohidrat; 4,76 mg zat besi (32% memenuhi AKG remaja putri dan 21,6% ALG kelompok umum), dengan total energi sebesar 355,75 kkal/100g.*
Kesimpulan: *Tepung umbi bit dapat digunakan untuk meningkatkan kandungan zat gizi snack bar, dimana dapat membantu memenuhi kebutuhan zat gizi remaja putri khususnya kebutuhan zat besi. Untuk penelitian selanjutnya, dapat ditambahkan pangan sumber protein hewani agar dapat meningkatkan penyerapan zat besi.*

KATA KUNCI*: remaja; snackbar; tepung; umbi bit; zat besi*

ABSTRACT

Background: *In Indonesia, the prevalence of anemia in adolescent girls increased from 37.1% (Riskesdas 2013) to 48.9% (Riskesdas 2018). A snack bar is one of the snacks favored by adolescents. The addition of beetroot flour as a source of iron to snack bars is expected to be an alternative healthy snack for adolescent girls.*
Objectives: *The objective of this study was to develop a snack bar formulation*
Methods: *This study used an experimental design. The snack bar was made in two stages. The first stage was to determine the best formula without adding beetroot flour, and the second stage was adding beetroot flour in the following amounts: 40 g (F1), 50 g (F2), and 60 g (F3). Analysis of nutrient content was carried out through the proximate test and spectrophotometry.*
Results: *The best formula was (F1), i.e., administering 40 g of beetroot flour. F1 contained 11.99% of protein, 10.62% of fat, 53.04% of carbohydrates, and 4.76 mg of iron (32% fulfilling Fe needed by adolescent girls based on the Dietary Reference Intake and 21.6% of the Reference Intake for the general category), with a total energy of 355.75 kcal/100 g.*
Conclusions: *Beetroot flour could be used to improve nutrient profiles of snack bars, which could be used to fulfill the nutrient needs of adolescents, especially for iron. For the next research, a new formulation is needed by adding animal protein sources to increase iron absorption.*

KEYWORDS*: adolescent; beetroot; flour; iron; snack bar*

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INTRODUCTION

Adolescence marks the period when children are transforming into adults. Several events signaling the transformation process are accelerated physical, mental, emotional, and social development experienced by young people aged above ten years old (1). In this life stage, nutritional and health statuses significantly contribute to successful health development in adolescents. Adolescent girls are susceptible to anemia (2). According to WHO, the prevalence of anemia in adolescent girls who live in developing countries is 27% (3). Meanwhile, in Indonesia, the prevalence increased from 37.1% (2013 Basic Health Research) to 48.9% (2018 Basic Health Research), and the proportion of patients with anemia is in the group between the age of 15-24 and 25-34 years old (4).

A factor that generates anemia in a population is a complex relationship between social, political, ecological, and biological factors (5). As suggested by Agragawal, anemia is mainly induced by nutrition and infections (6). A poor nutritional status also aggravates an iron-lacking condition, especially when regarding a lack of folic acid, vitamin A, or B12 (7).

A snack bar is a cereal- or nut-based snack in a bar form. In this research, our snack bar is made from red bean and soybean flour. The two staple ingredients are used as substitutes for wheat flour commonly used in making snack bars.

Red beans are a source of vegetable protein. When 100 grams of wheat flour contain 10 g of protein and 22 mg of calcium, red beans contain higher protein and calcium content, i.e., 22.3 g and 502 mg, respectively. Red beans contain a better protein, namely leucine of 76.16 mg (8). Protein is important in iron absorption. Soybean flour contains 8.4 grams/100 grams of iron. Soybeans, which contain 40.4 grams/100 grams of protein, have the highest protein content of all beans (9).

Administering beetroot flour to a snack bar is expected to increase its nutrition content, especially iron. Beetroots are rich in vitamins A, B, and C and water. Additionally, beetroots contain carbohydrates, proteins, and fat contributing to body health. Nutrition in beetroots, as mentioned in the List of Ingredients (2017), is, eg, 108 mg of folic acid, 27 mg of phosphorus, 43 mg of vitamin C, 23 mg of magnesium, 9.6 mg of carbohydrates, and 1 mg of iron (10). Research conducted by Ikawati and Rokhana (2018) showed that consumption of beetroot can increase hemoglobin levels, which in Menstruating women usually have lower Hb levels (11), and also research conducted by Penggalih et al., 2021 showed that instant beet juice has the same effectiveness as commercial Fe tablets as anemia prevention for young women athletes (12). Therefore, researchers are interested in developing food formulations in other forms such as snack bars with the addition of beetroot

Snack bars are one of the snacks favored by adolescents. Administering beetroot flour is expected to be an alternative healthy snack for adolescent girls. Accordingly, it is noteworthy to carry out research on snack bar formulation with beetroot to produce snacks, hereinafter referred to as Kabita Snack Bar (KSB).

MATERIALS AND METHODS

The research design was experimental. Nutrition testing and sensory test are executed in the laboratory of PT. Saraswanti Indo Genetech (SIG) Bogor. The research was performed in two stages, namely introductory and advanced research stages. In the introductory research stage, we determined the best formula and in the advanced one, we produced KSB with beetroots administered in three different formulas. In the introductory research stage, we made three formulas, each of which had a different ratio of red bean flour and soy flour. One snack bar formula generated a mold of snack bar dough, which was equal to ten servings, as demonstrated in **Table 1**.

The determination of materials, quantities, and manufacturing processes in this study refer to research conducted by Janah (2017) (13). The advanced research stage was composed of several substages, which were the making of the formula, sensory test, and analysis of the selected KSB nutrition. We made three different formulas concerning the amount of beetroot flour administered. The formulas were F1 = 40 grams,

Table 1. The Preliminary Formulation of Kabita Snack Bar

Ingredient	Ingredient Weight (gram)		
	F1	F2	F3
Red bean flour	135	120	105
Soy bean flour	15	30	45
Margarine	25	25	25
Salt	4	4	4
Sugar	25	25	25
Honey	30	30	30
Pineapple jam	60	60	60
Peanuts	40	40	40
Dates	15	15	15
Water	81	81	81

F2 = 50 grams, and F3 = 60 grams. The snack bar formulation with beetroot flour is exhibited in **Table 2**.

Table 2. The Preliminary Formulation of KSB Administered with Beetroot Flour

Ingredient	Ingredient Weight (gram)		
Red bean flour	120	120	120
Soybean flour	30	30	30
Beetroot flour	40	50	60
Margarine	25	25	25
Salt	4	4	4
Sugar	25	25	25
Honey	30	30	30
Pineapple jam	60	60	60
Peanuts	40	40	40
Dates	15	15	15
Water	81	81	81

The first stage of making the snack bar was weighing the ingredients. The second stage was homogenizing dried ingredients, i.e., red bean flour, soybean flour, beetroot flour, honey, pineapple jam, peanuts, and dates. The third stage was homogenizing wet ingredients, namely oil, salt, and sugar. The fourth stage was mixing dried and wet ingredients and administering water. The fifth stage was molding the dough in a rectangular form using a mold. The last stage was baking the dough using an oven at 100°C for 40 minutes and increasing the temperature to 120°C for ten minutes. When cooked, the snack bar was released from the mold and left to proof at room temperature for 20 minutes.

The sensory test and nutrition analysis was performed on the snack bar administered with beetroot flour. The sensory test was undertaken by engaging two trained panelists using assessment indicators of appearance, flavor, color, aroma, texture, and form (the SNI 01-2891-1992 method, point 1.2).

The analysis of nutrition content was carried out through a proximate test and spectrophotometry. All tests were conducted in *Duplo* (twice). Nutrition contents analyzed were as follows:

1. Total energy (proximate calculation)
2. Energy from fat (proximate calculation)
3. Water content (SNI 01-2891-1992 (gravimetry))
4. Carbohydrate content (18-8-9 /MU/SMM-SIG)
5. Fat content (18-8-5/MU/SMM-SIG point 3.2.2 (Weibull))
6. Protein content (18-8-31/MU/SMM - SIG (Kjeltec))
7. Ash content (SNI 01-2891-1992, 6.1)
8. Iron content (18-13-1/MU/SMM-SIG (ICP OES))

Data were processed using SPSS Statistics 23. The ANOVA test was executed to analyze the difference in nutrition content between formulas. Nutrition content was presented in the form of the mean resulting from the two *Duplo* tests. The best KSB formula was determined through the consideration of the result of the sensory test and iron analysis.

RESULTS AND DISCUSSIONS

Snack Bar Formulation

We determined the best snack bar formula without beetroot flour administration. Based on the trial-and-error test made, F2 was considered the best formula. The trial-and-error test was as follows: We used the original formula and the same baking process but substituted the main ingredient and dried fruits. From the activity, the product we made was too burnt. We then changed the baking duration. F3 had a dominant soybean flavor, which might be regarded as disturbing by consumers. F1 had a poor flavor combination and a slightly tough texture. Eventually, we selected F2 as the basic formula for the snack bar.

Sensory Test

A sensory test was a test to describe the sensory characteristics of a product. Product appearances, covering the product color, appearance, texture, and form, were the main considerations consumers took when choosing a product (14). The sensory test in this research was carried out in the SIG Laboratory and followed the SNI standards for sensory tests. Aspects assessed were aroma, color, appearance, flavor, texture, and form of the three formulas. The result of the sensory test is indicated in **Table 3**.

Table 3 The Result of KSB Sensory Test

Sensory Test	F1	F2	F3
Aroma	Normal	Normal	Normal
Color	Reddish brown	Reddish brown	Reddish brown
Appearance	Normal	Normal	Normal
Flavor	Sweet	Sweet	Sweet
Texture	Soft	Soft	Soft
Form	Solid	Solid	Solid

The result of the sensory test manifested that all formulas shared the same sensory properties. The three formulas produced a normal aroma which was not indicative of the aroma of fresh beetroots. The reddish-brown color was the effect of beetroots' color, i.e., dark red, and the sweet favor resulted from carbohydrates. The snack bars made from the three formulas had a soft texture and solid form, like any other snack bar.

Analysis of Nutrition Content

The KSB product was examined for its nutrition content through two analyses, namely proximate analysis and micronutrient analysis. The proximate analysis was executed to identify water, ash, fat, protein, and carbohydrate content. Meanwhile, the micronutrient analysis was performed to investigate iron content. The proximate and iron analyses were undertaken in *Duplo*/twice. Snack bar quality requirements refer to comparison data from commercial snack bar from PT Otsuka Amerta Indah (15) and SNI 01-4216-1996 regarding Quality Requirements for Weight Control Diet Food Body (16). **Table 4** points out the result of the analysis of the average KSB nutrient content.

Water content. Water content constituted the percentage of water that was contained by material and could be stated as wet weight (%bb) or dry weight (%bk). The water content of a food ingredient might influence its acceptability, freshness, and storability (17). The water content of a food ingredient or product might determine the ingredient or product texture and thereby influencing panelists' acceptability levels of the product texture (18). Based on the analysis result, KSB F2 with beetroot flour of 50 grams and F3 with beetroot flour of 60 grams did not showcase any significant difference in water content. However, KSB F2 with beetroot flour of 50 grams and F1 with beetroot flour of 40 grams showcased a significant difference in water content. F1 had the lowest water content, which was 20.5%bk.

Table 4 Kabita Snack Bar Nutrient Content

Nutrient	Content				
	F1	F2	F3	Commercial*	SNI 01-4216-1996**
Water (%bb)	20.50^{a}	23.18^{b}	22.55^{b}	11.40	-
Ash (%bb)	3.84^{a}	3.88^{b}	4.22^{b}	-	-
Fat (%bk)	20.50^{b}	8.9^{a}	11.30^{c}	20	1.4-14
Protein (%bk)	11.99^{a}	11.65^{a}	13.73^{b}	10	25-50
Carbohydrate (%bk)	53.04^{b}	51.88^{b}	48.23^{a}	-	-
Iron (mg/100 grams)	4.74^{c}	2.37^{b}	2.07^{a}	-	-
Total energy (kcal/100 grams)	355.74^{a}	334.35^{b}	349.60^{c}	140	120
Energy from fat (kcal/100 grams)	95.62^{a}	80.19^{b}	101.75^{c}	-	-

Description: The average scores on the same line and followed by the same letter show insignificantly different scores (Post Hoc Tukey test).

* PT. Otsuka Amerta Indah

** Badan Standarisasi Nasional

High water content might be the product of high water content in the staple materials, form, size, thickness, baking time, and temperature of the snack bar. Fatkurahman *et al*. (2012) explicated that the water content of a food product might be impacted by baking time and temperature (19). The water content of all formulas is higher than a commercial snack bar.

Ash content. Ash content made up an inorganic substance component in a food product and was used as the description of mineral content in a food product (17). F1, in this research, had the lowest ash content (3.84%bk). Furthermore, KSB F1 had significantly different ash content from KSB F2 and F3. When compared with the snack bar research by Janah, the ash content in this study was also higher (13). This might result from its high mineral content, e.g., calcium, magnesium, and iron.

Fat content. Fat content in a food product posed one of the energy sources for the body, and almost all foods contained fat (17). In this research, we used margarine and peanuts as fat sources. Fat functioned as an emulsifier, flavor enhancer, and texture giver to a product (18). In this research, all formulas showed significantly different fat content. F2 had the lowest fat content (8.9%bk), whereas F1 showed the highest one (20.5%bk). Fat content in F2 is lower than SNI and commercial snackbars. One of the roles of fat for young women is to reduce dysmenorrhea during menstruation and make the menstrual cycle more regular (20).

Protein content. Protein is one of the macronutrients of the body. The protein contained in food and consumed would be digested by protease enzymes within the digestive tract and transformed into its constituent units, i.e., amino acids (21). F3, in this research, had the highest protein content (13.73%bk). Protein content in all formulas is higher than commercial snack bars but lower than SNI. In this research, we used red bean flour, soy flour, and peanuts as protein sources. The role of protein in adolescents is important to support growth and development. Protein deficiency can lead to delayed growth, delayed sexual maturation, and reduced accumulation of lean body mass (22).

Carbohydrate content. Carbohydrates were substantive for living creatures. Carbohydrate compounds contributed 70-80% of energy sources to human activities. Carbohydrates constituted a compound comprising carbon, hydrogen, and oxygen elements found in nature (18). As illuminated by Winarno (2008), carbohydrates served as a determinant of the flavor, color, and texture of a food product (17). As demonstrated by the result, F1 had the highest carbohydrate content (53.04%bk). The high carbohydrate content might be yielded by several types of carbohydrate sources used, namely jam, sugar, honey, and dates. The ingredients, with high carbohydrates (glucose), contributed high carbohydrate content to the snack bar in this research. The carbohydrate content in all formulas was lower than the snack bar study with the addition of torbangun conducted by Janah (13) and the pumpkin snack bar study conducted by Perwita *et al.* (23). Carbohydrates are the main source of energy in food, as well as a source of dietary fiber.

Iron content. Iron made up one of the paramount micronutrient substances for adolescent girls. Iron is entailed for increasing the mass of erythrocytes and myoglobin demanded in muscle cell formation (24). Iron deficiency might breed anemia. The need for iron in adolescents, both girls, and boys, increases in line with rapid growth and increases in muscle mass and blood volume. Adolescent girls need more with the presence of menstruation (23). In this research, the iron source was beetroot flour. The three formulas had significantly different iron content. F1, with the least amount of beetroot flour, showed the highest iron content. The result was not aligned with the hypothesis, that the more the beetroot flour was administered, the higher the iron content. The condition might be brought about by iron damage during the cooking process in either F2 or F3. Iron content in KSB F1 was included in the category of iron sources claimed commensurate with BPOM (2016), which stated that food claimed as mineral sources posed that containing minerals at least 15% of the Reference Intake for the general category. The minimum iron content in food claimed as iron

sources were 3.9 mg (25). F1 had an iron content of 4.74 mg/100 grams and accordingly, catered to 32% of the Dietary Reference Intake for adolescent girls and 21.6% of the Reference Intake for the general category.

The weakness in this study is that organoleptic tests have not been carried out such as hedonic tests and hedonic quality tests using an assessment scale and the vitamin C content has not been tested to enhance iron absorption.

CONCLUSIONS AND RECOMMENDATIONS

The determination of the best formulation was contingent on nutrient assessment. The sensory test did not exhibit any difference between the three KSB formulas. We decided on the best formula from the nutrient analysis, which laid out that the formula bringing on the highest iron content but the lowest water content was the recommended one in this research. Iron content was considered pivotal as it addressed the prevalence of anemia in adolescents, who were suggested to consume iron-source food as the intervention. Besides, we also considered that water content was salient here because the lower the water content of a product, the longer the storability of the product.

The best formulation is hence F1, with beetroot flour of 40 grams. F1 had a water content of 20.5%bb, the protein content of 11.99%, fat content of 10.62%, carbohydrate content of 53.04%, iron content of 4.76 mg (fulfilling 32% of the Dietary Reference Intake for adolescent girls and 21.6% of the Reference Intake for the general category), and the total energy of 355.75 kcal/100 g. The iron content of KSB F1 could be claimed as an iron source commensurate with BPOM (2016), which stated that food claimed as a mineral source posed that containing minerals at least 15% of the Reference Intake for the general category, and the minimum iron content in food claimed as iron sources were 3.9 mg (25).

The next researcher may add animal protein sources to augment iron absorption and carry out organoleptic, hedonic, and hedonic quality tests using an assessment scale and test the vitamin C content.

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