Future of Food: Journal on Food, Agriculture and Society
10 (1) February 2022

The potential of red kidney beans and brown rice-based flakes for breakfast to reduce obesity

Dina Arafa Shabayek [1], Rimbawan Rimbawan [1*] AND Slamet Budijanto [2]

[1] Department of Community Nutrition, Faculty of Human Ecology, IPB University, Bogor 16680, Indonesia
[2] Department of Food Science and Technology, IPB University, Bogor 16680, Indonesia

* Corresponding author: rimbawan@apps.ipb.ac.id

Data of the article

First received : 05 August 2021 | Last revision received : 13 September 2021
Accepted : 11 January 2022 | Published online :15 February 2022
DOI : 10.17170/kobra-202110144903

Keywords

Breakfast meal; Brown rice; Flakes; Obesity; Red beans

The global epidemic of obesity has become one of the most important public health issues. It is predicted that by 2030, 38% of global adults will be overweight. One of the factors that cause obesity is skipping breakfast. Breakfast meal flakes are popular and ready-to-eat in several countries. However, the breakfast flakes on the market are high in carbohydrates, causing consumers to have a limited choice of breakfast products, especially for patients who suffer from obesity. The nature of the problem described above inspired the design of this research to produce and develop breakfast flakes made with brown rice and red kidney beans as the main ingredients to prevent obesity. The study was designed with four formulas (F1-F4) and five attributes. The results included the organoleptic data, total fat, SFAs, MUFAs, PUFAs, dietary fiber, and proximate analysis. Based on the organoleptic results, formula F4 had the highest hedonic score, and the nutritional content (F4) was contained (373.81 kcal per 100 g), whereas nutrients (moisture, ash, protein, carbohydrate, fat, and dietary fiber) were 9.68 % w/b, 6.43 % w/b, 23.57 % w/b, 52.67 % w/b, 7.65% w/b and 14.53 %w/b respectively. The ash content was high due to sodium content; therefore, reducing the salt in the formula will decrease sodium content. The ratio between ω-6 to ω-3 fatty acids in flakes F4 was 0.53 that may provide nutritional benefits. Furthermore, Fe, Ca, Na, and K content was 3.98 mg, 137.10 mg, 1381.64 mg, and 793.15 mg, respectively. Based on these results, no nutrition claims can be proposed to the F4 flakes due to their high sodium content. When reformulation is conducted to reduce the sodium content to be lower than 300 mg per serving size, the F4 flakes can be claimed as high protein and high fiber, which helps consumers feel full longer and may make it a weight loss-friendly food. It also contains essential minerals, including iron and potassium. In conclusion, red beans flakes are suitable for consumption as a breakfast meal and may be a good suggestion for preventing obesity.

1. Introduction

The global epidemic of obesity is growing at an unprecedented pace and has become one of the world's most important public health issues. It is predicted that by 2030, 38% of the world's adult population will be overweight without effective intervention (Wang et al., 2019). Several influences correlate with obesity and metabolic disorders, including genetics and physiological differences (gender and age), living environments, and habits (diet, stress, smoking, alcohol, and exercise). Obesity contributes to multiple metabolic conditions, such as pathologies linked with inflammation, cardiovascular diseases, hypertension, coronary problems, and diabetes mellitus (Wang *et al.,* 2019). To manage obesity, dietary changes and herbal solutions may be used to prevent their adverse effects, instead of medications. One of the main health care priorities is the prevention and management of chronic diseases, as it accounts for nearly 60% of all deaths worldwide (World Health Organization 2003). Accordingly, the nutritional process through some functional foods is an alternative and effective treatment for the delivery of some effective food components in the management of chronic diseases, specifically considering the high costs of health care in some countries, especially in developing countries (Gehan 2017).

Breakfast meal flakes (BMF) is a popular ready-to-eat breakfast food commonly consumed by children, school youth, andadults at breakfast and is served with liquid milk or Yoghurt (Nuriana *et al.,* 2019). Currently, existing breakfast food products are made from wheat, corn, millet, and rice, high in carbohydrates. This creates consumer limitations to breakfast choices, especially for individuals with obesity. One of the factors that cause overweight or obesity is skipping breakfast. This is because those who skip breakfast often succumb to eating junk food containing high carbohydrates content and fats like fried foods (Mishartina *et al.,* 2018). Data from the Indonesian Food and Drug Authority (BPOM 2016), showed that there are about 1,015 products that were officially registered with the keyword "grains" and only 67 products were officially registered with the keyword "flakes." Most of the grains and flakes listed are generally made of corn and wheat. However, it is still rare to find flakes made from legumes such as red beans. There is an important need to search for functional foods that have multiple health benefits, provide many different nutritional values, and reduce obesity (Abdulrashed *et al.,* 2016). In this study, we prepared nutritional breakfast flakes food with ingredients such as brown rice, red beans, chia seeds, and ginger as a functional food with nourishing properties targeted for reducing the risk of overweight and obesity.

Red beans are known as a plant protein source, which contains around 21- 27% per 100g with a low glycemic index value, namely 26, which is good for obesity and diabetes mellitus sufferers because the increase in sugar levels in the blood is slow, and peak sugar content is slow (Astuti *et al.,* 2019). Red kidney beans have a water-soluble fiber that can reduce cholesterol levels and blood sugar levels ((Mishartina *et al.,* 2018) and contain alpha-amylase and alpha-glucosidase inhibitory activity contributing to delayed digestion of carbohydrates (Riantiningtyas and Marliyati, 2017). Hence the selection of red beans is a good source of protein used as a ready-to-eat cereal or flakes (Rakhmawati *et al.,* 2014).

Brown rice contains many bioactive compounds and is an important source of dietary fiber and minerals, including the rare mineral selenium, which is instrumental in inducing DNA damage repair and the synthesis of damaged cells to promote apoptosis (Ravichanthiran *et al.,* 2018). Moreover, brown rice is rich in magnesium, which has a vital role in our bodies, as it acts as a cofactor for more than 300 enzymes. Brown rice also contains a high amount of dietary fiber; therefore, brown rice has a lower glycemic index than white rice. In addition, it has vitamin E, which is an antioxidant, aids DNA repair, immune support, and metabolic processes (Ravichanthiran *et al.,* 2018). Furthermore, brown rice flour is the finest and most nutritious cereal flour because it has many anti-allergic proteins and low calcium salts and does not contain gluten protein (Singh *t al.,* 2017). This study aimed to develop breakfast meals (flakes) with brown rice and red kidney beans as the main ingredients. Organoleptic and nutritional content analysis including total fat, SFAs, MUFAs, PUFAs, dietary fiber, and proximate analysis were conducted considering that consumption of the breakfast meals as part of a calorie-controlled diet.
Hypothesis: "Formulating a nutritionally balanced breakfast flakes food with the main ingredients brown rice and red kidney beans as a functional food in a dietary plan, with high protein and dietary fiber, with improved nutritional properties targeted to prevent the risk of overweight and obesity."

2. Material and Methods

Materials

In this study, dried red kidney beans (Phaseolus vulgaris L.), brown rice (Oryza Sativa L.), ginger, honey, table salt, coconut oil, chia seeds, and water were used as raw materials obtained from the local market in Bogor, West Java, Indonesia.
Materials and reagents used in this study include distilled water, hexane, concentrated sulfuric acid

(H_2SO_4), selenium mix, ion-free water, phosphate buffer nitric acid (HNO3), 30% NaOH, HCl (0.03 N; 0.1 M and 6 M), indicators methyl red, methylene blue, ethanol 78%, 95%, MES-TRIS (Buffer pH 8.2), alpha-amylase, protease, amyl glucosidase, filter paper, and acetone.

Methods

2.1. Raw Ingredients Preparation

Brown rice and red kidney beans were the main ingredients used to make the flakes. Red kidney beans were soaked in water at room temperature for 24 hours, with periodic replacement of the water every 12 hours, then washed with running water (Riantingtyas and Marliyati 2017). This step was followed by drying for 15-20 minutes, then followed by a peeling process aimed at reducing the coagulation of the flour (Akaerue and Onwuka 2010), improving the appearance, and decreasing flour density (Pangastuti *et al.,* 2013). The deshelled beans were dried in an oven at 60°C for 12 hours. Next, a mixer and disk mill were used to ground the red kidney beans and then sieved them with 60 meshes, which resulted in the kidney beans flour. The same methods were used to obtain brown rice flour (Riantingtyas and Marliyati 2017).

Fresh ginger root was peeled, washed well, diced, and dried with a cabinet dryer for 8 hours at 50° C. The dried samples were ground using a commercial manual milling machine to produce a ginger powder which was stored in an airtight moisture-controlled cabinet (Wang *et al.,* 2019). The reason for using ginger powder is the availability of a crucial active ingredient in ginger called "shogol", which is produced more in dried ginger and has anti-cancer and anti-inflammatory effects (Wang *et al.,* 2019).

2.2. Production of flakes

Four different flake types (F1-F4) were made from four different ratios of brown rice flour to red kidney beans flour (70:30; 60:40; 50:50 and 40:60). Equal amounts of coconut oil, ginger powder, chia seeds, honey, and salt were added to each formula for obtaining four formulations of dough. Next, the dough was steamed for 3 minutes at 70 ° C using a steamer pan (Astuti *et al.,* 2019). After steaming, the dough was formed into a circle and flattened with a 0.5 mm thick noodle maker, cut into 1 cm x 1 cm slices, and placed on a tray, then roasted in the oven at 130°C for 13 minutes. The product was then cooled and stored in airtight polyethylene plastic containers (Riantingtyas and Marliyati 2017).

2.3. Sensory Evaluation

Thirty-four semi-trained panelists who participated in the sensory evaluation were students from the Department of Human Nutrition, IPB University, and consisted of both genders. They were instructed to evaluate four formulas regarding sensory characteristics such as color, taste, aroma, texture, and overall acceptability and then indicate the preference of the specified attributes by providing the appropriate number related to the hedonic scale. The rating scale used is a scale of 1 (lowest score) to 5 (highest score): (1) MOST DISLIKED, (2) DISLIKED, (3) NEUTRAL, (4) LIKE, (5) MOST LIKED. Assessment attributes used

Table 1. The composition of four formula

Ingredients	Formula			
	F1	F2	F3	F4
Brown rice (g)	98 (70%)	84 (60%)	70 (50%)	56 (40%)
Red bean (g)	42 (30%)	56 (40%)	70 (50%)	84 (60%)
Chia seeds (g)	7.5	7.5	7.5	7.5
Ginger powder (g)	2	2	2	2
Salt (g)	2	2	2	2
Honey (g)	15	15	15	15
Coconut oil (g)	7	7	7	7
Water (g)	70	70	70	70

in the hedonic test include color, aroma, taste, texture, and overall acceptability.

2.4. Chemical Analysis

Nutritional content analysis carried out on selected flakes included moisture content by vacuum oven, ash content using the gravimetric method, protein content analyzed by Kjeldahl method, fat content analyzed by Soxhlet method, and the determination of carbohydrates is carried out by the difference method (AOAC 2005), namely: 100% - (Moisture content + ash + protein + fat). The levels of dietary fiber were analyzed by the enzymatic gravimetric method. Fatty acid components were analyzed by Gas Chromatography (GC), and minerals analysis (Na, Ca, K, and Fe) were analyzed by using Atomic Absorption Spectrophotometer (AAS).

2.5. Analysis of the Nutritional contribution of flakes

According to BPOM (2016), the serving size is the amount of food product usually consumed in one meal. In this study, the percentage contribution of the nutritional content of flakes products was calculated by dividing the number of nutrients contained in one serving size flakes with each Nutrient Reference Values (NRVs). The serving size of the flakes is determined based on the average yield of suggestions for serving commercial products.

2.6. Statistical Analysis

Data were analyzed using Microsoft Excel 2010 computer program and the Statistical Program (SPSS), version 26.0 for the Windows operating system. Hedonic data was tested for normality using the Kolmogorov-Smirnov test ($p > 0.05$). The data from the organoleptic analysis used the Kruskal Wallis test because the data variables were not normally distributed. Then continued with the Mann Whitney difference test with a confidence level of 95% ($p \leq 0.05$).

3. Results

3.1. Sensory Evaluation Results

Thirty-four semi-trained panelists from IPB University's Department of Human Nutrition participated in the sensory evaluation, from both genders. Due to their prior sensory test experience, they could discriminate the food products tested. They were instructed to evaluate four formulas regarding sensory characteristics such as color, taste, aroma, texture, and overall acceptability and then indicate the intensity of the specified attributes by providing the appropriate number related to the five hedonic scales. The scale fits with the sensory test trait being measured, and the scale was chosen so that the distance between scale points gets closer to each other to measure the acceptability of the flakes product and the flakes preferences of panelists.

The hedonic test includes four formulas (F1, F2, F3, F4) with five attributes, color, aroma, taste, texture, and overall acceptance. Based on Table 4.1, there are significant differences between formulas on texture and taste attributes ($p<0.05$). The formula F4 had the highest average score for taste and overall criteria, so this was the best acceptable formula because F4 had better taste and overall acceptance than F2, F3, and F1.

Color and taste are important factors in the acceptance of a food product. Color is the number one sensory attribute that consumers see. Therefore, product preference is influenced by color. The hedonic test results showed no significant difference ($p > 0.05$) between F1, F2, F3, and F4, although F3 (3.88) received the highest color preference. The preference of the brownish-yellow color of these products is determined by the additives of brown rice and red beans flour. The Kruskal Wallis test results plus the Mann Whitney test showed a significant difference in the taste attributes of flakes formulas ($p <0.05$). Usually, red beans flour has a strong, distinctive taste caused by the presence of the lipoxygenase enzyme, which naturally gives the nuts a special aroma (Pertiwi *et al.,* 2017).

However, in this study, the red beans used were dry, so the unpleasant taste was not too strong. Roasting can enhance sensory properties and improve the taste of foodstuffs (Fellows 2000). Based on the results F4, has the highest value, namely 3.61. The differences in taste of each formula were due to the different proportions of red beans flour and brown rice. The greater proportion of brown rice caused the taste to

ISSN-Internet 2197-411x OLCL 862804632

Table 2. Hedonic test statistical analysis results

Formula	Brown rice flour	Red beans flour	Aroma	Color	Taste*	Texture*	*Overall*
F1	70%	30%	3.58±0.82 [a]	3.58 ±0.82 [a]	3.08 ± **0.75**[a]	2.94 ±0.88[a]	3.29±0.67 [a]
F2	60%	40%	3.42±**0.56** [a]	3.79±**0.76** [a]	3.23±**0.78**[a]	3.88±**0.76**[b]	3.55±**0.65** [a]
F3	50%	50%	3.44±**0.66** [a]	3.88±**0.76** [a]	3.17±**0.86**[ab]	3.14±**0.89**[a]	3.44±0.78 [a]
F4	40%	60%	3.47±**0.56** [a]	3.5±**0.70** [a]	3.61±**0.77**[ab]	3.70±**0.83**[b]	3.61±0.77 [a]

* The sensory attribute based on the Kruskal Wallis test, p-value is significant if <0.05. The notation a, b = different test results based on the Mann Whitney continued test between formulas. Different letters in the column indicate significant differences (p <0.05). The rating scale used is a scale of 1 to 5: (1), MOST DISLIKED (2), DISLIKED (3), NEUTRAL (4), LIKE (5) MOST LIKED.

be less favorable to the panelists. This can be seen in the result of the taste attribute, which differs greatly between F4 (40:60) compared to other formulas.

Aroma caused by the food ingredients determines the properties and satisfaction of these foods. In this study, the red beans used were dry. Therefore the unpleasant aroma of red beans, usually caused by the presence of lipoxygenase enzyme, was not too strong. The classification test results on the aroma attribute showed the difference in the formula has no significant effect on the panelists' preference scores (p> 0.05), although sample F1 has the most liked aroma value (3.58) followed by F4 (3.47), F3 (3.44), and F2 (3.42).

Similarly, flakes products' texture recommends that it be crispy but not easily damaged with water or milk. Kruskal Wallis test results continued with the Mann Whitney test results showed that the flakes difference in composition has a significant effect on the panelists' preference scores of the texture attribute of the flakes (p <0.05). Flakes formula, F2 received the highest preference value (3.88), followed by F4 (3.70), F3 (3.14), and F1 (2.94). F2 and F4 have a very crispy texture compared to F1 and F3, due to the additional effect of a greater proportion of red bean flour. This is probably because of the texture factor of dry kidney beans, which is hard and crispy (Kurnianingtyas *et al.*, 2014).

The texture of red beans can be attributed to the starch (amylose and amylopectin) content, as amylose and amylopectin play a role in the formation of gelatinization, causing a crispy texture (Rohmah 2013).

Based on the overall acceptability results, F4 (40%: 60%) scored the highest. We attributed the panelists' level of preference of F4 over other flakes products to its higher composition of red beans flour. The trend with other flakes also showed that the more red beans added, the greater the choice value for the flakes product. This indicates that the addition of red bean flour influences the level of preference of panelists over flakes products. The more red beans added, the greater the value of preference for the flakes product. This can be seen in the results of adding red bean flour with Formula F4 (3.61), which resulted in a higher level of preference for panelists compared to F2 (3.55), F3 (3.44), and F1 (3.29).

3.2. Nutritional Content of Selected Flakes (F4)

The results in Table 3 show the contents of energy, moisture, ash, protein, carbohydrates, and fat in F4 were compared with SNI (Indonesian National Standard). Based on the results, the energy value of F4 flakes was 373.81 kcal per 100 g. Carbohydrates contributed 56 % of the total energy and 52.67% of the total weight. The SNI requires at least 60% of carbohydrates to be present in the product. The main source of carbohydrates in F4 flakes was brown rice flour. The moisture content value of the F4 flakes was 9.68% wet basis. This value was higher than the maximum value of SNI that is 3.0% but also is a slightly higher moisture content requirement for high-grade grains than (4%-8%), based on Nielsen (2010). The high moisture content could be due to protein content found in red beans, which have functional binding properties and water holding capacity, and most of the red beans' fiber content can absorb more moisture (Pangastuti et al.,2013). This may increase the water activity. Hence, it is recommended to control the water activity to prevent spoilage and maintain shelf life and food quality.

In this study, the primary sources of the fat content of the F4 flakes are derived from coconut oil and chia seeds. This study showed that the fat content of F4 flakes was 7.65 % wet basis. These levels met the standards set for Cereal products according to SNI (7. 0%). The protein content of F4 flakes was 23.57 % wet basis, andthe high protein value is due to the addition of red kidney beans as a source of protein, which is around 21-27% per 100 g of material (Astuti *et al.,* 2019). The protein in red kidney beans may lower cholesterol and LDL (low-density protein) and increase HDL (high-density protein) cholesterol levels (Rakhmawati *et al.,* 2014). The ash content of the F4 flake was 6.43 % wet basis. The high percentage of ash indicates that the product is possibly rich in minerals, maybe because of brown rice, chia seeds, ginger, and kidney beans which contain several minerals that can increase mineral content (Agustina *et al.,* 2013).

The F4 flakes product analysis results showed a total dietary fiber content of 14.53 % wet bases. Based on the Indonesian Food and Drug Authority (BPOM 2016) and the European Food Safety Authority (EFSA 2008), processed food can claim high fiber if it contains at least 6 g per 100 g. Therefore, F4 flakes can be classified as high-fiber nutritional products. Previous studies have shown that consumption > 25 g/day of fiber helps prevent the risk of obesity by maintaining the stability of lipids in the blood, slowing the absorption of fats from the small intestine, and increasing satiety. Additionally, it reduces the secretion of the hormone ghrelin. Hence, consuming high-fiber flakes with low caloric energy can prevent obesity (Nelson *et al.,* 2009).

Table 3. Nutritional content of selected flakes (F4)

Nutrients (100 g)	Result of proximate analysis	
	(%WB)	SNI (%WB)
Energy (Kcal)	373.81	
Protein	23.57	Min. 5.0
Fat	7.65	Min. 7.0
Carbohydrate	52.67	Min. 60.0
Moisture	9.68	Max. 3.0
Ash	6.43	Max. 4.0
Calcium (mg)	137.10	
Sodium (mg)	1381.64	
Potassium (mg)	793.15	
Iron (mg)	3.98	
Fiber	14.525	

ISSN-Internet 2197-411x OLCL 862804632

3.3. The Fatty acid content of F4 flakes (fatty acid profile)

The fatty acid composition of F4 flakes has been analyzed, and thirteen fatty acids have been found, as can be seen in Table 4, consisting of eight saturated fatty acids (SFA), three monounsaturated fatty acids (MUFAs), and two polyunsaturated fatty acids (PUFAs). The essential fatty acids in humans are ω-3 (omega 3) PUFA, alpha-linolenic acid (ALA) and ω-6 (omega 6) PUFA, linoleic acid (LA). Generally, SFAs were primarily distributed in higher amounts than MUFAs and PUFAs. Lauric acid was the highest value in SFAs because lauric acid is presen t in coconut oil with content ranging from 45% – 50% and coconut oil is its primary source (Assunção *et al.,* 2009). Studies have confirmed that medium-chain saturated fatty acids (such as lauric acid found in coconut oil) and monounsaturated fatty acids such as oleic acid are less likely to increase insulin resistance, fat storage, and obesity compared to long-chain saturated fatty acids (such as palmitic acid). Interestingly, lauric acid and oleic acid have high oxidation rates of fatty acids, which may lead to their burning of energy and reduced storage potential in adipose tissue, thus promoting increased energy consumption (DiNicolantonio and O'Keefe 2017).

As seen in Table 4, the highest level of PUFAs was in Alpha-linolenic acid (ω-3). Particularly, linolenic fatty acids are greater than linoleic fatty acids, with a ratio of 1222:655 mg/100g. According to the recommendations of FAO/WHO (Lunn and Theobald 2007), high-quality fatty acids should have a ratio of linoleic fatty acids to linolenic fatty acids that does not exceed 4:1. The n-6/n-3 ratio is considered to be the key factor for balanced nutritional importance. The potential health benefits of alpha-linolenic have gained attention in recent years, and evidence on the role is growing. We need to consume more long-chain n-3 PUFAs and less saturated fatty acids. This is consistent with current dietary recommendations of consuming a minimum of 1% energy as n-6 PUFAs and 0.2 % energy as n-3 PUFAs (Lunn and Theobald 2007). The UK Department of Health recommends an ideal ratio of ω-6/ω-3 should be at least 0.20 to provide nutritional benefits for human health. The ratio ω-6/ω-3 showed a value of 0.53% to provide nutritional benefits and remain within appropriate and safe consumption limits, as stated by Simopoulos 2008.

Table 4. The fatty acids content of selected flakes

Types of fatty acids (mg/100g)	F4 Flakes
Saturated fatty acid (SFA)	
Caprylic acid	332
Capric acid	265
Lauric acid	2018
Myristic Acid	796
Palmitic Acid	928
Stearic Acid	253
Arachidic Acid	13
Dodecanoic Acid	6
Unsaturated fatty acids	
Monounsaturated fatty acids (MUFA)	
Palmitoleic acid	3
Oleic acid /omega 9 /n-9	870
11- Eicosanoic acid C20: 1	7
Polyunsaturated fatty acid (PUFA)	
Linoleic acid (ω-6)	655
Alpha-Linolenic acid /omega (ω-3)	1222
Ratio ω-6/ω-3	0.53

The Omega-3 (PUFAs) content of the F4 flakes can be attributed to the addition of chia seeds. Simultaneously, n-3 polyunsaturated fatty acid alpha-linolenic acid (ALA)] may be protective and enhance insulin resistance, lower blood cholesterol (LDL) and increase HDL. Interestingly, Omega-3 can be anti-obesity effects (such as increased fatty acid oxidation, increased basal metabolism, increased protein, and muscle formation (DiNicolantonio and O'Keefe 2017). Increasing the ratio-6 / ω-3 to the maximum can pose a risk to human health (Domiszewski et al.,2011).

3.4. Contribution of nutrition of the selected flakes to RDA and nutrition claims

Table 5 shows the contribution of nutrition of the selected flakes to RDA, nutrition claims, and Nutrient Reference Values (NRVs). The nutritional content was obtained from the proximate analysis results and was compared with the nutritional needs of the general population based on the Nutrient Reference Values (NRVs) to obtain the nutritional contribution of the flakes to energy and nutrient needs, when taken with 250 ml of milk. The Recommended Dietary Allowance (RDA) is set at 2,150 kcal per day, and requirements for breakfast meal energy is 20-25% of the daily RDA (Sukasih and Setyadjit 2012). The selected flakes provide an energy contribution of 8.69 % and 15.90 % if consumed with milk. This value is less than the required compared with the recommended breakfast requirementswhich is 20-25% of daily nutritional needs (Sukasih and Setyadjit 2012).

Based on Table 5, the selected flakes' energy, protein, fat, and carbohydrate content were 373.81kcal, 23.57 g; 7.65 g, and 52.67 g per 100 g, respectively. Furthermore, the contribution of Fe, Ca, Na, and K content per 100 g of the selected flakes product was 3.98 mg, 137.10 mg, 1381.64 mg, and 793.15 mg, respectively The selected flakes (F4) contributed 17.38 % of the total daily energy requirement.

According to Regulation No. 13 of The Indonesian Food and Drug Authority (BPOM 2016), a portion of processed food with a claim on the label must meet the requirements of intake per serving no more than 18 g of total fat; 4 g saturated fat; 60 mg cholesterol; and 300 mg sodium. As the sodium contents in the selected flakes product are more than 300 mg, no nutrition claim can be made for this food product.

When a reformulation can be conducted by reducing salt content to make the product contain sodium lower than 300 mg, a nutrition claim may then be proposed. By this concern, the selected flakes (F4) satisfy about 39%, 24%, 18%, and 17% of NRVs for protein,

Table 5. Contribution of nutrition of the selected flakes to RDA and nutrition claims

Ingredient	Nutritional content serving (50 g)	Milk 250 ml	F4 with milk	NRVs	% RDA	% RDA	
				General	Serving Size 50g	Serving Size 50g with milk	Nutritional Claims
Energy (Kcal)	186.90	155	341.9	2150	8.69	15.90	
Protein (g)	11.78	8.3	20.08	60	19.64	33.47	High protein
Fat (g)	3.82	8.38	12.2	67	5.7	18.21	
Carbohydrate (g)	26.33	11.65	37.98	325	8.1	11.68	
Fiber (g)	7.26	0	7.26	30	24.2	24.20	High fiber
Fe (mg)	1.99	0.08	2.07	22	9.045	9.40	Source iron
Ca (mg)	68.55	291	359.55	1100	6.23	32.68	
Na (mg)	690.82	103	793.82	1500	46.05	52.92	
K (mg)	396.57	369	765.57	4700	8.43	16.28	Source potassium

ISSN-Internet 2197-411x OLCL 862804632

dietary fiber, iron, and potassium, respectively. Based on BPOM (2016) regulation, the flakes product may be considered high protein because it contains more than 35% NRVs per 100 g product. These selected flakes also contain dietary fiber of more than 6g/100g and are considered as high fiber. The iron and potassium contents in the selected flakes product are also higher than 15% of the NRVs for those minerals. Thus, the food product may also be classified as the source of iron and potassium when the sodium content can be reduced to be less than 300 mg per serving size.

3.5. Comparison of the selected flakes (F4) with other commercial flakes

Table 6 compares the nutritional content and dietary fiber in flakes products made from red beans and brown rice flour with commercial flakes products. The nutritional content of the selected flakes was compared to commercial flakes available in Indonesia and other countries from different manufacturers to compare the usage effects of red beans and brown rice flour based on the nutritional content of the flakes chosen. The total dietary fiber content in the selected flake products was 14.525 mg/100g, much greater than other commercial flake products. This high fiber is due to red kidney beans, brown rice, and chia seeds. The protein content in the selected flake products was 23.57%, higher than other commercial flake products. This high protein is due to the use of red kidney beans as a source of protein. The selected flakes provide an energy contribution of 368 kcal. The selected flakes contribute 52.67 g to carbohydrates. The nutritional value of the selected flakes product has higher protein, high fiber, and lower prices than other flakes.

Table 6. Comparison of the selected flakes (F4) with other commercial flakes

Product flakes	Weight	Nutritional Value					
		Calories	Protein	Fat	Carbo Hydrate	Dietary fiber	Price
	(g)	(kcal)	(g)	(g)	(g)	(g)	(Rupiah)
Forbidden organic Brown Rice Flakes	100	368	6.8	2	78.9	1.4	96600
Brown rice flakes	100	352.7	7.1	2.4	72.3	5.0	23658
Natural Brown rice	100	376.6	8.2	2	80	0	162400
Bigoz Organic Free Brown Rice Flakes	100	362	8	4.5	74.6	4.7	60248
Kellogs Coco pops Brown Rice	100	113	1.5	0.6	26.1	0.8	25000
Barbaras Brown Rice Crips non organic	100	160	2	1	25	1	102480
Selected Formula	100	373.8	23.5	7.6	52.67	14.52	15900

ISSN-Internet 2197-411x OLCL 862804632

4. Discussion

4.1. The Potential Effects of Dietary Fiber on Appetite Regulation and Obesity

Dietary fiber has many functions in the diet, one of which may help control energy intake and reduce risks (diabetes, cardiovascular disease, obesity, bowel cancer, and constipation) which may lead to hemorrhoids when its effects are prolonged, and disorders that have serious negative effects on human health as a result of lifestyle changes. When there is an imbalance in the diet or a lack of dietary fiber intake, it will lead to some health problems that may last a lifetime (Al Hammadi 2017). Fiber has lower energy density, and it contains fewer calories than protein and fat but a larger volume and is richer in micronutrients. One of the beneficial effects of fiber is promoting a feeling of fullness and desire to consume food, thus decreasing food intake. High-fiber foods can hold water and require more salivation and chewing, which therefore bring about satiety (Al Hammadi 2017). The recommended daily dietary fiber intake for healthy adults is between 20 and 38 grams per day. One serving of F4 flakes contains 7.26 g of fiber, giving 24.2% fiber needed per day. Hence, it can be classified as high fiber (6 g per 100 g) based on BPOM (2016).

Recent studies have clearly shown that increasing dietary fiber can cause weight loss by automatically reducing calorie intake, slowing digestion, and the absorption of nutrients which helps prevent blood sugar levels from rising too quickly after eating and increasing the feeling of fullness (Howarth *et al.,* 2001). Additionally, other epidemiological studies indicate an association between low fiber intake and higher BMI (Howarth *et al.,* 2001). Importantly, fiber has been associated with reduced weight gain, reduced risk of obesity, and has become rare in people who eat a high fiber diet gaining less weight than those on a low-fiber diet (Slavin and Green 2007). Foods rich in fiber naturally require more chewing effort and/or time. This is hypothesized by reducing the intake rate to promote satiation.

4.2. The Potential Effects of High Protein Diet and Weight Loss

The Recommended Dietary Allowances (RDAs) for protein are set at a minimum of 0.8 g/kg of body weight, whereas high-protein diets are advisable for approximately 1.2 g to 1.5 g/kg body weight and lower than 2 g/kg body weight. Based on the results of F4 flakes, the contribution of protein intake was 19.64% per serving size, which can be considered a high protein meal. Recently, scientific evidence has suggested that the right high-protein diet may be a useful tool in the fight against obesity, being more likely to help keep the weight off, improve weight maintenance, and increase satiety (Tang *et al.,* 2013). Interestingly, the human body burns more calories in digesting protein than it does digesting carbohydrates or fat because protein has a higher rate of thermogenesis than three times the rate of carbohydrate and ten times the rate of fat so that it can control weight or the amount of energy required for the digestion, absorption, and metabolization of nutrients. Another scientific evidence showed that a high-carbohydrate diet breaks down about 35% of lean tissue and 65% of fat, but a high-protein diet reduces lean tissue breakdown to 20% while increasing fat breakdown to 80% (Tang *et al.,* 2013).

Skipping or eating a low-protein breakfast promotes protein breakdown rather than fat loss until a high-protein meal (more than 30 g) is consumed. During a catabolic state, muscle protein synthesis decreases while muscle protein breakdown increases. Thus, a high-protein breakfast slows protein breakdown and keeps people feeling fuller for longer. In light of these findings, breakfast becomes the most ctritical high-protein meal of the day. It can promote protein synthesis rather than energy intake, which means that eating high-quality protein throughout the day can protect lean tissues while losing weight (Tang *et al.,* 2013).

5. Conclusion

In this research, breakfast meals (flakes) were developed with brown rice and red kidney beans as the main ingredients. Based on organoleptic and nutritional content analysis, the best formula flakes were obtained from a formula based on the ratio of brown rice flour to red kidney bean flour (60:40) as the main ingredients (F4). These selected flakes contained a high amount of several nutrients but a relatively low amount of calories (373.81 kcal per 100 g). Im-

ISSN-Internet 2197-411x OLCL 862804632

portantly, it is high in protein and fiber, which may help consumers feel full longer and make it a weight loss-friendly food. It also contains essential minerals, including iron and potassium. Expectedly, red beans flakes are suitable for consumption as a breakfast meal and maybe a good suggestion for reducing overweight and obesity.

Conflict of Interest

The authors declare no conflict of interest. Furthermore, the funder had no role in the study's design, in the interpretation of data or collection, analyses, the decision to publish the results, and the manuscript's writing.

This research was supported by the Directorate General of Higher Education, Ministry of Education and Culture, Republic of Indonesia, through the KNB Scholarship.

Appendix

Analysis of Dietary Fiber Content (Asp and Björck 1992).

The analysis of food fiber content with the enzymatic method begins with sample preparation, weighing 10 g of sample (W) into an Erlenmeyer flask, then adding 25 ml of Na-phosphate buffer and making a suspension. Buffer is added to stabilize the termanyl enzyme. The Erlenmeyer flask was added 100 µl termanyl then the flask was closed and incubated at 100 °C for 15 minutes while occasionally stirring, and it was removed and cooled. The addition of termanyl breaks down the starch by the gelatinization process first. After that, 20 ml of distillate water was added, and the pH was adjusted to pH 1.5 by adding 4 M HCl, then adding 100 mg of pepsin. PH regulation aims to ensure optimum environmental conditions for pepsin activity. The Erlenmeyer flask was closed and incubated at 40 °C and agitated for 60 minutes. After reaching 60 °C, Erlenmeyer was removed and added 20 ml of distilled water. The pH was adjusted to 6.8 by adding 4 M NaOH (the optimum pH for pancreatin enzyme activity). After the pH is appropriate, 100 mg of pancreatin enzymes are added, then the flask is closed and incubated at 40 °C and agitated for 60 minutes. After that, the pH was lowered to 4.5 using HCl. The solution was filtered with a dry crucible of known weight (porosity 2) containing 0.5 g of dry celite, then washed 2 times each with 10 ml of distilled water, and the final result was the residue and filtrate.

Analysis of Fatty Acids (AOAC 2005)

This study's analysis of fatty acids used Gas Chromatography (GC). The extraction process using the Soxhlet method is the first stage of fatty acid analysis, after which the fat is weighed up to 20 grams in the form of oil. The next stage is the methylation process, and this process aims to form compounds derived from fatty acids, namely methyl esters. The methylation process is carried out by flowing back the fatty acids in a water bath using NaOH-methanol, isooctane, and BF3 solvents. The 20 mg sample was put into a test tube, and 1 ml NaOH-methanol was added to the sample 0.5 N, heated for about 20 minutes, and then refrigerated. 2 mL of 20% BF3 solution and 5 mg / mL internal standard, then the sample was heated again for 20 minutes and cooled. After cooling with 2 mL saturated NaCl and 1 mL isooctane, the mixture was carefully whipped. The isooctane solution is then transferred to a tube that has been mixed with 0.1 g of anhydrous Na_2SO_4 salt using a pipette and left for 15 minutes before adding up to 1 µl of the standard FAME mixture (Supelco 37 components of methyl fatty acid) Esther blend) then injected. 1 µl sample was injected into gas chromatography (GC). Fatty acid determination is done by injecting methyl ester into gas chromatography with the following conditions:

Column: Cyanopropyl methyl sil (capillary column
Column dimensions: p = 60 m, Ø in = 0.25 mm, 025 µm Film Tickness
Flow rate N_2: 30 mL / minute
Air flow rate: 400 mL / min
Flow rate He: 30 mL / minute H_2
Injector temperature: 220℃
Flow rate: 40 mL / min
Detector temperature: 240℃
Column temperature: Program temperature

Column temperature:
Split Ratio: 1:8
Inject Volum: 1 µL
Linear Velocity: 23.6 cm/sec
Retention and peak times were measured for each fatty acid and compared with standard retention times.

Rate (°C/minutes)	Temp (°C) Hold	Time (minutes)
125	5	-
10	185	5
5	205	7
3	225	10

This is done to obtain information about the type and amount of fatty acids in the sample. The fatty acid content in the sample can be calculated using the following formula:

$$Fatty\ acid\ content\ in\ sample(\%) = \frac{\frac{Ax}{As}\ x\ C\ standar\ x\ \frac{V\ example}{100}}{example\ gram}\ x\ 100\%$$

Note:
Ax = Sample area
C standard = standard concentration
V standard = Sample volume
As = Standard area

Calcium levels analysis using the atomic absorption spectroscopy (AAS) method (Apriyantono 1989)

The sample was prepared for calcium levels using wet ash. The sample was weighed 0.5-1.0 g and placed in an Erlenmeyer flask. Then 10 ml of concentrated H2SO4 solution and 10 ml of concentrated HNO3 solution were added. Then the solution is heated until clear and left to stand even cold. The solution is then diluted and measured with ion-free water in a 100 ml measuring flask. The solution was then homogenized with a stirrer. The solution was filtered with Whatman 42 filter paper and then read with AAS. The same procedure is performed for blanks. A standard Ca curve must be worked out in advance to calculate the Ca content in the sample. The calculation of the calcium content of a sample can be seen in the following calculation formula:

Information:

$$Ca\ content\ (\frac{mg}{100g}) = \frac{[\frac{mm\ sampel - mm\ blanko - b}{a} \times \frac{Vol\ aliquot}{1000} \times \frac{Fp}{100}]}{sample\ weight\ (gram)}$$

mm of sample = length of sample curve of AAS reading
mm blank = length of AAS reading blank curve.

Analysis of Fe levels using the Atomic Absorption Spectrophotometry (AAS) Method (Tautkus *et al.*, 2004).

Analysis of sample Fe content has the same procedure as analysis of Ca content, the only difference is the standard curve used. Ca content uses a standard Ca curve, while Fe content uses a standard Fe curve. Calculation of sample Fe content is carried out using

$$Fe\ content\ (\frac{mg}{100g}) = \frac{[\frac{mm\ sampel - mm\ blanko - b}{a} \times \frac{Vol\ aliquot}{1000} \times \frac{Fp}{100}]}{sample\ weight\ (gram)}$$

the formula below:

Information:
mm of sample = length of sample curve of AAS reading
mm blank = length of AAS reading blank curve.

References

Abdulrashed, R., Gazem, A., Chandrashekariah, S.A. 2016. Pharmacological Properties of Salvia Hispanica (Chia) Seeds: A Review. J Crit Rev. 3(3):63– 67

Akaerue, B.I, and Onwuka, G.I. 2010. Evaluation of the yield protein content and functional properties of mungbean (Vigna radiata (L.) wilczek) protein isolates as affected by processing. Pakistan Journal of Nutrition. 9(8):728-735.

[AOAC] Association of Official Analytical Chemists. 2005. Official Methods of Analysis of the Association of Official Analytical of Chemist. Virginia (USA): The Association of Official Analytical Chemist, Inc.

Agustina, N., Waluyo, S., Warji, T. 2013. Pengaruh suhu perendaman terhadap koefisien difusi dan sifat fisik kacang merah (Phaseolus vulgaris L.). J Teknik Pertanian Lampung. 2(1):35–42.

ISSN-Internet 2197-411x OLCL 862804632

AlHammadi, E.2017. Effects of Dietary Fiber Intake on Body Weight and Waist Circumference. Arab Journal of Nutrition and Exercise (AJNE), 77-84.

Apriyantono, A. 1989. Petunjuk Laboratorium Analisis Pangan, IPB-Press, Bogor.

Asp,NG.,Björck,I.1992. Resistant starch. Trends Food Sci Technol. 3 C:111–114. doi:10.1016/0924-2244(92)90153-N.

Assunçao, M.L., Ferreira, H.S., dos Santos, A.F., Cabral, Jr.C.R. and Florêncio, T. M. 2009. Effects of dietary coconut oil on the biochemical and anthropometric profiles of women presenting abdominal obesity. Lipids, 44(7):593-601.

Astuti, S., Suharyono, A.S., Anayuka, S.A. 2019. Sifat Fisik dan Sensori Flakes Pati Garut dan Kacang Merah dengan Penambahan Tiwul Singkong. Jurnal Penelitian Pertanian Terapan. 19(3):225-235.

[BPOM] Badan Pengawasan Obat dan Makanan. 2016. Acuan Label Gizi Produk Pangan. Jakarta (ID): Cek produk BPOM.

DiNicolantonio, J.J.,O'Keefe, J.H. 2017. Good fats versus bad fats: a comparison of fatty acids in the promotion of insulin resistance, inflammation, and obesity. Missouri medicine. 114(4): 303.

Domiszewski, Z., Bienkiewcz, G.,Plust, D. 2011. Effects of different heat treatment on lipid quality of stripe catfish (Pangasius hypophthalamus). Acta Scientiarum Polonorum Technologia Alimentaria.

[EFSA] European Food Safety Authority. 20008. The Setting of Nutrient Profiles for Foods Bearing Nutrition and Health Claims Pursuant to Article 4 of The Regulation (EC) No 1924/2006. Scientific opinion on dietetic products, Nutrition and Allergies. The EFSA Journal. 644: 1-44

Fellow, A.P. 2000. Food Processing Technology, Principles and Practise. 2 nd ed. Woodread. Pub. Lim. Cambridge. England. Terjemahan Ristanto W dan Agus Purnomo.

Gehan, F.A.R. 2017. Phytochemical Evaluation, Anti-obesity and Antihyperlipidemic Effects of Combined Administration of Green Coffee, Cinnamon and Ginger. Plant. 5(5):80. doi:10.11648/j.plant.20170505.12.

Howarth, N.C., S.c M., Saltzman, E., Roberts, S.B. 2001. Diet Fiber and Weight Regulation. Nutr Rev. 59(5):129–139.

Kurnianingtyas, A., Rohmawati, N., Ramanani, A. 2014. Pengaruh penambahan tepung kacang merah terhadap daya terima, kadar protein, dan kadar serat pada bakso jantung pisang. E-Jurnal Pustaka Kesehatan. 2(3):285-491.

Lunn, J., Theobald, H.E. 2007. The health effects of dietary unsaturated fatty acids. Nutr Bull. 32(1):82–84. doi:10.1111/j.1467-3010.2007.00623. x.

Mishartina., Ansarullah., Asyik., N. 2018. Pengaruh Formulasi Breakfast Flakes Berbahan Baku Ubi Jalar Putih (Ipomoea Batatas L) Dan Kacang Merah (Phaseolus vulgaris L) Terhadap Penilaian Organoleptik Dan Fisikokimia. J Sains dan Teknol Pangan. 3(2):1221–1236.

Nelson, M., Suvher, K., Sara, L. 2009. Nutrition Therapy and Pathophysiology. Australia: International Student Edition.

Nielsen, S. 2010. Food Analysis. Berlin (DE): Springer.

Nuriana, A., Aini, N.,Karseno. 2019. Formulation of Breakfast Meal Flakes Based on Suweg Flours and Stabilized Rice Bran using Response Surface Methodology. Jurnal Aplikasi Teknologi Pangan. 8(2).

Pangastuti, H., Affandi, D., Ishrtani, D. 2013. Karakteristik sifat fisik dan kimia tepung kacang merah (Phaseoulus vulgaris L.) dengan beberapa perlakuan pendahuluan. Jurnal Teknosains Pangan. 2(1): 20-29.

Pertiwi, A.D., Widanti, Y.A, Mustofa, A. 2017. Substitusi Tepung Kacang Merah (Phaseolus Vulgaris L.) Pada Mie Kering Dengan Penambahan Ekstrak Bit (Beta Vilgaris L.). Jurnal Teknologi Dan Industri Pangan Universitas Slamet Riyadi Surakarta. 1(1):67–73.

Rakhmawati, N., Amanto, B.S.,Praseptiangga, D. 2014.

Formulasi dan Evaluasi Sifat Sensoris dan Fisikokimia Produk Flakes Komposit Berbahan Dasar Tepung Tapioka, Tepung Kacang Merah (Phaseolus vulgaris L.)dan Tepung Konjac (Amorphophallus oncophillus). Jurnal Teknosains Pangan. 3(1).

Ravichanthiran, K.Ma.ZF., Zhang, H., Cao, Y., Wang, C.W., Muhamma, S. and Pan, B. 2018. Phytochemical profile of brown rice and its nutrigenomic implications. Antioxidants. 7(6): 71.

Riantiningtyas, R.R.,Marliyati, S.A. 2017. Formulation of Flakes with Red Kidney Bean and Red Palm Oil as a Potential Instant Breakfast for Type 2 Diabetes. Jurnal Sains Kesihatan Malaysia. 15(2): 91-96.

Rohma, M. 2013. Kajian Kandungan Pati, Amilosa Dan Amilopektin Tepung Dan Pati Pada Beberapa Kultivar Pisang (Musa Spp). Jurnal Prosiding Seminar Nasional Kimia.1(1):223–227.

Simopoulos, A.P. 2008. The importance of the omega-6/omega-3 fatty acid ratio in cardiovascular disease and other chronic diseases. Experimental Biology and Medicine. 233: 10.3181/0711-MR-311.

Singh, A., Sharma, S., Singh, B. 2017. Influence of grain activation conditions on functional characteristics of brown rice flour. Food Sci Technol Int. 23(6):500–512. doi:10.1177/1082013217704327.

Slavin, J., and Green, H. 2007. Dietary fibre and satiety. Nutrition Bulletin, 32:32-42.

Sukasih, E., Setyadjit, N. 2017. Formulasi Pembuatan Flake Berbasis Talas Untuk Makanan Sarapan (Breakfast Meal) Energi Tinggi Dengan Metode Oven. J Penelit Pascapanen Pertan. 9(2):70. doi:10.21082/jpasca.v9n2.2012.70-76.

Tang, M., Armstrong, CL., Leidy, HJ., Campbell, WW. 2013. Normal vs. high-protein weight loss diets in men: effects on body composition and indices of metabolic syndrome. Obesity, 21(3), E204-E210.

Tautkus, S., Steponeniene, L., Kazlauskas, R. 2004. Determination of iron in natural and mineral waters by flame atomic absorption spectrometry. J Serbian Chem Soc. 69(5):393–402. doi:10.2298/JSC0405393T.

Wang, J., Wang, P., Li, D., Hu, X., Chen, F. 2019. Beneficial effects of ginger on prevention of obesity through modulation of gut microbiota in mice. European Journal of Nutrition.

Wang, S., Chen, L., Yang, H., Gu, J., Wang, J., Ren, F. 2019. Regular intake of white kidney beans extract (Phaseolus vulgaris L.) induces weight loss compared to placebo in obese human subjects. Food Science &Nutrition. 8:1315–1324.

[WHO] World Health Organization. 2003. Diet, Nutrition and the prevention of chronic disease. WHO Technical Report Series no. 916. Geneva: WHO.

ISSN-Internet 2197-411x OLCL 862804632