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CHEMICAL CHARACTERISTICS OF KEPOK BANANA BUD (*Musa paradisiaca Linn.*) FLAKES WITH VARIATIONS OF MOCAF FLOUR

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ABSTRACT

Flakes are food products that have the shape of thin sheets, brownish yellow in color with a practical presentation. Flakes are easy to process and generally consumed for breakfast. Flakes that are rich in dietary fiber and protein can serve as a source of energy while also offering functional advantages. The objective of this study is to generate flakes with elevated levels of dietary fiber and protein by utilizing mocaf and yellow kepok banana bud flour. The use of mocaf flour in the manufacture of flakes intends to improve the fiber content, while the use of yellow kepok banana bud (YKBB) flour aims to boost the protein level. This research was conducted to determine the chemical characteristics of flakes with variations of mocaf flour and KBF. The chemical characteristics include moisture, ash, crude fiber, total protein, lipid, and carbohydrate content. This study used a completely randomised design (CRD) with 2 replications with a ratio of wheat flour, mocaf flour, and YKBB flour as much as the control (20g:0g:0g), F1 (10g:10g:0g), F2 (10g:2.5g:7.5g), F3 (10g:5g:5g) and F4 (10g:7.5g:2.5g). The results showed that the moisture content was 2.43–3.19% w.b., the ash content was 2.55–11.72% d.b., the crude fiber content was 2.17–8.40% d.b., the total protein content was 4.34–7.85% d.b., lipid content 2.46–3.17% d.b., and carbohydrate content was 76.91–87.98% d.b.

Keywords: mocaf flour; flakes; yellow kapok banana bud (YKBB) flour

ABSTRAK

Flakes merupakan produk pangan berbentuk serpihan yang memiliki bentuk lembaran tipis, berwarna kuning kecoklatan dengan penyajian yang praktis. Flakes tergolong pada produk pangan yang mudah diproses dan umumnya dikonsumsi untuk sarapan. Flakes tinggi serat pangan dan protein dapat dimanfaatkan sebagai sumber energi dengan tetap memberikan manfaat fungsional. Penelitian ini bertujuan untuk menghasilkan flakes tinggi serat pangan dan protein menggunakan mocaf dan tepung jantung pisang kepok kuning (YKBB). Penelitian ini dilakukan untuk mengetahui karakteristik kimia flakes dengan variasi tepung mocaf dan tepung kelopak YKBB meliputi kadar air, kadar abu, kadar serat kasar, kadar protein total, kadar lemak dan kadar karbohidrat *by different*. Penelitian ini menggunakan Rancangan Acak lengkap (RAL) dengan 2 kali ulangan dengan perbandingan tepung terigu, tepung mocaf dan tepung kelopak YKBB sebesar kontrol (20g:0g:0g), F1 (10g:10g:0g), F2 (10g:2,5g:7,5g), F3 (10g:5g: 5g) dan F4 (10g:7,5g:2,5g). Flakes hasil penelitian ini diperoleh hasil kadar air sebesar 2,43 – 3,19% b.b., kadar abu 2,55–11,72% b.k., kadar serat kasar 2,17–8,40% b.k., kadar protein total 4,34–7,85% b.k., kadar lemak 2,46–3,17% b.k., dan kadar karbohidrat by different 76,91–87,98% b.k.

Kata kunci: flakes; tepung jantung pisang kapok kuning (YKBB); tepung moca

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INTRODUCTION

Breakfast refers to the initial meal consumed within two to three hours after getting up in the morning. Breakfast is the first meal of the day, consumed after a person's longest duration of sleep. It often includes food and drink from at least one food group mentioned in MyPlate (Tay et al., 2021). Breakfast cereals that are specifically engineered to reduce the time and effort required for breakfast preparation are favored. Breakfast cereals, typically consumed as the initial meal of the day, mostly consist of grains. Some breakfast cereals can be consumed partially cooked, while others are eaten cold or combined with milk, yogurt, or fruit juice (Frimpong et al., 2022).

Flakes are a widely consumed breakfast cereal that has been recognized since ancient Greek times. Historically, flakes originated as a result of health reform efforts led by James Caleb Jackson, a conservative vegetarian, in 1863. James prepared breakfast using dough made from wheat graham flour to mitigate several health issues associated with excessive consumption of meat products. This breakfast cereal is produced through the process of baking dough made from wheat graham flour, followed by crushing it and then baking it once again (Perdon et al., 2020). Flakes were derived from wheat flour and various flours or basic materials from different cereal groups (Anderson & Mills, 2000). Before consumption, it is imperative to immerse the final product in milk for an extended period due to its exceptionally rigid texture. The product that is obtained as a result is referred to as cereal granules (Perdon et al., 2020). The process of producing cereal granules by removing the baked cereal batter is referred to as flaking. The classification of flakes is determined by the primary ingredients employed, such as wheat flakes, corn flakes, and rice flakes (Anderson & Mills, 2000). Flakes have thin sheets, yellow-brown with a practical serving, and contain good nutrition for health so that flakes can trigger a feeling of satiety (Anderson & Mills, 2000; Padovani et al., 2007).

According to the specifications outlined in SNI 01-4270-1996, the minimum protein level of flakes is 5.0% (Putri et al., 2020). Organic wheat flour flakes have a protein content of 9.4 g, a fiber content of 9.4 g, and provide 406 kcal of energy. Fortified corn flakes have a protein content of 7.1 g, a fiber content of 3.6 g, and provide 357 kcal of calories (Perdon et al., 2020). Corn flakes by Padovani et al. (2007) have low protein and crude fiber content, they are 6.25% and 2.6%, respectively. Breakfast cereals in the form of flakes should have essential nutrients like protein and easily digestible carbohydrates to offer energy for physical activity. Additionally, they should be high in fiber to prevent frequent hunger sensations and to obtain the functional advantages of fiber. (Fauzi et al., 2019; Papunas et al., 2013; Permana & Putri, 2015; Susanti et al., 2017; Utama et al., 2019).

Mocaf flour is an engineering modification of casava flour using fermentation techniques (N. A. Putri et al., 2018; Yani & Akbar, 2018). Mocaf flour has a relatively high starch content average 60-80%, depend on the raw material, microorganism used, and the method of production (Anindita et al., 2020; Kurniati et al., 2012; Nugraheni et al., 2015). Starch content of mocaf needed in making breakfast cereal, such as flakes, chips, and porridge (Agustia et al., 2019; Anggraeni & Yuwono, 2014; Susanti et al., 2017). Nevertheless, the breakfast cereal needs to be added another nutritional compound to give energy balance in the body. Mocaf flour contains relatively low protein. Mocaf flour contains maximum 1.0% protein and 3.4% fiber content (Anindita et al., 2020; Nugraheni et al., 2015). The protein and fiber in flakes can be improved by adding yellow kepok banana bud (YKBB) flour.

Although the banana bud is categorized as a by-product of bananas. The substance, generally referred to as banana inflorescence, has been utilized due to its nutritional composition and bioactive components. The carbohydrate amount of a banana bud ranges 53.78–57.2%, while the protein level ranges 13.75–19.60%. The fat content is 0.23–0.98%, and the moisture content can vary from 8.33% to 92%. Additionally, banana buds include a dietary fiber content of 65.6–70.07% (Choudhury et al., 2023). The presence of these nutritional substances serves as the foundation for the utilization of banana buds in traditional culinary preparations, such as stir-fries. In addition, the existence of bioactive substances in banana buds has motivated numerous researchers to utilize banana buds as functional food and nutraceutical ingredients. Additional applications encompass the preservation of food and food coloring (Choudhury et al., 2023; J. Bhaskar et al., 2011; Ramu et al., 2020; Ravindran et al., 2021). Many studies have been conducted regarding the manufacture of flakes. Several researchers have tried to produce flakes with various raw materials such as jack bean (Agustia et al., 2019), corn and red bean (Permana & Putri, 2015), mocaf and corn flour (Susanti et al., 2017), and germinated corn flour (Utama et al., 2019), but there has been no research on flakes with variations of mocaf and YKBB flour. Therefore, in this study, flakes were made with variations of mocaf and YKBB flour.

MATERIALS AND METHOD

Material

The equipment used in this study were knives, cutting boards, basins, spoons, digital scales, thermometers, steam pans, gas stoves (Rinnai), cabinet dryers, 80 mesh sieve, stir sticks, pans, mixers (Philips), blenders (Philips), oven (Kirin), plastic spatula, porcelain crucible, oven (Memmert), desiccator, analytical balance (Ohaus), spatula, iron tongs, electric furnace, vials, Kjeldahl tube, fume hood, desiccator, burette, stand, mortar, pestle, erlenmeyer, waterbath, funnel (Iwaki), Soxhlet tool, measuring pipette and propipet. The materials used in this study were yellow kepok banana bud (YKBB) obtained from a traditional market in Yogyakarta, wheat flour (Kunci Biru), mocaf flour (Mocafine), granulated sugar (Gulaku Murni), margarine (Forvita), salt (Cap Kapal), vanilla (Koepoe-koepoe), and citric acid (Cap Gajah). Some of the analytical reagent pro analysis grade such as Na_2SO_4, $CuSO_4$, Selenium/TiO_2, concentrated H_2SO_4, NaOH, TiO(NaOH) 40%, $Na_2S_2O_3$ 5%, H_3BO_3 4%, indicator BCG- MR, 0.02 N HCl, 1.25% NaOH, 96% ethanol, aquadest, litmus paper, filter paper and cotton.

Method

1. YKBB flour production

The production of YKBB began with sorting the banana bud. The banana bud used in this study were inner white and slightly red petals, fresh and unblemished, not sliced, not scratched and not smelly or rotten. Then, each petal was washed and cut 1 x 1 cm wide. Next, the petals were soaked in a citric acid solution (0.2%) for 30 minutes. The petals are then rinsed and steamed for 6 minutes at 70 °C, then drained and cooled. Next, the petals were dried in a cabinet dryer at 60 °C for 6 hours. Dried banana buds were floured using a blender and sieved using an 80-mesh sieve (Triastuti et al., 2018).

2. Flakes production

The flake production in this study was carried out using a combination of wheat flour, mocaf flour, and YKBB flour, as well as other additional ingredients with the formulations presented in **Table 1**. First, the flour in different portions was mixed. Then, other ingredients were added until evenly mixed to form a homogeneous flakes dough. Then, flakes were created with a 1 mm thickness, then in the oven at 150 °C for 30 minutes.

3. Analytical methods

The analytical method used in this study was a one-factor, Completely Randomised Design (CRD) analysis method with 5 formulations and 2 replications for each formula. The formulations used in this study with a comparison of wheat flour, mocaf flour and YKBB flour were control (20g: 0g: 0g), F1 (10g: 10g: 0g), F2 (10g: 7.5g: 2.5g), F3 (10g: 5g: 5g) and F4 (10g: 2.5g: 7.5g). The parameters evaluated in this study included moisture, ash, lipid, crude protein, and carbohydrate by difference using AOAC methods (Fitriani et al., 2021). Crude fiber content was determined used acid and basic hydrolysis (Anonim, 1995).

4. Statistical analysis

The data were obtained from the evaluation parameters and then were statistically analysed using SPSS ver. 20 software. The F test was applied to evaluate the data, and DMRT was used as a post hoc test.

Table 1. The formula for making flakes

Ingredients	Formulations (g)				
	Control	F1	F2	F3	F4
Wheat flour	20	10	10	10	10
Mocaf flour	0	10	7.5	5	2.5
YKBB flour	0	0	2.5	5	7.5
Sugar	7.2	7.2	7.2	7.2	7.2
Cornstarch	4.0	4.0	4.0	4.0	4.0
Margarine	1.2	1.2	1.2	1.2	1.2
Salt	0.30	0.30	0.30	0.30	0.30
Vanilla	0.12	0.12	0.12	0.12	0.12
Baking Soda	0.12	0.12	0.12	0.12	0.12
Water (mL)	30	30	30	30	30

RESULTS AND DISCUSSION

Moisture Content

The results of this study can be seen in **Table 2**. The analysis of the moisture content of the five flake samples showed a significant difference ($\alpha<0.05$). The highest moisture was 3.19% which was obtained from the F2 treatment (10 g wheat flour: 2.5 g mocaf flour: 7.5 g YKBB flour), while the lowest moisture content was 2.44% obtained from the F4 treatment (10 g wheat flour: 7.5 g mocaf flour: 2.5 grams YKBB flour). The F2 flakes sample has a higher moisture content than the control, 2.50%, and higher than the cereals quality standard according to SNI 01-4270-1996 (Putri et al., 2021), which is a maximum of 3%. The F4 flakes sample has a lower moisture content than the control and lower than the cereal quality standard, according to SNI 10-4270-1996.

Table 2. Chemical characteristics of yellow kapok banana bud flakes

Formulations	Moisture content (%)	Ash content (%)	Crude fiber content (%)	Total protein content (%)	Lipid content (%)	Carbohydrate content (%)
Control	2.50 ± 0.10^{ab}	11.64 ± 1.77^{b}	2.17 ± 0.06^{a}	6.98 ± 0.10^{c}	3.25 ± 0.16^{b}	78.12 ± 1.73^{ab}
F1	2.54 ± 0.02^{ab}	10.73 ± 0.83^{b}	6.53 ± 0.25^{d}	4.34 ± 0.04^{a}	2.46 ± 0.07^{c}	82.47 ± 0.80^{c}
F2	3.19 ± 0.05^{c}	11.72 ± 0.43^{b}	8.40 ± 0.02^{e}	7.85 ± 0.02^{d}	3.70 ± 0.26^{c}	76.91 ± 0.14^{a}
F3	2.95 ± 0.10^{bc}	9.78 ± 1.26^{b}	5.26 ± 0.07^{c}	6.78 ± 0.00^{c}	3.25 ± 0.18^{b}	80.28 ± 1.44^{bc}
F4	2.43 ± 0.37^{a}	2.55 ± 0.01^{a}	3.33 ± 0.03^{b}	5.76 ± 0.32^{b}	3.71 ± 0.10^{c}	87.98 ± 0.22^{d}

Note: Numbers with their Standard Deviations (SDs) followed by the different letters within the same column indicate a significant difference ($\alpha = 0.05$).

The results of this study indicate that the higher the addition of YKBB flour, the higher the moisture content of the flakes. It is due to the higher amylose content of YKBB flour than mocaf flour. YKBB flour contains 25% amylose, while mocaf is 19% amylose (Wanita & Wisnu, 2013). This result is in line with the utilisation of purple sweet potatoes as a chip (Anggraeni & Yuwono, 2014). The higher the amylose content, the greater the moisture absorption index. The soaking process caused higher amylose content will cause the starch granules to swell, and water absorption occurs. When the granules are swelling, they will quickly experience the process of gelatinisation. The more starch that undergoes the gelatinisation process, the greater the ability of the material to absorb water (Putri et al., 2018).

In addition, YKBB flour contributes a higher moisture content because it has a higher moisture content than mocaf. Banana bud flour contains 11.37% moisture, while mocaf flour contains 6.9% (Ariantya, 2016). YKBB flour has hygroscopic characteristics, so it quickly absorbs water from the surrounding air so that it is easily damaged and becomes acidic (Florent et al., 2015). Nevertheless, the moisture content from this study is lower than flakes from the combination of purple sweet potato and kepok banana bud flour. The moisture content of purple sweet potato flour flakes and kepok banana bud ranged from 3.86% to 5.21% due to a higher moisture content from the raw material

(Hikmah, 2020). The moisture content of sweet potato flour was 7.31%, while mocaf flour contains less moisture content (6.9%) (Ariantya, 2016). The findings of this study also demonstrate an inverse relationship with previous studies, indicating that an increase in the amount of wheat flour used is associated with a corresponding increase in moisture content (Utama et al., 2019). The moisture content of the control sample was markedly lower than that of the F2 formula in this investigation, while research by Utama et al. (2019) showed that the incorporation of a higher proportion of wheat flour led to a rise in the moisture content when compared to flake samples made from corn sprout flour. The reason for this is because corn sprout flour possesses a diminished water content in comparison to wheat flour (Utama et al., 2019).

Ash Content

The ash content determination aims to know the mineral content in the sample (Papunas et al., 2013). Based on **Table 2**, the ash content of the five samples showed a significant difference. The flakes sample with the highest ash content is the F2, which is 11.71%, while the flakes with the lowest are the F4, which is 2.55%. The difference in ash content was due to the difference in the proportions of mocaf flour and YKBB flour. In this study, the ash content of flakes ranged from 2.55% - 11.71%. However, the maximum ash content from the national standard for breakfast cereal is 4%. So, in the F4 samples, the ash content is suitable for the standard.

Ash refers to the inorganic substances that are left behind after the combustion of organic materials. The composition and amount of ash vary depending on the specific material and the method used for ashing. The residue obtained represents the entirety of the ash content in the sample. The purpose of ash content determination is to quantify the quantity of coarse mineral content present in the sample, namely the inorganic minerals that remain after the process of ashing (Pangestuti & Darmawan, 2021; Putri et al., 2021). Elevated ash concentration may suggest a significant presence of inorganic constituents, although additional investigation is required to fully interpret these findings.

The results of this study indicate that the higher the YKBB flour added, the ash content of flakes also increased. The increment of ash content is due to the chemical components in the raw materials used. Banana bud flour has a relatively high ash content ranging from 9-12% (Florent et al., 2015), while mocaf flour has an ash content of 0.15% (Nugraheni et al., 2015). In addition, the ash content in the flakes depends on the proportion of mocaf flour. Based on the mocaf flour production, there was a salt addition. This step is expected for the different ash content in each sample. The salting step in mocaf flour production can improve the ash content (Susanti et al., 2017).

The result of the present study is inverse to the flake production from the combination of corn and mocaf flour. The corn flour/mocaf flour ratio at 80%/20% resulted in flakes with 1.46% ash content (Susanti et al., 2017). Corn flour has a lower ash content than YKBB flour. Corn flour has 0.39% less than JPPK flour, which has a 15.10% ash content (Ariantya, 2016). So, the ash content of the flakes in this research is higher than corn-mocaf flour flakes.

Crude Fibre Content

All of the samples are significantly different in their crude fiber content. The F2 formula has the highest crude fiber content (8.40%). Inversely, the control has the lowest value (2.17%). The results show that the higher the YKBB proportion, the higher the crude fiber content. The crude fiber content increased by 1.16% to 6.23% compared to the control. It is due to a high fiber content of banana bud flour. Previous research explained that banana bud has 15.25% crude fiber content (Ariantya, 2016). YKBB's crude fiber is higher than mocaf flour. Mocaf only has 3.01% crude fiber (Nugraheni et al., 2015). All of the samples in this research have high crude fiber content and pass the maximum content (0.7%) of crude fiber of cereal based on SNI 01-4270-1996 (Putri et al., 2021). However, this finding can be used as essential knowledge for advanced research using banana bud as a dietary fiber source for functional food.

Crude Protein Content

The highest crude protein content was in the F2 sample, 7.85 %, while the lowest crude protein content was in the F1, 4.34 %. The statistical analysis of the five flake samples showed a significant difference. The total protein content in this study ranged from 4.34 % to 7.85 %. Based on this, the total protein content in this study follows the quality standards of cereals according to SNI 01-4270-1996 with a minimum total protein content value of 5% (Putri et al., 2021). Kepok banana bud has a higher protein content than other types of banana. The protein content in this banana bud can cause a savory taste, covering the bitter taste of tannins (Florent et al., 2015).

Flakes from mocaf and corn flour have 1.76% crude protein content (Susanti et al., 2017). In this study, the protein content of flakes was higher than previous research (Susanti et al., 2017), because corn flour contains 7.49% crude protein (Arief et al., 2014), while banana bud flour contains 9.14% protein. Banana bud flour contains higher protein than corn flour (Ariantya, 2016).

Lipid Content

The analysis of variance showed that the treatment of the proportions of mocaf flour and YKBB flour had a significant effect on the lipid content of flakes. **Table 2** shows that the sample with the highest lipid content was produced from the F4 sample (3.71%), while the lowest lipid content was made from the F1 (2.46%). The statistical analysis of the samples showed a significant difference. The flakes produced had an average lipid content of 2.46% - 3.71%. The F4 flakes sample had a higher lipid content than the control sample, where the control sample had 3.25% lipid content. The Control sample does not contain mocaf flour and YKBB flour, so the lipid content is lower. Banana bud flour contains 1.34% lipids, while mocaf contains 0.8% (maximum). It means that the more YKBB flour is added, the lipid content of the flakes will increase (Nugraheni et al., 2015).

In addition, Food ingredient that is processed using high temperatures and for a long time can cause the lipid structure of a food ingredient to break and come out, resulting in flakes that have a crunchy texture. The decrease in lipid content is caused by factors that trigger the breakdown of lipids. Heat can cause lipid degradation into smaller molecules, for example, free fatty acids and ketone compounds (Fitriani et al., 2021; Maharani et al., 2022). The lipid content from cornflakes in a previous study was 13.09%. In this study, the lipid content is lower previous (Susanti et al., 2017). It is because the lipid content of corn flour is 2.51% (Susanti et al., 2017), while banana bud flour contains 1.34% lipid content (Ariantya, 2016).

According to the findings, the flakes had a lower lipid content than the standard according to SNI 01-4270-1996, with a minimum lipid content value of 7% (Putri et al., 2021). The product's low lipid content is a disadvantage. This is due to the utilization of small quantities of margarine in the production of the flakes. Despite having a lower lipid content than the standard, this product can serve as a functional meal to mitigate the risk of hyperlipidemia.

Carbohydrate Content

The results show that the proportions of mocaf flour and YKBB flour significantly affected the carbohydrate content of the flakes. The carbohydrate content can be seen in **Table 2**. Based on **Table 2**, the highest carbohydrate content was found in the F4 sample. Its carbohydrate content was 87.98%, while the lowest was found in F2 (76.91%). The higher the addition of mocaf flour, the higher the carbohydrate content. Conversely, the higher the addition of YKBB flour, the lower the carbohydrate content in the flakes. The higher the substituted mocaf flour, the higher the carbohydrate content because mocaf flour has a higher carbohydrate content than banana bud flour. Banana bud flour contains 63.04% carbohydrates (Ariantya, 2016), whereas mocaf flour has a higher carbohydrate content than wheat flour (74.48%) (Kurniati et al., 2012; R. A. N. Putri et al., 2020).

The heating process can cause a decrease in carbohydrate content in the flakes. In this heating process, complex carbohydrates will be broken down into simpler compounds and can reduce the levels of carbohydrates in the product. In this study, the resulting flakes had carbohydrate content ranging from 76.91 – 87.98%. Based on this, the carbohydrate content of flakes in this study followed the quality standards of cereals according to SNI 01-4270-1996 with a minimum carbohydrate content value of 60% (R. A. N. Putri et al., 2021).

CONCLUSION

The addition of mocaf flour and YKBB flour affected the chemical properties of the flakes. The proportions of mocaf flour and YKBB flour significantly affected the five samples. The F2 sample was selected as the best sample due to its maximum fiber and protein content, which were measured at 8.4% and 7.85% respectively. This selection was made in accordance with the objective of enhancing the fiber and protein content by utilizing YKBB flour and including mocaf.

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