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Utilization of kepok banana flour and tempeh flour in making flakes

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ABSTRACT

Utilization of banana flour in making flakes is one of the efforts to diversify flakes products. Flakes made from kepok banana flour have a high carbohydrate but low protein content. According to SNI, the minimum requirement for protein in cereal products is 5%, so to meet the protein content in flakes, it needs to be combined with other ingredients, such as tempeh flour. The use of tempe flour in making flakes made from kepok banana flour is expected to increase the protein content of flakes. This research aimed to determine and obtain the best ratio between kepok banana flour and tempeh flour for making flakes. This research used a completely randomized design with four treatments and four replications. The treatments in this research were the difference in the ratio between kepok banana flour and tempeh flour, namely PT0 (kepok banana flour 100%), PT1 (90:10), PT2 (80:20), and PT3 (70:30). Data were analyzed using variance analysis and then continued with Duncan's New Multiple Range Test at 5% level. The result showed that the ratio of kepok banana flour and tempeh flour significantly affected moisture, ash, fat, protein, crude fiber, carbohydrate contents, crispy resistance in milk, and descriptive and hedonic sensory test. The best ratio of kepok banana flour and tempeh flour was 70:30, respectively. It had 1.77% moisture, 3.39% ash, 11.40% fat, 9,23% protein, 5.52% crude fiber, 74.22% carbohydrate, and crispy resistance in milk 7,61 minutes with a description of light brown, banana and tempeh flavored, crunchy texture, and banana and tempeh taste. Panelists preferred a hedonic assessment of color, aroma, taste, and overall assessment, and panelists preferred the crunchy texture.

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INTRODUCTION

The pattern of people's lives will experience changes due to the times. These changes have indirectly changed people's food consumption patterns, demanded practicality and prepared breakfast. Flakes are one of the breakfast food products that can be used as an alternative. Flakes are cereals from cereals such as wheat, rice, and corn. According to data from the Agricultural and Processed Food Products Export Development Authority (APEDA), the global market share for breakfast cereal products is projected to increase by 4.3% from 2017 to 2025. At first, to make flakes from whole corn kernels were known as cornflakes, but innovations have been developed to manufacture flakes. Flakes can be made from other raw materials high in carbohydrates, such as tubers. One source of carbohydrates that can be used as an alternative to making flakes is kepok banana flour.

Prabawati et al. (2008) stated that kepok banana flour is better than other types of bananas because the color of the flour produced is whiter and more attractive. Banana flour has a relatively high carbohydrate content of 80.6g per 100g of ingredients but a low protein content of 2.9g per 100g (Mahmud et al. 2018) . According to SNI, the minimum requirement for protein for cereal products is 5%. To meet the protein content according to the Indonesian flake standard (SNI), flakes made from banana flour must be combined with food ingredients with high protein content, such as tempeh flour. Tempe flour is an alternative processing to extend the shelf life of tempeh because tempeh has limitations in a relatively short storage time. Tempeh flour is alternative processing to extend tempeh's shelf life because tempeh has limitations in a relatively short storage time. According to Yulianti et al. (2019), tempeh flour has a high protein content, 46.00g in 100g of ingredients. The use of tempeh flour in making flakes made from kepok banana flour is expected to increase its protein content. Widasari & Handayani (2014) researched modified cassava and tempeh flour on the resulting flakes. This study obtained the best result: the proportion of wheat flour-moca 1: 2 and the addition of 20% tempeh flour with 9.61g protein, 6.85g fiber content, and 1.52g moisture content. Among the advantages of tempeh flour, it is easy to mix with carbohydrate sources to enrich its nutritional value and store or process into fast food. Tempe flour can be substituted for baby porridge, drinks, instant tempeh seasoning, and binder in beef meatballs, biscuits, and others. In baby food, tempeh can potentially increase resistance to infection, prevent diarrhea, and replace baby cereals (Albertine et al. 2008).

Several researchers have researched shale processing using various raw materials. Mahmudah et al. (2017) studied the physical, chemical, and sensory characteristics of the Samarinda kepok banana flakes by substituting arrowroot starch. Based on this research, flakes with 85% banana flour and 15% arrowroot starch were the best treatment. Winarti et al. (2016) have also researched kepok banana flakes physicochemical properties with cassava flour substitution. From this research, flakes with the addition of 70% kepok banana flour and 30% cassava flour were the best treatment flakes with a yield of 62.635%, water content 4.307%, starch content 76.653%, fiber content 2.323%, fracture strength 0.727 kg/cm^2, and rehydration power 71.379%. Based on the description, it is necessary to do research with the title Utilization of Kepok Banana Flour and Tempe Flour in Making Flakes which aims to determine and obtain the proper ratio of kepok banana flour and tempeh flour the quality of the flakes.

METHODS

The raw materials used in making the flakes are white kepok bananas 110 DAA (HSA) and tempeh (HB), used as flour obtained from the Simpang Baru Panam market. Other ingredients used are tapioca (Pak Tani Gunung), granulated sugar (Gulaku), margarine (Blue band), egg yolk, salt (Dolphin), baking soda (koepoe-koepoe), and water. The chemicals for analysis are distilled water, concentrated H_2SO_4, HCl 0.02 N, K_2SO_4 10%, H_3BO_3 1%, NaOH 40%, n-hexane, 95% alcohol, and methyl red indicator.

This research was conducted using an experimental method using a completely randomized design (CRD) with four treatments and four replications to obtain 16 experimental units. The formulations for making flakes are based on preliminary research, namely PT0 (100% kepok banana flour), PT1 (kepok banana flour: 90:10 tempeh flour), PT2 (kepok banana flour: 80:20 tempeh flour), and PT3 (kepok banana flour: flour tempeh 70:30).

Observations were made on moisture content (oven method), ash content (dry ashing method), fat content (Soxhlet method), protein content (Kjeldahl method), crude fiber content (Gravimetric method), carbohydrate content (by different method), crunchiness resistance flakes in milk, and descriptive and hedonic sensory analysis. The data obtained were then analyzed by analysis of variance (ANOVA). If the test results show an F count ≥ F table, a further test is carried out with the Duncan Multiple Range Test (DMRT) at the 5% level to determine the difference in each treatment effect. Data analysis using SPSS software version 26 in 2019.

Making kepok banana flour

The manufacture of kepok banana flour refers to Gusnita (2018), Abbas et al. (2009), and Candra et al. (2021). Kepok bananas used to make flour are kepok bananas with dark green skin and a hard texture. Next, the kepok bananas are steamed for 15 minutes to reduce the sap. The fruit flesh is thinly sliced with a thickness of ± 0.4cm, then soaked with a 2% salt solution for 15 minutes to prevent browning reactions in bananas so that the color of the banana flour produced was better than other treatments. Kepok banana fruit was drained and dried at 60℃ for 6 hours in the oven. The resulting banana cassava was ground using a blender and then sieved using an 80-mesh sieve to obtain banana flour.

Making tempeh flour

Making tempeh flour referred to Yulianti et al. (2019), Andriani et al.(2014), and Mursyid et al.(2014). The tempeh used to make flour is processed through two heating treatment stages before drying and steaming for 15 minutes. The purpose of the steaming process before drying was to reduce the unpleasant aroma of tempeh. The steamed tempeh was then cut into pieces ± 0.2cm thick and ± 3 cm long and then dried using an oven at 60℃ for 5 hours. The dry tempeh was then ground using a blender and sieved using an 80-mesh sieve to obtain tempeh flour.

Making flakes

Flake making was done according to Simbolon et al. (2017), Sukasih & Setyadjit(2017), and Nurhidayanti et al.(2017). Mix kepok banana flour and tempeh flour according to the treatment ratio and add 4.7g tapioca, 11.30g sugar, 4.16g margarine, 3.25g egg yolk, 1.40g salt, 0.19 g baking soda, and 10ml of water. All ingredients were mixed until a homogeneous dough was formed. The dough was flattened to a thickness of ± 1mm. The thin dough was molded using a round cake mold with a diameter of ± 2.5cm. The printed dough was placed and arranged on a baking sheet, followed by a roasting process using an oven at 105℃ for 45 minutes to produce flakes.

RESULTS AND DISCUSSIONS

Proximate analysis

The variance results showed that the different ratios of kepok banana flour and tempeh flour significantly affected moisture, ash, fat, protein, crude fiber, carbohydrate, and crispy flake resistance in milk. The average results of the proximate analysis of flakes are shown in Table 1.

Table 1 The result of the proximate analysis of flakes

Assessments	The ratio of kepok banana flour: tempeh flour			
	PT0	PT1	PT2	PT3
Moisture content (%)	$2.80^{d} \pm 0.19$	$2.43^{c} \pm 0.23$	$2.11^{b} \pm 0.04$	$1.77^{a} \pm 0.14$
Ash content (%)	$3.13^{a} \pm 0.04$	$3.20^{ab} \pm 0.04$	$3.25^{b} \pm 0.03$	$3.39^{c} \pm 0.10$
Fat content (%)	$4.99^{a} \pm 0.11$	$6.73^{b} \pm 0.19$	$8.80^{c} \pm 0.18$	$11.39^{d} \pm 0.18$
Protein content (%)	$2.75^{a} \pm 0.11$	$4.74^{b} \pm 0.17$	$6.79^{c} \pm 0.80$	$9.23^{d} \pm 0.22$
Crude fiber content (%)	$6.38^{d} \pm 0.08$	$6.05^{c} \pm 0.11$	$5.86^{b} \pm 0.04$	$5.52^{a} \pm 0.14$
Carbohydrate content (%)	$86.33^{d} \pm 0.31$	$82.90^{c} \pm 0.27$	$79.05^{b} \pm 0.94$	$74.22^{a} \pm 0.09$
Crispy resistance in milk* (minute)	$6.52^{a} \pm 0.05$	$6.71^{ab} \pm 0.14$	$6.89^{b} \pm 0.03$	$7.61^{c} \pm 0.23$

Note:
The different superscript notations in the same row show significant differences at the test level α = 5%
*Liquid milk with a milk temperature of 29ºC as much as 70 ml (1:5)

Moisture content

Based on Table 1, the water content of the flakes in the PT0 (100% kepok banana flour) treatment showed significantly different results from the other treatments. The moisture content of the flakes ranges from 1.77-2.80%. The moisture content increased with the high ratio of kepok banana flour to tempeh flour. Because the moisture content of kepok banana flour was higher than that of tempeh flour, the moisture content of flakes using more kepok banana flour will result in higher moisture content. The results of the water content analysis showed that the moisture content of the kepok banana flour obtained was 7.30%, and that of tempeh was 5.56%.

Moisture content was related to the fiber content of the material. Zaimah (2009) stated that fiber had high water absorption due to its large polymer size, complex structure, sizeable water-binding capacity, and free hydroxyl groups. The higher the fiber content in a material, the more water content would increase. The results showed that the fiber content of kepok banana flour and tempeh flours were 6.98% and 3.86%. The high fiber content in kepok bananas allowed for more water absorption, which caused the moisture content of PT0 (100% kepok banana flour) flakes to be the highest using kepok banana flour more than tempeh flour.

Another factor that caused the flakes moisture content in this study to be higher than in the commercial products was the difference in the flakes thickness and the surface area where the flakes in the commercial product were thinner than the flakes in this study. According to Muchtadi and Sugiyono (2013), several factors were influenced by the decrease in moisture content: drying time, drying temperature, and thickness or thinness of materials.

The moisture content of flakes obtained in this study met the SNI for cereals, where the moisture content requirement for cereal is a maximum of 3%. The flake moisture content in this study was higher than that of the commercial cornflakes, where the moisture content of the cornflakes was 1.84%. The flake moisture content in this study was higher because the raw material's moisture content is higher than the moisture content of commercial raw materials. Commercial products, "corn flake", were generally made from corn. Water content that is too high in flakes can affect the shelf life and crispness (Wahyuningsih et al. 2018).

This study found that the water content of the flakes was lower than the results of previous studies by Mahmudah et al.(2018). They got flake water content was 3.13–3.55% but close to the results of the research of Simbolon et al.(2017), where the water content obtained was 1.95–2.50%.

Ash content

Based on Table 1, the ash content of the flakes in the PT0 (100% kepok banana flour) treatment showed significantly different results from the PT2 (80% kepok banana flour: 20% tempeh flour) and PT3 (70% kepok banana flour: 30% flour tempeh) treatments. However, it was not significantly different from the PT1 treatment. The ash content of the flakes ranges from 3.13–3.39%. The resulting ash content increased along with the high ratio of tempeh flour to kepok banana flour. It was because the ash content of the tempeh flour was higher than the ash content of kepok banana flour. The ash content analysis results showed that the ash content of the kepok banana flour was 1.71%, and the tempeh flour was 3.21%. Differences also influenced the ash content of the flakes in the study's mineral content in the raw material. Winarno (2008) stated that a food product's ash content was related to the material's minerals. According to Mahmud et al. (2018), the mineral content in kepok bananas was 10 mg calcium, 300mg potassium, 10mg sodium, 30 mg phosphorus, 0.1mg copper, 0.2mg zinc, and 0.50mg iron. In comparison, tempeh contains 155mg of calcium, 234 of potassium, 9mg of sodium, 326mg of phosphorus, 0.57mg of copper, 1.7 mg of zinc, and 4mg of iron.

The ash content of the flakes in this study met the SNI for cereals, where cereal ash content was a maximum of 4%. The ash content of the flakes in this study almost matched the ash content in commercial products. The ash content in the commercial cornflakes product was 3.52%. The ash content of flakes in this study was greater than those made from banana kepok flour and arrowroot starch but lower than those made from rice bran flour and tempeh flour. Mahmudah et al.(2018) obtained ash content ranging from 2.25 to 2.50% in flakes made from banana kepok Samarinda with arrowroot starch substitution. Dianingtyas et al. (2018) obtained ash content ranging from 6.17–6.72% in bran and tempeh flour flakes.

Fat content

Based on Table 1, it can be seen that the fat content of flakes had a significant effect between treatments. Fat content increased from 4.99–11.39%, along with the increasing use of tempeh flour with high-fat content. The fat content of kepok banana flour was 0.51%, while the fat content of tempeh flour was 29.92%. Setyaningsih & Suraya (2021) mentioned that adding fat to the dough functioned as an emulsifier, an enhancer of the taste and texture of the product. In the manufacture of flakes can be added sources of fat in the form of egg yolks and margarine with the addition of 4.16 g and 3.25 g, respectively, in 100 g of dough. The fat content in egg yolk was 31.90%, and margarine was 81.00% (Mahmud et al., 2018).

This study's fat content of PT0 (100% kepok banana flour) and PT1 (90% kepok banana flour: 10% tempeh flour) treatments was lower than SNI for cereals. The minimum requirement for fat, according to SNI, is 7%. The fat content of PT0 (100% kepok banana flour) treatment was also lower than the commercial cornflakes, which was 5.78%. The low-fat content in the PT0 (100% kepok banana flour) and PT1 (90% kepok banana flour: 10% tempeh flour) treatments was caused by large amounts of kepok banana flour, namely 100% and 85%. Based on the study's result, the fat content of kepok banana flour was 0.51%. The additives are another factor that causes the fat content in this study to be lower than SNI for commercial cereals and flakes. Cereal products and flakes on the market generally use chocolate. Chocolate in 100 g of ingredients has a fat content of 42.6% (Mahmud et al., 2018).

The fat content of the flakes in this study was lower than the results of the study by Dianingtyas et al.(2018) but higher than the research results of the Mahmudah et al.(2018). Dianingtyas et al.(2018) obtained fat content ranging from 11.47–12.33% in bran and tempeh flour flakes. Mahmudah et al.(2018) obtained fat content ranging from 6.84 to 7.34% in flakes made from Samarinda kepok banana with arrowroot starch substitution.

Protein content

Based on Table 1, the protein content of flakes in PT0 (100% kepok banana flour) treatment showed significantly different results from other treatments. The protein flake content ranges from 2.75–9.23%. The protein content produced in this study increased along with the increasing use of tempeh flour. It was supported by the data analysis of raw materials, which showed that the kepok banana flour's protein content was 2.64%, and the tempeh flour was 27.50%. The protein content of this study's PT0 (100% kepok banana flour) and PT1 (90% kepok banana flour: 10% tempeh flour) treatment flakes did not meet the SNI quality standard for cereals, namely at least 5% and the commercial product flakes "cornflakes". It was due to differences in the raw materials used. Commercial cereals and flakes are generally made from wheat and corn. The research results by Murtini et al. (2005) obtained the protein content of various wheat flour varieties ranging from 8.13%. Mahmud et al. (2018) stated that in 100 g of ingredients, the protein content of corn flour is 9.2%. Using skim milk and chocolate in commercial cereals and flakes also affects protein content. In 100 g of ingredients, skim milk and chocolate's protein content was 35.6% and 8%.

The protein content of flakes in this study was higher than in previous studies by Mahmudah et al.(2018), which was 0.57–1.79%. Flakes in this study and previous studies used kepok banana flour but also used arrowroot starch. Arrowroot starch has a lower protein content than tempeh flour, where the protein content of arrowroot starch is 0.11% while tempeh flour is 27.50%. This causes the protein content in this study to be higher than in previous studies.

Crude fiber content

Based on Table 1, the crude fiber content of flakes in PT0 (100% kepok banana flour) treatment showed significantly different results from other treatments. The flakes crude fiber content ranges from 5.52–6.38%. The crude fiber content produced in this study increased along with using kepok banana flour because the crude fiber content of kepok banana flour was higher than the crude fiber content of tempeh flour. The crude fiber content analysis showed that the crude fiber content of Kepok banana flour was 6.98%, and tempeh flour was 3.86%. According to SNI, the crude fiber content of the flakes obtained in this study did not meet the quality standards of cereal, namely a maximum of 0.7%, and the commercial product "cornflakes" was 1.77%. This study's crude fiber content of flakes is higher than SNI and commercial products because of differences in the raw materials used. Generally made commercial cereals and flakes were from wheat and corn with lower fiber content.

Even though the flakes crude fiber content exceeds the quality standard, this could help fulfill the fiber per day. The daily need for fiber is based on research by the Research and Development Center for Nutrition, Ministry of Health of the Republic of Indonesia (2001) in Putri (2018), which stated that Indonesians need 6-15 g of crude fiber a day. The fiber content of these flakes was good for the health of the human body.

Carbohydrate content

Based on Table 1, the carbohydrate content of flakes in the PT0 (100% kepok banana flour) treatment showed significantly different results from the other treatments. The flake's carbohydrate content ranges from 74.22 to 86.33%. The more kepok banana flour and the less tempeh flour used, the carbohydrate content will increase due to because kepok banana flour's carbohydrate content is higher than the carbohydrate content of tempeh flour. The carbohydrate levels that have been carried out showed that the carbohydrate obtained from the kepok banana flour was 87.85%, and the tempeh flour was 33.82%. According to Ayustaningwarno (2014), carbohydrates were calculated using the formula 100% minus the total content of water, ash, fat, and protein. The higher the ingredient's total water, ash, fat, and protein content, the lower the carbohydrate content and vice versa. The level of carbohydrate flakes in this study did not only come from kepok banana flour and tempeh. The use of additional ingredients such as tapioca and sugar can also increase the flakes carbohydrate content. Mahmud et al. (2018) stated that in 100 g of ingredients, tapioca and sugar's carbohydrate and sugar content was 88.20% and 94.00%.

The results of previous research by Lawalata et al. (2018) and Mahmudah et al. (2017) obtained that carbohydrate flakes ranged from 81.8 to 85.72% and 84.79–87.19%. The carbohydrate content in this study was lower than the results of previous studies. It was due to the ingredient's carbohydrate content in making flakes. Previous studies used cornflour and arrowroot starch, which had higher carbohydrates than tempeh flour in this study, namely 86.35 and 86.39%.

Crispy resistance in milk

Table 1 shows that the crispy resistance of flakes in the milk ranges from 6.52–7.61 minutes. The resistance of crunchy flakes in milk in PT0 (100% kepok banana flour) treatment showed significantly different results with PT2 and PT3 treatments but not significantly different from PT1 treatment. The resistance of crispy flakes in milk increases with more and more use of tempeh flour. It was related to the starch content in the flakes. The more starch content in the flakes, the smaller the flakes crispy resistance in the milk. The starch content in kepok banana was 53.12% (Candra et al. 2021), and tempeh flour was 34.83% (Yulianti et al. 2019). The starch content in kepok bananas is higher than in soybeans, so the more use of kepok banana flour, the more starch content in the flakes would increase. According to Reyniers et al. (2018), starch played a role in forming the structure of the flakes. Water binds starch, and then with the high-temperature treatment, the starch is gelatinized and forms a cavity in the product structure. The more gelatinized starch, the more air cavities formed, making the flakes crisper. The more cavities formed when rehydration occurs, the more water would be trapped in the flakes, so the level of rehydration would increase. It caused the crispy resistance of the flakes in the milk to be smaller. The analysis of the resilience of the crunchy flakes in milk in this study aligns with the research of Mahmudah et al.(2018), which states that the more use of kepok banana flour, the lower the resistance of the crunchy flakes in milk.

Sensory assessment

The sensory test was conducted to see the panelists responses in describing and stating the preference level for the flakes produced. The resulting sensory test data is in Table 2.

Color

Table 2 showed that the more the use of tempeh flour, the more brown the flakes would be because the color of the tempeh flour was darker than the color of the kepok banana flour. The color of the kepok banana flour produced in this study was yellowish-white, while the tempeh flour obtained was brownish-yellow. The color of the flakes formed was the mixture of kepok banana flour and tempeh flour and the mixture of additional ingredients such as margarine and egg yolk. When mixed according to treatment, making flakes in this study would produce different dough colors. The dough's color got darker with the addition of increasing tempeh flour. The color of the tempeh flour was darker than the kepok banana flour.

Table 2 Flake sensory assessment data

Assessments	The ratio of kepok banana flour: tempeh flour			
	PT0	PT1	PT2	PT3
Descriptive sensory test:				
Color	$4.10^{c} \pm 0.55$	$3.03^{b} \pm 0.49$	$2.83^{b} \pm 0.46$	$2.47^{a} \pm 0.57$
Aroma	$4.07^{c} \pm 0.45$	$3.57^{b} \pm 0.50$	$2.60^{a} \pm 0.62$	$2.43^{a} \pm 0.63$
Crunchy	$4.23^{c} \pm 0.57$	$3.83^{b} \pm 0.65$	$3.70^{ab} \pm 0.53$	$3.50^{a} \pm 0.51$
Taste	$4.23^{c} \pm 0.68$	$3.37^{b} \pm 0.56$	$3.10^{b} \pm 0.45$	$2.20^{a} \pm 0.66$
Hedonic sensory test:				
Color	$4.24^{c} \pm 0.77$	$3.84^{b} \pm 0.58$	$3.62^{ab} \pm 0.60$	$3.42^{a} \pm 0.86$
Aroma	$4.12^{d} \pm 0.63$	$3.86^{c} \pm 0.50$	$3.56^{bc} \pm 0.54$	$3.04^{a} \pm 0.73$
Crunchy	$4.14^{c} \pm 0.57$	$3.90^{b} \pm 0.54$	$3.70^{ab} \pm 0.54$	$3.54^{a} \pm 0.58$
Taste	$4.04^{c} \pm 0.73$	$3.74^{b} \pm 0.63$	$3.52^{b} \pm 0.68$	$3.02^{a} \pm 0.68$
Overall assessments	$4.08^{c} \pm 0.49$	$3.72^{b} \pm 0.50$	$3.58^{b} \pm 0.54$	$3.08^{a} \pm 0.70$

Note: The different superscript notations in the same row show significant differences at the test level α = 5%

Descriptive score Color: 1. Very brown 2. Brown 3. Beige brown 4. Creamy 5. Very creamy. Aroma: 1. It has a very tempeh aroma 2. It smells like tempeh 3. It smells like between banana and tempeh 4. It smells like a banana 5. It has a very banana aroma. Crispy: 1. Not very crunchy 2. Not crunchy 3. A little crunchy 4. Crispy 5. Very crunchy. Taste: 1. The very taste of tempeh 2. Taste of tempeh 3. The taste between banana and tempeh 4. Taste of banana 5. The very taste of banana.

Hedonic score: 1. Very disliked 2. Disliked 3. Somewhat like 4. Like it 5. Very much like it

The formation of brown on the flakes was due to an enzymatic and non-enzymatic browning reaction. The enzymatic browning reaction occurred due to phenol oxidation catalyzed by the Polyphenol oxidase enzyme, causing a color change (Winarno, 2008). The formation of brown color was also caused by a non-enzymatic browning reaction, namely the Maillard reaction (Estiasih et al. 2016).

Table 2 showed that the more the use of kepok banana flour to tempeh flour, the more favorable the hedonic assessment of the color of flakes. Estiasih et al. (2016) stated that color was the main thing that affected food products quality attributes. The hedonic assessment of the color of the PT3 flakes was favored by the panelists, presumably because it had a less attractive color. Brown color in food products could be desired and undesirable (Kusnandar 2010). The panelists unwanted the brown color in the PT3 treatment because it looked less attractive.

Aroma

Table 2 showed that the less use of kepok banana flour and the more tempeh flour, the more flavorful the flakes aroma would be with tempeh. Conversely, the more kepok banana flour to tempeh flour, the more banana-flavored the flakes would be. According to Widjanarko (2012), the aroma of bananas results from the metabolism of leucine and then becomes 3-methyl butanol, 3-methyl butanoate, and 3-methyl butyl ester. All of them were compounds for forming aroma in bananas, so the more kepok banana flour, the more banana flavored the flakes.

Table 2 shows that the addition of kepok banana flour and tempeh flour affects the flavor of the flakes produced hedonically. The flakes preference level increased with more kepok banana flour and less tempeh flour. It was presumably because the panelists preferred banana's distinctive aroma to the distinctive aroma of tempeh (beany flavor). According to Kanetro (2017), using nuts and processed legume products unpleasant aroma is problematic. The lipoxygenase enzyme activity during soybean processing caused an unpleasant aroma, which reduced consumer preference for soy products. The compound that produced the most unpleasant odor was ethyl phenyl ketone. Lipoxygenase was very heating unstable, so during making tempeh flour, the tempeh was steamed to reduce the unpleasant aroma of tempeh.

Crunchy

Table 1 showed that the more use of kepok banana flour and the less use of tempeh flour, the more crispy the flakes were because the amylopectin content of kepok banana flour was higher than tempeh flour. Candra et al. (2021) obtained the research results that the amylopectin content of kepok banana flour was 80.8%. The research results by Ratnawati et al. (2019) received a soy amylopectin content of 24.13%. Products made from flour or starch high in amylopectin will have a crunchier texture. The ratio of amylopectin and amylose in starch affected the texture of the flakes. The higher the amylopectin, the more puffing would occur, making the resulting flakes porous, crunchy, and crunchy. This result was in line with Reyniers et al. (2018) opinion, which stated that starch would bind to water. With the high-temperature treatment, the starch was gelatinized to form cavities in the product structure, causing the product to become crunchy.

Table 2 shows that the addition of kepok banana flour and tempeh flour affects the crispiness of the flakes produced hedonically. More and more kepok banana flour would produce crisper flakes and be liked by the panelists. The crunchiness of the flakes was also related to the crispy resistance of the flakes. The crunchier texture of the flakes results in a lower crispy resistance in the milk. The crunchy flakes form cavities that cause the milk to be absorbed more efficiently so that the crispy resistance of the flakes in the milk will decrease.

Taste

Table 2 shows that the less use of kepok banana flour and the more tempeh flour was added, the flakes produced will taste more tempeh. Wang et al. (2019) stated that taste could come from the food. Candra et al. (2021) stated that the dominant flavor-giving compounds found in bananas were isoamyl acetate, butanoic acid, 3-methyl-3-methyl ester, hexanal, trans-2-hexanal, and 1-hexanol. Harahap et al. (2018) state that tempeh's flavor components are ester, terpenoids, alcohol, aldehyde, ketone, furan, and nitrogen-containing compounds.

Table 2 shows that the addition of kepok banana flour and tempeh flour affects the taste of the flakes produced hedonically. Along with the increasing use of tempeh flour, the panelists assessment of the flakes decreased. Adding more and more tempeh flour to manufacture flakes caused an unpleasant taste and a slightly bitter after-taste on the resulting flakes. According to Kanetro (2017), the lipoxygenase enzyme activity during soybean processing caused an unpleasant aroma and taste, reducing consumer preference for soy-processed products.

Overall assessments

Table 2 showed that the more and more tempeh flour was added, the panelists preference for flakes overall acceptance decreased. The increasing use of tempeh flour resulted in an unpleasant aroma on the flakes and a bitter after-taste that the panelists used less. Based on Table 2, it was concluded that the more use of kepok banana flour and the less use of tempeh flour, the panelists preference for the overall assessment of flakes increased. The panelists prefer PT0 (100% kepok banana flour) treatment flakes with a creamy color, banana aroma, crunchy, and banana flavor.

CONCLUSION

The ratio of kepok banana flour and tempeh flour in the manufacture of flakes significantly affected moisture, ash, fat, protein, crude fiber, carbohydrate content, crispy resistance in milk, and the resulting sensory quality. It was found that the ratio of kepok banana flour and tempeh flour (70:30) was the best treatment that produced flakes with a moisture content of 1.77%, ash content of 3.39%, fat content of 11.40%, and protein content. 9.23%, crude fiber content of 5.52%, carbohydrate content of 74.22%, and crispy resistance in the milk of 7.61 minutes with descriptions of brown color, aroma between banana and tempeh, crunchy texture, and taste between banana and tempeh. The hedonic sensory test on the selected PT3 treatment obtained flakes with aroma, taste, and overall assessment preferred, and panelists preferred crispiness. The physicochemical characteristics of flakes with the ratio of banana kepok flour and tempeh flour (70:30) have met SNI-01-4270-1996 regarding Cereal Quality Requirements, except for crude fiber content. The crude fiber content of these flakes did not meet SNI standards due to differences in the raw materials usedAlthough the crude fiber content of the flakes exceeds quality standards, this can help meet fiber per day.

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