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Physicochemical And Organoleptic Characteristics Of Flakes Based On Fermented Rice Bran And Beneng Taro Flour (*Xanthosoma undipesh* K.Koch)

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ABSTRACT

Flakes are a food product and are expected to be able to meet market demand by presenting products that are practical, easy to serve, and fulfill the body's nutritional content. This research aims to determine the level of consumer acceptance of flakes products based on taro beneng flour and fermented rice bran flour by varying the ingredient formulation: taro beneng flour, fermented rice bran flour, rice flour; and the baking time 15 and 20 minutes. The selected treatment will undergo further analysis regarding its physical (color, texture, and rehydration power) and chemical (moisture, ash, fat and crude fiber content) properties. The hedonic test results showed that the sample F1 (45:10:45)% obtained the highest favorability test results in term of color, aroma, taste, texture, and overall attributes. The selected treatments were formulations F1 (45:10:45)% and F2 (40:15:45)% with a baking time of 15 and 20 minutes. The physical characteristic test results include color (lightness 48.80 – 51.70), texture (0.68 – 0.89 N), and rehydration power (47.55 – 85)%; while the chemical characteristic test results include water (2.60 - 4.4)%, ash (2.74 – 3.14)%, fat (19.47 – 22.46)%, and crude fiber (19.78 – 23.06)%.

Keywords: beneng taro flour, flakes, fermented rice bran, organoleptic characteristic, physicochemical characteristic

INTRODUCTION

The impact of the post-covid-19 pandemic has resulted in consumers who usually buy food in restaurants preferring to package food or order it online (Ministry of Industry, 2021). According to Andriani (2022), during the Covid-19 pandemic, people choose to diversify their food and prioritize the quality of food products to meet the nutrition the body needs.

Fulfillment of nutrition is mainly done by having breakfast, not only to fulfill nutrition but also to provide energy for carrying out daily activities. With changes in lifestyle in the digital era and the impact of the post-pandemic, people prefer to fulfill their food needs instantly or practically, and have good nutrition to meet the body's needs. One of the food products commonly consumed for breakfast that can be served practically is flakes. Flakes are a form of dry food product which is served brewed with milk, a round, flat shape and is made from wheat flour (Susanti *et al.*, 2017).

Wheat as the raw material for flakes is a subtropical crop that is difficult to grow in Indonesia, so wheat imports are quite high and will have a negative impact on Indonesia's food security. Data from the Ministry of Agriculture (2018) shows that Indonesia is the largest wheat importing country after Türkiye. In order to reduce wheat imports, efforts are needed to diversify food by optimally utilizing local food resources as raw materials for making flakes.

The quality characteristic that really influences flakes products is texture. Maskan (2012) shows that the high starch content in flour as a raw material for flakes will produce a crunchy flakes texture. One of the flours that has a high starch content is rice flour with an amylopectin content of 88.22% and amylose of 11.78% of the starch (Immaningsih, 2012). Apart from rice flour, taro beneng flour, which is flour produced from taro beneng, an indigenous tuber of Banten Province, can also be used as a raw material for making flakes because of its high carbohydrate content with an amylopectin content of 37.02% and amylose of 19 .27% (Rostianti *et al.*, 2018). So far, the use of taro beneng is considered to be very minimal. As planting area and availability increases, it is hoped that the use of this commodity can increase added value, both selling value and use in food products, and increase product shelf life. Beneng taro flour contains the following levels of water, ash, fat and protein, respectively: 10.46%; 4.85%; 0.28%, and 3.4% (Rostianti *et al*., 2018).

One of the ingredients which is a by-product of the food processing process which is not used optimally is rice bran, so far it has only been used as animal feed. Rice bran is a by-product of rice milling. The rice milling process produces 70% rice (endosperm) as the main product, as well as several by-products such as husks (20%) and rice bran (8-10%) (Chen *et al*., 2012). Rice bran has water content of around 8.59-9.70%; ash 9.47-10.86%; fat 15.80-23.75%; crude protein 13.20-13.37%; carbohydrates 42.32-51.99%; and crude fiber 13.56-17.97% (Hartati *et al*., 2015). Other components contained in rice bran are phenolic components (1.96-6.65%), γ-oryzanol (1.52-9.12 mg/g), α-tocopherol (41.36-43.57μg/g) , γ-tocopherol (25.00-37.97 -μg/g) (Moongngarm *et al*., 2012).

The nutritional content and bioactive components of rice bran can be increased, one way is through the fermentation process. The fermentation process can improve the nutritional content, sensory characteristics and functionality of rice bran (Faizah, 2019). Rice bran that had been fermented for 48 hours with lactic acid bacteria will increase in phenolic levels to 2.85 mg/mL; antioxidants around 78.49%-78-79%; tocopherol 4.51 mg/L; γ-oryzanol 3.61 mg/L; and ferulic acid 0.82 mg/L (Sawangwan *et al*., 2020). Le *et al.,* (2019) also stated that unfermented rice bran had a phenolic compound content of 609.44 mg GAE/g, while rice bran that had been fermented with *Lactococcus lactis* will increase in the phenolic compound content to 844.13 mg GAE/g. Therefore, it is very possible that beneng taro flour and fermented rice bran can be used as raw materials for making flakes.

The ingredient formulation and baking time greatly influence the organoleptic and physicochemical characteristics of flakes. Research conducted by Aktas and Akin (2020) regarding the effect of adding rice bran and corn bran on the chemical properties of fermented cereal-based products, shows that cereals with the addition of 15% fermented rice bran can increase nutritional composition such as ash content of 3.64%; protein 16.39%; fat 6.91%; antioxidant activity 59.40%; and phenolic compounds

142.4 mg/100g. Research conducted by Maulida (2019) regarding the characteristics of nixtamal corn flour flakes substituted with various types of flour and baking time, showed that the selected treatment, namely nixtamal corn flour flakes substituted with sweet potato flour with a baking time of 20 minutes, had an average of water content 1.63%; starch content 42.71%; crude fiber content 2.43%; color parameters 3.71; aroma of 2.18 (slightly like); aroma on 2.09 (slightly like); taste 3.94 (like); and crispness 3.79 (like).

From the descriptions above, this research needs to be carried out. The selection of selected treatments was carried out based on the results of an organoleptic test using the effectiveness index method (De Garmo) to analyze the physical and chemical characteristics of the flakes product.

MATERIALS AND METHODS

Tools and Materials

The tools used in making flakes are an oven (Maspion),gas stove (Rinnai-Ceflon), mixer (Philips, HR-1530), baking pan, blender (Philips, HR2115), freezer (GEA), basin, and spatula. Meanwhile, the tools used in the analysis are UTM (AND, USM-500N), chromameter (Colorflex, EZ), furnace (Suhaterm, EU-1222-TO-041), fumehood (Bio Clamb), oven (Memmert, UN55), waterbath (Memmert), analytical balance (Excellent, HZK), digital scale (Kova), hot plate (C-MAG HS7), and a set of glassware (Pyrex).

The material used in making flakes is beneng taro flour obtained from Sindangheula Village, Pabuaran District, Serang Regency. Fermented rice bran (Cap 3 Ikan) obtained from PT. Seraya Halal Indonesia, rice flour (rose brand), chicken eggs, water, sugar (Gulaku), milk powder (Dancow), chocolate bar (Colatta Milk Chocolate), baking soda (Koepoe-Koepoe), vanilla powder (Koepoe-Koepoe), margarine (Royal Palmia), backing paper, and salt (Refina). Meanwhile, the materials used in the analysis are distilled water, HCl (merck), 70% alcohol (merck), H_2SO_4 (merck), NaOH (merck), n-hexane (Merck), acetone (merck), ethanol (merck), fat-free cotton, tissue, gloves, filter paper (Whatman), aluminum foil (Klinpak).

Flakes Making

Flakes making refers to research of Nasution (2019) with modification. The initial step is mixing all the ingredients such as beneng taro flour, fermented rice bran flour, and rice flour until homogeneous. Next, add milk powder, eggs, sugar, baking soda, vanilla powder, margarine and salt to the dry ingredient mixture. The mixture of ingredients is then mixed using a mixer until homogeneous. Once homogeneous, the dough is steamed for five minutes at 100°C. After steaming, the dough is cooled and molded by flattening it using a roller and cutting. The flattened dough is then placed on a baking sheet and baked in the oven at 120°C for the specified time (15 and 20 minutes). The formulation for making flakes can be seen in Table 1. The flow diagram for making flakes can be seen in Figure 1.

Organoleptic Test

The test that carried out is a hedonic test to determine the level of liking or acceptance of the panelists (Garnida, 2020). The parameters tested are color, aroma, taste, texture and overall. This test involved 35 untrained panelists. To observe color, aroma, texture and overall parameters, the product is served directly, while to observe taste parameters the product is served mixed with warm milk. Panelists were asked to rate each test parameter on a scale of 1 to 7 as follows: 1 = strongly dislike, 2 = dislike, 3 = slightly dislike, 4 = neutral, 5 = slightly like, 6 = like, and 7 = strongly like. Next, the data obtained will be summarized and processed further to determine the selected treatment.

Determination Selected Treatment (de Garmo Method)

Determination of the selected treatment is carried out based on the results of organoleptic tests on eight treatment samples and the four best treatments will be selected. To determine the selected treatment, using the de Garmo method (Linangsari *et al.*, 2022).

This method is carried out by determining the weighted value for each test parameter with a relative number of 0-1. The weighted value will depend on the level of importance of the respective test parameters whose results are obtained as a result of the treatment. After determining the weighted value of each test parameter, the treatment effectiveness value for each test parameter will be calculated. The final step is to calculate the result value of each treatment for each parameter. The following is the formula used to determine the weighted value, effectiveness value, and outcome value.

$$\text{Weighted value} = \frac{\text{Total value per test parameter}}{\text{Total value of all test parameters}}$$

$$\text{Efectiveness Index} = \frac{\text{Treatment value} - \text{lowest value}}{\text{highest value} - \text{lowest value}}$$

$$\text{Outcome value} = \text{Weighted value x Efectiveness Index}$$

After that, the values of all test parameters per treatment are added up and ranking is made to determine the highest to lowest total values. The treatment with the highest value can be declared as the selected treatment and will be continued for analysis of physical and chemical characteristics.

Physical Characteristics Analysis

Color (Siwi, 2018)

Color measurements are carried out by chromameter (Colorflex, EZ) Measurements were carried out three times in different areas and averaged. Color testing is carried out to determine the color results L*, a*, b*. The three coordinates L*, a*, b* represent color chromaticity (L*, L=0 represents black and L=100 represents white). The chromaticity is between red and green (a*, a* positive value represents red and a* negative value represents green), and the chromaticity b* yellow and blue (b* positive value represents yellow and b* negative value represents blue).

Texture (Irviani, 2014)

Texture analysis was carried out using a tensile strength tool, namely UTM (AND, USM-500N), by placing flakes on a coaster and then a needle. The value listed on the screen is the texture value, the gauge is lowered slowly until the flakes break, the value listed on the screen is the texture value, expressed in units (N).

Rehydration Power (Chandra et al., 2017)

Rehydration power measurements were carried out to determine the ability of the flakes to absorb water after drying. Measurement of rehydration power is carried out by weighing the sample using a digital balance of 1 gram (A), then immersing it in 100 mL of water for 5 minutes. The flakes were drained for 2 minutes, and the final weight of the flakes was weighed (B). The rehydration power of flakes can be obtained using the following equation.

$$\text{Rehydration power (\%)} = \frac{\text{B-A}}{\text{A}} \text{ x } 100\%$$

Note:

A : Weight of flakes before soaking (g)

B : Weight of flakes after soaking (g)

Chemical Characteristics Analysis

Water Content (AOAC, 2005)

The aluminum cup was kept at a constant temperature of 105°C, then cooled in a desiccator and weighed (W0). The fine sample was weighed 2 grams in a aluminum cup of constant weight (W1), then the sample was dried in an oven at 105°C for six hours. After that, the sample was cooled in a desiccator for 30 minutes and weighed (W2). This stage is repeated until the sample reaches a constant weight. Calculation of water content is carried out using the following formula.

$$\text{Water Content (\%)} = \frac{W_1 - W_2}{W_1 - W_0} \times 100\%$$

Ash Content (AOAC, 2005)

The porcelain cup was kept at a constant temperature of 105°C, then cooled in a desiccator and weighed (W0). The fine sample was weighed as much as 1 gram in a constant porcelain cup (W1), then the sample was burned on a stove with plate until it was smokeless and continued with ashing in a furnace at a temperature of 600°C until white. After that the sample was cooled in a desiccator and weighed (W2). These steps are repeated until the weight is constant. Calculation of ash content is carried out using the following formula.

$$\text{Ash Content (\%)} = \frac{W_1 - W_2}{W_1 - W_0} \times 100\%$$

Fat Content (AOAC, 2005)

The weight of the fat flask to be used is constant at temperature of 105°C, then cooled in a desiccator and weighed (W2). A fine sample of 5 grams (W1) and wrapped in filter paper in the form of a sleeve. The sample is then put into a soxhlet which has been connected to a fat flask. Hexane solvent is poured until the sample is submerged and extraction is carried out for 6 hours or until the fat solvent that drops into the fat flask is clear in color. The fat solvent has been used, distilled, and stored. The fat extract in the fat flask is then dried in the oven at 105°C until the weight is constant. The fat flask was cooled in a desiccator and weighed (W3). Calculation of fat content is carried out using the following formula.

$$\text{Fat Content (\%)} = \frac{W_3 - W_2}{W_1} \times 100\%$$

Crude Fiber Content (AOAC, 2005)

2.5 g fine sample (W1) placed in a 100 mL beaker glass. The sample was added with 15 mL of 96% ethanol and stirred for 30 seconds. The sample solution was left for 15 minutes. The sample is filtered using constant filter paper. The sample precipitate was added with 45 mL of ethanol and filtered. The filter paper is dried in an oven at 105°C until the filtrate is dry and placed in a desiccator for 15 minutes. The filtrate was scraped, then put into a beaker glass and 50 ml of 1.25% H_2SO_4 was added. The solution was covered with aluminum foil and heated in a waterbath at 60°C for 30 minutes. The solution was added with 50 mL of 3.25% NaOH then heated again in a waterbath at a temperature of 60°C for 30 minutes. The solution was filtered using constant Whatman filter paper and known weight (W2). The filter paper was washed with 25 mL of hot 1.25% H_2SO_4, 50 mL of hot distilled water, and 25 mL of ethanol. The filter paper is dried until constant weight (W3). Crude fiber content is calculated based on the following formula.

$$\text{Crude Fiber Content (\%)} = \frac{W_3 - W_2}{W_1} \times 100\%$$

Statistical Analysis

The research design used was a factorial Completely Randomized Design (CRD) consisting of 2 factors. The first factor is the variation in the formulation of beneng taro flour, fermented rice bran and rice flour, namely F1 (45% : 10% : 45%), F2 (40% : 15% : 45%), F3 (35% : 20 % : 45%), and F4 (40% : 25% : 45%). The second factor is baking time which consists of 2 levels, namely W1 = 15 minutes and W2 = 20 minutes. The data obtained was then analyzed using ANOVA (Analysis of Variance) at α=5% to determine whether there was a real influence on each test parameter. If it shows a significant difference, then proceed with the Duncan's Multiple Range Test (DMRT) at $\alpha = 5\%$ to determine the level of treatment that provides a significant difference.

RESULTS AND DISCUSSION

Organoleptic Test

Organoleptic testing is a method used to test the quality of a material or product using the five human senses based on preferences and desires for a product (Garnida, 2020). Thus, in organoleptic testing the human senses function as a tool in testing to determine the level of liking or acceptance of a product being tested. This research using hedonic test, because it is to determine the panelists' preferences for new products. The results of organoleptic tests on flakes products of four formulations and baking times of 15 and 20 minutes are shown in Figure 2.

Color

Color is an important attribute in determining the quality of food products, because consumers will usually see the product initially from its physical appearance from the outside. Colors that are bright, not dull, not dark will usually attract consumer to buy or consume it.

According to Garnida (2020), color is a physical property that characterized by the distribution of the light spectrum. Without light, the material or product will not be visible or show its color. The data shows that the color of the flakes product is good in formulas F1 to F4 with a baking time of 15-20 minutes ranging from 4.31 - 4.94 (neutral to slightly like).

The highest value was obtained for the F1 sample with baking for 15 minutes, namely 4.94 (neutral to slightly like); and the lowest value was obtained for sample F2 with baking for 20 minutes is 4.34 (neutral to slightly like). Based on this data, it is known that panelists prefer flakes products with a ratio of Beneng Taro Flour: Fermented Rice Bran: Rice Flour = 45%:10%:45%, where the amount of fermented rice bran flour added is the lowest. The preferred color of flakes is thought to be bright brown. Table 3 shows that the lightness value of the F1 sample with a baking time of 15 minutes is 50.83, which is higher than the F2 sample with a baking time of 20 minutes, namely 50.08. This is because there are phytochemical compounds in rice bran flour which can produce a brown color. Paramita and Widya (2015), also stated that in making flakes a mailard reaction occurs because the sugar will react with the protein at the baking temperature which produces a brown color on the surface of the product.

Aroma

Aroma is a sensory attribute that can be measured using the sense of smell. The aroma of an ingredient or food product can be detected by panelist sense of smell when the volatile compounds contained therein enter the nose and are responded to by the olfactory system. In this regard, Garnida (2020) explains that aroma attributes can be detected when the material or product contains volatile compounds and has sufficient concentration to interact with one or more olfactory receptors. The volatility of food materials or products is influenced, among other things, by the condition of their surface, for example, materials or products that have a soft, porous and moist surface cause volatile compound to evaporate more easily compared to materials or products that have a hard surface. Apart from that, volatile compounds will also usually come out of the material due to factors such as enzymatic reactions and physical treatment (cutting, heating, etc.).

The results of organoleptic tests on the aroma attributes of flakes products for both formulas F1 to F4 with a baking time of 15-20 minutes ranged from 4.46 – 5.09 (neutral to slightly like). The highest aroma value was obtained for sample F1 with baking for 20 minutes, namely 5.09 (slightly like to like) and the lowest value was obtained for sample F4 with baking for 20 minutes, namely 4.46 (neutral to slightly like). Based on this data, it is known that the F1 formulation produces an aroma that is preferred by panelists, where the amount of rice bran flour added is the lowest so that the aroma of fermented rice bran is not too pronounced. The addition of fermented rice bran flour in increasing quantities resulted in the aroma of the flakes product being undesirable, that rancid aroma that comes from fermented rice bran. This is because rice bran flour has a pleasant aroma and easily experiences rancidity caused by enzymatic lipase hydrolysis and oxidative rancidity (Gionte *et al.*, 2022). The use of additional ingredients such as sugar, milk powder, milk chocolate and margarine also play a role in the formation of the aroma of flakes products (Fauzi *et al.*, 2019). Baking process also causes the Maillard reaction which produces flavor in a food product such as aldehydes, furanones, etc (Rosida *et al.*, 2013), the Maillard reaction takes place quickly at a temperature of 100°C (Ulpiana, 2018), while the temperature used in baking flakes is 120°C.

Taste

According to Garnida (2020), taste is defined as a gustatory perception (salty, sweet, sour, bitter) caused by substances dissolved in the mouth; while flavor is defined as the sum of perceptions resulting from stimulation of the sensory tips grouped together at the entrance to the digestive and respiratory tract (taste and aroma). The hedonic test results on the taste attributes of flakes products in both formulas F1 to F4 with a baking time of 15-20 minutes ranged from 3.09 – 5.51 (slightly dislike to slightly like). The highest value was obtained for sample F1 with baking for 20 minutes namely 5.51 (slightly like to like), while the lowest value was obtained for sample F4 with baking for 15 minutes namely 3.09 (slightly dislike to neutral). This shows that the flakes that the panelists liked most were flakes with the lowest amount of fermented rice bran flour added which had a sweet taste and a slightly sour aftertaste. Research of Gionte *et al.* (2022) also shows a decrease in the level of preference for flakes as more bran is added. Just like the aroma attribute, the formation of taste attributes in the food processing process is also influenced by the addition of additional ingredients such as sugar, milk powder, chocolate bars, salt and margarine. Baking process also causes the Maillard reaction which produces taste in a food product such as acetylformoin, pyrazine, pyrroline, etc (Hustiany, 2016), the Maillard reaction takes place quickly at a temperature of 100°C (Ulpiana, 2018), while the temperature used in baking flakes, is 120°C.

Texture

The texture of food ingredients has an important role in the level of consumer acceptance and market value. Food product texture is a collective term for sensory experiences originating from visual and audio stimuli (Garnida, 2020). Consumers usually have varying expectations for different types of food products. Texture attributes are different from color and taste attributes, texture is often used as an indicator of food quality while color and taste are often used as indicators of food safety. The texture of flake products is usually closely related to the crispness of the product. The organoleptic test results on the texture attributes of flakes products in formulas F1 to F4 with a baking time of 15-20 minutes ranged from 4.34 – 5.37 (neutral to slightly like). The highest value was obtained for sample F1 with baking for 15 minutes, while the lowest value was obtained for sample F4 with baking for 20 minutes. Based on this, it shows that the

F1 sample with 15 minutes of baking has good crispness.

Overall

Overall is a parameter to determine the overall level of liking for flake products which is assessed from the parameters of color, aroma, taste and texture. The organoleptic test results on the overall attributes of flakes products in formulas F1 to F4 with a baking time of 15-20 minutes ranged from 3.74 – 5.31 (slightly dislike to slightly like). The highest value was obtained for sample F1 with baking for 15 minutes, while the lowest value was obtained for sample F4 with baking for 15 minutes.

Determining the Selected Treatment

Determination of the selected ingredient formulation treatment and baking time for making flakes based on taro beneng flour and fermented rice bran flour using the de Garmo effectiveness test method. In principle, this method is carried out by adding up the values or weights given according to the contribution of each parameter to each treatment. The weight is determined according to the priority level of each parameter that influences the results of the research or the level of consumer acceptance determined by standard in SNI, BPOM, or published article. The treatment with the highest total weight is determined as the selected treatment. Determining the selected treatment in the flakes making process can be seen in Table 2. and image of all flakes can be seen in Figure 3. The number of samples selected was four treatments because they amounted to half of all treatments.

From Table 2, it can be seen that those with the highest ranking were treatments F1W1, F1W2, F2W1, and F2W2, respectively. The four samples were then physically and chemically characterized to determine their quality characteristics.

Physical Characteristics

The physical characteristics of flakes include color, texture, and rehydration power, the results as shown in Table 3.

Color

Color is one of the attributes of food quality that plays a big role in determining what should be consumed. Often the first element to pay attention to in the appearance of a food product is color. Color is a response to the human sense of sight to light stimulation, where rays or light that hits an object can be refracted, reflected, or absorbed by that object. According to Garnida (2020), lightness is an attribute of a visual sensation according to what the object or thing looks like so that it looks more or less bright; as a trait, it is said to be bright or bright, and dull or dark.

The lightness value of flakes products with treatment F1 and F2 with a baking time of 15-20 minutes ranged from 48.80 – 51.70 shown in Table 3. The highest value was obtained in treatment F1 with a baking time of 20 minutes, and the lowest value was obtained in treatment F2 with baking for 15 minutes. This shows that flakes treated with F1 with a baking time of 20 minutes have the brightest color compared to the other three flake products. The addition of more rice bran flour causes the color of the flakes to tend to be browner. This is due to the phytochemical content found in rice bran which can cause a brown color (Gionte *et al.*, 2022). This lightness result is in accordance with the resulting ^{o}hue value, which is in the range of 63-64^{o}, that shows a yellow to reddish color.

Texture

Texture is all the rheological and structural attributes of materials that are measurable mechanically, visually, and auditorily; which is the quality of food that can be felt by the hands, fingers, tongue, palate and teeth (Garnida, 2020). For solid food products, sensory experiences related to fracture strength may be the most relevant texture features. According to Astarini *et al* (2014), texture is a value that shows the resistance of the food material to the pressure applied which is also related to the crispness of the product. An increasing texture value indicates an increase in the product's hardness.

The texture of the flake products in Table 4 ranges between (0.68 – 0.89) N, where the highest texture was obtained in flakes with F2 treatment at a baking time of 20 minutes, and the lowest texture was obtained in flakes with F1 treatment at a baking time of 15 minutes. This is because increasing the amount of rice bran can influence the texture of the flakes to become harder which is caused by an increase in the fiber content contained in the rice bran and the concentration of starch content, namely taro beneng, decreases. Starch contains amylose and amylopectin, where the amylopectin content in the ingredients has an important role in texture formation, namely the higher the amylopectin content, the resulting product has characteristics that are crunchy and porous (Gionte *et al.*, 2022). This is can also be seen in the results of the hedonic test of texture in Figure 2, which shows that the more fermented rice bran or the less beneng taro flour added to the flakes dough, the lower the panelists' acceptance of the texture.

Rehydration Power

Rehydration power or water absorption capacity is the ability of food ingredients or products to absorb water. This of course affects the texture or crispness of the flakes when served by adding milk as a breakfast menu, high water absorption capacity will result in a decreased level of crispiness. Astarini *et al*. (2014) stated that because flakes are a ready to eat cereal type product, when served they are expected to maintain their crunchiness. According to Gandhi *et al.* (2012), a good quality breakfast cereal product must be able to maintain its crispness for more than two minutes in a bowl of milk.

The rehydration power value of flakes products ranges between (47.55 – 85.18%). The highest water absorption value was obtained from flakes products with F1 treatment with a baking time of 15 minutes, while the lowest water absorption value was obtained from flakes products with F2 treatment with a baking time of 20 minutes. Based on this data, the desired flakes are flakes with F2 treatment with a baking time of 20 minutes because they can maintain their crispness when served with water. Water absorption capacity is influenced by the chemical content of materials such as starch content, especially the ratio between amylose-amylopectin, and water-soluble fiber which has the ability to bind and swell in water (Astarini *et al.*, 2014).

Chemical Characteristics

Chemical characteristics of flakes including water, ash, fat and crude fiber content are shown in Table 4

Water Content

The water content of flakes products will affect their texture or crunchiness. According to Astarini *et al*. (2014) stated that the difference in water content is caused by the starch and fiber content in composite flour, where starch has the property of being able to absorb water due to the presence of hydroxyl groups which can cause starch granules to absorb more water. Apart from that, fiber also has a high ability to bind water, especially soluble fiber which binds water strongly, but this bond can easily be affected by evaporation during the drying process because it is classified as a free water type.

From the results, it is known that the water content value of flakes ranges from 2.60% - 4.40%, where this value is still slightly above the minimum limit set in the cereal standard, namely a maximum water content of 3% (SNI 01-4270-1996). The highest flake water content was obtained in samples F2 with a baking time of 15 minutes, and the lowest water content was obtained in flakes treated with F1 with a baking time of 20 minutes. This shows that the more rice bran flour added, the higher the water content and the heating process can evaporate the free water content in the material so that the water content becomes lower. Samples F1W2 and F2W2 contain water content of 2.19% and 2.3% which is in accordance with the maximum standard for water content based on SNI 01-4270-1996, namely 3%.

Ash Content

The ash content in products is influenced by several things, such as the type of ingredients, drying time and temperature, as well as the use of high temperatures for a long time. The ash content of flakes obtained from the test results ranged from 2.74% - 3.14%, where flakes with F2 treatment at a baking time of 20 minutes had the highest ash content and conversely flakes with F1 treatment at a baking time of 15 minutes had the lowest ash content. This shows that a longer baking process can evaporate more water so that the water content decreases and the ash content increases, and the disappearance of organic compounds, so that remaining heat-resistant mineral compounds remain more concentrated. The addition of higher rice bran flour results in the ash content also increasing.

This is due to the high ash content in fermented rice bran, namely 8.98%. The ash content of these flakes meets cereal quality standards, namely a maximum ash content of 4% (SNI 01-4270-1996).

Fat Content

The fat content of the flakes obtained showed a value between 19.47% - 22.46%, the flakes with the highest fat content were obtained from the F2 treatment with a baking time of 15 minutes, while the flakes with the lowest fat content were from the F1 treatment with a baking time of 20 minutes. The high fat content contained in flakes products is directly proportional to the amount of fermented bran added. This is in line with research conducted by Gionte *et al.* (2022), namely the high fat content due to the addition of more fermented rice bran, resulting in the fat content in the flakes increasing. Rice bran has a fairly high fat content, namely 15.84% (Coritama *et al.*, 2021). The fat content in the flakes produced is higher than the quality requirements for cereal products based on SNI 01-4270-1996, namely a minimum of 7%.

Crude Fiber Content

The crude fiber content of the flakes produced ranges from 19.78% – 23.06%. The increase in crude fiber content is directly proportional to the addition of fermented rice bran in the flakes making process. According to Gionte *et al.* (2022), the addition of fermented rice bran resulted in an increase in crude fiber content, because rice bran is the inner part of the skin which contains more fiber than rice. The highest crude fiber content was obtained from flakes with F2 treatment for a baking time of 15 minutes, and the lowest crude fiber content value was obtained from flakes with F1 treatment for a baking time of 15 minutes.

The high crude fiber content in flakes is due to the addition of rice bran which has a crude fiber content of around 11.4 g in 100 g of rice bran (Coritama *et al.*, 2021). Rice bran contains more insoluble fiber than water soluble fiber, which is approximately 2%. The insoluble fiber in rice bran consists of around 8.7-11.4% cellulose, 9.6-12.8% hemicellulose, and some lignin (Cho and Dreher, 2001; Permana and Putri, 2015).

CONCLUSIONS

The results of the organoleptic test show that the treatment of the ingredient formulation between beneng taro flour, fermented rice bran flour, and rice flour affects the aroma, taste, texture, and overall attributes but does not affect the color attribute. From several treatments, the formulation of taro beneng flour: fermented rice bran: rice flour at 45%: 10%: 45% obtained the highest favorability test results in terms of color, aroma, taste, texture and overall attributes.

Determining the selected treatment using the effectiveness value by de Garmo method of the organoleptic test results obtained the first to fourth selected rankings respectively as follows: treatment F1W1 (beneng taro flour: fermented rice bran: rice flour at 45%: 10%: 45%, baking 15 minutes), F1W2 (beneng taro flour : fermented rice bran : 45% rice flour : 10% : 45%, baking 20 minutes), F2W1 (beneng taro flour : fermented rice bran : 40% rice flour : 15% : 45%, baking 15 minutes), and F2W2 (beneng taro flour : fermented rice bran : rice flour at 40% : 15% : 45%, baking 20 minutes).
Physical characteristic test results including color, texture, and rehydration power respectively ranged from 48.80 – 51.70 (lightness), 0.68 – 0.89 N, and 47.55% – 85.18%; while the chemical characteristic test results include water, ash, fat, and crude fiber content respectively ranging from 2.60% - 4.4%; 2.74% – 3.14%; 19.47% – 22.46%; 19.78 – 23.06%.

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Table 1. Flakes formulation in 220 grams

Ingredients (g)	Formulation			
	F1	F2	F3	F4
Beneng taro flour	45.00	40.00	35.00	30.00
Fermented rice bran	10.00	15.00	20.00	25.00
Rice flour	45.00	45.00	45.00	45.00
White sugar	25.00	25.00	25.00	25.00
Salt	1.00	1.00	1.00	1.00
Milk powder	15.00	15.00	15.00	15.00
Margarine	30.00	30.00	30.00	30.00
Baking soda	1.00	1.00	1.00	1.00
Bar chocolate	1.00	1.00	1.00	1.00
Vanila powder	0.86	0.86	0.86	0.86
Egg	25.00	25.00	25.00	25.00

Note:
F1 = Beneng taro flour : Fermented rice bran : Rice flour = 45% : 10% : 45%
F2 = Beneng taro flour : Fermented rice bran : Rice flour = 40% : 15% : 45%
F3 = Beneng taro flour : Fermented rice bran : Rice flour = 35% : 20% : 45%
F4 = Beneng taro flour : Fermented rice bran : Rice flour = 30% : 25% : 45%

Table 2. Results of Determining the Selected Treatment by de Garmo Method

Formula	Number of Result Values	Ranking
F1W1	0.9647	1
F2W1	0.7052	3
F3W1	0.1936	7
F4W1	0.2919	6
F1W2	0.8423	2
F2W2	0.5414	4
F3W2	0.4406	5
F4W2	0.1074	8

Note: Samples with a yellow background are selected samples which will then be analyzed for their physical and chemical characteristic

Table 3. Physical Characteristics of Selected Treatment Flakes

Parameter	Formulation of Beneng Taro Flour : Fermented Rice Bran : Rice Flour (F)	Baking Time (W)		Average
		15 Minutes (W_1)	20 Minutes (W_2)	
L*	45% : 10% : 45% (F_1)	50.83 ± 1.37^a	51.70 ± 1.73^a	51.27^F
	40% : 15% : 45% (F_2)	49.80 ± 0.51^a	50.08 ± 1.47^a	49.94^F
	Average	50.32^X	50.89^X	50.60
a*	45% : 10% : 45% (F_1)	11.41 ± 0.34^a	11.26 ± 0.46^a	11.33^F
	40% : 15% : 45% (F_2)	11.12 ± 0.67^a	11.38 ± 0.35^a	11.25^F
	Average	11.26^X	11.32^X	11.29
b*	45% : 10% : 45% (F_1)	22.97 ± 0.12^a	23.23 ± 0.36^a	23.10^F
	40% : 15% : 45% (F_2)	22.12 ± 0.48^a	23.48 ± 0.54^a	22.80^F
	Average	22.54^X	23.36^Y	22.95
Texture (N)	45% : 10% : 45% (F_1)	0.68 ± 0.01^a	0.72 ± 0.08^a	0.68^F
	40% : 15% : 45% (F_2)	0.80 ± 0.04^a	0.89 ± 0.78^a	0.84^G
	Average	0.74^X	0.80^X	0.77
Rehydration Power (%)	45% : 10% : 45% (F_1)	85.18 ± 3.99^c	75.28 ± 3.85^b	80.23^A
	40% : 15% : 45% (F_2)	70.30 ± 0.41^b	47.55 ± 3.46^a	58.92^B
	Average	77.74^X	61.41^Y	69.57

Note: Numbers followed by the same letters in columns or rows are not significantly different based on the 5% DMRT test. The letter FG shows the influence of the factor formulation (F). The letter XY shows the influence of the factor of baking time (W). Meanwhile, abc letters indicate the interaction between the two factors.

Table 4. Chemical Characteristics of Selected Treatment Flakes

Parameter	Formulation of Beneng Taro Flour : Fermented Rice Bran : Rice Flour (F)	Baking Time (W)		Average
		15 Minutes (W_1)	20 Minutes (W_2)	
Water Content	45% : 10% : 45% (F_1)	4.33 ± 0.23^a	2.19 ± 0.98^a	3.26^F
	40% : 15% : 45% (F_2)	4.41 ± 0.25^a	2.30 ± 0.86^a	3.36^F
	Average	4.37^X	2.24^Y	3.31
Ash Content	45% : 10% : 45% (F_1)	2.74 ± 0.07^a	2.94 ± 0.35^a	2.84^F
	40% : 15% : 45% (F_2)	3.17 ± 0.18^a	3.19 ± 0.57^a	3.18^F
	Average	2.96^X	3.07^X	3.01
Fat Content	45% : 10% : 45% (F_1)	19.75 ± 0.94^a	19.47 ± 0.87^a	19.61^F
	40% : 15% : 45% (F_2)	22.36 ± 0.26^a	20.73 ± 0.52^a	21.54^G
	Average	21.05^X	20.10^X	20.58
Crude Fiber Content	45% : 10% : 45% (F_1)	19.78 ± 1.05^a	19.96 ± 0.06^a	19.87^F
	40% : 15% : 45% (F_2)	23.06 ± 1.11^a	22.06 ± 0.42^a	22.56^G
	Average	21.42^X	21.01^X	21.21

Note: Numbers followed by the same letters in columns or rows are not significantly different based on the 5% DMRT test. The letter FG shows the influence of the factor formulation (F). The letter XY shows the influence of the factor of baking time (W). Meanwhile, abc letters indicate the interaction between the two factors.

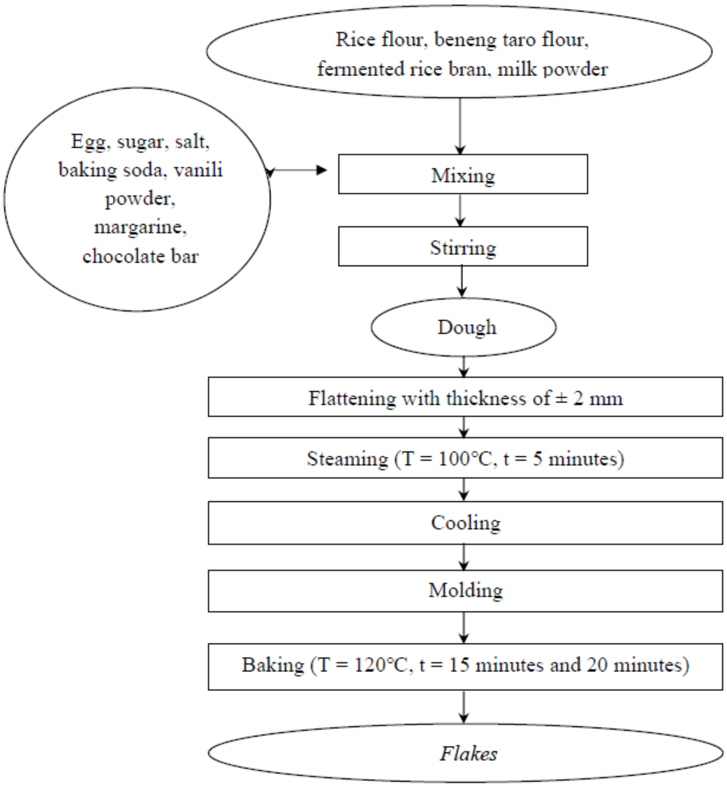

Figure 1. Flow chart for making flakes (Nasution, 2019 with modification)

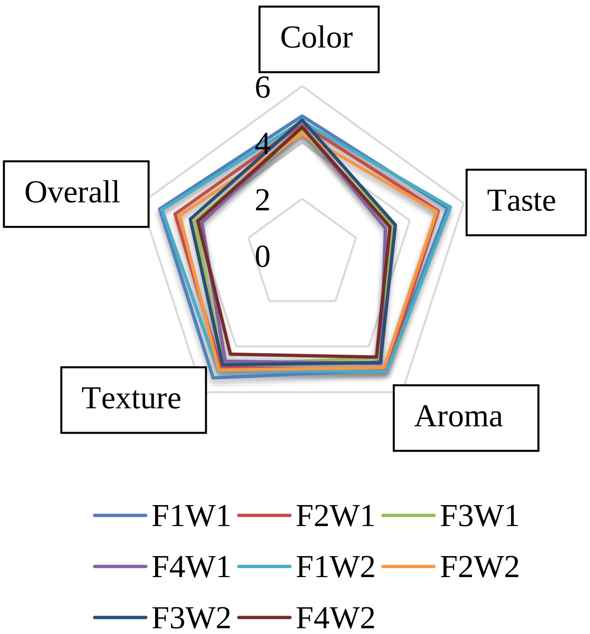

Figure 2. Organoleptic test result of flakes

Notes:

F1 = Beneng taro flour : Fermented rice bran : Rice flour = 45% : 10% : 45%
F2 = Beneng taro flour : Fermented rice bran : Rice flour = 40% : 15% : 45%
F3 = Beneng taro flour : Fermented rice bran : Rice flour = 35% : 20% : 45%
F4 = Beneng taro flour : Fermented rice bran : Rice flour = 30% : 25% : 45%
W1 = Baking time of 15 minutes
W2 = Baking time of 20 minutes

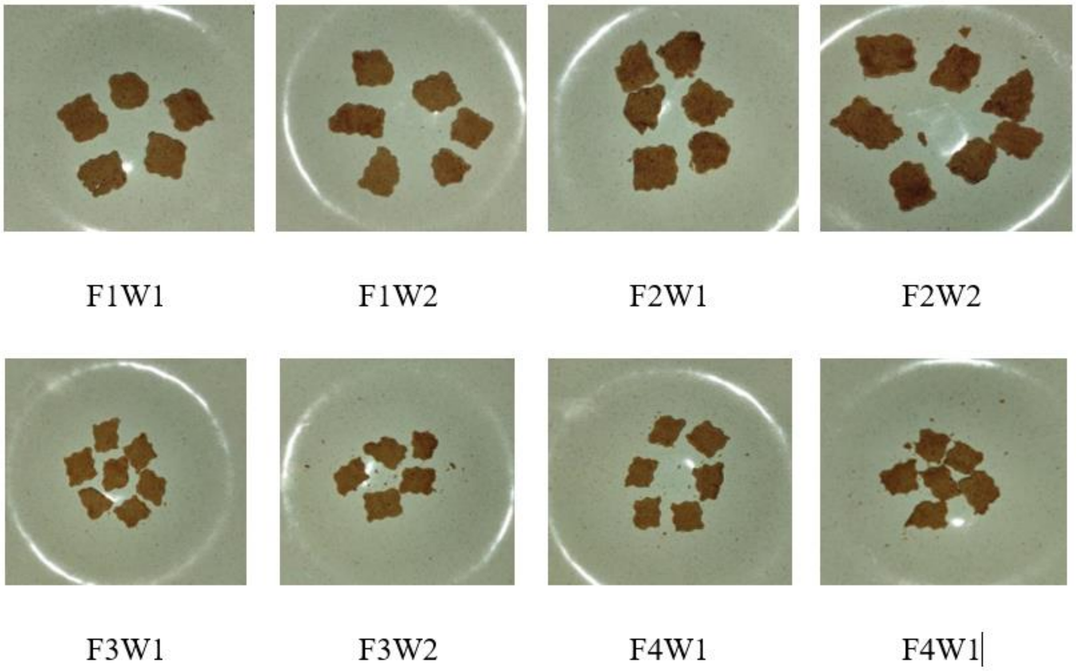

Figure 3. Flakes of fermented rice bran and beneng taro flour

Notes:

F1 = Beneng taro flour : Fermented rice bran : Rice flour = 45% : 10% : 45%
F2 = Beneng taro flour : Fermented rice bran : Rice flour = 40% : 15% : 45%
F3 = Beneng taro flour : Fermented rice bran : Rice flour = 35% : 20% : 45%
F4 = Beneng taro flour : Fermented rice bran : Rice flour = 30% : 25% : 45%
W1 = Baking time of 15 minutes
W2 = Baking time of 20 minutes