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Physicochemical and Organoleptic Characteristics of Cookies Made from Mocaf and Purple Sweet Potato Flour with The Addition of Robusta Coffee Powder

Oktaviani[1]*, Muhammad Handika Wahyu Agung Nugraha[2]

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ABSTRACT

Proximate analysis was conducted on cookies with different formulations of mocaf, purple sweet potato flour, and robusta coffee powder. This study aimed to analyze the proximate composition of cookies containing mocaf, purple sweet potato flour, and robusta coffee powder. A completely randomized design with five different treatments was used. The results showed that the moisture content ranged from 5.42% to 6.43%, with A5 (25% mocaf + 50% purple sweet potato flour + 5% robusta coffee powder) having the highest moisture level, exceeding the SNI standard (≤5%). The ash content ranged from 0.96% to 1.47%, meeting the SNI standard (≤1.5%). The highest fat content was found in A5 (35.03%) and A4 (50% mocaf + 50% purple sweet potato flour + 5% robusta coffee powder, 33.44%), which exceeded the SNI standard (≤9%). The highest protein content was also found in A5 (4.42%) but remained below the SNI standard (≥5%). The highest carbohydrate content was found in A1 (60.88%), whereas A5 had the lowest (52.79%). The highest crude fiber content was obtained for A5 (7.32%). The study concluded that increasing the proportion of purple sweet potato flour increased moisture, ash, fat, protein, and crude fiber content but decreased carbohydrate levels. In contrast, a higher proportion of mocaf increased carbohydrate content but reduced crude fiber levels.

Keywords: proximate analysis, robusta coffee powder, cookies, mocaf, purple sweet potato flour

INTRODUCTION

Snacks such as cookies, biscuits, wafers, and food bars have become increasingly popular. New product development is required to increase the quality of nutritional content and attractiveness (Hanifa 2013). Cookies are little, dry cakes with a crunchy texture and sweet flavor. They are commonly made using wheat flour, sugar, and eggs (Hastuti 2012). Cookies are relatively popular in Indonesia, with an average consumption growth rate of 33.3% between 2014 and 2018, which is greater than the 23.3% growth rate for wet cakes (Yunus 2019). Cookies made without wheat flour are rapidly being produced, including one that includes mocaf (modified cassava flour) and purple sweet potato flour. Mocaf and purple sweet potatoes were chosen since they are gluten-free and rich in fiber and rich in antioxidants and minerals. Gluten is a protein found in cereals such as wheat, oats, and barley and can cause problems in people with celiac disease, gluten allergies, and autism spectrum disorder (ASD) (Widya 2012; Yustisia 2013). By replacing wheat flour, cookies become healthier and can be consumed in groups with gluten intolerance. Mocaf is a modified cassava flour with characteristics like wheat flour, such as high viscosity and gelation ability, but is gluten-free. This flour also has a prebiotic effect on digestive health (Normasari 2010). Its nutritional content includes 1.9–3.4% fiber, 1.93% protein, 87.3% carbohydrates, and 2.72% fat (Anindya and Rustanti 2016). In addition, mocaf has a high starch content and a white color that does not have a distinctive odor like wheat. Purple sweet potatoes are rich in vitamins A, C, and B1 and minerals such as iron, phosphorus, and calcium (Devita *et al.* 2015). The high anthocyanin content of purple sweet potatoes makes them a natural coloring agent and a good source of antioxidants for health.

Previous studies have shown that mocaf is widely used in making cookies, such as in combination with broccoli or green beans (Diniyah 2021). For example, purple sweet potato flour has also been developed for cookies containing peanuts or yellow sweet potatoes. In addition, Gafar and Patoni (2020) studied the effect of robusta coffee powder in processing cookies, which provides a distinctive taste while increasing antioxidant content. However, research on mocaf-based cookies and purple sweet potatoes that are entirely gluten-free remains limited.

This study aimed to analyze the effect of adding mocaf, purple sweet potato flour, and robusta coffee powder on the proximate content of cookies, including water, ash, fat, protein, carbohydrates, and crude fiber. In addition, this study evaluated panelists' acceptance

[1] Plant Protection Study Program, Faculty of Agriculture, Universitas Sriwijaya, Palembang 30662, Indonesia
[2] Food Technology Study Program, Faculty of Agriculture, Universitas Muhammadiyah Malang, Malang 65144, indonesia
* Corresponding Author: Email: oktaviani@unsri.ac.id

of cookies organoleptically. With this formulation, it is expected that the resulting cookies will have greater health benefits, especially in terms of fiber and antioxidants, as well as being a gluten-free alternative that is more widely accepted by the community.

METHODS

Time and Place

The research activities were conducted from September to February 2022 at the Food Technology Laboratory of the University of Muhammadiyah Malang, Indonesia.

Tools and Materials

The equipment used in making cookies includes an oven, mixer, basin, baking pan, sieve, blender, and a cabinet dryer. The tools used for laboratory analysis included a person rate, Soxhlet, analytical balance AAA 250LL O' Hauss, UV Vis spectrophotometer type (UV-1800 Shimadzu), vacuum pump ABM Typ 4EKF56CX-4), Buchner funnel, and texture analyzer (TPA EZ test model SM-500N-168 Shimadzu).

The ingredients used in making cookies include mocaf obtained from an organic canteen shop in Malang City, purple sweet potatoes with typical characteristics of the Dampit area from Gunung Kawi Village, Malang Regency, and baking powder. The materials used for cookie analysis were distilled water, DPPH solution (2,2-diphenyl-1-picrylhydrazyl), ethanol (96%), petroleum benzene (p.a.), bovine serum albumin (BSA), biuret, anti-foam, NaOH (10% and 1.25 N), ethanol (96%), and H_2SO_4 (0.325 N).

Preparing Purple Sweet Potato Flour

Purple sweet potato flour was prepared by peeling and cleaning 4 kg sweet potatoes. Mocaf was mixed according to its composition. Mocaf is a flour product from cassava that is processed by modifying cassava cells through fermentation. The microorganisms that play a role in producing mocaf are lactic acid bacteria (BAL). It was then thinly sliced to a size 1–3 mm and dried in an oven at 60°C for 18 h. The dried sweet potato chips were then ground using a grinder and sieved to 80 mesh size. The compositions of the flour and the other mixtures are shown in Table 1.

Preparing Cookies

Cookies were prepared according to the modified method of Gafar and Patoni (2020), starting with smoothing butter, sugar, eggs, and salt using a high-speed mixer. Next, mocaf, purple sweet potato flour, robusta coffee powder, and full-cream milk powder were mixed until all ingredients were evenly mixed. The formulations of the mixed ingredients are listed in Table 2. The following process involved molding and baking in an oven at 160°C for 20–30 minutes.

Water Content Determination

The porcelain cup was dried in an oven for 24 hours at a temperature of 100–105°C. The porcelain cup was then cooled in a desiccator for 15 min. The empty porcelain cup weighed as the weight of bottle (A). The sample (2 g) was placed in the dried porcelain cup, and the weight of the material in the cup was recorded (B). The sample was then dried in an oven at 100–105 for 6 h. The samples were cooled in a desiccator for 15 min and re-weighed to obtain the final weight of the sample (C). Water content was calculated using the following formula (AOAC 2005):

$$\text{Water content (\%)} = \frac{B - C}{B - A} \times 100\%$$

Table 1 Composition of treatments using mocaf, purple sweet potato, and robusta coffee powder

Treatment	Mocaf (%)	Purple sweet potato flour (%)	Robusta coffee powder (%)
A1	100	-	5
A2	-	100	5
A3	75	25	5
A4	50	50	5
A5	25	75	5

Table 2 Formulation of ingredients used in the processing of making cookies

Ingredients	Treatment				
	A1	A2	A3	A4	A5
Mocaf (g)	100	-	75	50	25
Purple sweet potato flour (g)	-	100	25	50	75
Margarine (g)	45	45	45	45	45
Sugar (g)	35	35	35	35	35
Egg (g)	40	40	40	40	40
Skim milk (g)	5	5	5	5	5
Baking powder (g)	0.5	0.5	0.5	0.5	0.5
Robusta coffee powder (g)	5	5	5	5	5

Ash Content Assay

The sample (2 g) (A) was placed in a porcelain container of known weight (C), transferred to a furnace at 600°C for 4 h, and cooled in a desiccator for 15 min. Sample B was placed in a porcelain urn containing ash in a desiccator until it cooled and weighed until a constant weight. The ash content of the samples was calculated using the following formula (AOAC 2005):

$$\text{Ash Content (\%)} = \frac{\text{B} - \text{C}}{\text{A}} \text{ x } 100\%$$

Protein Content Assay

The protein content was measured using the Kjeldahl method. The sample (0.1 g) was placed in a 50 mL Kjeldahl flask, 2 g of catalyst were added, and 2 mL of concentrated sulfuric acid were added. The sample was destructed on an electric stove in a fume hood until boiling, and the solution became clear and cooled for 2–3 hours at a temperature of 450°C (solution until clear and no smoke). The destroyed sample was cooled, and 25 mL of distilled water was added. The sample was placed in a distillation apparatus, and 10 mL of 50% NaOH was added. The distillate was collected in an Erlenmeyer flask containing 10 mL of boric acid until a change from purple to light green occurred. The solution in the Erlenmeyer flask was titrated with 0.02 N HCl until light green changed to light purple. The volume of HCl was then recorded (AOAC 2005).

$$\text{N total (\%)} = \text{ml HCl sample} - \text{ml HCl blank)} - 100\% \text{ x } 14.008 \text{ g sample x } 100\%$$

$$\text{Protein Content (\%)} = \text{N total x Factor}$$

where the correction factor for snack is 6.25.

Fat Content Assay

The fat flask was dried in an oven at 105°C for 30 min, cooled in a desiccator for 15 min, and the empty flask was weighed. The sample (± 2 g) was ground using a hammer mortar. The Soxhlet extraction tool was assembled and connected to the water bath. The fine material was weighed (± 2 g), wrapped in filter paper (shaped like a tube), and inserted into the Soxhlet. The fat flask was filled with 20 mL of petroleum ether. The cooling water flowed through the condenser, and the water bath was turned on at a temperature of 85°C. The extraction took approximately 4 h, or until the oil was collected in the receiving flask. The organic solvent and oil in the receiving flask were separated, and then the flask was heated in an oven until a constant weight (*t* = 30 min). The heated receiving flask was cooled in a desiccator for 15 min and weighed to obtain the final weight. The weight of the oil was the difference between the initial and final weights of the flask. Fat content was calculated using the following formula (AOAC 2005):

$$\text{Fat Content (\%)} = \frac{\text{Final weight (g)} - \text{Weight of empty receiving flask (g)}}{\text{Initial weight of sample (g)}} \text{ x } 100\%$$

Carbohydrate Content by Difference

The percentage of carbohydrates was calculated using the following formula (AOAC 2005):

$$\text{Carbohydrate (\%)} = 100\% - (\text{Water content} + \text{Ash Content} + \text{Protein Content} + \text{Fat Content})\%$$

Crude Fiber Assay

The prepared filter paper was dried to a diameter of 4.5 cm (A g). An oven-dried porcelain cup was then prepared. The residue of the fat extraction was put into an Erlenmeyer ± 1 g (B g). 50 mL of 0.325 N sulfuric acid was added to the Erlenmeyer containing the sample on a unique heater under the condenser. Water flowed, and the heater was turned on, boiled for 30 min, and counted when it started to boil. 50 mL of NaOH 1.25N was added, and the unique beaker was installed back on the unique heater. After sufficient heating, the samples were filtered using a Buchner funnel fitted with a filter paper of known weight. In this filtration, it was rinsed successively with 5 mL of hot distilled water, 10 mL of 0.325 N sulfuric acid 0.325N, 5 mL of hot distilled water, and 10 mL of ethanol; the filter paper containing the residue was inserted into the porcelain cup using tweezers. The sample was dried in an oven at 100–105°C until the filter paper dried. The sample was boiled in a desiccator for 15 min, weighed, recorded as C g, and calculated as follows (AOAC 2005):

$$\text{Crude fiber content (\%)} = \frac{\text{C} - \text{A}}{\text{B}} \text{ x } 100\%$$

DPPH Method for Antioxidant Test

The aim of this analysis was to determine the antioxidant activity of the brownies. The procedure was performed to determine the IC_{50} (inhibition concentration 50%) of the test solution using DPPH and a UV-Vis spectrophotometer (Purwanto *et al.* 2017). A sample stock solution was made by dissolving NaOH (6.25 mg NaOH dissolved in 25 mL methanol (250 ppm). The DPPH solution was prepared by weighing 8 mg and then dissolving it in 50 mL methanol to obtain a 100-ppm solution. The solution was maintained at a temperature of 75-100°C protected from light for immediate use. The maximum wavelength of DPPH was then determined. Absorbance of the DPPH solution was measured at 517 nm. The antioxidant activity test was carried out by preparing test and reference solutions in various concentrations of methanol solvent through graded dilution. The absorbance and % inhibition of the test compound were calculated at various dilution concentrations with 100 ppm DPPH solution (0.5 mL), incubated for 30 min, and the absorbance was read at the maximum wavelength (517 nm). The percentage of inhibition was calculated using the following formula (AOAC 2005):

$$\text{Inhibition (\%)} = \frac{\text{Blank absorbance} - \text{Sample absorbance}}{\text{Blank absorbance}} \times 100\%$$

Texture Analysis

The texture of the cookies was tested by hardness testing using a texture profile analyzer tool (Fitriyani *et al.* 2017). The following are the stages of the hardness analysis. First, the texture analyzer was set. The thickness and diameters of the cookie samples were measured and then placed on the sample table. The equipment was run, and the probe was moved to touch the sample until it broke. The results of the movement and changes were processed by the computer and displayed as a graph (force vs. time), and then the hardness was recorded.

Organoleptic Analysis

The panelists performed organoleptic testing regarding taste, aroma, texture, and overall acceptance. This organoleptic testing was carried out with 40 panelists (Syafitri *et al.* 2019), after which the panelists assessed the samples given a code, and there was a hedonic scale, as in Table 3. The test was carried out with each panelist given a sample and an assessment paper containing an assessment score, and the panelists listed the values based on the table provided (SNI 01-2346-2006).

Data analysis

This study was conducted using the Simple Randomized Block Design with two factors, namely, the ratio of mocaf, purple sweet potato flour, and robusta coffee powder, with three replications in each treatment. The research data were then analyzed using Analysis of Variance (ANOVA) followed by Duncan's Range Test (DMRT) as a further test between treatments that were significant at the level of confidence (α = 0.05).

RESULTS AND DISCUSSION

Water Content

The water content of food determines the shelf life of the raw materials. The water content is the percentage of water contained in the material. Water content is an important characteristic of food ingredients because it can affect the appearance, texture, and taste of the food (Eni *et al.* 2017). Based on the analysis of variance, it is known that the A5 treatment (25% mocaf, 50% purple sweet potato flour, 5% robusta coffee powder) has a very significant effect on water content, with an average water content of 5.42–6.43% not by the maximum SNI of 5% (Table 4). The water content of cookies with A4 treatment using 25% mocaf, 50% purple sweet potato flour, and 5% robusta coffee powder produced the highest value of 6.43%. The standard water content of cookies that have been made does not comply with SNI because the water content of the raw materials exceeds the standard value of 5%, which is characterized by the easy dissolution of proteins in water. This is in line with the statement of Aisah *et al.* (2021) that the more the proportion of purple sweet potato flour that is added, the more the water content increases because the use of mocaf and purple sweet potato flour causes the protein to dissolve faster than other flours, such as those commonly used to make cookies, namely gluten-free flour. Generally, this gluten protein is insoluble in water, unlike wheat flour.

Treatment A1, using 100% mocaf and 5% robusta coffee powder, had the lowest cookie water content of 5.42%. This is because, during the fermentation process of this mocaf, there are acidic sugar compounds and water that do not stick, so, about the A1 treatment, there are acidic sugar compounds and water that do not stick to the horn skin and lactic acid

Table 3 Organoleptic score

Mark	Flavor	Aroma	Texture	Color
1	Very dislike	Very dislike	Very dislike	Very dislike
2	Do not like	Do not like	Do not like	Do not like
3	Moderately dislike	Moderately dislike	Moderately dislike	Moderately dislike
4	Neutral	Neutral	Neutral	Neutral
5	Moderately like it	Moderately like it	Moderately like it	Moderately like it
6	Like	Like	Like	Like
7	Really like	Really like	Really like	Really like

Table 4 Average water content of cookies with the addition of mocaf, purple sweet potato flour and robusta coffee powder

Treatment	Water (%)
A1 100% Mocaf + 5% robusta coffee powder	5.42a
A2 100% Purple sweet potato flour + 5% robusta coffee powder	6.37b
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	5.52a
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	5.99ab
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	6.43b

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%.

bacteria microbes that break down the components of the additional ingredients of mocaf. Robusta coffee powder also affects the water content of cookies because it is hygroscopic and contains protopectin substances, original sugar, acid, and water; therefore, the water content decreases. This is based on the finding by Danil and Novrini (2019) that fermentation also changes hygroscopic sugar compounds in mucus into alcohol. The degradation of the mucilage layer during fermentation reduces the water content of the additives, thereby affecting the drying time.

Ash Content

Based on the variance analysis, it is known that the A2 treatment (100% purple sweet potato flour, 5% robusta coffee powder) has a significant effect on the assessment of the chemical properties of the ash content of cookies. The results of the analysis of the ash content of cookies with the addition of mocaf, purple sweet potato flour, and robusta coffee powder showed an ash content of 0.96 to 1.47, which is the maximum SNI of 1.5% (Table 5). A1 treatment used 100% mocaf, and 5% robusta coffee powder gave the lowest ash content of 0.96% for cookies. A2 treatment using 100% purple sweet potato flour and 5% robusta coffee powder produced the highest ash content (1.47 %). The ash content was determined by SNI because it does not exceed the ash content value of 1.5% with the characteristics of the raw material for cookies that do not react during baking. This is in line with Santosa *et al.* (2016) because when not fermented, it can affect the activity of the mineral components in purple sweet potato flour; therefore, it does not react at all during fermentation. The more purple sweet potato flour added, the higher the ash content. The higher the proportion of purple sweet potato flour, the higher the mineral content is, and vice versa. The ash content produced was also low when the mineral content was low. The mineral content in purple sweet potatoes is iron 0.7 mg/100 g, phosphorus 49 mg/100 g, and calcium 30 mg/100 g (Santosa *et al.* 2016).

Robusta coffee, which contains potassium, calcium, magnesium, and non-metallic minerals (phosphorus and sulfur), also affects ash content. The ash content in robusta coffee is an inorganic residue from the combustion process or the result of the oxidation of organic components in robusta coffee powder. This is in accordance with Budiyanto *et al.* (2021), who found that the high ash content is due to the high mineral content and non-metallic minerals, such as phosphorus and sulfur, affecting coffee grounds during roasting. Yuwono and Waziiroh (2017) also stated that treatment in the drying fermentation process with a cabinet oven or roasting can reduce the ash content.

Fat Content

Fat is a macrocompound with the highest energy value compared to carbohydrates and proteins. Fat is also widely used to provide a better taste and texture to products, but it can also be used as a spoilage parameter for rancid foods (Mahirdini and Afifah 2016). Based on variance analysis, the significance value was set at 0.05. Treatment A5 (25% mocaf, 50% purple sweet potato flour, and 5% robusta coffee powder) affected fat content (Table 6). This is suspected of the addition of fat from the increase in fat, which can be produced from the breakdown of fatty acids in mocaf, purple sweet potato flour, and robusta coffee powder during fermentation caused by the microbes' secretion. According to Aisah *et al.* (2021), most microbial cell mass components are proteins and a small proportion of phospholipids.

Cookies in treatments A5 (25% mocaf, 50% purple sweet potato flour, and 5% robusta coffee powder) and A4 (50% mocaf, 50% purple sweet potato flour, and 5% robusta coffee powder) had fat contents that were not significantly different, namely 35.03% and 33.44%, respectively. The increase in the fat content of the cookies in treatments A5 and A4 was not affected by robusta coffee powder. However, this was due to the addition of mocaf and margarine, which was approximately 40 g, compared to the results with SNI

Table 5 Average ash content of cookies with the addition of mocaf, purple sweet potato flour and robusta coffee powder

Treatment	Ash (%)
A1 100% Mocaf + 5% robusta coffee powder	0.96a
A2 100% Purple sweet potato flour + 5% robusta coffee powder	1.47b
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	1.11ab
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	1.31ab
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	1.32ab

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%.

Table 6 Average fat content of cookies with the addition of mocaf, purple sweet potato flour and robusta coffee powder

Treatment	Fat (%)
A1 100% Mocaf + 5% robusta coffee powder	29.77a
A2 100% Purple sweet potato flour + 5% robusta coffee powder	30.52ab
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	31.65b
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	33.44c
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	35.03c

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%.

fat, which was a maximum of 9%. The addition of egg yolks also increased the fat content of the cookies. Mocaf has a high fat content; therefore, the fat content value in cookies in treatments A5 and A4 was the highest compared to other treatments. Pramadi *et al.* (2020) affirmed that fat is an organic compound in food ingredients that is important for the human body. Fat in the body can function as an energy reserve, including in the addition of mocaf.

Protein Content

Based on the analysis of variance, A5 treatment (25% mocaf, 50% purple sweet potato flour, and 5% robusta coffee powder) has a very significant effect on the assessment of the protein content of cookies (Table 7). It is known that the protein content of cookies produced using the A1 formulation with 100% mocaf and 5% robusta coffee powder gave the lowest cookie protein content value of 3.00%. The protein content in the A1 treatment was the lowest compared to the other treatments. This is because the A1 treatment used Mocaf with a low protein content. Likewise, robusta coffee powder content did not significantly affect the protein content of the cookies. The protein content did not comply with the SNI at an SNI protein of at least 5%. This is due to the denaturation and heating processes. According to Claudia and Widjanarko (2016), the treatment used high-protein purple sweet potato flour, so the more purple sweet potato flour used, the higher the protein content.

Carbohydrate Content

Based on the analysis of variance, the treatment A1 (100% mocaf, 5% robusta coffee powder) has a significant effect on the assessment of carbohydrate content in cookies (Table 8). The high carbohydrate content in treatment A1 is thought to be due to the high proportion of additional mocaf ingredients (up to 100%). The highest carbohydrate of 60.88%. The lowest carbohydrate content (52.79 %) was found in treatment A5 (25% mocaf, 50% purple sweet potato flour, and 5% robusta coffee powder). This is thought to be due to the increase in protein levels, which affects the calculation of carbohydrate levels. Mocaf carbohydrates primarily consist of simple sugars, pentoses, dextrin, cellulose, and starch (amylose and amylopectin) (Yani and Akbar 2019). Starch is the main component of carbohydrates and is essential for determining the quality requirements of mocaf. Yunianto *et al.* (2021) reported that other nutritional components influence carbohydrate levels. The lower the other nutritional components, the higher the carbohydrate content. Similarly, the higher the other nutritional components are, the lower the carbohydrate content.

Crude Fiber

Dietary fiber is a food ingredient that does not hydrolyze digestive enzymes. Fiber content is abundant in fruits and vegetables. The type of crude fiber in the raw materials was pectin (soluble dietary fiber). Fibers are carbohydrates that the body cannot digest (Maryoto 2020). According to the SNI01-2973-2011 standard, dietary fiber cookies have a cookie quality requirement of 0.5%. The quality requirements for cookies with Mocaf, purple sweet potato, and coffee powder substitutions can increase the crude fiber content of food (Tazhkira 2021). Based on the analysis of variance, the ratio between the A5 mocaf treatments (25% mocaf, 50% purple sweet potato flour, and 5% robusta coffee powder) had a significant effect ($p < 0.05$) on the crude fiber content of cookies. The average crude fiber contents of cookies with mocaf, purple sweet potato flour, and robusta coffee powder are shown in Table 9. The addition of apple flour had a significant effect on the crude fiber content of the cookies. The lowest crude fiber content was found in treatment A1, with a formulation of 100% mocaf and 5% robusta coffee powder (4.71 %). This is because mocaf has a relatively low fiber content. Corresponding to Prayitno *et al.* (2018), the raw materials that affect the crude fiber content of cookies are mocaf, which has a fiber content of 1.9–3.4%, and purple sweet potato

Table 7 Average protein content of cookies with the addition of mocaf, purple sweet potato flour and robusta coffee powder

Treatment	Protein (%)
A1 100% Mocaf + 5% robusta coffee powder	3.00a
A2 100% Purple sweet potato flour + 5% robusta coffee powder	3.94ab
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	4.25ab
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	3.41ab
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	4.42b

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%

Table 8 Average carbohydrate content with the addition of mocaf, purple sweet potato flour and robusta coffee powder

Treatment	Carbohydrate (%)
A1 100% Mocaf + 5% robusta coffee powder	60.88c
A2 100% Purple sweet potato flour + 5% robusta coffee powder	57.17b
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	57.45b
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	55.97b
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	52.79a

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%

flour, 4–5%. Purple sweet potato flour has a higher fiber content than mocaf; therefore, the more purple sweet potato flour is added, the higher the fiber content.

The highest crude fiber content was found in treatment A5 with a 25% mocaf formulation, 50% purple sweet potato flour, and 5% robusta coffee powder (7.32 %). The higher the crude fiber content, the better the digestion. This follows the opinion of Setyaningsih (2021), who stated that cookies containing high levels of crude fiber are suitable for the body. Fibers can regulate bowel movements and prevent constipation (difficulty in defecating) because they provide a load on food residue in the large intestine. Crude fiber is a compound that cannot be digested by the digestive organs of humans or animals and is insoluble in acids (H_2SO_4) or bases (NaOH). According to Lalopua (2017), crude fiber is the residue of food ingredients after treatment with boiling acids and alkalis. It consists of cellulose, with a small quantity of lignin and pentose.

Antioxidant

Based on the results of the antioxidant activity test on cookie products, it is known that the antioxidant activity of cookies becomes more potent as the amount of purple sweet potato flour formulation increases (Table 10). Anthocyanins in purple sweet potatoes have more potent antioxidant activities than those in red sweet potatoes. Purple sweet potatoes are dominated by purple potatoes, so their antioxidant activity is undoubtedly related to their anthocyanins (Angelia 2019). Purple sweet potato flour has increased antioxidant levels because of its high anthocyanin content. The antioxidant activity of cookies in the A5 treatment with 25% mocaf formulation, 50% purple sweet potato flour, and 5% robusta coffee powder (74.92%) was higher than that of cookies in the A2 treatment with 100% mocaf and 5% robusta coffee powder (73.29%).

The increase in antioxidant activity in the A5 treatment is thought to have occurred because of the addition of purple sweet potato flour, which is known to have an antioxidant content. In contrast, in the A2 treatment, there was a decrease, allegedly because there was no addition of purple sweet potato flour, so the antioxidant activity was low. Putra (2020) suggested that chlorogenic acid, flavonoids, and flavonoid compounds can eliminate free radicals and peroxides, act as antioxidants, and effectively suppress lipid oxidation. Robusta coffee powder also affects the antioxidant properties of the cookies. According to Munira *et al.* (2020), the antioxidant ability of robusta coffee powder and the content of chemical compounds are important for increasing the antioxidant activity in samples mixed with purple sweet potato flour.

Texture

Based on the results of the variance analysis, the addition of purple sweet potato flour has a significant effect on the organoleptic assessment of the cookie texture. Based on the results of the organoleptic study in Table 11, the addition of cookies in the A5 treatment (25% mocaf, 50% purple sweet potato flour, and 5% robusta coffee powder) had a significant effect on the texture of the cookies presented in Table 8. The organoleptic test of the texture of the A5 treatment

Table 9 Average crude fiber content of cookies with the addition of mocaf, purple sweet potato flour and robusta coffee powder

Treatment	Fiber (%)
A1 100% Mocaf + 5% robusta coffee powder	4.71a
A2 100% Purple sweet potato flour + 5% robusta coffee powder	6.02b
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	5.10a
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	6.54c
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	7.32d

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%.

Table 10 Average antioxidant activity with the addition of mocaf, purple sweet potato flour and robusta coffee powder

Treatment	Antioxidant (%)
A1 100% Mocaf + 5% robusta coffee powder	27.71a
A2 100% Purple sweet potato flour + 5% robusta coffee powder	73.29d
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	41.70b
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	57.22c
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	74.92d

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%.

Table 11 Average texture test of cookies with the addition of mocaf, purple sweet potato flour and robusta coffee powder

Treatment	Texture (%)
A1 100% Mocaf + 5% robusta coffee powder	47.72a
A2 100% Purple sweet potato flour + 5% robusta coffee powder	60.19c
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	50.40b
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	60.22c
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	62.65d

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%.

cookies showed an average of 62.65%. This is because the more purple sweet potato flour added, the higher the fracture strength because it affects the hardness level of the cookies. Diniyah *et al.* (2019) reported that fracture (fracture strength) was approximately 68.242 g/mm. The texture of cookies is influenced by the starch, amylose, and amylopectin contents of the raw materials used to make them. The organoleptic assessment of texture was the highest compared to that of the others. Arabica coffee powder can act as a dough stabilizer that can unite fat and water in cookies. Dahlia *et al.* (2019) reported that cookies are affected by tempering, which functions to mix and smooth so that the texture of the cookies becomes smooth and dense.

Meanwhile, the lowest organoleptic assessment results were observed in treatment A1 with a formulation of 100% mocaf and 5% robusta coffee powder (47.72%). This study was significantly different from all other treatments because appropriate purple sweet potato flour was not added. Damayanti *et al.* (2020) stated that product hardness decreases due to the increasing water content in the ingredients or dough used. The wider the formation of many strands, the stronger the gel and the better the texture of the product. The temperature rotation mechanism forms a double-loop structure. When heated above the gel-forming temperature, the polymer in solution becomes a random spiral. This polymer is highly cross-linked, and as the spiral shape grows, it aggregates to form a firm gel shape (Pumpente 2019).

Brightness Intensity of Cookies

Based on the results of the variance analysis, adding 100% mocaf to the making of cookies significantly affected the brightness (lightness) level of cookies (Table 12). The highest value of brightness level was observed in treatment A1 with a formulation of 100% mocaf and 5% robusta coffee powder of 56.23%, and the lowest value was observed in treatment A2 with a formulation of 100% purple sweet potato flour and 5% robusta coffee powder of 28.20%. The higher the concentration of purple sweet potato flour, the more harmful or negligible the L value read on the color reader, which means that the brightness produced in the cookies becomes darker. The resulting cookies became darker because the added purple sweet potato flour had a dark color. This occurs because of the Maillard reaction, or non-enzymatic browning, that is, the reaction between reducing sugars and amino acids accompanied by heating (Kurniadi *et al.* 2019).

Redness (a+) and Yellowness (b+) of Cookies

Based on the results of the analysis of variance, the A3 treatment with the addition of 75% mocaf, 25% purple sweet potato, and 5% robusta coffee powder had a significant effect on the redness level (a) of cookies (Table 13). Redness level (a) was determined using the 5% DMRT test. Based on the variance analysis, the results of the A1 treatment with the addition of 100% mocaf and 5% robusta coffee powder in making cookies significantly affected the yellowness level (b) of cookies. Yellowness level value (b) from the 5% DMRT test. The highest redness level of cookies was in treatment A3 (75% mocaf, 25% purple sweet potato flour, and 5% robusta coffee powder) at 12.60%. The lowest was in treatment A1 (100% mocaf and 5% robusta coffee powder) at 9.40%. Adding mocaf gives them a value read on the color reader that is more harmful or negligible, which means that the redness produced on the cookies becomes darker.

Table 12 Average brightness (L) of cookies with the addition of mocaf, purple sweet potato flour and robusta coffee powder

Treatment	Brightness intensity (L)
A1 100% Mocaf + 5% robusta coffee powder	56.23e
A2 100% Purple sweet potato flour + 5% robusta coffee powder	28.20a
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	43.70d
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	40.67c
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	37.53b

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%.

Table 13 Average redness (a+) and yellowness (b+) of cookies with the addition of mocaf, purple sweet potato flour and robusta coffee powder

Treatment	Redness intensity (a+)	Yellow intensity (b+)
A1 100% Mocaf + 5% robusta coffee powder	9.40a	39.09d
A2 100% Purple sweet potato flour + 5% robusta coffee powder	12.12cd	21.60a
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	12.60d	33.46c
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	11.52bc	23.64b
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	11.13b	22.91b

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%.

The highest yellowness level of the cookies was in treatment A1 (100% mocaf and 5% robusta coffee powder) at 39.09%, and the lowest was in treatment A2 (100% purple sweet potato flour and 5% robusta coffee powder) at 21.60%. The higher the concentration of purple sweet potato flour, the more harmful or negligible the value read on the color reader; this means that the yellowness produced on the cookies becomes darker. The dark color was caused by the raw material of purple sweet potato flour added to the dark dough.

Flavor

Taste is a sensation produced by a material inserted into the sense of taste in the mouth. Taste is influenced by several factors, including chemical compounds, temperature, concentration, and interactions, which are the main components of taste. Based on the analysis of variance, it is known that the addition of 75% mocaf, 25% purple sweet potato flour, and 5% robusta coffee powder has a significant effect on the organoleptic assessment of the taste of cookies (Table 14). The organoleptic assessment showed that the highest assessment of the taste of cookies by the panelists was for treatment A3 (75% mocaf, 25% purple sweet potato flour, and 5% robusta coffee powder) at 4.76%. This is also suspected to be due to the addition of robusta coffee powder, which has a natural taste and improves the taste of the cookies. Apriyanto *et al.* (2016) reported that adding coffee powder significantly affected the taste of cookies and influenced the panelists' level of preference for the taste of cookies. This is supported by Sunarharum *et al.* (2019), who found that fermentation plays a role in forming precursor compounds that contribute to the taste of freshly brewed coffee.

The average organoleptic taste of the cookies in treatment A2 (100% purple sweet potato flour and 5% robusta coffee powder) produced the lowest value (4.08 %). The low taste of the cookies produced was due to the addition of purple sweet potato flour to the raw materials used for making the cookies. The increasing content of purple sweet potato flour that panelists preferred for cookies decreased because purple sweet potato flour tends to have a bitter aftertaste (Imawan *et al.* 2020).

Aroma

The sensory assessment of aroma shows that the panelists' assessment of the addition of cookies to the A5 treatment (25% mocaf, 50% purple sweet potato flour, and 5% robusta coffee powder) has a very significant effect on the texture of the cookies (Table 15). The organoleptic test of the texture of the A5 treatment cookies showed the highest average value of 5.16%. This is thought to be due to the ethyl phenol in mocaf, purple sweet potato flour, and coffee powder, which can provide aroma. Rosida *et al.* (2020) reported a process of maturation and homogenization of dough, which was carried out for several hours at a temperature above 60°C. During this process, there was a decrease in the viscosity of the dough, a reduction in unpleasant odors, decrease in water content, and increase in the aroma of the cookies, resulting in an optimal aroma.

Meanwhile, the lowest value of panelist preference was in the A1 treatment (100% mocaf and 5% robusta coffee powder) at 4.24%. This is because cookies do not contain any additional ingredients that provide a distinctive aroma. Rosida *et al.* (2020) reported that chemical components in the form of volatile compounds (aroma), such as aldehydes, ketones, and several carbonyl compounds, and several other compounds, such as polyphenols, theobromine, and organic acids, act as formers of the taste and aroma of cookies. Aroma is produced from the volatile substances contained in a product. Volatile substances evaporate quickly; therefore, they are easily carried by the air and captured by the nose as a sense of smell (Rosida *et al.* 2020).

Table 14 Average organoleptic taste with the addition of mocaf, purple sweet potato flour and robusta coffee powder

Treatment	Flavor (%)
A1 100% Mocaf + 5% robusta coffee powder	4.48ab
A2 100% Purple sweet potato flour + 5% robusta coffee powder	4.08a
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	4.76b
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	4.32a
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	4.44a

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%.

Table 15 Average organoleptic aroma with the addition of mocaf, purple sweet potato flour and robusta coffee powder

Treatment	Aroma (%)
A1 100% Mocaf + 5% robusta coffee powder	4.24a
A2 100% Purple sweet potato flour + 5% robusta coffee powder	4.92a
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	4.44b
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	4.68ab
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	5.16b

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%.

Color

Based on the analysis of variance, it is known that A5 treatment with 25% mocaf, 50% purple sweet potato flour, and 5% robusta coffee powder had a significant effect on the organoleptic assessment of the color of cookies (Table 16). The results of Duncan's Multiple Range Test (DMRT0.05) further test the effect of adding mocaf, purple sweet potato, and robusta coffee powder on the organoleptic assessment of the color of cookies. The highest average organoleptic color was 4.72%.

The high average organoleptic color value is due to the coffee undergoing a long fermentation process for 20 h, where mocaf, purple sweet potato flour, and robusta coffee experience a Maillard reaction involving low reducing sugars (glucose and fructose) and high amino groups (amino acids) in the fermentation process, so that the color is not too dark. This is supported by the opinion of Rahayu and Nurwitri (2019), that the form of color influence occurs during fermentation such that it undergoes a Maillard reaction in the presence of volatile compounds, especially if the raw materials are appropriately fermented at a particular time.

The lowest average organoleptic color given by the panelists was in treatment A1 (100% mocaf and 5% robusta coffee powder) at 4.04%. This is because the balance between mocaf and robusta coffee powder is incorrect. Koesoemawardani *et al.* (2022) stated that adding robusta coffee powder can lower the pH of a product, resulting in a brighter color. In the conching process, the coffee powder can also form bonds with sugar, so that the color of the mocaf appears uneven.

Preference

Based on the analysis of the ratio of mocaf, purple sweet potato flour, and robusta coffee, it has a significant effect (p <0.05) on the preference for cookies. The average organoleptic values of the cookie preference with different proportions of mocaf, purple sweet potato flour, and robusta coffee powder are shown in Table 17. Preference is a stimulus caused by the ingredients eaten, and is felt by the sense of taste, smell, and other stimuli. These ingredients influence the preferences for these cookies. The average value of the organoleptic assessment of cookies' preferences ranges from 4.52 to 5.04%. The preferences of the cookies obtained from the assessment were quite disliked. The average result of the highest organoleptic preference was in treatment A5, which used 25% mocaf. The 50% purple sweet potato flour and 5% robusta coffee powder had the highest values (5.04%). This was due to the low content of mocaf. Mocaf has a distinctive aroma and taste that consumers do not like when processing its ingredients. This is because hydrolyzed starch granules produce monosaccharides as the starting material to produce organic acids, especially lactic acid, which is then absorbed by the material. This substance neutralizes the aroma and taste of mocaf (Yunianto *et al.* 2021).

CONCLUSION

Increasing the proportion of purple sweet potato flour increased the water, ash, fat, protein, and crude fiber contents, but decreased the carbohydrate content. Conversely, using high amounts of mocaf increased the carbohydrate content but decreased the crude fiber content. The combination of ingredients used significantly affected the proximate characteristics of cookies, with the A5 treatment showing the highest levels in most parameters, except carbohydrates.

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Table 16 Average organoleptic color with the addition of mocaf, purple sweet potato flour and robusta coffee powder.

Treatment	Color (%)
A1 100% Mocaf + 5% robusta coffee powder	4.04a
A2 100% Purple sweet potato flour + 5% robusta coffee powder	4.56b
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	4.36a
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	4.44ab
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	4.72b

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%

Table 17 Average organoleptic preferences with the addition of mocaf, purple sweet potato flour and robusta coffee powder.

Treatment	Likeability (%)
A1 100% Mocaf + 5% robusta coffee powder	4.52a
A2 100% Purple sweet potato flour + 5% robusta coffee powder	4.56a
A3 75% Mocaf + 25% purple sweet potato flour + 5% robusta coffee powder	4.88ab
A4 50% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	4.76ab
A5 25% Mocaf + 50% purple sweet potato flour + 5% robusta coffee powder	5.04b

Remarks: Numbers followed by the same letter indicate no significant difference based on Duncan's test α = 5%

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