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PHYSICOCHEMICAL CHARACTERISTICS AND ACCEPTABILITY OF COOKIES MADE WITH MOCAF AND MILLET *(Setaria italica* L*)* FLOUR

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ABSTRACT

Mocaf and millet flour are local ingredients suitable for functional cookies. Therefore, this research aimed to analyze the effect of mocaf and millet flour ratio on the physicochemical properties and acceptance of cookies. The experimental treatments included the ratio of mocaf : millet flour comprising (P1) 100% : 0%, (P2) 75% : 25%, (P3) 50% : 50%, (P4) 25% : 75%, and (P5) 0 % : 100%. Chemical characteristics such as water content, protein, fat, reducing sugar, and dietary fiber were analyzed using the AOAC method. The hardness, brittleness, and cohesiveness values were examined using a texture analyzer, while organoleptic tests were carried out on panelists. The results showed that the highest values for water content (6.25%) and fat content (29.65%) of cookies were found in P3 treatment. Protein and dietary fiber levels increased along with the percentage of millet flour. The highest value for reducing sugar content (16.88%) was discovered in treatment P3. The hardness (212.94N) and brittleness (5.19N) values were the highest in treatment P5, while cohesiveness (0.42) was in treatment P2. The preferred acceptance was cookies with a ratio of mocaf : millet flour of 50% : 50%. However, there was no effect of the ratio of mocaf : millet flour on water content (p= 0.331), fat (p= 0.174), reducing sugar (p= 0.056), and cohesiveness (p= 0.425). A significant correlation was observed between protein (p= 0.002), dietary fiber (p= 0.007), hardness (p= 0.005), brittleness (p= 0.016), and acceptance.

1. Introduction

Biscuits are crispy, thin, and flat cookies commonly made in small sizes (Ihromi et al., 2018). The stages of making cookies include the preparation, mixing ingredients, kneading, molding, baking, cooling, and packaging process (Pangestika et al., 2021). Based on the Indonesian National Standard (SNI) on the quality of biscuits (Badan Standarisasi Nasional, 2011), cookies are a kind of biscuits made from soft and crunchy dough, which have a less dense texture.

Despite the numerous benefits, cookies with functional components have not been widely developed. Functional food is processed food that contains one or more functional components based on scientific research with physiological benefits. These components are proven to be harmless and beneficial for health (Sidiq et al., 2022);(Philia et al., 2020). One of the ingredients that can be used as a base for cookies with functional components is fermented cassava (mocaf) and millet flour.

Cassava is a local food that has several advantages, including high micro and micronutrient levels, with a low glycemic index (cassava GI 46). Other advantages are soluble dietary fiber content, which can be used as a probiotic in the intestine and stomach. Furthermore, cassava comprises glucoside compounds that are harmful (poisonous) and can produce cyanide acid (Rauf et al., 2018). The process to remove these glucoside compounds is by fermenting cassava into mocaf flour (Muhammad Iqbal Nusa, Budi Suarti, 2012).

Mocaf flour can replace wheat flour due to the presence of similar chemical and physical characteristics. Specifically, the starch content of mocaf flour is 78.27% - 85.63%, approximately similar to wheat of 78.36%, is white, neutral odor, and neutral flavor (Suarti et al., 2016). The fermentation process of cassava into mocaf flour uses Lactic Acid Bacteria (LAB) (Kristanti et al., 2020). This process creates changes in flour characteristics, including increased viscosity, rehydration power, easily dissolved, and neutral flavor to cover the taste by 70%. Therefore, mocaf flour has similar characteristics to wheat, showing potential as a substitute for various products such as noodles, bread, nuggets, and other snacks (Asmoro et al., 2017).

The dietary fiber content of mocaf flour (6%) is 19% higher than wheat (0.3%), while the protein (1.2%) is 650% lower compared to wheat (9%). Furthermore, the fat content at 0.6% is 67% lower compared to wheat flour (1%) (Ihromi et al., 2018). According to (R. M. Putri & Kurnia, 2017), mocaf flour contains energy (350 calories), which is 5% higher than wheat flour (333 calories), and carbohydrates (85%) are 10% greater compared to wheat flour (77.2%). The high fiber in mocaf can serve as a functional component in cookies, which are consumed by pregnant women to reduce the risk of lousy defecation habits on pregnant women (Mutalazimah & Cahyanti, 2019).

Millet is another cereal crop with high dietary fiber and carbohydrate content, although it is only used for bird food (R. A. N. Putri et al., 2020). Previous research has shown that millet flour (Suparti & Sholihah, 2021) contain GI of 54.5% with 12.1% protein, 1.68% fat, 81.52% carbohydrates, and 7.8% dietary fiber (Muhammad et al., 2020). It also contains a high fiber content, such as cellulose, hemicellulose, phenolic esters, and glycoproteins (Sulistyaningrum, A., Hayati, N.Q, Rahmawati, n.d.). Millet flour has the potential as a basic ingredient for processed food to strengthen food security. This serves as a method of diversifying food with local raw materials (Sulistyaningrum, A., Hayati, N.Q, Rahmawati, n.d.).

The quality of cookies from millet and mocaf flour is decided based on their physicochemical properties. These include water content, protein, fat, sugar, and dietary fiber, while physical properties are hardness, brittleness, and cohesiveness. Organoleptic properties are characteristics that evaluate the acceptance of a product (Yasinta, 2017).

2. Materials and methods

The sample of mocaf from *Ladang Lima* and millet from *Organis* were taken in September 2022. This experimental research was carried out to examine the physicochemical properties of cookies by comparing mocaf and millet flour. The design used a Completely Randomized Design (CRD) with four treatments. These comprise (P1) 100% mocaf and 0% millet flour, (P2) 75% mocaf and 25% millet flour, (P3) 50% mocaf and 50% millet flour, (P4) 25% mocaf and 75% millet flour, and (P5) 0% mocaf and 100% millet flour. Each treatment was repeated and analyzed in duplicate, leading to a total of 20 treatments. The acceptance research used a panelist test to allow the implementation of the code of ethics at the UMS Faculty of Medicine, **No.4246/B.1/KEPK-FKUMS/IV/2022**.

2.1.Procedure for Cookies Ratio of Mocaf with Millet Flour

The dough was a mixture of butter, powdered sugar, and skim milk using a mixer for approximately 3-7 minutes. Egg yolks were added to the mixture and mixed until expanded with a change of color (Yasinta, 2017). Subsequently, flour was poured according to the treatment and blended for 5 minutes. The dough obtained was molded and baked. The compound of the ingredients was adjusted to the percentage of flour in the mixture used in cookies made of mocaf and millet flour.

2.2. Water content

Analysis of water content in mocaf flour cookies with millet was carried out using the Thermo Gravimetric method (Shariff et al., 2023). Initially, the crucible was weighed at a constant rate (a gram), and the sample was added (b grams). The crucible was baked in the oven for 6 hours at a temperature of 105^{0}C and weighed to achieve a constant weight (C grams).

2.3. Protein, Fat, Reducing Sugar, and Total Food Fiber Content

Analysis of protein levels in food ingredients applied the Micro Kjeldahl method (Chang & Zhang, 2017). Meanwhile, fat content analysis was performed using the Soxhlet method (Ellefson, 2017). Analysis of reducing sugar content applied the spectrophotometric method (Shariff et al., 2023) and total food fiber content used the Multienzyme method (Kristanti et al., 2020).

2.4. Physical Properties Testing

Hardness tests, brittleness, and cohesiveness of cookies were investigated by a Texture Analyzer tool which was commenced by cutting of sample to the size of (2x2x2) cm^3. The Texture Analyzer machine was turned on for a minimum of 30 minutes before use and programmed according to the determined parameters, namely hardness, brittleness, and cohesiveness. Subsequently, the sample was put under the pressure tool and operated. The magnitude of hardness, brittleness, and cohesiveness were observed on the monitor screen. The gel strength value was the force required to define the sample expressed in Newton units (N).

2.5. Acceptance Testing

Acceptance was carried out using organoleptic tests (Sofyan et al., 2022). The parameters tested were color, odor, flavor, texture, and overall, with 7 scales. These included like extremely, like, like moderately, neutral, dislike, dislike moderately, and dislike extremely with a total of 34 fairly trained panelists.

2.6. Data analysis

Data analysis was carried out using SPSS version 20. Specifically, chemical test results, physical properties, and acceptance were conducted using normality and homogeneity tests with the Kolmogorov-Smirnov. When the data were not normally distributed, the Kruskal-Wallis test was performed. Meanwhile, when there was an influence with a significance value of $p<0.05$, the Dunnet difference test was performed.

3. Results and discussions

3.1. Water content

Water content data were not normally distributed ($p= 0.028$), hence, the Kruskal Wallis test proceeded with the analysis results in Table 1.

Table 1. Moisture Content of Cookies Ratio of Mocaf and Millet Flour

Treatment	Water Content (%)
P1 (100% : 0%)	5.81 ± 0.59
P2 (75% : 25%)	5.68 ± 0.52
P3 (50% : 50%)	6.25 ± 0.07
P4 (25% : 75%)	5.45 ± 1.21
P5 (0% : 100%)	5.46 ± 0.52
p-value	**0.331**

The results of the Kruskal-Wallis statistical test on water content showed p value = 0.331. This showed that cookies with a ratio of mocaf flour : millet flour of 100% : 0%, 75% : 25%, 50% : 50%, 25% : 75%, and 0% : 100% did not have a significant difference. According to the average value of water content of mocaf with millet flour, the results did not meet the quality required for cookies. This was based on the 2011 Indonesian National Standard (SNI) (Badan Standarisasi Nasional, 2011), where cookies accommodated water content of more than 5%. Cookies with the lowest water content of 5.45% were from the ratio of 25% mocaf flour: 75%

millet flour. The highest results obtained were 6.25%, found in 50% : 50% cookies.

3.2. Protein Content

The protein content data were normally distributed (p= 0.297), but not homogeneous (p= 0.032). Therefore, the next analysis was carried out by the Kruskal Wallis Test, with the results shown in Table 2.

Table 2. Protein Content of Cookies Ratio of Mocaf and Millet Flour

Treatment	Protein Content (%)
P1 (100% : 0%)	3.19 ± 0.13[a]
P2 (75% : 25%)	4.27 ± 0.61[ab]
P3 (50% : 50%)	5.51 ± 0.71 [bc]
P4 (25% : 75%)	6.24 ± 0.46[c]
P5 (0% : 100%)	8.07 ± 0.58 [d]
p-value	**0.002**

Value with different letter notations shows significant differences (Duncan P<0.05).

Protein content of cookies with a ratio of mocaf : millet flour 100% : 0%, 75% : 25%, 50% : 50%, 25% : 75%, and 0% : 100% had a significant difference. In the average protein content of mocaf and millet, cookies that met the quality requirements per Indonesian National Standard (SNI) in 2011 (Badan Standarisasi Nasional, 2011) had a minimum protein of 5 grams in every 100 grams. These cookies were obtained in treatments P3, P4, and P5. Cookies with the lowest protein content of 3.19% were found in the ratio of 100% mocaf : 0% millet flour. Meanwhile, the highest protein content results obtained were 8.07% in 0% mocaf flour cookies: 100% millet flour ratio. This suggested that the use of higher millet in mocaf flour cookies led to increased protein content.

Research by (Izwardy, 2018) stated that protein content of mocaf flour was 1.2 grams, while (Muhammad et al., 2020) reported 12.1 grams. Based on the previous research, the higher the use of millet flour, the greater the protein content in cookies.

3.3. Fat content

Fat content data in the normality test were not normally distributed (p= 0.059). Therefore, analysis was carried out using the Kruskal-Wallis test, with the results shown in Table 3.

Table 3. Fat Content of Cookies Ratio of Mocaf and Millet Flour

Treatment	Fat Content (%)
P1 (100% : 0%)	30.28 ± 0.37
P2 (75% : 25%)	29.53 ± 1.37
P3 (50% : 50%)	29.91 ± 0.29
P4 (25% : 75%)	29.65 ± 0.79
P5 (0% : 100%)	28.78 ± 0.57
p-value	**0.174**

The results of the Kruskal Walls statistical test showed p= 0.174. This suggested that cookies with a ratio of mocaf : millet flour in all treatments did not have a significant effect. Based on the average fat content of cookies, the lowest value of 28.78% was found in the ratio of 0% mocaf : 100% millet flour. The highest value of 30.28% was obtained in 100% mocaf : 0% millet flour. The results showed that as the use of millet flour increased, fat content reduced. This could be attributed to the lower fat content of millet flour at 1.68%, while mocaf flour had 2.72% (Gusriani et al., 2021).

3.4. Reducing Sugar Levels

The results of the normality test data on reducing sugar levels were not normally distributed (p= 0.000). Consequently, further analysis was carried out using the Kruskal-Wallis test, with results presented in Table 4.

Reducing sugar content in this research, based on the results of the Kruskal-Walls statistical test, showed p= 0.056. This suggested that cookies with a ratio of mocaf : millet flour of 100% : 0%, 75% : 25%, 50% : 50%, 25% : 75%, and 0% : 100% did not have a significant difference. Based on the average reducing sugar content of cookies, the lowest value of 13.52% was obtained in the ratio of 25% mocaf : 75% millet flour.

Table 4. Reducing Sugar Content of Cookies Ratio of Mocaf and Millet Flour

Treatment	Reducing Sugar Content (N)
P1 (100% : 0%)	18.33 ± 2.22
P2 (75% : 25%)	16.11 ± 0.11
P3 (50% : 50%)	16.88 ± 0.70
P4 (25% : 75%)	13.52 ± 4.57
P5 (0% : 100%)	15.41 ± 0.98
p-value	**0.056**

3.5. Total Dietary Fiber Content

Data on total dietary fiber content were normally distributed (p= 0.386), but not homogeneous (p= 0.000). This led to further analysis using the Kruskal-Wallis test, with results shown in Table 5.

Table 5. Total Food Fiber Content of Cookies Ratio of Mocaf and Millet Flour

Treatment	Total Food Fiber Content (%)
P1 (100% : 0%)	2.42 ± 1.81[a]
P2 (75% : 25%)	4.10 ± 1.31[a]
P3 (50% : 50%)	4.69 ± 0.59[a]
P4 (25% : 75%)	5.65 ± 0.63[a]
P5 (0% : 100%)	8.41 ± 0.67[b]
p-value	**0.007**

Value with different letter notations shows significant differences

The results of the Kruskal-Wallis statistical test showed that the p-value = 0.007, indicating a significant influence on the total food fiber content of cookies. Further testing was conducted with the Dunnett T3 test, where the results showed significant differences ($p<0.05$) between treatments P1, P3, P4, and P5, as well as P5 and all treatments. This suggested that cookies with a ratio of mocaf : millet flour 100% : 0%, 75% : 25%, 50% : 50%, 25% : 75%, and 0% : 100% had a significant difference.

In average total dietary fiber content cookies, the lowest value of 2.42% was obtained in the ratio of 100% mocaf : 0% millet flour. The highest value of 8.41% was obtained at a ratio of 0% mocaf : 100% millet flour. The data showed that a high millet flour ratio in making mocaf flour cookies caused an increase in total food fiber content. According to (Izwardy, 2018), the fiber content of mocaf flour was 6 grams, while (Muhammad Iqbal Nusa, Budi Suarti, 2012) reported a 7.8 grams. Based on observation, the use of millet flour increased along with fiber content in cookies. Moreover, dietary fiber in food will affect the properties of the food, as higher content correlated with lower glycemic index (Wahyuningtias, 2010). The dietary fiber in millet flour was higher compared to mocaf. Due to the high glycemic index content, as millet flour increased, there would be a significant decrease in reducing sugar.

3.6. Hardness Value

Hardness data were not normally distributed, with the results of the Kruskal-Wallis test shown in Table 6. Based on the results, the p-value <0.05 showed that there was a significant effect of treatment (P1, P2, P3, P4, and P5) on the hardness (N) of cookies made of millet and mocaf flour.

The results of the hardness test on cookies show that P5 had the highest average value of 212.94N. This value was influenced by the fiber and protein content of the raw materials, which played a role in absorbing water causing weakly bound (Dias et al., 2010). Millet flour contained a protein of 12.1% and a fiber of 7.8% (Dias-Martins et al., 2018). Mocaf flour comprised a protein of 1% and a fiber of 1.9% - 3.4% (Widasari & Handayani, 2014).

3.7. Brittleness Value

Brittleness analysis was examined using the ANOVA, with the results presented in Table 6. This analysis was carried out to determine whether there was a significant influence of the ratio of millet and mocaf flour on the brittleness of cookies. According to the results of the Kruskal-Wallis statistical test with a value of $p<0.05$, there was a significant effect of treatment (P1, P2, P3, P4, and P5) on the brittleness value of millet and mocaf flour cookies.

The results of the brittleness test on cookies showed that mocaf and millet flour ratio of 0%: 100% had the highest average value of 5.19N. Meanwhile, mocaf and millet flour ratio of 100%: 0% had the lowest average value, namely 2 .89N.

3.8. Value of Cohesiveness

Cohesiveness is the pressure area from the second to the first compression and has no units. It is often measured as the degree to which the product is destroyed mechanically [20]. Therefore, analysis was carried out using the Kruskal-Wallis test to determine the significant effect of the ratio of millet and mocaf flour on the cohesiveness of cookies. The results of the cohesiveness test analysis on cookies are shown in Table 6.

The results of the cohesiveness test on cookies show that P2, the ratio of mocaf flour to millet flour 75%: 25% had the highest average value of 0.42. According to (Shaliha et al., 2017), a high cohesiveness material correlated with elevated integrity of materials.

Table 6. Hardness Value, Brittleness, and Cohesiveness of Cookies Ratio of Mocaf Flour and Millet Flour

Treatment	Means ± SD		
	Hardness (N)	**Brittleness (N)**	**Cohesiveness**
P1 (100% : 0%)	165,29±8,69^{b}	2,89 ± 0,63^{a}	0,27 ± 0,15
P2 (75% : 25%)	142,76±18,14^{ab}	3,77 ± 0,54^{a}	0,42 ± 0,03
P3 (50% : 50%)	129,57±27,18^{ab}	3,17 ± 1,12^{a}	0,40 ± 0,03
P4 (25% : 75%)	188,53±7,10^{a}	3,34 ± 0,72^{a}	0,40 ± 0,03
P5 (0% : 100%)	212,94±48,98^{ab}	5,19 ± 1,14^{b}	0,40 ± 0,05
p-value	**0,005**	**0,016**	**0,425**

Value with different letter notations shows significant differences

3.9. Acceptance

The acceptance of cookies with mocaf flour and millet flour ratio of 100% : 0%, 75% : 25%, 50% : 50%, 25% : 75%, and 0% : 100% includes color, odor, flavor, texture, and overall. The results of the analysis were completed using the Kruskal-Wallis test to find out the real effect of the ratio of millet flour and mocaf flour on the acceptance of cookies. The results of cookies acceptance analysis are shown in Table 7.

Table 7. Cookies Acceptance Test Results Ratio of Mocaf Flour and Millet Flour

Treatment	Nilai Mean ± SD				
	Color	**Odor**	**Flavor**	**Brittleness**	**Overall**
P1 (100%:0%)	4,59±1,86^{a}	5,38±0,98^{ab}	5,26±1,31^{ab}	5,29±1,54^{ab}	5,09±1,54^{ab}
P2 (75%:25%)	5,59±1,04^{abc}	5,94±0,88^{b}	5,06±1,20^{a}	4,97±1,38^{ab}	5,26±0,99^{ab}
P3 (50%:50%)	6,03±0,71^{b}	5,71±0,90^{ab}	5,79±0,77^{b}	5,59±1,13^{b}	5,82±0,71^{b}
P4 (25%:75%)	5,06±1,23^{ac}	5,44±1,21^{ab}	4,56±1,37^{ac}	4,62±1,57^{ac}	4,68±1,14^{ac}
P5 (0%:100%)	4,85±1,37^{ac}	5,00±1,39^{a}	4,38±1,47^{a}	4,47±1,46^{a}	4,62±1,39^{a}
p-value	**0,000**	**0,013**	**0,000**	**0,006**	**0,000**

Value with different letter notations shows significant differences

Based on Table 7, the results of the acceptance test with color parameters showed that the ratio of millet and mocaf flour 50%: 50% had the highest average of 6.03. This could be attributed to the presence of millet flour, which contributed color to cookies. Treatment P3 was preferable because the color was as bright and attractive as general cookies. Meanwhile, treatment P1 had a pale color or was less attractive than other treatments. Cookies made with P4 and P5 showed a darker color, which was less attractive. According to (Martins et al., 2000), proteins with reducing sugars during heating would generate browning which formed melanoidin compounds.

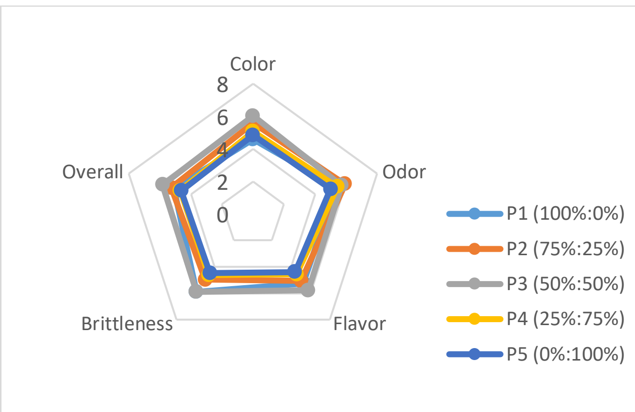

Figure 1. Cookies Acceptance Test Results Ratio of Mocaf and Millet Flour

The results of the odor acceptance test in Figure 1 showed that P2 had the highest average of 5.94. This was because cookies with treatment P2 had a similar odor to general products. The decrease in the level of odor preference in cookies was caused by the dominance of millet flour. According to (Pakhri et al., 2017), the unpleasant odor was due to the breaking down of protein into amino acids by heat. The reaction between amino acids and sugar would produce aroma, while the fat in the ingredients was oxidized and broken down by heat. Therefore, some of the active ingredients produced by the process would react with amino acids and peptides to produce odor.

The results of the flavor acceptance test showed that the ratio of millet and mocaf flour 50%: 50% had the highest average of 5.79, while P5 had the lowest value of 4.38. Generally, flavor plays a significant role in acceptance, particularly in new products, where consumers will greatly determine the quality (Verma et al., 2015). The flavor of cookies is influenced by several factors including temperature, chemical compounds, ingredient components, and interactions with other flavor components. The high level of preference for the flavor at P3 was because cookies had a savory flavor, while P5 was bitter (aftertaste). When making cookies with millet flour as a substitute, it leaves a bitter aftertaste due to the presence of the epidermis which emits tannin (Widyastuti et al., 2019).

Food texture is an important aspect of consumer acceptance, particularly in crunchy products such as cookies. Based on the results of the brittleness acceptance test on cookies, the treatment most preferred by the panelists was P3 with an average of 5.59, while P5 had the lowest value of 4.47. The low level of texture preference was because P5 had a slightly rough texture, while P3 was crunchy, soft, and smooth.

Based on Figure 1, the results of the overall acceptance test on all cookies showed that P3 had the highest average of 5.82, while P5 had the lowest of 4.62. As shown by the observed parameters, the best treatment was P3 at a ratio of millet and mocaf flour of 50%: 50%.

4. Conclusion

In conclusion, this research showed that there was no effect of the comparison of mocaf and millet flour on water content, fat, reducing sugar, and cohesiveness. Meanwhile, there was a significant effect on protein content, dietary fiber, hardness, brittleness, and acceptance. The overall acceptance test results showed that the most preferred cookies formulation with highest rating was obtained in P3 with 50%:50% ratio of mocaf and millet flour.

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