



# Substituting Wheat Flour with Mocaf Flour in Making Dry Cakes

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## ABSTRACTS

Mocaf flour is a carbohydrate source that can be used as a substitute for wheat flour, thus reducing dependence on wheat in making cookies. This study aims to determine the appropriate percentage of wheat flour substitution with Mocaf flour and its effect on the chemical and organoleptic properties of cookies. The method used was an experiment with a Completely Randomized Design (CRD) and a single-factor treatment with six levels, namely 0% mocaf flour substitution (control), 15%, 30%, 45%, 60%, and 75%. The results showed that the higher the percentage of wheat flour substitution with Mocaf flour, the lower the water content, while the starch and ash content tended to increase. The aroma, flavor, and color scores decreased, while the texture score increased. Substitution of wheat flour up to 75% produced cookies with good chemical and organoleptic properties.

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## 1. INTRODUCTION

Wheat flour-based foods have long been an important part of dietary patterns in many countries, including Indonesia. Wheat flour is one of the strategic food commodities widely used in the food industry, ranging from bread, noodles, pastries, and cookies. One of the most popular products is cookies, known for their complex, crunchy texture, high fat content, and long shelf life (Masrikhiyah, 2021). Cookies are usually made from wheat flour, salt, sugar, fat, eggs, and leavening agents, resulting in products with organoleptic characteristics that consumers favor.

However, Indonesia's reliance on wheat flour poses serious challenges for national food security. Data from the Central Bureau of Statistics (2024) show that Indonesia's wheat imports reached 9.45 million tons as of September 2024, with a consistent upward trend year after year. Indonesia is one of the world's largest wheat importers, with wheat flour consumption continuing to increase annually. Most of the wheat needed for flour production is imported because wheat plants cannot grow optimally in Indonesia's tropical climate. This condition makes wheat flour relatively expensive, and its price fluctuates depending on global market conditions and the rupiah exchange rate. The high dependence on wheat imports has driven the search for more economical, sustainable, and locally sourced alternatives to reduce reliance on imported wheat flour (Izzatunnisa, 2022; Widodo, 2023).

Modified Cassava Flour (Mocaf) emerges as an attractive and strategic alternative for diversifying national food sources. Mocaf is a flour product derived from cassava (*Manihot esculenta* Crantz) that has been modified through fermentation using lactic acid bacteria. This fermentation process applies the principle of biological modification of cassava cells, which transforms conventional cassava flour into a product with improved functional properties. Fermentation with lactic acid bacteria alters flour characteristics, such as increasing rehydration capacity, solubility, viscosity, and gelation ability, and producing better taste and aroma than ordinary cassava flour (Kristanti et al., 2020).

Mocaf has several significant advantages over wheat flour, both economically and nutritionally. First, in terms of raw material availability, cassava is a tuber crop that grows readily in Indonesia, with high productivity and lower prices than wheat. Cassava production data in Indonesia indicate enormous potential to develop into carbohydrate-based food industry commodities (Yudha et al., 2023). Second, from a health perspective, Mocaf has significant potential benefits, including prebiotic effects that support the growth of beneficial gut microbes, colon cancer prevention, and hypoglycemic effects beneficial for people with diabetes mellitus. Third, Mocaf is gluten-free, making it safe for individuals with celiac disease, gluten intolerance, or wheat allergies (Marta et al., 2024).

From a chemical composition perspective, Mocaf differs from wheat flour. Mocaf contains higher starch levels (85–87%) compared to wheat flour (60–68%), making it a good source of energy. Mocaf's high carbohydrate content makes it an effective alternative for bakery products. In addition, Mocaf contains higher calcium levels than wheat flour, although its protein content is lower (Yashinta et al., 2021). The fundamental difference between Mocaf and wheat flour is the absence of gluten in Mocaf. Gluten is a protein found in wheat that provides elasticity and expansion in dough, which is crucial in bread and cake making. Although Mocaf does not contain gluten, its use as a substitute in cookie production is still feasible because cookies do not require strong gluten structures as bread does (Masrikhiyah, 2021).

Several previous studies have examined the use of Mocaf as a substitute for wheat flour in various food products over the past five years. One study showed that Mocaf cookies containing tempeh flour exhibited physicochemical and organoleptic characteristics

acceptable to consumers (Kristanti et al., 2020). Another study found that Mocaf-based biscuits substituted with soybean flour at various ratios showed improved nutritional status (Ratnawati et al., 2020). Research on coconut butter cookies showed that Mocaf substitution provided unique product characteristics favored by consumers (Rahman et al., 2021). Meanwhile, another study found that Mocaf substitution in soft cookies produced a crunchy yet soft texture, even at 100% Mocaf composition (Ayuningtyas & Jayendra, 2023).

Recent studies show that pumpkin and Mocaf cookies have good physicochemical properties, antioxidant activity,  $\beta$ -carotene content, and sensory attributes (Indrianingsih et al., 2024). Meanwhile, research on gluten-free biscuits evaluating the functional properties of composite flours from local Indonesian tubers, including Mocaf, found that biscuits formulated with Mocaf had characteristics similar to those of wheat-flour biscuits (Marta et al., 2024). Other research on the rheological and textural properties of gluten-free cookies made with pearl millet and flaxseed also supports their development as healthy alternatives (Bashir et al., 2020). These studies indicate that Mocaf has excellent potential as a wheat-flour substitute. However, the optimal substitution percentage and its effects on product characteristics need to be studied explicitly for each food product type. In research on the effects of Mocaf and soybean flour ratios on the nutritional and sensory components of cookies, it was found that cookies containing 20% Mocaf and 80% soybean flour met SNI standards, with a moisture content of 3.22% and a protein content of 17.29% (Septiana et al., 2024).

In the context of cookie production, substituting wheat flour with Mocaf is an interesting topic for further study. Cookies have a dry, crunchy, hard texture with a low moisture content. These characteristics differ from those of other bakery products, such as bread, which require strong gluten structures. Therefore, Mocaf has the potential to be used as a wheat-flour substitute in cookies at relatively high levels without significantly reducing product quality. Mocaf cookies with 5% substitution of katuk leaf flour meet quality criteria, with high vitamin C and calcium content (Ratnasari, 2024).

This study aims to explore the appropriate percentage of wheat flour substitution with Mocaf and its effects on the chemical and organoleptic properties of cookies. Using an experimental method and a Completely Randomized Design (CRD), this study is expected to provide insights into the potential of Mocaf as an alternative raw material in the food industry, particularly in cookie production. The parameters observed include chemical properties (moisture, starch, and ash content) and organoleptic properties (aroma, taste, color, and texture) of the cookies produced. Through this study, it is expected that the optimal formulation will be determined to produce high-quality cookies, both in terms of nutrition and taste, so they can be accepted by the wider community and contribute to the national food diversification program based on local resources.

The results of this study are expected to provide practical contributions to the food industry by developing cookie products made with local flour that are more economical and sustainable. In addition, this research is expected to support government programs to reduce reliance on wheat imports by utilizing cassava, a locally abundant commodity. Thus, this study has important implications not only for food technology but also for national food security and economic development based on local resources (Hadistio et al., 2019; Widodo, 2023).

## 2. METHODS

This study used a Completely Randomized Design (CRD) with one treatment factor. The treatment consisted of 6 levels of Mocaf flour substitution: 0% (100% wheat flour as a

control), 15%, 30%, 45%, 60%, and 75%. This study aims to determine the effect of the percentage of wheat flour substitution with Mocaf flour on the chemical and organoleptic properties of cookies. The subjects of this study were cookies produced from various combinations of wheat flour and Mocaf flour.

**Table 1.** Treatment carried out as a test.

Test	Treatment level percentage of wheat flour substitution with Mocaf flour (%)					
	0	15	30	45	60	75
1	T0U1	T1U1	T2U1	T3U1	T4U1	T5U1
2	T0U2	T1U2	T2U2	T3U2	T4U2	T5U2
3	T0U3	T1U3	T2U3	T3U3	T4U3	T5U3

T = Percentage of wheat flour substitution with Mocaf flour  
 U = Number of test

Data were collected by analyzing moisture, starch, and ash content, as well as through organoleptic tests assessing color, aroma, flavor, and texture. Chemical analyses were conducted using methods established in the literature. Organoleptic evaluations were conducted by trained panelists, who assigned scores according to predetermined criteria.

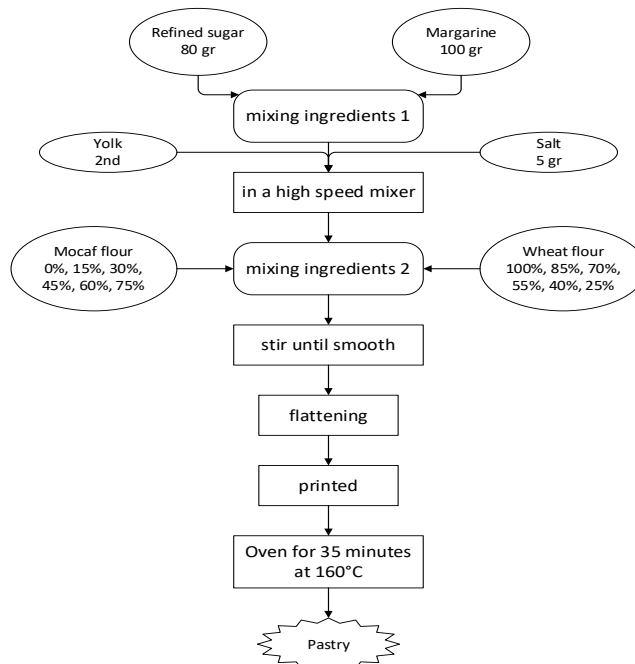
The collected data were analyzed using analysis of variance (ANOVA) to determine the significance of treatment effects. When significant differences were identified, further analysis was conducted using the Honestly Significant Difference (HSD) test at a 5% significance level.

**2.1. Equipment**

The equipment used in this study included a mixer, oven, weighing scale, and measuring instruments.

**2.2. Materials**

The materials used in this study consisted of wheat flour, Mocaf flour, powdered sugar, margarine, egg yolk, and salt.



**Figure 1.** Flow diagram of the process of making cookies (modified by Soenardi 2002).

### 3. RESULTS AND DISCUSSION

#### 3.1. Results

This study shows that substitution of wheat flour with Mocaf flour affects the chemical and organoleptic properties of the resulting cookies:

**Table 2.** Results of analysis of water content, starch, and ash in dry cakes using various substitutions of wheat flour with Mocaf flour.

Treatment	Moisture content	Starch content	Ash content
T0	11,8215 b	13,6133 a	0,4590 a
T1	7,5988 a	13,9400 a	1,5544 ab
T2	6,5109 a	29,9167 b	2,9783 b
T3	6,1436 a	33,3000 b	3,4720 b
T4	6,1039 a	34,3533 b	5,9380 c
T5	4,6675 a	35,1033 b	6,4915 c
BNJ 5%	3,1766	6,8890	2,2269

Notes: Numbers followed by the same letter in the same column are not significantly different at the 5% level

**Table 3.** The results of the analysis of the aroma, color, texture, and taste scores of dry cakes using various substitutions of wheat flour with Mocaf flour.

Treatment	Aroma	Color	Texture	Flavor
T0	3,50 b	3,94	2,50	3,55 b
T1	3,44 b	3,50	2,69	3,31 ab
T2	3,31 b	3,44	2,88	3,06 ab
T3	3,31 b	3,31	2,94	2,88 ab
T4	3,00 ab	3,31	3,13	2,69 ab
T5	2,38 a	2,63	3,19	2,50 a
BNJ 5%	0,825	-	-	0,942

Notes: Numbers followed by the same letter in the same column are not significantly different at the 5% level

- **Moisture Content**

The moisture content of cookies decreased as the percentage of Mocaf flour substitution increased. The highest moisture content was observed in the treatment with 100% wheat flour (T0), at 11.82%, while the lowest was in the treatment with 75% mocaf flour (T5), at 4.67%.

Mocaf flour has a lower water absorption capacity than wheat flour due to differences in starch granule structure and the absence of gluten (Kristanti et al., 2020). This results in products with a higher Mocaf flour content tending to have a lower air content after baking.

- **Starch Content**

As the level of Mocaf flour substitution increased, the cookies' starch content tended to increase. The highest starch content, 35.10%, was observed in treatment T5, whereas the lowest, 13.61%, was recorded in treatment T0.

These results align with research reporting that mocaf flour cookies with varying fat types and concentrations showed an increase in total carbohydrate content as the proportion of mocaf flour increased (Yashinta et al., 2021). The high starch content of Mocaf flour contributes to the energy value of the final product and has the potential to serve as a good source of complex carbohydrates (Masrikhiyah, 2021).

- **Ash Content**

The ash content of the cookies increased with higher levels of Mocaf flour substitution. The highest ash content was observed in treatment T5 (6.49%), while the lowest ash content was found in treatment T0 (0.46%).

This increased ash content indicates that Mocaf flour has a higher mineral content than wheat flour. The higher ash content in Mocaf flour compared to wheat flour indicates nutritional advantages, particularly in terms of mineral content such as calcium, phosphorus, and iron (Annisa & Rahayu, 2022). This increased ash content adds nutritional value to the final product, making cookies made with mocaf flour substitutes richer in minerals than conventional wheat-flour-based cookies (Satar & Emilia, 2023).

## 3.2. Discussion

### 3.2.1. Chemical Properties Analysis

- Moisture Content

Increasing the Mocaf flour content decreases the moisture content of cookies. This is due to Mocaf flour having a lower moisture content than wheat flour. Mocaf flour has a moisture content of around 11.9%, while wheat flour has a higher moisture content (Ministry of Health of the Republic of Indonesia, 2018). This reduction in moisture content aligns with SNI 01-2973-1992, which stipulates a maximum moisture content of 5% for biscuits, thereby ensuring a longer shelf life for cookies (National Standards Agency, 1992).

Low moisture content in cookies is crucial for preventing microbial growth and extending shelf life (Medho et al., 2022). Research on cookies containing jackfruit seed flour also shows that a lower moisture content contributes to a crispier texture and greater product stability during storage (Selvianti et al., 2024). Low moisture content is an indicator of good physical quality of cookies (Novia et al., 2023).

- Starch Content

The higher starch content in cookies made with Mocaf flour indicates that Mocaf flour has a higher starch content than wheat flour. This provides the potential for higher nutritional value in the final product, especially as a carbohydrate source. Mocaf-based biscuits substituted with soy flour at various ratios have a higher carbohydrate content than control biscuits made from wheat flour (Ratnawati et al., 2020). Cookies substituted with mocaf flour have a higher total carbohydrate content, which contributes to the product's energy value (Safira et al., 2022). The resistant starch in Mocaf flour also provides additional health benefits, including a prebiotic effect that supports digestive health (Setiarto et al., 2015; Rozali, 2024).

- Ash Content

The increased ash content in cookies indicates that mocaf flour has a higher mineral content than wheat flour (Wulandari & Putri, 2022; Nabila et al., 2025). This indicates an increase in the product's nutritional value from a micronutrient perspective. The organoleptic characteristics and protein content of mocaf flour cookies containing lompek fish flour indicate an increase in nutritional value, including a higher ash content (Novia et al., 2023). The higher mineral content in Mocaf flour makes the final product more nutritious, especially for consumers who need additional minerals.

### 3.2.2. Organoleptic Properties Analysis

- Aroma

The aroma of cookies tends to decrease as the proportion of mocaf flour increases. Cookies made with 100% wheat flour have a more desirable aroma, while those made

with 75% mocaflour tend to be less preferred due to mocaflour's distinctive aroma. Cookies made from mocaflour with varying amounts of margarine and butter show that the distinctive aroma of mocaflour can be masked by butter in the formulation (Aprilianti et al., 2025).

Substituting mocaflour for wheat flour in soft cookies produces products with a different aroma than wheat-flour-based cookies, but remains acceptable to consumers at certain substitution levels (Ayuningtyas & Jayendra, 2023). Unfavorable aromas with high mocaflour substitution can be overcome by adding flavoring agents such as vanilla, chocolate, or spices (Satar & Emilia, 2023).

- Color

The color value of cookies decreased, but did not reach statistical significance. The combination of yellowish-white mocaflour and white wheat flour influences cookie color. Cookie color is influenced by the Maillard reaction during baking, which occurs between reducing sugars and amino acids (Annisa & Rahayu, 2022). Differences in chemical composition between Mocaflour and wheat flour can affect the intensity of the Maillard reaction and produce slightly different final colors. Changes in cookie color can be influenced by the type of flour used and baking conditions (Medho et al., 2022). Cookies with mocaflour and soy flour substitutes produce a slightly brown color; however, color changes in cookies with mocaflour substitutions are generally within the acceptable range for consumers (Septiana et al., 2024).

- Texture

Substituting mocaflour improves cookie texture, making them crispier (Ihromi et al., 2018). Cookies containing 75% mocaflour showed the highest texture scores. The crisp texture of Mocaflour cookies is due to their lower air content and a different starch structure compared to wheat flour (Kristanti et al., 2020).

The absence of gluten in Mocaflour also contributes to a more brittle, crunchy texture, a desirable characteristic for cookie products (Marta et al., 2024). Cookies made with mocaflour substitutes have a crisper, firmer texture than wheat-flour-based cookies and are highly preferred by consumers (Safira et al., 2022). This crunchy texture is one of the advantages of Mocaflour cookies that distinguishes them from conventional products.

- Flavor

Cookie flavor tends to decline as the proportion of Mocaflour increases. This unpopular flavor is attributed to the lack of aroma and flavor characteristics in wheat flour. Flavor perception in cookies is influenced by the context and product characteristics, including sweetness, aroma, and texture (Arroyo et al., 2024). Unpopular flavors with high mocaflour substitution can be improved by optimizing the formulation, such as adding sugar, salt, and appropriate flavoring agents to mask the less desirable mocaflour flavor (Yashinta et al., 2021).

#### 4. CONCLUSION

This study shows that substituting wheat flour with Mocaflour significantly affects the chemical and organoleptic properties of cookies. The higher the percentage of Mocaflour substitution, the water content decreases (from 11.82% to 4.67%), the starch content increases (from 13.61% to 35.10%), and the ash content increases (from 0.46% to 6.49%), which indicates a higher mineral content and a longer shelf life according to SNI 01-2973-1992 standards. From an organoleptic perspective, although aroma and taste scores decrease with

increasing mocaf substitution, the cookies' texture improves, becoming crispier, with the highest score in the 75% substitution treatment. At the same time, color does not show a significant difference. A mocaf flour substitution of up to 75% is the best formulation for producing cookies with good chemical and organoleptic characteristics, making mocaf flour an excellent substitute for wheat flour in cookie production, supporting national food diversification and reducing dependence on wheat imports.

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