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THE PROCESS OF PROCESSING CASSAVA INTO MOCAF FLOUR

PROSES PENGOLAHAN SINGKONG MENJADI TEPUNG MOCAF

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Abstract

Mocaf flour is a local product that can be utilized as an alternative to wheat flour in various food products. Using local food sources, such as cassava, is essential to support food security and reduce dependence on imports. This article is a review examining various methods of processing cassava into Mocaf flour. Mocaf flour is a cassava-based product with the potential to replace wheat flour. The Mocaf processing method consists of several stages, including sorting, peeling, washing, cutting, fermentation, drying, milling, and sieving, which result in high-quality flour with improved texture and flavor. A critical stage in the production of Mocaf flour is the fermentation process. Cassava fermentation can be done using microbes, such as Lactobacillus plantarum bacteria and tape yeast, or through non-microbial fermentation. This fermentation process alters the physicochemical properties of cassava, enhancing viscosity, and rehydration capacity, and reducing its bitterness.

Keywords: *Cassava, Fermentation, Mocaf Flour.*

Abstrak

Tepung Mocaf merupakan salah satu produk lokal yang dapat dimanfaatkan sebagai pengganti tepung terigu, menjadi berbagai produk olahan makanan yang beragam. Pemanfaatan bahan pangan lokal seperti singkong diperlukan untuk mendukung ketahanan pangan dan mengurangi ketergantungan terhadap impor. Artikel ini merupakan artikel review yang disusun untuk mengulas berbagai metode pengolahan singkong menjadi tepung Mocaf. Tepung mocaf merupakan produk olahan singkong yang berpotensi menggantikan tepung terigu. Proses pengolahan Mocaf terdiri dari beberapa tahapan, yaitu sortasi, pengupasan, pencucian, pemotongan, fermentasi, pengeringan, penepungan, dan pengayakan, yang menghasilkan tepung berkualitas dengan tekstur dan rasa yang lebih baik. Tahapan penting dalam pembuatan tepung mocaf adalah proses fermentasi. Fermentasi singkong dapat dilakukan dengan menggunakan mikroba, seperti bakteri Lactobacillus plantarum dan ragi tape, serta fermentasi tanpa mikroba. Proses fermentasi ini mengubah sifat fisikokimia meningkatkan viskositas, daya rehidrasi, dan mengurangi rasa pahit pada singkong.

Kata kunci: Fermentasi, Singkong, Tepung Mocaf.

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INTRODUCTION

The import of wheat flour, a key carbohydrate source in Indonesia, has been steadily increasing every year. According to a report from the Indonesian Wheat Flour Producers Association (APTINDO), wheat flour consumption in Indonesia reached 2.79 million tons in the first quarter of 2014, marking a 5.4% increase compared to the 2.65 million tons recorded in the first quarter of 2013. This rapid rise in wheat demand, if not addressed promptly, has the potential to burden the country's foreign exchange reserves, considering the significant budget allocation required to meet this demand. To reduce dependence on imports, Indonesia needs to optimize the use of local food resources. Utilizing these local food sources is expected to support national food security, reduce the trade deficit, and encourage the growth of the domestic food industry (Hadistio *et al*., 2019).

As an agrarian country, Indonesia is endowed with abundant natural resources, including a variety of carbohydrate-rich food commodities. One such abundant source of carbohydrates in Indonesia is cassava (Hadistio *et al*., 2019). Currently, Indonesia is the fourth-largest producer of cassava in the world. The top three producers are Nigeria with 57 million tons, Thailand with 30 million tons, and Brazil with 23 million tons, followed by Indonesia with 19-20 million tons. In Indonesia, cassava production centers are spread across 13 provinces. The top five cassava-producing provinces are Lampung, Central Java, East Java, West Java, and Yogyakarta Special Region. According to data from the Directorate General of Food Crops, the area planted with cassava in 2019 was 628,305 hectares, with a production of 16.35 million tons (Dinas Kominfo Jawa Timur, 2021). Efforts to utilize cassava as a staple for food security can be carried out through various innovations, one of which is the development of Modified Cassava Flour (Mocaf) technology. This technology aims to improve the quality of Mocaf, making it more appealing to consumers and enhancing its physicochemical properties. With characteristics similar to wheat flour, Mocaf can be used as a substitute for wheat flour in the production of various food products, such as cookies, bread, and noodles. The development of Mocaf-based products not only reduces dependence on imported wheat flour but also creates new market opportunities and increases the competitiveness of local food products both domestically and internationally (Hadistio *et al*., 2019).

Mocaf (Modified Cassava Flour) is a modified product derived from cassava flour, produced through a slightly different processing method. While the production steps are similar to those of regular cassava flour, there is a key difference in the processing—specifically, the use of fermentation with microbes. This fermentation process helps improve the quality of the flour, enhancing its texture, taste, and nutritional content, making it more suitable for use in a wide range of food products (Sandy *et al*., 2022). Microbes that can be used in this process are lactic acid bacteria. When growing on cassava, these microbes produce pectinolytic and cellulolytic enzymes capable of breaking down the cell walls of cassava, allowing starch granules to be released. This process results in changes to the characteristics of the resulting flour. The starch granules then undergo hydrolysis, producing monosaccharides that serve as raw materials for the formation of organic acids. The acidic compounds produced mix with the flour, creating a distinctive aroma and flavor that can mask the undesirable odor and taste of cassava. This fermentation process is also effective in reducing HCN content in cassava. Additionally, it significantly alters the taste of Mocaf flour, reducing cassava's characteristic bitterness by approximately 70%, and resulting in a more neutral flavor (Nurdini *et al*., 2024).

Fermentation, derived from the Latin word *fervere* meaning "to boil," refers to a chemical process in which gases, such as carbon dioxide (CO_2), are produced. This process differs from the phenomenon of boiling water as it involves changes at the microorganism level. In cassava processing, fermentation is carried out to improve the quality of cassava flour. During fermentation, the microbes used can enhance the nutritional profile of cassava, particularly by increasing its protein content and reducing the levels of harmful cyanide acid (HCN), which is toxic to health. The fermentation process also makes cassava flour easier to apply in various food products, as it can disperse more easily in dough and aids in the formation of a three-dimensional structure between components. This results in better consistency in the final product, making it more stable and of higher quality (Tandrianto *et al*., 2014).

This article is a review that aims to discuss various research methods that have been developed in the processing of cassava into Modified Cassava Flour (Mocaf). In this article, the author does not conduct direct empirical research but instead collects, analyzes, and summarizes the findings of previous relevant studies to provide a comprehensive overview of the application of these methods. The purpose of this article is to evaluate the advantages and disadvantages of various methods for processing cassava into Mocaf flour. The focus of this article is on compiling information based on literature studies without involving experiments or the collection of primary data.

STAGES OF CASSAVA PROCESSING INTO MOCAF FLOUR

The process of transforming cassava into Mocaf flour involves several stages, including sorting, peeling, washing, slicing, fermentation, drying, milling, and sieving.

Sorting Stage

Sorting is the first and critical stage in the cassava processing process. During this stage, the cassava to be processed is carefully selected to separate the high-quality roots from those that do not meet the quality standards, such as those with blue spots or signs of rotting. This step ensures that only the best cassava is used in further processing, which is essential for maintaining the desired quality of the final product, Mocaf flour (Ningrum, 2023).

Peeling Stage

The peeling stage involves removing the skin from the cassava tubers, which is a crucial step in the process of making Mocaf flour. This step is typically performed manually using a knife, allowing for better control over the quality of the raw material. By carefully peeling the

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cassava, the outer layer, which may contain impurities or contaminants, is discarded, ensuring that only the clean, usable part of the tuber is processed further (Helilusitianingsih, 2023).

Washing Stage

The washing stage is carried out to remove any residues that may remain from the previous fermentation process. The main objective is to ensure that the cassava used in the subsequent steps is clean and free from dirt or microorganisms that could affect the quality of the final product. Thorough washing helps eliminate potential contaminants, ensuring the cassava is ready for further processing without compromising the quality of the Mocaf flour (Riswanto, 2019).

Cutting Stage

After the washing process, the cassava is then reduced in size by cutting it using a specialized cutting tool or slicer (Yani, 2018). Cut the material into thin slices with a thickness of approximately 0.2 to 0.3 cm. These slices are shaped to resemble chips, providing an even texture and facilitating the subsequent processing stages (Suarti *et al*., 2016).

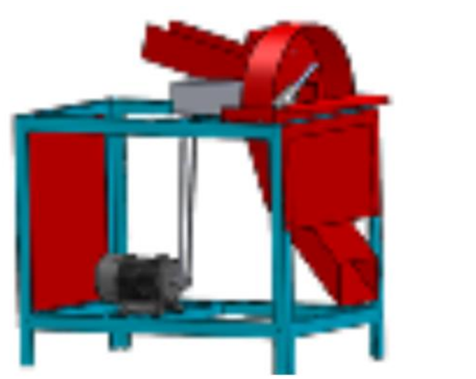

Figure 1. Slicer for Cassava Cutting Tool (Astuti *et al*., 2020).

Fermentation Stage

Fermentation plays a crucial role in the processing of Mocaf flour, where microbes are directly added to the sliced cassava and allowed to ferment for at least 12 hours. This process aims to alter the chemical properties and texture of the cassava, resulting in higher-quality Mocaf flour (Asmoro, 2021). During fermentation, the color of the cassava changes to a whiter hue, and its structure becomes more brittle, making it easier to crumble when pressed. This process also produces Mocaf flour with characteristics similar to wheat flour, making it a suitable substitute in the production of various food products. (Ningrum, 2023). Several types of microbes used during the cassava fermentation process are shown in Table 1.

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Table 1. Fermentation Methods in the Production of Mocaf Flour

Mocaf Making Method	Types of Microbes	Research References
Fermentation Using Bacteria	*Lactobacillus plantarum*	(Asmoro, 2021). (Assalam *et al*., 2019). (Anindita *et al*., 2019). (Kurniati *et al*., 2012). (Tandrianto *et al*., 2014). (Tandrianto & Mintoko, 2014).
Fermentation Using Fungi	Ragi Tape	(Helilusiatinatiningsih, 2023). (Aisah *et al*., 2021). (Ningrum, 2023). (Amri & Pratiwi, 2014).
Fermentation Without Adding Enzymes or Microbes	-	(Emilda *et al*., 2024). (Achmad *et al*., 2023). (Riswanto *et al*., 2019). (Asmoro, 2021).

Natural Fermentation

The fermentation of cassava is carried out using a salt solution. First, the cassava is thoroughly cleaned to remove any dirt or impurities. After cleaning, the cassava is soaked in a saltwater solution for two nights. This soaking process allows fermentation to occur effectively, enhancing the texture, flavor, and preservation of the cassava (Riswanto *et al*., 2019).

As an alternative, the fermentation process can be carried out spontaneously without the addition of specific microbes, by soaking cassava in water or saltwater for three days. This method allows the natural microorganisms present around the cassava to initiate the fermentation process naturally (Asmoro, 2021). The fermentation process for 120 hours using saltwater aims to eliminate the cyanide content in cassava. This fermentation helps reduce the toxicity levels of cassava, making it safer for consumption (Achmad *et al*., 2023).

Cassava slices are soaked for 3 days in a natural fermentation process, without the addition of enzymes or other additives. During this period, natural microorganisms work to alter the chemical properties of the cassava, making it safer and ready for use (Emilda *et al*., 2024).

Cut cassava into thin slices using a knife or a special chip cutter until they form very thin slices. After that, soak the cassava slices in clean water for three days. During the soaking process, ensure to change the water every 24 hours to keep the cassava well submerged. Once completed, remove the cassava from the water and drain it until the moisture is gone (Baihaqi *et al*., 2022).

Fermentation is carried out using *Lactobacillus plantarum*.

Lactobacillus plantarum has amylolytic capabilities, meaning it can produce amylase enzymes. These enzymes function to modify the amylose components in mocaf, thereby improving the quality and properties of the flour (Asmoro, 2021). The fermentation time and

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process using *Lactobacillus plantarum*, according to several previous researchers, are shown in Table 2.

Table 2. Mocaf Fermentation Process using *Lactobacillus plantarum*

Fermentation Time	Fermentation Process	Research References
24, 48, and 72 hours.	The fermentation process is carried out using the submerged fermentation method at a temperature of 37°C, with plastic wrap covering the container. During this process, *Lactobacillus plantarum* lactic acid bacteria are added, with fermentation times of 24, 48, and 72 hours to determine their effect on the quality of the resulting mocaf.	(Wulandari *et al*., 2021).
5 days.	The fermentation process using *Lactobacillus plantarum* produces the best mocaf flour after 5 days of fermentation. During this period, microorganisms work optimally to modify the flour components, resulting in better quality and enhanced functional properties of mocaf.	(Kurniati *et al*., 2012).
12, 24, 36, 48, 60, 72 hours.	Cassava is peeled, washed thoroughly, and grated to increase the surface area for fermentation. The grated cassava is then placed in a fermentation container, and water containing 10,000,000 cells/ml of microorganisms is added. Fermentation is carried out at room temperature. Initially, a starter culture is prepared, and Lactobacillus plantarum is harvested at the 6th hour. After that, the main fermentation begins by transferring the starter solution to the material to be fermented. Sampling is conducted at various time intervals: 0, 12, 24, 36, 48, 60, and 72 hours.	(Tandrianto *et al*., 2014).
72 hours.	The grated cassava is placed into a fermentation bottle, and *Lactobacillus plantarum* bacteria are added at a concentration of 2% of the cassava's weight. Distilled water is then added until the cassava is submerged at a ratio of 3:2 to the cassava volume. The incubation process is carried out until the microorganism cell count reaches 10 million cells/ml, with the fermentation temperature maintained at 30°C. Fermentation lasts for 72 hours to ensure optimal microorganism growth.	(Tandrianto & Mintoko, 2014).
120 hours.	In the fermentation stage, cassava that has been stored in a temporary storage tank is mixed with the mixing process and bacteria from the mixing tank into the fermentation tank. Fermentation is carried out using Lactobacillus plantarum bacteria for 120 hours at a temperature of 30°C under anaerobic conditions.	(Anindita *et al*., 2019).

Fermentasi menggunakan ragi tape

Tape yeast contains a variety of microbes, including bacteria, molds, and yeasts. Some bacteria found in tape yeast include *Pediococcus sp.* and Bacillus sp., while the molds involved

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include *Amylomyces roux*, *Mucor* sp., and *Rhizopus* sp. Additionally, tape yeast also contains yeasts such as *Saccharomyces fibuligera*, *Saccharomyces malanga*, *Saccharomyces cerevisiae*, *Pichia burtonii*, and *Candida utilis*, all of which play a role in the fermentation process to enhance the quality of Mocaf flour (Nurdini *et al*., 2024). The fermentation time and process using tape yeast, according to several previous researchers, are shown in Table 3.

Table 3. Fermentation Process Using Tape Yeast

Concentration	Fermentation Time	Fermentation Process	Research References
5 %	3 days	The fermentation process begins by soaking cassava slices in a 5% salt solution for 6 hours. After that, the cassava, which has been reduced in size, is fermented using tape yeast at a 5% concentration for 3 days. This process aims to alter the chemical properties and improve the quality of the fermented cassava.	(Aisah et al., 2021).
1,5 %	24, 48, and 72 hours	The comparison of measurements in the fermentation process is 300 grams of cassava, which is added with tape yeast at a concentration of 1.5% of the cassava weight, along with 500 ml of clean water. During soaking, the cassava chips must be fully submerged in water, and the fermentation container must be tightly sealed. The soaking fermentation lasts for 48 hours, with the soaking water and yeast being replaced once daily to ensure optimal fermentation conditions.	(Ningrum, 2023).
1 sd	3 days	The cassava soaking is done by mixing 1 tablespoon of tape yeast with 1 liter of water, then soaking it for 3 days.	(Helilusiatinatiningsih, 2023).
0,5 %	3 days	The fermentation stage is carried out with two different treatments. In the first treatment, the cassava is soaked in a 5% salt solution for 6 hours. In the second treatment, no salt soaking is performed. Both treatments are then fermented using tape yeast at a concentration of 0.5% for 3 days to initiate the fermentation process and improve the quality of the cassava.	(Amri & Pratiwi, 2014).

Drying Stage

The drying stage in Mocaf production is an important process aimed at reducing the moisture content of the fermented cassava, resulting in flour with good quality and a long shelf life. The optimal time and drying process, according to several previous researchers, are shown in Table 4.

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Table 4. Drying Process of Mocaf Flour

Drying Time	Drying Process	Research References
24 hours.	The drying process is carried out using a cabinet dryer at a temperature of 60°C for 24 hours. This technique aims to reduce the moisture content of the material, making the resulting product more durable and ready for use in the next stages.	(Ningrum, 2023).
4 – 5 hours.	After the fermentation process is complete, the cassava chips are washed again to remove the sour taste and odor that developed during fermentation. Then, the chips are drained and dried using an oven at 80°C for 4-5 hours to reduce the moisture content and ensure the product is ready for use or storage.	(Nusa *et al*., 2012).
8 and 10 hours.	The drying process is carried out using an oven, starting at a temperature of 50°C for 8 hours. After that, the temperature is increased to 60°C, and the drying continues for another 10 hours until the cassava is completely dry. The process is considered complete when the cassava can be easily broken.	(Yani, 2018).
3 – 5 days.	Cassava drying is carried out under the sun after the fermentation process. The drying process lasts for 3-5 days, depending on weather conditions. Alternatively, drying can also be done using an oven at 120°C for 2 hours to accelerate the drying process and ensure the cassava is completely dry.	(Achmad *et al*., 2023).
2 hours.	The solid is dried at a temperature of 55°C for about 2 hours to reduce its moisture content.	(Tandrianto *et al*., 2014).
2 hours.	The fermented cassava is dried in an oven at 50ºC for 2 hours to reduce its moisture content, making the cassava more durable and ready for use in the next process.	(Tandrianto & Mintoko, 2014).
8 hours.	The cassava is then dried using a cabinet dryer at a temperature of 70ºC ± 5ºC for 8 hours to reach optimal moisture levels and ensure the cassava is thoroughly dried.	(Aisah *et al*., 2021).
1 – 2 days.	The cassava strips are drained first to reduce their moisture content before drying. Then, the strips are dried in an oven at 40ºC for 1-2 days until the desired dry condition is achieved.	(Amri & Pratiwi, 2014).

The Milling Stage

After the cassava is cut into thin chips, the next step is the grinding process using a milling machine. This grinding process aims to transform the cassava slices into a-fine flour, ready for further processing (Nusa *et al*., 2012).

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Figure 2. Flour Milling Machine (Astuti *et al*., 2020).

The Sieving Stage

The sieving process is an important step in mocaf flour production to ensure that the resulting flour has a smooth texture and is free from solid contaminants or impurities (Achmad *et al*., 2023). The processed cassava is then sifted using a sieve with an 80 mesh size, resulting in mocaf flour as the final product (Yani, 2018).

Figure 3. Mocaf Flour (Emilda *et al*., 2024).

COMPARISON OF FERMENTATION WITH AND WITHOUT THE ADDITION OF BACTERIA.

Modification of mocaf processing by fermentation using lactic acid bacteria causes significant changes in the physicochemical and amylographic properties of starch, as well as the physical and organoleptic properties of flour. This fermentation process makes mocaf more soluble in water, expands faster when heated, and has a brighter or whiter color. In addition, fermented mocaf flour does not have the typical cassava aroma and has a softer texture compared to unfermented cassava flour or wheat flour. These changes improve the quality of mocaf flour, making it a better alternative to replace wheat flour in various food applications (Yulifianti *et al*., 2012).

The use of microorganisms, such as Lactobacillus plantarum bacteria, in mocaf production has been proven to produce high-quality products, both in terms of flour characteristics such as color, smell, and taste, as well as in reducing cyanide levels in cassava.

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Several cassava processing centers have even implemented lactic acid bacteria *Lactobacillus plantarum* in their fermentation processes to improve the quality of the resulting mocaf flour (Assalam *et al*., 2019).

The fermentation process of cassava in mocaf flour production not only enhances the quality of the flour but also improves its protein content. Fermentation using Lactobacillus plantarum for 72 hours has been found to yield the best results, producing flour with optimal characteristics in terms of texture, aroma, and flavor. This fermentation duration allows the enzymes produced by the microbes to work optimally, hydrolyzing starch and boosting the nutritional content, including protein levels (Tandrianto *et al*., 2014).

According to Ningrum (2023), the best treatment in mocaf flour production using tape yeast at a concentration of 1.5% and a fermentation time of 48 hours yielded several parameters indicating good quality. The moisture content of the mocaf flour was recorded at 9.40%, ash content at 0.30%, and protein content at 4.70%. The yield obtained was 34.60%, with flour solubility at 33.43%. In terms of color, the lightness value was recorded at 98.63, redness at 1.50, and yellowness at 7.65. Additionally, the results of the organoleptic test showed an aroma score of 2.73 (neutral) and a color score of 3.30 (neutral), indicating that the mocaf flour has good characteristics and is organoleptically acceptable.

According to Wulandari (2021), the best treatment in mocaf flour production was obtained by using the *Lactobacillus plantarum* lactic acid bacteria strain and a fermentation time of 48 hours. The results showed a protein content of 2.06%, pH value of 5.44, moisture content of 2.55%, and a yield of 25.32%. This treatment produced mocaf flour with good quality, which can be used as an alternative to wheat flour.

The fermentation method commonly used in mocaf production involves adding cultures or starter microorganisms, such as bacteria, fungi, or yeasts. This method allows for better control over the fermentation process, resulting in mocaf with consistent quality. Alternatively, spontaneous fermentation without the addition of specific microbes can be carried out by soaking cassava in water or salt water for 3 days. Although this method is less efficient compared to the use of additional microorganisms, spontaneous fermentation can produce mocaf flour with better whiteness (Asmoro, 2021).

According to Amri & Pratiwi (2014), the best mocaf is produced through a fermentation process using tape yeast, which begins with soaking cassava in a salt solution. The cassava is then fermented with tape yeast at a concentration of 0.5% for 3 days. This process results in mocaf with the highest protein content, 40.86%, and a low moisture content of 6.64%, making it a high-quality mocaf flour.

The drying treatment of 8 hours at a drying temperature of 70°C is the best, as measured using the De Garmo test. This treatment produces mocaf flour with optimal quality, both in terms of physical and chemical properties, resulting in better outcomes compared to other treatments (Aisah *et al*., 2021). Mocaf flour can last up to one year with its taste and smell remaining stable without significant changes. This indicates that mocaf flour has a good shelf life, making it a practical and long-lasting choice for various food products (Emilda *et al*., 2024).

CONCLUSION

Mocaf flour can be improved in quality through fermentation using lactic acid bacteria, which alters the physicochemical properties and amylography of starch, as well as the physical and organoleptic properties of the flour. This process makes mocaf more soluble in water, allows it to expand more quickly when heated, and results in a brighter or whiter color. Its texture is also softer compared to non-fermented cassava flour or wheat flour. The use of microorganisms, such as *Lactobacillus plantarum* bacteria, in mocaf production has been shown to produce a high quality product in terms of flour characteristics, color, smell, taste, and cyanide content in cassava.

The best treatment for mocap flour is achieved by using tape yeast at a concentration of 1.5% and a fermentation time of 48 hours. This method results in high-quality mocaf flour with a high protein content and low moisture content. The best mocap is produced through a fermentation process using tape yeast, which begins with soaking the cassava in a salt solution. The De Garmo test shows that the drying treatment of 8 hours at a drying temperature of 70°C produces mocaf flour with optimal quality in terms of both physical and chemical properties. Mocaf flour can last up to one year with stable taste and aroma, making it a practical and long-lasting choice for various food applications.

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