Effect of Planting Time and Cassava Variety to MOCAF (Modified Cassava Flour) Quality Level

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Abstract. The more significant demand for flour requires alternative substitute materials from local products, one of which is mocaf flour derived from cassava. The quality of mocaf flour is primarily determined by the quality of cassava. Constraints faced in the supply of mocaf flour, are influenced by the availability of cassava. On the other hand, the quality of mocaf flour is also determined by the quality of cassava produced. Therefore, it is necessary to conduct research on the content and physical properties of mocaf flour produced from differences in planting time and cassava varieties. This research was compiled using a factorial completely randomized design. There were 12 treatment combinations with 3 replications, with the first factor being cassava varieties, including varieties of Bamban, Gambyong, Gatotkaca, and Kirik. The second factor is planting time, which is May, June, and July. The total number of treatments was 36 treatment units. The results showed that cassava varieties with planting time in May, June, and July produced mocaf flour with the content and physical properties in accordance with the Indonesian National Standard (SNI). Gatot varieties with planning time in May, June, and July possess the best quality compared to other varieties.

1. Introduction
The need for wheat flour in Indonesia is increasing every year, which is caused by the diversity of food products made from flour. According to the Central Statistics Agency [1] The number of Indonesia's wheat imports in 2017 is around 11.48 million tons/year. One effort to reduce the use of imported flour is to develop composite flour based on local food ingredients. Cassava (Manihot esculenta) is the third source of food in Indonesia after rice and corn. The cassava production in Indonesia is quite high and is generally consumed directly. Cassava demonstrates high potential to be developed as a processed product, among others by innovating cassava into a mocaf. However, the planting period of cassava is carried out in various ways, so that the availability of cassava varies each year and it is assumed that the content and physical characteristics of the mocaf produced will also vary.

Mocaf (Modified Cassava Flour) is flour derived from thinly chopped, fermented, dried, and crushed cassava which can then be processed into food products [2]. Mocaf (Modified Cassava Flour) exhibits
white characteristics, does not smell like cassava and can be processed into a variety of foods, for example cookies, cake, bread and noodles. Therefore, mocaf flour represent an alternative product that can substitute flour. Based on information, Mocaf has a standard to get the best quality, as presented in Table 1.

| No. | Criteria                        | Mocaf Profile | SNI | Codex Stan | Subagio |
|-----|--------------------------------|---------------|-----|------------|---------|
| 1.  | Water content (%)               | Max. 13       | Max. 13 | Max 13    |         |
| 2.  | Protein level (%)               | -             | Max. 1,0 | Max. 1,0 |         |
| 3.  | Starch level (%)                | Min. 75       | 82 – 85 | 85 – 87   |         |
| 4.  | Level of food fiber (%)         | Max. 2,0      | Max. 2,0 | 1,9 – 3,4 |         |
| 5.  | HCN level (mg/kg)               | Max. 10 ppm   | 10 – 40 ppm | -    |         |
| 6.  | White degree (MgO = 100)        | Min. 87       | -     | 88 – 91   |         |
| 7.  | The ash rate (%)                | -             | Max. 3,0 | Max. 0,2 |         |
| 8.  | Fat level (%)                   | -             | 0,4 – 0,8 | 0,4 – 0,8 |         |
| 9.  | Large flour granules            | 100% pass the 80 mesh sieve | Min 90% must pass the filter 0.60 mm | Max. 80 mesh |
| 10. | Smell                           | Neutral       | -     | Neutral   |         |

The problem that arises in the development of mocaf is the absence of data on the content and physical characteristics of mocaf with different planting time and varieties in producing mocaf. Therefore, it is necessary to conduct research to determine the content and physical properties of mocaf produced from cassava in different planting periods and varieties. The purpose of this study was to obtain the best quality (content and physical properties) of mocaf at different planting times of various cassava varieties.

2. Materials and Methods
This research was conducted in May-December 2018 at the Postharvest and Agrobiotechnology Laboratory of the Faculty of Agriculture, Muhammadiyah University, Yogyakarta, Primary Chem-Mix Laboratory. The materials used in this study were 4 varieties of Bambang cassava, Gambyong, Gatot glass and Kirik, with planting time in May, June and July, aquadest, aceton, 95% ethanol, BaSO4, 1% pepsin enzyme, beta amylase enzyme, enzyme alpha amylase, and others.

The tools used are knives, buckets, cutting boards, blenders, flouring machines, plastics, and 80 mesh sieves, cups, scales, pans, ovens, kjeldahl pumpkins, and others. The study was conducted by laboratory experimental methods arranged in a Completely Randomized Design (CRD) with a factorial treatment design. Factor 1: Variety of Cassava S1 = Bamban; S2 = Gambyong; S3 = Gatotkaca; S4 = Kirik Factor 2: Planting Time B1 = May; B2 = June; B3 = July
Each treatment was repeated 3 times to obtain 36 experimental units, so that 12 treatment combinations were obtained.

The mocaf content tested in this study included water content, protein content, starch content, food fiber content, HCN content, white degree. Organoleptic test on mocaf conducted was the observation of scents by panelists. Observation data were analyzed using analysis of variance (ANOVA) at an error level of 5%. If there are significant differences between treatments, then continued with Duncan Multiple Range Test (DMRT) at the 5% level. Data analysis is also carried out by the comparative or comparison method.
3. Results and Discussion

3.1 Water Level Analysis

Water content is one of the parameters that must be considered because the processed mocaf flour products are included in the edible cassava edible processed product class, therefore some requirements must be met as quality standards for Mocaf flour, one of which is the maximum moisture content of Mocaf 13% which refer to SNI 7622-2011 (Table 1).

Table 1. shows that gambyong variety at the age of 6 months yielded mocafs with the best water content of 10.91%, but not significantly different from the Bamban varieties planted in May and July, and significantly different from other treatments.

The increase in water content in a mocaf can be influenced by the weather at the time of harvest. Cassava harvested in the wet season has a higher water content than cassava harvested in the dry season. In this study the Bamban and Gambyong varieties in July and August are harvested in the wet season so that the water content is higher than the literature. In the type of tubers that have high water content.

| Variety   | Water content (%) | Planting Time (Month) | Average |
|-----------|-------------------|-----------------------|---------|
|           | May   | June | July |       |
| Bamban    | 11.29 ab | 11.51 b | 11.33 ab | 11.38 |
| Gambyong  | 10.91 a | 12.05 c | 12.52 d | 11.83 |
| Gatotkaca | 12.17 cb | 13.18 e | 13.05 e | 12.80 |
| Kirik     | 13.03 e | 13.08 e | 13.27 e | 13.13 |
| Average   | 11.85 | 12.45 | 12.54 | (+)   |

Note: Numbers followed by the same letter indicate no significant difference in the test DMRT level 5%.

Gatotkaca and Kirik varieties planted in May, June and July contain 13% water content, allegedly influenced by weather differences that result in the length of the drying process. The difference in water content between treatments is expected to be due to the drying process. Drying process which is carried out after the fermentation process can also affect the water content to be produced, the longer the heating process, the water content will also be lower but the impact that will result is browning the material, the drying method is carried out using the sunlight method. The presence of the wind in drying using sunlight can help the process of air exchange and release water vapor resulting from evaporation of the sample which causes the drying process to be faster.

Based on SNI 7622-2011 mocaf quality standards namely mocaf moisture content of 13% is the maximum allowable moisture content. All varieties planted in May, June and July are in accordance with SNI. The best water content in the Gambyong variety during planting in May has the lowest water content. So the lower the water content, the better the quality of flour because it will extend the shelf life.

3.2 Protein Level Analysis

In the research of it was stated that mocaf flour utilizes advantages over ordinary cassava flour (tapioca), is high in protein content, lower HCN, and dispersion into food products is easier [5]. Protein content in mocaf is higher than ordinary cassava flour because protein is produced during the fermentation of mocaf flour making. Protein can cause brown color when drying and heating.

Table 3. shows that the Gatotkaca varieties planted in August produced mocaafs with the best protein content of 0.65%, but were not significantly different from the Bamban, Gambyong and Gatotkaca
varieties planted in May and June. The average observations of cassava protein levels in Table 2. show that the various varieties planted in May, June and July had a significantly varied effect on protein content with an average of 1.39% and 1.53%, with higher protein levels compared to the Bamban varieties, Gambyong, and Gatotkaca planting time in May.

Table 3. Average protein level (%)

| Variety   | Planting Time (Month) | Average |
|-----------|-----------------------|---------|
|           | May       | June     | July     |         |
| Bamban    | 0.69 a    | 1.39 cd  | 1.39 cd  | 1.16    |
| Gambyong  | 0.70 a    | 1.11 d   | 1.18 d   | 1.00    |
| Gatotkaca | 0.66 a    | 0.68 a   | 0.65 a   | 0.66    |
| Kirik     | 0.81 c    | 0.60 b   | 1.53 cd  | 0.98    |
| Average   | 0.72      | 0.94     | 1.19 (+) |         |

Note: Numbers followed by the same letter indicate no significant difference in the test DMRT level 5%.

Each cassava variety has a various nutrient content. The number of cassava varieties causes the nutritional content and physical characteristics of the cassava to be varied [6]. In the Gatotkaca and Kirik varieties with planting time in June and July, the protein content decreased due to numerous planting times. Differences in planting time result in a variety of nutrient content and physical properties of cassava [7]. In addition, the amount of water content contained in cassava will affect the protein content contained. The more water content in cassava, the lower the protein content.

Based on the average protein content, there was an increase which was planted in May, June and July, this was allegedly due to the fermentation process. The increase in protein levels was caused by cassava fermentation for 72 hours with Lactobacillus plantarum lactic acid bacteria producing the enzyme proteinase. An increase in protein content is obtained from the activity of the protease enzyme produced by microbes present in the fermentation process. The length of time of fermentation makes the population of Lactobacillus plantarum increase, thus making the levels of dissolved protein also increase.

Mocaf from cassava varieties Gatotkaca planted in July and Kirik in June experienced a decrease in protein content. This happens because the fermentation process of Lactobacillus plantarum produces a protease enzyme that causes complex proteins to break down into shorter peptide fractions and amino acids, thereby increasing levels of dissolved protein. Based on SNI 7622-2011 mocaf quality standards namely the maximum content of mocaf protein content of 1.0%. So that in this study both the Bamban variety and the Gambyong variety with planting time in May and Gatotkaca with May, June and July are in conformity with SNI.

3.3. Starch Level Analysis

Based on the quality standard of mocaf flour referring to SNI 7622-1989 in (Table 1.), the mocaf flour starch content is 75% which is the minimum limit allowed. The mean observation of cassava starch content in Table 4. shows that the varieties of Bamban, Gambyong, Gatotkaca, and Kirik during planting in May, June and July had a significantly different effect on starch content. The test results showed that the mocaf of the Gambyong variety planted in July had the highest starch content of 95.63%, while the Kirik mocaf planted in May had the lowest starch content of 77.71%.
### Table 4. Average starch level (%)

| Variety  | Planting Time (Month) | Average |
|----------|------------------------|---------|
|          | May   | June  | July  |         |
| Bamban   | 91.64 d | 88.80 f | 93.39 b | 91.27   |
| Gambyong | 92.76 c | 90.57 e | 95.63 a | 92.99   |
| Gatotkaca| 77.71 k | 78.43 j | 79.34 i | 78.49   |
| Kirik    | 81.50 h | 82.18 g | 82.56 g | 82.08   |
| Average  | 85.90 | 85.00 | 87.73 (+) |         |

Note: Numbers followed by the same letter indicate no significant difference in the test DMRT level 5%.

In Table 4 shows the Bamban and Gambyong varieties planted in June have decreased starch content, the decrease in starch content is thought to be influenced by an increase in water content that occurs during planting in May. High water content causes many starch granules to be filled with water so that the acid will easily enter the starch granules and acid hydrolysis or shorter chain breakdown.

In table 4, Gambyong varieties with July planting time showed the highest levels of starch. While the increase in starch content is thought to be due to the fermentation process at the time of making mocaf. In fermentation, bacterial activity is able to form starch, so that starch levels in all varieties increase. This is in line with the statement of [3], stating the length of time of fermentation makes the population of *Lactobacillus plantarum* increase, thereby making dissolved starch levels also increase, the statement can be attributed to the statement of which states that the fermentation process of making Mocaf utilizes lactic acid bacteria that are able to produce pectinolytic and cellulolytic enzymes that can destroy the cell wall of cassava, resulting in the formation of soluble starch. More and more starters will increase the starch developed.

3.4. HCN Level Analysis

The setting of HCN content in mocaf flour is regulated in SNI 7622-1989 in (Table 1.), which obtain a maximum of 10 ppm. Table 5 shows that there were interactions between varieties and planting time, in the Gatotkaca variety and planting time in May the lowest HCN content (6.33 ppm) was significantly different from all treatments. Although there are differences in HCN levels between treatments, it can be noted that all HCN levels are still below 10 ppm in accordance with SNI.

### Table 5. Average HCN level (ppm)

| Variety  | Planting Time (Month) | Average |
|----------|------------------------|---------|
|          | May   | June  | July  |         |
| Bamban   | 7.84 de | 8.18 e | 8.18 e | 8.07   |
| Gambyong | 6.93 b  | 7.22 cde | 9.48 f | 7.88   |
| Gatotkaca| 6.33 a  | 7.66 cde | 8.98 cde | 7.66   |
| Kirik    | 7.15 bc | 7.83 de | 9.11 f | 8.03   |
| Average  | 7.06 | 7.72 | 8.94 (+) |         |

Note: Numbers followed by the same letter indicate no significant difference in the test DMRT level 5%.

The difference in HCN levels is expected to be influenced by the planting environment, different cassava varieties, washing, and fermentation. The content of HCN in cassava depends on variety, location, and agricultural conditions. Differences in mocaf cyanide levels were also thought to be influenced by HCN concentrations in cassava itself. Results of cassava varieties Gambyong, Kirik, Gatotkaca and Bamban are classified as highly toxic cassava, because they possess HCN levels of more than 100 ppm. This is due to the fact that cyanide acid is volatile in the air, so that during the
manufacturing process of mocaf during the drying process, cyanide acid decomposition reaches 80%. Besides the decrease in HCN, levels are also influenced by the immersion process, because HCN is soluble in water.

According to the SNI standard mocaf standard maximum cyanide content of 10 ppm. The results of this study, all varieties with planting time in May, June and July produce mocaf according to SNI mocaf standards. Based on FAO (Food Agriculture Organization) foodstuffs with HCN content of 40 ppm are safe for consumption by humans. Thus, the mocaf results of this study are still safe for consumption.

3.5. Level of Food Fiber Analysis
The content of food fiber content in mocaf flour by a maximum of 2.0% becomes the permissible quality standard, the level refers to SNI 7622-1989 and Codex Stan 176-1989 (Rev. 1-1995) in (Table 1).

The results of analysis of variance in food fiber content showed that there was an interaction between wood varieties and planting time. The treatment of Gambyong varieties with planting time in May gave the best food fiber content (10.02%) significantly different from the other treatments (Table 6).

| Variety  | Planting Time (Month) | Average |
|----------|-----------------------|---------|
|          | May | June | July |       |
| Bamban   | 6.08 e | 3.96 g | 4.99 f | 5.01 |
| Gambyong | 10.02 a | 6.77 c | 7.22 b | 8.01 |
| Gatotkaca | 5.11 f | 5.84 e | 6.33 d | 5.76 |
| Kirik    | 4.11 g | 6.02 e | 5.87 e | 5.34 |
| Average  | 6.33 | 5.65 | 6.11 (+) |

Note: Numbers followed by the same letter indicate no significant difference in the test DMRT level 5%.

High and low levels of food fiber in mocaf is thought to be influenced by cassava varieties, water content, and planting time. Showed there were differences in the levels of food fiber from various cassava varieties due to the diverse age of cassava harvest, resulting in varying levels of food fiber produced. Cassava is better to harvest when the water content reaches 50-80%, because above the water content is less profitable, because the tubers obtained contain a lot of water and the starch content is low. Harvesting under 50% water content produces hard tubers because the tubers become woody so they contain many fiber.

Increased levels of food fiber in mocafs occur due to increasing age of cassava harvest. The increasing level of tuber aging results in a firmer texture of the tubers, this is due to the increasing starch content. However, if it is too old, the fiber content will increase and there will be a decrease in the starch rate. This is appropriate in this study, an increase in fiber content and followed by a decrease in starch content in several varieties of mocaf. In the quality of food fiber from mocaf, the limits of SNI are undetermined. Fiber has been known to have many benefits for the body, especially in preventing disease, although this component has been unincorporated as a nutrient.

3.6 White Degree Analysis
Color test is one indicator of determining the quality standard of a food from processed flour products, because as a determinant of attractiveness from the level of consumer preferences. Based on the quality standard of mocaf flour from the white degree test which refers to SNI 7622-1989 (Table 1.), which is 87 which is the minimum limit allowed.

The resulting mocaf possesses different degrees of white (table 7), the Bamban variety planted in May produces the best white degree of mocaf content of 93.78. The difference in the degree of white is determined to be caused by differences in the variety of cassava used. The results of the
characteristics of cassava in various varieties used for making mocaf have yellow tuber color.

### Table 7. Average of White Color of Mocaf

| Variety  | Planting Time (Month) | Average |
|----------|-----------------------|---------|
|          | May       | June     | July     |         |
| Bamban   | 93.78 a   | 91.09 e  | 90.59 f  | 91.82   |
| Gambyong | 93.04 b   | 91.27 e  | 90.87 ef | 91.73   |
| Gatotkaca| 92.48 c   | 92.16 cd | 92.12 cd | 92.25   |
| Kirik    | 92.54 c   | 92.42 c  | 91.90 d  | 92.28   |
| Average  | 92.96     | 91.73    | 91.37 (+)|         |

Note: Numbers followed by the same letter indicate no significant difference in the test DMRT level 5%.

In Table 7, a decrease in the degree of white in all varieties that occur during July planting is thought to be influenced by the drying method used will affect the white color of the mocaf. Mentioned that drying using an oven with a high temperature resulted in a considerable decrease in beta-carotene levels. The higher the drying temperature, the lower the beta-carotene content. The decrease in beta-carotene levels will result in a non-enzymatic browning process in food.

The difference in the degree of white in the mocaf is thought to be influenced by the length of the immersion process and the protein content in the mocaf. The protein content contained in cassava flour affects the brown color of the flour. It is caused by the drying and heating process during the mocaf making process. Based on SNI quality requirements for minimum degree of white mocaf 87%. The results of the white degree test of all mocaf of various varieties and harvest age have complied with the quality requirements (SNI). White degree of all varieties and ages of harvest has a brightness of more than 87%, which means that the mocaf is classified as white.

### 3.7 Aroma

Testing the characteristics of the mocaf flour aroma is carried out aiming to determine the quality of the catch by exercising the sense of smell. The aroma of mocaf flour used as food raw material greatly influences the level of consumer acceptance of the final product produced. Based on the quality standard of mocaf flour which refers to SNI 7622-1989

| Variety  | Planting Time (Month) |
|----------|-----------------------|
|          | May       | June      | July     |
| Bamban   | 3.1       | 3.4       | 3.2      |
| Gambyong | 3.0       | 3.2       | 3.1      |
| Gatotkaca| 2.8       | 2.9       | 2.9      |
| Kirik    | 3.0       | 3.1       | 3.0      |

Note: score 2 means cassava scented score 3 means a slightly aromatic cassava

The aroma is one of the key variables, because in general consumers taste for food products is largely determined by the aroma. Food raw materials profoundly affect the level of consumer acceptance of the finished product produced on the mocaf aroma. The emergence of odor in raw materials is caused by the presence of volatile substances, slightly soluble in water and fat. Based on the organoleptic test of mocaf aroma presented in table 8, most of them produce scores above 3, which means that the flour produced is slightly aromatic of cassava, only in the Gatotkaca variety only when planting in May, June or July scores below 3 means that it is aromatic of cassava.

Smell (aroma) can be defined as something that can be observed with the sense of smell. To produce odors, odor substances must be able to evaporate, slightly soluble in water and slightly soluble in fat. Flavors and aromas arise due to natural and synthetic chemical compounds and the reaction of these compounds with the nerve endings of the tongue and nose. The smell of food determines the deliciousness of these foods. In the case of odor, it has more to do with the five sensing devices.
The change from scented cassava to neutral is suspected due to the presence of microbes used for the fermentation process. That the fermentation process plays a role in triggering the formation of lactic acid. When bacteria break down cellulose and perforate the walls of starch granules to produce glucose, glucose will be converted by bacteria into lactic acid that smells like milk. The aroma of lactic acid that describes the distinctive smell of cassava, so that the scented mocaf becomes neutral. The fermentation process changes the characteristics of mocaf in the form of gelation ability, increased viscosity, rehydration power and ease of dissolving. The treatment of cassava drying after fermentation will also affect the mocaf results. During the drying process there can also obtain changes in color, texture, aroma, and others. Although these changes can be limited to a minimum by providing pre-treatment of the material to be dried. The drying process can cause volatile flavor to disappear and bleach the pigment. Based on the research of stated that shorter drying time can minimize the formation of distorted odors due to undesirable microbial growth. But in cassava varieties and harvest age, mocafs with Bamban and Gambyong varieties at 6, 7 and 8 months of harvest still have better aroma quality, because they retain a near neutral flavor (slightly aromatic cassava).

4. Conclusions
All cassava varieties with planting time in May, June and July produce mocafs with good physical properties and properties for consumption. Variety of Gatotkaca planting time in May, June and July obtains the quality in accordance with SNI mocaf.

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