# Optimization of Physicochemical and Organoleptic Properties of Cookies made of Modified Cassava Flour and Mung Bean Flour

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**Abstract.** Wheat flour is usually the main ingredients of majority of cookies. Despite its high consumption, however it is not widely available. It will be efficacious to substitute wheat flour with modified cassava flour (MOCAF) combined with mung bean flour to enhance protein content of cookies. The aims of this study were (1) to assess the impact of different proportions of MOCAF to mung bean flour on the physicochemical and organoleptic characteristic of cookies, (2) to ascertain the optimal proportion of MOCAF to mung bean flour that generates ideal cookies based on the organoleptic characteristic of cookies. The research design used was Randomized Block Design with one factor. The proportion of MOCAF to mung bean flour consisted of 100:0, 85:15, 70:30, 55:45, and 40:60. The results showed that the proportion of MOCAF to mung bean flour affected moisture content, spread ratio, hardness, lightness, colour, and preferences for colour, hardness, and taste. The proportion 70:30 of MOCAF to mung bean flour showed the finest treatment and scored significant preference level for colour, hardness, taste, and ease of swallowing. The optimization of physicochemical and organoleptic properties of cookies with modified cassava flour and mung bean flour was successfully achieved and qualify the cookies nutrition.

**Keyword.** Cookies, Modified Cassava Flour, Mung Bean Flour.

## 1 Introduction

Cookies are one of the foods that are highly consumed by local community at various age groups. Wheat flour is the main ingredient in making cookies. Cookies are a type of biscuits made from soft dough, crunchy, and when fracture cross-section appears textured less densely [1]. The ingredients which are commonly used in making cookies are flour, baking

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powder, sugar, shortening, and egg yolk. Consumption of wheat flour is usually higher than its availability hence there is a need to find alternative. A suitable substitute to wheat flour is the cassava flour. Cassava production is growing as local commodity in Indonesia, the production in 2017 was 19,053,748 tons, while in 2018, it was 19,413,233 tons [2]. Increased production of cassava shows the high potential of cassava to replace wheat flour is very high.

Cassava can be transformed into various products, such as modified cassava flour (MOCAF). Modified cassava flour, also known as MOCAF, has better sensory characteristics than cassava flour and similar to wheat flour's characteristics. Cookie produced with MOCAF can increase the diversity of local commodity-based products to reduce wheat flour consumption.

MOCAF contains 85% carbohydrates, 0.6% fat, 1.2% protein, 6% fibre, 11.9% water, and 1.3% ash [3]. Some examples of bakery products that MOCAF can be used are cookies [4], biscuits [5] and cake and bread [6]. Wheat flour substitution with MOCAF can be carried out up to 100% when processing cookies [7]. MOCAF protein content is low, so it is necessary to add other foods that contain a higher protein content so that the protein content of cookies can match the Indonesian National Standard (referring to biscuits) [1]. To increase protein content in bakery products, several researchers have combined MOCAF with other food ingredients, such as combining MOCAF and banana flour in cookies [8], and integrating MOCAF with broccoli and mung bean flour in making cookies [9].

Mung beans are one of the food ingredients that contain a high protein content. The nutritional content in mung beans is carbohydrates 56.8%, fat 1.5%, protein 22.9%, fibre 7.5%, water 15.5%, and ash 3.3% [10]. Hence, mung beans have the potential to be added as a source of protein in food products, in this case, MOCAF-based cookies. The use of mung bean flour will affect the nutritional content of cookies made from MOCAF. The higher the proportion of mung bean flour the high the protein content as protein content of mung bean flour is higher than MOCAF.

The addition mung bean flour to MOCAF-based cookies will enhance the protein's ability to bind water and glue the particles of the cookie component so that the higher the proportion of mung bean flour will affect the texture of cookies and darker colors. Therefore, the proportion of MOCAF with mung beans used in this study was 100:0, 85:15, 70:30, 55:45, and 40:60. Differences in the proportion of MOCAF with mung bean flour are thought to affect the physicochemical and organoleptic properties of cookies. Therefore, the aims of this study were (1) to assess the impact of different proportions of MOCAF to mung bean flour on the physicochemical and organoleptic characteristic of cookies, (2) to ascertain the optimal proportion of MOCAF to mung bean flour that generates ideal cookies based on the organoleptic characteristic of cookies.

## 2 Materials and methods

### 2.1 Processing of cookies

The ingredients used in the cookie processing were MOCAF Ladang Lima brand from Pasuruan, mung bean flour (Vigna radiata var. LR Wilczek) Gasol Organic Agriculture brand from Cianjur, icing sugar Rose brand, Blue Band margarine, eggs, Koepoe Koepoe brand baking powder, and salt. The formulation for cookies making were 200g MOCAF, 118g icing sugar, 94g margarine, 70g egg yolks, 4g baking powder, and 2g salt. As a treatment, the proportion of MOCAF to mung bean flour in five levels, 100:0, 85:15, 70:30, 55:45, and 40:60.

The making of MOCAF – mung bean cookies began with weighing all ingredients according to the formulation. The margarine, icing sugar, and egg yolks were mixed with a high-speed mixer for 2 minutes until it reaches a creamy consistency. The dry ingredients: MOCAF, mung bean flour, baking powder, and salt were mixed with a spatula, then gradually added to the creamy mixture and mixed with a spatula. The dough was molded by weighed as much as 7g and then molded using a circular mold (diameter 3.5cm). The dough was baked in the oven at 148-151°C for 20 minutes. The cookies were cooled at 25°C for 15 minutes, then packaged in polypropylene packaging with aluminium foil laminate that has been given silica gel.

### 2.2 Moisture content

Moisture content was carried out using the thermogravimetric method. Water content analysis was carried out using the thermogravimetric method. Weighed 1 gram of sample, dried in an oven at 100-105°C for 3 hours, then cooled in a desiccator for 10 minutes and weighed. Dried again in the oven until reach a constant weight is obtained [11].

$$\text{Moisture content (\%wb)} = \frac{\text{initial weight sample} - \text{weight sample after dried}}{\text{initial weight sample}} \times 100\% \qquad (1)$$

### 2.3 Spread ratio

This is the ratio between cookies diameter and cookies thickness, which is assessed by measuring six cookie diameters horizontally (diameter I), then rotated 90o and measured the cookie diameter (diameter II). The diameter of cookies is obtained by adding up the results of diameter I and diameter II and then dividing by 12. Measure the height of the six cookies. Cookie thickness is obtained from the average thickness of cookies [4].

$$\text{Spread ratio} = \frac{\text{Cookies diameter}}{\text{Cookies thickness}} \qquad (2)$$

### 2.4 Texture analysis

Texture analysis was performed using the Texture Analyzer (TA-XT Plus). In this study, the texture parameter analyzed was hardness. The type of probe used is a "Three Point Bend Rig" that presses the product until it breaks. Texture analysis used three cookies for each treatment, and each repetition were taken randomly.

### 2.5 Colour analysis

Colour analysis was carried out using the Minolta CR-10 Colour Reader. This tool can assess the colour of cookies in values of L (lightness), a* (redness), b* (yellowness), c (chroma), and oh (hue).

### 2.6 Organoleptic analysis

The organoleptic analysis used in this study was the Hedonic Scale Scoring (preferred test) by measuring the level of preference and acceptance of the product by consumers expressed using a scale [12]. The parameters tested were preference for colour, hardness, taste, and ease of swallowing MOCAF – mung beans cookies. The total number of panellists in this test was 50 untrained panellists. All of the panellists were students of the Faculty of Agricultural Technology, Widya Mandala Catholic University, Surabaya. There were five samples of cookies with a diameter of 3.5 cm, which are presented randomly and have been given with three-digit numbers code. The scale used to describe the level of preference of the panellists is a scale of 1 (very dislike) to 7 (very likeable).

### 2.7 Data analysis

The study used a Randomized Block Design with one factor, which was the difference in the proportion of modified cassava flour (MOCAF) with mung bean flour. There were five levels of a proportion of MOCAF to mung bean flour which was repeated five times to obtain 25 experimental units.

The dependent variable in this study was the physicochemical and organoleptic characteristics of MOCAF-mung bean cookies. Physicochemical characteristics consisted of moisture content, spread ratio, texture (hardness), and colour. The organoleptic characteristics consisted of preference for colour, hardness, taste, and ease of swallowing. Proximate and crude fibre analysis performed on the best treatment based on organoleptic tests using spider web diagrams. The obtained data from the physicochemical and organoleptic test were statistically analyzed using Analysis of Variance (ANOVA) at = 5%. If there was a significant effect, the statistical analysis continued was with Duncan's Multiple Range Test (DMRT) at = 5%.

## 3 Results and discussion

### 3.1 Moisture Content of Cookies

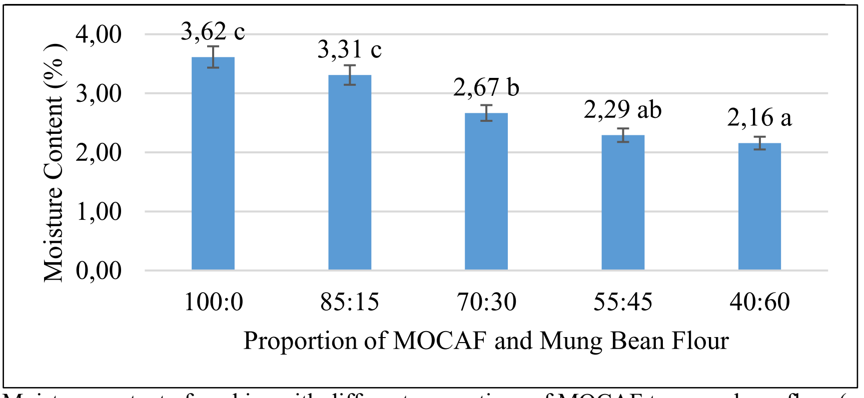


**Fig. 1.** Moisture content of cookies with different proportions of MOCAF to mung bean flour (note: the average with different letter notation shows a significant difference at =5%).

The moisture content of cookies decreased with the higher proportion of mung bean flour (Fig. 1). It is caused by differences in the composition of MOCAF to mung bean flour. The starch content in MOCAF is higher than that of mung bean flour. MOCAF contains 84.44% starch [13]. Mung bean starch contains a total starch content of 54.73% [14]. The higher the starch content in flour, the higher the ability to trap water, so that the moisture content of cookies increases at a high proportion of MOCAF.

MOCAF has a high-water absorption capability of 11.33 – 12.00 ml/g [15]. While, mung bean flour has a water absorption capacity of 2.1 g water/g flour [16]. Higher water absorption capacity. Higher absorption capacity causes more water to be absorb, so that the cookies moisture content is high.

MOCAF is a flour that has been modified so that the starch in MOCAF has the capability to absorb a large amount of water. In addition, the fibre content in MOCAF is 0.015%, which is lower than in mung bean flour (2.37%) that is mainly cellulose [17]. Fibre types such as cellulose have hydrophilic properties [18]. The decrease in the water content of higher mung bean flour proportion cookies is due to the type of fibre's in mung bean flour (cellulose) which easy to trap water but easy to release water.

### 3.2 Spread Ratio of Cookies

As a result of differences in the composition of MOCAF and mung bean flour, the spread ratio of cookies increased with the higher proportion of mung bean flour (Fig. 2). The water absorption ability of MOCAF and mung bean flour affects the spread ratio of cookies. As water absorption ability of MOCAF is higher than that of mung bean flour, the dough viscosity became increase which renders the dough's ability to spread even lower, resulting in a decreased spread ratio of cookies. Consequently, the higher the proportion of mung bean flour, the spread ratio of cookies increases.

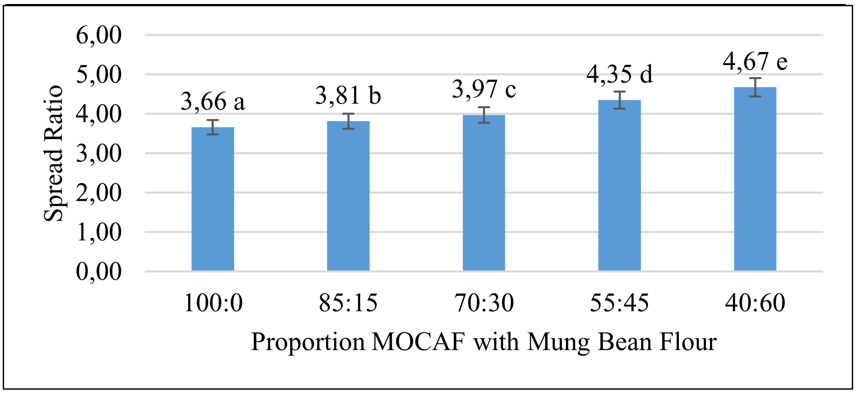


**Fig. 2.** Spread ratio of cookies with different proportions of MOCAF to mung bean flour note: the average with different letter notation shows a significant difference at =5%).

### 3.3 Hardness Texture of Cookies

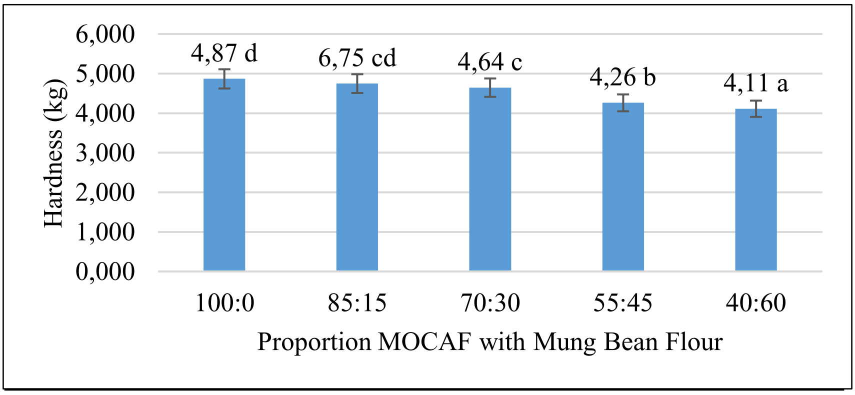


**Fig. 3.** Hardness of cookies with different proportions of MOCAF to mung bean flour note: the average with different letter notation shows a significant difference at =5%).

Hardness of cookies decreased with the higher proportion of mung bean flour (Fig. 3), which is induced by differences in the composition of MOCAF and mung bean flour. The lower the hardness value, the lower the force required to break the cookies. The starch content in

MOCAF and mung bean flour affects the hardness of cookies. MOCAF contains higher starch than mung bean flour. The starch content in MOCAF is able to absorb high water so that the water content of cookies becomes higher. This makes cookies to be tough so that the hardness of cookies increases. In addition, the significant ability of MOCAF starch to absorb water also causes cookies to have a solid ability to maintain the shape of the cookie dough during baking so that the spread ratio of cookies is low. The low spread ratio of cookies indicates that the force required to break the cookies is increasing.

### 3.4 Colour Analysis of Cookies

The composition and colour of MOCAF and mung bean flour influences the colour of the cookies produced. The colour of cookies is also affected by the Maillard reaction that occurs during the baking process. The value of L decreased with the higher proportion of mung bean flour. This can happen as the higher the proportion of mung bean flour, the more Maillard reactions occur so that the brown colour formed on cookies is increasing. The value of a* decreased with the higher proportion of mung bean flour. On the other hand, the value of b* decreased with the higher proportion of mung bean flour. The decrease in a* value was generated by mung bean flour which had a lower a* value than MOCAF. The higher the proportion of mung bean flour, the browner colour of the resulting cookies will be. It is also affected by the Maillard reaction that occurs when baking the cookies. Mung bean flour contains higher protein than MOCAF, so the resulting Maillard reaction becomes more intensified. The decreased b* value was due to the increasing amounts of Maillard reactions formed in the higher proportion of mung bean flour. The chroma value of cookies decreased with the higher proportion of mung bean flour. This displays that with a higher proportion of mung bean flour, the intensity of the colour of the cookies decreases. The chroma value is affected by the a* and b* values of cookies. The decreasing values of a* and b* cause the value of chroma to decrease. On the other hand, the value of hue (°h) increased with the higher proportion of mung bean flour. The hue value of mung bean flour is higher than that of MOCAF, so the higher the proportion of mung bean flour, the higher the value of hue cookies.

**Table 1.** Colour of cookies with different proportion of MOCAF to mung bean flour.

| | Proportion of MOCAF to Mung Bean Flour | | | | |
|---|---|---|---|---|---|
| | 100:0 | 85:15 | 70:30 | 55:45 | 40:60 |
| L | $71,80^{e}$ | $68,76^{d}$ | $66,31^{c}$ | $63,36^{b}$ | $62,09^{a}$ |
| a* | $10,91^{c}$ | $10,77^{c}$ | $10,21^{b}$ | $9,75^{ab}$ | $9,39^{a}$ |
| b* | $33,61^{b}$ | $33,56^{b}$ | $33,45^{b}$ | $33,15^{b}$ | $32,53^{a}$ |
| C | $35,28^{c}$ | $35,21^{c}$ | $34,73^{bc}$ | $34,50^{b}$ | $33,83^{a}$ |
| °*hue* | $71,97^{a}$ | $72,10^{a}$ | $72,99^{b}$ | $73,58^{bc}$ | $73,89^{c}$ |
| Color | | | | | |

### 3.5 Organoleptic Analysis of Cookies

The organoleptic parameters tested were preference for colour, hardness, taste, and ease of swallowing. The colour, hardness, and taste of cookies are increasingly preferred in cookies that contain a proportion of mung bean flour. The hardness preference of cookies on the proportion of MOCAF with mung bean flour of 100:0 has the lowest value of hardness preference. It could be due to the less crunchy texture of the cookies. Cookies with a high proportion of mung bean flour increase the hardness preference of cookies because they have a crunchy texture. The taste preferences of cookies increased with the higher proportion of mung bean flour. The Maillard reaction produces compounds that provide a savory flavor [19]. Cookies with high proportion of mung bean flour produce more Maillard reactions as the protein in mung bean flour is high, so cookies have a richer taste. In the ease of swallowing preference of cookies, there was no significant difference. It can be caused by the water content in cookies is not much different, so that the ease of swallowing cookies is not significantly different.

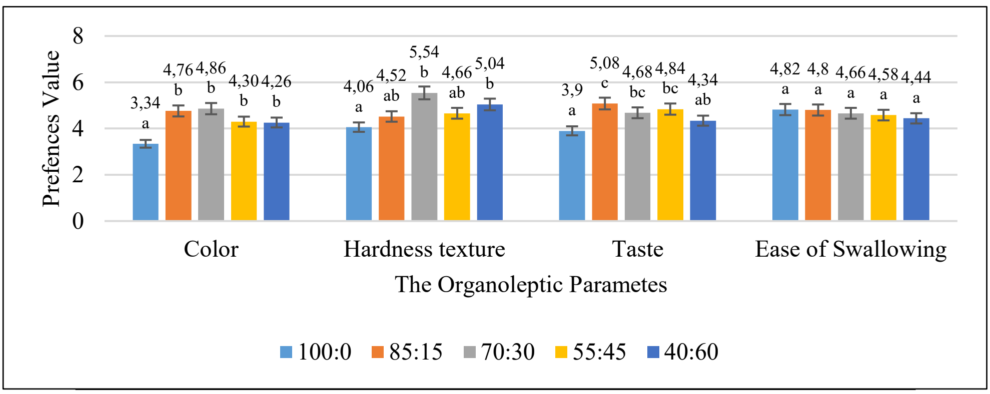


**Fig. 4.** Organoleptic properties of cookies with different proportions of MOCAF to mung bean flour note: the average with different letter notation shows a significant difference at =5%).

### 3.6 Best Treatment

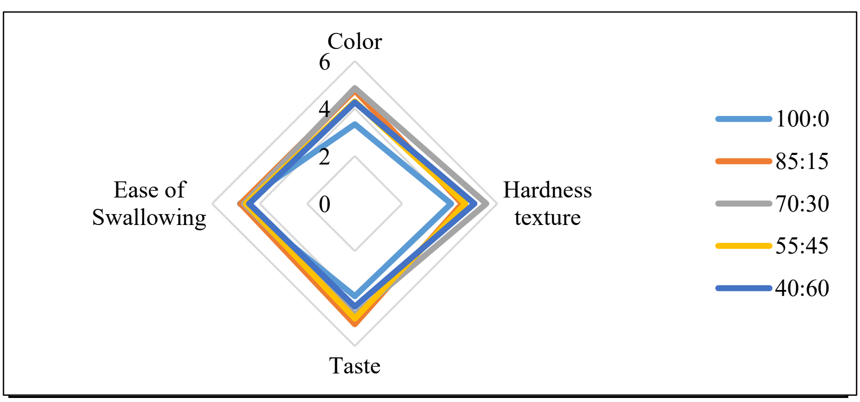


**Fig. 5.** MOCAF – mung bean cookies spider web graphic.

Cookies with the proportion of MOCAF to mung bean flour as much as 70:30 was considered the best treatment with the largest total triangular area of 43.50 based on the results of organoleptic tests that focused on the parameters of colour, texture, taste, and ease of swallowing. The average value of panellists preference for colour, hardness, taste, and ease of swallowing with the proportion of MOCAF to mung bean flour at 70:30 was 4.86 (slightly like), 5.54 (like), 4, 34 (neutral), and 4.44 (neutral). Based on these proximate analysis and crude fibre content in cookies with the proportion of MOCAF with mung bean flour of 70:30 is 6.07% protein content; fat content 21.54%; water content 2.39%; ash content 2.47%; carbohydrate content of 67.25%, and crude fibre content of 0.23%. These findings are in accordance with the quality requirements [QR] of cookies which refer to QR of biscuits on SNI 2973:2011 [1]. According to SNI 2973:2011, the maximum moisture content of cookies is 5%, and the minimum crude protein is 5% [1]. It demonstrates that cookies with the proportion of MOCAF to mung bean flour of 70:30 under SNI 2973:2011. Cookies with the proportion of MOCAF to mung bean flour of 70:30 have added value, namely the crude fibre contained in cookies of 0.23%. It shows that the purpose of using mung bean flour to increase protein content in MOCAF cookies is fulfilled and in accordance with SNI 2973:2011.

## 4 Conclusions

The study revealed that the higher proportion of mung bean flour, the lower moisture content, the higher spread ratio, the reduced hardness, the less colour includes lightness, a* value, b* value, and chroma, the increased hue, and colour, hardness, and subsequently the taste preferences level increased. The ratio 70:30 of MOCAF to mung bean flour showed the finest treatment and scored significant preference level on a scale of 1 to 7, resulting in a preference for the colour of 4.86 (slightly like), hardness 5.54 (like), taste 4.68 (slightly like), and ease of swallowing 4.66 (slightly like). At this optimum proportion [70:30], the moisture content was 2.36%, protein content was 6.07%, fat content was 21.54 %, ash content was 2.47%, carbohydrate content was 67.25%, and crude fibre content was 0.23%. Optimization of the physicochemical and organoleptic properties of cookies with modified cassava flour and mung bean flour was successfully achieved, and enhanced the nutritional standards of the cookies.

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