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The Effect of Different Techniques in Processing of Purple Yam Flour (*Dioscorea alata*) on the Characteristics of Mocaf-Based Cookies

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Abstract:
The utilization of purple yam flour is expected to enhance the functional value of cookies. This study aims to determine the effect of processing techniques of purple yam flour (*Dioscorea alata*) on the characteristics of mocaf-based cookies. This study uses a Completely Randomized Design. Complete with treatments of various processing technique for yam flour: P1 (yam tubers are cut, then steamed, sliced, and dried), P2 (yam tubers are sliced, soaked in 1% citric acid for 30 minutes, steamed, and dried), P3 (yam tubers are cut, then soaked in water for 24 hours, sliced, and dried), P4 (yam tubers are cut, steamed, mashed, mixed with mocaf, and dried), and P5 (yam tubers are soaked in 1% citric acid for 30 minutes, steamed, mashed, mixed with mocaf, and dried). The research shows that the processing techniques affect the color and flavor of the cookies. The encapsulation with mocaf able to retain the color of purple but appear to be darker and not preferred by the panelist. Based on the sensory analysis, the selected cookies from treatment P3 was chosen to produce yam-mocaf cookies. This cookie has color values L*, a*, b* of (37.95; 9.30; 2.10), hardness 77.76gF, moisture content 6.75%, ash content 2.22%, fat content 17.28%, protein content 6.81%, fiber content 5.48%, carbohydrate content 66.79%, and anthocyanin content of 47.01 mg/100g.
Keywords: Cookies, Mocaf, Purple Yam Flour

1. Introduction

According to the Indonesian National Standardization Agency (2022), cookies are a type of biscuit snack made from soft dough, with a crunchy texture and an appearance that seems less dense when broken. Cookies have distinctive characteristics such as high sugar and fat content, as well as low moisture content (less than 5%). This makes its texture crunchy when bitten (Rosida et al., 2020).

Cookies are usually made using low-protein wheat flour, sugar, and eggs. The use of low-protein flour helps achieve a texture in cookies that is more suitable for dry cookies, which are usually more brittle and crunchy compared to bread or cake. Amri & Pratiwi (2015) stated that the use of mocaf can be an alternative to address the dependence on imported wheat as a raw material substitute for flour and can also be part of local food diversification efforts.

In the production of mocaf-based cookies, the addition of other ingredients is necessary to enhance the functional value and acceptance of the resulting cookies. Mocaf itself has a low protein content of 1.2%. As stated in Arsyad (2016), the protein content in biscuits decreases as the substitution of mocaf increases. According to the Indonesian National Standardization Agency (SNI 2973:2022, 2022), the protein content requirement for the quality of Cookies is at least 4.5%, thus additional ingredients are needed to increase the protein content in the produced Cookies. One of the local food ingredients that can be used as functional food is tubers. Seeing the potential of local food ingredients such as tubers that have not been optimally utilized, innovation can be developed, and one of the promising tubers is purple yam.

Purple yam (*Dioscorea alata*) is one of the prospective local food plants and can be used as a source of functional food because it contains high levels of carbohydrates, phenolic compounds, and anthocyanins.

In addition, compared to other types of tubers, purple yam contains a higher protein content of 4.73 (Ezeocha & Ojimelukwe, 2012; Nadia Lula & Hartari Ariyanti, 2012). Although it has a high protein and carbohydrate content, purple yam tubers have a low sugar level due to the presence of bioactive antidiabetic components such as discosin and allantonin, making them a potential alternative carbohydrate source for diabetics (Suharman et al., 2020; Tamaroh, 2020). Purple yam tubers also contain beneficial components, namely anthocyanins, which serve as a source of antioxidants that are useful for countering free radicals. Anthocyanins are also natural dyes derived from the flavonoid family that are water-soluble, producing red, blue, or violet colors (Fang et al., 2011).

Purple yam tubers can be processed into flour and yam starch. Flour is a product obtained from the grinding process of food ingredients such as grains or tubers into fine particles, while starch is a carbohydrate derived from the extraction of grains and tubers. In this study, purple yam tubers are utilized in the form of flour, which is expected to enhance functional value and provide natural color to the produced Cookies, making them acceptable to the commercial.

The processing of purple yam tubers into flour to produce mocaf-based cookies requires proper processing methods because one of its important bioactive components, anthocyanins, contained in purple yam tubers, is easily degradable and water-soluble. In addition, purple yam tubers contain the enzymes polyphenol oxidase and peroxidase, which play a role in browning reactions (Purnawati, 2015).

In general, flour production is carried out by drying food ingredients and then grinding or milling them. Several modifications have been made in the study of purple yam flour production, including steamed and dried purple yam flour (Purnawati, 2015; Tamaroh, 2020). The steaming method can inactivate polyphenol oxidase and peroxidase enzymes that are involved in browning reactions, resulting in flour that is not brown in color. Then, the production of flour from slices of purple yam tubers soaked in 1% citric acid, steamed, and dried (Ulyarti & Fortuna, 2016). Soaking in 1% citric acid can prevent color changes in purple yam tubers, maintain anthocyanin content, and act as an antioxidant compound because anthocyanins are more stable at acidic pH. There are also those who make purple yam flour through a 24-hour soaking process followed by drying (Muhammad et al., 2014). Soaking for 24 hours can reduce the slime present in purple yam and maintain the texture of the yam. In addition, mixing mocaf in the production of mocaf cookies can be done simultaneously with the preparation of purple yam flour. In this way, it is expected that the color-forming components in the purple yam tuber can be encapsulated by mocaf, making them more heat-resistant during the flour drying process. Based on these, the research was carried out to determine the effect of processing techniques of purple yam flour (*Dioscorea alata*) on the characteristics of mocaf-based cookies.

2. Research Method

Methods

This study uses a Completely Randomized Design (CRD), consisting of 5 treatment levels with 4 replications, resulting in 20 experimental units. The treatment in this study is the type of purple yam tuber flour added to the cookie dough. The flours were processed using 2 techniques (with or without encapsulation with mocaf). Each consists of several techniques as shown below.

1. The production of yam tuber flour without encapsulation using mocaf
   P1: The yam tubers are cut, steamed, sliced, and dried.
   P2: The yam tubers are sliced, soaked in 1% citric acid for 30 minutes, steamed, and dried.
   P3: The yam tubers are cut, soaked in water for 24 hours, sliced, and dried.
2. The production of purple yam tuber flour with encapsulation using mocaf
   P4: The yam tubers are cut, steamed, mashed, mixed with mocaf, and dried.
   P5: The yam tubers soaked in 1% citric acid, for 30 minutes, steamed, mashed, mixed with mocaf, and dried.

The preparation of yam flour (P1) (Tamaroh, 2020).

The steps taken are as follows: first, the purple yam tubers are peeled, then the peeled flesh is washed, and the unused parts are removed to eliminate any remaining dirt and slime. The next step is cutting the yam into cubes (size 3x3x3 cm^3), then the purple yam is steamed for 8 minutes, after which the steamed purple yam is sliced thinly (about 2-3 mm) and dried by baking. The baking is done until the purple purple yam slices are dry (characterized by being easily broken), and the baking.

The preparation of yam flour (P2) (Ulyarti & Fortuna, 2016).

The yam tubers are peeled, washed, and sliced to a thickness of 0.5 cm. The slices of yam tuber are then soaked in a 1% citric acid solution while submerged for 30 minutes, to prevent color changes in the purple yam tuber and also serving as an antioxidant compound. After soaking, the yam tubers are then rinsed with clean water, and the yam slices are blanched with steam (steaming at 100°C) for 10 minutes and then cooled. The blanched yam slices are dried in an oven at 60ºC for 8 hours until their moisture content does not exceed 14%. The next step is to grind the dried yam slices using a blender and sift them with a 60 mesh sieve.

The preparation of yam flour (P3) (Muhamad et al., 2014).

The steps taken are that the peeled yam tubers are washed and soaked in water for 24 hours at room temperature. Soaking the yam tubers for 24 hours results in the least amount of slime while maintaining the texture of the yam tubers. The yam tubers are then sliced to a thickness of 2 mm to facilitate the grinding process. After that, the sliced yam tubers were dried at a temperature of 60°C for 8 hours. Next, the sliced yam tubers were blended until smooth, resulting in yam flour. The yam flour is then sifted using a 60 mesh sieve.

The preparation of yam flour (P4)

The purple yam tuber is peeled, then the peeled flesh is washed and the unusable parts are removed to eliminate any remaining dirt and slime. The next step is to cut the yam into cubes (size 3x3x3 cm^3) and then steam the purple yam for 8 minutes. Then, the steamed yam is mashed and mixed with mocaf, and the flour is dried at a temperature of 60°C for approximately 10 hours. After drying, the yam and mocaf are blended again using a blender and then sifted with a 60 mesh sieve.

The preparation of yam (P5)

The yam tubers are peeled, washed, and sliced to a thickness of 0.5 cm. The slices of yam tuber are then soaked in a 1% citric acid solution, fully submerged for 30 minutes, to prevent color changes in the purple yam tuber and also serving as an antioxidant compound. After soaking, the yam tubers were rinsed with clean water, then the yam slices were blanched with steam (steaming at 100°C) for 10 minutes and cooled. The blanched yam slices were then ground and mixed with mocaf, and then baked at 60ºC for approximately 10 hours until the moisture content did not exceed 14%. The next step is to grind the steamed purple yam and mocaf mixture and sift it with a 60 mesh sieve.

Cookies Preparation (Purba et al., 2017)

15g of powdered sugar, 9.4g of eggs, 0.1g of salt, and 19.4g of margarine were mixed using a mixer for about 3 minutes, then add 29g (60%) of mocaf and 19g (40%) of purple yam flour (as per treatment), 8g of powdered milk, and 0.1g of baking soda. The dough was kneaded until it can be shaped, shaped and baked at 130°C for 23 minutes.

Procedures

Texture (Hardness) with Texture Analyzer/TA (Baer & Dilger, 2014), water content (SNI 2973:2011, 2011), ash content (AOAC, 2005), fat content (AOAC, 2005), protein content (AOAC, 2005), anthocyanin content (Huang et al., 2017), sensory properties (Ayustaningwarno, 2014).

3. Results and Discussion

Purple Yam Flour

The appearance and description of purple yam tuber flour with various processing methods used for cookie's production can be seen in Table 1. In Table 1, it can be seen that purple yam tuber flour with different processing methods results in different shapes, aromas, tastes, colors, and moisture content. This difference is caused by the treatment or method of processing used. In treatment P1 (the yam tubers were cut, steamed, sliced, and dried), flour was obtained with a fine texture, a distinctive yam aroma, a neutral taste, and a reddish-purple color due to the steaming process. According to Ekici et al (2014), anthocyanins are very sensitive to pH and temperature. When yam tubers are heated through steaming, their natural pH can change to become more alkaline, shifting the anthocyanin pigments from the purple spectrum to red. L* value: 43.4, a*: 19.7, b*: -6.5, and moisture content 10.86%. In Purnawati (2015), the moisture content of purple yam flour with the steaming process was 7.56%, while in Tamaroh (2020), the moisture content of purple yam flour ranged from 7.77-10.66%, so the moisture content of the flour obtained in this study was higher.

Table 1. Purple yam flour with several processing techniques

Flour Processing Techniques	**Appearance of Flour**	**Flour Description**
P1: The yam tubers are cut, steamed, sliced, and dried.		Form: smooth Aroma: distinctive purple yam Taste: neutral Color: reddish purple (L*a*b*): 43,4; 19,7; -6,5) Moisture Content: 10.70%
P2: The yam tubers are sliced, soaked in 1% citric acid for 30 minutes, steamed, and dried.		Form: smooth Aroma: distinctive purple yam Taste: slightly sour Color: purple (L*a*b*): 41.6; 18.6; -7.3 Moisture Content: 10.86%
P3: The yam tubers are cut, soaked in water for 24 hours, sliced, and dried.		Form: granular (clumped) Aroma: distinctive purple yam Taste: neutral Color: light purple (L*a*b*): 48.5; 15.7; -3.7 Moisture Content: 10.50%
P4: The yam tubers are cut, steamed, mashed, mixed with mocaf, and dried.		Form: somewhat fine Aroma: somewhat mocaf-flavored Taste: neutral Color: purple (L*a*b*): 44,9; 18,1; -4,8 Moisture Content: 10.94%
P5: The yam tubers soaked in 1% citric acid, t: 30 m, steamed, mashed, mixed with mocaf, and dried.		Form: somewhat fine Aroma: somewhat mocaf flavored Taste: slightly sour Color: purple (L*a*b*): 43.9; 18.2; -6.1 Moisture Content: 11.73%

Note: L* (Lightness), a* (Redness), b* (Yellowness)

In treatment P2 (the yam tubers are sliced, soaked in 1% citric acid for 30 minutes, steamed, and dried), a fine flour is obtained with a characteristic purple yam aroma and a slightly sour taste caused by the citric acid soaking treatment. According to Lalu et al (2023), citric acid soaking imparts a sour taste to banana flour. The color is purple, with L* value: 41.6, a*: 18.6, b*: -7.3, and a moisture content of 10.86%. According to Purnawati's research (2015), the moisture content of purple yam flour with the citric acid soaking and steaming process was 8.55%, so the moisture content of the flour obtained in this study is higher.

In treatment P3 (the yam tuber is cut, soaked in water for 24 hours, sliced, and dried), flour with a granulated (lumpy) form was obtained. The relatively long soaking treatment causes the clumped form. This can cause the yam tubers to absorb a lot of water, so suboptimal drying results in moisture, causing the produced flour to tend to clump. The aroma produced in the flour is characteristic of yam, with a neutral taste and a color that appears as a bright purple. This is caused by prolonged soaking, which triggers the degradation of anthocyanin pigments, leading to a decrease in anthocyanin stability and the fading of the purple color (Egbuonu et al., 2014). L* value: 48.5, a*: 15.7, b*: -3.7, and moisture content of 10.50%. In Afidin et al (2014), the moisture content of purple yam flour with a 24-hour water soaking process was 8.49%, so the moisture content of the flour obtained in this study is higher.

In treatment P4 (the yam tuber is cut, steamed, mashed, mixed with mocaf, and dried), flour with a somewhat clumpy texture was obtained. This happens because purple yam paste has a higher moisture content compared to mocaf, which has undergone a drying process. Mocaf has hygroscopic properties (easily absorbs water), when wet pasta is mixed with dry flour like mocaf, the inconsistency in moisture content can cause small clumps to form in the flour mixture. The aroma of the resulting flour is somewhat mocaf-like due to the mixing with mocaf, with a neutral taste, and the visible color is a slightly bright purple, L*: 44.9, a*: 18.1, b*: -4.8, and a moisture content of 10.94%.

In treatment P5 (the yam tuber soaked in 1% citric acid, t: 30 m, steamed, mashed, mixed with mocaf, and dried), the resulting flour had a somewhat clumpy texture, a slightly mocaf aroma due to the mocaf mixture, a slightly sour taste from the citric acid soaking, a purple color, L* value: 43.9, a* value: 18.2, b* value: -6.1, and moisture content: 11.73%.

The moisture content in the purple yam tuber flour obtained in the study ranges from 10.50-11.73%. Compared to previous research, the moisture content results in this study obtained higher values. The high moisture content can be caused by the type and age of the yam tubers used, and the drying time and temperature can also be factors contributing to the differences in moisture content of the resulting yam tuber flour. In addition, storing purple yam flour for too long and in a humid place can also affect the moisture content of the flour. Referring to the wheat flour requirements used by the Indonesian National Standard (SNI 3751:2009, 2009) that the maximum moisture content of wheat flour is 14.5%. Furthermore, according to Earle (1968), high-quality flour should have a moisture content not exceeding 14%, so it can be said that the results of this study has met the standards.

Description of Cookies

The appearance and description of cookies made with the addition of purple yam tuber flour using various processing technique can be seen in Table 2.

Table 2. Appearance and description of cookies influenced by the addition of yam flour with 5 different flour processing technique

Flour Processing Technique	Appearance of Cookies	Cookies Description
P1: The yam tubers are cut, steamed, sliced, and dried.		Color: dark purple Texture: somewhat crunchy
P2: The yam tubers are sliced, soaked in 1% citric acid for 30 minutes, steamed, and dried.		Color: light purple Texture: somewhat crunchy

Flour Processing Technique	**Appearance of Cookies**	**Cookies Description**
P3: The yam tubers are cut, soaked in water for 24 hours, sliced, and dried.		Color: light purple Texture: somewhat crunchy
P4: The yam tubers are cut, steamed, mashed, mixed with mocaf, and dried.		Color: bright purple Texture: somewhat crunchy
P5: The yam tubers soaked in 1% citric acid, t: 30 m, steamed, mashed, mixed with mocaf, and dried.		Color: very dark purple Texture: not crunchy (somewhat hard)

It can be seen in Table 2 that cookies with the addition of purple yam tuber flour, processed differently, also show differences in color and texture of the resulting cookies. Cookies with the addition of flour in treatment P1 (purple purple yam cut, steamed, sliced, and dried) produced a somewhat dark color and a somewhat crunchy texture. In treatment P2 (purple purple yam sliced, soaked in 1% citric acid for 30 minutes, steamed, and dried), it produced a somewhat bright color and a somewhat crunchy texture. In treatment P3 (purple purple yam cut, soaked in water for 24 hours, sliced, and dried), it produced a somewhat dark color and a somewhat crunchy texture. In treatment P4 (purple purple yam cut, steamed, mashed, mixed with mocaf, and dried), it produced a somewhat dark color and a somewhat crunchy texture. In treatment P5 (purple purple yam soaked in 1% citric acid for 30 minutes, steamed, mashed, mixed with mocaf, and dried), it produced a very dark color and a somewhat hard texture.

The difference in color and texture produced is due to the different processing methods. It is known that purple yam tubers have relatively high anthocyanin content, and anthocyanins themselves are easily degraded, so different processing technique affect the color of the resulting cookies.

Sensory Properties of Cookies

The average acceptance results of the panelists towards the hedonic quality of mocaf cookies with different processing technique of purple yam flour can be seen in Table 3 - 5. Based on the comparison of orthogonal contrasts of the hedonic color quality that has been analyzed, it can be seen in Table 3 that there are no significant differences between treatment P1 (Yam tubers cut, steamed, sliced, and dried), P2 (Yam tubers sliced, soaked in 1% citric acid for 30 minutes, steamed, and dried) and P3 (Yam tubers cut, soaked in water for 24 hours, sliced, and dried). the average color value of the cookies can be seen in Table 3, where the colors obtained in treatments P1 and P2 are bright, while P3 has a somewhat darker color. This is because the steaming and citric acid soaking treatments both help maintain a significant amount of anthocyanins in the purple yam tuber flour as the base ingredient in the production of mocaf-based cookies (Purnawati, 2015), whereas the 24-hour water soaking treatment causes the anthocyanins to dissolve into the water and accelerates the degradation of anthocyanins, resulting in a paler flour color that makes the cookies darker.

Table 3. The influence of different processing technique of purple yam flour on the color of mocaf cookies determined by sensory analysis

Comparison	Average treatment					L^2	$r\sum Ci^2$	$\{L^2/r\sum Ci^2\}$	F-count
	P1	P2	P3	P4	P5				
	2,58	2,54	3,12	4,42	2,00				
P1 P2 *vs* P3	2	-1	-1	0	0	169	156	1.08	1.74 ns
P2 *vs* P3	0	1	-1	0	0	225	52	4.33	3.35 ns
P4 *VS* P5	0	0	0	1	-1	3969	52	76.33	122.62 **
P1 P2 P3 *vs* P4 P5	2	2	2	-3	-3	5329	780	6.83	10.98 **

Note: ** = significantly different at the 1% level, ns = not significantly different at the 5% level, Color = 5: Very Dark Purple, 4: Darkish Purple, 3: Purple, 2: Lightish Purple, 1: Light Purple

The color comparison between P2 (sliced yam tubers, soaked in 1% citric acid for 30 minutes, steamed, and dried) and P3 (cut yam tubers, soaked in water for 24 hours, sliced, and dried) did not significantly affect the color of the resulting Cookies. The color obtained in treatment P2 is bright, whereas P3 achieves a somewhat darker color.

The color comparison between Cookies treated with P4 (purple yam cut, steamed, mashed, mixed with mocaf, and dried) and P5 (purple yam soaked in 1% citric acid, t: 30 m, steamed, mashed, mixed with mocaf, and dried) significantly affects the color of the resulting Cookies. Cookies in treatment P4 in the Table show a somewhat dark color, whereas treatment P5 produces a bright color. The difference in color in these Cookies is due to the stability of anthocyanins, which is influenced by pH and temperature during the processing. Citric acid treatment increases anthocyanin stability, resulting in a more stable purple color in Cookies compared to the steamed treatment without acid, so the purple color in Cookies from the P5 treatment is brighter than in Cookies from the P4 treatment.

The color comparison between Cookies treated with P1, P2, P3, and P4, P5 significantly affects the color of the resulting Cookies. This is due to the different stages of processing and the addition of purple purple yam flour, resulting in different colors of the Cookies.

Table 4. The influence of different processing technique of purple yam flour on the flavor of mocaf cookies determined by sensory analysis

Comparison	Average treatment					L^2	$r\sum Ci^2$	$\{L^2/r\sum Ci^2\}$	F-count
	P1	P2	P3	P4	P5				
	3,27	3,15	3,46	2,85	2,42				
P1 P2 *vs* P3	2	-1	-1	0	0	4	156	0,03	0,04 ns
P2 *vs* P3	0	1	-1	0	0	64	52	1,23	1,98 ns
P4 *VS* P5	0	0	0	1	-1	121	52	2,33	3,74 ns
P1 P2 P3 *vs* P4 P5	2	2	2	-3	-3	10609	780	13,60	21,85 **

Note: ** = significantly different at the 1% level, ns = not significantly different at the 5% level. Flavor = 5: Very delicious, 4: Delicious, 3: Quite delicious, 2: Just okay, 1: Not delicious

Based on the comparison of orthogonal contrasts of the hedonic flavor quality that has been analyzed, it can be seen in Table 4 that there are no significant differences between treatment P1 (Yam tubers cut, steamed, sliced, and dried), P2 (Yam tubers sliced, soaked in 1% citric acid for 30 minutes, steamed, and dried) and P3 (Yam tubers cut, soaked in water for 24 hours, sliced, and dried). The average flavor value of the Cookies can be seen in Table 4, where the flavors obtained from treatments P1, P2, and P3 are somewhat pleasant due to the same amount of formulation added in the making of the Cookies.

The color comparison between P2 (sliced yam tubers, soaked in 1% citric acid for 30 minutes, steamed, and dried) and P3 (cut yam tubers, soaked in water for 24 hours, sliced, and dried) did not significantly affect the flavor of the produced Cookies. The flavor obtained in treatments P2 and P3 was somewhat good. Similarly, the treatment P4 (Yam tubers cut, steamed, mashed, mixed with mocaf, and dried) and P5 (Yam tubers soaked in 1% citric acid for 30 minutes, steamed, mashed, mixed with mocaf, and dried) did not have a significant effect on the flavor of the resulting cookies.

The comparison of flavor between Cookies treatments P1, P2, P3 and P4, P5 significantly affects the flavor of the resulting Cookies, due to the different flour processing techniques. In treatments P1, P2, and P3, the flour was made by fully drying the purple purple yam tubers, whereas in treatments P4 and P5, the flour was made by mixing purple purple yam paste with mocaf before drying.

Table 5. The influence of different processing technique of purple yam flour on the texture of mocaf cookies determined by sensory analysis

Cookies	Texture	Category
P1: The yam tubers are cut, steamed, sliced, and dried.	3.23 ± 0.95	A bit crunchy
P2: The yam tubers are sliced, soaked in 1% citric acid for 30 minutes, steamed, and dried.	3.42 ± 0.90	A bit crunchy
P3: The yam tubers are cut, soaked in water for 24 hours, sliced, and dried.	3.31 ± 1.29	A bit crunchy
P4: The yam tubers are cut, steamed, mashed, mixed with mocaf, and dried.	3.46 ± 0.99	A bit crunchy
P5: The yam tubers soaked in 1% citric acid, t: 30 m, steamed, mashed, mixed with mocaf, and dried.	2.73 ± 1.37	Not Crunchy

Note: 5: Very crunchy, 4: crunchy, 3: somewhat crunchy, 2: not crunchy, 1: hard

The different techniques used in yam flour processing have no significant effect on the texture of the cookies (Table 5). The cookies have a somewhat crunchy texture. The gluten content influences the texture of Cookies in the flour, which was in line according to Manley (2000) in Fitriyani et al (2017), gluten is a very important component in the dough that will affect the texture of Cookies. In this study, the flours used were mocaf and purple purple yam flour, which do not contain gluten, resulting in a somewhat crunchy texture. This is in accordance with Kurniawan et al (2018), which show that adding composite flour from purple yam and beans in the cookie dough tends to decrease the panelists' preference due to the absence of gluten.

As seen in multiple comparison tests for texture, taste, and overall acceptance, the different processing techniques did not affect the sensory properties of mocaf cookies (Table 6).

Table 6. The influence of different processing technique of purple yam flour on the sensory properties of mocaf cookies determined by multiple comparison test

Cookies	Texture	Taste	Overall Acceptance
P1: The yam tubers are cut, steamed, sliced, and dried.	4.88±1.21	4.77±1.14	4.88±1.11
P2: The yam tubers are sliced, soaked in 1% citric acid for 30 minutes, steamed, and dried.	4.77±1.42	4.65±1.20	4.77±1.34
P3: The yam tubers are cut, soaked in water for 24 hours, sliced, and dried.	5.00±1.41	4.73±1.25	4.81±1.27
P4: The yam tubers are cut, steamed, mashed, mixed with mocaf, and dried.	4.15±1.85	4.38±1.77	4.27±1.82
P5: The yam tubers soaked in 1% citric acid, t: 30 m, steamed, mashed, mixed with mocaf, and dried.	3.85±1.95	4.00±1.50	3.81±1.96

Note: 7 = Much better than R, 6 = Better than R, 5 = Slightly better than R4= No different from R, 3= Slightly worse than R, 2= Worse than R, 1= Much worse than R

The Characteristics of Yam-Mocaf Cookies

The selection of the best treatment was chosen based on sensory testing according to the hedonic quality scale and multiple comparisons. Hedonic quality testing includes color, flavor, and texture, while multiple comparison testing includes texture, taste, and overall. The hedonic quality test and the multiple comparison test on cookies with different processing methods of purple yam flour can be seen in Table 3, Table 4, Table 5 and Table 6. Based on the texture parameters in the hedonic quality and texture tests, taste, and overall in the multiple comparison tests, there was no significant effect, whereas based on the color and flavor parameters in the hedonic quality tests, there was a significant effect.

The highest panelist rating for the color hedonic quality parameter was for treatment P4 (Yam tubers cut, steamed, mashed, mixed with mocaf, and dried), which received a score of 4.42, described as purple (mulberry purple) or somewhat dark. Meanwhile, the highest panelist rating for the flavor hedonic quality parameter was for treatment P3 (Yam tubers cut, soaked in water for 24 hours, sliced, and dried), which received a score of 3.46, meaning somewhat tasty. Flavor is an important quality attribute that determines the acceptability of the produced food. Flavor is also the sensation produced by food when it is in the mouth, especially caused by taste and aroma, making flavor the key to whether a food product is delicious or not. Based on the hedonic quality test in this study, the highest flavor parameter was found in treatment P3, so P3 was more selected based on its sensory characteristics for further research, namely physical and chemical tests to determine its functional value.

Table 7. Physical properties of cookies with the addition of selected flour

The Chosen Treatment	Hardness (gF)	Color			Color description	Color
		L*	a*	b*		
P3	77.76 ± 28.44	37.95	9.30	2.10	Very dark grayish red	

Note: L* (Lightness), a* (Redness), b* (Yellowness)

The physical characteristics of the chosen cookies are presented in Table 7. In the study conducted by Julianti (2023), mocaf cookies with the addition of 1% citric acid-soaked purple yam flour resulted in a hardness value of 1088.73gF. Meanwhile, in this study, the hardness value of the cookies was obtained at 77.76gF. This means lower value of hardness in this study may be due to the different amounts of flour used in the formulations. Julianti used mocaf and yam flour in a ratio of 80%:20% while in this study, the ratio was 60%:40%.

The chosen cookie is also nutritious as shown in Table 8 below. However it does not meet SNI criteria for water content according to SNI 01-2973-2022 with maximum moisture content for cookies should be 5%. This may be due some factors, one of which is the high concentration of fibre as a result of yam flour addition (Andini & Tamaroh, 2023). The cookie also does not meet criteria for maximum ash content according to SNI 01-2973-2022 at 1.5%. This is due to higher ash content of yam flour (2.46% to 3.56%) compared to mocaf (0.17-0.37%). The dominant mineral content in purple yam flour is calcium, phosphorus, and iron (Hapsari et al., 2014).

Table 8. The composition of yam-mocaf cookies

Chemical composition	Percentage (%)
Water (%)	6.75 ± 1.31
Ash (%)	2.22 ± 0.21
Fat (%)	17.28 ± 0.64
Protein (%)	6.81 ± 0.84
Carbohydrate (%)	66.79 ± 0.54
Fiber (%)	5.48 ± 1.95
Anthocyanin (mg/100g)	47.01± 4.64

Conclusion

The processing technique of purple yam flour affects the hedonic quality of color and flavor in mocaf-based cookies with addition of yam flour. The encapsulation of purple yam with mocaf before drying in flour processing produced different colors, flavors, and textures of cookies than those produced using flour without encapsulation. Among processing techniques without mocaf encapsulation, P3, (the yam is cut, soaked in water for 24 hours, sliced, and dried), is the chosen technique based on sensory properties. The selected cookie using yam flour from treatment P3 has a texture value of 77.76gF, moisture content of 6.75%, ash content of 2.38%, fat content of 17.28%, protein content of 6.81%, fiber content of 5.48%, carbohydrate content of 66.79%, and anthocyanin content of 47.01 mg/100g.

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