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Sensory Profiles and Chemical Properties of Biscuit Made from Mocaf and Tempe Flour

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ABSTRACT

Background: Biscuit is a bakery product made from wheat flour with or without the addition of other foods. The need for wheat flour in Indonesia is obtained by importing it in large quantities, so that alternative food ingredients are needed as a substitute for wheat flour. Mocaf flour is known as an alternative cassava flour to replace wheat. Mocaf flour has weaknesses when compared to wheat such as lower protein content, so the protein content in biscuits can be increased by adding other protein sources such as tempeh. To make tempeh more preferable, a change in the form of tempeh is made into flour. This study aims to determine the effect of the ratio of mocaf flour and tempeh flour on the characteristics of biscuits. **Methods**: The type of research used is experimental research, using a completely randomized design with 5 treatments and 3 replications. **Results**: The results showed that the difference in the ratio of mocaf flour to tempeh flour had a significant effect on organoleptic quality which included color, aroma, texture, taste, overall acceptability, aroma quality, texture quality, moisture content, fiber content, and protein content. The best treatment from this study was P1 with (90% mocaf flour: 10% tempeh flour) with color quality characteristics of 4.16 (like), aroma 4.21 (like), taste 4.44 (like), texture 4.14 (like), with aroma quality 2.92 (not unpleasant), texture quality 2.61 (crispy) and overall acceptability 4.38 (like) with 2.85% water content, 8.16% protein content and fiber 4.87%.

Keywords: Mocaf Flour; Tempeh Flour; Organoleptic; Nutritional Value Content

INTRODUCTION

Biscuit is dry bakery products produced through a dough baking process consisting of wheat flour and its substitutes, oil or fat, and can be added to other food ingredients and permitted food additives[3]. Round, square and stick biscuits have undergone many developments in various flavors and are very popular with the public. However, there are still a few biscuits that have a high nutritional content[11]. Until now, the need for wheat in Indonesia is met through imports in large quantities. Based on information from the Central Statistics Agency (BPS), in 2019 Indonesia imported up to 34,467 tons of wheat. This number even increased by 2.6 million tons compared to the previous year[8]. Therefore, it is necessary to look for alternative food options that can function as substitutes or even substitute for wheat flour. Indonesia has various types of local resources that are rich in nutrients that can replace wheat, such as cassava.

Mocaf flour is known as a substitute for wheat flour derived from cassava. The word mocaf means modified cassava flour, which means it has different properties from ordinary cassava flour. Mocaf has advantages over ordinary cassava flour, namely the color of the flour is whiter, the viscosity is higher, the rehydration is better and the cassava taste can be covered. According to the Indonesian Food Composition Table (2017), 100 g of mocaf flour contains 1.2 g of protein, 0.6 g of fat, 85 g of carbohydrates, 6 g of dietary fiber, 1.3 g of ash content and 11.9 g of water. In addition, mocaf flour does not contain gluten, and the high content of mocaf starch can be used as a substitute for wheat flour in making biscuits[1]. Mocaf flour is safe for people with autism, also safe for people with hypercholesterolemia. In addition, mocaf contains phytoestrogens, hormones that play a role in preventing early menopause in women[13]. Apart from these advantages, mocaf flour also has several disadvantages compared to wheat flour, for example the protein content of mocaf flour is only 1.2%, while wheat flour is 8-13%[13].

The protein content in biscuits can be increased by adding other protein sources such as tempeh. Tempe is one of the most famous fermented foods in Indonesia. The raw material for making tempe that is commonly used in Indonesia is soybean (Glycine max L). Fermentation of soybeans into tempeh does not only involve Rhizopus but also other microorganisms such as yeast and lactic acid bacteria. Tempe has various benefits such as antihypertensive, anti-diabetic, antioxidant and anti-cancer[17]. Tempeh is in great demand by the general public because it is not only cheap, but also a source of protein which is nutritious and rich in essential amino acids, and is often seen as a substitute for meat and poultry[5]. If you want to increase the popularity of tempe among the people, modifications can be made by changing its shape to tempeh flour which has various variations in color, shape, aroma, and taste. The transformation of tempeh into tempeh flour makes it more durable because it undergoes drying which can reduce the water content to around 4-8%. Thus, tempeh flour can be stored for months at room temperature[11]. The nutritional content of tempeh flour per 100 g consists of 46 g of protein, 24.7 g of fat, 19.3 g of carbohydrates, 2.5 g of fiber, 2.3 g of ash, and 7.7 g of water[6]. Tempe flour can be stored for months at room temperature[11].

Based on the results of research conducted by Oktaviana, Hersoelistyorini and Nurhidajah, (2017) said that increasing the use of

mocaf flour could reduce the dough's ability to expand and reduce the protein content in pastries, while the use of tempeh flour had a significant effect on the moisture, protein and fat content of mocaf cakes. The results of research conducted by Retnaningsih et al., (2020) selected the best biscuits with a ratio of mocaf flour and tempeh koro gude flour (90%: 10%). In research conducted by Kristanti et al., (2020) that the best biscuit with a formulation ratio of 75% mocaf flour and 25% tempeh flour.

Based on this background, researcher is interested in conducting research on the effect of the ratio of mocaf flour and tempeh flour on the characteristics of biscuits.

METHOD

The type of research used in this study was experimental research, the design used was a randomized block design (RAK) with 5 treatments and 3 repetitions. The samples analyzed were biscuits with different ratios of mocaf flour and tempeh flour. This research was conducted at the Food Laboratory of the Nutrition Department Polytechnic of Health Denpasar which included product manufacture and organoleptic assessment. This research was also conducted at the Food Analysis Laboratory, Faculty of Agriculture, Udayana University, to identify the water, protein and fiber content in biscuits. The time of this research was carried out from December 2022 to March 2023.

RESULTS

Table 1. The Average Value of Hedonic Test and Hedonic Quality

Treatment	Color	Texture	Aroma	Flavor	Reception Whole	Quality Aroma	Quality Texture
P1	4,16a	4.14a	4,21a	4,44a	4,38a	2,92a	2,61a
P2	4,12a	4.07a	3,96b	4,31a	4,18b	2.84a	2,39b
P3	4.01a	3,79b	3,83b	3,21a	4.08b	2,81a	2,38b
P4	3,52b	3,66b	3.69c	3,69b	3.76c	2,71b	2,32bc
P5	3,37c	3.49c	3,63c	3.46c	3,63c	2,63b	2,21c

Description: Different letters behind the mean indicate a significant difference (P>0.05).

The average value of the organoleptic assessment of the color of the biscuits using mocaf flour and tempeh flour varied from 3.37 to 4.16, indicating that the color of the biscuits was considered neutral to be liked. P1 biscuits had the highest preference value of 4.16 (liked), while P5 biscuits had the lowest value of 3.37 (neutral). The higher the ratio of tempeh flour used, the lower the preference value for the color of the biscuits. This indicates that the color of the biscuits is getting less favorable (neutral) with increasing the ratio of tempeh flour.

Based on the results of the hedonic test on the texture of biscuits using mocaf flour and tempeh flour, the average organoleptic score was obtained between 3.49 (neutral) to 4.14 (very like). The use of tempe flour with a higher ratio causes the average value of biscuit texture to decrease. Meanwhile, for texture quality, the average value of the hedonic test for biscuit texture quality ranged from 2.21 to 2.61. The higher the ratio of tempe flour, the harder the biscuits and the lower the ratio of tempe flour, the better the texture.

The average value of the organoleptic assessment of the aroma of mocaf flour and tempeh flour biscuits ranged from 3.63 to 4.21. Biscuits P1 has the highest average preference value, namely 4.21 (likes) and P5 has the lowest average preference value, namely 3.63 (likes). While the average value of the hedonic quality test for the aroma of biscuits from mocaf flour and tempeh flour ranged from 2.63 to 2.92. Mocaf flour biscuits and tempeh flour P1 had the highest hedonic quality test average score of 2.92 and the lowest P5 was 2.63 (not unpleasant).

The average organoleptic rating for the taste of biscuits made from mocaf flour and tempeh flour ranged from 3.46 to 4.44, which means neutral to like. P1 biscuits had the highest preference score of 4.44 (liked), while P5 had the lowest score of 3.46 (neutral). The higher the tempeh flour ratio, the biscuit taste score decreased, indicating that the preference score decreased and the taste was increasingly disliked (neutral).

The overall organoleptic assessment of biscuits using mocaf flour and tempeh flour with different treatments has an average value between 3.63 to 4.38 (likes).

Table 2. Objective Analysis Average Score

Treatment	Average Value of Objective Analysis of Biscuits		
	Water	**Proteins**	**Fiber**
P1	2.85±0.34a	8.15±0.21a	4.87±0.88a
P2	3.09±0.04a	8.56±0.25b	3.62±0.10b
P3	3.53±0.12b	10.46±0.12c	3.44±0.13b
P4	3.78±0.03b	10.83±0.14cd	3.55±0.18b
P5	3.84±0.08b	13.27±0.20e	3.22±0.12b

Description: Different letters behind the mean indicate a significant difference (P>0.05).

Water content

The first treatment had a moisture content of 2.85%, the second treatment was 3.09%, the third treatment was 3.53%, the fourth treatment was 3.79%, and the last treatment had a moisture content of 3.84%. The analysis showed that the lowest water content was found in mocaf flour and tempeh flour biscuits in the first treatment, which was 2.85%. Meanwhile, the highest water content was found in biscuits in the fifth treatment with a moisture content of 3.84%.

Protein Content

The average value obtained for mocaf flour biscuits and tempeh flour with the first treatment containing a protein content of 8.16%, the second treatment containing a protein content of 8.57%, the third treatment having a protein content of 10.47%, the fourth treatment containing protein of 10.84%, and the fifth or last treatment has a protein content of 13.28%. The results of the analysis of protein content showed that mocaf flour and tempeh flour biscuits had the lowest protein content in

the first treatment of 8.16% and the highest protein content in the fifth treatment biscuits of 13.28%.

Fiber Content

The first treatment had a fiber content of 4.87%, the second treatment had a fiber content of 3.63%, and the third treatment had a fiber content of 3, 45% mocaf flour biscuits and 45% tempeh flour. The fiber content of the treatment was 3.55% and the fifth or final treatment fiber content was 3.22%. Analysis of fiber content showed that the lowest fiber content was found in mocaf flour and tempeh flour biscuits in the 5th treatment, which was 3.22%, and the highest in the 1st treatment, which was 4.87%.

DISCUSSION

Sensory Profiles

From the results of subjective analysis using analysis of variance, differences in the comparison of mocaf flour and tempeh flour in biscuits have a significant effect on color, aroma, taste, texture, overall acceptability, aroma quality, and texture quality.

Color

Based on the least significant difference test (BNT), there were significant differences between the several treatments, depending on panelist preference. The color of the biscuit is dominated by the yellow color of the tempeh flour. The higher the ratio of tempe flour, the color of the biscuit becomes brown. The results of this study corroborate the analysis of the color properties of biscuits, with an increase in the proportion of tempeh flour indicating a shift towards a darker color (brown). In line with the findings of Hidayah and Anna (2019), the more tempeh flour was substituted, the color of the goyang flowers became browner and less attractive to the panelists.

The browning process of mocaf flour biscuits and tempeh flour becomes brown due to the Maillard reaction during baking. The Maillard reaction is a non-enzymatic browning caused by the high-temperature catalytic reaction of carbohydrates and proteins in foods, and the Maillard reaction plays an important role in the browning of biscuits[7].

Texture

Based on the average panelist hedonic test on acceptable biscuit texture levels, as well as hedonic texture tests and hedonic texture quality tests with different proportions of mocaf flour and tempeh flour, biscuits treated with P1 got the highest score. The higher the percentage of tempeh flour, the higher the hardness value of the biscuits, while the lower the brittleness of the biscuits. This is due to the low swelling power of the biscuits, which hardens the texture of the biscuits[6]. The texture of the biscuit is influenced by the starch in mocaf flour which consists of

amylose and amylopectin. The more mocaf flour starch molecules, the better the ability to absorb water. When the drying process is carried out, the binding capacity of the product's water molecules is small, as well as the structure of the product. become more crunchy[16].

The crunchy texture of mocaf flour and tempeh flour biscuits is also influenced by other ingredients such as sugar, margarine, baking powder and eggs. Sugar not only gives a sweet taste, but also helps to ripen and soften the cellular structure of the biscuit, serves to form uniform cells in the fruit pulp and gives it a soft texture[14].

Flavor

Based on the least significant difference (BNT) test, several treatments had significant differences in taste according to the preference of the panelists. Biscuits in the P1 treatment were the most preferred flavors of mocaf flour and tempeh flour biscuits by the panelists. Because the higher the ratio of tempeh flour, the higher the typical tempeh flavor that is generated and masks the savory taste of margarine. The taste of the biscuit is also influenced by several other ingredients such as milk, sugar, eggs and mocaf flour.

Aroma

Based on the hedonic test, the average taste tolerance of mocaf flour biscuits and tempeh flour by the panelists who achieved the highest score was in the P1 treatment. Based on the Least Significant Difference (BNT) test, there were significant differences in taste in several treatments, depending on the preference of the panelists. The higher the ratio of tempe flour, the more specific the taste of tempe. The taste of the resulting mocaf flour and tempeh flour can be affected by the off-flavor caused by the tempeh flour used to make the biscuits. Ginting, Meriahta and Manurung (2020) stated that an unpleasant odor is produced by the enzyme lipoxygenase. The lipoxygenase enzyme hydrolyzes soybean fat to produce compounds belonging to the hexanal and hexasol groups which give rise to a foul odor.

According to research by Elviena's (2016) regarding the quality of biscuits made from a combination of sorghum and tempeh flour, bleaching tempeh flour can remove the unpleasant odor attached to tempeh, so that the biscuits produced do not have a distinctive taste. The blanching process aims to kill Rhizopus mold and deactivate enzymes so as not to stimulate metabolic changes that cause discoloration and the appearance of an unpleasant odor[12]. In this study, a blanching process was carried out to reduce the off-flavor of tempe flour which was realized by steaming at 100°C for 15 minutes before drying in the oven.

Overall acceptance

Assessment of color, taste, aroma, and texture is an aspect contained in the overall acceptance. The overall suitability of the subjects with the most preferred biscuits in terms of color, aroma, taste and texture was the P1 treatment, with a hedonic score of 4.32. Based on the significant difference test (BNT), each treatment has a significant difference in overall acceptance according to the preferences of the test subjects. Treatments P2, P3, P4, and P5 were still acceptable to the panelists with hedonic scores of 4.18, 4.08, 3.76 and 3.63 (liked).

Chemical Characteristics

Water content

Mocaf flour biscuits and tempe flour water content ranges from 2.85% - 3.84%. The difference in the results of the moisture content in the biscuits is caused by the difference in the ratio of mocaf flour and tempeh flour and the high temperature during baking. Based on the biscuit quality requirements (SNI), the maximum moisture content is 5%. In this study, biscuits met the quality requirements for biscuits with the highest moisture content of mocaf flour and tempe flour in treatment P5 or the last treatment of 3.84%, and the lowest moisture content in the first treatment was found to be 2.85%. This is presumably because the percentage of tempeh flour used in making biscuits is higher so that the protein content is higher, because protein has the ability to bind water[15]. The water content in 100 grams of mocaf flour is 11.9 grams and the water content in 100 grams of tempe flour is 7.7 grams.

Protein Content

Biscuits with P5 treatment had the highest protein content of 13.28%, while biscuits with P1 treatment had the lowest protein content of 8.16%. The increase in the protein content of biscuits was due to the higher protein content of tempe flour, which contained 18.54% protein. 10.8% fat; 9.39% carbohydrates; 3.38% fiber; 1.38% ash (Schakel et al., 2016). Tempe protein content increased after the drying process due to loss of water content. The protein content of tempeh flour ranges from 46% to 50.18%3. The protein in tempe flour comes from soybeans. Soybean contains 36.9% protein7. All the biscuits tested met the quality requirements of SNI 2973-2011 biscuits, namely a minimum protein content of 5%.

Fiber Content

The highest fiber content in mocaf flour and tempeh flour biscuits was in treatment P1 which was 4.87%, while the lowest fiber content was in treatment P5 which was 3.22%. This shows that the higher the content of mocaf flour, the higher the fiber content of the biscuits. This is influenced by the main ingredients, namely mocaf flour and tempeh flour. The higher the percentage of tempeh flour, the lower the fiber content in the biscuits because tempeh flour has

lower fiber than mocaf flour so that it affects the biscuit fiber. According to the Indonesian Food Composition Table (2017), the fiber content of mocaf flour in 100 grams is 6 grams, while the fiber content of tempeh flour in 100 grams is 2.5 grams[6]. Biscuit quality requirements for fiber content do not exist, this shows that the fiber content is 4.87 g in the best treatment, namely P1 with a ratio of 90% mocaf flour and 10% tempeh flour which is one of the advantages of this tempeh mocaf biscuit.

CONCLUSION(S)

Based on the research results, data analysis and discussion described, it can be concluded that:

1. Biscuits with different ratios of mocaf flour and tempeh flour had a significant effect on organoleptic tests including color, aroma, taste, texture, overall acceptability, aroma quality test, and texture quality test.
2. The results of subjective analysis of mocaf flour biscuits and tempeh flour produced were color levels 3.37 – 4.16 (neutral-like), aroma 3.63 - 4.21 (like), taste 3.46 – 4.44 (neutral -like), texture 3.49 - 4.14 (neutral-like), overall acceptance rate 3.63 - 4.38 (like), aroma quality test 2.63 - 2.92 (not unpleasant), and aroma test texture quality 2.21 - 2.61 (slightly crunchy - crunchy).
3. The resulting mocaf flour and tempeh flour biscuits have met the Indonesian National Standard (SNI) with a moisture content of 2.85% - 3.84%, a protein content of the resulting biscuits of 8.16% - 13.28%, and the fiber content produced by the biscuits is 4.87% - 3.22%.
4. Based on the overall acceptance of mocaf flour biscuits and tempe flour with the most acceptable characteristics organoleptic, namely in treatment P1 with a ratio of 90% mocaf flour: 10% tempeh flour with characteristics of color, taste, aroma, texture and overall acceptance. One recipe produces 35 biscuits weighing 4 grams each. The nutritional content of 1 portion (40 grams) of P1 biscuits is 8.16 grams protein, 4.87 grams fiber. According to the RDA, adults, especially women aged 19-29 years, need 2250 kcal of energy, 60 grams of protein and 32 grams of fiber. So that mocaf flour and tempeh flour biscuits can meet 5.44% of protein needs, and 6.08% of fiber needs for snacks in a day (AKG, 2019).

Conflict of Interest

We all authors declare that there is no conflict of interest from this research activity.

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