Study of Mocaf Biscuits Made from a Combination of Bean Flour and Banana Puree Types

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Abstract. Mocaf (modified cassava flour) is a locally sourced ingredient that can be an alternative in making complementary biscuits. However, the low protein content in mocaf, it is necessary to add ingredients that contain high protein, one of which is beans. The addition of banana puree also intended to increase its nutritional content of biscuit because bananas contain inulin. The aims of this research were to investigated the influence of combination of bean flour and banana puree types to the chemical characteristics of mocaf biscuit. This study employed a Completely Randomized Design with two factors : bean flour types (soybean, mung bean, and red bean flour) and banana puree types (Raja, Ambon, and Nangka). It was observed that the proximate, calorie, total sugar, total dietary fiber (TDF) and inulin content of mocaf biscuit. The results showed that the bean flour and banana puree types had a significantly affected on the TDF and inulin content of mocaf biscuit. Mocaf biscuit which fullfilled SNI 01-7111.2-2005 for complementary biscuits was sample A2B3 (mung bean flour and Nangka banana puree) with 4.90% moisture content, 1.82% ash, 10.50% protein, 16.30% fat, 71.38% carbohydrate, 474.21 kcal/100g, 21.50% total sugar, 4.85% TDF and 1.77% inulin.
Keywords : mocaf biscuit, banana puree, bean flour

1 Introduction

Biscuits are often produced from wheat flour, sugar, and fat and have a low moisture content, allowing them to have a relatively long shelf life. When preparing complementary food biscuits, mocaf (modified cassava flour) can be used in place of wheat flour because it includes carbohydrates that can fulfill a toddler's energy requirements. In addition, the use

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of mocaf is also an effort to realize national food security due to the abundant availability of cassava in Indonesia. Cassava production in Indonesia ranks fifth in the world, namely 18.3 million tons in 2020 [1]. It is required to add additional ingredients with a high protein content because mocaf has a low protein content.

Bean is one of the native food products that can be utilized as an ingredient for biscuits owing to the high protein content, which ranges between 20-40%. Several types of beans which production is quite high in Indonesia are soybean, mung bean and red bean, namely 613,300 tons in 2020, 234,718 tons in 2018 and 100,316 tons in 2017, respectively [2–4]. Banana (*Musa spp*.) is a tropical fruit that is widely cultivated in Indonesia. Banana production in Indonesia was estimated to have reached 8.74 million tons in 2021 [5]. Bananas can also be added to make biscuits because apart from adding to the aroma and taste of biscuits, bananas also contain nutrients that are good for health, one of which is inulin. Bananas have an inulin value of 0.3-0.7 g/100 g, while banana flour has an inulin level of 0.9-2.0 g/100 g [6]. Inulin and oligo fructose can function as prebiotics which can reduce the amounts of pathogenic bacteria in the digestive system.

Some previous studies on mocaf biscuits that have been carried out include the addition of spinach, anchovy flour, moringa flour, catfish flour, mango flour, soybean flour, pumpkin flour, liver, pumpkin puree and carrots [7–13]. However, none of these studies have formulated biscuits for toddlers. The purpose of this study was to look into the impact of the combining of types of bean flour and banana puree on the mocaf biscuit's chemical qualities as complementary food. The chemical properties of mocaf biscuit observed include proximate, calorie, total sugar, total dietary fiber and inulin content.

2 Materials and method

2.1 Materials

SME Harapan Jaya in Subang provided the modified cassava flour (Mocaf). From a local market in Subang, three varieties of banana, including Raja, Ambon, and Nangka, as well as soybeans (*Glycine max*) and mung beans (*Vigna radiata*), were bought. *Phaseolus vulgaris* L., sometimes known as red beans, were bought in a local market in Lembang. Egg yolk, powdered sugar, baking powder (Koepoe-Koepoe), unsalted butter (Anchor), and lecithin were additional components used to make biscuits.

2.2 Bean flour preparation

The seeds were sorted, cleaned, and soaked in water between 60° and 70°C for for 3 h before being dehulled and dried in a cabinet dryer for 12 h at 50°C. The dried seeds were processed in a disc mill and put through a 40 Mesh sieve to make bean flour.

2.3 Production of mocaf biscuits

The biscuit formula is provided in Table 1. It was made in accordance with the procedure used by Ratnawati *et al.* [12]. To create the dough, the components are combined with a mixer. Using a dough sheeter, the dough was sheeted to a 7 mm thickness. The dough was spread out on a baking sheet and baked for 10 mins at 150°C. The biscuit was then turned

over and cooked for another 20 to 30 mins at 100°C. The biscuit was set in a container and stored at ambient temperature for additional testing after cooling for 5 mins.

2.4 Analysis of mocaf biscuits

The amount of moisture, ash, and fat in the biscuit was measured using the AOAC technique [14]. To calculate the protein content, a DuMaster protein analyzer (D-480, Buchi, Switzerland) was utilized. The overall carbohydrate content was established using differences. Total energy was defined using the following calorie coefficients: proteins (4 kcal/g), carbs (4 kcal/g), and fat (9 kcal/g) [15]

The Luff Schoorl technique was used to determine the biscuit's total sugar content [16] . The biscuits' total dietary fiber (TDF) content was assessed using AOAC techniques [17]. The inulin content was measured using an Agilent 1260 Infinity II HPLC (Agilent USA, Santa Clara) equipped with a Metacharb 87C column. With slight modifications, the technique reported by Bekers *et al.* [18] was used to extract inulin.

2.5 Statistical analysis

A completely randomized design was applied in this experiment. The acquired data was examined using analysis of variance (ANOVA) in SPSS version 13. Then, Duncan's test was applied to find out whether the data differences were significant. The results are shown mean standard deviation (SD), with each measurement being done in triplicate. The optimum treatment was chosen using the De Garmo effectiveness index [19]. The steps involved in determining the result value (Nh) are as follows: determining the variable weight value (BV) based on respondents' evaluations of each variable's level of relevance, determining the effectiveness value (Ne) by dividing the difference in treatment value and the smallest value by the difference in treatment value and the highest value, determining the result value (Nh) of each variable obtained by multiplying the weight value (BV) by the effectiveness value (Ne).

3 Results and discussion

3.1 Mocaf biscuits' content for proximate and calorie

Table 2 provides the proximate and calorie content of the biscuit. The findings reveal that bean flour type had significance effect on the moisture content ($p<0.05$) while banana puree type had no significant impact ($p>0.05$). The range of the biscuit's moisture content, 4.55–5.72%. In this study, only the biscuit samples A2B1, A2B3, A3B1, and A3B2 met the requirements of the SNI 01-7111.2-2005 for complementary food, which is that biscuits have a maximum moisture content of 5% [20]. Meanwhile, other samples were higher than this value. The moisture content of the raw material has an impact on the moisture content of the end product. According to Hapsari *et al*. [22] and Hasanah *et al.* [23] that moisture content of Raja, Ambon and Nangka banana were 74.39, 72.94 and 77.54%, respectively. In addition, the moisture content of soybean, mung bean and red bean flour were 7.49, 5.63 and 7.60% [21,22].

Table 2 shows that the bean flour type had significance effect on the ash content ($p<0.05$). The total amount of ash indicates the minerals content in a material. The range of ash content of sample were from 1.82 to 2.51%. These value higher than the ash content of biscuits made from a mixture of banana flour and 10% pigeon pea (2.23%) [23]. The ash content of samples complies with SNI 01-7111.2-2005 because the value is not more than 3.5% [21]. Biscuits made from soybean flour have a higher ash content than mung bean and red bean. According to Ratnawati *et al.* [24], the amount of ash content in soybean, mung bean, and red bean flour was 4.23, 2.70, and 2.70%, respectively. Meanwhile, the ash content of Raja, Ambon and Nangka were 0.9, 0.78 and 0.82% [24,25].

According to Table 2, the findings of the statistical analysis ($p<0.05$) revealed that the kind of bean flour had a true influence on the protein content of biscuits. Meanwhile, the variety of banana puree had no impact on protein content ($p>0.05$). The protein content of biscuits were 9.98-13.50 % and this value in accordance with SNI 01-7111.2-2005 for biscuit as complementary food in which requires that the minimum protein content is 6% [20]. The protein content of soybean flour biscuits was greater than that of mung bean and red bean flour biscuits. It is due to soybean flour having a higher protein level than the other two types of bean flour. Soybean, mung bean, and red bean flours had protein contents of 40.94%, 24.99%, and 22.53%, respectively [21].

From the result in Table 2 it was found that bean flour type had significantly affected on the samples' fat content ($p<0.05$), but the banana puree type had no significantly affect. The fat content of sample ranged between 15.13-21.56%. From the all treatments, mocaf biscuits made from soybean flour were not in accordance with Indonesian National Standards requires a maximum fat level of 18% in biscuits as a complementary food [20]. It is due to the fat level of soybean flour was higher than mung bean and red bean flour. Fat content of soybean, mung bean and red bean flour were 25.01, 1.31, and 1.11%, respectively [21].

Table 1. Proximate and calorie content of mocaf biscuit

Type of bean flour	Type of banana puree	Parameter					
		Moisture content (%)	Ash (%, db)	Protein (%, db)	Fat (%, db)	Carbohydrate (%, db)	Calorie (kcal/100g)
A1	B1	**5.72 ± 0.03^{Ba}**	**2.51 ± 0.02^{Ca}**	**13.29 ± 0.97^{Ba}**	**20.79 ± 0.02^{Ca}**	**63.41 ± 0.95^{Aa}**	**493.90 ± 0.04^{Ca}**
	B2	**5.27 ± 0.08^{Ba}**	**2.24 ± 0.06^{Ca}**	**13.22 ± 1.05^{Ba}**	**21.56 ± 0.03^{Ca}**	**62.98 ± 1.14^{Aa}**	**498.82 ± 0.17^{Ca}**
	B3	**5.56 ± 0.03^{Ba}**	**2.29 ± 0.05^{Ca}**	**13.50 ± 1.39^{Ba}**	**21.05 ± 0.02^{Ca}**	**63.16 ± 1.34^{Aa}**	**496.09 ± 0.19^{Ca}**
A2	B1	**4.55 ± 0.02^{Aa}**	**1.92 ± 0.03^{Aa}**	**10.26 ± 0.26^{Aa}**	**15.22 ± 0.03^{Ba}**	**72.60 ± 0.27^{Ba}**	**468.45 ± 0.22^{Ba}**
	B2	**5.41 ± 0.16^{Aa}**	**1.96 ± 0.05^{Aa}**	**10.61 ± 0.04^{Aa}**	**16.09 ± 0.04^{Ba}**	**71.34 ± 0.12^{Ba}**	**472.61 ± 0.24^{Ba}**

	B3	**4.90 ± 0.15^{Aa}**	**1.82 ± 0.10^{Aa}**	**10.50 ± 0.14^{Aa}**	**16.30 ± 0.08^{Ba}**	**71.38 ± 0.24^{Ba}**	**474.21 ± 0.44^{Ba}**
A3	B1	**4.88 ± 0.19^{Aa}**	**2.02 ± 0.02^{Ba}**	**9.98 ± 0.14^{Aa}**	**15.39 ± 0.04^{Aa}**	**72.61 ± 0.12^{Ca}**	**468.86 ± 0.24^{Aa}**
	B2	**4.67 ± 0.11^{Aa}**	**2.01 ± 0.04^{Ba}**	**10.15 ± 0.08^{Aa}**	**15.46 ± 0.04^{Aa}**	**72.37 ± 0.10^{Ca}**	**469.26 ± 0.32^{Aa}**
	B3	**5.38 ± 0.31^{Aa}**	**1.99 ± 0.08^{Ba}**	**10.17 ± 0.18^{Aa}**	**15.13 ± 0.06^{Aa}**	**72.71 ± 0.25^{Ca}**	**467.73 ± 0.26^{Aa}**

By using the DMRT test, different uppercase at various columns shows a significant difference ($p<0.05$).
By using the DMRT test, different lowercase within the same column shows a significant difference ($p < 0.05$).

As shown in Table 2, the statistical evaluation indicated that the bean flour type had a true influence on the carbohydrate level of the biscuits ($p<0.05$), but the banana puree type had no effect. Mocaf biscuits have carbohydrate contents ranging from 62.98 to 72.71%, close to the carbohydrate content of banana flour biscuits substituted with pigeon pea and sweet potato flour (10:10:80), namely 62.46% [23]. Calculation of carbohydrates in this study was based on restrictions of other components, namely moisture, ash, protein and fat content. Carbohydrate content is inversely proportional to other contents. As a result, if the content of these components is large, the carbohydrate content is low.

Based on Table 2, calorie content of biscuits varied from 467.73-498.82 kcal/100g, it was highest in A1B2 and lowest in A2B1 samples. The SNI 01-7111.2-2005 requires that biscuit as complementary food must have a calorie content of not less than 400 kcal/100 g [20]. The mocaf biscuit in this study complies with SNI because the calorie content is more than 400 kcal/100 g. The varieties of bean flour and banana puree had a considerable influence on the calorie level of the biscuit. Mocaf biscuit with addition soybean flour had highest calorie content. This is due to the protein and fat level of mocaf biscuits with the supplementation of high soybean flour which contributes to the calorie calculation. Those values are higher compared to 349.4 kcal/100 g found in biscuit [22].

3.2 Total sugar, total dietary fiber and inulin content of mocaf biscuits

As shown in Table 3, the statistical analysis revealed that the bean flour type had a real influence on the total sugar of mocaf biscuits ($p<0.05$), however, the banana puree type had no real effect. The range of total sugar of mocaf biscuit were from 20.86 to 22.38%. Biscuits made from soybean flour and Raja banana puree had the greatest amount of total sugar. Total sugar of Raja, Ambon and Nangka banana were 20.82, 20.41 and 19.91%, respectively [26–28]. Meanwhile, the bean flour type treatment showed that mocaf biscuits made from red bean flour tended to have lower total sugar than biscuits made from soybean and mung bean flour. Total sugar of soybean, mung bean and red bean were 11.7, 7.2 and 8%, respectively [29]. The total sugar of mocaf biscuits is in accordance with SNI 01-7111.2-2005 which is less than 30% [20].

Table 2. Total sugar, total dietary fiber (TDF) and inulin content of mocaf biscuit

Type of bean flour	Type of banana puree	Parameter		
		Total Sugar (%, db)	TDF (%, db)	Inulin (%, db)
A1	B1	**22.38 ± 0.23^{Ba}**	**8.65 ± 0.23^{Ca}**	**0.99 ± 0.04^{Aa}**
	B2	**22.06 ± 0.25^{Ba}**	**11.01 ± 0.10^{Cb}**	**0.90 ± 0.03^{Ab}**
	B3	**22.26 ± 0.61^{Ba}**	**12.05 ± 0.20^{Cc}**	**0.82 ± 0.02^{Ab}**
A2	B1	**21.75 ± 0.42^{ABa}**	**6.56 ± 0.22^{Ac}**	**0.63 ± 0.04^{Ba}**
	B2	**21.83 ± 0.29^{ABa}**	**6.16 ± 0.13^{Ab}**	**1.85 ± 0.08^{Bb}**
	B3	**21.50 ± 0.40^{ABa}**	**4.85 ± 0.22^{Aa}**	**1.77 ± 0.06^{Bb}**
A3	B1	**21.32 ± 0.54^{Aa}**	**8.98 ± 0.26^{Bc}**	**2.05 ± 0.02^{Ca}**
	B2	**21.34 ± 0.35^{Aa}**	**7.34 ± 0.13^{Bb}**	**2.63 ± 0.05^{Cb}**
	B3	**20.86 ± 0.64^{Aa}**	**5.62 ± 0.24^{Ba}**	**1.43 ± 0.07^{Cb}**

By using the DMRT test, different uppercase at various columns shows a significant difference ($p<0.05$).
By using the DMRT test, different lowercase within the same column shows a significant difference ($p < 0.05$).

According to Table 3, TDF content of biscuit ranged between 4.85 to 12.05% with the highest TDF content is A1B3 sample (biscuit made from soybean flour and Nangka banana puree). Biscuits made from soybean flour have a higher TDF content (13.20%) than other bean flours, and also higher than biscuits made from 10% soybean flour, banana flour and sweet potato flour reported by Adeola and Ohizua [23], namely 11.73%. The TDF of soybean, mung bean and red bean flour are 9.89, 7.13 and 6.57% [21,30] The TDF content of banana is 1.79% [30]. According to Indonesian National Standards, total dietary fiber that is permitted in complementary food products is a maximum of 5%. From these requirements, only the A2B3 sample complied with the SNI 01-7111.2-2005 because the TDF content was less than 5% [20].

Table 3 shows that bean flour and banana puree types were significantly effect ($p<0.05$) on the inulin content of mocaf biscuit. In this study, the mocaf biscuit made from red bean flour and Ambon banana puree (A3B2) produced the highest inulin content. Inulin is present in ripe bananas ranging from 0.58 – 1.09% [31]. Inulin-type fructans, according to Teferra [31] are resistant to digestion by human enzymes and are primarily fermented in the colon by health-promoting bacteria. The inulin content in the current biscuits is lower than that of the banana bar product studied by Sarifudin *et al.* [32] which ranged from 2.57 to 4.10%.

3.3 The optimum treatment determination

The effectiveness index approach was used to select the optimum treatment based on the greatest overall result value (Nh) by taking into account their moisture, ash, protein, fat, carbohydrate, calorie, total sugar, TDF, and inulin content. Assessment of smaller better for parameters of moisture content, ash, fat, total sugar and TDF content, while the assessment of higher smaller for parameters of protein, carbohydrate, calorie and inulin content. Based on Table 4, it suggested that A2B3 samples (mocaf biscuit made from mung bean flour and Nangka banana puree) was the best treatment. The optimal treatment had 4.90% moisture content, 1.82% ash, 10.50% protein, 16.30% fat, 71.38% carbohydrate, 474.21 kcal/100g, 21.50% total sugar, 4.85% TDF and 1.77% inulin.

Table 3. Determination of the optimum treatment with effectiveness index

Samples	∑Nh	Ranking
A1B1	**0.29688**	**9**
A1B2	**0.37831**	**7**
A1B3	**0.31585**	**8**
A2B1	**0.59942**	**2**
A2B2	**0.52259**	**6**
A2B3	**0.60555**	**1**
A3B1	**0.53418**	**5**
A3B2	**0.56671**	**4**
A3B3	**0.57782**	**3**

4 Conclusion

The findings demonstrated a strong relationship between the types of bean flour and banana puree on the TDF and inulin content of mocaf biscuits. Based on effectiveness index using De Garmo, the best mocaf biscuit were those made from mung bean flour (20%) and Nangka banana puree (14%). The selected biscuit formula in this study also fulfilled SNI 01-7111.2-2005 for biscuit as complementary food in terms of moisture, ash, protein, fat, calorie, total sugar and TDF content.

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