Physicochemical characteristics and sensory muffins from mocaf, orange sweet potato flour, breadfruit flour, orange sweet potato starch, and breadfruit starch

M R Fahlevi¹, M Nurminah¹,²* and R J Nainggolan¹

¹Department of Food Science and Technology, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Indonesia.
²Center for Tubers and Roots Crop Study, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Indonesia.

E-mail: *miminurminah@usu.ac.id or mimisinaga@yahoo.co.id

Abstract. The purpose of this study was to determine the physicochemical and sensory characteristics of muffins produced from mocaf, orange sweet potato flour, breadfruit flour, orange sweet potato starch, and breadfruit starch with various comparisons. A non-factorial completely randomized design (CRD) was used to make muffin from formulation of mocaf, orange sweet potato flour, breadfruit flour, orange sweet potato starch, and breadfruit starch (P) with ratio of 70%:15%:5%:5%, 60%:20%:10%:5%, 50%:25%:15%:5%, 40%:30%:20%:5%, 30%:35%:25%:5%, 20%:40%:30%:5%, 10%:45%:35%:5% and 100% wheat flour (control) which showed a very significant effect on the L value (brightness), ash content, protein content, crude fibre content, organoleptic colour, aroma, taste, and texture. The best quality muffin produced from the composite flour 50% mocaf, 25% orange sweet potato flour, 15% breadfruit flour, 5% orange sweet potato starch and 5% breadfruit starch.

1. Introduction

The increasing public consumption of "introduced" foods such as noodles, pasta, pizza, bakery products (bread, biscuits, cookies or muffins) threatens national food security. This is due to the use of wheat flour as a raw material, in 2017 the import volume of wheat flour increased by 9% from the previous year to 11.48 million tons [1]. Muffin is an introduced food that is preferred by the public. The muffin is classified as quick bread because the processing process is not fermented [2]. The characteristic of muffins is that the crust surface is golden brown, the crumb pores are not uniform, and it is not too fluffy because the muffins usually use medium or low quality flour with a protein content of around 8%-10% [3,4]. To reduce the volume of wheat flour imports, there need to replace the wheat flour with mocaf (modified cassava flour), orange sweet potato flour, and breadfruit flour.

Mocaf (Modified Cassava Flour) is flour made from modified cassava cells by fermentation using lactic acid bacteria (LAB) [5]. Mocaf can be used as a food ingredient or as a raw material for noodles, bakeries, cookies, and semi-wet foods. Moreover, orange sweet potato flour can be used as a substitute in making ice cream, dry noodles, bread, and cookies at 15%, 20%, 50%, 100% respectively [6]. In addition, bread fruit can also be applied to various products without
changing nutritional content [7]. The aim of this research was to know the physicochemical and sensory characteristics of muffin formulation and to find the best formulation for making muffin.

2. Materials and methods
This research was conducted at the Foodstuff Chemical Analysis Laboratory and Food Technology Laboratory, University of North Sumatra. Mocaf was obtained from Bakery Innovation, Orange Sweet Potatoes, and Breadfruit from Pasaraya MMTC, Medan.

Process producing muffin refer to [8] with a few modifications to the roasting temperature to 180°C for 20 minutes.

This study consisted of 1 control (100% wheat flour) and 7 treatment comparisons of mocaf, orange sweet potato flour, breadfruit flour, orange sweet potato starch, and breadfruit starch, namely:

- \( P_1 \) = 70%: 15%: 5%: 5%: 5%
- \( P_2 \) = 60%: 20%: 10%: 5%: 5%
- \( P_3 \) = 50%: 25%: 15%: 5%: 5%
- \( P_4 \) = 40%: 30%: 20%: 5%: 5%
- \( P_5 \) = 30%: 35%: 25%: 5%: 5%
- \( P_6 \) = 20%: 40%: 30%: 5%: 5%
- \( P_7 \) = 10%: 45%: 35%: 5%: 5%
- \( P_8 \) = 100% wheat flour (control)

Each treatment was made in 3 replications, so that the total sample size was 24 samples.

Analyse colour (brightness) using a Minolta chromameter (type CR 200, Japan) [9], ash content using ashing of dry [10], protein content using the Kjeldahl method [11], crude fibre content is done using the crude fibre method [12], sensory analysis in this study uses a hedonic rating test 1 - 7 (very dislike, do not like, rather dislike, neutral, rather like, like, really like), and de-Garmo method to determine the best muffin [13].

3. Results and discussion

3.1 Brightness

![Figure 1](image.png)

**Figure 1.** The relationship between the ratio of composite materials to muffin brightness.

Description:  
- \( P_1 \) = 70%: 15%: 5%: 5%: 5%  
- \( P_2 \) = 60%: 20%: 10%: 5%: 5%  
- \( P_3 \) = 50%: 25%: 15%: 5%: 5%  
- \( P_4 \) = 40%: 30%: 20%: 5%: 5%  
- \( P_5 \) = 30%: 35%: 25%: 5%: 5%  
- \( P_6 \) = 20%: 40%: 30%: 5%: 5%  
- \( P_7 \) = 10%: 45%: 35%: 5%: 5%  
- \( P_8 \) = 100% wheat flour (control)

The addition of more orange sweet potato flour caused the decrease in brightness (Figure 1). The reduction might be due to a decrease in the proportion of mocaf used, but the proportion of orange
sweet potato flour and breadfruit flour increased so that the resulting muffin colour was slightly pale yellow to brownish yellow. In contrast, muffin made of 100% wheat flour had the highest brightness reaching to 66.33%. This is in accordance with Yuliana, et al. [14], mentioning that the high sugar content in orange sweet potato flour and breadfruit flour can cause browning reactions in the resulting products.

3.2 Ash, protein and crude fibre content

Figure 2 present ash (a), protein (b) and crude fibre content (c) of the muffin. The analysis showed that P7 had the highest ash content, namely 2.21%, while P8 (control) had the lowest ash content, namely 1.81%. The ash content of muffins is influenced by the mineral content of the raw materials used. The increase in ash content of P1 – P7 muffins was caused by the proportion of adding orange sweet potato flour and breadfruit flour in each treatment. Oke and Workneh (2013) [15], state that orange sweet potato contains minerals such as copper, calcium, potassium, and iron which are quite high. In addition, breadfruit flour contains minerals and vitamins that are more complete than rice [16].

Figure 2. The relationship between the ratio of composite materials to the ash (a), protein (b) and crude fibre (c) content of the muffins.

Description :  

P1 = 70%: 15%: 5%: 5%: 5%  
P2 = 60%: 20%: 10%: 5%: 5%  
P3 = 50%: 25%: 15%: 5%: 5%  
P4 = 40%: 30%: 20%: 5%: 5%  
P5 = 30%: 35%: 25%: 5%: 5%  
P6 = 20%: 40%: 30%: 5%: 5%  
P7 = 10%: 45%: 35%: 5%: 5%  
P8 = 100% wheat flour (control)
In terms of protein content, muffin made from 100% wheat flour had the highest protein. In contrast, the lowest protein content was found in muffin with more mocaf compared to the others. The difference in protein content related to the protein content of the raw materials. Wheat flour contains gluten which is a type of natural protein that is insoluble in water, while orange sweet potato flour and breadfruit flour have lower protein content [17]. Although mocaf has physical characteristics that are almost similar to wheat flour, mocaf has low protein compared to wheat flour.

Similar to ash content tendency, the lowest crude fibre content was obtained from muffin with 100% wheat flour. The addition of mocaf increased the crude fibre, in which more mocaf resulted in the decrease of protein. According to Pradipta and Putri (2015) [18], that wheat flour has low fibre content due to its processing.

3.3 Organoleptic analysis

Figure 3. The relationship between the ratio of composite materials hedonic colour (A), aroma (B), taste (C) and texture (D) of the muffin.

Description:

| Description | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 |
|-------------|----|----|----|----|----|----|----|----|
| P1 = 70%: 15%: 5%: 5%: 5% | 5.46 | 5.65 | 5.86 | 5.65 | 4.82 | 4.63 | 4.31 | 6.30 |
| P2 = 60%: 20%: 10%: 5%: 5% | 5.23 | 5.65 | 5.86 | 5.65 | 4.91 | 4.63 | 4.31 | 5.94 |
| P3 = 50%: 25%: 15%: 5%: 5% | 5.29 | 5.65 | 5.86 | 5.65 | 4.91 | 4.63 | 4.31 | 5.94 |
| P4 = 40%: 30%: 20%: 5%: 5% | 5.29 | 5.65 | 5.86 | 5.65 | 4.91 | 4.63 | 4.31 | 5.94 |
| P5 = 30%: 35%: 25%: 5%: 5% | 5.29 | 5.65 | 5.86 | 5.65 | 4.91 | 4.63 | 4.31 | 5.94 |
| P6 = 20%: 40%: 30%: 5%: 5% | 5.29 | 5.65 | 5.86 | 5.65 | 4.91 | 4.63 | 4.31 | 5.94 |
| P7 = 10%: 45%: 35%: 5%: 5% | 5.29 | 5.65 | 5.86 | 5.65 | 4.91 | 4.63 | 4.31 | 5.94 |
| P8 = 100% wheat flour (control) | 5.29 | 5.65 | 5.86 | 5.65 | 4.91 | 4.63 | 4.31 | 5.94 |

Figure 3 shows the organoleptic values of colour (a), aroma (b), taste (c) and texture (d) of the muffin. The panellist gave the highest scores for muffin made 100% wheat flour. The panellist preference scores on muffin colour increased with replacement of orange sweet potato up to 35% (P1 –
P1). The use of low mocaf caused the result of muffin colour become darker, then the high sugar content in orange sweet potato and breadfruit caused a Maillard reaction that effects the brightness of muffin. However, the addition of more sweet potato flour resulted in the decrease in colour preference. According to Winarno (2004) [19], colour is an important attribute in food products, because the most important thing done by panellist in assessing a food product is its visual appearance.

For aroma, the highest value was found in muffin with 50% mocaf, 25% orange sweet potato and 15% breadfruit flours, followed by the muffin made 100% wheat flour. The lowest score for preference was obtained in muffin with the addition of mocaf, sweet potato and breadfruit flours (P6). On muffins P1 – P3, the panellist preference for aroma increased, but on muffins P4 – P7 the panellist preference for aroma decreased. The high carbohydrate content in the composite material causes the Maillard reaction, so that when roasting it produces volatile compounds [20]. This is in accordance with Sasmita, et al. (2007) [21] which stated that breadfruit flour is caused by volatile compounds attached to it even though it has been pretreated.

For taste, muffin with 100% wheat flour had the highest taste value. The score ranged from 4.31 to 6.12 indicating that the panellist mostly like the muffin. The panellist preferred muffin with the addition up to 25% of sweet potato and the panellist preference score decreases from P4 – P7.

For texture highest texture score was found in muffin with 100% wheat flour and the lowest obtained from the addition of 10% mocaf, 45% sweet potato and 35% breadfruit flours. Meanwhile, muffin made of 40% mocaf was the maximum point of the panellist preference score for the muffin texture. Nindriyani, et al. (2011) [22], stated that the starch content of flour affects the physical properties of the product, starch plays an important role due to its gelatinization and retrogradation properties. P8 (100% wheat flour) has the highest preference response from panellist, the gluten content in wheat flour caused the dough to be more compact, so that the muffin has a texture that is liked by panellist.

4. Conclusions
The results showed that the muffins with the ratio of composite ingredients (50%mocaf, 25% orange sweet potato flour, 15% breadfruit flour, 5% orange sweet potato starch and 5% breadfruit starch) produced the best quality muffin.

References
[1] The Indonesian Wheat Flour Association 2017 Import of Indonesian Flour (Jakarta: APTINDO)
[2] Smith JS and Hui YH 2004 Food Processing: Principles and Applications (New York: Wiley-Blackwell)
[3] Vail GE, Philips JA, Rust LO, Griswold RM and Justin M 1978 Foods 7th ed (Boston: Houghton Mifflin Company) p 277
[4] Baixauli R, Sanz T, Salvador and Fiszman A 2008 Muffins with resistant starch: Baking performance in relation to the rheological properties of the better J. Cereal Sci. 47
[5] Nia A, Herlina P and Subagio A 2018 Karakteristik mocaf berdasarkan metode penggilingan dan lama fermentasi [Characteristics of mocaf (modified cassava flour) based on milling method and fermentation time] J.Agrotechnology
[6] Ginting, Erliana, Joko S, Utomo, Yullfianti R and Jusuf M 2011 Potensi ubi jalar ungu sebagai pangan fungsional [Potential of purple sweet potatoes as functional food] J. Food Crop Science and Technology.
[7] Waryat, Muflihani Y and Yossi H 2014 Diversifikasi pangan dari tepung sukun untuk mengurangi konsumsi tepung terigu di Kepulauan Seribu, Provinsi DKI Jakarta [Diversification of food from breadfruit flour to reduce consumption of wheat flour in the Thousand Islands, DKI Jakarta Province] Urban Agriculture Bulletin 41 p 13
[8] Eko HP, Sitanggang AB, Agustin DS, Hariyadi P and Hartono S 2012 Formulation and process optimization of muffin produced from composite flour of corn, wheat and sweet potato J. Technol and Food Industry 2 p 1
[9] Hutching JB 1999 *Food Colour and Apearance* (Maryland: Aspen publisher Inc)
[10] Sudarmadji S, Haryono B and Suhardi 1997 *Prosedur Analisa untuk Bahan Makanan dan Pertanian [Analysis Procedure for Food and Agricultural Material]* (Yogyakarta: Liberty)
[11] AOAC 1995 *Official Methods of Analysis of AOAC International* (Washington DC: Association of Official Analytical Chemist)
[12] Apriyantono A, Fardiaz D, Puspitasari NL, Sedarnawati Y and Budianto S 1989 *Food Analysis Laboratory Guidelines* (Bogor: Bogor Agricultural Institute)
[13] De Garmo EP, Sullivan WG and Canada JR 1984 *Engineering Economy Sevench Edition* (New York: Macmillan Pub. Co.)
[14] Yuliana N, Nurdjanah S, Sugiharto R and Amethy D 2014 Effect of spontaneous lactic acid fermentation on physico-chemical properties of sweet potato flour *Microbiology Indonesia* 8 p 1
[15] Okay MO and Workneh TS 2013 A review on sweet potato postharvest processing and preservation technology *African J. Agricultural Research* 8 p 4990
[16] Suyanti S, Widowati and Suismono 2003 Teknologi pengolahan tepung sukun dan pemanfaatannya untuk berbagai makanan olahan [Breadfruit flour processing technology and its use for various processed food products] *J. Agricultural Development Research Journal* 2 p 12
[17] Nurminah M, Ginting S and Sitorus CJ 2019 Physicochemical properties of egg roll from composite flour of wheat and purple fresh sweet potato *IOP Ser Earth Environ Sci* 012029
[18] Pradipta IBYV and Putri WDR 2015 Pengaruh proporsi tepung terigu dan tepung kacang hijau serta substitusi dengan tepung bekatul dalam biskuit [The effect of the proportion of wheat flour and green bean flour and its substitution with bran flour in biscuits] *J. Food and Agroindustry* 3 p 793
[19] Winarno FG 2004 *Kimia Pangan dan Gizi [Food Chemistry and Nutrition]* (Jakarta: Gramedia Pustaka Utama)
[20] S Nurdjanah, Yuliana N, Zuidar AS and Naim IE 2017 The Characteristic of Muffin from Resistant Starch-Rich Purple Sweet Potato Flour *J. Agroindustry Technology* 9 p 1
[21] Fauzi AA, Muhsin and Sakina A 2016 The Effect of breadfruit soaking solution variations on the physicochemical characteristics of breadfruit flour *J. Agricultural Technology Education* 2 p 79
[22] Nindyarani, Krisna A, Sutardi and Suparno 2011 Karakteristik kimia, fisik dan inderawi tepung ubi jalar ungu (*Ipomoea batatas poiret*) [Chemical, physical, and sense characteristics of purple sweet potato flour (*Ipomoea batatas poiret*) and its processed products] *J. AGRITECH* 31 p 273