Physicochemical and sensory characteristics of brownies from composite flour (modified breadfruit, purple sweet potato, saga seeds, and mocaf)

D R K Lubis 1, M Nurminah 1,2* and R J Nainggolan 1,2

1 Department of Food Science and Technology, Faculty of Agriculture, Universitas Sumatera Utara, Medan, North Sumatra 20155, Indonesia
2 Centre for Tubers and Roots Crop Study, Faculty of Agriculture, Universitas Sumatera Utara, Medan, North Sumatra 20155, Indonesia

*E-mail: miminurminah@usu.ac.id

Abstract. Breadfruit is a plant that has potential as a national food security reserve because breadfruit is able to produce throughout the year, breadfruit is also a vegetable food ingredient that contains a lot of carbohydrates. Purple sweet potato can improve the taste of food processing products, because of its distinctive purple color, and high nutritional content. Saga seeds are high protein-producing plants concurrently increasing the nutritional value of food, and mocaf is the result of cassava fermentation by special enzymes that produce products that have characteristics such as wheat flour and have the potential as a food substitute for wheat flour. In this study, producing brownies from various composite flour to develop food diversity in Indonesia. The final results of the study showed that composite flour (modified breadfruit, purple sweet potato, saga seeds, and mocaf) with a ratio of 35%: 45%: 15%: 5% produced the best quality brownies in terms of hedonic values (taste, aroma, color, texture, general acceptance), water content, ash content, fat content, protein content, and fiber content.

1. Introduction
Brownies are chocolate cakes with sweet taste, attractive colors, delicious aromas, and not too fluffy texture. Brownies are included in a kind of blackish-brown cake and slightly harder texture. Brownies have a harder texture than cakes because they do not require the development of gluten so they can be substituted with other flour. In making these brownies, brownies are substituted with some flour, namely modified breadfruit flour, purple sweet potato flour, saga seed flour, and mocaf. Breadfruit is also a vegetable food that contains a lot of carbohydrates [1]. In the modification of breadfruit flour, the modification used with the addition of acetic acid can make breadfruit flour more swollen and bind less water, there by improving undesirable characteristics [2]. Utilization of purple sweet potato flour can improve the taste in food processing products, because of its distinctive purple color, and a different taste from ordinary brownies and increased nutritional content [3]. Saga seeds contain 48.2% protein content so that as an alternative food enhancing nutritional content in brownies [4]. Other researchers also used mocaf as a substitute for wheat flour, quality brownies that use mocaf with the addition of other composite flour, can increase the nutritional value of brownies, and the addition of mocaf flour to brownies can as an alternative to food products also minimize the use of wheat flour, and food diversification by utilizing local resources optimally [5,6].
2. Materials and Method
This research was conducted at the Laboratory of Food Chemical Analysis and Food Technology and Food Technology Study Program, Faculty of Agriculture, University of North Sumatra, Medan, mocaf obtained from Bakery Innovations, purple sweet potato obtained from Pasaraya MMTC, saga seeds obtained from the area University of North Sumatra and breadfruit obtained from Setia Budi, Medan.

Making brownie is done by flour and mixed according to treatment. Other ingredients are prepared and weighed accurately, the ingredients are sugar 50g, eggs 35g, vegetable oil 70g, margarine 1g, chocolate bar 70g, cocoa powder 20g, baking powder 2 mg. Put all the ingredients, pour the better in the pan, steamed 150°C, 60 minutes, then packaged in a sealed polyethylene plastic package. This research was made with The four controls and four comparative treatments, namely: P1 = 100% wheat flour (Control 1), P2 = 100% modified breadfruit flour (Control 2), P3 = 100% purple sweet potato flour (Control 3), P4 = 100% mocaf (Control 4), P5 = 50: 30: 20: 0, P6 = 45: 35: 15: 5, P7 = 40: 40: 10: 10, P8 = 35: 45: 5: 15. Each treatment was made in 3 replications, so that the total sample size was 24 samples.

Analysis of water content analysis is done using the oven method [7], ash content using ashing of dry [8], crude fiber content is done using the crude fiber method [9], fat content is done with boiling flask [10], sensory analysis in this study uses a hedonic rating test 1-7 (very dislike, do not like, rather dislike it, neutral, rather like, like, really like), specific volume is done by the displacement test method [12], and color (brightness) uses the chromameter Minolta (Type CR 200, Japan) [13], the de-Garmo method to determine the best brownies [14].

3. Results and Discussion

3.1. Water content
The results showed that P8 brownie had the highest moisture content, namely 49.191% and P3 brownie had the lowest water content, namely 32.654%. This is because P8 brownies are brownies using composite flour, because several factors can affect the moisture content of a food ingredient, namely types of components, which are in the material such as tools, temperature, thickness of the material, and cooking time. According to Prayitno, et al. (2018) [15], the high water content of brownies is caused by the brownie cooking system using a steamer without a drying process, so that when steaming, the large number of drops of water that falls on the brownies affects the amount of water that evaporates because it dissolves in brownie cakes.

![Figure 1. The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to moisture content (error bar=standard deviation)]
Brownies have a lower water content according to Nindyrani, et al [16], this indicates that the condition of the product is dry enough so that the quality is good, and is due to the evaporation of water in the product. The results of the study the brownie moisture content had met the set standards, the quality requirements for the maximum water content of 65%, while in this study the water content ranged from 32.654%-49.191% so that it met the SNI set for brownies.

3.2. Ash content
The results showed that P7 brownie had the highest ash content, namely 2.443% and P5 brownie had the lowest ash content, namely 0.163%. This can be due to differences in the ash content in different mineral content of each raw material, so that inorganic or mineral components are mixed in a food ingredient. This is in accordance with Alam et al. [17] which states that high ash content can be due to different mineral content of each raw material used, while low ash content can be caused by the flour processing process which goes through the washing and soaking stages. Washing can cause mineral dissolution in water. The washing process can cause the minerals to dissolve in the water. The decrease in the ash content causes evaporation during the ashing process.

![Figure 2. The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to ash content](image)

3.3. Protein content
The results showed that P8 brownies had the highest protein content, namely 5.792% and P4 brownies had the lowest protein content, namely 2.667%. This is because P8 brownies are brownies using composite flour (modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour.) With a ratio of P8 = 35: 45: 5: 15, the protein content of each ingredient is also high, such as saga seeds which contain 48.2% protein, according to Pratiwiningsih [18], the use of saga seeds as raw material for protein sources has the potential to increase the nutritional value and quality of a product, and other raw materials such as breadfruit also contains a high protein content of 5.0278% so that the mixture of flour raw materials used can increase the protein content in food products. Whereas P4 brownie uses 100% mocaf which has a low protein content, this is because mocaf protein is low, according to Diniyah, et al., [19] mocaf has around 0.3-3.5% protein, which is quite low compared to other composite flour comparisons used.
3.4. Fat content

The results showed that P6 brownie had the highest fat content, namely 32.806% and P4 brownie had the lowest fat content, namely 13.746%. This is because the differences in fat content are different from each brownie substitution raw material. It is known that P6 brownies are brownies from composite flour, breadfruit has a high fat content of 3.6708% and saga seeds contain a high fat content of 22.6%, according to Zainal, et al., [20], apart from the raw material, this is due to additional fat-containing ingredients such as eggs, margarine, vegetable oil, and chocolate bars, which cause fat content in high brownies most of the ingredients. According to Diniyah, et al., [21], the fat content of mocaf is only around 1.5-2.1%.
3.5. **Crude fiber content**

The results showed that P5 brownies had the highest fiber content, namely 19.759% and P4 brownies had the lowest fiber content, namely 10.534%. This is because brownies are increasing the proportion of raw materials used causing the fiber content to be higher, according to Ardiyanti [22], the increase in crude fiber content occurs because the crude fiber of raw materials has a high crude fiber content and low fiber content. P4 is a brownie using 100% mocaf, it is known that mocaf contains low fiber content, compared to other raw materials used.

![Figure 5. The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to crude fiber content]

3.6. **Carbohydrate content**

The results showed that P3 brownie had the highest carbohydrate content, namely 39.356% and P8 brownie had the lowest carbohydrate content, namely 21.117%. According to Novia [23], the higher the content of other nutrients in food or food, the lower the carbohydrate content contained in a food ingredient, and conversely, the lower the other nutritional components, the higher the carbohydrate content contained in the food ingredient.

![Figure 6. The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to carbohydrate content]
3.7. Flavor
The results showed that P1 brownie had the highest aroma, namely 6,358, and P8 brownie had the lowest aroma, namely 4,194. This is because P1 brownies are brownies using 100% flour, this is influenced by the ingredients used, such as chocolate, without the addition of several other raw materials, according to Zuhriani [24] in steamed brownie products using wheat flour which gives a distinctive aroma brownie. Due to the addition of additional ingredients such as chocolate and no other raw materials, the product is preferred. Unlike the P8 brownies which have the lowest aroma using a ratio of modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour, with a ratio of P8 = 35: 45: 5: 15, this is because the raw material does not use wheat flour but uses ingredients that are has a strong aroma like saga seed flour. The addition of saga seed flour used in treatment P8 was the highest value of all treatments carried out.

Saga has an unpleasant aroma. According to Anam, et al [25] the unpleasant odor is caused by the presence of the lipoxygenase enzyme which oxidizes unsaturated fatty acids into volatile compounds, so that the aroma of brownies feels stronger in contrast to the distinctive aroma of brownies, and also uses breadfruit raw materials which modified with acid, so that a sour aroma was felt. According to Hidayati (2011)[26], the aroma of the flour is mixed, resulting in a distinctive aroma and taste that can mask the distinctive taste of brownies which tends to be disliked.

![Figure 7. The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to flavor](image)

3.8. Texture
The results showed that P1 brownie had the highest texture, namely 6,358 and P4 brownie had the lowest texture, namely 5,085. This is because P1 brownies are brownies using 100% flour. According to Astawan [27], this is because brownies are made from 100% flour where flour has the ability to form gluten when the flour is moistened with water to produce a soft texture, while the results Research shows that P4 brownies have the lowest texture, this is because P4 is 100% mocaf, in contrast to the nature of flour which has gluten to produce a soft texture. According to Prayitno, et al [28] the more mocaf is used, the harder the brownies are is produced, and the composition of mocaf makes the brownies less moist and less fluffy, this is because mocaf does not have characteristics like wheat flour, so that brownies are less preferred by panelists.
The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to texture

### 3.9. Taste

The results showed that P1 brownie had the highest taste, namely 6,348 and P4 brownie had the lowest taste, namely 4,958. This is influenced by the percentage of flour used, and other additives, such as sugar and chocolate. According to Asryad [29] the browines produced show different levels of preference for different flavors, influenced by the flour used. In P4 browines, it is known that 100% has a lower taste, according to Sari [30], because cake products that use mocaf generally give a taste that does not match the quality of 100% flour cake that gets the highest taste, because when eaten the crumbs are still left behind in the tongue and throat, causing a distinctive taste of mocaf which is less delicious when consumed.

![Organoleptic Taste Composite Flour Formulations (P)](image)

Figure 9. The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to taste

### 3.10. General acceptance

The results showed that P1 brownie had the highest general acceptance, 6,330 and P4 brownie had the lowest general acceptance, 4,864. Brownie P1 is the preferred 100% wheat flour brownie, because wheat contains gluten which functions to make the dough elastic and easy to shape, and produces a distinctive brownie flavor, while the P8 brownie made from mocaf flour is very different from 100% wheat brownies resulting from.
Figure 10. The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to general acceptance

3.11. Specific volume
The results showed that P3 brownie had the highest specific volume of 0.223 mL/g and P7 brownie had the lowest specific volume of 0.200 mL/g. The specific volume of each material is not much different, and has almost the same value. Brownies P3 is a brownie made from 100% purple sweet potato flour, the specific volume increase is due to various factors, one of which is the protein content of purple sweet potato flour. The protein content can form a brownie structure due to heat due to coagulation and the starch experiencing gelatinization, and the increased dough can be caused by the sugar content of purple sweet potato flour so that the volume of the dough increases. Hardoko, et al [31]. At P7 has the lowest value, due to the use of composite flour, so that the ability of the material to absorb is low.

Figure 11. The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to specific volume
3.12. Hue value

The results showed that P6 brownie had the highest \( ^{\circ} \)Hue value 52.588, and P7 brownie had the lowest \( ^{\circ} \)Hue value 44.075. Brownies with modified breadfruit flour substitution, purple sweet potato flour, mocaf, and saga seed flour in treatment P6 and P8 had values that were not significantly different from control. Overall, the higher the use of composite flour tends to decrease the panelists' preference, however the use of a limited amount actually produces the panelist's preferred color. The \( ^{\circ} \)Hue value on the brownie shows the lower the level of substitution used.

![Figure 12. The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to \( ^{\circ} \)Hue value](image)

3.13. L* value

The results showed that P1 brownie had the highest L* value, namely 29,867 and P3 brownie had the lowest L* value, namely 16,733. This shows that 100% control of wheat flour has the highest L* value which is the brightest value, while P3 has a lower L* value due to the use of 100% purple sweet potato flour, so that the resulting color is thicker and added with additional ingredients. used like brown, this is in accordance with the literature of Hunter [32] which states that the higher the L* value, the brighter the color level, if the lower the L* value, it indicates darker color levels.

![Figure 13. The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to L* value](image)
3.14. $A^*$ value

The results showed that brownie P2 had the highest $a^*$ value, which was 10.533 and brownie P3 had the lowest $a^*$ value, which was 6.067. This is because the higher the $a^*$ value (positive) indicates the color will be more reddish, while the lower $a^*$ value (negative) indicates the color will be more greenish. Brownie P2 has a high value, resulting in a more reddish color in brownie products compared to brownies from other treatments. This is related to the high levels of anthocyanins in purple sweet potato flour, so that P3 100% purple sweet potato flour has a lower $a^*$ value. Han et al., [33] stated that there was a relationship between anthocyanin levels and redness values.

![Figure 14](image)

**Figure 14.** The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to $a^*$ value

3.15. $B^*$ value

The results showed that the brownie P2 had the highest $b^*$ value, namely 11,467 and the P3 brownie had the lowest $b^*$ value, namely 6,000. According to Hunter [34], a higher (positive) value of $b^*$ indicates the color will become more yellowish, while a lower value (negative) indicates the color will become more bluish. Brownies with 100% purple sweet potato had a low value, and brownies with 100% modified breadfruit had a high value which was more yellowish than the brownies in the other treatments.

![Figure 15](image)

**Figure 15.** The relationship between modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour to $b^*$ value
4. Conclusion
Composite flour formulations (modified breadfruit flour, purple sweet potato flour, mocaf, and saga seed flour) with a ratio of P8 = 35:45:5:15 producing the best quality and quality brownies.

References
[1] Setiawati, A., Rahimsyah., And Ulyarti. 2015. Study of making fiber-rich brownies from coconut dregs flour. Jambi University Research Journal Science Series. 17 (1): 84-89.
[2] Sunarwati, D. A, Rosidah., And Saptariana. 2012. Effect of substitution of breadfruit flour on the quality of steamed brownies. Journal of Food Science and Culinary. 1 (1): 13-19.
[3] Mutmainah, F., D. Rahadian. AM, and BS Amanto. 2013. Study of the physicochemical characteristics of modified breadfruit flour (Artocarpus communis) with variations in soaking time and acetic acid concentration. Journal of Food Technology. 4 (2): 46-53.
[4] Cahyani, E., U. Renda., And Nasrullah. 2018. Effect of substitution of purple sweet potato flour on the quality of steamed brownies. Journal of Administration, Accounting, Business, and Humaiaora. 1 (1): 213-217.
[5] Lolok, N., PD Pasambo., And H. Barium. 2017. Anti-fertility effect test combination of saga seed extract (Abrus precatorius L.) and bitter melon (Momordica charantia L.) seeds in male mice (Mus musculus). Journal of Mandala Pharmacon Indonesia. 3 (2): 96-102.
[6] Alam, MGP, Suardy., And R. Fadilah. 2019. Effect of substitution of mocaf flour (Modified cassava flour) on the quality of the pinch cake. Journal of Agricultural Technology Education 5 (1): 55-68.
[7] AOAC. 1995. Official Methods of Analysis of the Association of Official Analytical Chemists. Association of Analytical Chemists, Inc. Arlington, VA.
[8] Sudarmadji, S., et al. 1997. Analysis procedures for food and agricultural ingredients. Liberty, Yogyakarta.
[9] Apriyantono, A., D. Fardiaz, NL Puspitasari, Y. Sedarnawati, and S. Budianto. 1989. Food Analysis Laboratory Guidelines. Inter-University Center, Bogor Agricultural University, Bogor.
[10] AOAC. 1995. Official Methods of Analysis of the Association of Official Analytical Chemists. Association of Analytical Chemists, Inc. Arlington, VA.
[11] SNI 01-2346-2006
[12] Yananta, AP 2003. Improvement of the minor tuber flour process. Thesis, Faculty of Agricultural Technology, IPB, Bogor.
[13] Hutching, J. B. 1999. Food Color and appearance. Aspen publisher Inc., Maryland.
[14] De Garmo E, P., W. G. Sullivan., dan J. R. Canada. 1984. Engineering Economy. Seventh Edition. Macmillan Pub. Co, New York.
[15] Prayitno, AS, R. Tjiptaningdyah., FK Hartati. 2018. Chemical and organoleptic properties of steamed brownies from the proportion of mocaf flour and flour. Journal of Indonesian Agricultural Technology and Industry. 10 (1): 1-7.
[16] Nindyarani, AK, Sutardi., And Suparmo. 2011. Chemical, physical, and sensory characteristics of purple sweet potato flour (Ipomea batatas poiret) and its processed products. Agritech Journal. 31 (4): 273-280.
[17] Alam, MGP, Suardy., And R. Fadilah. 2019. Effect of substitution of mocaf flour (Modified cassava flour) on the quality of the pinch cake. Journal of Agricultural Technology Education 5 (1): 55-68.
[18] Pratiwi, DP, A. Sulaeman., And L. Amalia. 2017. The use of breadfruit flour (Artocarapus altitis sp.) In making various snacks as an alternative nutritious food for PMT-AS. Journal of Nutrition and Food. 7 (3): 175-180.
[19] Diniyah, N., N. Yuwana., Maryanto., BH Purnomo., And A. Subagio. 2018. Characterization of sera mocaf (modified cassava flour) from sweet and bitter varieties of cassava. Journal of Postharvest Agricultural Research. 15 (3): 114-122.
[20] Zainal. 2015. Organoleptic quality of steamed brownies from black rice flour. Food Journal. 1 (1): 1-15.
[21] Diniyah, N., N. Yuwana., Maryanto., BH Purnomo., And A. Subagio. 2018. Characterization of sera mocaf (modified cassava flour) from sweet and bitter varieties of cassava. Journal of Postharvest Agricultural Research. 15 (3): 114-122.
[22] Ardiyanti. 2001. Effect of proportion of wheat flour with wheat bran as a source of fiber and the addition of margarine to the quality of cookies. Brawijaya University, Malang.
[23] Novia, R. 2018. Brownie product development with substitution of black oncom flour and sorghum for malnourished toddlers. Journal of Public Nutrition. 1 (1): 1-15.
[24] Zuhriani, Frida. 2015. Organoleptic quality of steamed brownies from black rice flour. Food Journal. 1 (1): 1-15.
[25] Anam, C., NH Riyadi., And A. Nur. 2013. Application of edible coating of cassava starch in the manufacture of saga candy (Adenanthera pavonina) on sensory characteristics, shelf life, and chemistry. Journal of Food Technology. 2 (3): 121-130.
[26] Hidayati, N. R. 2011. Pengaruh konsentrasi dan lama perendaman asam laktat terhadap kadar glukosa dan kualitas tepung garut (Maranta arundinecea L). Jurnal Pangan. 1(1):1-6.
[27] Astawan, Made. 2009. Complete Carbohydrate Guide. Dian Rakyat, Jakarta.
[28] Prayitno, AS, R. Tjiptaningdyah., FK Hartati. 2018. Chemical and organoleptic properties of steamed brownies from the proportion of mocaf flour and flour. Journal of Indonesian Agricultural Technology and Industry. 10 (1): 1-7.
[29] Arsyad, M. 2016. The effect of adding mocaf flour on the quality of biscuit products. Agropolitan Journal. 3 (3): 52-61.
[30] Sari, FO 2015. Experiments in making mocaf flour cake using the sponge method and pound method and using different sugars. Semarang.
[31] Hardoko., L. Hendrato., And TM Siregar. 2010. Utilization of purple sweet potato (Ipomea batatas L. Poir) as a substitute for wheat flour and a source of antioxidants in fresh bread. Journal of Technology and Food Industry. 21 (1): 25-35.
[32] Hunter, R. S. 1948. Photoelectric Color-difference Meter. JOSA. 38(7):661.
[33] Han, F., Ju, Y., Ruan, X., Zhao, X., Yue, X., Zhuang, X., Qin, M., dan Fang, Y. 2017. Color, anthocyanin and antioxidant characteristics of young wines produced from spine grapes (Vitis davidii Foex) in China. Food and Nutrition Research. 61(1):1-11.
[34] Hunter, R. S. 1948. Photoelectric Color-difference Meter. JOSA. 38(7):661.