EFFECT OF THE SUBSTITUTION OF WHEAT FLOUR WITH PURPLE SWEET POTATO (*Ipomoea batatas* L.) FLOUR ON THE ANTIOXIDANT ACTIVITY AND BAKED PRODUCT QUALITY

Abstract

This study aimed to determine the effect of substitution of wheat flour with purple sweet potato flour on the end-quality and antioxidant activity of the resulting roll cakes. Furthermore, the objective was to determine the optimal percentage of the substitution of wheat flour with purple sweet potato flour that would be graded as the best and most preferred by the panelists. This study used a completely randomized design (CRD) with 5 treatment levels and 3 replications. Observational data were analyzed using analysis of variance (ANOVA) and Duncan's New Multiple Range Test (DNMRT) at 1% significance level. The treatment in this study was the substitution of purple sweet potato flour for wheat flour in the manufacture of roll cakes, namely 20, 30, 40, 50 and 60%. The results showed that the substitution of purple sweet potato flour for wheat flour in the production of sponge rolls had a very significant effect on the content of water, ash, fat, protein, crude fiber, carbohydrates, and had no significant effect on antioxidant activity. The most preferred sponge cake was treatment E (substitution of purple sweet potato flour for 60% wheat flour) with a moisture content of 8.65%, ash content of 1.19%, fat content of 17.41%, protein content of 10.18%, crude fiber content 19.23%, carbohydrate content 62.56%, and antioxidant activity 62.47%.

Keywords: purple sweet potato flour, wheat flour, antioxidant activity, baked product quality

INTRODUCTION

Wheat flour is one of the main ingredients in cake making, whether steamed, fried or baked. The need for wheat flour is very high even though Indonesia is not a country that produces wheat flour raw materials. The raw material for wheat flour production is wheat, a type of cereal that cannot grow optimally in tropical areas such as Indonesia. To replace wheat flour raw materials such as wheat, it is necessary to look for substitute raw materials such as plants which have a high carbohydrate component, especially starch. Wheat flour is the result of extraction from the milling process of wheat (*Triticum sativum*) which is composed of 67-70% carbohydrates, 10-14% protein, and 1-3% fat, (Fitasari, 2009).

Purple sweet potato (*Ipomoea batatas* L.) is a type of tuber that has many advantages over other tubers and is the fourth source of carbohydrates in the world and Indonesia, after rice, corn and cassava. Sweet potato is one type of food that has bright prospects in the future because it can be used as a carbohydrate-producing food ingredient as well as an industrial ingredient. However, people's interest in consuming food from sweet potatoes is still low. This is because the processing of sweet potatoes in Indonesia is still limited and simple, such as boiling/steaming, baking or frying. In addition, there is a perception that sweet potato is an inferior food that is not in the same class as wheat or corn (Ketra and Wulandra, 2015).

Rolled sponge cake is a processed product that has long been known by the public because

it has a fairly high nutritional content, is often used as a dessert dish in various luxury hotels and restaurants, has a high selling price and is easy to process. The raw material for making sponge rolls is wheat flour made from wheat which can be substituted with sweet potato flour. Sponge rolls made from sweet potato flour require protein in the form of gluten, which is owned by wheat flour. Gluten in wheat flour makes the texture of the sponge rolls soft, improves taste, as a source of protein and a source of carbohydrates (Desrosier, 2008).

RESEARCH METHODS

Materials and tools

The main ingredients used in this study were wheat flour, purple sweet potato flour, TBM, eggs, vanilla, margarine, powdered sugar, which were obtained from Pasar Raya Padang. The chemicals used for the chemical analysis included: (1) n-hexane as a solvent for determination of the oil content solvent, , (2) H_2SO_4, HgO, K_2SO_4, NaOH, were used for the determination of protein content(3) ethanol, H_2SO_4, NaOH 1.25 N, 10% K_2SO_4, were used for the determination of crude fiber (4) 45 ppm DPPH and CH_3OH were used to determine the antioxidant activity.

The tools used in making sponge rolls are scales, containers, spoons, ovens, mixers, pans, knives. While the tools for analysis are (1) tools for analyzing moisture content are ovens, gegep, porcelain dishes, erlenmeyer, analytical balances, (2) ash content are porcelain dishes, scissors, saucers, (3) analysis of carbohydrates content are test tubes, pipettes , petri dish, mortal, spatula, Bunsen burner, and opaque paper, matches, tissue, (4) Fat content is socket, electric heater, oven, analytical balance, filter paper, fat flask, desiccator, (5) Test for protein content namely 500 ml Kjedahl flask, distillation apparatus, 50 ml burette, 5 ml measuring pipette, 50 ml Erlenmeyer, dropping pipette, beaker glass, fume cupboard, (6) The antioxidant test is a UV-Vis spectrophotometer.

Research design

The design used in this study was a completely randomized design (CRD) consisting of 5 treatment levels and 3 replications. Observational data were analyzed using analysis of variance (ANOVA) and Duncan's New Multiple Range Test (DNMRT) at 1% significance level. The treatment in this study was the substitution of purple sweet potato flour for wheat flour in the manufacture of roll cakes as follows: A = 20%, B = 30%, C = 40%, D = 50%, E = 60%. Production of modified purple sweet potato flour (Hartoyo, 1999).

Purple sweet potato is cleaned with clean water and then peeled. After removing the skin, the sweet potato is sliced thinly with a thickness of 0.1-0.4 cm. After being sliced, it is dried in the sun for 7 hours for 3 days. Then the dried sweet potato is mashed using a blender. After that, it is sieved using a 60 mesh sieve. Sweet potato flour is ready to use.

Making roll cakes (Murthado, 2002)

Mix eggs, TBM, sugar, vanilla, then stir until smooth and fluffy with a hand mixer for ± 20 minutes. Add flour, sweet potato flour according to treatment, melted butter, mix using a high speed mixer for 2 minutes. Substitution of purple sweet potato flour for wheat flour according to the treatment. After mixing is complete, the dough is then put into a baking sheet that has been lined with oil paper and smeared with butter and sprinkled with flour. Then put the dough into the oven with a temperature of 150oC for ± 15 minutes. After the baking process is complete, spread butter on the surface of the dough and then roll it as a roll cake.

Observation

Observations in this study were: moisture content, ash content, fat content, protein content, crude fiber content, carbohydrate content, (AOAC 2005), antioxidants and organoleptic

tests.

Data analysis

Data obtained from observations will be analyzed statistically using Analysis of Variance (Anova). If F count ≥ F table then proceed with the Duncan New Multiple Range Test (DNMRT) at 1% level.

RESULTS AND DISCUSSION

In general, the results of the study showed that the substitution of purple sweet potato flour for wheat flour had an effect on sponge rolls. The effect of the percentage of purple sweet potato flour with wheat flour on the parameters observed is presented in Table 1.

Table 1. The average substitution of purple sweet potato flour for wheat flour for the parameters observed.

Treatment	Water Content %	Ash Content %	Fat Content %	Protein Content %	Crude Fiber Content %	Carbohydrate Content %	Antioxidant Activity %
A = 20%	20.72	0.71	23.34	18.12	7.12	37.08	40.01
B = 30%	17.64	1.01	21.19	16.35	10.14	43.79	44.38
C = 40%	15.22	1.10	19.65	14.62	13.51	49.40	51.16
D = 50%	10.71	1.13	18.53	12.00	16.23	57.63	56.15
E = 60%	8.65	1.19	17.41	10.18	19.23	62.56	62.47

Water content

Table 1 shows the moisture content of sponge rolls ranging from 8.65–20.72%. The water content value of rolled sponge cake showed decreased results along with the increasing amount of purple sweet potato flour. Sweet potato flour has a low water content because the sponge cake is processed by roasting at 1500C so that the baking process is able to evaporate and reduce the amount of water content in the sponge cake dough (Nurdjanah et al., 2011). The highest water content was found in treatment A (substitution of purple sweet potato flour for 20% wheat flour) which was 20.72%. While the lowest water content was found in treatment E (substitution of purple sweet potato flour for 60% wheat flour) which was 8.65%. The more use of purple sweet potato flour and the less flour, the water content will decrease, and vice versa. The histogram is shown in Figure 1.

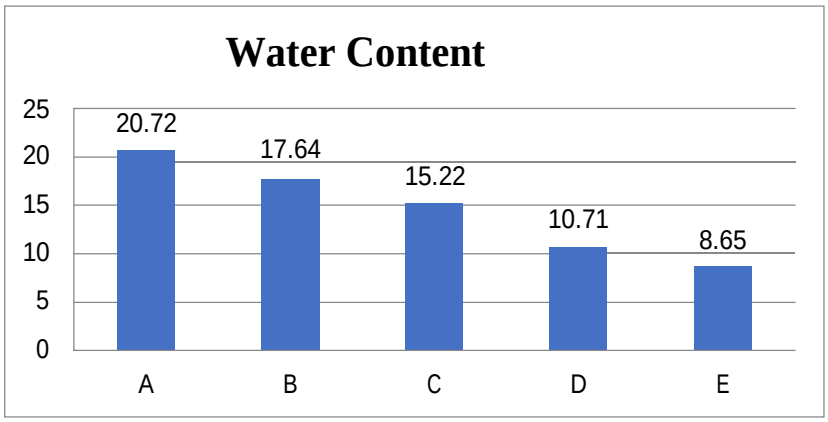

Figure 1. Histogram of water content of sponge rolls.

According to Ambarsari et al (2009), purple sweet potato flour has a water content of 83.3%, while wheat flour has a water content of 12.00% (Musita, 2014). This is in accordance with the research that has been done, the more the use of purple sweet potato flour in the manufacture of roll cakes, the lower the water content of roll cakes. The water content of the sponge rolls produced for all treatments complies with the Indonesian National Standard (SNI 01-3840-1995) for sweet bread, which is a maximum of 40%.

Ash Content

Table 1 shows the ash content of roll cakes ranging from 0.72-1.19%. The more added purple sweet potato flour in the production of roll cakes, the higher the ash content of roll cakes. This is because purple sweet potato flour has high minerals which causes the ash content to increase (Nurhayati et al, 2014). The highest ash content of rolled sponge cake was found in treatment E (substitution of purple sweet potato flour for 60% wheat flour), namely, 1.19%, while the lowest ash content was found in treatment A (substitution of purple sweet potato flour for 20% wheat flour), namely, 0.72%. The more use of purple sweet potato flour and the less flour, the ash content will increase, and vice versa. The histogram is shown in Figure 2.

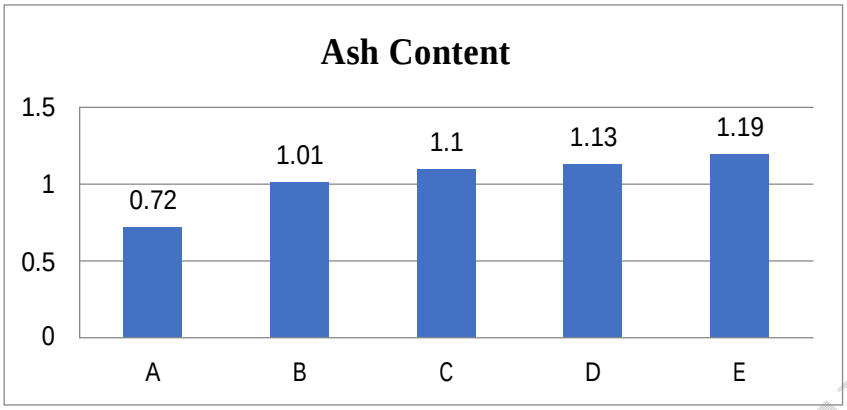

Figure 2. Histogram of roll ash content.

The ash content of roll cake for all treatments has met the Indonesian National Standard (SNI 01-3840-1995), which is a maximum of 3%. This is because wheat flour has a lower ash content than purple sweet potato flour. The ash content of wheat flour is 0.46% while the ash content of sweet potato flour is 1.91 (Mukhlisa et al 2013).

Fat level

Table 1 shows the fat content of rolled cakes ranging from 17.41–23.34%. The more purple sweet potato flour added to the roll cake production, the lower the fat content. This is because the fat content of purple sweet potato flour is lower than wheat flour.The highest fat content was found in treatment A (substitution of purple sweet potato flour for 20% wheat flour) which was 23.34%. Meanwhile, the lowest fat content was found in treatment E (substitution of purple sweet potato flour for 60% wheat flour) which was 17.41%. The more use of purple sweet potato flour, the fat content will decrease, and vice versa. The histogram is shown in Figure 3.

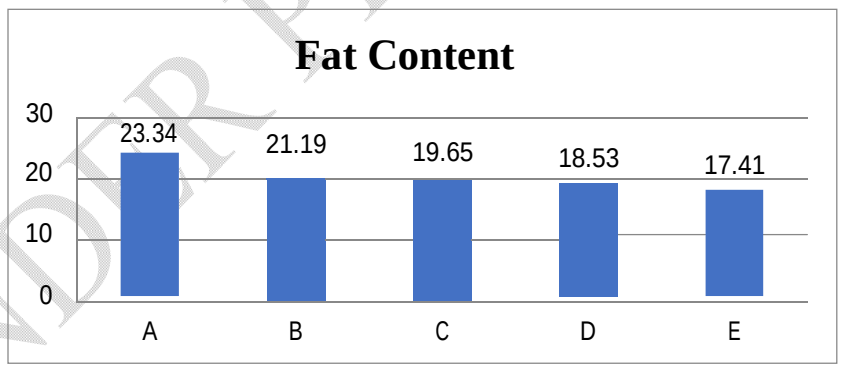

Figure 3. Histogram of the fat content of rolled sponge cake.

The fat content of the rolled sponge cake produced for all treatments was above the maximum fat content limit in the Indonesian National Standard (SNI 01-3840-1995) for sweet bread, which is a maximum of 3.0%. This is because the fat in the sponge rolls is also obtained from margarine, eggs and TBM which are added to the sponge roll dough formulation (Zaddana, et al 2018) and wheat flour has a higher fat content than purple sweet potato flour. The fat content of wheat flour is 1.2% while the fat content in sweet potato flour is 0.17% (Adhelinika et al, 2013). This statement is in accordance with the results which show that the increase in purple sweet potato flour in the manufacture of roll cakes reduces the fat content in the product.

Protein Content

Table 1 shows the protein content of sponge rolls ranging from 10.18–18.12%. The more use of purple sweet potato flour in the production of rolled cakes, the lower the protein content of the rolled cakes produced. This is because wheat flour contains higher protein than purple sweet potato flour. The highest protein content of roll cake was found in treatment A (substitution of purple sweet potato flour for 20% wheat flour), namely 18.12%, while the lowest protein content was found in treatment E (substitution of purple sweet potato flour for 60% wheat flour), namely 10. 18%. The more use of purple sweet potato flour, the protein content will decrease, and vice versa. The histogram is shown in Figure 4.

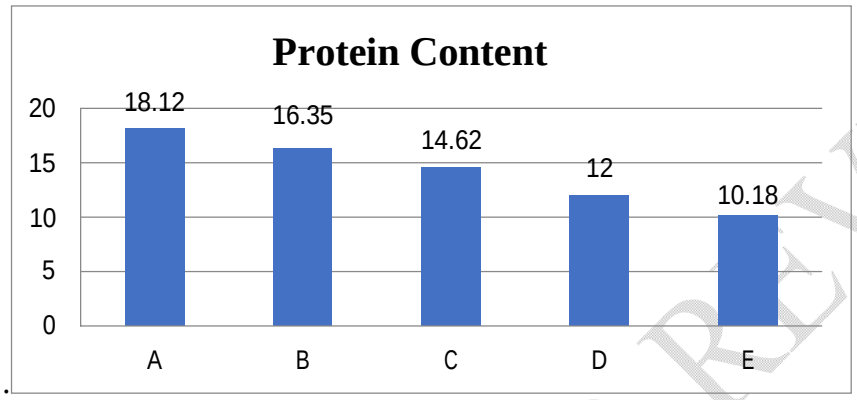

Figure 4. Histogram of protein content of sponge rolls.

According to Rakhmah, (2012) the protein content in sponge rolls produced using 50% sweet potato flour and 50% wheat flour formulations is 6.52%. This is because purple sweet potato flour has a lower protein content than wheat flour. The protein content of sweet potato flour is 1.43% while wheat flour is around 11.8 (Ramadhani, 2019). The more use of purple sweet potato flour in the manufacture of roll cakes, the protein content of roll cakes decreases.

Crude Fiber Content

Table 1 shows the crude fiber content of sponge rolls ranging from 7.12–19.23%. The more use of wheat flour in the manufacture of rolled cakes, the lower the crude fiber content. This is because wheat flour has low crude fiber compared to purple sweet potato flour. The highest crude fiber content of rolled sponge cake was found in treatment E (substitution of purple sweet potato flour for 60% wheat flour), namely 19.23%, while the lowest crude fiber content was found in treatment A (substitution of purple sweet potato flour for 20% wheat flour) that is, 7.12%. This statement is in accordance with the results of the study showing that the crude fiber content is inversely proportional to the water content, the higher the crude fiber content, the water content will decrease and vice versa the lower the crude fiber content, the higher the water content generated. The more use of purple sweet potato flour and the less flour, the crude fiber content will increase, and vice versa. The histogram is shown in Figure 5.

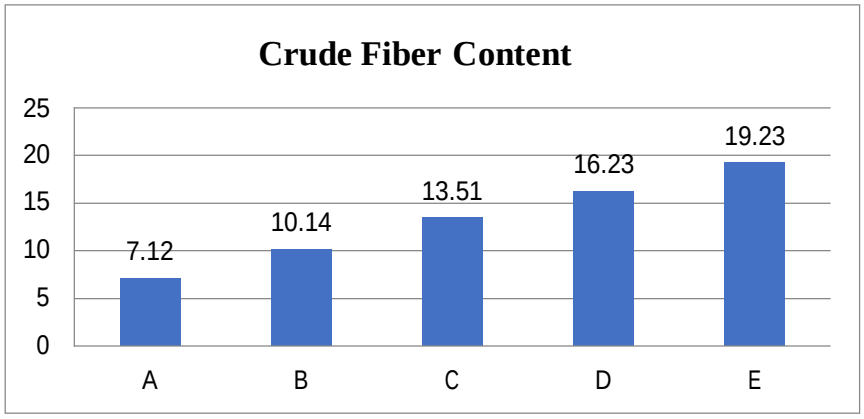

Figure 5. Histogram of crude fiber content of sponge rolls.

The crude fiber content of the rolled sponge cake produced for all treatments was above the maximum crude fiber content limit. This is because wheat flour has a lower crude fiber content than purple sweet potato flour. The crude fiber content of purple sweet potato flour is 2.40% (Nindyarani, et al 2011) while that of wheat flour is 1.92% (Adhelinika, et al 2013). The more use of wheat flour in the manufacture of rolled cakes, the lower the crude fiber content of rolled cakes. Crude fiber is a component of cellulose, pentose and other components. This component of crude fiber has no nutritional value in the body (Hermayanti et al. 2006).

Carbohydrate Content

Table 1 shows the carbohydrate content of roll cakes ranging from 37.08–62.56%. The more use of purple sweet potato flour in the production of roll cakes, the higher the carbohydrate content of the rolls produced. This is because purple sweet potato flour contains high carbohydrates compared to wheat flour. The highest carbohydrate content of roll cake was found in treatment E (substitution of purple sweet potato flour for 60% wheat flour), namely, 62.56%, while the lowest carbohydrate content was found in treatment A (substitution of purple sweet potato flour for 20% wheat flour), namely, 37.08%. The more use of purple sweet potato flour and the less flour, the carbohydrate content will increase, and vice versa. The histogram is shown in Figure 6.

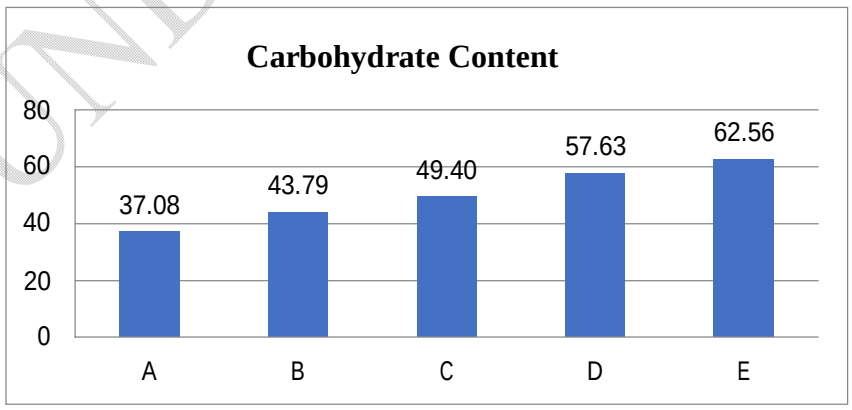

Figure 6. Histogram of carbohydrate content in rolled sponge cake

The results of this study are in accordance with the statement above that roll cakes containing purple sweet potato flour contain more carbohydrates, so the carbohydrate content will be higher. The carbohydrate content of wheat flour is lower, namely 74.5% (Fitriani Basrin 2020) while the carbohydrate content of purple sweet potato flour is 90.37% (Nindyarani, et al 2011).

Antioxidant Activity

Table 1 shows the levels of antioxidant activity of sponge rolls ranging from 40.01 to 62.47%. The more use of purple sweet potato flour in the production of roll cakes, the higher the antioxidant content of the rolls produced. The increase in the addition of purple sweet potato flour in the production of roll cakes causes the antioxidant activity to increase. Purple sweet potatoes also contain many sources of antioxidants from anthocyanins, vitamin C, vitamin E and beta-carotene. The anthocyanin content in purple sweet potato is 110-210 mg/100 g (Nintami and Rustanti, 2012).

The highest antioxidant content of rolled cakes was in treatment E (substitution of purple sweet potato flour for 60% wheat flour), namely, 62.47%, while the lowest antioxidant levels were found in treatment A (substitution of purple sweet potato flour for 20% wheat flour), namely, 40.01%. The more use of purple sweet potato flour and the less flour, the antioxidant activity will increase, and vice versa. The histogram is shown in Figure 7.

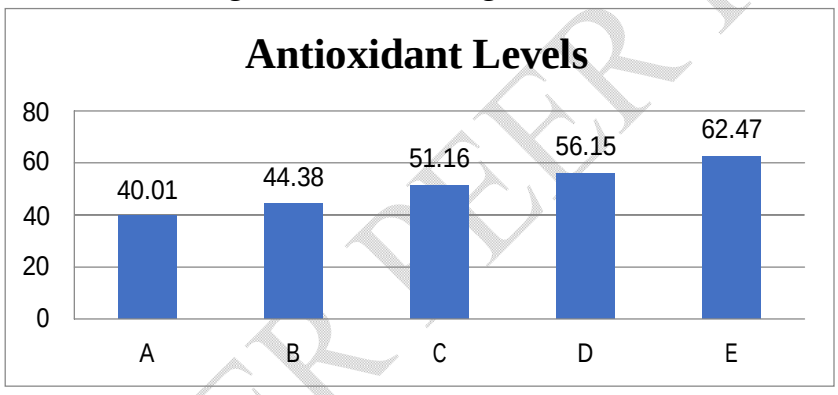

Figure 7. Histogram of antioxidant levels of sponge rolls.

Antioxidant activity is not contained in SNI, but it is very important to examine antioxidants to determine the antioxidant content of a mixture of purple sweet potato flour and wheat flour in roll cakes. This purple sweet potato flour can be an alternative food ingredient that contains antioxidant compounds that are good for the body. Sponge rolls with more purple sweet potato flour content, the antioxidant activity will also be higher.

Organoleptic Value

Organoleptic tests are carried out through sensory assessment, namely by tasting the taste, aroma, observing the texture, color of the sponge rolls. The test was carried out by means of roll cakes made according to the treatment formulation. Tested by 25 untrained panelists.

Table 2. Recapitulation of the average organoleptic value of sponge rolls

Treatment	Flavor	Aroma	Texture	Colour	Average
A	4.32	4.56	4.48	4.40	4.44
B	4.32	4.40	4.76	4.88	4.60
C	4.60	4.84	4.92	4.76	4.78
D	5.32	5.00	5.04	5.16	5.13
E	5.76	5.56	5.88	5.60	5.70
Average	4.87	4.87	5.02	4.96	

Flavor

Table 2 shows the panelist's highest assessment of the taste of the sponge rolls found in treatment E (substitution of purple sweet potato flour to 60% wheat flour) namely 5.76% (very like). The panelist's lowest assessment of the taste of roll cake was in treatment A (substitution of purple sweet potato flour for 20% wheat flour), namely 4.32% (rather like it). The data obtained showed that the higher the addition of purple sweet potato flour the higher the level of panelist acceptance. The taste preferred by the panelists was treatment E (substitution of purple sweet potato flour for 60% wheat flour), which had a distinctive taste of purple sweet potato, meaning that the higher the amount of added purple sweet potato flour, the stronger the distinctive taste of purple sweet potato in the rolled cake. produced (Nindyarani et al, 2011). The taste contained in the sponge rolls can come from the addition of flour and other additives.

However, from the panelist acceptance data it can be concluded that the mixing of purple sweet potato flour with wheat flour has been accepted by the panelists with a scale of 4.60 to 5.32 likes and 5.76 likes very much, which means the panelists already like the taste of the roll cake.

Aroma

Table 2 shows the panelist's highest rating of the aroma of rolled sponge cake in treatment E (substitution of purple sweet potato flour for 60% wheat flour), namely 5.56% (very like it). While the panelist's lowest assessment of the aroma of roll cake was found in treatment A (substitution of purple sweet potato flour for 20% wheat flour), namely 4.56% (like).

The more addition of purple sweet potato flour resulted in an increase in aroma acceptance. The aroma that the panelists liked the most was treatment E (substitution of purple sweet potato flour for 60% wheat flour), which had a distinctive aroma from purple sweet potato flour, that the higher the amount of added purple sweet potato flour in making sponge rolls, the stronger the distinctive aroma of sweet potato purple sweet potato produced (Nindyarani et al, 2011). This is because the purple sweet potato flour itself has a strong aroma. The aroma contained in the sponge rolls comes from the raw materials and other additives during roasting.

Texture

Table 2 shows the highest score for the texture of the sponge rolls is in treatment E (substitution of purple sweet potato flour for 60% flour) namely 5.88% (very like it), while the lowest texture of the sponge rolls is found in treatment A (substitution of purple sweet potato flour to 20% wheat flour, namely 4.48% (rather like), which means that the level of acceptance of the panelists is on a scale from slightly like to like. The texture found in treatment E (substitution of purple sweet potato flour for 60% wheat flour) was most preferred by the panelists because the resulting roll cake had a soft texture. The low level of panelists' acceptance of treatment A (substitution of purple sweet potato flour for 20% wheat flour) was caused by the more addition of

rolled cake flour, the harder or denser it would become. Food texture is largely determined by the content of water, fat, protein and carbohydrates. Texture is a sensation of pressure that can be observed with the mouth (during biting, chewing and swallowing). Sensing various textures, including wetness, dry, hard, smooth, rough, and oily (Noviyanti, et al. 2016).

Color

Table 2 shows that the highest assessment of the color of the roll cake was found in treatment E (substitution of purple sweet potato flour for 60% wheat flour), namely 5.60% (very like it). Because the dark purple color is more attractive to the panelists. Meanwhile, the lowest rating was in treatment A (substitution of purple sweet potato flour for 20% wheat flour), namely 4.40% (rather like it). Because the light purple color is less attractive to the panelists. Color assessment is carried out by direct visual observation of the product with the sense of sight of each panelist. Determining the quality of a product depends on many factors, but before other factors are tested and analyzed, the color factor visually appears first in determining panelist acceptance of the product (Winarno, 2004).

CONCLUSIONS AND SUGGESTIONS

CONCLUSION

Substitution of purple sweet potato flour for wheat flour on the quality of roll cakes had a very significant effect on moisture content, ash content, fat content, protein content, crude fiber content, carbohydrate content and had no significant effect on antioxidant activity. The most preferred roll sponge by the panelists was treatment E (substitution of purple sweet potato flour for 60% wheat flour) with a moisture content of 8.65%, ash content of 1.19%, fat content of 17.41%, protein of 10.18%, crude fiber content 19.23%, carbohydrates 62.56%, and antioxidant activity62.47%.

SUGGESTION

Suggestions for further research is to do research on estimating the shelf life of roll sponge products using purple sweet potato flour.

REFERENCES

AOAC, (2005) 'Physical, chemical and sensory properties of brownies substituted with sweet potato flour (Ipomoea batatas L.) with addition of black cumin oil (Nigella sativa L.)', in IOP Conference Series: Earth and Environmental Science. doi: 10.1088/1755-1315/102/1/012084.

Anton Ramadhan Ketra. Okta Wulandra. 2015. Substitution of Sweet Potato Flour in Making Sponge Rolls.

Ambarsari, I., Bachelor, S., and Choliq, A. 2009. Recommendations in setting quality standards for sweet potato flour. Journal of standardization, 11(3), 212-219.

Adhelinika, P.M. et al. 2013. Study of the Addition of Millet Flour and Purple Sweet Potato Flour (Ipomoea batatas L) As a Substitute for Wheat Flour in the Making of Flakes.

Ayudya Luthifia Nintami and Ninik Rustanti. 2012. Crude Fiber Content, Antioxidant Activity, Amylose and Wet Noodle Preference Test With Purple Sweet Potato Flour Substitution (Ipomoea batatas var Ayamurasaki) for Patients with Type-2 Diabetes Mellitus.

Desrosier, 2008. Food Preservation Technology. Translator M. Muljohardjo. UI Press, Jakarta.

Eka Fitasari. 2009. Effect of Wheat Flour Addition Rate on Moisture Content, Fat Content, Protein Content, Microstructure, and Organoleptic Quality of Processed Gouda Cheese.

Hartoyo, A. 1999. Study of Technology for Making Instant Sweet Potato Flour Rich in Pro Vitamin A. Thesis. Faculty of Agricultural Technology, IPB, Bogor.

Hermayanti, Yeni, and Eli Gusti. (2006). Proximate Analysis Module. SMAK 3 Padang. Padang Murthado, T. 2002. Roll cake. Gramedia Pustaka Utama, Jakarta.

Musita, N. (2014) 'Utilization of Stone Banana Flour (Musa Balbisiana Colla) in Making Brownies the Utilization of Musa Balbisiana Banana Flour in Brownies', Industrial Research Journal, 8(3), pp. 171–178.

Mukhlisa et al. 2013. Quality Evaluation of Cookies Made from Purple Sweet Potato Flour (Ipomea batatas L.), Tempe Flour and Rebon Shrimp Flour (Acetes erythraeus).

Nurhayati et al., (2014). Banana quality technology with a spray drying system for biscuits. Journal of industrial research dynamics Vol 25 NO. 1

Nurdjanah et al., (2011). Characteristics of brown from a mixture of stone banana flour (Musa balbisiana) and wheat flour at various levels of substitution. Journal of Technology and Industry of Agricultural Products Volume 16, No.1,

Noviyanti, et al. (2016). Analysis of organoleptic assessment of brownie cake substitution of wikau maombo flour. Journal of Food Science and Technology. 1.1 : 58-66.

Winarno F G. (2004). Food chemistry and nutrition. Gramedia. Main library. Jakarta

Yaumil Rakhmah, 2012. Study of Making Sponge Rolls from Sweet Potato Flour (Ipomoea Batatas).
Degree program. Hasanuddin University Makasar.

Zaddana, et al. (2018) Antioxidant activity and food fiber content of biscuits mixed with brown rice bran (Oriza glaberrima) and purple sweet potato (Ipomoea batatas). Phytopharmaka pharmaceutical journal. Vol. 8, No. 2.

Zanuarizky Oryza Ramaddani, Bambang Dwiloka, Yoyok Budi Pramono. 2019. Effect of substitution of wheat flour with kapok banana flour (Musa Acuminata L.) on protein content, fiber content, swelling power, and hedonic quality of steamed cakes.