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Ice Cream Cup Production Using Purple Sweet Potato (*Ipomoea batatas L. Poir*) as a Substitute Ingredient

Pembuatan Cup *Es Krim Menggunakan Ubi Jalar Ungu (Ipomoea batatas L. Poir*) *sebagai Bahan Substitusi*

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Abstract

This study aimed to define the proportion of purple sweet potato addition as a substitute ingredients of the ice cream edible cup and to reduce its baking time. This study was designed using Central Composite Design (response surface method) with 2 factors, i.e. the proportions of purple sweet potato powder and the baking time with water content, cup resistance, and fracturability as the responses. The main component of purple sweet potato ice cream cup is starch and cellulose as shown by the characteristic of the functional group which are C-H of alkene, C= C of alkyna, C = O of aldehyde/ketone/carboxylic acid/ester, C-C group of aromatic ring, C-O alcohol/ether/carboxylic acid/ester, C-H of aromatic ring and C-H of alkene. The result of the study showed that the the optimum proportion of purple sweet potato powder was 75% and the baking time was 45 minutes with the water content of 4.37%, cup resistance of 253.64 minutes, fracturability of 0.2125 N, protein content of 4.79%, and carbohydrate content of 4.66%. Based on the consumer's acceptance aspect, purple sweet potato ice cream cup was the mostly liked because of its texture and flavor, meanwhile its color and aroma was the mostly disliked.
Keywords: baking, central composite design, ice cream cup, purple sweet potatoes

Abstrak

Tujuan penelitian untuk menentukan proporsi penambahan ubi jalar ungu sebagai substitusi pada pembuatan edible cup *es krim serta lama waktu pemanggangannya. Penelitian dirancang dengan menggunakan Metode Respon Permukaan Desain Komposit Terpusat (*response surface method*) dengan 2 faktor berupa proporsi tepung ubi jalar ungu serta lama pemanggangan dengan 3 respon yaitu terhadap kadar air, ketahanan* cup*, dan daya patah. Komponen utama penyusun* cup *es krim ubi jalar ungu adalah pati dan selulosa yang ditunjukkan oleh gugus fungsi karakteristik yaitu gugus C-H alkane, C= C alkuna, C = O aldehid/keton/asam karboksilat/ester, gugus C-C cincin aromatik, C-O alkohol/eter/asam karboksilat/ester, C-H cincin aromatik serta C-H alkena. Hasil penelitian menunjukkan bahwa* cup *es krim terpilih pada proporsi optimal tepung ubi jalar ungu 75% dan lama pemanggangan 45 menit dengan kadar air sebesar 4,37%, ketahanan* cup sebesar *253,64 menit, daya patah sebesar 0,2125 N, kadar protein sebesar 4.79%, dan kadar karbohidrat sebesar 4,66%. Penerimaan konsumen* cup *es krim ubi jalar ungu yang terbaik adalah disukai pada tekstur dan rasa, sedangkan warna dan aroma tidak disukai.*
***Kata kunci**:* cup *es krim, desain komposit terpusat, pemanggangan, ubi jalar ungu*

INTRODUCTION

The development of food industry has also demanded innovation on packaging material industry. Simplicity and flexibility aspects of the packaging becomes one of user's choices in determining packaging material. Plastic is one of the option that mostly used in food industry. However, this material is very difficult to decompose and may result in environmental pollution. The improvement of eco-friendly and edible packaging technology (Schmid et al., 2012; Wei & Yazdanifard, 2013) has been widely developed (Larotonda et al., 2004). Natural polymer has been commonly utilized while the polymer that can be used including cellulose, starch, collagen, chitosan, protein (Shit & Shah, 2014). Some categories of the natural polymer include hydrocoloid, polypeptide, fat and synthetic polymer and composite that can be consumed (Shit & Shah, 2014). Some kinds of the developed edible packaging are using cassava (Larotonda et al., 2004), potato, cocoyam and sweet potato (Alobi et al., 2017), cassava (Alobi et al., 2017), sorghum (Kigozi et al., 2014), whey protein (Schmid et al., 2012), banana (Astuti & Erprihana, 2014), and seaweed (Siah, Aminah, & Ishak, 2015). Ice cream, classified as dessert, is produced from frozen dairy product containing milk solids (which may contain or not contain milk fat) and consumed in frozen form (Goff & Hartel, 2013). It has regular content of fat, high content of fat and non-fat. This product is packed in paper cup, plastic and cone made of upright and cone waffle.

The ice cream packaging should protect the product from external environmental factors (temperature, oxidation). It also has to be easy to distribute and eco-friendly (Deosarkar et al., 2016). One of the ice cream packaging types is cup made of paper or plastic. Plastic ice cream cup does not break easily although its is exposed to melted ice cream. Yet, it can cause an increase in the environmental waste amount. For this reason, edible ice cream cup can be a good alternative. Similar to the ice cream waffle cone which is made of wheat flour (Salo, 2014), edible ice cream cup also uses wheat flour as its main ingredient since it contains gluten which has elastic characteristic.

On the other hand, the variation in sweet potato commodity processing is still around chips product, substitution of bun and cake. According to the Central Statistics Agency (2015), the amount of sweet potato production in 2015 is up to 2,297,634 tons. However, this sweet potato consists of several types, while the most common type is white, yellow, orange and purple-fleshed sweet potato. However, purple sweet potato is still less known than any other types, although the antocyanin content of this type is considered high and becoming a source of natural antioxydant which can be beneficial for our body (Nurdjanah et al., 2017). Antocyanin content of purple sweet potato is relatively high, which is up to 519 mg/100gr of the wet weight. Purple sweet potato content is also dominated by high carbohydrate so that it becomes a potential ingredient that can be processed into flour. This purple sweet potato powder can be developed further into a disposable edible cup since this type of powder contains high starch, so that it is quite suitable for producing edible cup in order to get compact structure.

The advantage of purple sweet potato is that it contains antocyanin functioning as antioxydant (Nurdjanah et al., 2017) and natural food coloring. High starch content in purple sweet potato powder (Krochmal-Marczak et al., 2014) , that is around 14.70%-14.91%, is a potential subtitution ingredient of edible cup. Therefore, it can increase its added-value and lower the high demand of wheat flour. Edible ice cream cup requires low water content and water holding capacity. Basically, the only thing that differs cup and cone ice cream is its shape.

METHODS

Ayamurasaki purple sweet potato powder and wheat flour are the main raw ingredients. Sweet potatoes flour is processed from fresh sweet potatoes (3 – 7 days after being harvested). The ingredient used was purple sweet potato powder, more specifically the ayamurasaki variety. Wheat flour used in this study was Kunci Biru wheat flour which contains moderate protein (9-11%). Other additional ingredients included egg, blueband margarine and 'Cap Kapal' fine salt. Equipments used during this study including Memmert UN 55 53L oven, cup mold, cosmos mixer type CM-1579 , texture analyzer brookfield texture CT V1.4, glassware, stopwatch. Sweet potatoes' processing stage is presented in Figure 1.

Purple sweet potato powder produced using modification method (Sipayung, Herawati, & Rahmayuni, 2014) (Figure 1) was used to substitute flour in ice cream cup production. Sweet potato powder was combined with wheat flour since sweet potato powder has low protein content. Besides, wheat flour also has elastic protein, that is glutenin.

The experiment was designed by using Surface Response Method of Central Composite Design with 2 factors, which were the proportion of purple sweet potato and baking time. From the previous study, it is known that 100% purple sweet potato powder cannot be used as edible cup, so that it has to be combined with wheat flour. Therefore, treatment ratio determination in this study was conducted as following explanation.

Determining the level of the factors that would be identified. There are two factors covered in this study, those are purple sweet potato powder (X1) and baking time (X2). Each factor consists of two degrees, labeled by +1 and -1 and 0 as the center point. The observation on the center point was repeated for five times, in accordance to the 2 factor of central composite design. The factors of the planned design were:

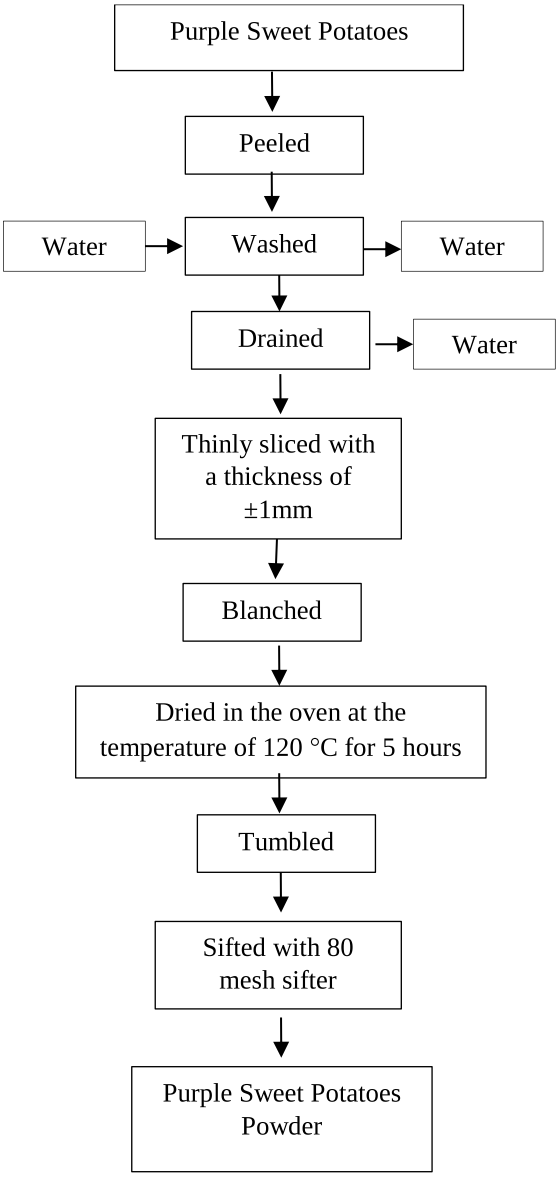


Figure 1. Processing Stages of the Purple Sweet Potato Powder (Modified form Sipayung, Herawati & Rahmayuni, 2014)

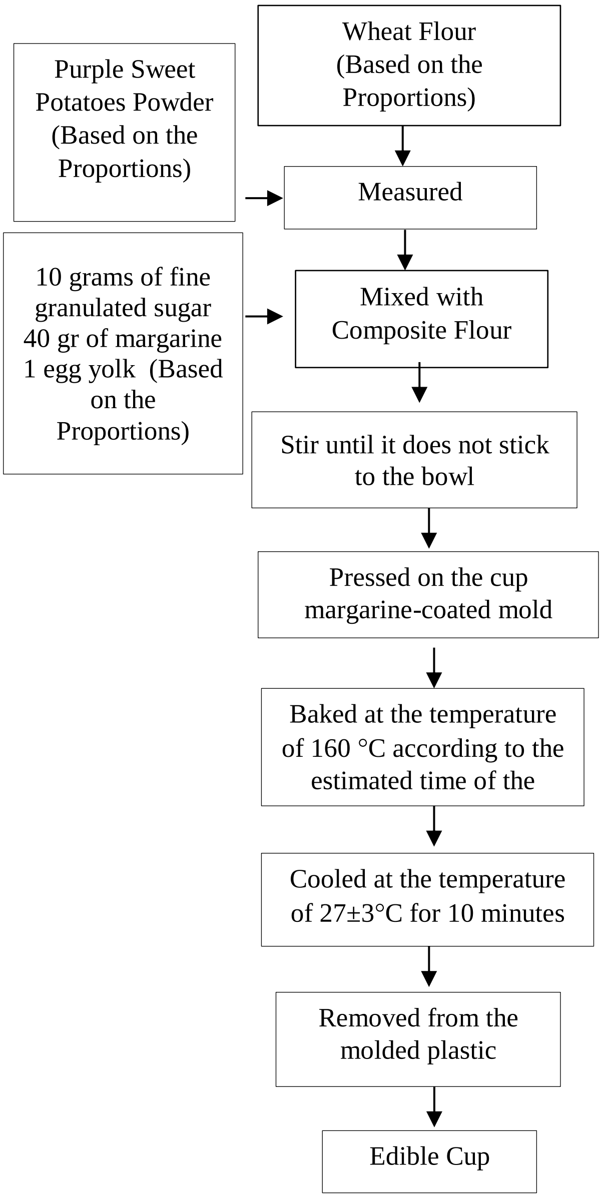


Figure 2. Stages of Edible Cup Production

1. Three degrees of the proportion of purple sweet potatoes powder (A)
   $X_1 \rightarrow$ (X_1= -1) = 45%
   (X_1= 0)* = 60%
   (X_1= +1) = 75%
   The difference between factor degrees = 15%
2. Three degrees of baking time (B)
   $X_2 \rightarrow$ (X_2=-1) = 25 minutes
   (X_2=0)* = 35 minutes
   (X_2=+1) = 45 minutes
   The difference between factor degrees = 310 minutes

The observed responses were including water content (Y1), resistance (Y2) and fracturability (Y3).

Figure 2 illustrate the stages of the experiment. The proportion of sweet potatoes with wheat flour and baking time is in compliance with the arranged experiment plan. The observation was performed on the raw ingredients by using some parameters, such as water content (Sudarmadji, Haryono, & Suhardi, 2010), protein content (Sudarmadji et al., 2010), carbohydrate (Sudarmadji et al., 2010), Fourier Transorm Infra

Red (FTIR) and Scanning Electron Microscope (SEM) Edx (Julinawati et al., 2015) Fracturability (Choy, Hughes, & Small, 2010) and supporting cup's ability were also observed (Aprilliani, Erungan, & Tampubolon, 2010). In ice cream cup, additional testing was performed against the optimization result, in the form of protein content (Sudarmadji et al., 2010), carbohydrate (Sudarmadji et al., 2010), FTIR and also organoleptic test.

RESULTS AND DISCUSSION

The Characteristic of the Raw Ingredients

Purple Sweet Potatoes Powder

Based on the proximate analysis result on purple sweet potato powder, it contained 43.47% of carbohydrate, 2.67% of protein and 7.24% of water content. The result of spectrum analysis by using FTIR method showed that purple sweet potato powder contained certain functional group such as N-H of amine and O-H – alcohol hydrogen/phenol bond, C - H aromatic ring that usually appeared in the wave length of 690 – 900 and 3010 – 3100 cm^{-1}, that are presented in Figure 3. Sukadana (2010) stated that C=O group and O-H group shows the existence of flavonoid compound class. Antioxydant nature of the flavonoid comes from its ability to transfer an electron to free radical compound (Xing et al., 2009; Mamonto, Runtuwene & Wehantouw, 2014). Purple sweet potato can be consumed as antioxydant source for body and also, its pigment can be used as natural coloring (Nurdjanah et al., 2017).

From the result of the observation on the purple sweet potato powder using SEM EDX (Figure 4), it can be seen that purple sweet potato powder has uneven surface. Uneven surface of the powder was expected due to the high content of amylopectin it contained, around 8.6% (Alobi et al., 2017), and also its high-fiber content (Krochmal-Marczak et al., 2014) that was 0.86 – 1.14 mg/100gr. High-fiber food are good for children that usually have lowfiber intake. Moreover, this product used purple sweet potato to wrap ice cream that is loved by most children. Nurdjanah et al. (2017) mentioned that heating process of the purple sweet potato at the temperature of 70-90 °C will decrease the thickness of the dough.

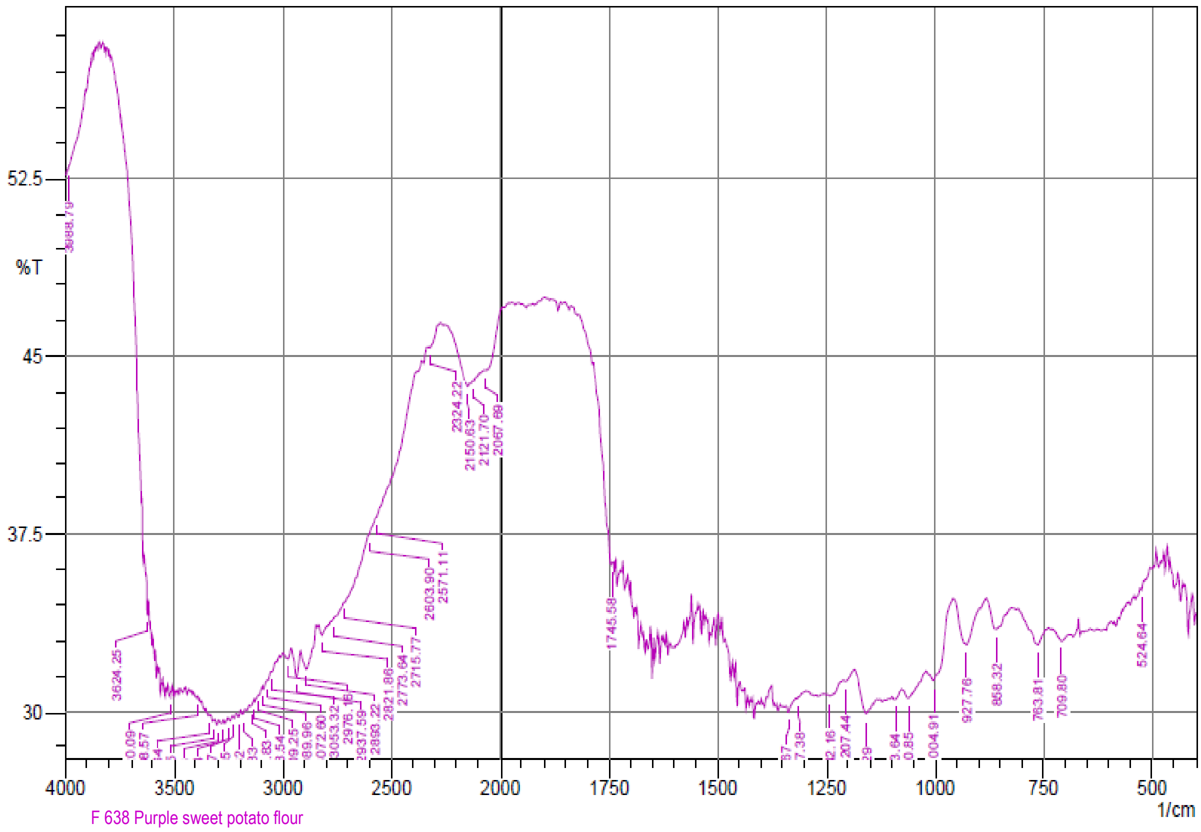
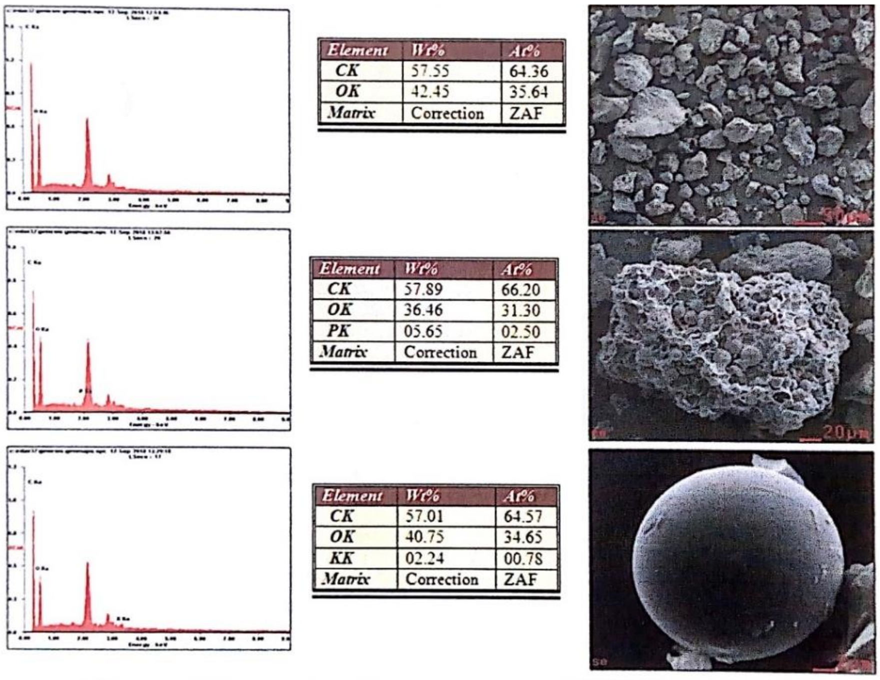


Figure 3. FTIR Graphic of Purple Sweet Potato



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Matrix	Correction	ZAF

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Matrix	Correction	ZAF

Element	Wt%	At%
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Figure 4. SEM EDX result of Purple Sweet Potatoes

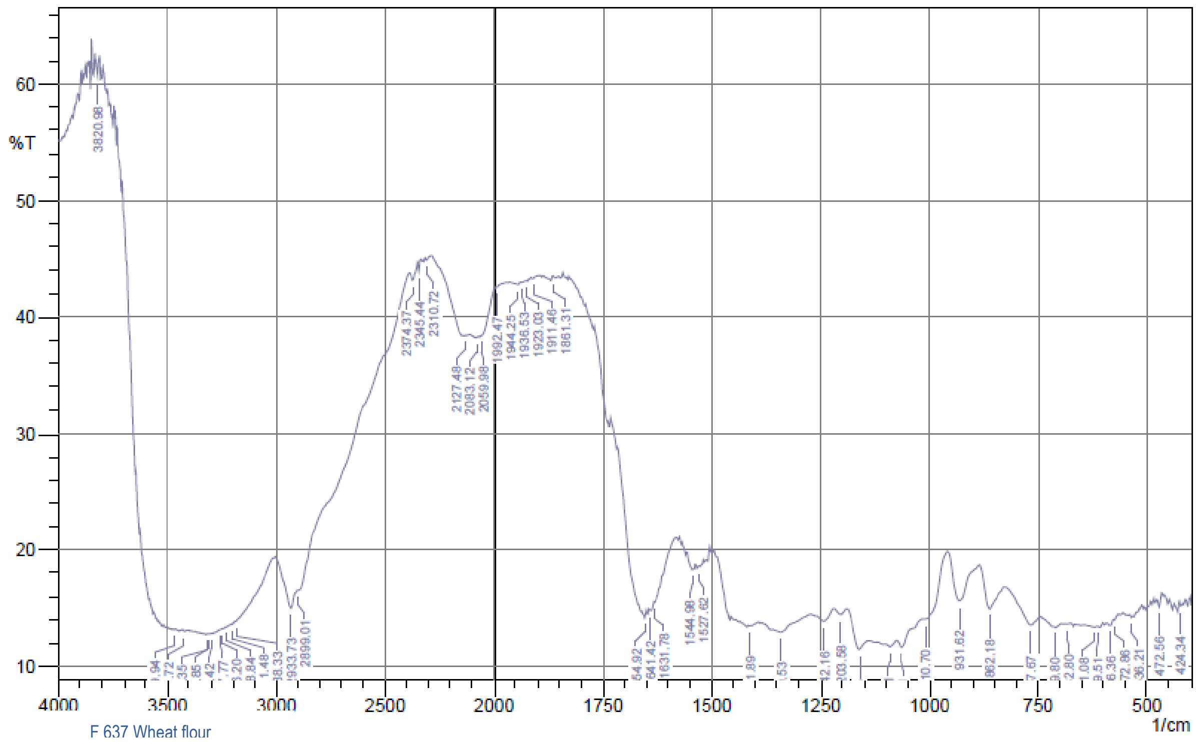


Figure 5. FTIR Graphic of Wheat Flour

<u>Wheat Flour</u>

Proximate content of wheat flour consists of 68.63% of carbohydrate content, 8.07% of protein and 13.15% of water content. From the result of spectrum analysis on wheat flour (Figure 5), it can be seen that there were functional groups of N-H of amine, and O-H of alcohol hydrogen/phenol bond, and C - H of alkane that usually appear at the wave length of 2850 - 2970 and 1340 - 1470 cm $^{-1}$. This indicates that wheat flour contains glutenin protein. SEM EDX analysis result (Figure 6) showed that wheat flour surface was more even, in accordance to its proximate content, which was high in carbohydrate and protein content. Wheat flour is a suitable ingredient to produce edible packaging.

Water Content

The average water content of the ice cream cup ranges from 3.11 – 6.74. The longer the baking time, the lower its water content. Meanwhile, the higher the proportion of purple sweet potato powder, the higher the water content. High proportion of purple sweet potato inhibits the water evaporation, This condition was in line/contrary to the study of Nurdjanah et al. (2017). Statistic model of the chosen water content response is linear model, since its p value is 0.0801 ($p>0.05$). From the result of variance analysis, it can be seen that the model, proportion treatment and baking time is not real different, and likewise the model lack-of-fit. The linear model was chosen based on the PRESS value of 15.34, yet its correlation value, R^2 =0.3964, shows that the model's correlation is low, which is only 39.6% with relatively high residue, that is 60.1%. This means that there is an impact beyond the model influencing treatment.

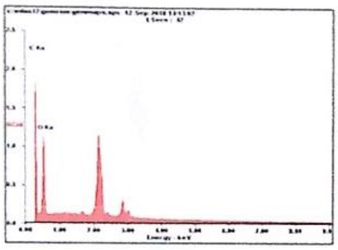
Adj R-Squared value shows a value of 0.2757, which indicated the correlation as many as 0.2757. In Design Expert 7 program, polynomial equation in the form of code variable in water content response of purple sweet potato ice cream cup was obtained as follows:

$$Y1 = 4.10 - 0.042X_1 - 0.81\ X_2$$

Model deviation value (Lack of fit) for water content response was 0.0899 ($p<0.05$) with insignificant status. This showed that linear model was still lack of certain aspects if it was used as a prediction.

Graphic of the result of the study was visualized in the form of contour plot and three dimensional model of the response surface which showed a relationship between two interconnected factors on the response. The relationship between the proportion factor of purple sweet potato powder and baking time on the water content response is shown in Figure 7.

In general, water content of the ice cream cup is relatively low, as the ingredients of ice cream packaging that were already appropriate as the water content of ice cream cone waffle also ranges from 3 – 4% (Salo, 2014). Further review process was needed to figure out cup's ability to protect the ice cream during storage and distribution process.



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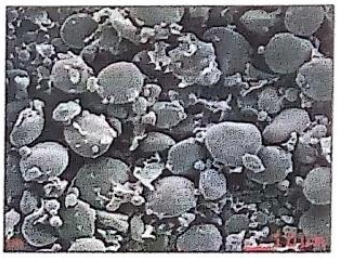

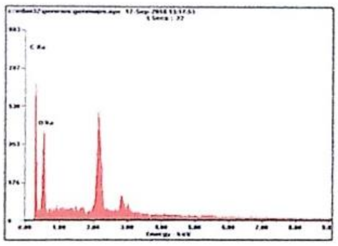

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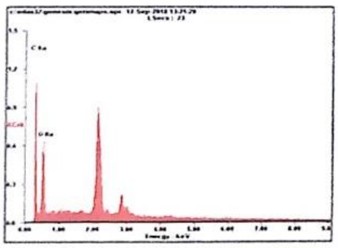

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Matrix	Correction	ZAF

Figure 6. SEM Edx Result of Wheat Flour

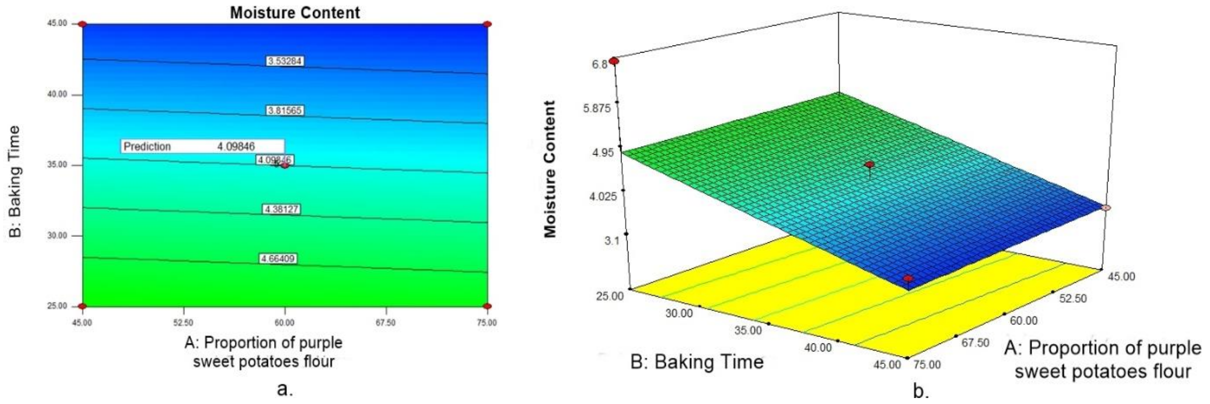

Figure 7. The Impact of the Proportions of Purple Sweet Potatoes Powder and Baking Time on the Water Content

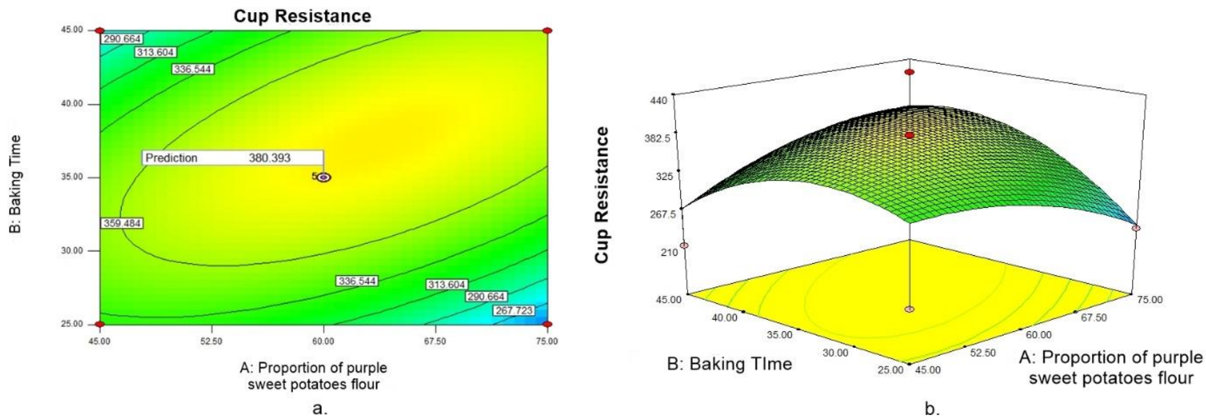

Figure 8. The Impact of Purple Sweet Potato Powder Proportions and Baking Time on the Cup Resistance

Cup Resistance

Quadratic model was selected as a model that influence the response of ice cream cup resistance, since its p value is 0.2376 ($p > 0.05$). This result shows that the error model chance was above 5%, so that the quadratic model brought real (significant) impact on cup resistance response. From the inaccuracy testing of the model, a value of 1.430E+0.005 was obtained. This value shows that the model inaccuracy was significant on the cup's resistance response. The estimated model brought insignificant impact, while model inaccuracy brought significant impact.

Based on the summary of the statistical model, PRESS value of the quadratic model is 2.930E + 0.05 and the R^2 value = 0.4278. This indicates that quadratic model is not able to explain a variety of the impact of purple sweet potato powder proportion and the baking time on the cup resistance, as the data which support the model was only 42.78%, while the residue value was higher, that was 58.22%, which explaining the error and other reviewed factors. The polynomial quadratic equation in the form of code is the response of cup resistance, which is explained as follows:

$$Y2 = 380.39 + 2.03X_1 + 14.26X_2 + 45.34X_1X_2 - 27.36X_1^2 - 50.69X_2^2$$

The visualization of contour plot and surface's three dimensional fracturability was presented in Figure 8. That image showed that a proportion factor of sweet potato powder and the baking time interact to cup resistance response. However, its interaction did not bring significant impact due to high baking temperature, which is 160 ˚C. Nurdjanah et al. (2017) stated that gelatinization process needs the temperature of 90 ˚C.

Fracturability

The average value of the fracturability varies from 0.25 – 0.60N. The fracturability response in the statistical analysis chosen was the quadratic model with p value of 0.1323 ($p > 0.05$). This shows that the chance of model error is more than 5%, so that the quadratic model did not bring significant impact on fracturability response. In the model, inaccuracy test which resulting that quadratic model was chosen because the p value is 0.484. This meant that the model inaccuracy on the fracturability response was insignificant. This indicates that quadratic model is suggested to use, yet it brings insignificant impact against the response, so that it needs to be fixed first. The polynomial quadratic equation in the form of code was the response of cup resistance, which was explained as follows:

$$Y3 = 0.32 + 0.025X_1 - 0.097X_2 - 0.100X_1X_2 - 0.020X_1^2 + 0.095X_2^2$$

The visualization of contour plot and surface's three dimension of the fracturability is presented in Figure 9. That image showed that a proportion factor of sweet potato powder and baking time interact to cup resistance response.

The highest fracturability value in the proportion treatment of purple sweet potato powder (60%) and baking time of 20.86 minutes was 0.7125N. Meanwhile, the lowest fracturability value in the proportion of purple sweet potato powder (60%) and baking time of 35 minutes was 0.125N. This is thought to be caused by higher amylopectin content than the amylose content in purple sweet potatao powder (Oluwole et al., 2014). According to Nindyarani, Sutardi & Suparmo (2011) amylose content of purple sweet potato powder ranges from 24.79±0.94% and its amylopectin content is as many as 49.78%. Albab & Susanto (2016) stated that high amylopectin products tend to produce frangible products since it is lightweight. On the contrary, high amylose content will bring hard texture.

Baking time and the proportion of the addition of purple sweet potato powder did not bring significant impact on the hardness level. It is expected that this condition is resulted from the narrow range used, so that it does not bring any significant impact on hardness level response. Too long baking process has caused too low water content. As a result, the product will be broken easily. Oluwole et al. (2014) stated that to make a crunchy texture of sweet potato processed products, the baking temperature should not be higher than 140 ˚C, while the experiment used the temperature of 160 ˚C.

Optimization of Water Content Response, cup Resistance and Fracturability

The optimization result of the prediction in the response analysis showed that the optimum water content is 3.25003% with the prediction limit in the range of 0.96% - 5.54% obtained from the proportion treatment of 75% purple sweet potato powder and baking time of 45 minutes. The optimization result of the prediction on ice cream cup resistance shown by RSM was 363.986 minutes with the prediction limit in the range from 132.73-595.24 minutes which was obtained from the proportion treatment of 75% purple sweet potato powder and baking time of 45 minutes. The optimization result of the prediction on the ice cream cup fracturability shown by RSM was 0.219805 N with the prediction limit ranges from −0.15 N to 0.59 N, which was obtained from the use 75% purple sweet potato powder and baking time of 45 minutes.

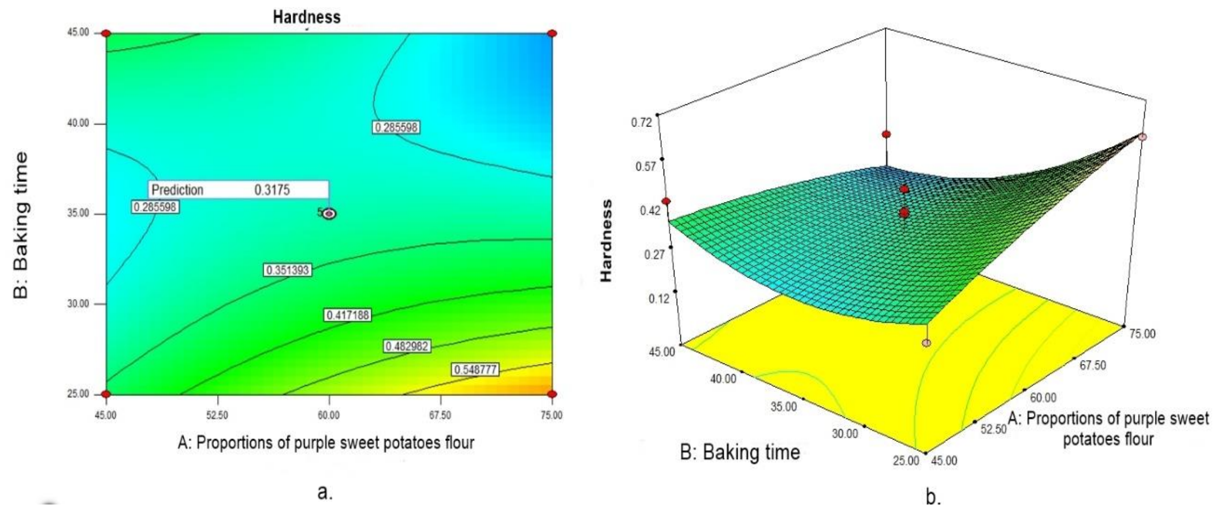

Figure 9. The Impact of Purple Sweet Potato Powder Proportions and Baking Time on the Fracturability

Table 1. Predicted value and result of the study

Parameter	The Lowest Prediction	Prediction	The Highest Prediction	Verification Result	The Difference	Deviation (%)
Water Content (%)	0.96	3.25003	5.54	4.37	1.111997	25.45
Cup Resistance (minutes)	132.73	363.986	595.24	253.64	110.346	43.50
Fracturability (N)	−0.15	0.219805	0.59	0.2125	0.007305	3.44

The Verification of the Optimum Condition of the Model Prediction Result.

Verification was performed to ensure that the recommended optimum condition in the computing result had similar response to the result of laboratory scale study. If the response value shown is different, then it will be compared to the minimum and maximum value of each response and the deviation of each response can be defined. The prediction value and the result of the studyis presented in Table 1.

In Table 1 it can be seen that the optimum result of the actual water content after being verified was 4.37%. The optimization result of the ice cream cup actual resistance after being verified was 260.384 minutes. The optimization result of the ice cream cup actual fracturability after being verified was 0.2125 N.

Overall, the verification result of each response is within the prediction range. Based on this condition, it can be said that RSM model relatively shows optimum water content response, cup resistance and fracturability. The verification result is within the prediction limit or meets the requirement determined by the RSM program.

Organoleptic

The verification result of the chosen ice cream cup remake was then analyzed using the organoleptic analysis, especially on its aroma, flavor, color and texture, to 30 panelists. Based on the organoleptic analysis performed to 30 panelists, the result was shown in Figure 10.

Based on the panelists' degree of liking, the highest average is the texture, which is around 5.2. This means that the product is liked by the people. Although the cup texture was favoured by the panelists, they also suggest to fix the texture so that it is not easily broken. The result of the study of Kigozi et al. (2014) shows that the panelists prefer the use of sorghum flour for ice cream cone production as it produces better texture. It needs further review process to figure out the use of sorghum flour as the replacement of wheat flour.

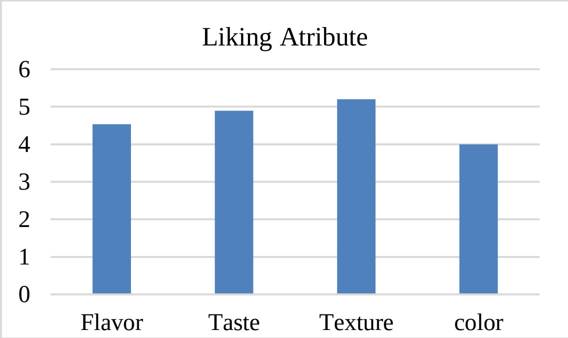

Figure 10. Graphic of the Average Degree of Liking of Ice Cream Cup

Figure 11. Purple Sweet Potatoes Cup with the Best Treatment

Meanwhile, the second position of the degree of likeness was the taste of ice cream cup with the average value of 4.89, which means that the taste of ice cream cup is already good and the cup is acceptable for the panelists. In addition, the taste of the ice cream cup does not really affect the taste of the ice cream. The third position of the degree of likeness is the aroma, with the average value of 4.5 which means that it is not really preferred, as the panelists does not really like the strong aroma of the purple sweet potato. The last degree of liking is the color, with the average value of 4 that means it is disliked by the panelists. The ice cream cup color that is considered too dark does not catch the panelists' attention as they do not think it represents the use of purple sweet potato powder in the ice cream cup dough.

Table 2. The interpretation of FTIR spectrum absorbance of purple sweet potato powder ice cream cup

No	Wave Value (cm^{-1})	Functional Group
1	2850 – 2970	C=H of alkane
2	2100 – 2260	C=C of alkyne
3	1690 – 1760	C=O of Aldehyde/ketone/carboxylic Acid
4	1500 – 1600	C-C aromatic ring
5	1050 – 1300	C-O of Alcohol
6	690 – 900	C-H of aromatic ring
7	675 – 995	C-H of alkene

The Analysis of Ice Cream Cup Cluster

The functional group of purple sweet potato ice cream cup is verified using the FTIR method. The spectrum analysis indicated that the absorbance of wave value from fraction is as shown in Table 2. Based on the FTIR analysis result, it can be figured out that purple sweet potato ice cream cup has functional group which has similar characteristic with starch and cellulose, shown by the characteristic of the functional group, which includes C-H of alkane, C=C of alkyna, C=O of aldehyde/ketone/carboxylic acid/ester, C-C group of aromatic ring, C-O of alcohol/ether/carboxylic acid/ester, C-H of aromatic ring and C-H of alkena.

CONCLUSION

The main component of the purple sweet potato ice cream cup is starch and cellulose as shown by the characteristic of the functional group, including C-H alkene, C=C alkyna, C=O aldehyde/ketone/carboxylic acid/ester, C-C group of aromatic ring, C-O alcohol/ether/carboxylic acid/ester, C-H of aromatic ring and C-H alkena. The amount of optimum substitution of purple sweet potato is 75% and the baking time is around 45 minutes with 4.37% of water content, 253.64 minutes of *cup* resistance, and 0.2125 N of fracturability.

References

Albab, S. U., & Susanto, W. H. (2016). Pengaruh proporsi mocaf dengan ubi jalar oranye danpenambahan baking powder terhadap sifat kerupuk cekeremes. *Jurnal Pangan Dan Agroindustri*, *4*(2), 515–524.

Alobi, N. O., Sunday, E. A., Magu, O., Oloko, G. O., & Nyong, E. (2017). Analysis of starch from non-edible root and tubers as sources of raw materials for the synthesis of biodegradable starch plastics. *Journal of Basic Sciences and Applied Research*, *3*(1), 27–32.

Aprilliani, I. S., Erungan, A. C., & Tampubolon, K. (2010). *Pemanfaatan Tepung Tulang Ikan Patin (Pangasius hypopthalmus) pada Pembuatan Cone Es Krim*. Skripsi. Departemen Teknologi Hasil Perairan. Fakultas Perikanan dan Ilmu Kelautan. Institut Pertanian Bogor. Bogor.

Astuti, P., & Erprihana, A. A. (2014). Antimicrobial edible film from banana peels as food packaging. *American Journal of Oil and Chemical Technologies*, *2*(2), 65–70.

Badan Pusat Statistik. (2015). *Produksi Ubi Jalar Menurut Provinsi (ton), 1993-2015*. Jakarta. Retrieved from https://www.bps.go.id/dynamictable/2015/09/09/883/produksi-ubi-jalar-menurut-provinsi-ton-1993-2015.html

Choy, A.-L., Hughes, J. G., & Small, D. M. (2010). The effects of microbial transglutaminase, sodium stearoyl lactylate and water on the quality of instant fried noodles. *Food Chemistry*, *122*(4), 957–964. https://doi.org/10.1016/j.foodchem.2009.10.009

Deosarkar, S. S., Khedkar, C. D., Kalyankar, S. D., & Sarode, A. R. (2016). Ice Cream: Uses and Method of Manufacture. In *Encyclopedia of Food and Health* (pp. 391–397). Elsevier. https://doi.org/10.1016/B978-0-12-384947-2.00384-6

Goff, H. D., & Hartel, R. W. (2013). *Ice Cream* (7th ed.). Boston, MA: Springer US. https://doi.org/10.1007/978-1-4614-6096-1

Julinawati, Marlina, Nasution, R., & Sheilatina. (2015). Applying SEM-EDX techniques to identifying the types of mineral of jades (giok) Takengon, Aceh. *Jurnal Natural*, *15*(2), 44–48.

Kigozi, J., Banadda, N., Byaruhanga, Y., Kaaya, A., & Musoke, L. (2014). Optimization of texture in sorghum ice cream cone production using sensory analysis. *The Open Food Science Journal*, *8*(1), 18–21. https://doi.org/10.2174/1874256401408010018

Krochmal-Marczak, B., Sawicka, B., Supski, J., Cebulak, T., & Paradowska, K. (2014). Nutrition value of the sweet potato (Ipomoea batatas (L.) Lam) cultivated in south – eastern Polish conditions. *International Journal of Agronomy and Agricultural Research (IJAAR)*, *4*(4), 169–178.

Larotonda, F. D. S., Matsui, K. N., Soldi, V., & Laurindo, J. B. (2004). Biodegradable films made from raw and acetylated cassava starch. *Brazilian Archives of Biology and Technology*, *47*(3), 477–

484. https://doi.org/10.1590/S1516-89132004000300019

Mamonto, S. I., Runtuwene, M. R. J., & Wehantouw, F. (2014). Aktivitas antioksidan ekstrak kulit biji buah pinang yaki (Areca vestiaria Giseke) yang diekstraksi secara soklet. *Pharmacon*, *3*(3), 263–272.

Nindyarani, A. K., Sutardi, & Suparmo. (2011). Karakteristik kimia, fisik dan inderawi tepung ubi jalar ungu (Ipomoea batatas Poiret) dan produk olahannya. *Agritech*, *31*(4), 273–280.

Nurdjanah, S., Yuliana, N., Astuti, S., Zukryandry, & Hernanto, J. (2017). Physico chemical, antioxidant and pasting properties of pre-heated purple sweet potato flour. *Journal of Food and Nutrition Sciences*, *5*(4), 140–146. https://doi.org/10.11648/j.jfns.20170504.11

Oluwole, O. B., Kosoko, S. B., Owolabi, S. O., Olatope, S. O. A., Alagbe, G. O., Ogunji, O. A., … Elemo, G. N. (2014). Effect of baking temperature on the quality of baked sweet potato crisps. *British Journal of Applied Science & Technology*, *4*(23), 3419–3429. https://doi.org/10.9734/BJAST/2014/10432

Salo, A. (2014). *Single-serve Ice Cream Packaging: Packaging Structures Enhancing Brand*. Tesis. Lahti University of Applied Sciences. Institute of Design and Fine Arts. Degree Programme in Design Packaging and Brand Design. Finland.

Schmid, M., Dallmann, K., Bugnicourt, E., Cordoni, D., Wild, F., Lazzeri, A., & Noller, K. (2012). Properties of whey-protein-coated films and laminates as novel recyclable food packaging materials with excellent barrier properties. *International Journal of Polymer Science*, *2012*, 1–7. https://doi.org/10.1155/2012/562381

Shit, S. C., & Shah, P. M. (2014). Edible polymers: Challenges and opportunities. *Journal of Polymers, 2014*, 1–13. https://doi.org/10.1155/2014/427259

Siah, W. M., Aminah, A., & Ishak, A. (2015). Edible films from seaweed (Kappaphycus alvarezii). *International Food Research Journal*, *22*(6), 2230–2236.

Sipayung, E. N., Herawati, N., & Rahmayuni. (2014). Potensi tepung ubi jalar ungu (Ipomoea batatas L.), tepung tempe dan tepung udang rebon dalam pembuatan kukis. *Jurnal Online Mahasiswa Fakultas Pertanian Universitas Riau*, *1*(1).

Sudarmadji, S., Haryono, B., & Suhardi. (2010). *Prosedur Analisa untuk Bahan Makanan dan Pertanian*. Yogyakarta: Liberty.

Sukadana, I. M. (2010). Aktivitas antibakteri senyawa flavonoid dari kulit akar awar-awar (Ficus septica Burm F). *Jurnal Kimia*, *4*(1), 63–70.

Wei, L. T., & Yazdanifard, R. (2013). Edible food packaging as an eco-friendly technology using green marketing strategy. *Global Journal of Commerce & Management Perspective*, *2*(6), 8–11.

Xing, Z., Wen-li, M., Yan-bo, Z., Jian, L., Wen-jun, D., & Hao-fu, D. (2009). Phenolic constituents from the fruits of Areca catechu and their anti-bacterial activities. *Journal of Tropical and Subtropical Botany*, *17*(1), 74–76.