

Optimization of Soursop (*Annona muricata* L.) Puree Concentration and Margarine on Quality of Muffins

Optimasi Konsentrasi Puree Buah Sirsak (Annona Muricata L.) dan Margarin terhadap Kualitas Muffin

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Abstract

Reducing the fat used in muffin production is necessary to produce muffins with low-fat content without changing physical characteristics. This reduction can be achieved by adding ingredients with high fiber content, such as soursop. This study aims to obtain the optimum concentration of soursop puree and margarine to produce muffins with the best texture, pore size, moisture content, and lowest fat content. The method used in this study is the Response Surface Methodology with the Central Composite Design using two factors, the concentration of soursop puree and margarine. The optimum treatment results obtained were the concentration of 16.159% soursop puree and 27.391% margarine with a hardness response of 3.390 ± 0.144 N, a pore size of 0.529 ± 0.046 mm², a fat content of $8.302 \pm 0.328\%$, and moisture content of $33.269 \pm 0.397\%$. The optimum muffins have fat content, fiber content, carbohydrate content, hardness, pore size, reddish, yellowish, and taste attributes that are significantly different from control muffins. Moisture content, ash content, protein content, volume expansion, baking loss, density, brightness, attributes of color, aroma, texture, pores, and overall were not significantly different from the control muffins.

Keywords: margarine, muffin, optimization, soursop puree

Abstrak

Penggunaan lemak perlu dikurangi untuk menghasilkan muffin dengan kadar lemak rendah tanpa mengubah karakteristik fisik. Hal ini dapat dilakukan dengan cara penambahan bahan yang memiliki kadar serat tinggi, salah satunya buah sirsak. Penelitian ini bertujuan untuk mendapatkan konsentrasi penambahan puree buah sirsak dan margarin yang optimum agar dihasilkan muffin dengan tekstur, ukuran pori, dan kadar air terbaik serta kadar lemak terendah. Metode yang digunakan pada penelitian ini adalah Response Surface Methodology dengan rancangan Central Composite Design menggunakan dua faktor, yaitu konsentrasi puree buah sirsak dan margarin. Hasil perlakuan optimum yang diperoleh adalah konsentrasi puree buah sirsak 16,159% dan margarin 27,391% dengan respon kekerasan $3,390 \pm 0,144$ N, ukuran pori $0,529 \pm 0,046$ mm², kadar lemak $8,302 \pm 0,328\%$, dan kadar air $33,269 \pm 0,397\%$. Muffin optimum memiliki kadar lemak, kadar serat, kadar karbohidrat, kekerasan, ukuran pori, kemerahan, kekuningan, dan atribut rasa yang berbeda signifikan dengan muffin kontrol. Kadar air, kadar abu, kadar protein, volume pengembangan, baking loss, densitas, kecerahan, atribut warna, aroma, tekstur, pori, dan keseluruhan tidak berbeda signifikan dengan muffin kontrol.

Kata kunci: margarin, muffin, optimasi, pure buah sirsak

INTRODUCTION

Muffins are bakery products that consumers appreciate because of their soft spongy texture and distinctive taste characteristics (Ureta, Olivera, & Salvadori, 2014). According to National Eating Trends data in 2012 (Agriculture and Agri-Food Canada, 2012), muffins consumption reaches 12%

of sweet food consumption. Muffins have several physical and chemical parameters that serve as quality standards for these products, including texture, pore size, moisture content, and fat content (Phillips, 2000). The texture and pore size of muffins is essential because it can determine consumer acceptance. Good muffins have a dense but soft texture, moist, not crumbly, have uniform

small pore sizes, and are evenly distributed throughout the crumb (Lionora, Dewi, & Rahaju, 2013). Water content is one of the parameters that affect muffins' texture and pore size.

Muffins contain a relatively high-fat content of around 18-22 g/100 g of ingredients. The fat comes from margarine, which plays an essential role in trapping gas and producing a soft texture. The high-fat content in muffins can contribute to significant calorie intake (Centers for Disease Control and Prevention, 2017). If not balanced with a healthy lifestyle, a large calorie intake can lead to various diseases, such as obesity and heart disease. Margarine also has adverse effects on health if consumed in excess because margarine generally contains saturated fat and trans fat, both can trigger an increase in bad cholesterol in the body (Dhaka et al., 2011). The fat used in muffins production needs to be reduced to produce low-fat content muffins without changing their physical characteristics, making them healthier for consumption.

One way to reduce fat in muffins production is by adding ingredients containing high fiber content, such as soursop (Mrabet et al., 2016). Fiber acts as a fat replacer that can bind water so that it can keep the muffins moist. Soursop contains fiber (3.3 g/100 g), has a distinctive aroma, slightly sour taste, and contains antioxidants beneficial to health (Zabidi & Yunus, 2014). Antioxidants in soursop consist of polyphenols (0.473 g/100 g) and vitamin C (38.24 mg/100 g) (Prasetyorini et al., 2014). According to Statistics Indonesia, soursop has considerable potential because its production in Indonesia reached 62,282 tons in 2017, this figure increased by 11.38% from 2016 (Badan Pusat Statistik, 2018). However this abundant production has not matched optimal utilization. Generally, soursop is only processed into juice, jam, and ice cream, so that it requires diversification of soursop processing by adding it to muffins production.

The addition of soursop in muffins production needs to be limited because it can affect the muffins' texture and pore size. Soursop fiber can reduce gluten's ability to trap gas which causes the texture of muffins to more rigid, and the pore size is not even (Hussien, 2016). This study aims to obtain the optimum concentration addition of soursop puree and margarine to produce muffins with the best texture, pore size, moisture content, and lowest fat content. The concentration used for optimization based on preliminary research was the addition of 15% soursop puree as the lower

limit and 70% as the upper limit and the margarine concentration of 10% as the lower limit, and 45% as the upper limit.

METHODS

Materials

The ingredients used for muffins production are ripe soursop flesh, salt, sugar, and eggs obtained from Pasar Besar Malang, East Java, Indonesia, medium protein flour (Segitiga Biru), full cream milk powder (Indomilk), special margarine cake and cookies (Blue Band), vanilla, and baking powder (Hercules). Materials for chemical analysis are H₂SO₄ (Merck), distilled water, NaOH (Merck), 95% ethanol (Merck), boiling stone, HNO₃, HCl, H₃BO₃ (boric acid), methyl red indicator, pp indicator, and petroleum ether.

Equipment

The equipment used for muffins production is electric oven (Kirin), a hand mixer (Cosmos), a blender (Philips), a digital scale, a baking sheet, muffin cups, and a 40 mesh sieve. The equipment for chemical analysis processes is electric ovens (Memmert), electric furnaces (Thermolyne), electric stoves (Maspion), soxhlet extractors, Kjeldahl distillation units (Buchi), desiccators (Simax), fat flasks, Kjeldahl flasks (Buchi), fume hoods, burette, static, texture analyzer (Imada ZP-200 N), a color reader (Konica Minolta), fat-free cotton, fine filter paper, and other glassware.

Research design

The study was compiled using the Response Surface Methodology with a two-factor Central Composite Design, the concentration of soursop puree with a lower limit of 15% and an upper limit of 70% and margarine with a lower limit of 10% and an upper limit of 45%. The combination of experiments and optimization results was verified three times, then analyzed using a paired t-test (p-value > 0.05). Physical, chemical, organoleptic characteristics tests, and fat-reduced calculations were carried out on the optimum muffins. The test results were compared using a paired t-test (p-value > 0.05) with control muffins (muffins without soursop puree addition).

Research Stages

The research was conducted into two stages, preliminary research and main research. Preliminary research was conducted to obtain a concen-

trated formulation of soursop puree and margarine in muffins production. In preliminary research, muffins were made with the concentration of soursop puree to margarine ratio of 80:10, 10:15, 42,5: 27,5 and 70:45, then observed in texture, pores, color, taste, and aroma that were closest to the characteristics. muffins on the market. The main research was conducted to obtain the optimum concentration of soursop puree and margarine to produce muffins with the best texture, pore size, moisture content, and lowest fat content.

Methods

Muffin production begins with mixing the wet and dry ingredients separately. Dry ingredients include 120 g of wheat flour, 7 g of baking powder, and 1.25 g of salt, while wet ingredients include 65 g of sugar, 2 g of vanilla, 54 g of eggs, 12 g of milk, margarine, and soursop puree. The mixing of the wet ingredients into the dry ingredients is carried out after each ingredient is evenly mixed. The finished dough is then put in a muffin cup and baked at a temperature of 175 °C for 35 minutes.

The analysis was carried out on the soursop puree, which includes the water content of the gravimetric method (Modification of Indonesian National Standardization (SNI) 01-2891-1992 (Badan Standardisasi Nasional, 1992)), the fat content of the soxhlet method (Association of Official Analytical of Chemist (AOAC), 2005), and crude fiber content (AOAC, 2005). The analysis on the optimized muffins includes physical characteristics (texture using the Imada ZP-200N Texture Analyzer, pore size using ImageJ software, volume development using the rapeseed displacement method, density, baking loss, and color using a color reader), chemical characteristics (moisture content, ash, protein, fat, crude fiber, and carbohydrates by difference), organoleptic characteristics (hedonic test with 100 untrained panelists on two samples, optimum and control muffins), and the calculation of reduced-fat.

Analysis Procedure

Fat Content Analysis of Soxhlet Extraction Method (AOAC, 2005)

The 3 g sample was wrapped in filter paper and covered with a fat-free cotton swab. The sample was placed in a Soxhlet extraction device. Fat flask, which weight is known, is attached to the tool then filled with solvent. The extraction was carried out for 5 hours by flowing cooling water.

The flask containing fat is then dried in an oven at 105 °C for 1 hour, and the drying result is weighed. The drying process was carried out again in an oven at 105 °C for 4 hours. The product was then put into a desiccator and weighed. The treatment was repeated until a constant weight was obtained (≤ 0.0005 g).

Gravimetric Method Water Content Analysis (Modification of Indonesian National Standardization (SNI) 01-2891-1992 (Badan Standardisasi Nasional, 1992))

The aluminum plates were oven-dried at 105 °C for 4 hours. A sample of 3 g was placed in an aluminum plate with a known weight and then oven-dried at 105 °C for 4 hours. The drying product is put into a desiccator and then weighed. The treatment was repeated until a constant weight was obtained (≤ 0.0005 g).

Texture Analysis (Hardness) (Modified AACC, 2000)

Samples were left for 30 minutes at room temperature after the roasting process, and then their hardness was measured using a universal testing machine as many as 3 points (tip, center, and base of the sample). The results obtained are averaged to obtain the hardness value (Newton).

Pore Size Analysis using ImageJ Software (Lin & Holten-Andersen, 2014)

The sample was sliced vertically and then scanned. The sample scans were selected and cropped to 4 x 4 cm. The results were processed using ImageJ software.

RESULTS AND ANALYSIS

Soursop Puree Chemical Characteristic

The soursop puree analysis results, including moisture content, fat content, and crude fiber content, are shown in Table 1. High water content in soursop puree (especially free water), can cause the dough to be too thin and the product to collapse when added to the dough. This high water content will give the muffins a tougher texture, as the water will evaporate during the baking process, resulting in drier crumb muffins. Muffin's hardness is also related to pores. If the number of pores is small and the size is large, the muffins' texture will get tougher (Bartolozzo, Borneo, & Aguirre, 2016). The low-fat content of soursop did not significantly affect the fat content of muffins. Fat plays a role in the formation of texture, moisture

from crumbs, mouthfeel, and in the aeration process for constructing pores in muffin products (Ain, Marina, & Sakinah, 2016). The crude fiber content in soursop can be used as a fat replacer which can reduce fat in bakery product production because of its ability to bind water and produce sensory effects similar to fat (Onacik-Gür et al., 2016).

Optimization Results on Muffin Texture, Pore Size, Fat Content, and Moisture Content

Table 2 shows the optimization of soursop puree and margarine concentration on the texture, pore size, fat content, and muffins' water content.

Hardness Response Analysis

The model suggested by the Design Expert is a quadratic model. The analysis of variance (ANOVA) results for the response to hardness is presented in Table 3. The actual similarities of the selected models on the response to hardness are as follows:

$$Y = +6.70813 - 0.047647A - 0.15287B - 7.27273E-005AB + 9.21686E-004A^2 + 2.27600E-003B^2. \quad (1)$$

Figure 1 shows the relationship graph between variables on the response to hardness. Figure 1 explains that the hardness value will decrease if the lower the concentration of soursop puree and the higher the margarine concentration. The fiber in soursop has a water holding capacity that can bind and retain water until its saturation point. The addition of soursop at a particular concentration can keep the muffin moist and produce a softer texture. Research by Martínez-Cervera et al. (2011) proved that the addition of fat replacer from brown fruit fibers at low to medium concentrations (11.5-23%) could reduce the hardness of the product when compared to controls. Still, the addition of a higher fat replacer (34.5%) would increase the product's hardness. The increase in product hardness can occur because the fiber has reached its saturation point in binding water. The amount of free water that is not bound by the fiber will evaporate during the baking process, and the dry crumb is produced. Margarine plays a role in providing moisture to muffins because it has properties as a softener. Margarine fat will coat the starch-protein matrix to produce muffins with a soft texture (Hussien, 2016).

Table 1. Chemical characteristics data of soursop puree

Component	Soursop Puree		p-value
	Analysis Results	Reference ^a	
Water Content (% weight)	84.38 ± 0.19*	81.16	0.001
Fat content (% weight)	0.30 ± 0.01	0.30	0.667
Crude fiber content (% weight)	3.41 ± 0.20	3.30	0.449

Each data analysis result is the mean of 3 replications ± standard deviation.

^a = United States Department of Agriculture, Food Data Central ID 167761 (United States Department of Agriculture, 2019)

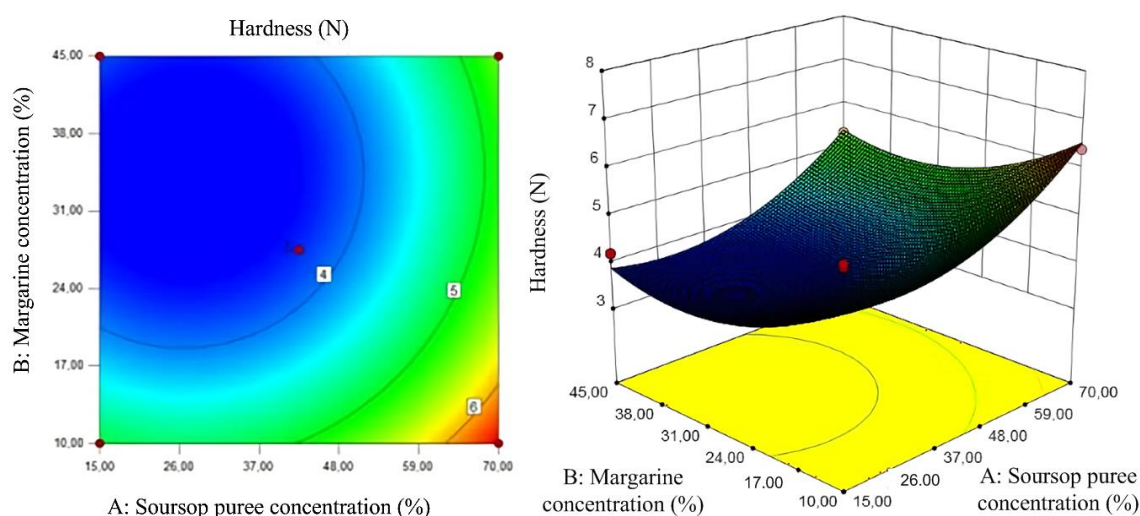
* significantly different from the reference

Table 2. Response analysis results data

Std	Run	Concentration of Soursop Puree (%) X ₁	Margarine Concentration (%) X ₂	Hardness (N) R ₁	Pore Size (mm ²) R ₂	Fat Content (%) R ₃	Water Content (%) R ₄
1	3	15.00	10.00	5.13	1.11	5.25	33.86
2	12	70.00	10.00	6.40	1.80	4.93	41.33
3	4	15.00	45.00	4.22	0.89	12.30	32.97
4	5	70.00	45.00	5.33	1.09	10.16	40.14
5	10	3.61	27.50	3.70	0.32	9.70	27.86
6	6	81.39	27.50	6.47	0.98	7.84	42.81
7	8	42.50	2.75	5.90	2.10	3.68	39.35
8	13	42.50	52.25	4.27	1.45	12.97	34.44
9	2	42.50	27.50	3.67	0.67	8.80	37.86
10	1	42.50	27.50	3.90	0.67	8.70	36.57
11	7	42.50	27.50	3.67	0.69	8.35	36.19
12	11	42.50	27.50	3.70	0.65	8.30	36.02
13	9	42.50	27.50	3.97	0.68	8.29	36.51

Table 3. Results of analysis of variance (ANOVA) hardness response

Source	Sum of Squares	Df	Mean Square	F Value	p-value Prob > F	
Model	13.29	5	2.66	41.77	< 0.0001	Significant
A- Soursop Puree Concentration	4.98	1	4.98	78.31	< 0.0001	Significant
B- Margarine Concentration	2.32	1	2.32	36.49	0.0005	Significant
AB	4.900E-003	1	4.900E-003	0.077	0.7894	Not significant
A ²	3.38	1	3.38	53.12	0.0002	Significant
B ²	3.38	1	3.38	53.12	0.0002	Significant
Residual	0.45	7	0.064			
	Lack of Fit	0.36	0.12	5.97	0.0586	Not significant
	Pure Error	0.081	0.020			
Cor Total	13.73	12				

**Figure 1.** Hardness Response Surface Graph**Table 4.** Results of analysis of variance (ANOVA) in response to pore size

Source	Sum of Squares	Df	Mean Square	F Value	p-value Prob > F	
Model	3.09	5	0.62	3052.09	< 0.0001	Significant
A- Soursop Puree Concentration	0.42	1	0.42	2053.13	< 0.0001	Significant
B- Margarine Concentration	0.43	1	0.43	2108.77	< 0.0001	Significant
AB	0.059	1	0.059	292.90	< 0.0001	Significant
A ²	4.635E-004	1	4.635E-004	2.29	0.1740	Not significant
B ²	2.14	1	2.14	10578.92	< 0.0001	Significant
Residual	1.417E-004	7	2.024E-004			
	Lack of Fit	7.782E-004	2.594E-004	1.62	0.3178	Not significant
	Pure Error	6.388E-004	1.597E-004			
Cor Total	3.09	12				

Pore Size Response Analysis

The model suggested by the Design Expert is a quadratic model. The analysis of variance (ANOVA) for the pore size response is presented in Table 4. The actual equation of the selected models in the pore size response is as follows:

$$Y = +1.73588 + 0.016163A - 0.10209B - 2.52987E-004AB - 1.07934E-005A^2 +$$

$$1,81171E-003B^2. \quad (2)$$

Figure 2 shows a graph of the relationship between variables to the pore size response. Figure 2 explains that the pore size will decrease if the concentration of soursop puree is lower and the margarine concentration is higher. The decrease in pore size caused by the fat and fiber in the dough

at a specific concentration increases gluten's stability in trapping air. Good gluten stability will result in a small pore size because the product's pores will remain stable and not easily blend, resulting in a larger pore size. Good quality gluten will produce many air bubbles of a small and even size (Sabanis, Lebesi, & Tzia (2009). The air bubbles will be maintained not to expand too large and stick together so that the product has a small and even crumb structure with good expansion.

Fat Content Response Analysis

The model suggested by the Design Expert is the 2FI model. The analysis of variance (ANOVA) for the response to fat content is presented in Table 5. The actual equation of the selected model in response to fat content is as follows:

$$Y = +3.29314 + 2.82625E-003A + 0.22167B - 9.44416E-004AB. \tag{3}$$

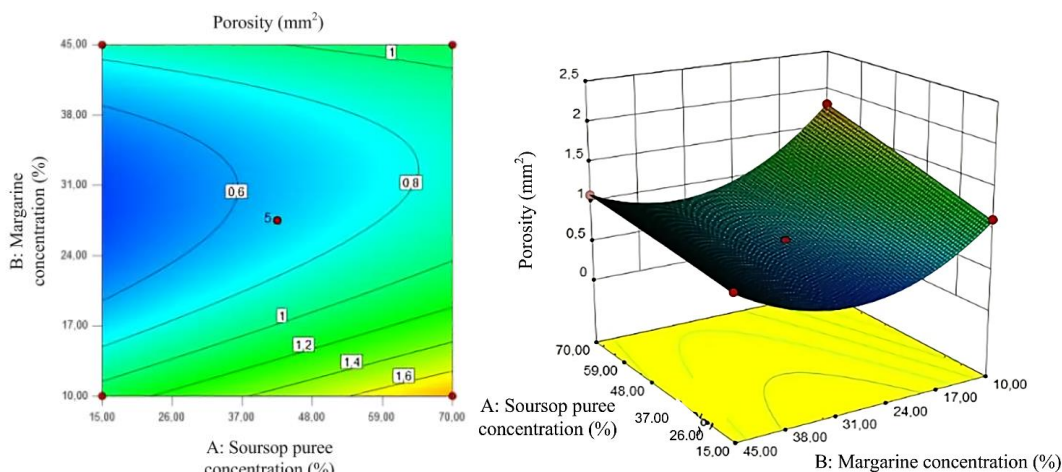


Figure 2. Pore Size Response Surface Graph

Table 5. Results of analysis of variance (ANOVA) in response to fat content

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F		
Model	84.81	3	28.27	284.70	< 0.0001	Significant	
A- Soursop Puree Concentration	3.24	1	3.24	32.64	0,0003	Significant	
B- Margarine Concentration	80.74	1	80.74	813.15	< 0.0001	Significant	
AB	0.83	1	0.83	8.32	0.0180	Significant	
Residual	0.89	9	0.099				
	Lack of Fit	0.66	5	0.13	2.22	0.2302	Not significant
	Pure Error	0.24	4	0.059			
Cor Total	85.70	12					

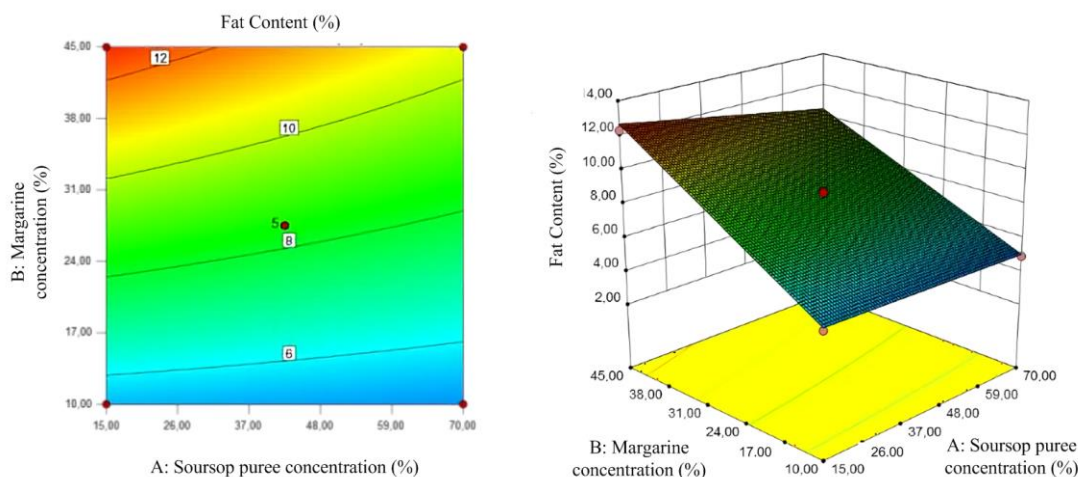


Figure 3. Fat Content Response Surface Graph

Figure 3 shows the graph of the relationship between variables on the response to fat content. Figure 3 explains that margarine concentration affects muffins' fat content more than the concentration of soursop puree. Soursop puree contains a relatively low fat (0.3%), but high concentrations of addition will increase muffins' fat content. The addition of soursop puree only increases the amount of fat in the ingredients in a very minimal amount because of its very low-fat content, which is 0.3%. This addition only causes the total amount of raw materials to be more which causes less fat to be counted during the analysis process (United States Department of Agriculture, 2019). The fat calculated during the analysis will be divided by the total ingredients. If the total ingredients are increasing, the fat content tends to be lower. If the total ingredients are low, the calculated fat content tends to be higher (Rios et al., 2014).

Water Content Response Analysis

The model suggested by the Design Expert is a linear model. The analysis of variance (ANOVA) for the response to water content is

presented in Table 6. The actual equation of the selected model in response to moisture content is as follows:

$$Y = +31.46990 + 0.16263A - 0.064447B. \quad (4)$$

Figure 4 shows the relationship graph between variables to the water content. Figure 4 explains that there is no interaction between the two factors. The water content will increase with the addition of the soursop puree concentration. Soursop contains high water content of up to 81.16%. This water will significantly affect the muffins' moisture content when added to the dough (United States Department of Agriculture, 2019). The fiber content in the soursop also causes the bound water content to be higher because the fiber absorbs water. Bonded water requires a higher temperature to evaporate than free water during the baking process. Materials that contain more bound water will produce a higher water content because the bound water will not evaporate during the baking process (Mildner-Szkudlarz et al., 2016).

Table 6. Result of analysis of variance (ANOVA) response to water content

Source	Sum of Squares	Df	Mean Square	F Value	p-value Prob > F		
Model	170.19	2	85.09	58.27	< 0.0001	Significant	
A- Soursop Puree Concentration	160.01	1	160.01	109.56	< 0.0001	Significant	
B- Margarine Concentration	10.18	1	10.18	6.97	0.0247	Significant	
Residual	14.60	10	1.46				
	Lack of Fit	12.50	6	2.08	3.96	0.1020	Not significant
	Pure Error	2.10	4	0.53			
Cor Total	184.79	12					

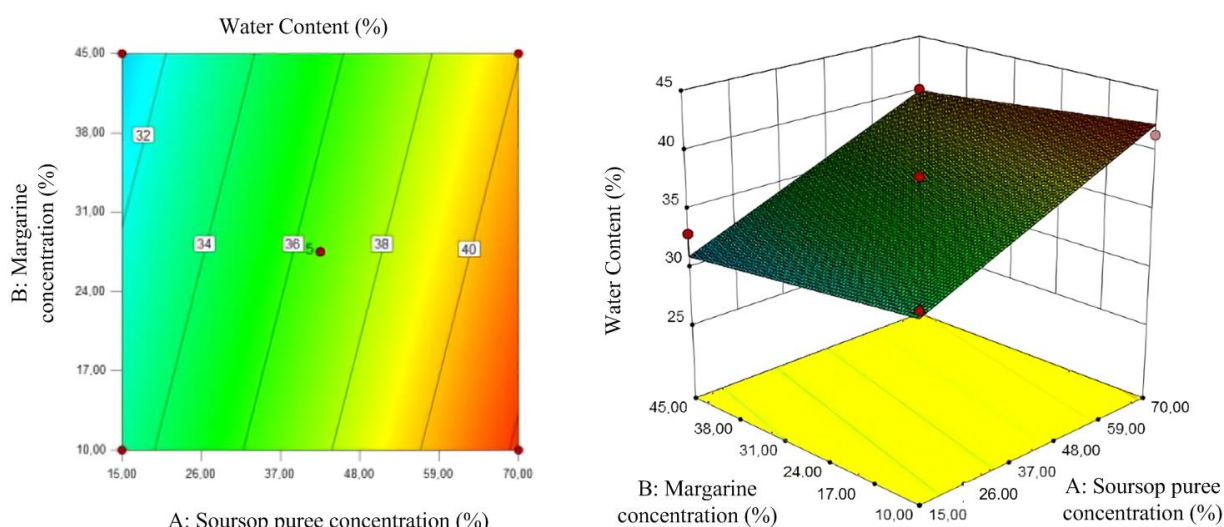


Figure 4. Water Content Response Surface Graph

Determination of Soursop Muffin Optimal Point

The optimum point of concentration of soursop puree and margarine given by the Design Expert 10.0.8 application is the concentration of soursop puree 16.148% and margarine 27.396%. The optimum point resulted in a hardness value of 3.667 N, a pore size of 0.445 mm², a fat content of 8.994%, and a moisture content of 32.330%. The optimum point results and response predictions from the Design Expert 10 application give a desirability value of 0.894.

Verification of Soursop Muffins Optimum Results

Verification is carried out to prove the suitability of the predicted value at the optimum point suggested by the application with the actual value at the time of analysis. Verification was carried out by applying the optimum point solution results from the actual program, 16.148% soursop puree concentration, and 27.396% margarine concentrations. The results obtained were then compared with the solutions given by the program in terms of hardness, pore size, fat content, and moisture content using a paired t-test with a p-value of more than 5%. The verification results are shown in Table 7.

The verification results were not significantly different from the prediction indicated by the calculation of the paired t-test, which resulted in a

p-value > 0.05. A p-value greater than 0.05 indicates that the two data are the same or not significantly different. In contrast, a p-value less than 0.05 that the two data are significantly different (Kim, 2015).

Optimum Muffin Chemical Characteristics

Chemical analysis was carried out to determine the effect of the concentration factor of soursop puree and margarine on the muffins' chemical characteristics. The results of the analysis were then compared with the control to determine the differences in the chemical characteristics of the muffins with the addition of the optimum soursop puree and margarine. The Analysis results can be seen in Table 8.

The water, ash, and protein content of the optimum muffins were not significantly different when compared to the control muffins (p-value > 0.05), which means that the addition of soursop puree and the reduction of margarine did not affect the moisture, ash, and protein content of the muffins (Table 8). The optimum and control muffin fat content was significantly different (p-value < 0.05). This difference is caused by the amount of margarine used in making the optimum muffins less than the control muffins. The margarine added to the optimum muffins was 27.396%, while the control muffins used 45% margarine. The fat in muffins provides texture, flavor, and aroma (Bashir et al., 2015).

Table 7. Verification results of soursop muffins

	Soursop Puree Concentration (%)	Margarine Concentration (%)	Hardness (N)	Pore Size (mm ²)	Fat Level (%)	Water Content (%)
Predictions			3,667	0,445	8,994	32,330
Actual	16,148	27,396	3,390 ± 0,144	0,529 ± 0,046	8,302 ± 0,328	33,269 ± 0,397
Paired T-test			0,080	0,087	0,067	0,055

Each data analysis result is the mean of 3 replications ± standard deviation.

Table 8. Optimum muffins' chemical characteristics compared to control muffins.

Component	Optimum Muffins	Control Muffins	p-value
Water content (% wb)	33.27 ± 0.40	34.13 ± 1.30	0.280
Ash content (% wb)	2.12 ± 0.07	1.95 ± 0.08	0.111
Protein content (% wb)	4.59 ± 0.28	4.89 ± 0.07	0.142
Fat content (% wb)	8.30 ± 0.33*	13.66 ± 0.54	0.007
Crude fiber content (% wb)	1.83 ± 0.13 *	1.27 ± 0.12	0.016
Carbohydrate content (by difference) (% bb)	51.72 ± 0.85 *	45.38 ± 1.87	0.019

Data were the mean of 3 replications ± standard deviation.

* significantly different from the controls

The optimum crude fiber content of muffins and control was significantly different (p -value < 0.05). This difference is caused by soursop puree addition to the optimum muffin with a crude fiber content of 3.3% soursop (United States Department of Agriculture, 2019). The higher addition of soursop puree, the higher muffins' fiber content. The optimum muffins have carbohydrate content which is significantly different from the control muffins (p -value < 0.05). The carbohydrate content was calculated in this study using the by-difference method. The difference in the amount of other chemical components such as moisture, ash, protein, and fat content dramatically affects the carbohydrates obtained. If the levels of components other than carbohydrates are very low, the carbohydrate result content will be

higher. If the levels of components other than carbohydrates are very high, the carbohydrate content result will be lower (Nollet & Toldra, 2015).

Optimum Muffin Physical Characteristics

The physical analysis was performed to determine the effect of the concentration factor of soursop puree and margarine on the muffins' physical characteristics. The analysis results were then compared with the control to determine the differences in the muffins' physical characteristics with the addition of the optimum soursop puree and margarine. Muffins' physical characteristics shown in Figure 5. The analysis results are shown in Table 9.

Table 9. Muffins optimum physical characteristics compared to the control muffins

Analysis	Optimum Muffin	Control Muffin	p-value
Hardness (N)	$3.39 \pm 0.14^*$	2.34 ± 0.21	0.009
Pore size (mm ²)	$0.53 \pm 0.05^*$	0.81 ± 0.06	0.002
Expands volume (%)	46.59 ± 1.97	48.89 ± 3.85	0.354
Baking loss (%)	13.30 ± 0.12	13.51 ± 0.94	0.772
Density (g/ml)	0.67 ± 0.01	0.65 ± 0.02	0.162
Color			
Brightness (L*)	66.40 ± 0.96	68.40 ± 1.21	0.194
Redness (a*)	$-3.50 \pm 0.26^*$	-2.30 ± 0.10	0.007
Yellowness (b*)	$27.00 \pm 1.27^*$	33.30 ± 1.05	0.034

Data were the mean of 3 replications \pm standard deviation.

* significantly different from the controls

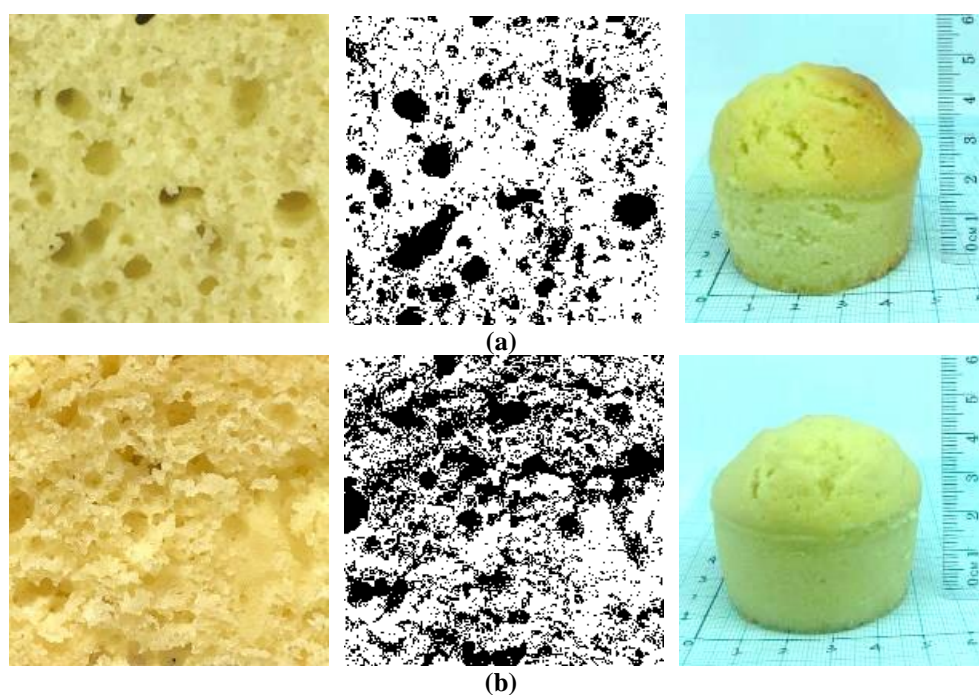


Figure 5. Muffins' Physical Characteristics (a) Control Muffin and (b) Optimum Muffin

Table 9 shows that the optimum and control muffins' hardness value is significantly different (p -value < 0.05). This difference is due to soursop puree addition, which contains fiber, so it provides more excellent mechanical resistance during compression. Fiber can also cause crumb matrices to be more compact and reduce muffins' softness (Rismaya, Syamsir, & Nurtama, 2018). The optimum muffin hardness was also higher when compared to the control because of the decrease in the amount of fat used. Fat plays a role in producing a soft texture because it can lubricate and coat the flour grains to prevent water absorption, thus inhibiting the starch gelatinization process (Colla, Costanzo, & Gamlath, 2018).

The optimum and control pore size values were significantly different (p -value < 0.05). This difference is caused by the addition of soursop puree, which contains fiber. A particular concentration of fiber will bind water and increase the dough's consistency, which can cause the rate of gas development during the baking process to decrease so that the pores are smaller (Sabani et al., 2009). The muffin's optimum pore size is also lower than the control because of the decrease in fat used. Reducing the amount of fat in the dough due to fat replacer causes a decrease in the number of air bubbles trapped in the dough during the stirring and baking processes (Hussien, 2016).

The expands volume, baking loss, density, and brightness (L^*) of the optimum muffins were not significantly different from the control muffins (p -value > 0.05). Those characteristics indicate that the optimization results of the muffin formulation are pretty good. However, other additives may affect the muffins' physical characteristics, the soursop puree addition and margarine reduction. The redness (a^*) and yellowness (b^*)

values of the optimum muffins were significantly different (p -value < 0.05) compared to the control. The redness (a^*) and yellowness (b^*) values of the optimum muffins are lower when compared to the control muffin. Those values mean that the optimum muffin color tends to be pale due to the difference in the amount of fat used. The fat added to the optimum muffins was 27.396%, while the control muffins used 45% fat. The fat used is yellow margarine. This fat plays a role in producing the color of the muffins. The higher the margarine concentration used, the muffins will turn yellow and vice versa (Cui, Min, & Bo, 2009).

Organoleptic Characteristics of Optimum Muffin

The organoleptic results (Figure 6) show that the addition of soursop puree and margarine from the optimization results does not have a significant effect (p -value > 0.05) on the level of preference for panelists on the attributes of color sensory, aroma, pore, texture, and overall. The optimum muffins has a taste preferred by the panelists compared to the control muffins on the taste sensory attribute. The addition of 16.148% soursop puree gave the muffins a distinctive flavor. Soursop has a sour and sweet taste, increasing consumer preference for certain food products (Aulia & Purwidiani, 2017). The sour taste of soursop comes from non-volatile organic acids, especially malic acid, citric acid, and isocitric acid. The sour taste can mask the unpleasant and bitter taste of other ingredients (Triastuti, Nurainy, & Nawansih, 2013). Panelists generally prefer optimum muffins because there is a distinctive taste of soursop that can mask the fishy taste of eggs and the taste of flour.

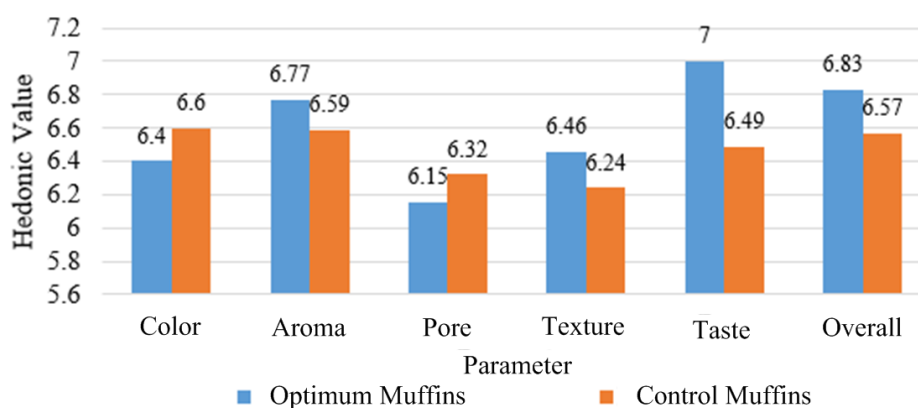


Figure 6. Graph of Optimal and Control Hedonic Muffins Test Average

Table 10. Optimum muffin's reduced fat claims compared to muffins control

Nutritional Components	Optimum Muffin	Control Muffin	Reduced-fat	Calories Difference
Fat	8.30%	13.66%	39.24%	
Calories from Fat	74.7 kkal	122.94 kkal		48.24 kkal

Calculation of Reduced-Fat Claims

The reduced-fat claim is one of the nutritional comparison claims. According to the Regulation of the Indonesian Head of the Food and Drug Administration No. 13/2016 (Badan Pengawas Obat dan Makanan, 2016), the calculation of reduced-fat claims can only be achieved if the food product contains at least 25% less fat than the reference food product. The reference food product used in this study was a control muffin without the addition of soursop puree. Table 10 shows the calculation of the reduced-fat claim.

Muffins with the addition of soursop puree and optimum margarine meet the requirements of reduced-fat claims (Table 10.), the percentage reduction in the fat content of 39.24% compared to control muffins. The decrease in fat levels affects the calories produced. Optimum muffins provide lower calorie intake than control muffins in the same amount with a difference of 48.24 kkal. According to McClements (2015), fat in food products plays many roles in determining the overall appearance, texture, taste, and biological response. Producing high-quality, reduced-fat claims pose challenges to achieving the same physicochemical, organoleptic, and physiological characteristics of high-fat products. Products with reduced-fat claims are highly recommended because decreasing the amount of fat can reduce of calorie intake.

CONCLUSIONS

The optimum treatment results were the concentration of 16.159% soursop puree and 27.391% margarine with a hardness response of 3.390 ± 0.144 N, a pore size of 0.529 ± 0.046 mm², a fat content of 8.302 ± 0.328 %, and a moisture content of 33.269 ± 0.397 %. The optimum muffins have fat content, fiber content, carbohydrate content, hardness, pore size, redness, yellowness, and taste attributes that are significantly different from control muffins. In contrast, for moisture content, ash content, protein content, expands volume, baking loss, density, brightness, color attributes, aroma, texture, pores, and overall were not significantly different from the control muffins.

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