Sys Rev Pharm 2020;11(10):715-721
A multifaceted review journal in the field of pharmacy

Optimization Of Microencapsulation Process Of Green Coffee Extract With Spray Drying Method As A Dietary Supplement

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ABSTRACT

Green coffee beans are coffee that has been peeled but does not roasted and contains a lot of chlorogenic acids which is useful for weight loss. The microencapsulation process uses the spray drying method using maltodextrin as a coating material and skimmed milk as a protein ingredient. This study was aimed to determine the percentage of maltodextrin and optimal skim milk to produce dietary supplement and also to find out the quality of dietary supplement obtained. The results of the study of an optimal percentage of maltodextrin and combined skim milk which was 8.61% and 3.22% respectively obtained total phenol 58.75 mg GAE / g with an accuracy of 93.10% and IC50 65.10 ppm with an accuracy of 95.76% . Dietary supplement products on the market contain total phenol of 57.52 mg GAE / g and IC50 87.65 ppm. Comparison with other products shows that the results of dietary supplements produced by microencapsulation have better quality than commercial dietary supplements.

Keywords: Green Coffee Bean, Maltodextrin, Spray Drying, Dietary, Supplement, Skimmed Milk

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INTRODUCTION

BACKGROUND OF RESEARCH

Coffee is well-known as a refreshing drink. Two of the most well-known coffee types in the Indonesian market are robusta and arabica. According to Indonesian's Ministry of Agriculture in 2017, Robusta coffee dominates coffee production in Indonesia by 72.59%. Green coffee is the type coffee beans that have been shelled but have not roasted. According to Isnindar et al (2017), coffee contains several important substances such as caffeine, phenolic compounds, chlorogenic acid, and antioxidant compounds that have the ability to neutralize free radicals inside human's body. Polyphenols are the antioxidants found inside coffee. the main polyphenol compound inside green cofee is chlorogenic acid. Polyphenol compounds are used to reduce body weight so that currently green coffee is widely consumed for diets, and obese people **[2].** According to the 2007 Basic Health Research data, the prevalence of obesity in Indonesia has reached 19.1%, calculated from the population aged 15 years and over **[3]**. It is estimated that obesity prevalence will increase with age, population increase, diet and lifestyle. obesity will cause several diseases such as high blood pressure, coronary heart disease, diabetes, stroke, and cancer **[4]**. Therefore, it is necessary to research dietary supplements that produce high total phenols and antioxidants with the addition of optimal fillers.

One of the microencapsulation methods that can be used is spray drying with the addition of maltodextrin as a coating material that will protect the extract from high temperatures so that the important components in it are not damaged and skim milk as a protein ingredient. Spray drying is a method used to convert feed liquid into powder **[5]**. According to Heldman et al (1981), the advantages of the spray drying process are a relatively fast-drying cycle, product retention in a short drying room, and the finished product is ready to be packed.

The optimization method that can be used is the Response Surface Method (RSM) Central Composite Design (CCD). According to Aritonang (2014), RSM is used for research that has a complex process and is widely used in food technology research. The RSM method can explore the correlation between many factors to obtain the most optimal production conditions **[8]**. In RSM, CCD is used to build a polynomial model, a mathematical function of the independent variables on the response formed **[9].**

MATERIAL AND METHODS

The materials used in this study were robusta argoupuro green coffee beans, Jember, East Java. The raw materials were obtained from Jember which were harvested in July 2018 with a dry process and after that, there was no pretreatment. The encapsulating materials used were maltodextrin and skim milk. Other additives are distilled water, methanol, gallic acid (C7H6O5), 10% Folin-Ciocalteu reagent, sodium carbonate (Na2CO3), and 1,1 Diphenyl-2-Pikrihidrazil (DPPH) 0.2 mM. The tools used are a spray dryer, grinder, disk mill, analytical scale, UV-Vis spectrophotometer, 40 mesh sieve, micropipette, Bluetip, cuvette, vortex, spatula, and other glass tools. The research conducted was an initial experimental study on a laboratory scale.

The research was conducted at the Entrepreneurship and Bioindustry Laboratory of FTP UB and the Pharmaceutical Biology Laboratory of FMIPA UII. The research period was from January to May 2019. This research carried out an optimization of the microencapsulation process of green coffee extract preparations using the CCD method in RSM with 2 factors, namely the percentage of maltodextrin and the percentage of skim milk to obtain 13 combinations of experimental designs. The responses used in this study were total phenolic content and antioxidant activity. The optimization results in Design Expert 7.1.5 Portable software are validated by extracting according to the optimal treatment of the results of the response surface

prediction then testing the total phenolic content and antioxidant activity.

The level used for the percentage of maltodextrin is 8.50 as the lower limit and 9.50 as the upper limit, while for skim milk it is 2.20 as the lower limit and 6.60 as the upper limit so that 13 combinations of experimental designs are obtained as in **Table 1.**

TablE 1. Experimental Design

No	Factor		Factor	
	X1	X2	Percentage Maltodextrin (% of the total extract)	Percentage Skim (% of the total extract)
1	-1	-1	8,50	2,20
2	+1	-1	9,50	2,20
3	-1	+1	8,50	6,60
4	+1	+1	9,50	6,60
No	**Factor**		**Factor**	
	X1	**X2**	**Percentage Maltodextrin (% of the total extract)**	**Percentage Skim (% of the total extract)**
5	-1,414	0	8,29	4,40
6	+1,414	0	9,71	4,40
7	0	-1,414	9,00	1,29
8	0	+1,414	9,00	7,51
9	0	0	9,00	4,40
10	0	0	9,00	4,40
11	0	0	9,00	4,40
12	0	0	9,00	4,40
13	0	0	9,00	4,40

The research was conducted in several stages, among others:

Making Green Coffee Powder

The green coffee beans are aerated at room temperature for 2 hours to reduce moisture content. Furthermore, the coffee beans are grinded using a disk mill gradually and then sieved with a 40 mesh sieve to produce the green coffee powder. The sieves obtained were stored in a plastic container and at room temperature. Green coffee powder that does not pass the sieve is then grinded again using a blender.

Green Coffee Powder Extraction

10 grams of green coffee powder were taken and added with 100 ml of distilled water then macerated for 24 hours at room temperature (± 25 ° C) without stirring. The extract was filtered with a filter cloth and stored in a glass bottle in cold temperatures.

Green Coffee Extract Microencapsulation Process

100 ml of green coffee extract was added with maltodextrin and skim milk using proportions according to the experimental design. The three ingredients are then mixed for 15 minutes for homogenization. Furthermore, the spray drying process is carried out with an inlet temperature of 120 ° C, an outlet temperature of 60 ° C-80 ° C for 30 minutes. The resulting microcapsule powder was then analyzed for total phenol content and antioxidant activity

Total Phenolic Content Analysis

The standard curve of gallic acid was made by weighing 0.01 grams of gallic acid powder. Then put it in a 100 ml volumetric flask and add distilled water to the limit mark and homogenize it to form a 100 ppm main solution. The solution is diluted with a concentration of 0 ppm, 20 ppm, 40 ppm, 60 ppm, 80 ppm, and 100 ppm. Each concentration was taken 0.5 ml and added 2.5 ml of 10% foline reagent, then homogenized and incubated for 5 minutes in the dark. After that, 2 ml of 7.5% Na2CO3 were added and incubated for 30 minutes in the dark. Measurement of absorbance using a wavelength of 765nm is then plotted into a curve where x is the concentration of gallic acid and Y is the absorbance so that the regression formula Y = ax + b is obtained.

The test solution was prepared by weighing 0.01 gram of encapsulated powder and dissolving it in 10 ml of distilled water. The solution was taken 0.5 ml and put into a dark test tube. The solution was mixed with 2.5 ml of Folin C reagent 10% distilled water and then homogenized and incubated for 5 minutes in the dark and at room temperature. 2 ml of Na2CO3 solution 7.5% aquadest solvent was added, homogenized, and incubated for 30 minutes in the dark. The blanks used were 0.5 ml distilled water plus 2.5 ml 10% foline reagent and 2 ml 7.5% sodium carbonate solution. The absorbance measurement used a wavelength of 765nm. The amount of phenolic compounds is measured based on the standard curve of gallic acid and expressed as mg Gallic Acid Equivalent (GAE / g extract. The content of phenolic compounds in the extract is calculated by the equation:

$$C = \frac{c \times fk \times V}{g}$$

C = concentration of total phenolic content (mg GAE/g)
c = concentration of galat acid (µg GAE/ml)
V = volume of extract solution taken for testing (ml)
g = weight of extract taken for testing (g)
fk = conversion factor

Analysis of Antioxidant Activity

Analysis of antioxidant activity was carried out using the DPPH method by dissolving 0.01 gram of microcapsule powder in 10 ml of methanol to obtain 1000 ppm mains solution. The mother liquor was diluted with a concentration of 60 ppm, 70 ppm, 80 ppm, 90 ppm, and 100 ppm. Samples at each concentration were taken 2 ml and put into a dark test tube. Each test tube was added with 1 ml of DPPH 0.2 mM, homogenized, and incubated in the dark for 30 minutes. The control solution was prepared by means of 1 ml DPPH 0.2 mM put in 2 ml methanol then homogenized and incubated for 30 minutes in the dark. The absorbance measurement used a wavelength of 517 nm. The DPPH uptake value before and after the addition of the sample was calculated as percent inhibition (% inhibition) by the formula:

$$\% \text{ Inhibisi} = \frac{A\ kontrol - A\ sampel}{A\ kontrol} \times 100\%$$

Then the results are entered into the linear regression equation Y = aX + b where Y is the percent inhibition and

X is the concentration. This equation is used to determine the IC50 value of each sample.

RESULT AND DISCUSSION

Results of Centralized Composite Design

According to Qonitatillah (2018) research, Jember robusta coffee powder contains a total phenol of 35,670 mg GAE / g and antioxidant activity with an IC50 value of 62.507 ppm. This shows that after the microencapsulation process, the total phenol will increase while the antioxidant activity will decrease as indicated by the high IC50 value.

Table 2. Centralized Composite Design Analysis Result

No	Factor		Factor		Response	
	X1	X2	Percentage Maltodextrin (% of the total extract)	Percentage Skim (% of the total extract)	Total Phenolic Content (mg GAE/gr)	IC_{50} value (ppm)
1	-1	-1	8,50	2,20	54,6957	62,6899
2	+1	-1	9,50	2,20	39,4783	86,9699
3	-1	+1	8,50	6,60	35,5652	80,3617
4	+1	+1	9,50	6,60	39,9130	98,553
5	-1,414	0	8,29	4,40	52,5217	81,14
6	+1,414	0	9,71	4,40	35,5652	98,8644
7	0	-1,414	9,00	1,29	51,6522	89,2033
8	0	+1,414	9,00	7,51	37,9565	100,084
9	0	0	9,00	4,40	47,9565	71,8591
10	0	0	9,00	4,40	48,8261	75,2135
11	0	0	9,00	4,40	51,8696	66,8424
12	0	0	9,00	4,40	48,8261	66,8361
13	0	0	9,00	4,40	49,9130	76,9766

Responds Analysis of *Total Phenolic Content*

The total phenol test aims to determine the concentration of phenol compounds contained in the microencapsulated powder per gram. The standard curve used in testing for total phenol is the standard curve for gallic acid because gallic acid is one of the natural phenols and is stable, pure, and relatively inexpensive than other standard solutions . Based on the data obtained, it can be seen that the highest total phenol response value is 54.6957 mg GAE / g obtained from treatment with a percentage of maltodextrin 8.50 and a percentage of skim milk of 2.20. The lowest total phenol was 35.5652 mg GAE / g obtained from treatment with a percentage of maltodextrin 8.50 and a percentage of skim milk 6.60 and a percentage of maltodextrin 9.71 and a percentage of skim milk 4.40. The research data obtained showed that the total phenol extract tended to increase with the smaller percentage of maltodextrin and the smaller percentage of skim milk used. The results obtained are following with the research of Widarta and Ni Made (2014), the higher the encapsulant concentration, the lower the total phenol of the microcapsule product. This is due to the higher the encapsulant concentration, the greater the ratio between the extract and the encapsulant. Data processing using RSM shows that the chosen model is Quadratic with both factors significant to the response. The polynomial equation obtained is

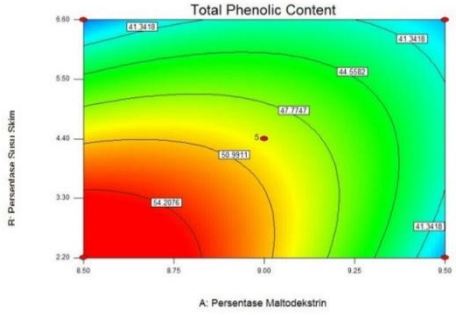
$Y_1 = 49,48 - 4,36X_1 - 4,76X_2 + 4,89X_1X_2 - 3,227X_1^2 - 2,84\,X_2^2$ ... (1)

$Y_1 = -741,18372 + 203,57083X_1 - 37,01945X_2 + 4,44664X_1X_2 - 12,88047X_1^2 - 0,58671X_2^2$ ... (2)

In optimizing the response surface for total phenol, the most influential factor is the percentage of maltodextrin (X1) with a coefficient value of 203.57083 which indicates that the percentage factor of maltodextrin has an effect of 203.57083 for every one-point increase. Next is the skim milk percentage factor (X2) with a coefficient value of 37.01945 which indicates that the solvent ratio factor has an effect of 37.01945 for each one-point increase.

The contour plot of the percentage factor of maltodextrin and skim milk to the total phenolic content response can be seen in **Figure 1.**

Figure 1. The Contour of Maltodextrin and Skim Milk Percentage Response Plot to Total Phenolic Content Response Microencapsulation of Green Coffee Extract



The result of the response is shown through the contour lines in the figure. The largest total phenol is shown starting from the deepest line and the lower the total phenol value is. The red contour shows the higher total

phenol, while the lower the total phenol content. The surface curve of the percentage response of maltodextrin and skim milk to the total phenolic content response can be seen in **Figure 2.**

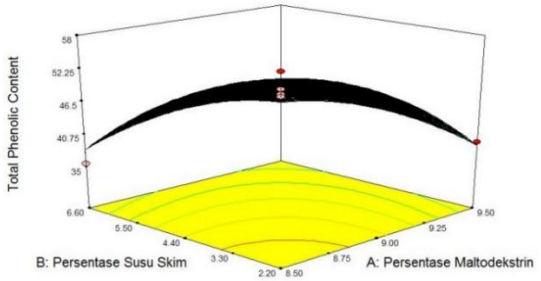


Figure 2. Surface Curve of Maltodextrin and Skim Milk Percentage Response to Total Phenolic Content Response Microencapsulation of Green Coffee Extract

Based on the response surface curve, it can be seen that the percentage factor of maltodextrin and skim milk has a significant effect. The graph also shows the Quadratic model, where the optimum condition is at the peak then decreases based on the two factors used. Based on these results, maltodextrin will protect the material from the release of nutrients due to high temperature, but the higher the percentage of maltodextrin and skim milk, the lower the total phenol content. This is due to the increasing number of total solids contained in the material so that it can reduce the intensity of the blue color in the foline reagent **[13]**. According to Al Fakkar (2018), the combination of skim milk and green coffee extract will produce total phenols, antioxidants, and high chlorogenic acid content which is useful as a dietary supplement.

Respond Analysis of Antioxidants Activity (IC_{50} value)

Antioxidant activity testing was carried out to determine how strong the antioxidant activity was in the microencapsulated powder of green coffee extract produced. Antioxidant activity can be seen from the IC50 value where the smaller the IC50 value, the greater the antioxidant activity. Based on the data obtained, it can be seen that the response to antioxidant activity has the lowest IC50 value, namely 62.6899 at 8.5% maltodextrin percentage and 2.2% skim milk percentage which means it has high antioxidant activity while the highest IC50 value is 100.0840 at the percentage of maltodextrin is 9% and the percentage of skim milk is 7.51%, which means that it has low antioxidant activity. The research data obtained indicate that the antioxidant activity will increase along with the reduction in the composition of the additional ingredients in the green coffee extract. The more the composition of maltodextrin and skim milk are added, the lower the antioxidant activity is indicated by the higher IC50 value.

These results are following the research of Yuliawaty and Wahono (2015), the addition of higher maltodextrin concentrations causes a decrease in levels of antioxidant activity. This is thought to be due to the increasing number of total solids contained in the material, namely maltodextrin as a filler, so that the measured antioxidant activity is less, so that with the increase in total solids in a material, the measured levels of antioxidant activity will be smaller. Also, it is suspected that it is also caused by changes in antioxidant compounds due to the heating process, namely vitamin C and other phenol compounds that are oxidized. There is a possibility that heating causes phenol compounds to decompose so that their ability as an antioxidant decreases.

The results of data processing using RSM show that the chosen model is Quadratic. The percentage factor of maltodextrin was significant for the response, but the skim milk percentage factor was not significant for the response. The polynomial equation for the Quadratic model in response to the IC50 (Y2) value which is influenced by the percentage of maltodextrin (X1) and the percentage of skimmed milk (X2) is as follows:

$Y_1 = 71{,}55 + 8{,}44X_1 + 5{,}58X_2 - 1{,}52X_1X_2 + 6{,}68\ X_1^2 + 9\ X_2^2$ … (1)

$Y_1 = 2055{,}09677 - 458{,}23859X_1 - 1{,}38064X_2 - 1{,}38380X_1X_2 + 26{,}73398X_1^2 + 1{,}86038X_2^2$ … (2)

In the optimization of the response surface for the IC50 value, the most influential factor is the percentage of maltodextrin (X1) with a coefficient value of -458.23859 which indicates that the percentage factor of maltodextrin has an effect of -458.23859 for each one-point increase. Next is the skim milk percentage factor (X2) with a coefficient value of -1.38064 which indicates that the skim milk percentage factor has an effect of -1.38064 for every one-point increase. The contour plot of the percentage of maltodextrin and skim milk percentage to the IC50 value of green coffee extract microencapsulation can be seen in **Figure 3.**

Based on **Figure 3**, it is shown that the more it comes out, the higher the IC50 value, which means the lower the antioxidant activity. Conversely, the deeper the IC50 value is lower, which means that the antioxidant activity is higher. Beside, in the graph, there are also different colors where the redder the color, the smaller the antioxidant activity, and the bluer the color is shown, the higher the antioxidant activity.

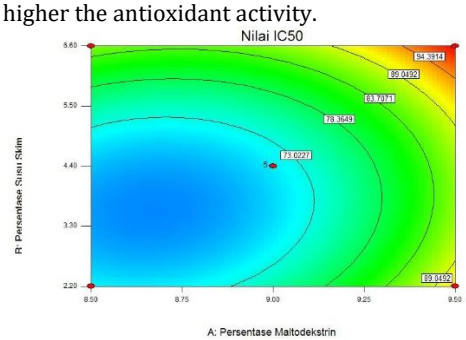


Figure 3. The Contour of the Percentage of Maltodextrin and Skim Milk Percentage Response Plot to the IC50 Response of Green Coffee Extract Microencapsulation

The contour plot of the total phenolic content response is different from the contour plot of the response IC50 value. This difference can be seen from the color of the contours where the expected contour of the total phenolic content response plot is red, which is the highest total phenol content. Conversely, the color of the contour plot of the expected response to the IC50 value is blue, which is the lowest IC50 value so that it has high antioxidant activity. The response surface curves of the percentage of maltodextrin and the percentage of skim milk to the IC50 value response are presented in **Figure 4.**

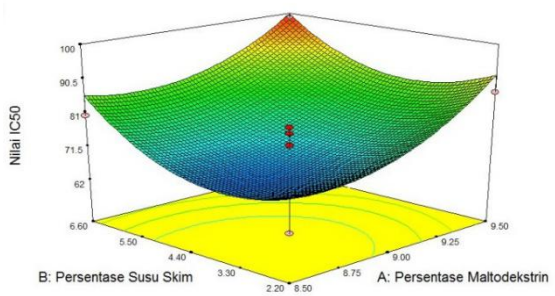


Figure 4. Surface Curve of Maltodextrin and Skim Milk Percentage Response to IC50 Value Response Microencapsulation Green Coffee Extract

Based on this curve, it can be seen that both factors affect on the IC50 value, but the percentage factor of maltodextrin is more dominant in influencing the yield produced. The graph also shows a Quadratic model, where it is shown through the optimum condition being at the peak then decreasing based on the two factors used. The percentage of maltodextrin and the percentage of skim milk generally affect on the resulting antioxidant activity. The addition of higher maltodextrin concentration causes a decrease in antioxidant activity levels. The more total solids contained in the material, namely maltodextrin as a filler and skim milk as a protein source, the less measured antioxidant activity. The antioxidant content is also thought to be influenced by the heating process, namely vitamin C and other phenolic compounds that are oxidized. There is a possibility that heating causes phenol compounds to decompose so that their ability as an antioxidant decreases **[16].**

Results of the Optimum Solution for Total Phenolic Content Response and Antioxidant Activity

The research was conducted to determine the optimal solution results from the optimization of the percentage of maltodextrin and the percentage of skim milk in the microencapsulation process of the phenol yield and the resulting antioxidant activity. The optimization limits for response and factors can be seen in Table 3. Both responses were selected with the maximum target because the study aimed to obtain the highest total phenol and antioxidant activity results from several treatment variations. Based on the limitations in Table 3, the optimum solution results obtained by the design expert software 7.1.5 can be seen in Table 4. In addition to the optimal solution results predicted by the program, there are also estimates of the lowest to highest values of the responses presented in Table 5. it can be seen the magnitude of the predictive value for both responses.

Table 3. Optimization Limits for Response and Factors

Criteria	Name	Target	Lower limit	Upper limit
Factor	Percentage Maltodekstrin (% of the total extract)	*In Range*	8,50	9,50
Factor	Persentase Susu Skim (% of the total extract)	*In Range*	2,20	6,60
Response	Total of phenol (mg GAE/g)	*Maximize*	35,5652	54,6957
Response	Antioxidant Activity (IC_{50} in ppm)	*Minimize*	62,6899	100,0840

green coffee extract by optimizing the total

Table 4. Optimal Solution Results from Design Expert Software 7.1.5

Parameter	Prediction Standart
Percentage Maltodextrin (%)	8,61
Percentage Skim (%)	3,22
Total Phenolic Content (mg GAE/g)	54,6957
IC_{50} value (ppm)	67,9855
Desirability	0,926
Information	*Selected*

Table 5. Solution Results From Lowest Until Highest Of Prediction

Parameter	Prediction	SE Pred	Lowest Prediction	Highest Prediction
Total Phenolic Content (mg GAE/g)	54,6957	2,63	48,49	60,90
Nilai IC_{50} (ppm)	57,9855	7,97	49,14	86,83

The results of the optimization of the total phenolic content response and antioxidant activity are also presented in the form of desirability which can be seen in **Figure 5.** According to Nurmiah et al. (2013), the desirability value is the value of the optimization objective function which shows the program's ability to fulfill desires based on the final set criteria whose value ranges from starting from 0 to 1. The closer to 1 the desirability value shows the program's ability to achieve optimization goals is getting more Perfe ct.

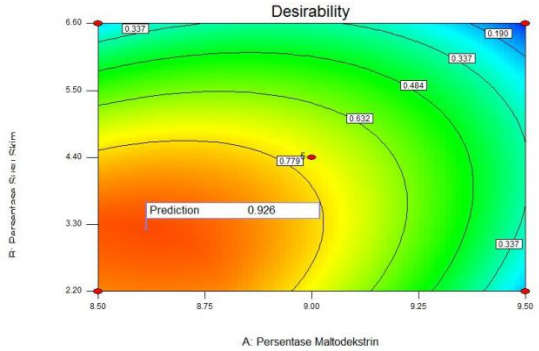


Figure 5. The Desirability of Total Phenolic Content Response Optimization Results and Antioxidant Activity

Based on **Figure 5**, it is shown that the desirability value is 0.926. The more it comes out, the smaller the desirability value. The results of the optimization have resulted in a desirability value that is on the red contour, which is the highest contour. This shows that the program can achieve near-perfect optimization goals. In addition to desirability, it is also displayed with the response surface curve of the optimization results of the total phenolic content response and antioxidant activity which can be seen in **Figure 6**.

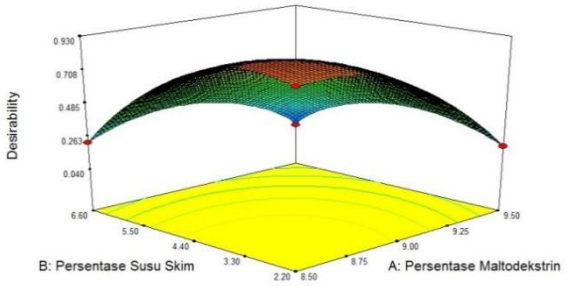


Figure 6. Response Surface Curve of Optimization Results of Total Phenolic Content Response and Antioxidant Activity

Verification of the Optimal Condition of the Model Prediction Results

Verification of the optimum conditions is carried out to ensure and see how accurate the program is in predicting the optimum point solution of each independent variable. Verification was carried out by re-researching the treatment according to the optimal point solution results, then measuring the total phenol response and antioxidant activity. The actual verification results are then compared with the solutions predicted by the program. The comparison of the actual verification results with predictions in the program can be seen in **Table 6**.

Table 6. Comparison of Actual Verification Results with Predictions in the Program

Respons	Lowest Prediction	Prediction	Highest Prediction	Actual Result	Difference	Acuration
Total of Phenol (mg GAE/g)	48,49	54,695	60,90	58,75	4,055	93,10%
IC_{50} value(ppm)	49,14	67,985	86,83	65,10	2,885	95,76%

In Table 6 it can also be seen that the actual response value is still at the PI (Prediction Interval) value. The results obtained are following the statement of Noordin et al. (2004), which states that the value of the verification results in the interval of 5% PI low and 95% PI high indicates that the optimum condition of the prediction results which has the highest desirability value gives fairly consistent and accurate results.

The results of verification of the optimum conditions showed that the encapsulated green coffee extract had a lower total phenol content and higher antioxidant activity than pure green coffee extract without the addition of coating materials. The lower total phenol was caused by the addition of maltodextrin and skim milk so that the total dissolved solids in the material were higher and affected the absorbance measurement in the spectrophotometer. Antioxidant activity which is not positively correlated with total phenol is because not all phenolic compounds extracted are phenolic compounds that function as antioxidants. An example is a lignin, which functions as a formation for plant cell walls, which is a phenyl group, but its function as an antioxidant is not yet known **[18]**. According to Djapiala et al. (2013), in the extract of Caulerpa racemosa shows that antioxidant activity is not positively related to total phenol because it is suspected that certain compounds when reacting with DPPH compounds do not function to reduce these compounds but have other functions so that they affect on ongoing antioxidant activity.

Comparison with Products on the Market

The microencapsulated products that have been produced are then compared with similar products on the mark et. This aims to determine the quality and position of the products produced with products that are known in the market. The parameters compared were total phenolic content, antioxidant activity, and solubility. The comparison results can be seen in **Table 7.**

Table 7. Comparison of Product

Parameter	Microencapsulation Powder Green Coffee Extract	Suplemen Diet Exitoc Greenco
Total Fenol	58,75 mg GAE./g	57,52 mg GAE/g
Nilai IC_{50}	65,10 ppm	87,65 ppm
solubility	Soluble	Difficult to dissolve

Based on this table, it can be seen that the quality of the microencapsulated powder of green coffee extract in this study has better quality than the dietary supplements that have been on the market. The insufficient solubility of the comparison product is thought to be due to the smaller or less fine particle size of the capsule powder. The milling process aims to reduce the size of the coffee so that it makes it easier for coffee grounds to dissolve in the solvent. Typically, the water-soluble components are chlorogenic acid, caffeine, nicotinic acid, melanoidin compounds, and hydrophilic volatile compounds which will be extracted higher if using high temperature and pressure. Beside, it is suspected that there are other ingredients in the Exitox Greenco supplement, namely Garcinia cambogia, Garcinia mangostana pericarpium,

and Guazuma ulmifolia. The total phenol content and lower antioxidant activity than the microencapsulated green coffee extract products using the spray drying method are thought to be influenced by the type and polarity of the solvent at the time of extraction where the type and polarity of the solvent can affect single electron transfer and transfer of hydrogen atoms which are key aspects in testing antioxidants **[20].**

CONCLUSION AND SUGGESTION

Some conclusions and suggestions are provided as follows :

1. The optimum conditions predicted by the program were the percentage of maltodextrin in 8.61% and 3.22% for skim milk, resulting in a total phenol of 54.6957 mg GAE / g and an IC50 value of 67.9855 ppm.
2. The comparison capsule has an IC50 value of 87.6497 and a total phenol of 87.65 mg GAE / g. Therefore, it can be concluded that the quality of microencapsulated green coffee extract products using the spray drying method is better than any dietary supplements on the market**.**

Suggestion

Further research is needed regarding other extraction factors that may affect the total phenol and antioxidant activity produced as well as the drying process of the spray drying method such as the temperature factor used so that it will not reduce the levels of the compounds needed.

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