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Analysis of Total Phenol and Flavonoid Compounds in Temulawak (*Curcuma xanthorrhiza* Roxb.) Tablets Based on Differences in Maltodextine Concentration

Analisis Total Senyawa Fenol dan Flavonoid pada Tablet Temulawak (Curcuma xanthorrhiza Roxb.) Berdasarkan Perbedaan Konsentrasi Maltodekstin

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ABSTRACT

Temulawak (*Curcuma xanthorrhiza* Roxb.) has empirical phenolics and flavonoids which can act as antioxidants. This study aimed to produce tablets of temulawak (*Curcuma xanthorrhiza* Roxb.) with variations in the addition of maltodextrin concentration and to find the best results. This research was conducted using a non-factorial Randomised Block Design (RBD) with 3 treatment levels, the ratio of maltodextrin to 1:2 (50%), 1:4 (25%) and 1:6 (16.70%). The results of this study showed that all tablets formed met the requirements of BPOM Number 32 of 2019 such that the tablets must be less than or equal to 10% and all the shaped tablets had a uniform weight. The tablets with 1:2 (50%) treatment had the highest value which was able to produce the highest total mean value of phenolics and flavonoids when compared with 1:4 (25%), 1:6 (16,70%) and control treatments. In a 1:2 (50%) treatment, the total phenolic value was 3.63 mg GAE/g ± 0.09, while the total flavonoid value was 6.11 mg QE/g ± 0.30. Therefore, it can be stated that the maltodextrin concentration treatment with a ratio of 1:2 (50%) was the optimum method for producing temulawak (*Curcuma xanthorrhiza* Roxb.) tablets in this study.

Keywords: Evaporator; flavonoids; phenolic; temulawak (*Curcuma xanthorrhiza Roxb.); vacuum cooling.*

ABSTRAK

Temulawak (Curcuma xanthorrhiza Roxb.*) mempunyai kandungan fenolik empiris dan flavonoid yang dapat berperan sebagai antioksidan. Tujuan penelitian ini adalah menghasilkan tablet temulawak (Curcuma xanthorrhiza* Roxb.*) dengan variasi penambahan konsentrasi maltodekstrin dan mendapatkan hasil terbaik. Penelitian ini dilakukan dengan menggunakan Rancangan Acak Kelompok (RAK) non faktorial dengan 3 taraf perlakuan, perbandingan maltodekstrin 1:2 (50%), 1:4 (25%) dan 1:6 (16,70%). Hasil penelitian menunjukkan bahwa semua tablet yang dibentuk memenuhi persyaratan BPOM Nomor 32 Tahun 2019 yaitu tablet harus kurang dari atau sama dengan 10% dan semua tablet yang dibentuk mempunyai berat yang seragam. Tablet dengan perlakuan 1:2 (50%) mempunyai nilai tertinggi yang mampu menghasilkan nilai rata-rata total fenolik dan flavonoid tertinggi jika dibandingkan dengan 1:4 (25%), 1:6 (16,70%) dan perawatan kontrol. Pada perlakuan 1:2 (50%), nilai total fenolik adalah 3,63 mg GAE/g ± 0,09, sedangkan nilai total flavonoid adalah 6,11 mg QE/g ± 0,30. Oleh karena itu, dapat dikatakan bahwa perlakuan konsentrasi maltodekstrin dengan perbandingan 1:2 (50%) merupakan metode pembuatan tablet temulawak (Curcuma xanthorrhiza* Roxb.*) yang optimum pada penelitian ini.*

Kata Kunci: *Evaporator; flavonoid; fenolik; temulawak (Curcuma xanthorrhiza* Roxb.*); pendinginan vakum*.

INTRODUCTION

Coronavirus Disease 2019, or COVID-19, is currently a health problem in more than 200 countries in the world. The number of COVID-19 cases to date continues to grow rapidly and has a negative impact on several sectors, including the economy, social and especially the impact on world public health and death in Indonesia (Tosepu, et al., 2020). According to WHO (WHO, 2020) is one of the preventive measures that can be used to prevent COVID-19 is enhancing and maintaining the body's immune system at its peak. The consumption of herbal plants is the best technique to increase the body's immunity. Consumption of herbal plants has the advantage of having relatively small side effects or even no side effects (Dewi & Jamhari, 2017). Temulawak rhizomes will produce starch with a yellowish white color rich in curcuminoid content. Temulawak rhizomes contain the compounds telandren, camphor, borneol, sineal, xanthorrhizol, isofuranogermakren, tricycline, alloaromadendren, and germakren. This compound composition is what causes ginger to have advantages in increasing the body's immunity (Ulfa, Sih, & Setyawan, 2021).

According to (Syamsudin, et al., 2019) temulawak (*Curcuma xanthorrhiza* Roxb.) is a plant that often used as a spice and a raw material for traditional medicine. Temulawak (*Curcuma xanthorrhiza* Roxb.) empirically has phenolic compounds and flavonoids that can act as antioxidants. The function of antioxidants is to counteract certain types of cells damage due to oxidation by oxidants in the body. Besides that, temulawak (*Curcuma xanthorrhiza* Roxb.) has the ability to increase stamina by immunomodulatory activity, which can increase the body's resistance to disease. Immunomodulators are medicinal substances that restore an imbalance in the immune system by restoring disturbed immune system function (immune restoration) and improving the body's immune system (Dewi & Isnawati, 2021). Temulawak (*Curcuma xanthorrhiza* Roxb.) is a plant that is

very commonly known in Indonesia and even the world. In 2017, Indonesia produced 24.561 tons; in 2018, it increased by 4.11% to 25.571 tons (BPS, Statistics of Indonesian Biopharmaceutical Plants, 2018); and in 2019, production increased further to 29.637 tons (BPS, Statistics of Indonesian Biopharmaceutical Plants, 2020) (Ulfa, Sih, & Setyawan, 2021; Indrisari, 2021).

Temulawak (*Curcuma* Roxb.) is widely used in medicine, and the benefits of the ginger content (*Curcuma xanthorrhiza* Roxb.) have been scientifically proven. The content of Temulawak (*Curcuma xanthorrhiza* Roxb.) is that there are curcumin compounds and essential oils that have antibacterial, anticancer, antioxidant, and antitumor functions (Inayah & Yusetyani, 2021). Of the many rhizomes or local plants in Indonesia, one of them is curcuma, which is easy to obtain androcess for preventing and treatingOVID-19 (Dermawaty, 2015). The compound contained in ginger is xanthorhizzol, which prevents immune cells from entering adipose tissue and reduces inflammatory cytokine genes. Xanthorhizzol has immunosuppressant properties because it can stimulate PRR (RIG-1), while COVID-19 patients are susceptible to Cytokine Release Syndrome (CRS). Thus, in COVID-19 patients with or without (CRS), the use of xanthorhizzol can reduce the pro-inflammatory response (Nugraha, H., M, F, & N., 2020).

Temulawak (*Curcuma xanthorrhiza* Roxb.) is widely used as a single medicine or as a mixture of other herbal plants. Temulawak (*Curcuma xanthorrhiza* Roxb.) is a plant that is useful for increasing the body's immune system (immunostimulator). Temulawak (*Curcuma xanthorrhiza* Roxb.) functions for health in the body, so efforts are needed to make preparations that are attractive to the public, namely in the form of tablets (Sutoyo, et al., 2020).

The increasing production of temulawak (*Curcuma xanthorrhiza* Roxb.) every year is not accompanied by public consumption. the use of temulawak (*Curcuma xanthorrhiza Roxb.*) as an herbal medicine is still limited to brewing or boiling it with uncertain doses. It is unable to increase the effectiveness and efficacy of Temulawak (*Curcuma xanthorrhiza* Roxb.). Consuming temulawak (*Curcuma xanthorrhiza* Roxb.) at the right doses can be done by making it into tablets form. To manufacture the tablets, the filler required is maltodextrin. Maltodextrin have functions to accelerate drying, prevent heat damage, coat flavor components and increase volume (Gabriela, Rawung, & Ludong, 2020). This research will produce a herbal product in tablets form from temulawak (*Curcuma xanthorrhiza* Roxb.) with addition variations of maltodextrin that can be consumed by the public more effectively and efficiently.

The quality of temulawak (*Curcuma xanthorrhiza* Roxb.) tablets can be determined using a total phenolic and flavonoid test. Phenolic and flavonoid compounds are secondary metabolites that play an important role in treatment and function as natural antioxidants so that it can scavenge free radicals (Arifiyana & Dipahayu, 2018). The purpose of this study was to produce tablets from temulawak (*Curcuma xanthorrhiza* Roxb.) and find the best treatment levels from addition variations of maltodextrin concentration based on Water content analysis, tablet weight uniformity analysis, total phenolic analysis, total flavonoid analysis, and response surface methodology analysis.

MATERIALS AND METHODS

Tools and Materials

The tools used in this research were a vacuum cooling evaporator, blender, oven, manual tablet printer, spectrophotometer vis., cuvette, moisture analyzer, digital scale, and glassware. The raw materials used in this research were temulawak (*Curcuma xanthorrhiza* Roxb.) from Ngaglik Hamlet, Ngreco Village, rt/rw 01/03, Selorejo District, Blitar Regency, East java Province, Indonesia. Other materials used were distilled water, maltodextrin, methanol, gallic acid, folin-ciocalteu, sodium carbonate, quercetin, aluminum chloride, potassium acetate, iron (III) chloride, magnesium powder, hydrochloric acid, and filter cloth.

Research Design

This research used a non-factorial Randomised Block Design (RBD) using one factor that was examined. The factor used was variations in maltodextrin concentration ranging from 1:2 (50%), 1:4 (25%) and 1:6 (16.70%). For example, a factor of 1:2 (50%) requires 100 mL of Temulawak (*Curcuma xanthorrhiza* Roxb.) extract and 200 grams of maltodextrin. Based on the regulation of BPOM number 32 of 2019 Requirements and Quality Safety of Drugs in Solid Dosage Forms. There were 3 types of treatment and it was repeated 3 times, so there were 9 samples in this study. The duration of this research is 3 months.

Research Procedure

The manufacture of tablets from ginger is based on laboratory research. By extraction. Ginger tablets are made using varying concentrations of maltodextrim over time. The tools, materials, and processes used are as follows:

Raw Material Preparation

The main ingredient used in this study was temulawak (*Curcuma xanthorrhiza* Roxb.), whose average age is 10-12 months, fresh and fungus-free. The rhizomes are thoroughly washed and drained, then coarse chopped. The following process weighs 250 grams and added 250 mL of distilled water (1:1) then crushed with a blender. A purée was then filtered as an extract of temulawak (*Curcuma xanthorrhiza* Roxb.).

Evaporation of Temulawak (*Curcuma xanthorrhiza Roxb.*) Extract

Temulawak (*Curcuma xanthorrhiza* Roxb.) extract was evaporated using a vacuum cooling evaporator at 45oC for 20 minutes with a pressure of ± -688 mmHg. The result of the evaporating process is that the moisture content of the temulawak (*Curcuma xanthorrhiza* Roxb.) extract is lower than that of the pure temulawak (*Curcuma xanthorrhiza* Roxb.). which stands at 89.53%, with an initial pre-treatment moisture level of 96.44%. Phenolics after evaporation were 5.246 mg GAE/g higher than before evaporation, or 3.776 mg GAE/g. In addition, after evaporation, flavonoids were also higher at 8.740 mg EQ/g, with an initial pre-evaporation value of 4.923 mg EQ/g.

Process of Making Temulawak (*Curcuma xanthorrhiza* Roxb.) Tablets

The basic tablet ingredient is evaporated *temulawak (Curcuma xanthorrhiza* Roxb*.) extract.* The extract was mixed with maltodextrin in the following proportions: 1:2 (50%), 1:4 (25%), and 1:6 (16.70%). After mixing, the sample will be placed in an oven at a temperature of 70oC until it becomes dry. Then, the dried samples were ground into powder using a mortar. The next step is to print it onto tablets with a tablet printer. The resulting tablet is 250 mg.

Research Parameters

Water Content Analysis

The water content test was carried out on the results of the temulawak (*Curcuma xanthorrhiza* Roxb.) tablet preparation. Based on the regulation of BPOM number 32 of

2019 Requirements and Quality Safety of Drugs in Solid Dosage Forms, the water content must be less than or equal to 10% (BPOM, 2019). Measurement of water content in temulawak (*Curcuma xanthorrhiza* Roxb.) was carried out using a moisture analyzer with the output data in the form of percent (%).

Tablet Weight Uniformity Analysis

Based on BPOM regulations concerning Requirements and Quality Safety of Drugs in Solid Dosages 2019, this analytical procedure was carried out. The test was carried out by weighing 20 tablets for each treatment, then the average weight of each tablet was obtained. Not allowed more than two tablets weighing deviate from the set average weight (Health, 2013).

After calculating the average weight of the tablet, the percentage deviation in the tablet's weight was calculated. Drugs that have physical quality, weight uniformity and good ingredients will provide good bioavailability because the pharmaceutical availability of the drug is high. The weight uniformity test is carried out to determine the uniformity of the dose for each tablet which is expected to be the same and in accordance with the safety of the tablet preparation. Weight uniformity testing can be carried out using an analytical balance. A good tablet size uniformity test is if it has a diameter of no more than 3 times or no less than 1 ⅓ of the tablet thickness (Ulfa, Nofita, & Azzahra, 2018).

Total Phenol Analysis

Curcumin in ginger is a phenolytic compound, so its mechanism of action as an anti-microbial is similar to the properties of other phenolic compounds (RI). Phenolics are compounds that are often found in plants (Oktaviana, Kawiji, & Atmaka, 2015).

Analysis of the phenol content of the temulawak (*Curcuma xanthorrhiza* Roxb.) tablets was carried out by spectrophotometry using the Folin-Ciocalteu calorimetric method. The standard solution used is gallic acid. A sample of 0.05 grams was then made into a test solution of 5000 ppm. Furthermore, 1 ml of the sample was put in a test tube which was closed with aluminum foil and mixed with 0.4 ml of Folin-Ciocalteau reagent in distilled water (1:1), then vortexed and incubated for 4 minutes. Next, 4 mL of 7% Na2CO3 reagent and 4.6 mL of distilled water were added. The mixture was vortexed, incubated for 2 hours at room temperature, and measured at a wavelength of 700 nm. Total phenol was obtained based on the standard curve equation for gallic acid. The test results are expressed as mg of gallic acid equivalent per gram of sample (mg GAE/g ± std. deviation). The concentrations of gallic acid used were 10, 20, 30, 40, and 50 ppm.

Total Flavonoid Analysis

Flavonoids are one of the largest groups of phenols. Flavonoid compounds have antioxidant, anti-inflammatory, antihepatotoxic, antitumor, antimicrobal activity. Flavonoids are natural compounds and can react with antioxidants. Flavonoids in the body can function to increase antioxidants which are good for the body to repair cells damaged by free radicals. Total flavonoid content is the flavonoid content in the sample, expressed as quercetin equivalent (EQ). Flavonoid levels were obtained from calculations using a linear regression formula, where the flavonoid levels in the sample (x) were determined by entering the sample absorbance in y with the quercetin linear regression equation (Indrisari, 2021).

Analysis of the flavonoid content of temulawak (*Curcuma xanthorrhiza* Roxb.) tablets was carried out by spectrophotometry using the calorimetric method of aluminum chloride (AlCl3). The standard solution used is quercetin. A sample of 0.05 grams was thenmade into a test solution of 5000 ppm. Then the sample was put in a test tube which was closed with 0.5 mL of aluminum foil and mixed with 1.5 ml of methanol, 0.1 mL of 10% AlCl3, 0.1 mL of 1 M potassium acetate, and 2.8 mL of distilled water. The mixture was vortexed, incubated for 30 minutes at room temperature, and measured at a wavelength of 440 nm. Total flavonoids were obtained based on the standard curve equation of quercetin. The test results are shown as mg quercetin equivalent per gram of sample (mg QE/g ± std. deviation).

Data analysis

The research data will be processed statistically using SPSS 20 with a non-factorial Randomised Block Design (RBD) analysis using ANOVA (Analysis of Variances) analysis to find out any significant differences. Suppose the results are significantly different ($p<0.05$). In that case, it will be followed by an LSD or BNT (Least Significant Difference) 5% confidence interval to find out whether these factors have a significant effect on the analysis of the tested temulawak (*Curcuma xanthorrhiza* Roxb.) samples.

Response Surface Methodology (RSM) Analysis

Response Surface Methodology (RSM) is a statistical and mathematical technique that analyzes a problem. Independent variables that will affect the response variable. The objectives of optimizing using the Response Surface Methodology (RSM) include relatively low cost, more efficient research time and shorter research runs. There are two methods in the Response Surface Methodology (RSM), namely Box – Behken Design (BBD) and Central Composite Design (CCD). The difference between Box – Behken Design (BBD) and Central Composite Design (CCD) is the number of independent variables, Box – Behken Design (BBD) uses 3 or more independent variables and Central Composite Design (CCD) uses 2 independent variables. The software used for optimization is Design Expert (Daulay & Maulinda, 2020).

RESULT AND DISCUSSION

Water Content Analysis

Moisture content has a close relationship to the stability index, especially in terms of storage and durability. Dried foodstuffs can be durable because the water content is reduced to a certain extent. The lower the water content of the material/product, the longer its shelf life (Feringo, 2019). The graph of the water content of temulawak (*Curcuma xanthorrhiza* **Roxb.**) tablets can be seen in Figure 1.

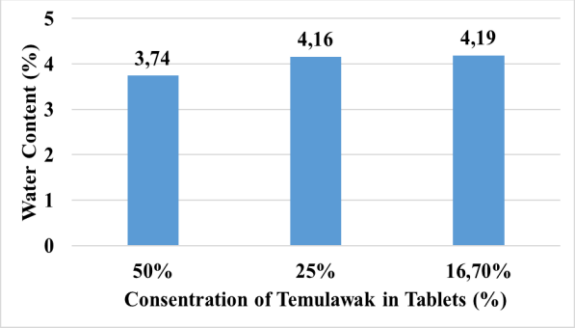

Figure 1. Water Content in Temulawak Tablets

Based on Figure 1, the water content of all treatment samples generally has a uniform value. In the uniformity analysis, the significance value was higher than 0.05 (P>0.05), so that different maltodextrin concentrations did not have a significant or significantly different effect on the results of water content (%).

According to the regulation of BPOM number 32 of 2019, the water content of tablet products must be less than or equal to 10%, so that the resulting tablets meet the requirements of BPOM (BPOM, 2019). In addition, according to (Widyastuti, et al., 2020), a good tablet drug has a 5% of water content value. Based on the data obtained, all treatment samples also met the standart of <5%. With the amount of water content that meets these requirements, the quality of the product can increase. In addition, it can also extend the shelf life of the tablets.

Tablet Weight Uniformity Analysis

The evaluation was carried out to determine the uniformity of the weight of each tablet so that there were similarities in the formulation and efficacy of each tablet. This evaluation was carried out for each treatment, namely 1:2 (50%), 1:4 (25%), and 1:6 (16,70%) treatments. Each will be weighed one by one, with each treatment consisting of 20 tablets. The average weight value of temulawak tablets (*Curcuma xanthorrhiza* Roxb.) can be seen in Table 1.

Table 1. Average of tablets weight

Treatment	Average value
1:2 (mg)/ 50%	253 mg
1:4 (mg)/ 25%	251 mg
1:6 (mg)/ 16,70%	250 mg

Based on the results obtained from the weight uniformity test in Table 1, it proves that the temulawak (*Curcuma xanthorrhiza* Roxb.) tablets with treatments of 1:2 (50%), 1:4 (25%), and 1:6 (16,70%) meet the requirements for uniformity of tablet weights set by the Indonesian Pharmacopoeia III. This is in accordance with the requirements for tablets with an average weight of 151–300 mg. There are no tablets whose weight deviates more than 7.5% from the average weight, and no tablets whose weight deviates more than 15% from the average weight.

Total Phenol Analysis

In the analysis, a control sample will be added in the form of an instant temulawak (*Curcuma xanthorrhiza* Roxb.) drink with the brand "Temulawak Mentari" which is used as a comparison for processed temulawak (*Curcuma xanthorrhiza* Roxb.) products on the market. Based on the uniformity analysis, it was shown that the interaction between extract and the concentration of maltodextrin given significantly affected the total phenolic value of the resulting tablets product. The average value of the total phenolic of tablets produced can be seen in Figure 2.

Figure 2 shows the average value of total phenolic in the sample in general has a downward trend with the increasing concentration of maltodextrin added in the manufacture of temulawak (*Curcuma xanthorrhiza* Roxb.) tablets. Treatment 1:2 (50%) had the highest total phenolic value with an average of 3.63 mg GAE/g ± 0.09 and treatment 1:6 (16,70%) had the lowest total phenolic value of 3.02 mg GAE/g 0.07.

The decreasing trend of the three treatment samples (1:2 (50%), 1:4 (25%), and 1:6 (16,70%)) occurred due to the increasing concentration of maltodextrin added. According to Widarta and Arihantanu (Widarta & Arihantanu, 2014), stated that the high concentration of maltodextrin affected the total phenolic value. The less maltodextrin concentration given, the higher the total phenolic value. Giving maltodextrin in large quantities will increase the total solids contained in the material as a filler. The addition of maltodextrin causes the intensity of the blue color produced during the reaction process to decrease, so that the measured total phenolic levels are low (Marpaung, Tafzi, & Rahmayani, 2021).

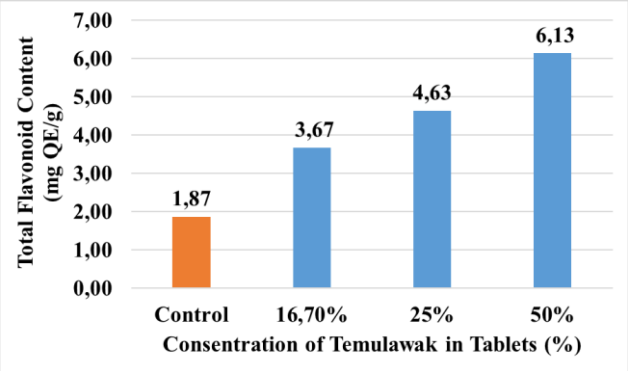

Figure 2. Average of total phenol content in temulawak tablets

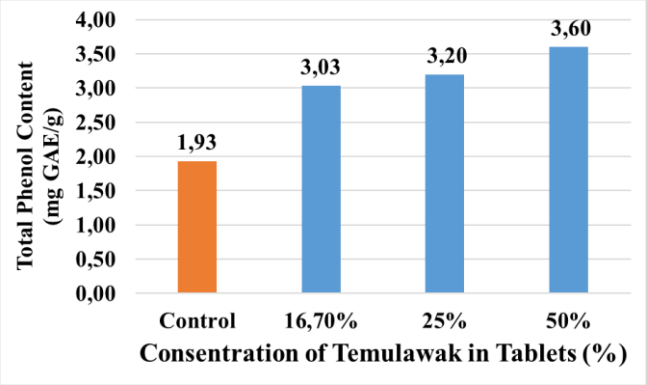

Figure 3. Average of total flavonoid content in temulawak tablets

Total flavonoid Analysis

Based on the uniformity analysis, it was shown that the interaction between temulawak (*Curcuma xanthorrhiza* Roxb.) extract and the concentration of maltodextrin given had a significant effect on the total flavonoid value of the resulting temulawak (*Curcuma xanthorrhiza* Roxb.) tablet product. The average value of the total flavonoids of temulawak (*Curcuma xanthorrhiza* Roxb.) tablets produced can be seen in Figure 3.

Based on Figure 3, it shows that the average value of total flavonoids in the sample in general also has a downward trend with the increasing concentration of maltodextrin added in the manufacture of temulawak (*Curcuma xanthorrhiza* Roxb.) tablets. The 1:2 (50%) treatment had the highest total flavonoid value with an average of 6.11 mg QE/g ± 0.30 and 59, and the sample with a 1:6 (16,70%) treatment had the lowest total flavonoid value with an average of 3.66 mg QE/ g ± 0.14. The decreasing trend of the three treatment samples (1:2 (50%), 1:4 (25%), and 1:6 (16,70%)) occurred due to the increasing concentration of maltodextrin added. This is similar to the total phenolic test, which proves that the lower the concentration of maltodextrin given, the higher the

total flavonoid value. The administration of large amounts of maltodextrin will increase the total solids contained in the material as a filler. This resulted in fewer total flavonoids being measured. The addition of maltodextrin causes the intensity of the yellow color produced during the reaction process to decrease, so that the total flavonoid levels measured are low (Marpaung, Tafzi, & Rahmayani, 2021).

Response Surface Methodology (RSM)

Analysis of Variance (ANOVA) is an analysis of a significant model, to be able to determine the relationship between variables that are used as the basis of research. The ANOVA table is in Table 2 and Table 3. Based on Table 2, the Model F-value of 4,95 implies the model is significant. The possibility of noise is 3,85%. The model is said to be significant if the p-value <0,05. So, in the table the significant models are shown in the B – P. Malto, A2, B2 model. If the value is > 0,1 then it is not significant. The F-value on the lack of fit of 0,25 indicates a discrepancy. There is a 85,67% chance that a Lack of Fit F-value this large could occur due to noise. Based on Table 3, the F-value of 2,06 is not significant, with a 20,21% possibility of noise occurring. In the B^2 model, the value is significant because the p-value <0,05. Lack of fit with an F-value of 0.14 is not significant. There is a 92,66% chance that a Lack of Fit F-value this large could occur due to noise.

Table 2. ANOVA analysis of total flavonoid

Source	Sum of Squares	df	Mean Square	F-value	p-value	Result
Model	23,35	5	4,67	4,95	0,0385	Significant
A-Temp	0,3139	1	0,3139	0,3328	0,5850	
B-P. Malto	8,27	1	8,27	8,77	0,0252	
AB	0,0069	1	0,0069	0,00744	0,9344	
A^2	8,88	1	8,88	9,42	0,0220	
B^2	8,82	1	8,82	9,35	0,0223	
Residual	5,66	6	0,9432			
Lack of Fit	1,14	3	0,3790	0,2514	0,8567	Not significant
Pure Error	4,52	3	1,51			
Cor Total	29,00	11				

Table 3. ANOVA analysis of total phenol

Source	Sum of Squares	df	Mean Square	F-value	p-value	Result
Model	3,35	5	0,6707	2,06	0,2021	Not significant
A-Temp	0,3254	1	0,3254	1,00	0,3559	
B-P. Malto	0,5673	1	0,5673	1,74	0,2348	
AB	0,0005	1	0,0005	0,0015	0,9700	
A^2	0,7993	1	0,7993	2,46	0,1681	
B^2	2,08	1	2,08	6,39	0,0449	
Residual	1,95	6	0,3254			
Lack of Fit	0,2469	3	0,0823	0,1448	0,9266	Not significant
Pure Error	1,71	3	0,5685			
Cor Total	5,31	11				

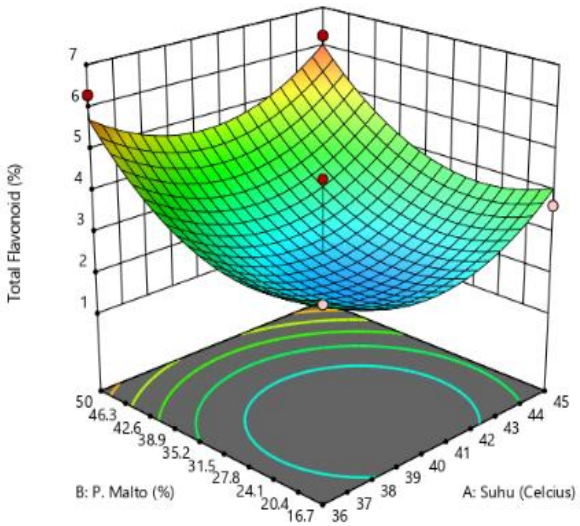

Figure 4. 3D graph of total flavonoid

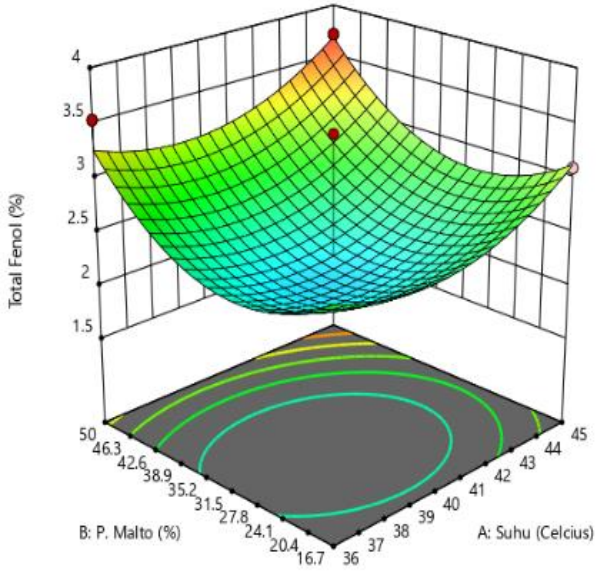

Figure 5. 3D graph of total phenol

Figure 4 is a 3-dimensional graph generated after modeling using Design-Expert. On the graph, there is a peak point which is indicated by a curved line. The optimum point on the graph is shown in the red graph with a total flavonoid of 6,26429% with a temperature of 45ºC and P. Maltodextrin of 1:2 (50%). Figure 5 is a 3-dimensional graph of total phenol with a relationship between temperature and malto ratio. Graphs were obtained from modeling using the software. In the graph, the optimum point is shown in the graph which has a red color with a total phenol of 3,7132% at a temperature of 45ºC and a maltodextrin ratio of 1:2 (50%).

CONCLUSION

Treatment with varying concentrations of maltodextrin had a very significant effect (sig. p<0.05) on the content of phenolic compounds and flavonoids. The best concentration of maltodextrin was in the 1:2 (50%) treatment with a total mean total phenolic value of 3.63 mg GAE/g ± 0.09 and flavonoids of 6.11 mg QE/g ± 0.30, while the lowest treatment was in treatment 1:6 (16,70%) with a mean total phenolic of 3.02 mg GAE/g ± 0.07 and total flavonoids of 3.66 mg QE/g ± 0.14. The high concentration of maltodextrin affects the total value because the ratio between extract and maltodextrin is getting bigger, so the total phenolic and flavonoid content of a product will be lower.

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