OPTIMIZATION OF DRYING PARAMETERS FOR DESICCATED COCONUT POWDER USING CENTRAL COMPOSITE DESIGN
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OPTIMASI PARAMETER PENGERINGAN KELAPA PARUT KERING MENGGUNAKAN DESAIN KOMPOSIT SENTRAL

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ABSTRACT
Desiccated Coconut (DC) is a product rich in fat, protein, carbohydrates and fiber. It is widely used as an additive for the snack industry. As a potential food additive product, every process needs to be considered to produce a good quality DC. The effort to maintain the quality of DC is to optimize the main process of making DC, namely the drying process. In several studies, the drying condition of DC was carried out differently, that is why an optimization process on DC drying is needed. This study aims to determine the temperature and drying time combination that produces DC with the optimum moisture content, fat content, and yield. The drying process used a food dehydrator with a temperature combination of 50°C to 70°C and a time of 2 to 4 hours. The research method used was a laboratory experimental method with Response Surface Methodology (RSM) optimization using Central Composite Design (CCD). It was presented that the optimum drying conditions given by RSM were obtained by drying at 70°C for 2 hours. The results obtained from the validation of a water content of 1.279% wet basis (wb), a fat content of 64.855% wb, and a yield of 42.363%, were following CODEX STAN 177-1991. Based on this study, it can be concluded that the combination of temperature and drying time affects moisture content, fat content, and DC yield.

ABSTRAK
Kelapa Kering (DC) merupakan produk yang kaya akan lemak, protein, karbohidrat, dan serat. Produk ini banyak digunakan sebagai bahan aditif untuk industri makanan ringan. Sebagai produk bahan tambahan makanan yang potensial, setiap proses perlu diperhatikan untuk menghasilkan DC yang berkualitas baik. Upaya menjaga kualitas DC adalah dengan mengoptimalkan proses utama pembuatan DC yaitu proses pengeringan. Terdapat perbedaan kondisi pengeringan terbaik pada beberapa penelitian sebelumnya, sehingga perlu dilakukan optimasi proses pengeringan DC. Penelitian ini bertujuan untuk menentukan kombinasi suhu dan waktu pengeringan yang menghasilkan DC dengan kadar air, kadar lemak, dan rendemen yang optimum. Proses pengeringan menggunakan food dehydrator dengan kombinasi suhu 50°C hingga 70°C dan waktu 2 hingga 4 jam. Metode penelitian yang digunakan adalah metode eksperimen laboratorium dengan optimasi Response Surface Methodology (RSM) menggunakan Central Composite Design (CCD). Dipaparkan bahwa kondisi pengeringan optimum yang diberikan oleh RSM diperoleh dengan pengeringan pada suhu 70°C selama 2 jam. Hasil yang diperoleh dari validasi kadar air 1,279% basis basah, kadar lemak 64,855% basis basah, dan rendemen 42,363% yang sudah sesuai dengan CODEX STAN 177-1991. Berdasarkan penelitian ini dapat disimpulkan bahwa kombinasi suhu dan waktu pengeringan berpengaruh terhadap kadar air, kadar lemak, dan rendemen DC.

INTRODUCTION
The coconut plant *(Cocos nucifera)* is a plant that belongs to the Palmae family and is a tropical plant. Coconut plants are believed to be native plants from the Indo-Malaysia region or originating from the Southeast Asian region so coconut plants are plants that are often found in Indonesia (*Chan and Elevitch, 2006)*. In 2018, Indonesia managed to export coconuts of more than 1.3 billion USD or the equivalent of 2.17 million tons and became one of the sectors contributing to the country's foreign exchange (*Ditjenbun, 2021*).

In addition, in 2020 according to data taken from (*Statista, 2022*), Indonesia is one of the largest coconut-producing countries in the world. Directorate General of Estate Crops also declared that Indonesia has a total area of coconut plantations reaching 3,401,893 Ha and many of them are scattered in coastal areas

Coconut is also known as the "tree of life" because coconut has an important role both from a socio-cultural and economic perspective (*Lo et al.,* 1997). Almost every part of the coconut plant has benefits for humans. One of the coconut products that is currently being developed is Desiccated Coconut (DC). DC is grated old coconut meat that is dried to a certain moisture content to extend shelf life (*Heathcock and Chapman*, *1983)*. This dry-grated coconut is in the form of granules with various levels of fineness, this form will facilitate packaging and storage. The more diverse the snack food industry such as bread, biscuits, and other processed foods, the need for grated coconut is also increasing. Adding dry-grated coconut to biscuit products will increase the levels of fat, protein, carbohydrates, and fiber needed by the body to add nutritional value to these biscuits (*Lubis et al., 2014*).

As an additive in various food products, DC is a product that has a high fat content. Therefore, fat content is generally used as an indicator to determine the quality of desiccated coconut because it is related to nutritional value and shelf life (*Yuvita et al.,* 2022). The water content in DC is also related to the quality of the product. According to Chen *(Chen, 201*9), there is a linear relationship between water content and water activity so there is a tendency that the higher the water content, the higher the a_w value. The water content will determine the amount of water in the material, while the water activity describes how the water content in the material will react with microorganisms. The higher the activity water content will increase microbial activity which can shorten the shelf life of the DC (*Serin et al., 2*018). The effort to maintain the quality of DC is to optimize the main process of making DC, namely the drying process. The main purpose of drying food products is to reduce the water content to a certain moisture content, allowing longer storage (*Yahya et al., 2020*). Temperature and drying time have a significant effect on the quality of the DC produced because the drying process will affect the moisture content, fat content, color, and aroma of the product (*Fennemas et al., 2017*).

The difference in optimal conditions for DC drying results in the need for an optimization process carried out for DC drying to produce products with quality according to applicable standards but with the most efficient time. The study was designed to determine the optimum drying conditions for DC manufacturing by the effects of temperature and drying time using the Response Surface Methodology (RSM). RSM was chosen because this method does not require large amounts of experimental data and does not take a long time to determine the optimum conditions for a process *(Majdi et al., 2019*). Data processing with RSM is done with the help of Design Expert version 13 software. In this study, there are two factors: temperature expressed by X_1, and drying time expressed by X_2. The lower and upper temperature limits used are 50°C and 70°C respectively. The lower and upper limits of drying time used were 2 hours and 4 hours, respectively. The main parameters to be analyzed in this study are moisture content, fat content, and partial drying yield. The research objective was to identify the temperature and drying time combination that yields DC with the best possible yield, fat content, and moisture content.

MATERIALS AND METHODS

1. Instrumentation

The tools used in this research were a coconut grater, sprayer, freezer, blanching tool, food dehydrator, Tyler sieve, mesh filter number 14, cup, oven, soxhlet apparatus set, and analytical balance. The food dehydrator used was the PAPALOLO Drying Stainless Steel Food Dehydrator Machine 10 Trays SS-10H brand. This tool has dimensions of 35x40x43 cm with a power consumption of 800 W. This tool has a temperature setting between 30-90℃ and a time setting between 30 minutes to 24 hours. There were 10 trays with a tray size of 30x28 cm.

2. Raw Material

The main raw material used in this research was old coconut with a hybrid variety obtained from the Bandung Gedebage Market, where the coconut was supplied from the Cipatujah, Tasikmalaya (West Java, Indonesia). Another material used was Natrium Metabisulfite ($Na_2S_2O_5$).

3. Method

The method used in this study was a laboratory experimental method where the number and combination of treatments (running) will be obtained from the design expert application version 13 using the DoE (Design of Experiment) design with the central composite design (CCD) type.

There were two numerical independent variables used in this research. The first independent variable used in this analysis was the drying temperature with the selected lower limit of 50℃ and the selected upper limit of 70℃. The second independent variable used was the length of drying time with the selected lower limit of 2 hours and the selected upper limit of 4 hours. The stages in determining the number of treatments (runs) in this study were 13 runs. The combination of these treatments was obtained from a randomized experimental design expert design.

4. The Process of Drying Desiccated Coconut with A Food Dehydrator

Before the drying process, the preparation of raw materials is made by choosing old coconut. Then the white meat preparation process and the grating process are carried out. Then, the coconut will undergo a process of administering 50 ppm of Natrium Metabisulfite ($Na_2S_2O_5$). The addition of Natrium metabisulfite is given as much as 0.0005% of the coconut mass used *(Mohpraman & Siriphanich, 2012*). The use of sodium metabisulfite can be anti-browning because the browning reaction catalyzed by the phenolase enzyme can be inhibited by the sulfite content. The sulfite content can also prevent the formation of *5 hydroxyl methyl furfural* compounds from D-glucose which can cause browning reactions (*Suryani et al., 2*016). Grated coconut is then blanched with steam at 90℃ for 5 minutes (Siriwongwilaichat et al., 2014). This blanching process serves to deactivate unwanted enzymes that can change the flavor, texture, and color. In addition, for the processing of materials to be dried, the blanching process will speed up the drying process because the cells will be made permeable to water movement (*Waisundara et a*l., 2007). Drying grated coconut using the drying conditions according to the design. 300 grams of sample is dried per run in a thin layer (S*angamithra et al*., 2013) and the process of exchanging tray positions is carried out every half of the drying process.

5. Response Measurement

DC moisture content testing was carried out using the thermogravimetric method (*AOAC, 2005*). The use of the thermogravimetry method also refers to research by Ogawa (O*gawa et al., 2012)*.

The equation for calculating the water content is as follows:

$$MC=\frac{b-(c-a)}{b}x100\% \tag{1}$$

where:

MC is the moisture content (% wb)

a - weight of empty cup (g)

b - mass of wet sample (g)

c - weight of the cup with the sample that has been dried

Measurement of fat content refers to SNI 01-2891-1992 regarding the method of testing food and beverages and refers *(Hewavitharana et al., 202*0) where measuring fat content on DC using the Soxhlet method. The Soxhlet method is a traditional technique used for extracting lipids in foods.

The equation for calculating the fat content is as follows:

$$FC=\frac{W_2-W_1}{W_{fc}}\ x\ 100\% \tag{2}$$

where:

FC is the fat content (%b/b)

W_{fc} - sample weight for measuring fat content (g)

W_1 - weight of fat before extraction (g)

W_2 - weight of fat desiccated coconut after extraction (g)

To find out the yield of drying is done with the following equation:

$$Yield(\%)=\frac{M_b}{M_a}x\ 100\% \tag{3}$$

where:

Yield is the partial drying yield (%)

M_b - mass of desiccated coconut (g)

M_a - mass of grated coconut (g)

6. Data Optimization

From the response measurement results obtained, the data was inputted and processed into the RSM program. Then the response target was determined based on the quality standard for desiccated coconut, namely CODEX STAN 177-1991 which was correlated with the results of measurements of water content, fat content, and yield. All response data were then processed using Design Expert®13 software. The results obtained were then translated into an equation model of the response function to the selected independent variables. Model selection analysis was carried out using the ANOVA test, namely model significance value, inappropriateness test, coefficient of determination (predicted R-squared, adjusted R-squared), and VIFs test using the Design Expert ® 13 program (*Pan et al., 2010*).

RESULTS

1. Independent Variables and Responses

A total of 13 samples with different temperature and drying time treatments have been tested and obtained the responses as shown in Table 1. These responses determine the model that can be used to obtain the optimum combination of temperature and drying time to produce DC which has a moisture content, fat content, and yield drying according to the specified criteria.

Table 1

Central Composite Design: Independent Variables and Responses

Run	Factor 1 A: Temperature (℃)	Factor 2 B: Drying time (Hours)	Response 1 Yield (%)	Response 2 Water Content (%wb)	Response 3 Fat Content (%wb)
1	70	2	42.448	1.196	64.839
2	45.857	3	44.202	3.593	63.673
3	60	4.414	40.020	1.382	64.044
4	60	3	42.272	1.878	64.152
5	60	3	42.193	2.075	63.247
6	50	4	42.036	2.411	63.479
7	60	3	42.251	1.515	63.321
8	60	3	41.152	1.293	64.099
9	50	2	43.260	2.677	63.196
10	74.142	3	42.051	1.148	64.456
11	70	4	40.352	1.129	63.688
12	60	3	42.183	1.825	63.932
13	60	1.585	42.053	3.195	63.994

Based on Table 1, it can be seen that the drying yield ranges from 40.020–44.202%. The difference in the yield values obtained indicates that the drying time and temperature affect the resulting yield values (Tontul a*nd Topuz, 2017)*. The higher the drying air temperature and the longer the drying time tends to have a lower yield value. The smallest yield is obtained from run 3 and the largest yield is obtained from run 2. The standard deviation value at 5 center points is 0.482, this shows that the deviation at the center point is quite low and the data does not have wide variations. Lower yield values are caused by more water content being evaporated. Based on Table 1 it can be seen that the drying water content ranges from 1–3.5%. The higher the drying air temperature and the longer the drying time tends to have a lower moisture content value. This is under Toledo (*Toledo et al., 20*07), that the higher the temperature and the longer the drying time given, can have a very large influence on the speed of water transfer so that the water content in the material will be lower. The smallest water content value is obtained from run 11 and the largest water content is obtained from run 2. The standard deviation value at the center point is 0.3108, this indicates a small deviation or the variation at the center point is not wide. Each treatment sample met the water content criteria specified by CODEX STAN 177-1991, namely a water content of less than ±3%.

Based on Table 1 it can be seen that the drying fat content ranges from 61–64%. The results obtained in this study the smallest fat content value was obtained from run 9 with drying conditions of 50℃ for 2 hours and the highest fat content was obtained from run 1 with drying conditions of 70℃ for 2 hours. The standard deviation value at 5 center points is 0.370, this indicates a small deviation or variation at a small center point. According to (*Zouari et al.,* 2019) an increase in drying time and temperature will result in an increase in the fat content on the wet basis due to a decrease in the water content on the wet basis. Each treatment sample met the fat content criteria specified by CODEX STAN 177-1991, namely fat content of more than 60%.

2. Mathematical Model Analysis of Response

The first step of RSM is to find the right approximation function to see the relationship between response Y and factor X through the first-order model. If the form of the relationship is quadratic, then for the function approach a higher-degree polynomial is used second-order model *(Erbay & Icier, 20*09). The relationship between the independent variables (drying temperature and drying time) to the dependent variable or response (moisture content, fat content, and yield) can be described by the linear, 2FI, and quadratic models which can be seen in Table 2. After the mathematical model of the response has been determined, an analysis of the model obtained is carried out. If the most suitable surface is found through a sufficient approximation, then the results of this analysis will be close to the actual function. The fit between the data distribution and the model is shown by the results ANOVA test, namely, model significance value, lack of fit test, coefficient of determination (predicted R-squared, adjusted R-squared), and VIFs test using the Design Expert ® 13 programs (*Pan et al., 2*010).

Table 2

Mathematical Model Analysis of Response

Response	Mathematical Models	F-Value	p-Value	Lack of Fit	R^2	Adj R^2 Model	Pred R^2 Model	Adeq Precision	VIFs each variable
Yield (%)	Quadratic	0.0027	0.9566	0.9566	0.9299	0.8798	0.8636	16.258	<10
Water Content (%wb)	Linear	0.001	0.1749	0.1749	0.7493	0.6991	0.5322	10.691	<10
Fat Content (%wb)	2FI	0.0749	0.8216	0.8216	0.5966	0.4622	0.2836	7.374	<10

The first analysis is the recommendation of the model used to determine the effect of the variables on the response. Based on Table 2, the model analysis values for the yield response are obtained using the quadratic model with an F-value of 0.0027, lack of fit 0.9566, adjusted R^2 0.8798, and predicted R^2 0.8636. Model analysis for moisture content response uses a linear model as suggested by the design expert application which can be seen in Table 2 with an F-value of 0.001, lack of fit 0.1749, adjusted R^2 0.811,6 and predicted R^2 0.3814. Meanwhile, the model analysis for response to fat content used the 2FI model as suggested by the design expert application with an F-value of 0.0749, lack of fit 0.8216, adjusted R^2 0.4622, and predicted R^2 0.2836. The selected model for each response is used based on the model with a significant F-value, in significant lack of fit, and the highest R^2 value. The Lack of fit F-value obtained (P> 0.05) indicates that it is not significant relative to the pure error. There is a 95.66% possibility that the Lack of fit F-value of this magnitude can occur due to noise. A significant model and a non-significant Lack of fit are good model condition because it shows the suitability of the response data. This gives a good picture of the fit of the model with the response. In other words, the model was fit with the responses data collected. With the fulfilment of these conditions, each response can be explained properly by the model and is suitable for describing the response data (*Karimifard & Alavi Mogha*ddam, *2018*).

The R^2 obtained in this study for the yield response was 0.9299. This value is quite good because the value is close to 1. The smaller R^2 value indicates a large deviation in the data or an error in the study (*Hadiyanto, 2*016). This value indicates that the data that can be described by the model is 92.99% and the temperature and drying time factors affect the response by 92.99% and 7.01% are influenced by other factors not examined. Meanwhile, for the response to water content, based on Table 2, it can be seen that the R^2 value obtained in this study was 0.7493. This value is quite low compared to the yield response value. This value indicates that the data that can be described by the model is 74.93% and it can be interpreted that the temperature and drying time factors affect the response by 74.93% and 25.07% are influenced by other factors not examined. As for the response to fat content, based on Table 2, it can be seen that the R^2 value obtained in this study was 0.5966. This value is quite low compared to the response value of the yield and water content. This value indicates that the data that can be described by the model is 59.66% and it can be interpreted that the temperature and drying time factors affect the response by 59.66% and 40.34% are influenced by other factors not examined.

The response model for drying yield, moisture content, and fat content stated a reasonable agreement, where the resulting model met the criteria. These criteria are the difference between Adj R-squared and Pred R squared less than 0.2 and Adequate Precision > 4.

The test results show that the equation formed by Design Expert ® 13 to predict the response of drying yield, moisture content, and fat content indicates that the model can be accepted and used in the design space. Based on Table 2 it can be seen that the model is good because it has a difference between adjusted R^2 and predicted R^2 below 0.2. The Adequate precision value for each response also shows a value greater than 4. Adequate precision measures the ratio of signal to noise. A good model is a model that has a ratio greater than 4 so that the model can be accepted and used in the design space (*Nguyen Tram Anh et al., 2021*).

Based on Table 2, it can be seen that the VIF value of each factor and the response has shown a value of <10. The VIF value is a factor that can determine how much the variance of the regression estimator coefficients increases compared to the orthogonal variables if they are connected linearly. The VIF value is used to test whether the non-multicollinearity assumption is met. The greater the correlation between the independent variables, the greater the VIF value. If the VIF value of the variable exceeds 10, it can be assumed that multicollinearity occurs. Multicollinearity symptoms will result in a regression model that is biased, unstable, and possibly far from the predictive value *(Daoud, 2018)*.

3. Mathematical Model of Each Response

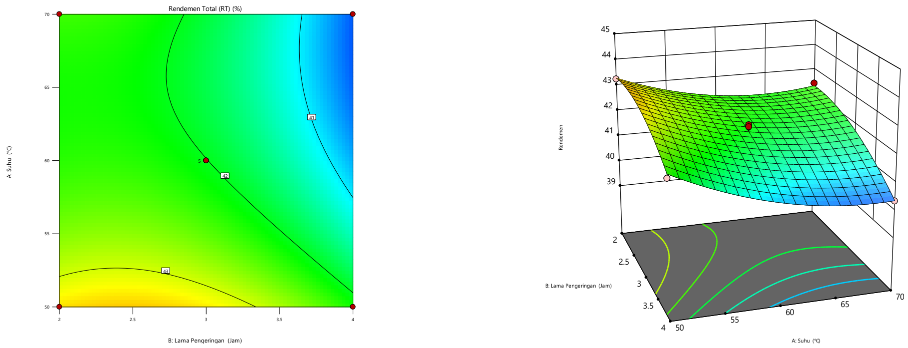
3.1. Yield Response Model:

RSM equation or model for process optimization DC powder drying to yield response is shown in equation 4:

$$Yield\ (\%) = +59.627 - 0.656(A) + 3.540(B) - 0.021(AB) + 0.005(A^2) - 0.500(B^2) \tag{4}$$

It can be seen that the quadratic model shows that the yield response is influenced by drying temperature and drying time, as well as the quadratic interaction between the two. The influence exerted by time is greater on yield than that of drying temperature. This can be seen from coefficient B which has a greater value of 3.54 when compared to coefficient A with a value of 0.656. This equation also illustrates that the drying temperature has an inverse effect on the response. This is indicated by a negative (-) constant. In contrast to time, which has a directly proportional effect on the response indicated by a constant positive (+) value.

In Figure 1a, a visual appearance of the yield results is presented which is marked by color differences. The bluer the area, the lower the yield, while the redder the area, the higher the yield. In Figure 1b, the shape of the three-dimensional graph is in the form of a parabola because the model used is quadratic. The yield values with blue or the lowest yield were obtained by the drying treatment which used the highest temperature and the longest drying time, whereas the graph with green, yellow, and red colored areas or the high yield was obtained from the drying with the lowest temperature and the shortest time.



(a) (b)

Fig. 1 - Contour Plot for Yield (a), 3D Plot for Yield (b)

3.2. Moisture Content Response Model:

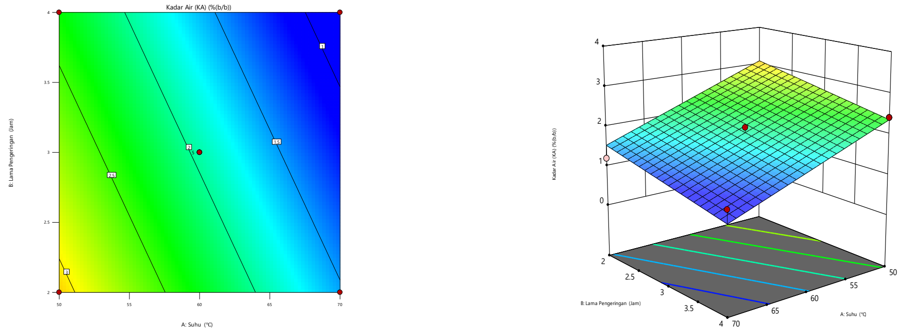
The selected RSM equation or model for optimizing the drying temperature and drying time in the DC drying process for the response to water content can be identified by equation 5:

$$Moisture\ Content\ (\%\ wb) = 7.699 - 0.077(A) - 0.362(B) \tag{5}$$

The water content response model obtained is a first-order model (linear). This indicates that the response to water content is only influenced by drying temperature and time and not the interaction between them. The influence given by time is more dominant on the response of water content than the effect of drying temperature. This can be seen from coefficient B with a value of 0.362 indicating a value that is greater than coefficient A, namely with a value of 0.07.

The equation illustrates that the effect of drying temperature and time is inversely proportional to the response of water content. The moisture content response will have a lower value when the temperature and drying time are added. This is also indicated by a negative sign (-) on the coefficients A and B which are opposite to the constants in the model.

In Figure 2a. The above shows the surface contour graph of the model from the temperature factor and drying time to the water content. The conditions of the factors with the maximum response value are marked in the yellow area, while the minimum response is marked in the blue area. Figure 2b showed a 3D graph of the water content response. Because the model obtained is linear, the graph is not a parabola. The higher the temperature factor and the longer the drying time, the less water content will be.



(a) (b)

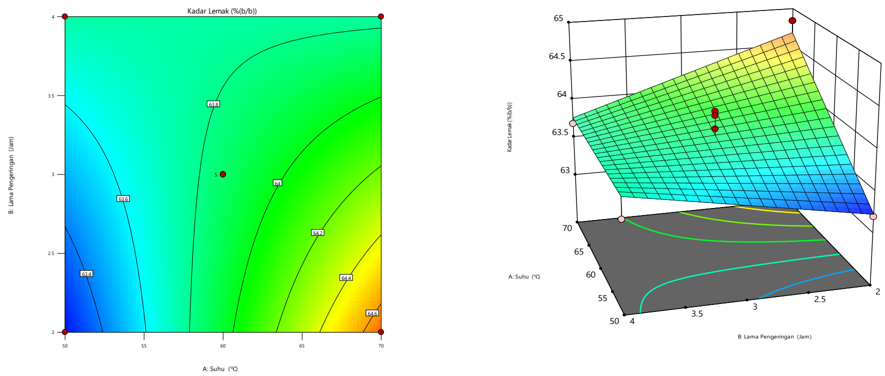
Fig. 2 - Contour Plot for Water Content (a), 3D Plot for Water Content (b)

3.3. Fat Content Response Model

The selected RSM equation or model for optimizing drying temperature and drying time in the DC drying process for the response of fat content can be identified by equation [6]:

$$Fat\ Content\ (\%wb)=5.481+0.144(A)+2.051(B)-0.035(AB) \quad (6)$$

The fat content response model obtained is the 2FI model. This shows that the response of fat content is influenced by drying temperature and time and the interaction between them. The effect given by time is more dominant on the response of fat content than the effect of drying temperature. This can be seen from coefficient B with a value of 2.0513 indicating a greater value than coefficient A, namely with a value of 0.144. The equation illustrates that the effect of drying temperature and time is directly proportional to the response of fat content. While the interaction between temperature and time is inversely proportional to the response of fat content. The response of fat content will have a higher value when the temperature and drying time are added. This is also indicated by a negative sign (+) on the coefficients A and B which are opposite to the constants in the model.



(a) (b)

Fig. 3 - Contour Plot for Fat Content (a), 3D Plot for Fat Content (b)

In Figure 3a, the above shows the surface contour graph of the model from the temperature factor and drying time to the water content. The conditions of the factors with the maximum response value are marked with red areas, while the minimum response is marked with blue areas. Figure 3b shows a 3D graph of the fat content response. Because the model obtained is 2FI, the graph is not a parabola. The longer the drying time, the more intact fat content is formed, and the fat content can be measured.

4. Optimization of Desiccated Coconut Drying Process

After obtaining a mathematical model for each response, the optimization process is carried out. The optimization design carried out on DC drying can be seen in Table 3. The determination of the upper and lower limits on the response is the result of recommendations based on the model that has been obtained from each response. The level of importance is determined based on CODEX STAN 177-1991.

Table 3 shows the target values, upper limit, lower limit, and importance of each optimization variable. The yield response is determined to have the maximum target. This target was set because it was desired that a drying process with optimal conditions still produce a high yield. Setting targets on the response of water content set a minimum target. The target is to comply with CODEX STAN 177-1991. High water content tends to cause the DC to agglomerate and will result in a high a_w value so that microbial activity increases. The fat content response is determined to have a maximum target, where the fat content is expected to have a value that exceeds 60% to comply with CODEX STAN 177-199. Therefore, desiccated coconut with a high-fat type can be produced from this optimization process.

Table 3

Criteria For Determining the Optimum Drying Condition of Desiccated Coconut

Response	Target	Lower Limit	Upper Limit	Importance
Yield (%)	*Maximize*	40.02	44.202	+++++
Water Content (%wb)	*Minimize*	1.129	3.593	+++++
Fat Content (%wb)	*Maximize*	63.196	64.839	+++++

The results of recommendations for optimum condition solutions for DC drying based on Design Experts can be seen in Table 4. The determination of optimum conditions is based on the highest desirability value. If this value is higher, it shows that every constraint or requirement previously arranged is increasingly being fulfilled (*Witek-Krowiak et al., 2014*). In addition to the accuracy of the data obtained for all runs, the desirability value depends on the required optimization design where the more complicated the conditions are, the smaller the desirability value. Therefore, the optimal conditions chosen in this study were factor 1 (temperature) 70 ℃ and factor 2 (time) 2 hours

Table 4

DC Drying Optimum Conditions Recommendations

No	Tempe rature (℃)	Drying Time (Hour)	Water Content (%Wb)	Fat Content (%wb)	Yield (%)	*Desirability*	
1	**70**	**2.000**	**1.532**	**64.683**	**42.353**	**0.750**	***Selected***
2	70	2.009	1.529	64.679	42.353	0.750	
3	70	2.035	1.519	64.667	42.353	0.749	
4	70	2.052	1.513	64.660	42.352	0.748	
5	70	2.333	1.411	64.531	42.301	0.732	
6	50	4.000	2.363	63.744	42.189	0.442	

5. Model Verification

The validation stage of RSM is used to determine the level of accuracy of the formula from the prediction results given by Design expert 13 with RSM-Central Composite Design. Based on Table 4, it is known that the optimal drying conditions are factor 1 (Temperature) 70 ℃ and factor 2 (Time) 2 Hours, so for the validation process, two repetitions are used which consist of the input run 1 sample value under the same conditions and re-drying under the same conditions. optimal. The water content values (%wb) for the two validation processes were 1.196%wb and 1.363%wb, the values for the fat content (%wb) obtained for the two validation processes were 64.839%wb and 64.872%wb, while for the drying yield values (%) for each validation process was 42.448% and 42.278%.

The validation confirmation results can be seen in the RSM optimum solution confirmation table in Table 5, where it can be seen that the results of the validation values for each response are still in the prediction range of 95% PI low and 95% PI high. In Table 5 it can be seen that the average response value for water content is lower, namely 1.279% than previously predicted, 1.531%. The water content validation results are also within the prediction range, namely between 0.632% (95% Low PI) to 2.431 (95% High PI). The fat content response obtained from the validation results was 64.855%, which was higher than predicted, namely 64.683%.

Table 5

RSM Optimum Solution Confirmation

Solution	*Predicted*	Std Dev	n	SE Pred	95% PI low	Data Mean	95% PI high
Water Content	1.531	0.443	2	0.403	0.632	1.279	2.431
Fat Content	64.683	0.356	2	0.369	63.847	64.855	65.519
Yield	42.352	0.377	2	0.399	41.407	42.363	43.298

The validation results are still in the range of PI 95% Low and PI 95% High, namely 63.847% to 65.519%. Finally, the validation results on the yield response were 42.363%, higher than the predicted 42.352%. The values obtained in the yield validation are in the range of PI 95% Low and PI 95% High, namely 41.407% – 43.298%. All validation results are still within the lowest and highest predictive ranges, so it can be said that the solutions offered by RSM were good (*Pan et al., 2010)*.

CONCLUSIONS

In the DC drying process, there is an interaction between temperature and drying time variables which results in different moisture content, fat content, and yield for each treatment. Based on the research result obtained a linear equation for the response to water content, a 2FI equation for the response to fat content, and a quadratic equation. In addition, it can be seen that optimization using the Design expert 13 program with RSM-Central Composite Design produces an optimization formula with a temperature of 70°C for 2 hours in a food dehydrator dryer resulting in a moisture content of 1.279% wb, fat content of 64.855% wb, and a yield of 42.363%, which complies with CODEX STAN 177-1991.

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