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TURMERIC DRYER (CURCUMA DOMESTICA VALET) USING A VACUUM OVEN

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Abstract

Turmeric (Curcuma domestica Valet), known as Curcuma longa, is a type of spice that is well known among Indonesians. Turmeric contains a variety of compounds such as curcumin, which is sensitive to high temperatures. It is possible to conduct further research to improve drying outputs based on the curcumin concentration in turmeric. This study aims to establish the optimum conditions for drying turmeric (Curcuma Domestica Valet) in a vacuum oven with variable such as pressure, temperature, and drying duration. This study uses turmeric that has been peeled, rinsed, thinly sliced, and weighed around 15 grams before being tested for water content and initial curcumin content. The turmeric is dried in a vacuum oven, and after one hour the dried turmeric is weighed and its water content and curcumin contents are analyzed. Based on the results of this study, the optimum condition for drying in a vacuum oven are at a pressure of 0,5013 Atm with a water content of 71,78% and a curcumin content of 1,54%, as well as at a temperature of 70 ^{o}C with a water content of 33,20% and a curcumin content of 2,64%.

Keyword: *vacuum oven; turmeric; drying*

INTRODUCTION

Turmeric (Curcuma domestica Valet), known as *Curcuma longa,* is a type of spice that is well known among Indonesians. Due to its relatively high water content of turmeric, decaying can be speed up.

Foodstuffs should have less than 10% water content. A foodstuff can be kept for a very long time at this level of water content since there is very little chance of microbal and fungal contamination during storage (Winarno, 1997).

Turmeric contains a variety of compounds such as curcumin, which is sensitive to high temperatures. The compound won't be damaged by conventional heating, but the surroundings will contaminate the rhizome (Winarto and Tim Lentera, 2003).

Table 1. Chemical Composition in 100 grams of Raw Tumeric

No.	Component Name	Composition
1.	Water	11,4 g
2.	Calorie	1480 cal
3.	Carbohydrate	64,9 g
4.	Protein	7,8 g
5.	Fat	9,9 g
6.	Fiber	6,7 g
7.	Ash	6,0 g
8.	Calcium	0,182 g

No.	Component Name	Composition
9.	Phosphor	0,268 g
10.	Iron	41 g
11.	Vitamin A	---
12.	Vitamin B	5 mg
13.	Vitamin C	26 mg
14.	Essential Oil	3%
15.	Curcumin	3%

Source: (Farel, 1990; Natarajan and Lewis, 1980 in Sejati, 2002; Winarto and Tim Lentera, 2003)

Drying is the process of eliminating relatively small amounts of water from a solid or gas mixture. Processes for transferring heat, mass, and momentum all occur during drying. Heat from the air is applied to the material to be dried so that heat will be transported from the hot air to the wet material. This heat will cause water to evaporate into the air. The basic sort of dryer is one that draws heat in through convection, conduction, or radiation (Mujumdar, 2004).

Drying method using oven is more beneficial because the temperature can be adjusted and water content can be reduced significantly fast. However, high temperatures can harm the compound in the sample so that lowering the quality (Muller and Heindl, 2006). High vacuum pressure and freezing temperatures throughout the drying process could result in products with favorable texture, color, rehydration, and other parameters (Estiaghi et al, 1994). This study used a vacuum dryer because it preserves the turmeric's components by drying at low temperatures and pressures below atmospheric pressure.

Vacuum drying takes place at low pressure, which reduces the boiling point of water and increases the temperature and heating medium differences. As a result, water flow rates are increased and heat is used more effectively. The benefit of vacuum drying is that it lowers the partial pressure of the boiling point, allowing water to evaporate at temperatures lower than 100°C.

The liquid that is evaporated during drying is free liquid, or the total amount of liquid in the material less the equilibrium liquid. Equilibrium liquid is a liquid that is in equilibrium with the partial vapor pressure in the drying air after being dried for a predetermined amount of time under constant conditions.

Bound moisture is the liquid content of a material whose vapor pressure is lower than the equilibrium pure liquid at the same temperature. If the drying process continues this way, the material's structure will be harmed (Perry and Green, 1997). Unbound moisture is a continuous liquid content present in the

material with a vapor pressure equal to that of a pure liquid at the same temperature (Treybal, 1981). Some factors that impact drying are:

Dryer air temperature

The rate of heat transmission will increase with the temperature differential between the material and the heating medium. Therefore, drying time is shorter.

Dryer airflow speed

The amount of water carried by drying air increases with its flow. Therefore, drying time is shorter.

Dryer air relative humidity

As the partial pressure of water in the drying air decreases and the relative humidity decreases, the air's capacity to bind water in the material increases.

Water content

The more water content contained in the material, the longer it will take to dry the material. The water content can be calculated by:

$$dry\ base = \left(\frac{kg\ water}{kg\ dry\ solid}\right) 100\%$$

Operation pressure

The lower the operating pressure, the lower the boiling point of the water in the material and the faster the drying process.

Material size

The larger the surface area of the material being dried, the faster evaporation occurs. And the thicker the material being dried, the longer the evaporation takes place.

This study aims to determine the optimum conditions for drying turmeric (Curcumin Domestica Valet) using a vacuum oven with pressure and temperature variables.

METHODOLOGY

Tools and materials

This study uses tools such as oven, vacuum pump, porcelain dish, desiccator, scale, silica gel plate 60 F254, volumetric flask. This study uses materials such as turmeric and 5 ml of ethanol.

Material Preparation

Turmeric (Curcuma Domestica Valet) is taken, separated from the skin, washed with water and then drained, sliced thinly.

Experiment

A vacuum oven is filled with turmeric (Curcuma Domestica Valet), then it is carefully closed and switched on. Drying is carried out for an hour at various pressures (0.8356 atm, 0.6684 atm, 0.5013 atm, 0.3342 atm, and 0.1671 atm), after which the

results are analyzed using TLC (Thin Layer Chromatography) to determine the curcumin concentration. Some of the results, moisture content is determined using the gravimetric/dry shrinkage method. Using the same methods, experiments are conducted at temperatures of 50°C, 60°C, 70°C, 80°C, dan 90°C.

ANALYSIS

The results were analyzed, including the water content and curcumin content.

Water Content Analysis (according to AOAC, 1984)

Five gram of sample is placed within a porcelain dish of known weight then dried to between 100°C and 105°C in an oven and dried to a constant weight. After that, it is chilled in desiccator before being weighed.

$$Water\ content\ (bb) = \frac{Wa - Wt}{Wa} x100\%$$

Where: bb = Wet bases

W_a = Initial material weight (grams)

W_t = Weight of the material after drying (grams)

Curcumin Content Analysis

Using TLC (Thin Layer Chromatography), curcumin content is analyzed. A standard curve is created in order to compare and evaluate the curcumin content. After being dried in a vacuum oven, the turmeric is weighed and dissolved in 5 ml of ethanol in a volumetric flask. With the standard regression of synthesized curcumin, a sample of 5 µl is injected with a microsyringe into a silica gel 60 F_{254} plate. The plate is placed inside the chamber, which is already filled with saturated chloroform-methanol mobile phase (98-2), and allowed to elute to its maximum concentration before being lifted and airborne. Densito spot curcumin with a 425 nm wavelength. Then calculate the curcumin content.

RESULTS AND DISCUSSION

Pressure Variable

Pressure effect water and curcumin content with constant variables: drying temperature is 60°C, drying period is 1 hour, thickness is 1 mm, and initial weight of the turmeric is 15 grams.

Table 2. Correlation of Drying Pressure to Water Content and Curcumin Content

No	Turmeric (*Curcuma Domestica Valet*) Drying Pressure (Atm)	Water Content (%)	Curcumin Content (%)
1	0.8356	79.18	1.82
2	0.6684	72.52	1.68

3	0.5013	71.78	1.54
4	0.3342	68.59	1.35
5	0.1671	66.13	1.17

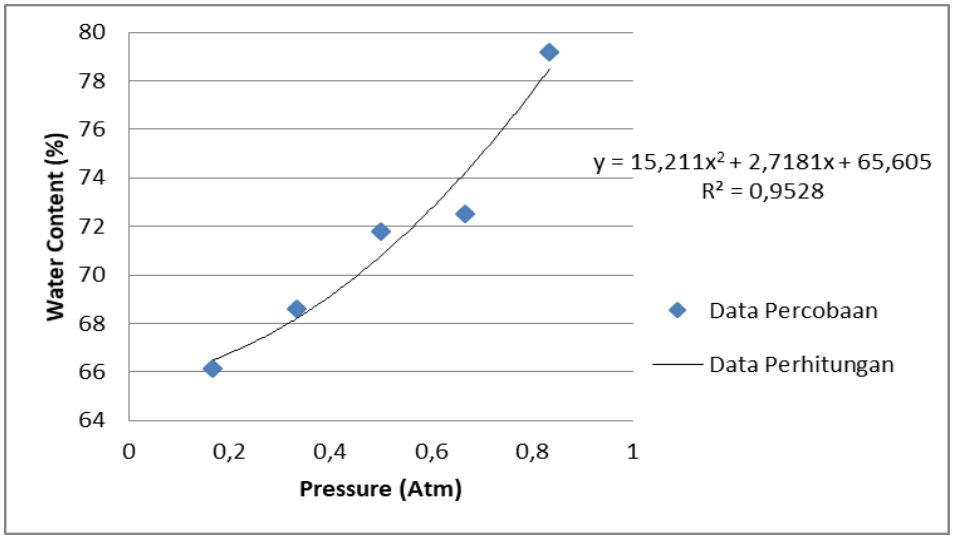

Figure 1. Correlation of Drying Pressure to Water Content

From Figure 1 and Table 2, the correlations between pressure and water content can be seen that the lower the oven pressure, the less water is contained in turmeric and the more water in the material is evaporated. This is because the lower the operation pressure used, the lower the boiling point of the water in turmeric so that at the same time and operating temperature the water contained in the turmeric evaporates more and more.

The equation $y_a = 15.211x^2 + 2.7181x + 65.605$ is found from Figure 1, with a pressure range of (x) between 0.1671 Atm and 0.8356 Atm. Through the approach with the above equation, the average percent error is 1.34%.

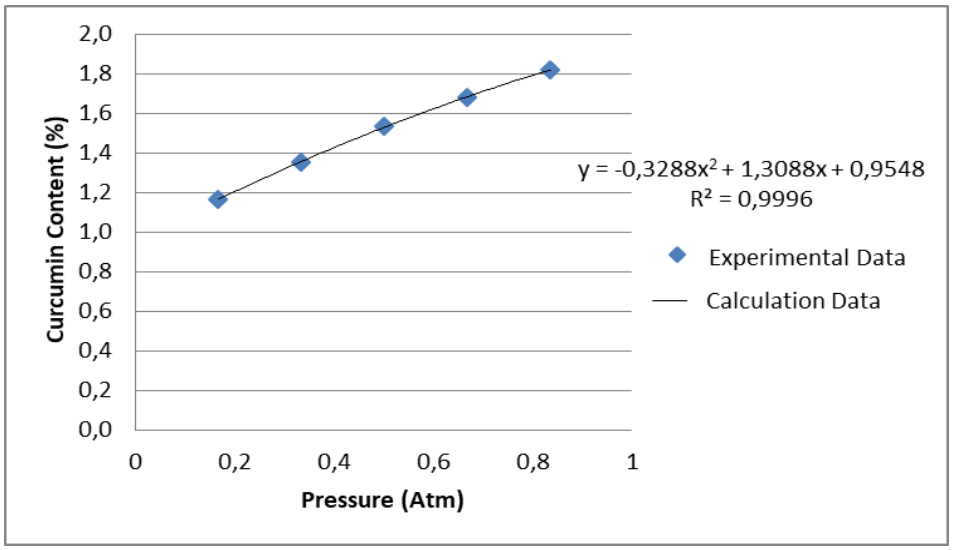

Figure 2. Correlation of Drying Pressure to Curcumin Content

From Figure 2 and Table 2, the correlations between pressure and curcumin content can be seen that the lower the operation pressure, the lower the curcumin content in turmeric. This is due to the drying process also evaporating a significant amount of curcumin.

The equation $y_b = -0.3288x^2 + 1.3088x + 0.9548$ is found from Figure 2, with a pressure range of (x) between 0.1671 Atm and 0.8356 Atm. Through the approach with the above equation, the average percent error is 0.26%.

The optimum condition is determined by the data with the highest curcumin content and the lowest water content. Therefore, the chosen pressure is 15 inHg (0.5013 Atm), as the curcumin content is still relatively high at 1.5355% and the water content is 71.78% at that pressure.

Temperature Variable

Effect of temperature on water content and curcumin content, with fixed variables: thickness is 1 mm, drying period is 1 hour, air pressure is 15inHg / 0.5013 Atm, and initial weight of the turmeric is 15 grams.

Table 3. Correlation of Drying Temperature to Water Content and Curcumin Content

No	Turmeric (*Curcuma Domestica Valet*) Drying Temperature (^oC)	Water Content (%)	Curcumin Content (%)
1	50	60.12	1.69
2	60	53.39	2.17
3	70	33.20	2.64
4	80	25.96	2.20
5	90	16.82	1.76

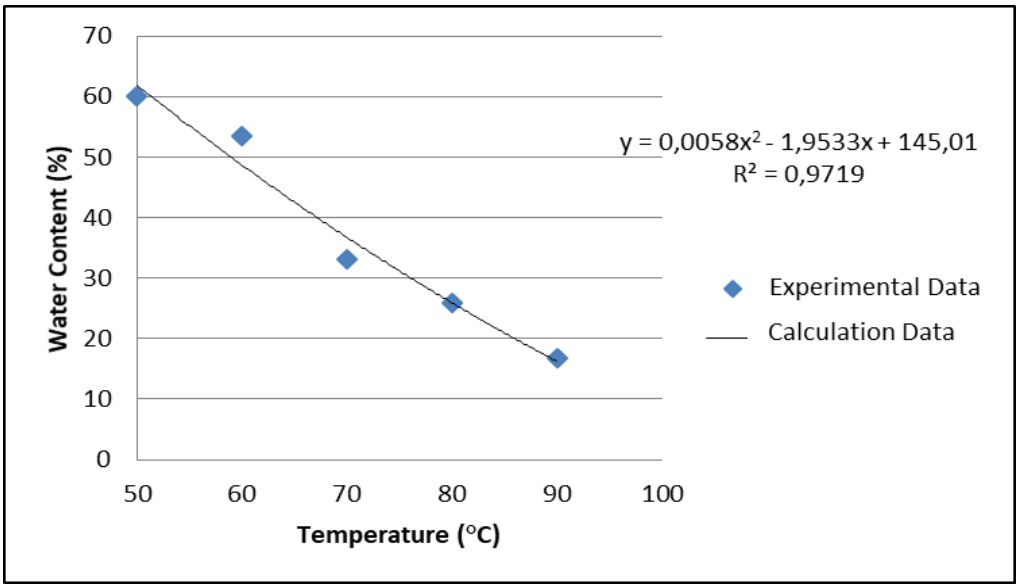

Figure 3. Correlation of Drying Temperature to Water Content

From Figure 3 and Table 3, it can be seen the correlation between temperature and water content in the material, the higher the temperature at operating conditions, the less water content in the material, the greater the drying speed. This is due to the fact that when the heat flowing through it increases, the water content of the turmeric will also evaporate more and more.

The equation $y_a = 0.0058x^2 – 1.9533x + 145.01$ is found from Figure 3, with a temperature range of (x) between 50 °C and 90 °C. Through the approach with the above equation, the average percent error is 5.26%.

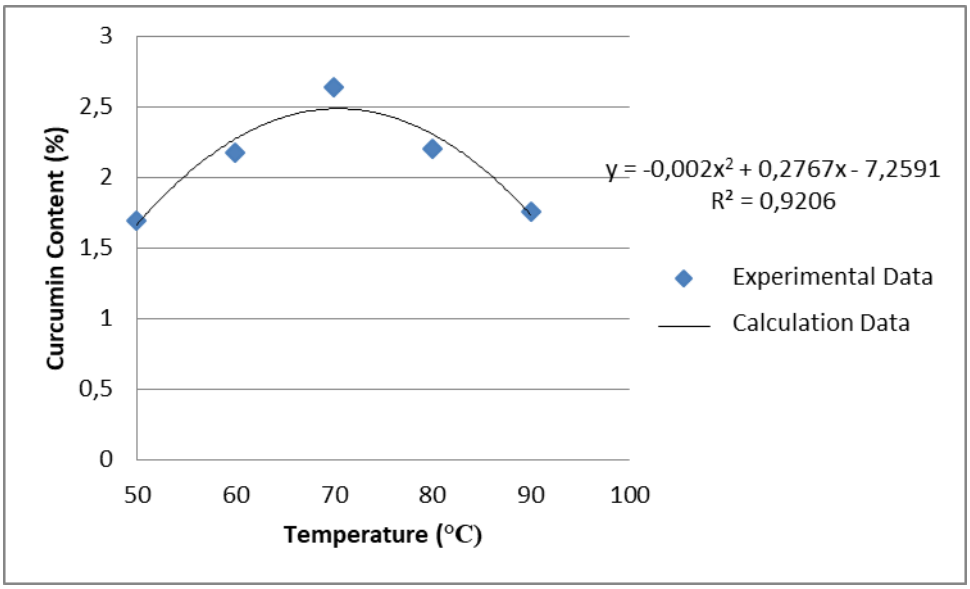

Figure 4. Correlation of Drying Temperature to Curcumin Content

From Figure 4 and Table 3, it can be seen the correlation between temperature and curcumin content. Curcumin content increase at temperature between 50 °C and 60 °C. This is because there is still a lot of water in turmeric so that the curcumin in turmeric is not too concentrated. The highest amount of curcumin is produced at a temperature of 70 °C. The concentration of curcumin decreases at temperatures between 80 °C and 90 °C. This is due to the fact that turmeric's curcumin will decompose at very high temperatures.

The equation $y_b = -0.002x^2 + 0.2767x – 7.2591$ is found from Figure 4, with a temperature range of (x) between 50°C and 90°C. Through the approach with the above equation, the average percent error is 8.81%.

The optimum condition is determined by the data with the highest curcumin content and the lowest water content. The two graphs show that the optimum temperature is 70°C with curcumin content of 2.64% and water content of 33.20%.

CONCLUSION

The research that has been done yielded two conclusions. The first finding is that pressure and temperature have an effect on how turmeric is dried in a vacuum oven,

affecting both the water content and concentrations of curcumin contained. The second finding is that the optimum conditions are found at 0.5013 Atm of pressure, with a water content of 71.78% and a curcumin content of 1.54% as well as at 70°C, with a water content of 33.20% and a curcumin content of 2.64%.

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