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Design of Temperature Measurement System on The Drying Process of Madura Tobacco Leaves

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Abstract – The quality of dried chopped leaves of tobacco is an important factor. The present work developed an oven for drying process to measure and evalute on drying shrinkage characteristic of choped leaves Madura tobacco. The oven has three racks for analyzing and monitoring the rate of drying shrinkage of Madura tobacco. Every rack has a different amount of chopped leaves as follows: 120 g on top rack, 100 g for middle rack and 80 g for bottom rack. Rate of drying shrinkage was analyzed for 20 minutes. The results showed that every rack has different rate of drying shrinkage for drying time. The rate of drying shrinkage was achieved at 26-35% for all racks with temperature distribution in oven at 25 – 30 °C.

Index Terms – Measurement, temperature, drying, shrinkage, chopped tobacco.

INTRODUCTION

Post-harvest handling, drying is an important stage to maintain quality of Madura chopped tobacco in accordance with the SNI 01-3942-1995. The drying process is a process of evaporation or decreased water content of a material so that the water levels reach equilibrium at normal temperature [1].

Tobacco leaf processing is the process of drying wet leaves become dry leaves (krosok or chopped). Meanwhile the chopped leaves of tobacco with colored dark, the drying process is done in a few days accompanied by of condensation process until the desired color [2].

Main problems in countryside for drying process of chopped leaves of tobacco is still using conventional method. The process depends on the presence of sunlight[3]. The weakness of traditional drying that still rely sunlight among requires a relatively long time and are very dependent on weather conditions so that the drying to be carried out cannot run optimally. Require large place to perform drying.

This research aims to create a drying sistem of chopped leaves of tobacco using a dryer rack type which utilizes heat energy from a tubular heater. The distribution of temperature, mouisture, drying rate, as well as process heat transfer to the system to be measured and analyzed.

METHOD

Chopped leaves of Madura tobacco as samples was used to determine characterization on drying shrinkage. 300 g of chopped leaves of Madura tobacco was divided into three racks as follows: 120 g on top rack, 100 g for middle rack and 80 g for bottom rack.

A tubular heater with output power of 600 W was used for heat supply in the oven. Blower in combination with fan blades which can set the speed of wind was used to ensure homogeneous of temperature distribution inside oven. Digital thermometer with type K thermocouple to measure and monitor temperature distribution inside oven. Anemometer for measuring wind speed from blower.

Figure 1 is a phase of testing and data collection is done in this study whereas the temperature measurement points shown in Figure 2. In the first rak, temperature measurements carried out at three different points, namely the position d (T_1), the position a (T_2), and the position c (T_3). Temperature measurement on the second shelf is done in three different points, namely the position c for T_1, the position d for T_2, and the position b for T_3. Meanwhile the temperature measurement on the third shelf is done in three different points, namely T_1 for the position d, T_2 for the position b, and T_3 for the position a. The temperature on the heat source is measured at the point of Tp.

Heating source is turned ON for 20 minutes at a flow rate 0.5 m/s with a blower voltage of 50 V. Changes in temperature are recorded every 5 minutes until the drying time is completed.

Moisture samples of chopped leaves of tobacco (K_{at}) can be calculated using equation as follows.

$$Kat = \frac{mb-mk}{mb} \times 100 \qquad (1)$$

Hereinafter, the drying rate (v) of chopped leaves of tobacco can be calculated with equation:

$$v = \frac{mb-mk}{t} \qquad (2)$$

In general, the heat transfer rate can be expressed with Newton's law of cooling as follows:

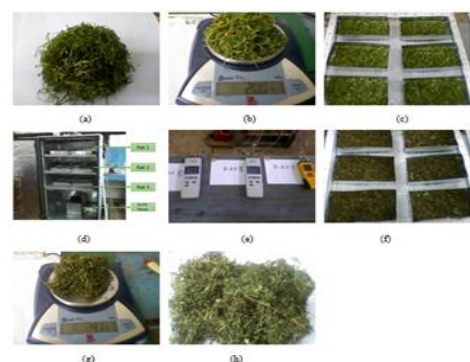$$q_{kv} = h_{kv} A (T_b - T_f) \qquad (3)$$

Figure 1. Testing phase and data colection

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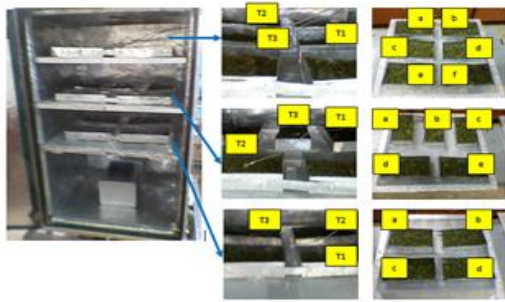
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Figure 2. The points of measurement
Temperature distribution.

RESULT AND DISCUSSION

Madura chopped tobacco drying process in this study lasted 20 minutes. Changes in temperature against time on testing are presented in Table 1.

Table 1. Results of Temperature Distribution in Space Dryer with Rack Mounted and Tobacco Ingredients Sliced for 20 Minutes

Information	Temperature Reached (°C)	The Highest Temperature (°C)	The Lowest Temperature (°C)
Heating Source	27,7-44,8	-	-
Temperature Out	30-31,2	-	-
Rack 1	25,8-28,4	a (26,5-28,4)	d (25,8-27,5)
Rack 2	26-28,8	c (26,1-28,8)	d(26-28)
Rack 3	26,2-30,3	a (26,8-30,3)	d(26,2-29,1)

Using equation 1 can be obtained percentage decline in the value of the water content in table 2.

Table 2. Results Percentage Decrease in Water Levels for 20 Minutes

Water Content	Percentage Decrese (%)	The Highest Percentage (%)	The Lowest Percentage (%)
Rack 1	27-34,5	a (34,5)	c (27)
Rack 2	26-32	b (32)	d&e(26)
Rack 3	29-35	a (35)	d(29)

Drying rate calculation using equation 2. Graphics drying rate for 20 minutes is shown in Table 3.

Table 3. Results The rate of drying Sliced Tobacco Ingredients for 20 Minutes

Information	Drying Rate Achieved (g/minute)	The Highest Rate of Drying (g/minute)	The Lowest Rate of Drying (g/minute)
Rack 1	0,27-0,35	a (0,35)	c (0,27)
Rack 2	0,26-0,32	b (0,32)	d&e(0,26)
Rack 3	0,29-0,35	c&d (0,35)	d(0,29)

To calculate the heat transfer rate received by each shelf using equation (3).

Table 4. Heat transfer on Shelf 1

T1	T2	T3	Q1(J)	Q2(J)	Q3(J)
25.8	26.5	26.5	0.00	0.00	0.00
26.6	27.2	27.2	5.09	4.04	4.04
27.1	27.5	27.5	7.50	5.77	5.77
27.2	27.9	27.9	8.08	8.08	8.08
27.5	28.4	28.3	9.81	10.97	10.97

CONCLUSION

Drying conducted for 20 minutes shows temperature distribution in the drying chamber 25-30 °C with a reduced water content 26-35% and the drying rate from 0.26 to 0.35 (g / min) and the heat energy of 0-20, 20 A. For the SNI test results obtained dryness level of 12.83%, while blackish green color characteristic elasticity (handle) obtained information rather sociable.

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