Design of Flash Dryer Cum-UV for Improving the Quality of Drying Cassava Chip

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Abstract. Drying is a scientific operation, which includes the transient transfer of heat and mass at some rate of process. The purpose of this study was to design and create a flash system dryer, which is equipped with UV. The selection of flash system dryers is based on conditions where some materials to be dried are sensitive to hot air contact due to prolonged drying. As a heat source, this dryer uses a heater to heat the air. In order to spread the heat evenly in the dryer room, the blower is installed on the heater. The intake of air blower is 60 m/s, while the air temperature on the air heater is conditioned at 50 and 60°C. In order to collect data of air temperature, a thermocouple is placed on heat channel pipe and dryer room. The performance test of the dryer by using cassava chips, showed that the lowest cassava chip water content was 7.2% at 50°C treatment temperature, and the highest water content by 18.5% at treatment temperature of 60°C.

1. Introduction

[1] stated that Indonesia is the second largest producer of cassava after Thailand. It’s just that Indonesian cassava is more widely consumed in the country. In the future Indonesia has the opportunity to develop the production of yams, including processed products and derivatives, so that it becomes one of the local foods that can be used as a yam-based agricultural industry. According to [2] cassava is one of the rice substitute foodstuffs that is quite important in supporting the food security of a region. However, there are still many obstacles faced in changing the consumption patterns of the community that have been formed so far. In order to sustain the food security of a region, it is necessary to socialize the diversification of food made from sweet potatoes or cassava as an alternative food.

Fermented processed cassava, is one of the efforts to extend the shelf life of cassava. One of the efforts fermented yam, namely drying. This is because, microbes can survive long on products with high material water content. Cassava in the form of slices of drying, can then be processed further into flour. Cassava flour, is one of the best flours as a substitute for wheat flour [3].

Drying is a method used to remove most of the water content of the material by providing heat. Reduction of material water content, usually done in materials with wet solid conditions, semi-solid, and liquid materials that will be converted into solid products by the process of evaporation of material liquids. The usual drying method is drying by venting. However, this method takes quite a long time, thus extending the overall bending process time [4].

One drying method that can overcome this problem is flash dryer. Flash dryer is a dryer by utilizing high-speed hot air for the process of drying materials. This drying method is relatively simple in operation, requires little place, is suitable for drying heat-sensitive foodstuffs, and the control system
can generally respond very quickly to changes in the operating conditions of the drying process, so in this study designed the design of flash dryer models with the addition of UV. The reason for the selection of flash type dryers is that the time needed to dry the material is relatively short. So that this dryer is suitable for materials that are sensitive to heat. Based on this, it is expected that this research can improve the quality and quantity of cassava in accordance with the wishes of the industry.

2. Literature review

Drying is a way to scatter or remove most of the water from the material using heat energy. The production of water from the material is carried out until the moisture content balances with certain environments where fungi, enzymes, microorganisms, and destructive insects become inactive [5]. Drying according to [6] has the understanding of the application of heating through regular conditions, so it can remove most of the water in a material by evaporating. Removal of water in a material by drying has a different unit of operation with dehydration. Dehydration will decrease the activity of water contained in the material by removing or removing more water, so that the shelf life of food becomes longer or longer.

When wet objects are thermally drained, there are two processes that take place simultaneously, namely:

1. Transfer of energy from the environment to evaporate water found on the surface of solid objects. This transfer of energy from the environment can take place by conduction, convection, radiation, or a combination of the three. This process is influenced by temperature, humidity, the rate and direction of airflow, the physical shape of the solids, the surface area of contact with air and pressure. This process is an important process during the early stages of drying when unbound water is removed. Evaporation that occurs on the surface of a solid is controlled by the diffusion of steam from the surface of the solid into the environment through a thin film layer of air.

2. Transfer of the mass of water contained in the object to the surface. When there is evaporation on the surface of the solid, there is a difference in temperature so that water flows from the inside of the solid object to the surface of the solid object. The structure of the solid object will determine the mechanism of internal flow of water.

Flash Dryer

Flash dryer is a dryer installation used to dry flour that has a certain moisture content. The purpose of using this tool is to dry the product and reduce the moisture content of the product that was originally high to low. This machine dries the flour by continuing to drain hot air. The drying process that occurs in flash dryers takes place quickly. The time needed by the material that is dried from starting to enter the dryer vessel until it comes out becomes the result of fast drying products, therefore flash dryer is also called a fast dryer. Flash dryer type dryers have been widely applied to the chemical industry, food factories, agricultural products, ceramics industry, cement factory, paper mill, pharmaceutical industry and flour factory [7].

According to [8] to achieve an efficient drying process, the dryer airflow rate used must be greater than the minimum speed treated to move the item, so determining the speed of air to be used to dry a material becomes important to note. The speed of air exhaled by the blower or fan must be greater than the fast fall of the particles to be drained (wet material). The speed of air flow during the drying process using pneumatic (flash dryer) should not be too low or too high. At speeds that are too low, the material particles cannot be lifted by airflow, so the drying process cannot run perfectly, while the flow of air speed that is too high will cause the heat contact between dry air and the material will become too short, as a result of which the drying process is not effective, because the evaporated water is only small and the final water content of the product is usually still high.
3. Material and methods
The design, manufacture and testing of dryers was carried out at the Metal Laboratory of the Department of Agricultural Technology, Polytechnic State of Jember in July to August 2021. The initial stage in the design and manufacture of dryers is to determine the size / dimensions of the dryer needed. Flash Dryer is planned to be equipped with

1. Materials Room
The material room in a flash type dryer has a design like a cabinet dryer type dryer. The material space consists of shelves made in multi-storey. The base where the material is placed, made perforated so that the heat that enters the material space will intersect directly with the material to be dried.

2. Ultraviolet
The addition of UV serves to improve the quality of drying materials. UV serves to reduce microbial contamination, which may be investigated during the dispersing process before drying so that it attaches to the surface of the material to be dried. UV laying is on the entire dryer room and on each shelf where the material will be dried. So that the process of UV administration can run optimally.

3. Blower and Heater
Blower placed on the side of the dryer room serves to supply air. In a flash dryer system, the heat exhaled is in the form of air that has been heated. Therefore, in this dryer is equipped with an air heater (air heater). The air heater serves to heat the air exhaled by the blower, so that the air that enters the dryer room is hot air.

4. Heating Room Temperature Controller
Thermocouples are placed on the heating room, to read the temperature conditions of the heating room. This thermocouple is connected with a temperature reader display placed on top of the dryer room, so that the temperature of the heating room can be read. Thermocontrol is also placed on the pipe that connects the heater and the heating chamber. So, if the temperature has reached the desired amount, then the water heater will die automatically. And, if the input temperature is less than the desired amount, then the water heater will turn on again.

Fig 1. Design of Flash Dryer-Cum UV

The specification of Flash Dryer:
1. Capacity : 4 shelves
2. Number of Trays : 8 Trays
3. Tray Size : 50 x 50 x 3 cm
4. Inner and outer body : Stainless steel plate
5. Tray : Stainless steel plate
6. Machine Frame : Iron
7. Heating : Electricity
8. Temperature Regulator : Automatic
9. Hot Air Distribution : Blower
10. Overall Dimensions of Dryer : 180 x 60 x 100 cm
11. Material weight : 5 kg of wet materials
Calculating the drying rate

The drying rate can be calculated by using the formula:

\[ Mk = \frac{M_0}{1 + MC_0(1)} \]

a. The total dry mass of the cassava chip, can be calculated by the formula:
b. The mass total of cassava chip, can be calculated by the formula:

\[ DR = (1 + MC) Mk \]

c. Drying rate

\[ DR = \frac{M_0 - M_s}{\text{time x surface area of cassava chip}} \]

**Drying efficiency**

According to [9], drying efficiency is the result of a comparison between the heat theoretically needed with the actual use of heat in drying. The amount of heat energy required for drying can be calculated using the formula:

\[ Q = Q_1 + Q_2 + Q_3 \]

a. \( Q_1 \) is the amount of heat used to heat a material, derived from the equation:

\[ Q_1 = m_w \cdot c_p \cdot (T_p - T_\infty) \]

b. \( Q_2 \) is a sensible of hot water, which is heat used to raise the temperature of water in the material, which is obtained from the equation:

\[ Q_2 = m_a \cdot c_a \cdot (T_p - T_\infty) \]

c. \( Q_3 \) is latent heat of water evaporation

\[ Q_3 = mw \cdot hfg \]

To determine the amount of heat (heat) given by hot air in the drying material, the formula:

\[ q = \rho \cdot V \cdot C_p (T_1 - T_2) \]

To determine the drying efficiency and efficiency of dryers, obtained by the use of the formula:

\[ \eta = \frac{Q}{q} \times 100\% \]

Where:

- \( m \) : mass of dried material (Kg)
- \( C_p \) : heat of the type of drying material (kJ/Kg.0C)
- \( \Delta T \) : increase in material temperature (0C)
- \( V \) : Volume of air
- \( C_p \) : dryer air mass (kg/m3)
- \( \eta \) : drying efficiency (100%)

### 4. Result and Discussion

#### 4.1 Drying Rate and Drying Efficiency

The drying rate in flash type dryers is greatly affected by the dryer's airflow. The dryer airflow rate used should be greater than the water transfer of the surface of the material during the drying process. The speed of airflow exhaled by the blower is used to spread the heat generated by the water heater into the dryer room. This distribution of hot air is used to evaporate the water content of cassava chips. The speed of airflow exhaled by the blower, measured using an anemometer. The measurements showed the speed of air flow in the dryer room by 60 m/s.

Based on the results of the measurement, the speed of air flow exhaled by the blower is quite high. Thus, the contact of the material with the flow of hot air is short. Therefore, flash dryer can be applied to materials that are sensitive to heat. Based on the results of the calculation of the drying rate for cassava chips for 4 hours of drying, which is 0.00885 gr/s at 50°C and 0.00985 gr/s at 60°C. Drying efficiency
is the amount of energy needed to evaporate water from the material divided by the energy produced during the drying process. Drying efficiency with the use of temperature 50°C, by 65.76% while at 60°C at 64.39%

4.2 Effect of Dryer Air to Cassava Chip Mass Decline

Flash dryer, utilizing hot air exhaled by the blower. Hot air is the result of heating by the water heater. Blowers placed side by side with the water heater will distribute and spread hot air throughout the dryer room. This hot air that intersects directly with the material, to evaporate the water content of the material. Hot air will cause evaporation, so the weight of cassava chips is also reduced. The drying process is determined for 4 hours, so the decrease in the mass of the material is measured every 30-minute span.

![Fig 4. Decrease in Mass (gr) material at a Drying Temperature of 50°C](image)

![Fig 5. Decrease in Mass (gr) material at a Drying Temperature of 60°C](image)

4.3 Effect of Dryer Air to Cassava Chip Water Content Decline

Drying temperature greatly affects the decrease in cassava chip water content. In the performance test of this flash type dryer used 2 magnitudes of temperature, namely 50°C and 60°C. This temperature difference is intended, to see the effect of temperature on the water content of the material, measurement of the water content of the material, done by the oven method. Determination of cassava chip moisture content is done 30 minutes with a drying length of 4 hours
In Figure 6 showed a graph of the drop in cassava chip moisture content at a drying temperature of 50°C. While in Figure 7 showed a graph of the decrease in the moisture content of the material at a drying temperature of 60°C. Based on both graphs, it can be observed that the length of drying has an effect on the decrease in the water content of the material. The selection of temperatures of 50°C and 60°C, based on conditions where, there are several types of materials that are sensitive to heat. So, it is determined that the use of drying temperature is not too high. Generally, drying materials with the use of temperatures of 50°C and 60°C, it takes a drying length of 8 - 10 hours to reach the appropriate cassava chip water content as a raw material for cassava flour.

Based on Indonesia's national standard on the quality requirements of cassava flour, the maximum cassava flour water content is 12%. Therefore, the water content of cassava chips before refining, the moisture content should not be more than 12%. Cassava chip water content values that conform to standard moisture content values, achieved at a drying temperature of 50°C for 210 minutes and require a drying length of 180 minutes at a drying temperature of 60°C.

Based on [10] research, The drying by using pneumatic dryer could reduce the water content of cassava grater up to 8-12% although the time of the drying process in the drying duct is quite short. The decrease in water content of cassava grater took place over time.

4.4 Degree of colour

The degree of white is the ability of a material to reflect light that hits the surface of the material [11]. The whiter the colour of flour, the higher the level of consumer acceptance of the flour. The purpose of measuring white degrees is to find out whether UV irradiation during the drying process affects the
colour quality of cassava chips. To find out, the effect of UV administration on the colour quality of cassava chips, measurements of cassava chips without UV irradiation during drying and cassava chips with irradiation during the drying process.

The measurements showed a brightness level of 81.29 for drying cassava chips without UV irradiation. Meanwhile, for cassava chips with UV irradiation during the drying process showed a brightness level of 79.4. The measurement result is close to the value of 100, which is assumed to be the best value. This value is below the standard for yam flour, where the value of vaginal discharge is at least 85. According to [12], a shorter drying time is able to minimize the formation of brown colour on cassava chips due to the heating process. UV irradiation is intended as a substitute for irradiation from sunlight. Based on the results of measurements, UV irradiation during the drying process has no real effect on the browning of cassava chips.

5. Conclusion
Flash dryers utilize the flow of hot air, to reduce the water content of the material. So that the decrease in the water content of the material, depending on the speed of hot air flow. The flow of hot air is quite high, bringing the drying time to a short time. Thus, flash dryers are suitable for heat-sensitive materials.

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