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Design of a Drying Equipment Moringa Leaf with Utilizing Temperature Air Conditioning Condenser

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Abstract

This study conducted to get drying equipment a Moringa leaf using air temperature from an air conditioning condenser. The first steps taken were collecting research literature, formulating problems, and design a drying equipment moringa leaf (moringa oleifera) using air temperature from an air conditioning condenser. Drying equipment tool made from plywood, wood, aluminum foil, styrofoam, and pipe channel to drying equipment. It works by utilizing air from the air conditioning condenser which is channeled through a pipe channel to drying equipment. The test was carried with modification intake channel to drying equipment without suction fan and using suction fan. Data collection is carried out every 30 minutes for 7 hours which starting from 10.00 AM to 05.00 PM. A sample of 800 grams of wet moringa leaf was placed on each drying rack. The result study without suction fan in the drying equipment show average temperature air from the condenser of 31.17 °C, average humidity of 68.8%, and a reduction in water content of moringa leaf of 35.5%. Meanwhile, the test using an air suction fan in the drying equipment was average temperature air from the condenser 34.10 °C, average humidity was 62.30% and the reduction in water content of moringa leaf was 40.8%. The drying rate of moringa leaf in the test using an exhaust fan is 0.0138 kg/hour, while the drying rate of moringa leaf in the test without using an exhaust fan is 0.01 kg/hour.

Keywords: Drying Equipment, Moringa Leaf, Air Conditioning Condenser, Temperature, Humidity.

1. Introduction

Moringa leaf (Moringa oleifera) is a plant that is easy to grow in tropical and sub-tropical climates such as Indonesia [1],[2]. Moringa oleifera can grow in places with an altitude of 0 - 2000 meters above sea level, with little rainfall [3]. Moringa oleifera is a herbal plant that grows widely in Indonesia, a plant that is often used for health. Moringa leaf (moringa oleifera) plant extract contains various phytochemicals such as alkaloids, flavonoids, steroids, glycosides which can be used as antimicrobials,

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antioxidants, anticancer and antidiabetic [4],[5]. Moringa oleifera is also a plant that is widely consumed by people as vegetables and drinks. The various nutritional content contained in Moringa leaf can be found in the roots, bark, leaf, flowers, fruit and seeds. In general, Moringa leaf are used for vegetables, and for potions to cure various diseases [6]. more than 90 nutrients, different antioxidants and eight essential aminos are contained in this plant [7]. Along with the times and technology, moringa leaf began to be used for drinks, soaps and medicines after being dried [8].

Business incubator is a government program implemented by the Ministry of Youth and Sports (KEMEPORA) to incubate budding entrepreneurs to become independent [9]. Universitas Teuku Umar has an Incubator called Inkubator Bisnis Teknologi Universitas Teuku Umar (IBT-UTU). One of the products produced by IBT-UTU moringa tea. In the process of making tea, the drying stage of moringa leaf is still done manually, namely by airing them in a closed room without being exposed to direct sunlight for 3-4 days, therefore an alternative drying device design is needed to dry moringa leaf [10]. The drying technique used without reducing nutrients and vitamins, where only the water content is reduced [11],[12].

Air conditioner (AC) is used to cool the room. Indonesia is a tropical country with air conditions that tend to be hot and humid, which is uncomfortable for activities, so a tool is needed to cool the room, namely an air conditioner, but the use of this air conditioner only uses cold air, but the air temperature that is discharged in the condenser is not used so that just wasted [13]. Air conditioner in households, educational institutions and government agencies is increasing in number and produces abundant heat from the air conditioning condenser [14]. Heat utilization from air conditioner is still small, causing heat energy to be wasted. The heat discharged from the condenser of a split air conditioner system has the potential to be used as a heat source for mechanical drying equipment, and research on this has been conducted for drying purposes during the winter season [15]. The heat produced by the air conditioner exhaust duct can reach a temperature of 40 °C. This air temperature can be used for the drying process of food ingredients [16]. The air heating method in split air conditioner has also been done by setting the heating mode [17].

Research on the utilization of waste heat from split air conditioning condenser was also conducted to control the temperature and humidity of air for rice drying. The results showed that the moisture content reduced to 11% after a 10-hour drying process. Temperature control was achieved using an exhaust fan with an average drying temperature ranging from 30-43 ºC [16]. Through research, researchers utilize waste heat from the air conditioning condenser through a drying chamber, so that apart from obtaining a cooling effect for comfort, a drying effect is also obtained for food or beverage products [18]. The drying process affects the chemical compounds contained in herbal plants, especially those compounds that are beneficial as antioxidants [19]. The antioxidant activity of moringa leaf is higher when using an oven drying method compared to direct sunlight drying method [20]. The purpose of this research is to utilize the waste heat from the air conditioning condenser for the drying of moringa leaf by modifying the inlet air temperature in the drying machine without using an exhaust fan and by using an exhaust fan, in order to preserve the nutrients and antioxidants present in the moringa leaf. Utilizing waste heat from the condenser as a working fluid in a moringa leaf dryer is a novelty in this research. The temperature of the dryer, humidity and water content in moringa leaf are parameters to determine the performance of the box dryer.

2. Method

This research was carried out experimentally, starting from creating a design for a moringa leaf dryer that utilizes exhaust heat from the condenser. The parameters used to determine the performance of this dryer are measuring the temperature of the dryer, humidity and water content of moringa leaf. This Study was conducted at the Mechanical Engineering Laboratory of Universitas Teuku Umar for 6 (six) months starting from March 2023 to August 2023. The steps taken in this study were to collect previous study literature then formulate existing problems and find solutions by collecting the latest research literature and theories related to existing problems [21], then making a design for a moringa leaf dryer (moringa oleifera) by utilizing air temperature from an air conditioning condenser [22]. The process and stages of making a moringa leaf dryer are made of plywood, wood, aluminum foil, styrofoam, pipe channel [23]. The way it works is by utilizing air from the air conditioning condenser,

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which is channeled through an pipe channel, then enters the drying chamber. The diagram of this study is shown in Figure 1.

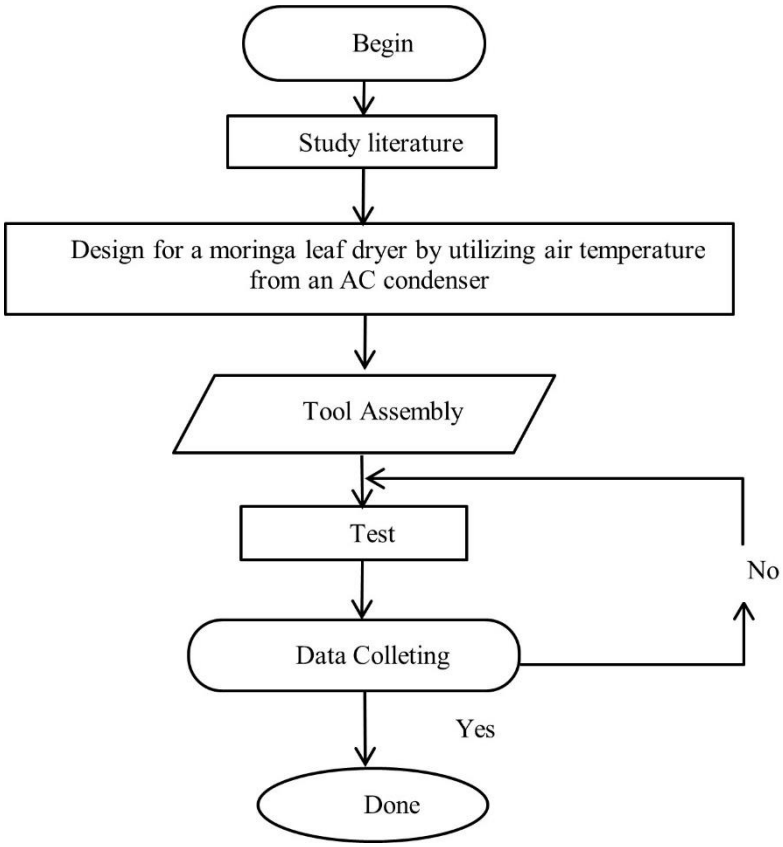

Figure 1. Diagram of This Study

Figure 2a shows the design of the moringa leaf dryer alar. Next, make a moringa leaf dryer. The moringa leaf dryer is attached to the air conditioning condenser to utilize air temperature from the air conditioning condenser exhaust to dry the moringa leaf in the dryer chamber. The installation of the dryer on the air conditioning condenser can be seen in Figure 2b.

(a) (b)

Figure 2. a) Design Drying Equipment; b) Installation of the Dryer on the Air Conditioning Condenser

The sample weight of wet moringa leaf used in this research was 200 grams of wet moringa leaf for each shelf with a total weight of 800 grams of moringa leaf which were placed on each drying rack as shown in Figure 3.

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Figure 3. Samples of Moringa Leaf

3. Result and Discussion

The aim of measuring the temperature on the air conditioning condenser is to determine the extent to which the heat potential of the air conditioning condenser can be used as a heating source to dry moringa leaf in the drying room. Temperature data was collected at several points, namely, the temperature in the air conditioning condenser, then in the drying room, namely the temperature on rack 1, the temperature on rack 2, the temperature on rack 3, the temperature on rack 4 using a type K thermocouple and measuring the humidity in the drying equipment. Using the Elitech RCW-800 Wifi Temperature and Humidity Data Logger, the mass of moringa leaf from rack 1, rack 2, rack 3 and rack 4 was weighed with a digital scale and the temperature around the drying rack was measured using a digital Thermocouples. The test was carried out for 7 hours starting from 10.00 AM to 05.00 PM and data collection was carried out every 30 minutes.The results of temperature and humidity measurements on the drying equipment were conducted from 10:00 AM to 05:00 PM, and these can be observed in Figure 4-7.

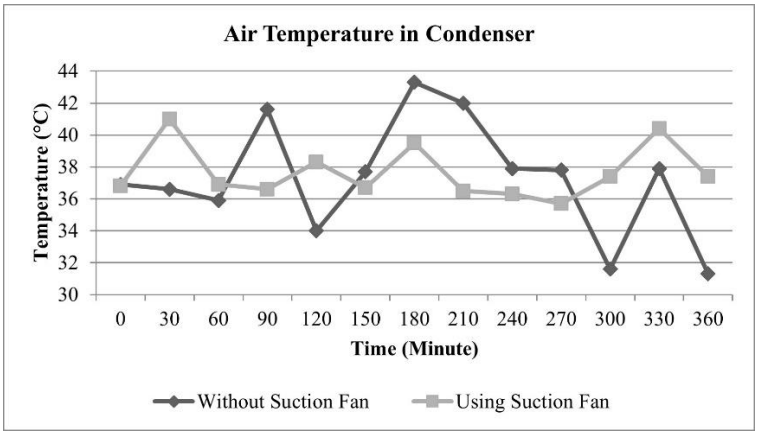

Figure 4. Air Temperature in Condenser

Figure 4 shows the differences in test results conducted by modifying the inlet air duct into the drying chamber, with and without the use of an exhaust fan. In the test without an exhaust fan, the highest temperature occurred at minute 180, reaching 43.3 °C. However, in the test with an exhaust fan, the temperature distribution tends to be more stable. The fluctuations in the exhaust air temperature from the air condition condenser are due to the fluctuating cooling load in the room, making the cooling load unstable. When the temperature inside the condenser rises, the compressor works to blow cold air into

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the room, while the condenser expels the hot air occurring inside the evaporator pipe. When the room temperature reaches the predetermined level, the compressor and exhaust fan shut off. Consequently, the condenser no longer expels excessively hot air, causing temperature fluctuations in the condenser.

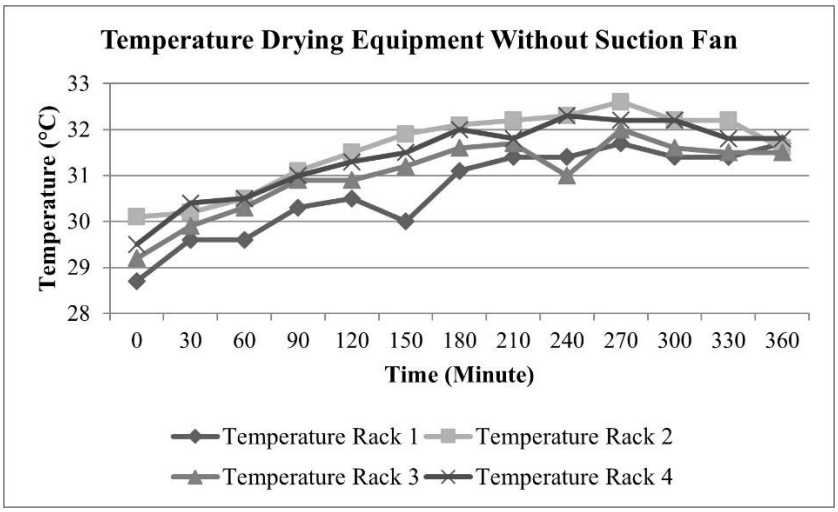

Figure 5. Temperature Drying Equipment without Suction Fan

The distribution of temperature in the drying equipment is quite uniform, as indicated by Figure 5 and Figure 6. Figure 5 shows the results of testing the temperature on the drying rack without using a suction fan, the highest temperature on rack 1 was 31.7 °C, on rack 2 was 32.6 °C and on racks 3 and 4 respectively 32 °C and 32.2 °C which occurred in 270 minutes. In this test there was a significant increase in temperature from the time the test was carried out until 270 minutes, but after 270 minutes there was a decrease in temperature to 360 minute. The average temperature in the drying chamber without using a suction fan was 31.17 ℃. Figure 6 shows the temperature of the drying chamber using a suction fan, the temperature in the chamber is more evenly distributed from the start of the test to the end of the test. The highest temperature occurred in rack 4, which was 35.6 °C in 330 minutes, while the highest temperature in racks 1 and 2 was 34 °C and 34.2 °C respectively in 330 minutes, and the average temperature was 34.10 ℃.

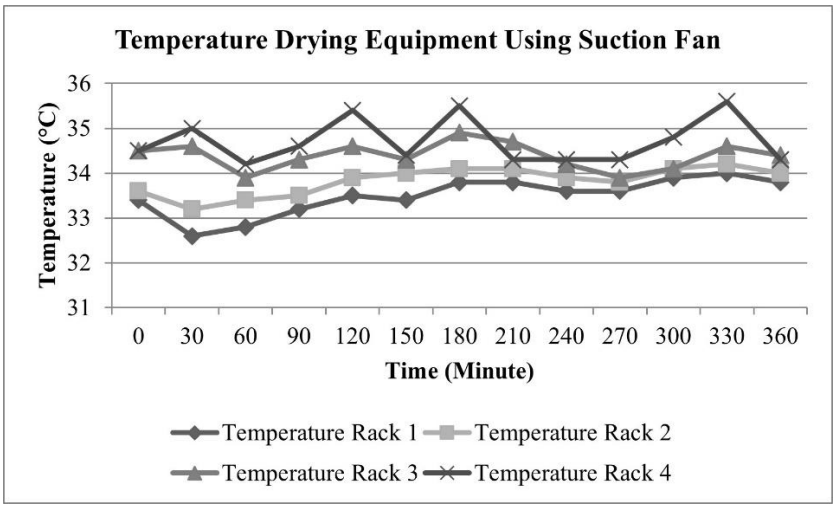

Figure 6. Temperature Drying Equipment using Suction Fan

Figure 7 shows that the air humidity in the drying room was 75.80% in the test without using a fan. This is in accordance with the theory which states that temperature is inversely proportional to humidity, the higher the temperature, the lower the humidity [24]. Meanwhile, the highest humidity in the test using a fan was 64.40% which occurred at the 30 minute. This shows that the test carried out using a fan in the drying room had a significant influence between temperature and humidity, where the

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temperature in the test using a fan was higher. than without using a fan and the humidity is also lower than without a fan.

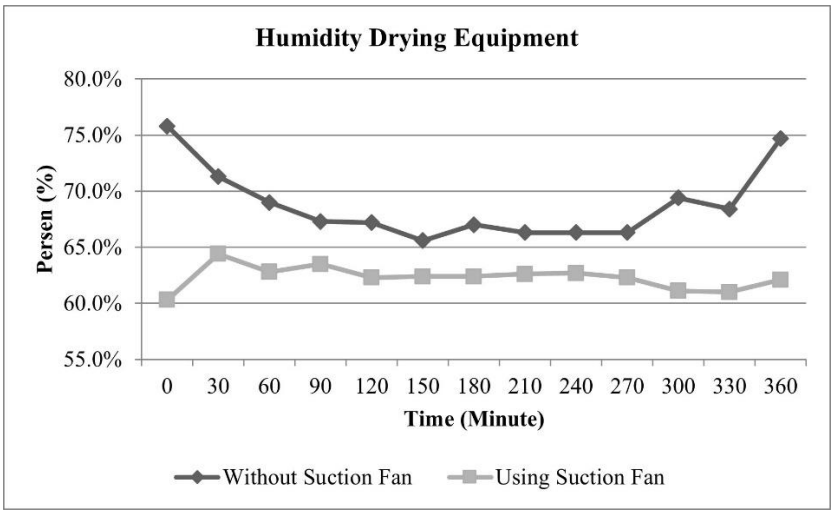

Figure 7. Humidity Drying Equipment

The process of measuring water content in this research uses the wet basis water content calculation method [25],[26]. Wet water content is the ratio between the weight of the water in the material and the dry material. The decrease in water content of moringa leaf after drying for 7 hours by testing without using a suction fan was 35.5%. While testing without using a suction fan decreased by 40.8%. Figure 8 shows the sample resulting from drying using hot air from the air conditioning condenser.

Figure 8. Drying Result

The reduction of moisture content in moringa leaf through the conducted testing has proven to be effective for drying moringa leaf. This method of drying does not damage the structural integrity of the moringa leaf. Drying without compromising the moringa leaf's structure will not diminish the nutritional and antioxidant content contained within the moringa leaf.
The drying rate of moringa leaf in the test using an exhaust fan is 0.0138 kg/hour, while the drying rate of moringa leaf in the test without using an exhaust fan is 0.01 kg/hour. Research results indicate that

drying moringa leaf using an exhaust fan at the inlet of the drying cabinet is more effective compared to not using an exhaust fan.

4. Conclusion

The conclusions from research on moringa leaf drying tools by utilizing hot air from an air conditioning condenser are as follows:

- From the results of research that has been carried out, the temperature of the exhaust hot air from the condenser without using a suction fan is 31.6 °C to 42 °C, while the temperature of the hot exhaust air from the condenser using a suction fan is 35.7 °C to 41 °C.
- The research results show that by using a suction fan at the inlet to the drying room you will get a better temperature than without using a suction fan with an average temperature of 34.10 °C using a suction fan and 31.17 °C without a suction fan.
- The decrease in the moisture content of moringa leaf after drying for 7 hours by testing without using a suction fan is decreased water content by 35.5%. while the test without using it using a suction fan decreased water content by 40.8%.

Utilizing heat from the air conditioning condenser can increase the energy efficiency of the system as a whole. This is because the heat from the air conditioning condenser, which has been considered waste, can be used as useful energy. Besides being used for drying moringa leaf, this dryer can also be used to dry other food ingredients and can also be used to dry clothes.

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