Biomass-Based Dryer Technology Innovation in the Agrotechnology Industry with the Internet of Things System

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Abstract. With the development of the era in the era of drying raw materials for processing sweet potato chips, this study aims to design innovative post-harvest technological tools for drying sweet potato chips based on biomass energy using the Internet of Things System. In this method, the data analysis stage was brought out by looking at the results of processing the observed data from source temperature, sensor internal temperature, humidity, IoT moisture sensor and water content loss manually in the sample on the drying rack. This Internet of Things-based technology tool has been successfully tested in a laboratory scale using an experimental method to produce a prototype tool that can be implemented immediately. Parameters measured were temperature, humidity, moisture content and heat in the dryer. This technological tool uses biomass energy from coconut shells as fuel with a mass of 3500 grams. The results showed that the time used during the drying process with various variations of coconut shell mass was 90 minutes for a mass of 3500 grams, with an interval of 10 minutes for each observation. The results for the mass of the coconut shell reach 3500 grams with the highest temperature value with an average source temperature of 91.25 °C, an average temperature in drying chambers of 66.66 °C with a minimum humidity of 12.2% and an average IoT moisture content 24.05% and the average moisture content manually is 23.28% and the maximum heat is 14467.81 Joules which is superior to other coconut shell masses. The measurement results of internal temperature data.

Keywords: Drying · sweet potato chips · coconut shells · Internet of Things · temperature · humidity content · heat · humidity

1 Introduction

One of the green environmental problems is by utilizing waste coconut shells as an energy source for drying agricultural products. The main problem in the business of drying agricultural products is the sustainability of energy sources. On the other hand, the demand for quality drying of agricultural products at low prices is highly desired by everyone, especially for industrial processing agricultural products. This dry field uses a modern drying process.

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Modern drying processes definitely require energy, one of which is biomass energy. Biomass energy is an energy alternative that must be prioritized and developed because Indonesia has agricultural waste producers that are not used properly, especially coconut shells. Coconut shells have the advantage of being abundantly available and easier to obtain than other biomass sources of energy (Muhammad et al. 2022). The use of drying technology based on coconut shell biomass energy results in drying of sweet potato biscuits with low water content quality. This research was conducted to implement an Internet Of Things System, on a dryer based on coconut shell biomass energy.

The working principle of the YL-69 sensor is that when two plates or probes are exposed to a conductive medium, electrons move from the positive electrode to the negative electrode, causing a current to flow and generating a voltage. This movement of electrons can be used to determine whether there is water in the experimental medium. If he laboratory medium is it will contain a conductive current, but if it is medium laboratory is dry, it will contain a non-electron conductor.

Calibration is a conventional value represented by a measurement standard that can be traced back to a national or international standard for the accuracy of the value displayed by a measuring instrument or measuring system, or a predetermined value for the material to be measured. With. Therefore, calibration helps determine the accuracy of the test equipment (Adla et al. 2020). Since the YL-69's sensor readings are analog values, we need to change the sensor readings before calibrating the sensor. This conversion is done in such a way that the value on the sensor is easy to read. The conversion result is a percentage value in the range of 0% to 100%. The smaller the percentage value, the lower the moisture content or soil moisture, and vice versa. The higher the percentage value, the higher the water content or soil moisture conditions. The equation used to convert YL-69 sensor readings can be seen in Eq. 1 (Darmawan et al. 2020).

2 DHT Sensors 22

The DHT22 sensor also has very precise calibration and excellent stability. The OTP storage program can also store calibration coefficients, so when the internal sensor detects something, the coefficients must be entered during calculations, so that they can be operated into the Arduino microcontroller (Ajala 2020).

The principle operation of the DHT22 sensor, a semiconductor material for temperature and humidity sensors, reads temperature and humidity values while sending data directly to Wemos in digital data form. The data transmission time between temperature and humidity is very long. Short, less than 40 ms.

3 Relative Humidity (Right)

Humidity affects the movement of fluids from within the material to the surface. Relative Humidity also determines the degree of dryness of the air's ability to wet the surface of the material. The lower the relative humidity, the faster the drying process because dry air will absorb more water. Therefore, a good drying process requires a relatively low humidity, depending on the properties of the material to be dried. Saturated vapor pressure is determined by temperature and relative humidity. The higher the temperature, the lower the relative humidity, which increases the saturation vapor pressure and vice versa (Ajala et al. 2019).

4 Radiant Heat Transfer

Electromagnetic waves can hit an object, then some of that radiation will be forwarded, some reflected, and some absorbed (Azaizia et al. 2020). To measure the level of radiant heat emitted can be calculated using Eq. 1.

$$q_{rad\mathrm{Ias}\mathrm{I}} = e.\sigma.A.T4 \tag{1}$$

where radiation q radiation represents the radiation flow rate (Watt), e is the emissivity of the object (0 < e < 1), σis the Stefan Bolttzman constant 5.67 × 10-8 (W/m.K), A is the cross-sectional area (m 2), and T is the temperature (K).

5 Method

This type of research uses quantitative methods. This research was carried out by measuring the value of moisture and moisture content in the drying room which was previously brought by IoT which was integrated in a dryer based on energy-based coconut shell biomass waste as much as 3500 grams shown in Fig. 1.

Before data collection is carried out, the tool system testing stage is carried out first to ensure the system can be used. After testing the system, the next step is data collection can be completed.

The data analysis stage was brought out by looking at the results of processing observed data from source temperature, sensor internal temperature, humidity, IoT moisture sensors and water content loss manually in samples on drying racks. Thus, it was concluded that the best results were in the study of drying sweet potato chips.

The combustion process in this research uses coconut shell biomass with a mass of 3500 grams. This kiln is located under the dryer which serves as a source of fire for this drying process to occur. The data collection system is carried out every five minutes, the data is directly stored in the computer, and then graphs can be made to observe the results of the drying process.

Before designing a dryer, tools and materials must be prepared first. The tools that need to be prepared include laptops, cellphones, Arduino one, and so on. At that time the materials prepared were coconut shells as a source of biomass energy and sweet potato crackers as samples to be used for drying can be seen in Fig. 2.

6 Results and Discussion

Research data will be displayed on a computer (as shown in Fig. 3), then it can be stored and processed for further analysis.

Figure 4 describes the results of the comparison of temperature in the drying chamber and humidity against time. The results of observations using a mass of 3500 grams of

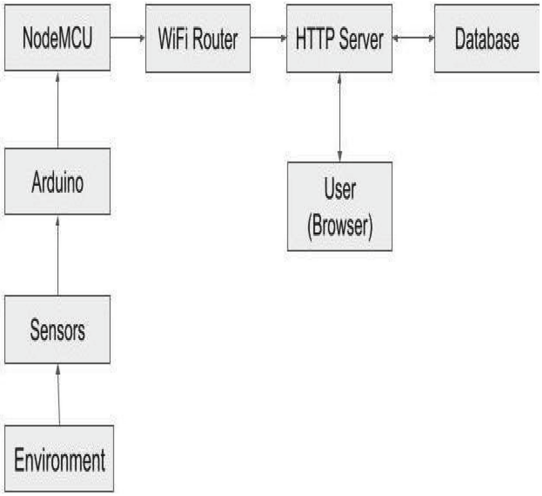

Fig. 1. IoT-Based Experimental System

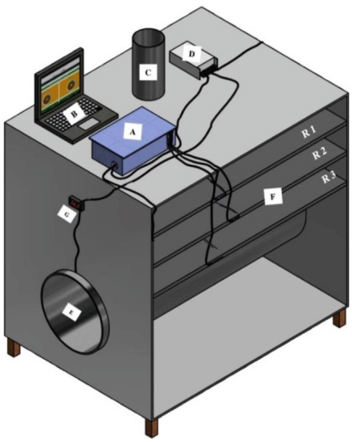

Fig. 2. Designing Innovation Tools

coconut shells obtained data on the average air humidity in the drying chamber was 24.56%.

Figure 5 shows the results of comparing IoT water content and manual water content. Whenever you observe the mass of coconut coir in shelf 3, the water content tends to decrease faster than the water content in shelves 1 and 2. This can happen because the location of shelf 3 is close to the heat source or biomass energy source. This means rack 3 generates more heat than racks 1 and 2. The higher the temperature, the faster the water in the cassava chips evaporates and the faster the drying speed. The higher the temperature, the greater the flow of heat and the faster the evaporation time of water.

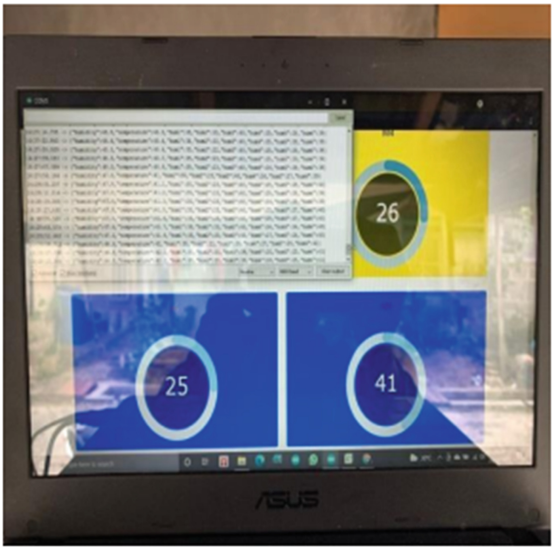

Fig. 3. System collection data research.

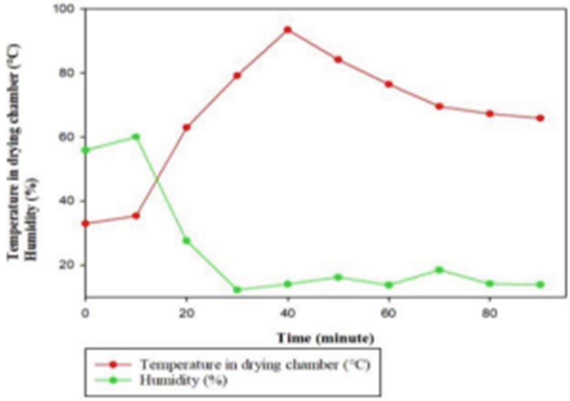

Fig. 4. Comparison of Internal Temperature and Humidity with Time in Coconut Scallop Cassava Chips with a mass of 3500 grams.

The average IoT water yield in the manual water content in the drying process of cassava chips is 23.28%.

Figure 6 describes the results of the comparison of heat and temperature in the drying chamber against time. The percentage of calorific value with a mass of 3500 grams of coconut shell can be seen from the heat that will be absorbed by the temperature of the source it uses and the faster the drying process is carried out. The heating value is 14467.81 j/s with an internal temperature of 79.1 °C.

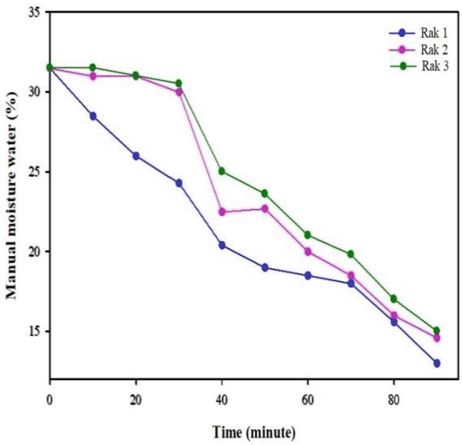

Fig. 5. Comparison of IoT moisture content and manual moisture content against time on coconut shell Cassava Chips with a mass of 3500 grams

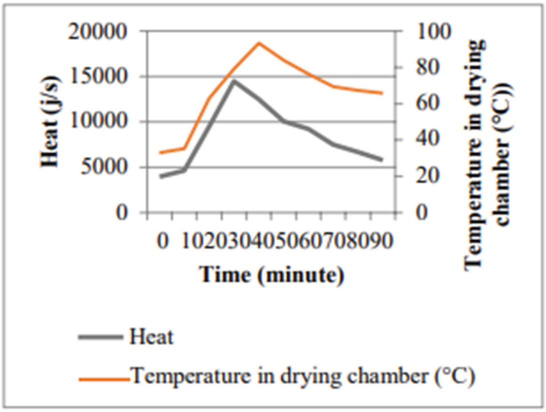

Fig. 6. Comparison of Heat and Internal Temperature against Time (a) coconut shell with a mass of 3500 grams

7 Conclusion

Innovation based drying technology on coconut shell biomass energy with the IoT system has been successfully applied to the agro-industry of food processing products made from cassava. The parameters measured were temperature, humidity, humidity content and heat in the drying apparatus. This technological tool uses biomass energy from coconut shells as fuel with a mass of 3500 grams. The results showed that the time used during the drying process with a coconut shell mass of 3500 grams with an interval of 10 minutes for each observation. The results for a mass of 3500 grams of coconut shells achieved the highest temperature value with an average source temperature of 91.25 °C, an average temperature in the drying chamber of 66.66 °C with a minimum humidity of 12, 2% and an average moisture content IoT is 24.05% and the average water content manually is 23.28% and the maximum heat is 14467.81 Joules which is superior to other coconut shell masses. The results of measurement data on internal temperature, humidity and moisture content can be viewed via the website on mobile phones or accessed via the Internet from Pages.

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