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PROTOTYPE OF TEMPERATURE AND HUMIDITY CONTROL IN COFFEE BEAN STORAGE ROOM

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ABSTRACT

The design and manufacture of roasted coffee beans storage system have been carried out, which is used to reduce the deterioration of roasted coffee beans quality. The method of a coffee bean storage device using a Peltier plate as a cooler and a DHT11 sensor for temperature readers is then controlled by Arduino Uno. The results of the manufacture of the tool found that the device can store roasted coffee beans with a reference temperature of 23 °C and humidity of 40% for a certain length of time. The tool can reach a set point with a coffee load mass of 0 Kg, 1 Kg, 2 Kg, and 3 Kg at different times for no-load time to get a set point temperature of 6 hours and humidity of 17 hours. Loading 1 kg of roasted coffee takes time to reach a set point of the temperature of 7 hours and humidity of 18 hours. Then for the burden of roasted coffee, 2 and 3 kg reach the set point at 8 hours and 10 hours, while for humidity, the same 18 hours. Adding a fan to the system increases the time the storage system reaches the set temperature of 23 °C.

KEYWORDS: coffee, peltier, control system, humidity, temperature

1. INTRODUCTION

Coffee is a commodity that is overgrowing. This can be seen from the total area of 1,241,836 ha and production of 675,915 tons in 2013, and most (90%) are smallholder plantations. The largest coffee farm in Indonesia is on Sumatra Island (60%), and the total area in Jambi Province is 25,935 ha, with a production of 13,326 tons (Kementan, 2013). As a plantation product in Indonesia, coffee is ranked sixth after oil palm, sugar rubber, tea, and cocoa.

Aji's research (2019) entitled design and build temperature and humidity control in the post-harvest Arabica coffee bean storage room, obtained results in the storage room reaching a temperature of 25 °C within 7 hours and humidity of 66% within 26 hours.

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In this study, what will be tested is coffee that has been roasted or coffee that coffee shops commonly use. Roasted coffee beans are certainly different in how to store them from post-harvest coffee (Aji 2019).

Coffee beans, after roasting, are left for 24 hours for the process of releasing carbon dioxide. After such a process, coffee should be immediately stored in free air. Otherwise, there will be an oxidation process. With the presence of oxygen gas entering the coffee beans, there will be a decrease in the taste, aroma, and quality of grilled coffee beans.

According to the research by Marin (2008) in the journal entitled the new aroma of roasted coffee, during storage, the coffee must be at a temperature of 23±.Two °C with a humidity of 40±10 % to obtain a fixed quality without significant changes.

The development of the coffee industry and the market today demands products consistent in quality and safe for consumption. One of the ways to improve quality is by storing it safely and at the right temperature and humidity for types of roasted coffee in general. Therefore, the author wants to make innovations by making roasted coffee storage devices that can maintain and maintain quality, namely by controlling the temperature and humidity to maintain the quality of the roasted coffee beans.

2. METHOD

The following is a tool scheme designed. The prototype of the coffee bean storage in the picture 1 is made using iron as a cabinet frame. Prototype size is 60 cm, width 40 cm, and height 40 cm. wardrobe walls are made of aluminum foil, styrofoam, and plywood, with a thickness of 3 cm. It is expected that from these dimensions, it can accommodate 6-10 kg of roasted coffee with a ratio of coffee and air circulation of 50%.

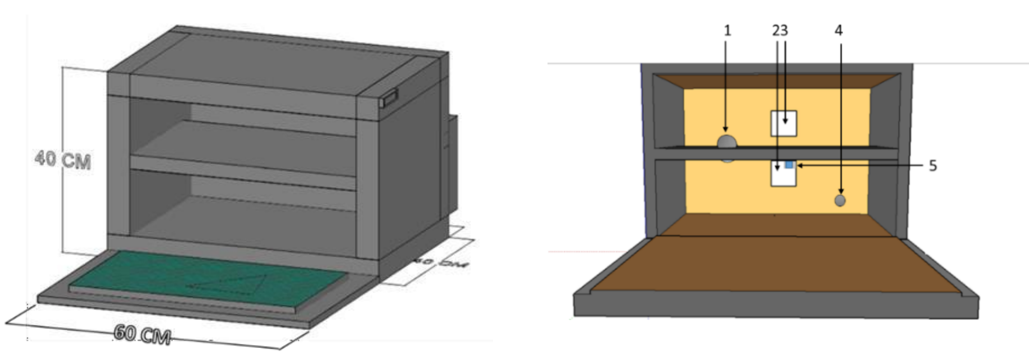

Figure 1. Design of Tool

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Information:
1. Blower
2. Heatsink and fan 9 cm x 9cm
3. Peltier and coldsink
4. Watertrap inlet
5. DHT11 sensor

2.1 Manufacture System

The process of making coffee bean storage devices in this study aims to produce an optimal system, and the following is making the system design that is displayed in the form of a block diagram:

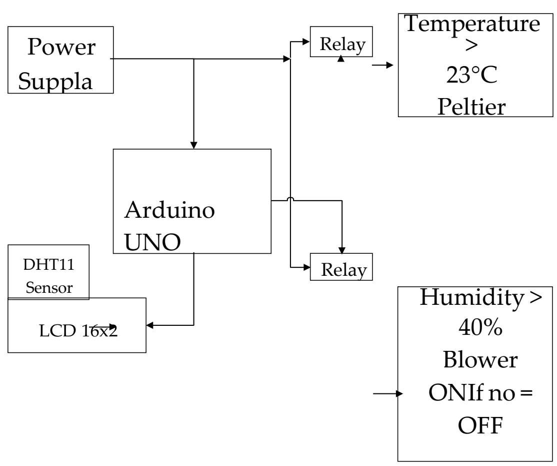

Figure 2. Diagram Blok Sistem

In Figure 2, the block diagram shows the workings of the roasted coffee bean storage system, which is made when the sensor gets the temperature and humidity values in the food storage controller. While for humidity, when humidity is more than 40%, the blower will work if it is less than 40%, the blower turns off.

For tool flow diagrams the same as in the following block diagram tool flow diagram:

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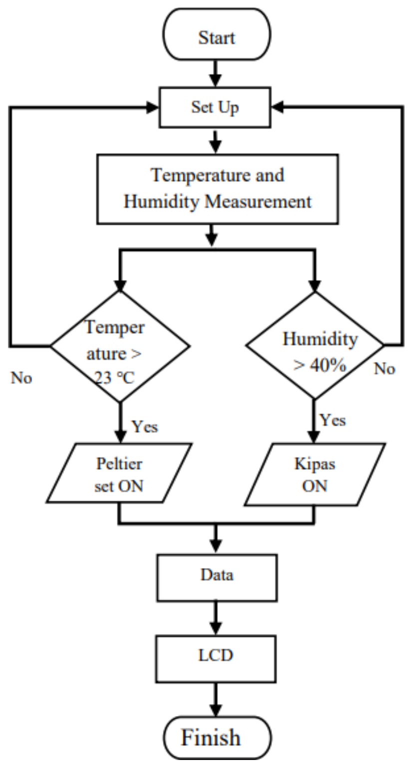

Figure 3. Diagram of Tool

2.2 Electrical Design

The electrical design process is by connecting previously designed components into a single unit system; each element has its role.

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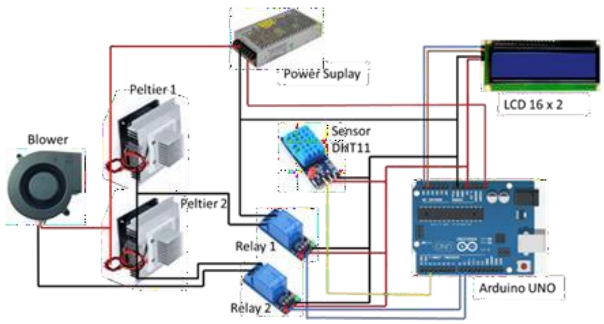

Figure 4. Component Design Scheme

2.3 Manufacture Tool

The process of making tools is carried out by combining tools and materials in the form of an iron frame, Styrofoam, and aluminum foil, then assembling with electrical which has been arranged by the electrical diagram so that it becomes a single unit. The electrical design process is by connecting previously designed components into a single unit system; each element has its role.

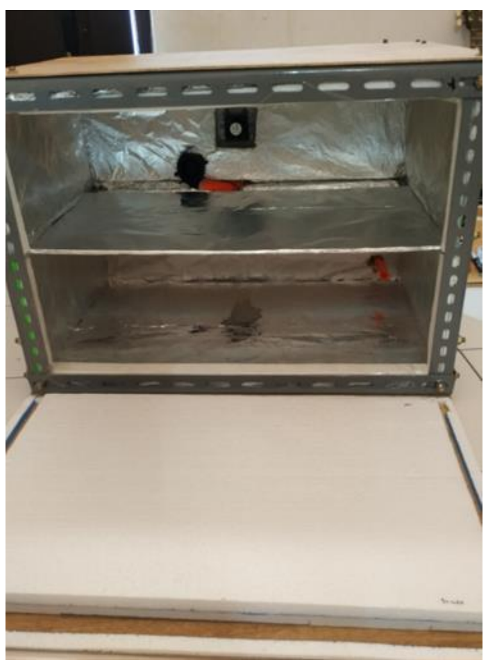

Figure 5. Result of Design Tool

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Figure 5. is the result of the tool design. The main component used as a coolant is Peltier as more excellent, which will then work according to the tool flow diagram in Figure 2.

2.4 Testing Tool

Sensor testing was done using the direct comparison method on the DHT22 sensor and a thermohygrometer at 25 and room humidity at 48%. The test was carried out on the Peltier plate's cooling medium; the sensor comparison was carried out at a temperature of 34 ℃ to 20 ℃.

The humidity sensor test using a DHT11 sensor with a throhygrometer was carried out on Humidifier media in an air-conditioned room with 40% humidity. The test is carried out at 40% to 60% humidity.

The percentage of errors known using the following equation:

$$\text{Error} = \frac{\text{Test Sensor Readings} - \text{Standard reading}}{\text{Standard reading}}$$

3. RESULT AND ANALYSIS

3.1 Sensor Testing Results

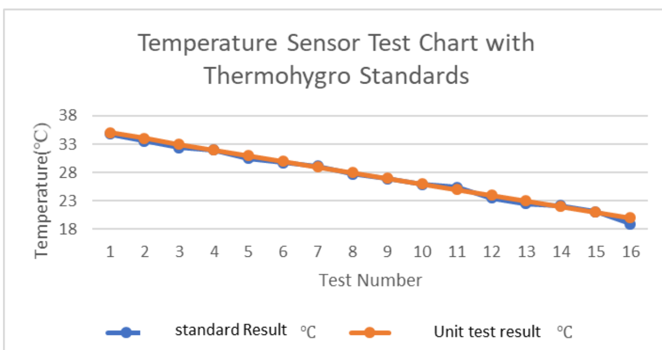

Figure 6 Graph Comparison of DHT11 sensor temperatures with thermohygrometer

Figure 6 is the result of testing for 1 hour; the error value for the DHT sensor is 1.36%. From this value, it can be concluded that the sensor can work well according to its specifications.

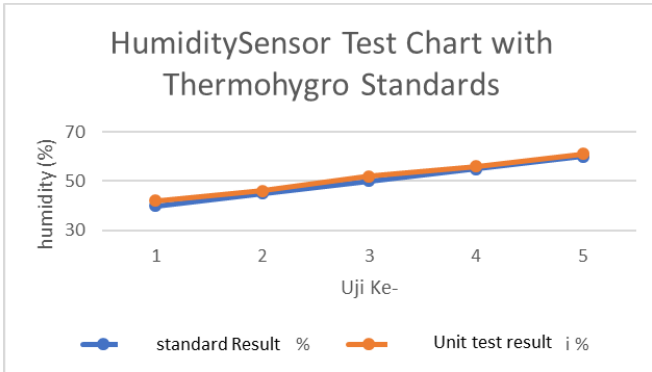

Figure 7. Graph Comparison of DHT11 sensor humidity with thermohygrometer

Figure 7 compares the DHT11 humidity sensor with the thermohygrometer, and the average error value is 2.9%. Compared with the 5% accuracy specification, the sensor is feasible.

3.2 Tool Testing Results

This test was carried out on the prototype under several conditions; the first was without a load of coffee beans, then the prototype was tested by giving coffee beans with a load variation of 1Kg, 2 Kg, and 3 Kg.

The results of the no-load prototype test are as follows.

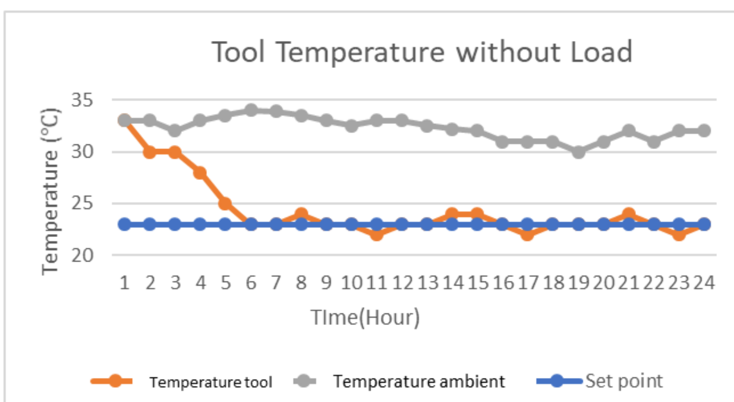

Figure 8. Temperature Chart of the Tool without load

Figure 8 is a graph of a prototype test without a load. The system shows it takes 6 hours to reach the desired temperature at 23°C.

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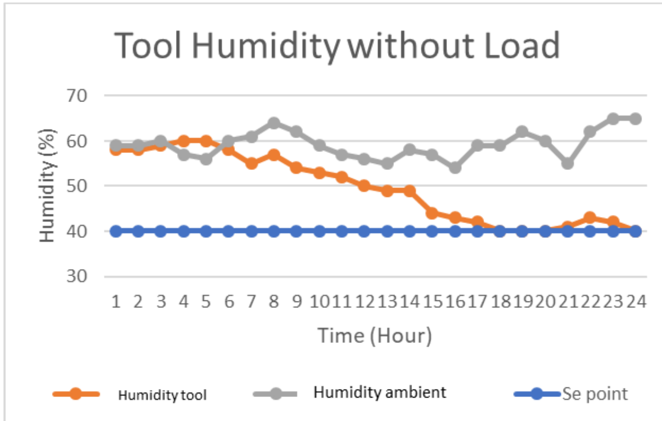

Figure 9. Humidity Chart of the Tool without load

Figure 9 is a graph of the humidity in the system reaching 40% at the 18th hour. According to the reference, getting to the moisture takes 13 hours. This result is faster than previous research (aji 2019) , which is 26 hours.

For testing the prototype system with a coffee bean load of 1 Kg, 2 Kg, and 3 Kg, briefly shown in the following Figure

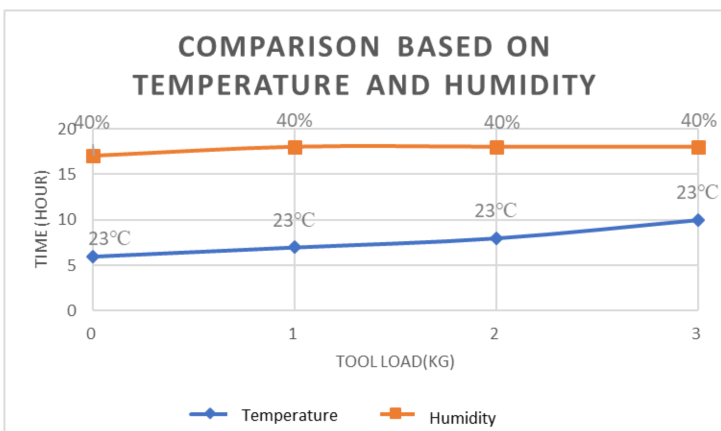

Figure 10. Comparison Chart Based on Temperature and Humidity

Based on Figure 10 on the prototype test without coffee beans, it takes 6 hours to reach the set temperature of 23℃. A prototype with a load of 1 Kg takes 7 hours; at a pack of 2 Kg, it takes 8 hours, while at 3 Kg, it takes 10 hours. Then on the humidity parameter, the prototype test without coffee beans took 17 hours to reach a humidity of 40%. Prototype with a load of 1 Kg, 2 Kg, and 3 Kg takes up to 18 hours.

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The process of reducing the temperature and humidity in the coffee bean storage device is characterized by reading the sensor displayed on the LCD then the condensation results from condensation or condensation which results in water being discharged. This proves the existence of a decrease in humidity due to a decrease in temperature. The incident is the same as the air conditioner in buildings or rooms that use air conditioners, there will be disposal of condensation. In the coffee storage device watertrap is less or ineffective in decreasing it can also be seen from the watertrap tube there is no water condensation or trapped water in it.

To find out that the control system on the coffee bean storage prototype that we designed has a good stability value, we carried out a 7-day diving system test by providing a coffee bean load of 1 Kg on this storage prototype. as for a brief, we display in the following figure:

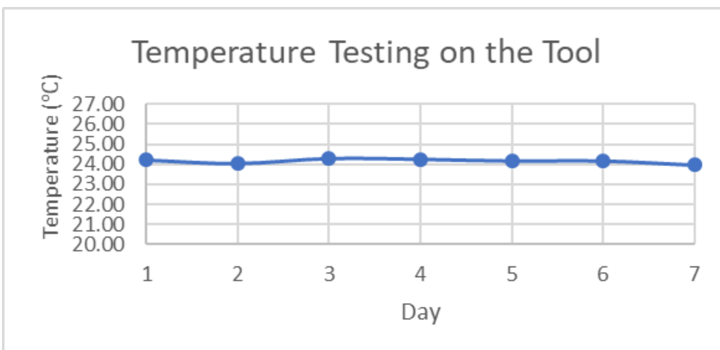

Figure 11. Temperature Testing Graph on the Tool

Based on Figure 11, a temperature of 24 has an error value of 3.31%. The error value, when compared to a reference (Marin, 2008) which has a limit of up to a temperature of 25℃, can still be tolerated. So, it can be concluded that the prototype control system for temperature parameters is running well.

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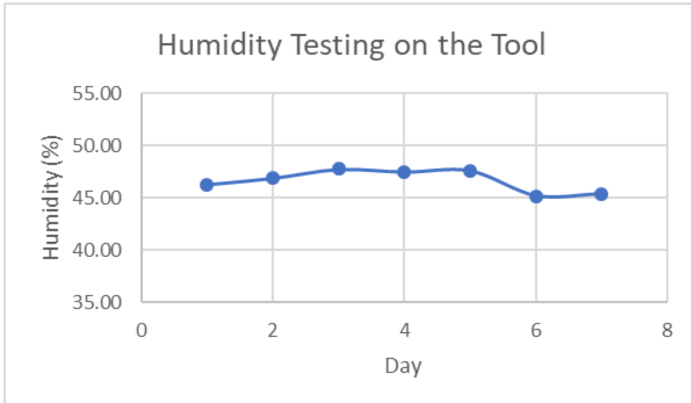

Figure 3.14 Moisture Testing Chart on the Tool

For the moisture value produced during the 7-day test, the value is still close to the upper limit by the set point. High environmental humidity factors may influence this, so the tool is less than optimal in lowering the humidity value.

The acquisition of moisture values during the 7-day test has a value that reaches 45%. According to the reference (Marin 2008), the upper humidity limit is 50%, and the value produced in this test is still tolerable.

We also measure a load of coffee beans as long as they are stored in the prototype within seven days. The bag of coffee beans, which was initially 1 Kg in the 7-day storage process, has decreased to 995 grams. But the depreciation is still in the safe category.

4. CONCLUSION

Based on the results and discussion of the research, it can be concluded that the design of the coffee bean storage prototype is capable of controlling according to the standard, for a temperature of 23±2℃ and a humidity of 40 ±10%. The tool can reach a set point with a coffee load mass of 0 Kg, 1 Kg, 2 Kg, and 3 Kg at different times for no-load time to get a set point temperature of 6 hours and humidity of 17 hours. Loading 1 kg of roasted coffee takes time to reach a set point of temperature of 7 hours and humidity of 18 hours. Then for the burden of roasted coffee, 2 and 3 kg reach the set point at 8 hours and 10 hours, while for humidity, the same 18 hours. Adding a fan to the system increases the time the storage system reaches the set temperature of 23.

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REFERENCE

[1] Direktoran Jenderal Industri Kecil Dan Menengah. 2017. *Buku Peluang Usaha IKM kopi*. KementerianPerindustrian: Jakarta.

[2] Prasetyo, Aji. 2019. Rancang Bangun Pengendalian Suhu Dan Kelembaban Pada Ruang Penyimpan BijiKopi Arabika. Jakarta : Universitas Nasional

[3] K. Marin, T. Požrl, E. Zlatić, and A. Plestenjak, "A new aroma index to determine the aroma quality ofroasted and ground coffee during storage," Food Technol. Biotechnol., vol. 46, no. 4, pp. 442–447, 2008.

[4] AH, Saptadi. 2014. Perbandingan Akurasi Pengukuran Suhu dan Kelembaban Antara Sensor DHT11 danDHT22. STT Telkom: Bandung.

[5] Badan Standardisasi Nasional. 2008. Standar Nasional Indonesia (SNI) Biji Kopi Nomor 01-2907-2008.Jakarta.

[6] Direktoran Jenderal Industri Kecil Dan Menengah. 2017. Buku Peluang Usaha IKM kopi. KementerianPerindustrian: Jakarta.

[7] Erinofiardi, dkk. 2012. Penggunaan PLC dalam Pengontrolan Temperatur, Simulasi pada Prototype Ru-angan. Bengkulu: Universitas Bengkulu.

[8] Haryadi, Yadi. 2010. Peranan Penyimpanan Dalam Menunjang Ketahanan Pangan. Institut Pertanian Bo-gor: Bogor.

[9] Y. Haryadi, "Peranan Penyimpanan Dalam Menunjang Ketahanan Pangan," vol. 19, no. 4, pp. 345–359,2010.

[10] Trias Prima Satya and Fitri Puspasari, "Kajian Ketidakpastian Pengukuran Suhu Dan Kelembaban UdaraPada Sensor Dht22 Berbasis Arduino Uno," J. Ilmu Fis., vol. 2, no. 2, pp. 103–112, 2014.

[11] I. Ismail, M. S. Anuar, and R. Shamsudin, "Effect on the physico-chemical properties of liberica greencoffee beans under ambient storage," Int. Food Res. J., vol. 20, no. 1, pp. 255–264, 2013.