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Design of Temperature and Humidity Control on Arabica Coffee Storage

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Abstract: ***Storage of coffee beans is essential to maintain the quality of coffee in terms of water content and humidity. So we need a storage room with a stable temperature and humidity. In this research, we will design a post-harvest coffee bean storage system, by maintaining the condition of the room at a temperature of 19°-27°C with humidity of 60% -70%. The design uses block diagrams and wiring diagrams, then makes a coffee bean storage box by using a fan as an actuator, and a DHT 11 sensor to measure the temperature and humidity of the room. The results of this study are the Arduino -Uno based Arabica coffee bean storage box takes 7 hours to get the expected set-point. the storage room has a temperature of 19°-27°C and humidity 60-70%***

Keywords : About four key words or phrases in alphabetical order, separated by commas.

I. INTRODUCTION

Storage of coffee beans is the next process to save the coffee from failure or loss of quality and wait for the following method. Quality food, storage technology becomes essential because during storage, often damage and loss are caused by various things. Both producers, exporters, and sellers aim to obtain good-quality, safe products and maintain this tendency of green beans throughout the productive chain. However, some factors are out of control from the storage step. After going through the drying process for about 3 to 4 weeks, the coffee beans then stored in warehouses with a standard reference temperature of 19℃−27℃ [3] and humidity of 60%−70%. [4] The warehouse must be well ventilated to maintain temperature and humidity. However, most of the warehouses have no tools or systems to control temperature and humidity. This case becomes uncontrolled due to the absence of an accurate temperature and humidity measuring system so that it impacts on the quality of the coffee beans.

Based on the problem above, the writer makes a design for controlling temperature and humidity in the green coffee storage room to maintain the temperature and humidity of the coffee to maintain quality and extend the coffee beans shelf life.

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II. PROCEDURE FOR PAPER SUBMISSION

The purpose of this research is to create a coffee bean storage room that can control temperature and humidity so that the quality of coffee beans can be appropriately maintained. The DHT 11 sensor will measure temperature and humidity, and will be managed by Arduino-Uno so that the coffee bean storage room will have a temperature and humidity following the expected set-points.

The storage room design is made of iron frame and styrofoam walls and coated with plywood. Figure I (a) block diagram illustrates in general how the circuit works as a whole.

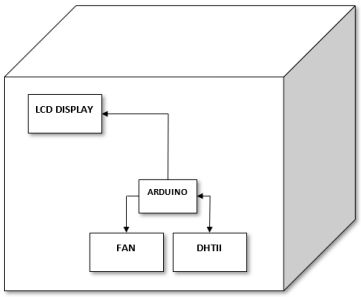

Fig 1. Experimental block diagram

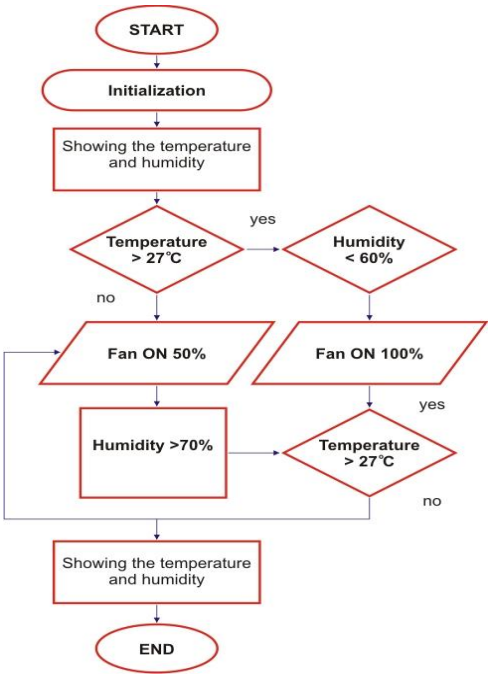

Fig 2. Flow chart System

The design and realization of the temperature and humidity control system in the post-harvest coffee storage room consists of several blocks composed of 2 DHT11 sensors, an Arduino-Uno microcontroller, an actuator block, and two fans. Figure 2 portray the way the work will be done in the process of controlling temperature and humidity in the storage room.

The controller circuit in Figure 3 below is the circuit used in controlling the temperature and humidity of the coffee beans

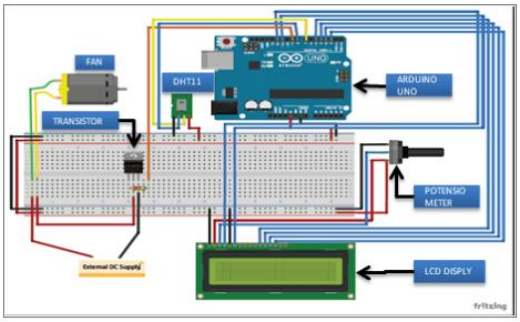

Fig 3. Wiring diagram of circuit used for controller

The storage room design (Figure 3) uses styrofoam and plywood because it is lightweight and can maintain temperature and humidity. Shelves made of iron.

Fig 4. Real design of storage box

For the prototype, two bags of Toraja arabica green coffee brought in each package containing 500 grams are Sample A and Sample B. (i) Storage is designed with dimensions of 80 cm x 80 cm x 80 cm. (ii) 2 DHT11 sensors are on each side of the wall of the storage box. (iii) Arduino-Uno controls the temperature (iv) Inputs obtained from the DHT11 sensor will produce temperature and humidity values. (v) The transistor functions as a fan regulator. (vi) Sample A is on the top shelf, and Sample B is on the bottom shelf.

Fig 5. Two bags of Toraja coffee beans in storage box shelf

The target temperature and humidity are 25 ℃ and 66%, respectively. the study lasted for 72 hours, temperature and humidity recorded during this time

III. RESULT AND DISCUSSION

A. Testing Of Non-Condition Storage Room

In Figure 6 during the 8-hour system the lowest temperature is 28.9 ℃, For 12 hours,

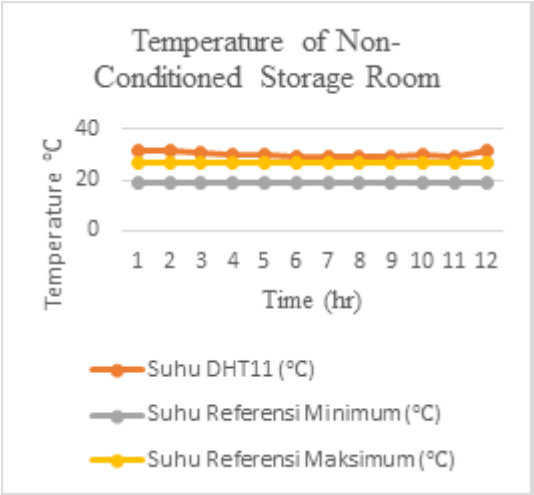

Fig 6. Temperature In Non-Conditioned Storage Box

the system runs at a temperature of 31.79 ℃, and this indicates that the temperature does not match the expected setpoint

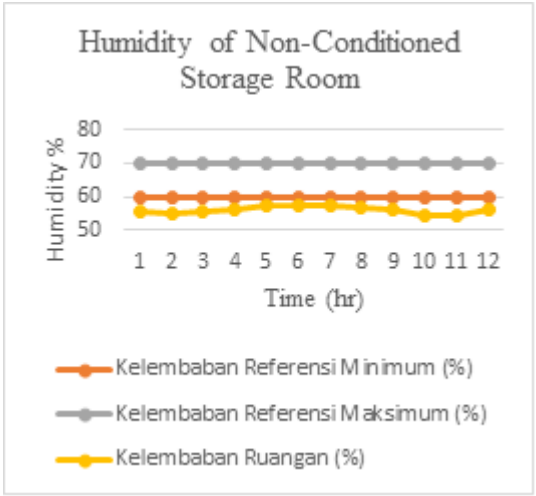

Fig 7. Humidity In Non-Conditioned Storage Box

Figure 7 is the humidity of the room without conditions, and the lowest humidity is 54.4% during the system stay within 10 hours, with the highest humidity of 57.55% for 5 hours. Thus the results of the moisture obtained do not match the expected setpoint.

B. Testing of Conditioned Storage Room

In Figure 8 the temperature inside the device is sufficiently maintained. The recommended reference temperature is between 19℃ to 27℃.

The temperature rise at the beginning of the experiment occurred because the system just started working. The initial temperature obtained during testing amounted to 29.27℃. As the system progresses, the temperature reaches a reference temperature of 26.13℃, which is after the system

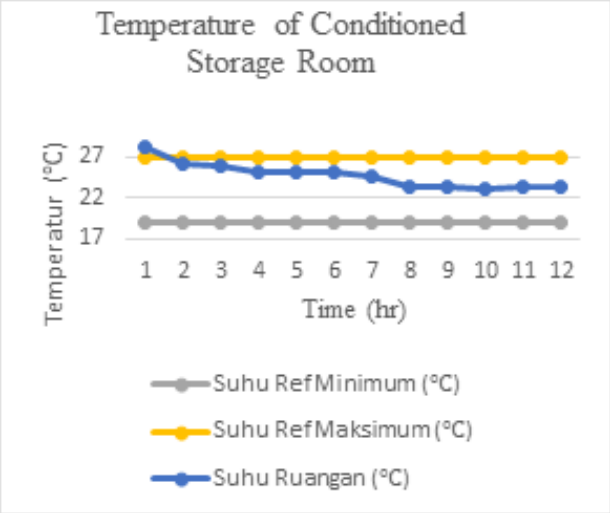

Fig 8. Temperature in conditioned storage box

It has been running for 1 hour. The lowest temperature obtained is 23.12℃ when the system has been running for 10 hours. The highest point of temperature after the system runs is typically 24.68℃ when the system runs for 5 hours, with an average room temperature conditioned for 12 hours is 24.84℃.

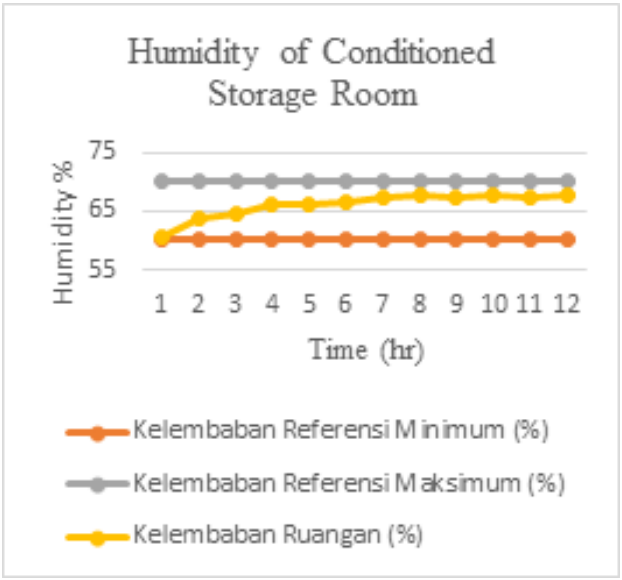

Fig 9. Humidity in conditioned storage box

Then for humidity seen Figure 9, the initial state has entered the reference temperature, which is between 60% to 70%. During 12 hours, the system can maintain moisture stability of 66.6%. Intervals of 4 hours humidity reached 66.21%. after the system runs for 12 hours, the humidity reaches 68.72%

C. Comparison Between The Temperature And Humidity Inside The Storage Room (Conditioned) And Outside The Storage Room

In figure 10 the system temperature can maintain at 25 ℃ - 24 ℃. Outside room temperature at 28 ℃ to 27 ℃, this shows that when the system is running, the outside temperature of the appliance does not affect the temperature inside the system. In Figure 11 , the humidity in the storage room is 66% - 67%.

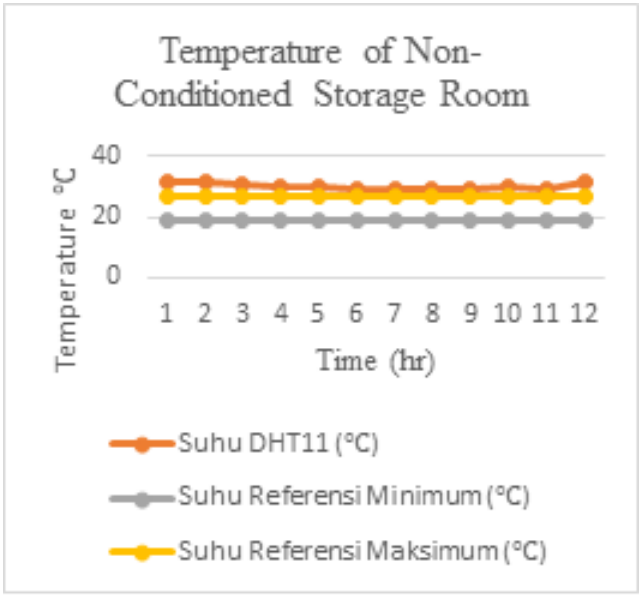

Fig 10. Temperature in storage box to outside box

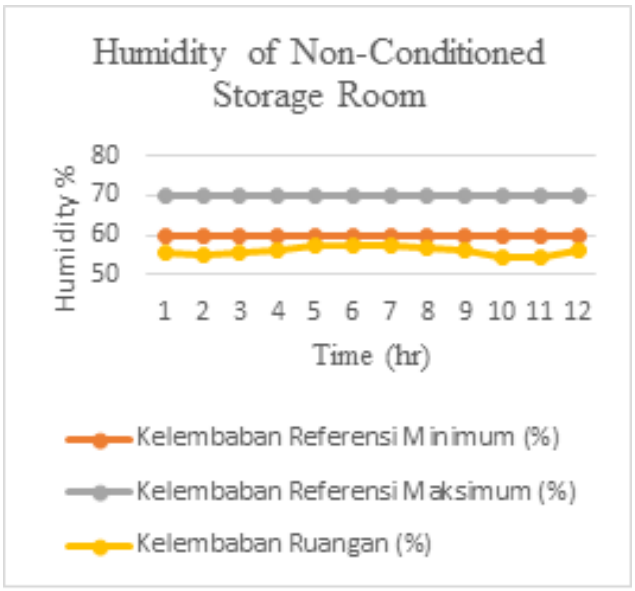

Fig. 11 Humadity In Storage box to Outside box

For storage box experiments with both sample bags for each Sample A on the upper shelf and sample B on the lower shelf, monitored throughout 72 hours long or three days. Room temperature testing is targeted to be stable between the reference temperature of 19℃−27℃ and focused on being stable at 25℃. For room humidity is targeted to be stable between the reference humidity of 60% -70% and targeted to survive at 66%.

D. Testing Room Temperature With Green Coffee Bean Samples

In Figure 12 the first decrease in coffee temperature occurs after 1 hour the system is working. The initial coffee temperature is 27.12 ℃ with a set point temperature of 25 ℃.

Room temperature drops to around 25 ℃ for 7 hours. The temperature was able to reach 24.53 ℃ for 17 hours, then it rose again and remained in the temperature range of 25 ℃ until the end of the study.

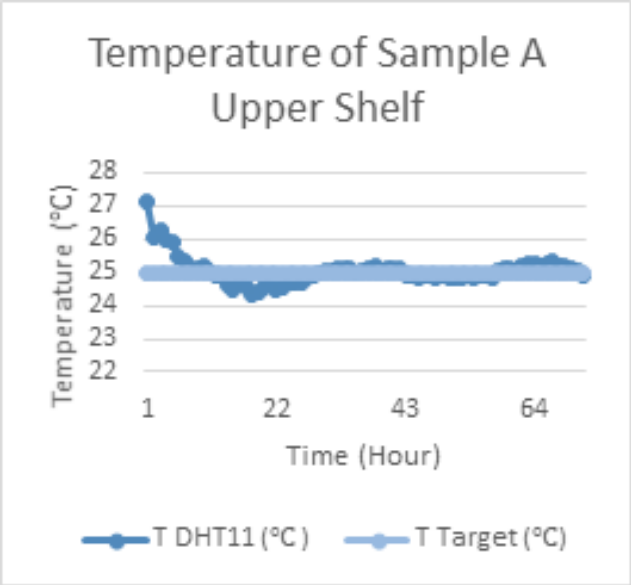

Fig 12. The temperature of storage box with sample bags A inside

In Figure 13 coffee samples are on the lowest shelf. Initial temperature shows 27.1 ℃ and goes to a setpoint temperature of 26.28 ℃ in the first hour. The coffee temperature began to meet the set point temperature at 7 hours of research. It was able to maintain the temperature to the lowest point of 24.81 ℃ and the rest at the target temperature of 25 ℃.

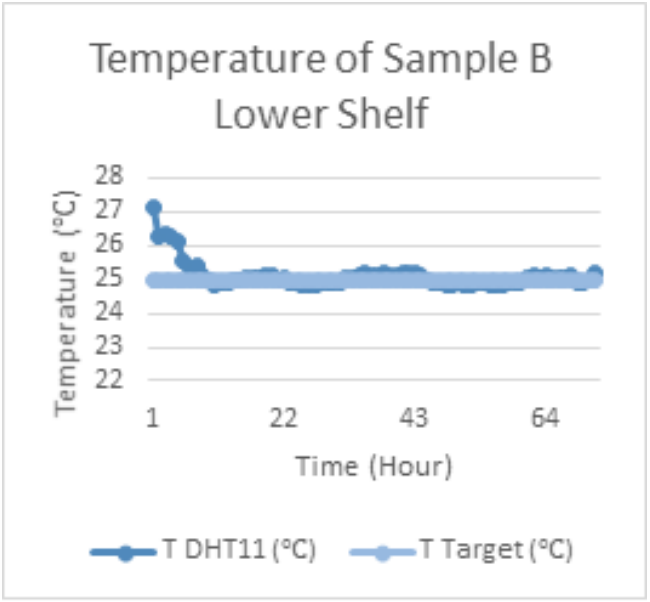

Fig 13. Temperatur of storage box with sample bags B inside

E. Humidity Testing of Room Conditioned With Green Coffee Beans

Seen on the Figure 14 sample A has reached the reference humidity (60%−70%) at the point of 60.34% at the beginning of the study and takes 1 hour to increase the humidity to 63.74%.

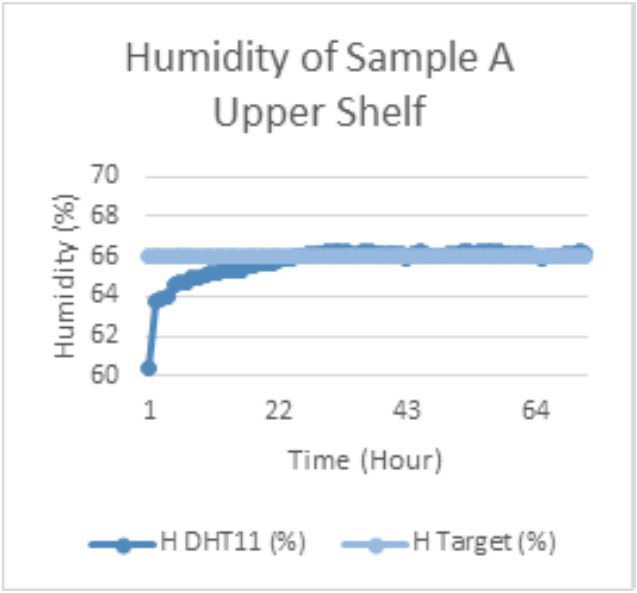

Fig 14. The Humidity of storage box with sample bags A inside

Figure 15 Humidity touches the coffee humidity target in the range of 66% starting from the 27th hour and can maintain it until the completion of the study. The top shelf coffee humidity is quite stable, with the lowest humidity valued at 65.9% and the highest humidity 66.25%. In Graph V (b), sample B humidity starts from the point of 60.6% and enters the target humidity at the 20th hour at 66.19%. The lowest humidity after 20 hours is 65.91%, and the highest humidity is 66.44%. This figure is quite stable in the area of 65% -66% until the end of the Research.

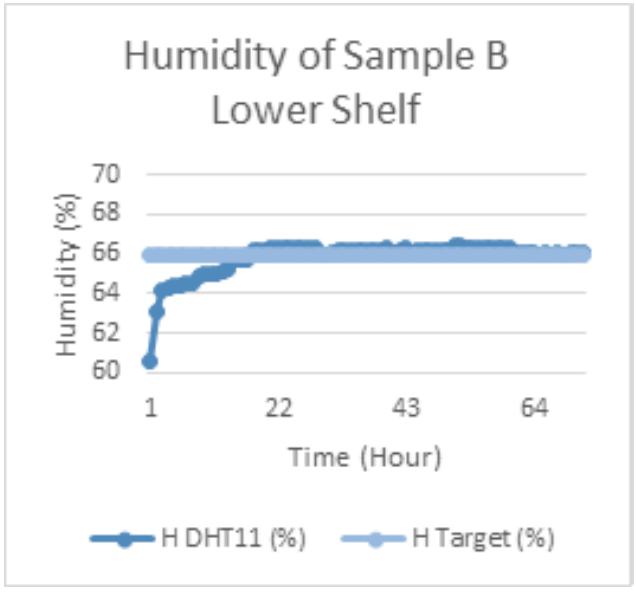

Fig 15. The Humidity of storage box with sample bags B inside

Both samples need 7 hours to lower the temperature to reach the target temperature in the range of 25 ℃. For humidity, coffee sample A reached the target humidity at 66.02% within 26 hours, and coffee sample B arrived at the target humidity at 66.19% within 18 hours.

IV. CONCLUSION

A temperature and humidity control device successfully made for storage post-harvest Arabica green coffee beans that we're able to maintain the coffee temperature for approximately 20 hours by keeping the temperature stretched 19℃−27℃ and humidity ranged 60%-70% in less than 30 hours.

REFERENCES

1. Ribeiro FC, Borém FM, Giomo GS, De Lima RR, Malta MR, Figueiredo LP. Storage of green coffee in hermetic packaging injected with CO2. Journal of Stored Products Research. 2011 Oct 1;47(4):341-8.
2. Coradi PC, Borém FM, Saath R, Marques ER. Effect of drying and storage conditions on the quality of natural and washed coffee. Coffee Science. 2007;2(1):38-47.
3. Badan Standardisasi Nasional. 2008. Standar Nasional Indonesia (SNI) Biji Kopi Nomor 01-2907-2008. Jakarta
4. Lopez-Garcia R, Mallmann CA, Pineiro M. Design and implementation of an integrated management system for ochratoxin A in the coffee production chain. Food Additives and Contaminants. 2008 Feb 1;25(2):231-40.
5. Peraturan Menteri Pertanian Nomor 49/Permentan/OT.140/4/2014/ Good Agriculture Practices /Gap On Coffee
6. Simić M. Design and development of air temperature and relative humidity monitoring system with AVR processor based web server. In2014 International Conference and Exposition on Electrical and Power Engineering (EPE) 2014 Oct 16 (pp. 038-041). IEEE.
7. Direktorat Jendral Perkebunan. 2018. Penanganan Pascapanen Kopi Secara Baik dan Benar (*good handling practices/ghp*). Kementerian Pertanian: Jakarta.
8. Ross CF, Pecka K, Weller K. Effect of storage conditions on the sensory quality of ground Arabica coffee. Journal of food quality. 2006 Dec;29(6):596-606.

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