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DESIGN AND CONSTRUCTION OF SPICE SHIPER AND DRYER (FIVING) WITH FUZZY LOGIC CONTROL APPROACH

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A B S T R A C T

One sector that needs to be researched intensively and comprehensively is the food sector (Spices). Spices (Temu-finding) or known as ginger plants are plants that are used as basic ingredients for traditional medicine or herbal medicine.problems faced by traditional herbal medicine farmers, including spice processing technology is still not there. This is evidenced that the processing of spices into traditional herbal medicine is done manually. The problem in the initial process of drying the basic ingredients of Madurese traditional herbal medicine, requires a relatively long time so that the productivity of Madurese traditional herbs can only be produced in a limited manner depending on the weather. Another problem is that human resources are still in the traditional paradigm, meaning they still believe that traditional herbal medicine processing is more efficacious than using processed using technology.The purpose of this research is to develop this technology designed to increase the productivity of traditional herbal medicine production in Madura so that it has high quality and competitiveness. On the other hand, increasing the productivity of traditional herbal medicine production will have a positive impact on spice farmers (findings) in the form of increasing the economic level of farmers and traditional herbal medicine entrepreneurs. It is hoped that this research can provide technological solutions to spice farmers and traditional herbal medicine entrepreneurs in Madura as well as increase the productivity of Madurese traditional herbs and spices.

Keywords: Slicer, Dryer, Spices(Findings), Fuzzy Logic Control.

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1. Introduction

One sector that needs to be researched intensively and comprehensively is the food sector (Spices). Spices (Temu-finding) or known as ginger plants are plants that are used as basic ingredients for traditional medicine or herbal medicine. The field survey regarding the drying of spices as the basic ingredients of traditional medicine or herbal medicine, there are several problems faced by traditional herbal medicine farmers, including spice processing technology that does not yet exist. This is evidenced that the processing of spices into traditional herbal medicine is done manually. The problem in the initial process of drying the basic ingredients of Madurese traditional herbal medicine, requires a relatively long time so that the productivity of Madurese traditional herbs can only be produced in a limited manner depending on the weather. Another problem is that human resources are still in the traditional paradigm, meaning they still believe that traditional herbal medicine processing is more efficacious than using processed using technology.From the description of the problem above, it shows that there is a need for research on the manufacture of technology that supports the production process of traditional herbal medicine in Madura. Research has been supported by the potential of Madura which is rich in spices (findings). Research must start from the initial preparation of the basic ingredients of traditional herbal medicine. The technology that makes it possible to support the process of providing the basic ingredients of traditional herbal medicine is the technology of slicing and drying spices (findings). This technology is designed to increase the productivity of traditional herbal medicine production in Madura in order to have high quality and competitiveness. On the other hand, increasing the productivity of traditional herbal medicine production will have a positive impact on spice farmers (findings) in the form of increasing the economic level of farmers and traditional herbal medicine entrepreneurs. One sector that needs to be researched intensively and comprehensively is the food sector (Spices). Spices (Temu-finding) or known as ginger plants are plants that are used as basic ingredients for traditional medicine or herbal medicine.

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2. Methods

This study uses a microcontroller as a microprocessor in the system by utilizing several sensors to obtain data accurately. The following is a block diagram of the system

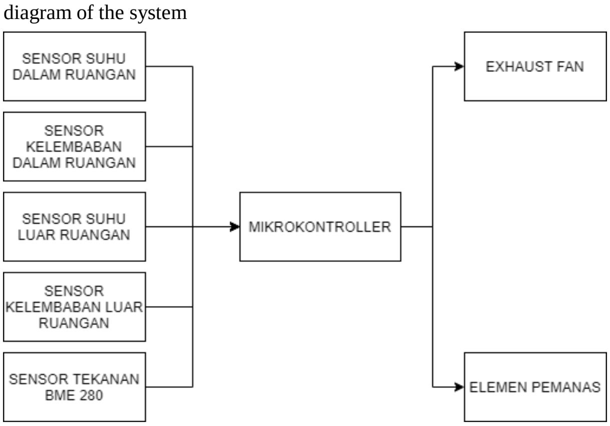

Figure 1. System Block Diagram

In Figure 1 is a block diagram as a whole. The input to this system consists of several components and sensors. The sensors used are temperature, pressure and humidity sensors. Temperature and humidity sensors are used as inputs to control indoor temperature and humidity. The microcontroller used is the Arduino Mega 2560 which is the center for processing and reading the state and instructions on the actuator. The process part is part of the microcontroller consisting of 5 parts:

1. Calculation of temperature is the process of converting the analog value of the temperature sensor that has been changed by the microcontroller.
2. Humidity calculation is the process of converting the analog value of the humidity sensor that has been changed by the microcontroller.
3. Fuzzy Logic Control for actuator decision making process

   The output section consists of 2 actuators as a medium for controlling the evaporation acceleration process in the room as a tool to monitor parameters
4. The heat element is used to increase the indoor temperature to speed up the evaporation process by controlling the temperature.
5. Exhaust fan for circulating temperature and air pressure in the room so that the spice drying process (findings) is perfect.

a. Dryer Room Prototype Mechanical Design

Appropriate mechanical design will support the acceleration of the drying process more optimally and perfectly so that it becomes better. Therefore, the room must be made suitable and heat-resistant so that it can withstand heat from all angles. The mechanical design of the room can be seen in Figures 2 to d. 4

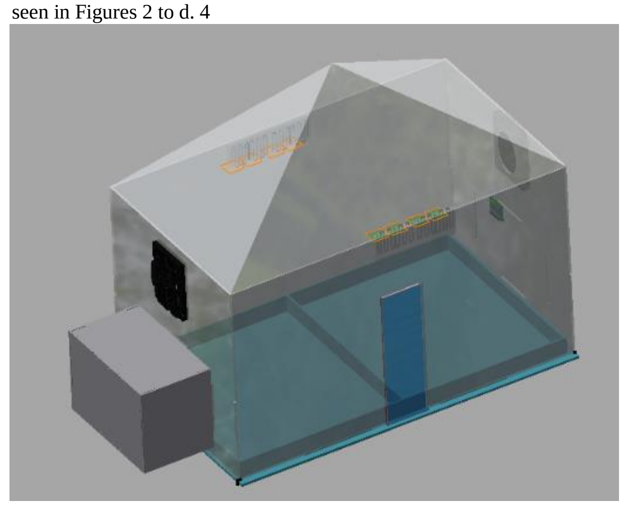

Figure 2. The mechanical design of the room, right side view

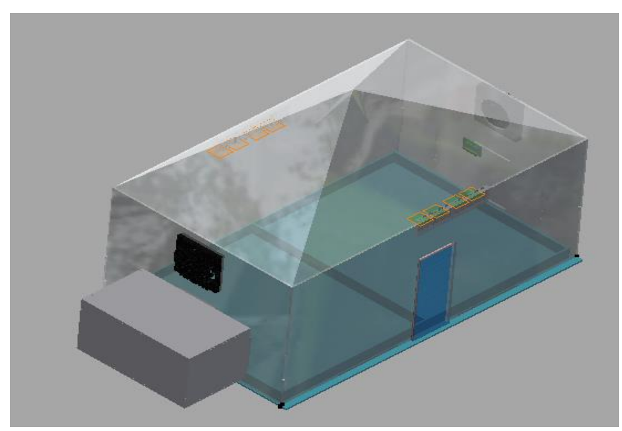

Figure 3. Mechanical design of the room top

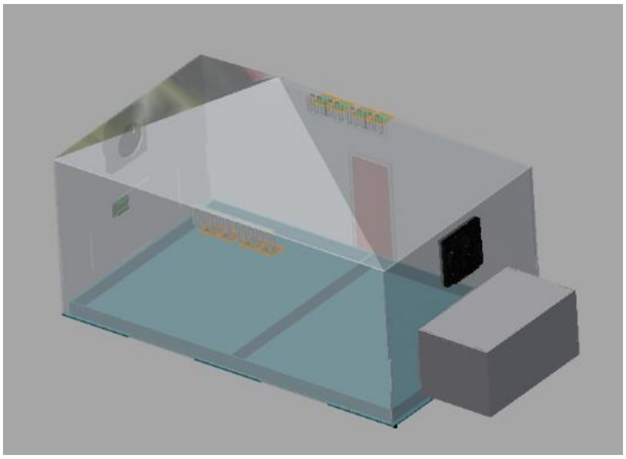

Figure 4. The mechanical design of the room on the left side

In the mechanical prototype room, there are several components, namely BME 280, light dimmer sensor, fan, switching power supply, heat element and arduino. Bme 280 is placed in the horizontal center of the room so that it is stable including detection, placing 2 fans on the side is used. to enter air from outside and take air from inside the room for the air circulation process, the AC light dimmer module acts as a regulator on the heating element to increase or decrease the temperature with a pwm voltage regulator. In the design of room hardware, the following are the details of the dimensions and materials to be used. This room has dimensions of 75 cm long by 45 cm wide and 30 cm high with a square shape and has a prism roof so that the heating process is optimal from all directions of light.For the frame material using aluminum because it is strong and lightweight. As well as using a cover or wall with a thickness of 4 ml of acrylic material because it is strong and heat-resistant, the salt container uses stainless steel because it is heat-resistant and anti-rust.

b. System Electronics Circuit

Making a drying room prototype requires electronic components and their design. In Figure 5 is the electronic design of the system.

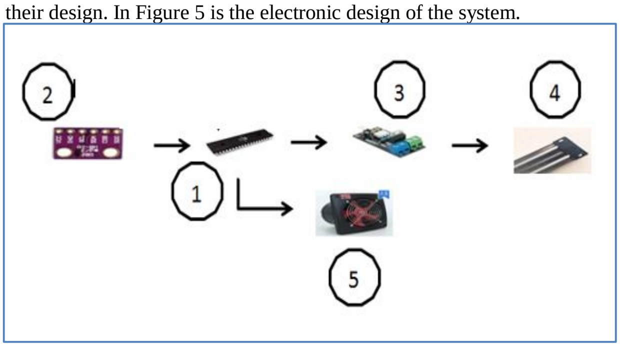

Figure 5. Room electronics design

The following is a description of the electronic components contained in Figure 5.

1. ATmega2560
   Arduino Mega 2560 is an Arduino board that uses the ATmega 2560 Microcontroller IC. This board has relatively many I/O pins, 54 digital inputs/outputs, 15 of which can be used as PWM outputs, 16 analog inputs, 4 UARTs. Arduino Mega 2560 is equipped with 16. Mhz crystal. For relatively simple use, just connect power from USB to PC / Laptop or via DC Jack using a 7-12 V DC adapter.
2. Temperature and humidity sensor BME- 280
   The BME280 is a breakout board based on the Bosch BME280 Athmospheric Pressure Sensor. The BME280 is capable of measuring pressure, temperature, altitude, and humidity, making it suitable for various applications such as indoor/outdoor navigation, weather monitoring, home automation, as well as for wearable devices.Electronic Speed Control
   ESC plays an important role in controlling the speed and direction of rotation of brushless motors. The choice of ESC depends on the maximum current of the brushless motor
3. AC light dimmer module
   Ac light dimmer 220v pwm module max 5a zero crossing detector is a dimmer module made by RobotDyn with the ability to be controlled by microcontrollers such as Arduino, Raspberry Pi and so on, with the pin zero crossing detector feature in this module, the microcontroller can find out the right timing to send PWM signal..
4. Heating element
   The heating element is one type of heating element whose use is versatile because it is tubular so that the model can be adjusted and its application can be for solid, liquid, or gas heating.In general, Tubular Heaters are used for plastic processing applications, printing, heating water/oil/chemical solutions, drying ovens, medical equipment, etc. this.
5. Exhaust fan
   Exhaust fan serves to suck air in the room to be discharged to the outside, and at the same time draws fresh air outside into the room. In addition, the exhaust fan can also adjust the volume of air to be circulated in the room

c. System Flowchart

This system functions by receiving data from temperature and humidity sensors which are connected to the microcontroller. The data from the sensor is used to adjust the temperature increase in the heat element and the activation of the exhaust fan in the room.

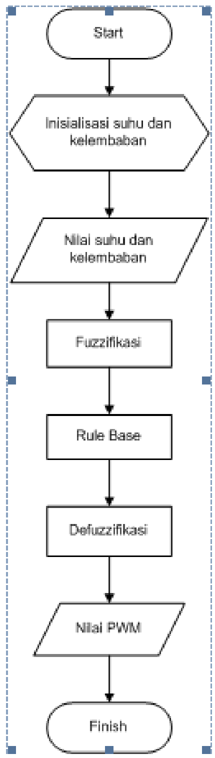

Figure 6. Fuzzy flowcart in the room

Figure 6 is a flowchart of the fuzzy method. The flowchart starts from the initialization of the temperature and humidity sensor. After getting the value from the temperature and humidity sensor, the next process is fuzzyfication, rule base, defuzzification and then getting the calculation output in the form of a value. pwm is the result of the fuzzy method process to increase the temperature in the room with a heating element and activate the exhaust fan.

d. Fuzzy Method Calculation Simulation

The fuzzy method used in this research is the Fuzzy Sugeno method, because it has the output in the form of a linear equation so that it is easier to describe in the program. In the fuzzy method there are several determining points consisting of the formation of the membership function and the rule base, the following is the explanation:

Membership function formation

a. Fuzzy Set Formation

The fuzzy set is made into three parts, namely the set X (temperature x), the set Y humidity, and the set Z (the output is the pwm value).

The general formula for the fuzzy method:

1. (x-a) / (b-a) a x b (linear representation ascending)
2. (b-x) / (b-a) a x b (descending linear representation)
3. (c-x) / (c-b) b x c (triangular curve representation)

The set X is shown in Figure 3.7 while the set Y is shown in Figure 8.

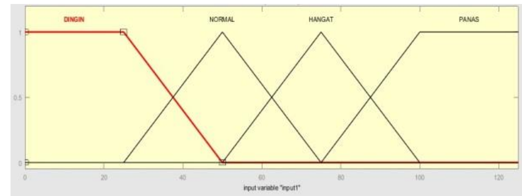

Figure 7. Set X (temperature x)

The set of X is divided into four membership functions, namely:

1. Cold has a value from 0 to 50
2. Normal has a value from 25 to 75
3. Warm has a value from 50 to 100
4. Heat has a value from 75 to 100

The following is the membership value of the set X

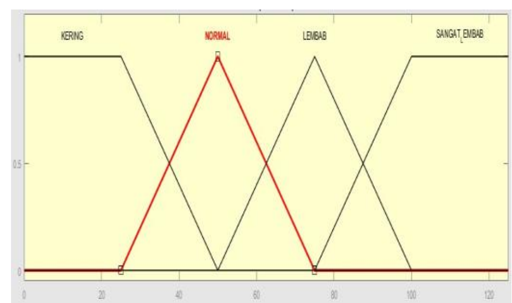

Figure 8. The set y (humidity)

The set of Y is divided into four membership functions, namely:

1. Dry has a value from 0 to 50
2. Normal has a value from 25 to 75
3. Moisture has a value from 50 to 100
4. Very Moist has a value from 75 to 100

3. Results and Discussion

a. Test result

The instrument testing in this study was conducted at the Mechatronic Engineering Laboratory, Trunojoyo University, Madura. Tests were carried out during the day and at night. The test scenario starts from sensor testing to overall tool testing.

a) DHT22 . Sensor Testing

In testing the DHT 22 sensor as a temperature and humidity measuring device on the Spice Dryer, it uses units that have been converted to degrees Celsius (ºC). The testing phase is carried out by detecting the normal temperature and humidity in the laboratory and the temperature when heat is given input. The program used on the Arduino Uno board is as follows:

```
hum = dht.readHumidity();
 temp= dht.readTemperature();
Serial.print("Humidity: ");
Serial.print(hum);
Serial.print(" %, Temp: ");
Serial.print(temp);
Serial.println(" Celsius");
delay(1000); //Delay 2 sec.
```

Figure 9. Arduino sketch DHT 22 program

The results of measurements from the DHT-22 sensor at temperature and humidity can be seen in Table 5.1 and Figure 5.2 are the results of testing readings in the laboratory room for data collection carried out during the day displayed on the LCD there are 10 data taken every minute for ten minutes

Table 1. DHT22 sensor reading

No	Humidity	Temperature
1	33,89	54,80
2	33,89	54,80
3	33,89	54,80
4	33,89	54,80
5	33,89	54,80
6	33,90	54,80
7	33,90	54,80
8	33,90	54,80
9	33,90	54,80
10	33,90	54,80

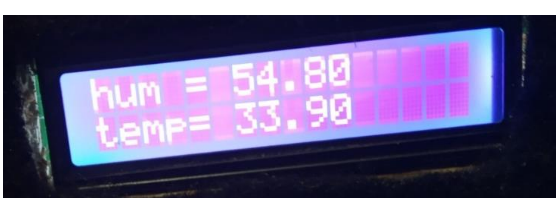

Figure 10. Normal indoor temperature and humidity reading

Figure 10 is an LCD monitor screen display from the results of the sample DHT 22 sensor readings, namely the state of the temperature during the day in the Mechatronics Laboratory room with a temperature of 33.90ºC and a humidity of 54.80.

b) Spice Dryer Temperature and Humidity Test

In the overall system experiment, the first thing to do is to collect temperature data. This is done to determine the temperature comparison between the inside of the Spice Dryer and the outside of the Spice Dryer.

Retrieval of Temperature and Humidity Data outside the Spice Dryer Data collection outside the glass room is divided into 3 samples, namely morning, afternoon and evening which are taken every 2 hours. This data collection was carried out for 2 days. The data that has been obtained is shown in Table 2, namely the first day of data collection in the morning, afternoon and evening. The results of outdoor data collection can be shown in the graph from Table 2 which is divided into 3 graphs, namely in Figure 11, Figure 12 and Figure 13. Details of Table 2 can be seen in Appendix 1.

Table 2. Sample data taking temperature outside the Spice Dryer

Time (minutes)	Data collection outside the Spice Dryer on the 1st day					
	Morning		afternoon		Evening	
	Temperature	Humidity	Temperature	Humidity	Temperature	Humidity
1	23,20	85,30	31,02	46,77	29,38	67,03
2	23,40	85,20	31,03	46,72	29,37	67,05
3	23,60	85,10	31,04	46,67	29,36	67,07
4	23,80	84,90	31,05	46,62	29,35	67,09
5	23,10	84,80	31,06	46,57	29,34	67,11
6	23,12	84,70	31,07	46,52	29,33	67,13
7	23,14	84,60	31,08	46,47	29,32	67,15
8	23,16	84,50	31,09	46,42	29,31	67,17
9	23,18	84,40	31,1	46,37	29,3	67,19
10	23,20	84,30	31,11	46,32	29,29	67,21
...	...	...	...	...	...	...
120	25,75	68,10	32,24	43,05	27,02	73,38

Table 2 shows that temperature & humidity data collection samples were carried out in the morning, afternoon and evening for 2 hours. This is done to determine changes in temperature and humidity for 2 hours in the morning, afternoon and evening. In the morning the data is taken at 06.00-08.00, while in the afternoon the data is taken at 11.00-13.00. As for data collection at night, this data was taken at 19.00-21.00. Figure 11, Figure 12 and Figure 13 are graphs of the results from Table 2 by differentiating the temperature and humidity in the morning, afternoon and evening for 2 days.

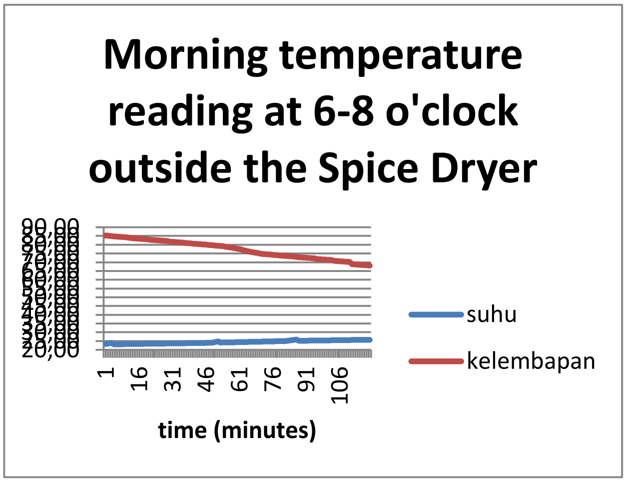

Figure 11. Graph of outside temperature of the Spice Dryer in the morning on day 1

In the blue line marked on the graph, the initial temperature is 22°C and the red line is humidity 47. After taking data every 10 minutes for 2 hours, it can be seen that the temperature outside the room at 08.00 has changed to 26°C and the humidity is 68 minutes. 113. In Figure 11 changes in temperature and humidity can be observed that when the temperature increases, the humidity decreases.

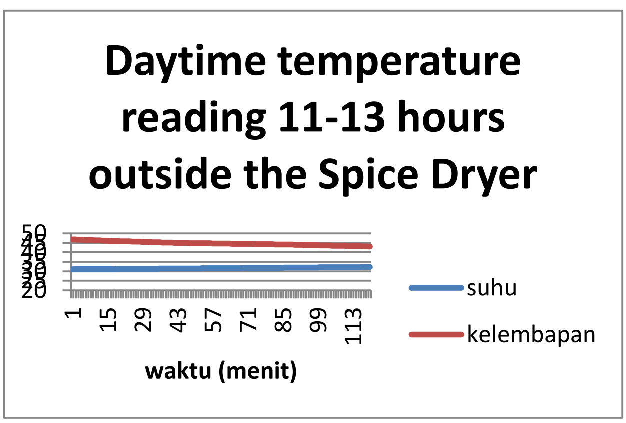

Figure 12. Outdoor temperature at noon on day 1

During daytime data collection from 11.00 to 13.00 the temperature only increased by 2°C, namely the initial temperature from 31°C humidity 46 to 34°C final humidity 43 at the final temperature 118 minutes. During two hours of data collection, temperature changes were observed. and humidity. Changes in humidity were seen at the beginning of data collection, humidity was 47. Then it decreased to 43 after 2 hours.

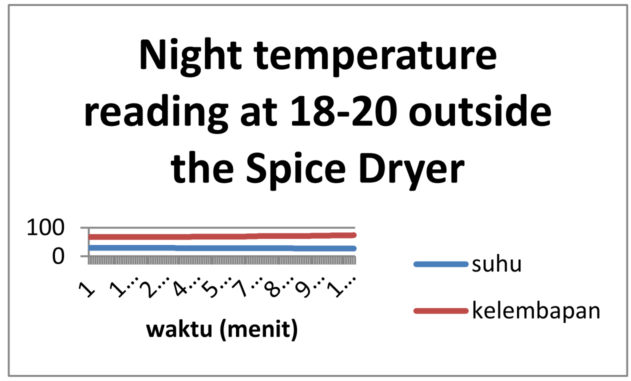

Figure 13. Outdoor temperature at night on day 1

Figure 13 is a graph of outdoor temperature and humidity data at 18.00-20.00. The first minute the temperature reached 29°C, while the humidity reached 68. The temperature and humidity data after data collection for two hours, changed until the temperature reached 27°C, while the humidity reached 72 at 120 minutes.

The second day also carried out temperature and humidity data collection outside the Spice Dryer at the same time. This test was carried out for two days with the aim of obtaining the values detected by the DHT22 sensor when experiencing changes in temperature and humidity. Outdoor data collection is divided into 3, namely morning, afternoon and evening. This data collection was carried out for 2 hours, namely in the morning at 06.00-08.00, in the afternoon at 11.00-13.00 and in the evening at 18.00-20.00.

c) Testing Sensor and Heater Readings in the Spice Dryer

Testing the readings of the DHT-22 sensor and heater in the Spice Dryer aims to determine the response of the system when not applying the method to its control. The heater is used as a heater to increase the temperature and lower the humidity in the Spice Dryer. Table 3 shows the data taken when testing the heating control in the Spice Dryer without using the method and using the method.

Table 3. Testing the heating control in the Spice Dryer without using methods and methods

Experiment with sensors and heaters in the room						
Time (seconds)	without method			by method		
	tempe rature	Hum idity	di me r	tempe rature	Hum idity	di me r
1	32,3	79,8	55	33,1	69,5	58, 4
2	32,4	79,7	55	33,2	69,5	58, 4
3	32,6	79,6	55	33,3	69,5	58, 4
4	32,7	79,5	55	33,4	69,5	58, 5
5	32,9	79,4	55	33,5	69,5	58,

						5
6	33,0	79,3	55	33,6	69,5	58,5
7	33,2	79,2	55	33,7	69,5	58,5
8	33,3	79,1	55	33,8	69,5	58,5
9	33,5	79	55	33,9	69,5	58,6
10	33,6	78,9	55	34,0	69,5	58,6
...	...	...	...	...	...	...
360	86,1	11,6	61	60,8	21,6	64,3

Based on Table 3, it can be seen that the temperature and humidity data that occurred during the application of control without methods in the laca house. The temperature change at the beginning of the test reached 54°C, while the humidity reached 68.

d) Testing Sensor and Heater Readings in the Spice Dryer with the Fuzzy Method
Testing the sensor and heater readings in the Spice Dryer by applying the fuzzy control method is carried out to determine the system response when getting temperature and humidity input from the DHT-22 sensor. The output of the fuzzy method is PWM to adjust the heater. The system response from the fuzzy method is expected to be able to adjust the output value with the input value given by the DHT-22 sensor.

Humidity, the data obtained starting from 69 to 6 minutes changed to 29. The graph of this data sample can be seen in Figure 14.

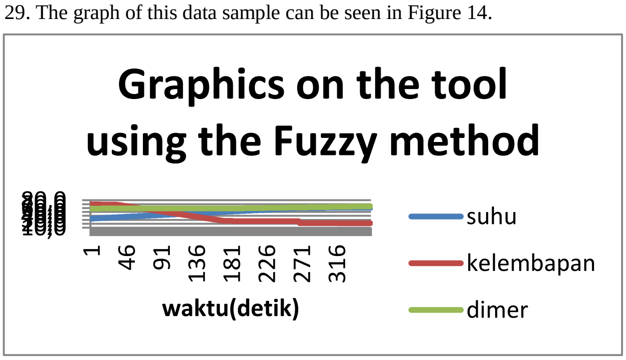

Figure 14. The graph of the application of the fuzzy method

Figure 14 shows that the system response at the 6th minute the temperature reaches 60°C, the fuzzy method keeps the temperature from rising. So it can be concluded that the fuzzy method can optimize the evaporation of spice slices in the Spice Dryer.

e) Overall Tool Test
The application of the fuzzy method on the Spice Dryer uses a DHT-22 sensor, where the DHT-22 sensor can determine the temperature and humidity in a place or room. Sensor readings are used as input for the fuzzy method used in this study. Figure 15 is a Spice Dryer used to optimize the evaporation of spiced slices. As for some data collection that has been carried out for 5 days, data collection is divided into 3 parts, namely:

1. Data collection in the morning, 06.00-08.00
2. Data collection during the day, 11.00-13.00
3. Data collection at night, 18.00-20.00

Figure 15. Spice Dryer

In addition to collecting data to determine the response of the system to changes in temperature and humidity, observations were also made on the container for holding the spice slices. This is done to find out whether the system can optimize the evaporation of spice slices in the Spice Dryer.

4. Conclusion

1) Conclusion

The conclusions in this study after the testing was carried out were as follows:

1. The sensor used in this study runs well, this is indicated by a very small error percentage of 0.98%.
2. The overall system runs as planned and has a 98% success rate when viewed from the results of the spices that have been dried through the equipment in this study.

2) Suggestion

Suggestions for this activity are in the form of a short duration of research work which has an impact on optimizing the sampling of testing. The results of this study can be used as material for comparison and reference for future research. For future research, it is hoped that the duration of the research will be longer, so that the results obtained are better than before.

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