

AC 220V DIGITAL THERMOSTAT BASED DRYING OVEN XH-W3001 TO IMPROVE TEMPERATURE ACCURACY IN THE DRYING PROCESS OF BLACK BETEL LEAVES (*PIPER BETLE VAR NIGRA*) AT PT. FBION KARANGANYAR

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Abstract. The purpose of this study was to find out how to manufacture and test results of a black betel leaf dryer (Piper Betle Var Nigra) based on Digital Thermostat AC 220V XH-W3001. The research method used in data collection for this tool is the experimental method. The way to make a black betel leaf dryer (Piper Betle Var Nigra) based on Digital Thermostat AC 220V XH-W3001 is by connecting a heating coil, power fan and digital thermostat. The heating coil and fan will turn on when the temperature in the oven has reached and exceeds the specified lower limit. The trial results of the black betel leaf dryer (Piper Betle Var Nigra) based on Digital Thermostat AC 220V XH-W3001 have excellent temperature accuracy in the drying process of black betel leaves as evidenced by the use of this tool in testing the device with a temperature of 40°C- 45°C.

Keywords: Oven, Drying, Temperature, Digital Thermostat, Black Betel Leaf.

INTRODUCTION

The rapid development of the manufacturing industry makes producers have to be smart in facing competition. Intense competition in the national market demands better quality of the products produced (Randa Imron et al., 2021). PT. Fajar Biofarmaka Nusantara or often called PT. FBION which is located in Karangpandan, Karanganyar. Central Java as one of the companies engaged in the traditional medicine industry. PT. FBION is on the development of black betel nut based products. Based on observations of existing production processes at PT. FBION still uses charcoal (manually) as a drying system. The results of traditional drying of black betel tend to produce products that are less uniform due to several factors, namely less stable temperatures and differences in the time in the drying process (Setyawan & Istiqlaliyah, 2021). The ideal drying temperature is in the temperature range of 40°C to 45°C.

Black betel is one type of betel plant which has many uses as medicine. Black betel leaves have special characteristics, namely the shape of the leaves resembles a heart, stems, dark green-black leaves and when held, the leaves feel thick and stiff (Maulidha et al., 2015). The thick and stiff leaf structure makes the black betel leaf production process take quite a long time, especially in the drying process. This drying is done to reduce the water content or moisture in the product. This is done to prevent microorganisms such as bacteria and fungi from making a product expired (Hakim et al., 2017). According to (Pin et al., 2009), the main consideration in drying herbs is to retain the phytochemicals that depend on the simplicia, most of which are very sensitive to heat. According to (Kumar et al., 2014), the use of higher temperatures can speed up the drying process but cause a

decrease in quality during the drying process, while the use of lower temperatures can maintain product quality but reduce the drying rate.

By looking at the various constraints above, we need a drying device with an automated system. In this study an automatic electric oven dryer was used. The advantages of using an automatic electric oven are that the drying process is faster, the temperature and drying time can be adjusted, and it is easy to control (Husna et al., 2017). The automatic electric oven used is based on an AC 220V Digital Thermostat which will read the temperature in the oven. Meanwhile, this 220V AC Digital Thermostat uses the XH-W3001 type because this tool can also be used for cooling applications.

The use of Digital Thermostat AC 220V XH-W3001 in drying ovens to improve temperature accuracy in the drying process of black betel leaves has not been widely carried out. In another study conducted by (Herlambang et al., 2021) regarding the design of the fuel preheater in diesel engines of inspection trains as an effort to reduce exhaust emissions by using a Digital Thermostat AC 220V XH-W3001 as a heating system, the results show that this Digital Thermostat can automatically cut off the flowing electric voltage. This automatic disconnection of the flowing electric voltage will later be used to adjust the drying temperature of black betel leaves in the temperature range of 40°C to 45°C as desired by PT. Fajar Biofarmaka Nusantara. Making this dryer is expected to help simplify the production process in the company.

RESEARCH METHOD

The research method used in data collection for this tool is the experimental method. The research was carried out to obtain a measuring tool for drying temperature of black betel leaves using an automatic electric oven based on the Digital Thermostat AC 220V XH-W3001.

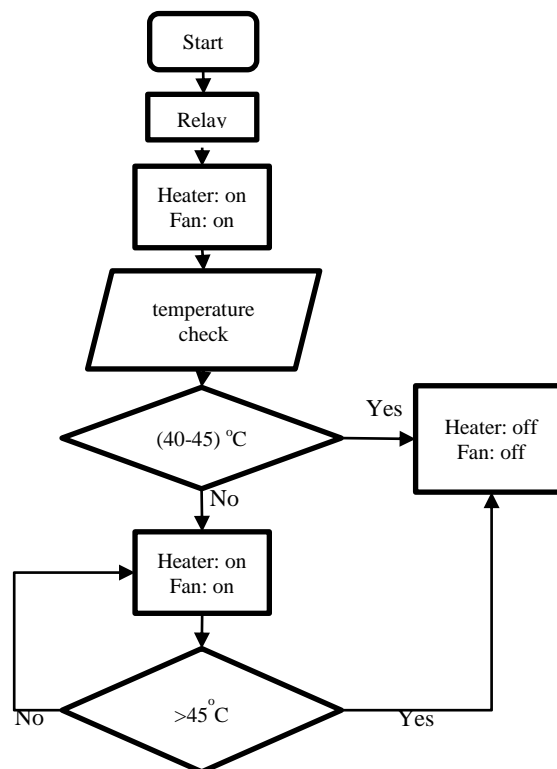


Fig. 1. Oven Working System Flow Chart.

In the process of designing this tool, a mature concept is needed as a design guide to support the components to be used. The design size of the tool to be used is 80 cm x 50 cm x 100 cm, thus the capacity of the black betel leaves contained during drying is ± 3 kg, where each rack is 1 kg. For the size of the shelves themselves 43 cm x 72 cm, there are 3 pieces.

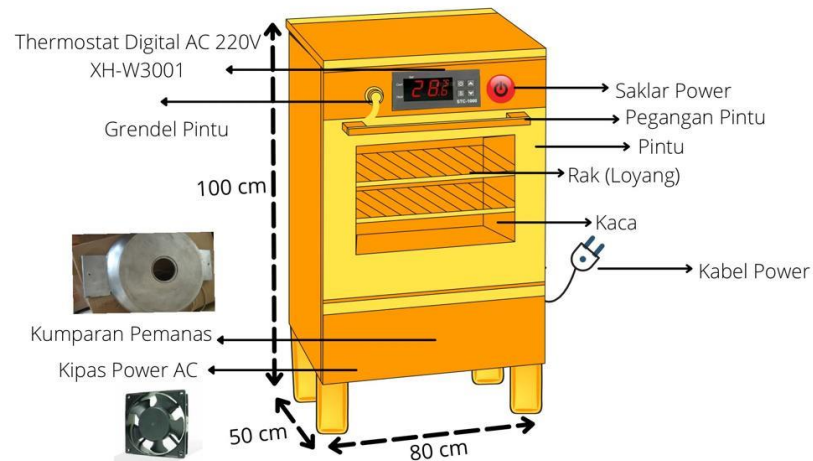


Fig. 2. Thermostat Based Oven Design.

In designing the electric current for the circuit system between the heating coil and the power fan are arranged in parallel, so if the oven is turned on, the heating coil and the power fan will turn on simultaneously, and vice versa. The heating coil and power fan will turn off if the temperature inside the oven is $>45^{\circ}\text{C}$, and will turn on again when the temperature in the oven is $<40^{\circ}\text{C}$ and in the temperature range of 40°C - 45°C . The temperature generated from the heating coil (heater) is controlled automatically via the Digital Thermostat AC 220V XH-W3001 to keep it stable. The sequence is as follows:

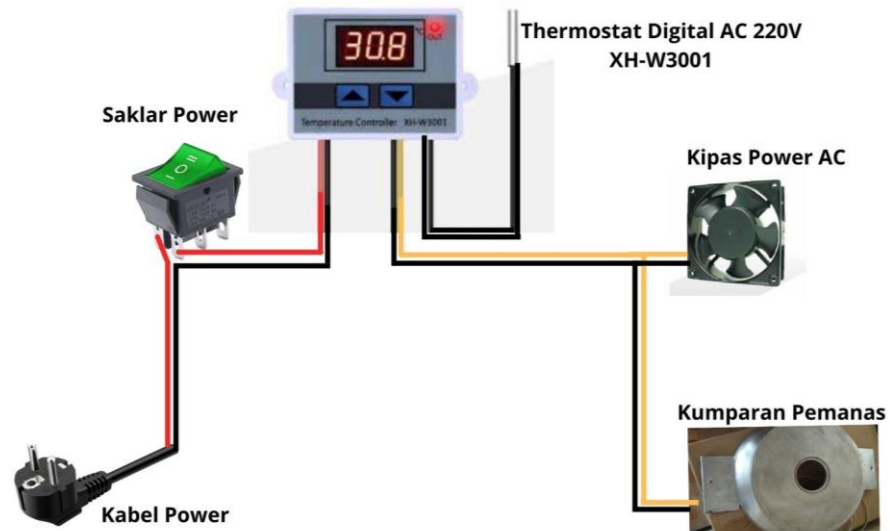


Fig. 3. Parallel Current Circuits.

There are several stages in the implementation of this research including planning, making tools, data collection, data analysis, and reporting. The following is an explanation at each stage of the research.

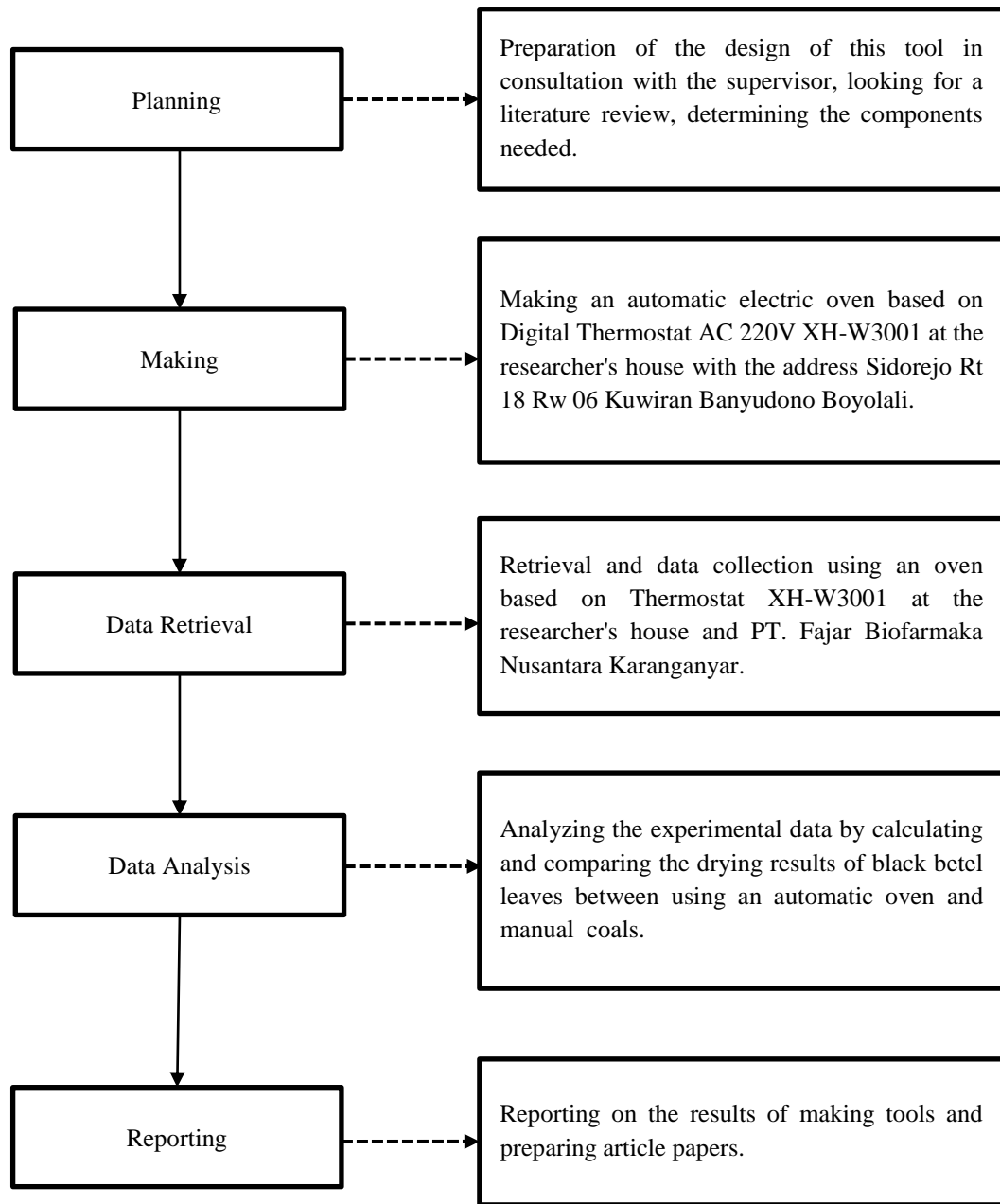


Fig. 4. Research Procedure.

The steps for collecting data for testing tools in this study are as follows: Make sure the oven is in the right condition, meaning here the CPU cable has been installed in the oven but don't plug it into the electric current first. Place the ingredients in the oven on a baking sheet and arrange the ingredients outside the oven to prevent the ingredients from falling into the oven. The baking sheet is then placed on the rack in the oven, and you can make sure the position of the pan is correct so that the door can be closed. Close the oven door as tightly as possible and lock the door with the two door latches. Plug the CPU cable into the wall socket by making sure the power switch button is off first before the cable is plugged in. Then after the cable is plugged in, the power switch button is pressed until it becomes on, and the thermostat will immediately detect the temperature in the oven. Set the thermostat according to the desired temperature, (the thermostat has two buttons, the left button or the up arrow indicates the button to set the lower limit of the existing temperature, the right button or the down arrow indicates the upper limit of the temperature to be set). The temperature is set by long pressing the buttons until the degree numbers change

automatically, then adjust the desired temperature by pressing the down and up buttons. Ensure that the user settings have been saved by the thermostat by waiting for the number of degrees on the thermostat to flash twice in about five seconds. The oven will automatically heat the ingredients to the temperature desired by the user. When the baking process is complete, turn off the switch and take the baking sheet and ingredients that are finished in the oven.

Data analysis is an activity of compiling and processing data obtained in research. The data analysis technique in this study was carried out by checking the drying temperature of black betel leaves in the temperature range of 40°C to 45°C indicated by the number of degrees on the Digital Thermostat AC 220V XH-W3001 when the oven was on. The trial technique in this study was by drying black betel leaves with a tool. For the drying process itself, it must be in the temperature range of 40°C to 45°C indicated by the number of degrees on the Digital Thermostat AC 220V XH-W3001 when the oven is on. Then the results of the drying process of black betel leaves can be seen according to a predetermined time.

RESULT AND ANALYSIS

1.1 Dryer



Fig. 5. Front View Tool.



Fig. 6. Side View Tool.



Fig. 7. Inside Look Tool.



Fig. 8. Power On Tool.

An electric oven based on the Digital Thermostat AC 220V XH-W3001 that is made can be used to dry black betel leaves to the desired temperature based on the heat around the sensor. Before drying, because the power cable is separate from the oven, it needs to be connected to the cable socket at the back of the oven first, then connected to the mains voltage. The way to make this tool is to focus on the Digital Thermostat AC 220V XH-W3001 as a controller for the drying process of black betel leaves. This type of thermostat has three cables with different functions, which include a red-black input cable, a black-yellow output cable and a temperature sensor cable. These three wires are located sequentially as shown by the following figure.



Fig. 9. XH-W3001 Thermostat Components.

The input cable serves as access to the mains voltage source. Then the output cable serves as access to the heating coil and fan power. The heating coil and the power fan in this oven are connected in parallel, so they will turn on and off simultaneously according to a predetermined temperature. While the temperature sensor cable functions to read the temperature around the sensor.

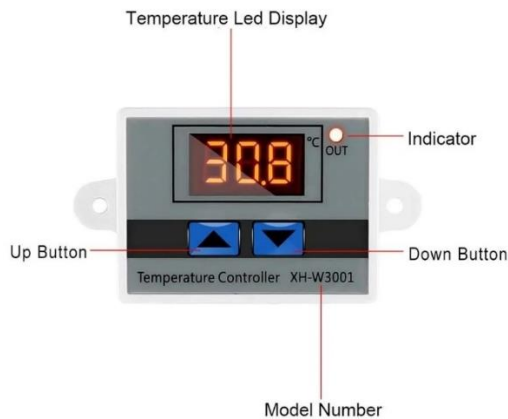


Fig. 10. XH-W3001 Thermostat Feature Button.

How to operate the XH-W3001 AC 220V Digital Thermostat, namely by pressing the existing features. This type of thermostat has two button features, namely the lower limit button and the upper limit button. The lower limit button is an up arrow symbol, while the upper limit button is a down arrow symbol.

After determining the lower limit temperature and upper limit temperature, the oven will execute the command according to the set temperature. Room temperature is the initial temperature read by the sensor cable. Then the temperature will rise when the heating coil and power fan turn on until the desired upper limit temperature. When the temperature is at the upper limit or exceeds the upper limit, the heating coil and power fan will turn off. Both will turn on again when the temperature in the oven has reached the specified lower limit.

Digital Thermostat Calibration AC 220V XH-W3001 is carried out so that the temperature value read by this thermostat corresponds to the actual value based on a standardized tool. The calibrator used is a digital thermometer type HTC-1. With the same initial temperature source (room temperature), the temperature reading values of the HTC-1 type digital thermometer and the Digital AC 220V XH-W3001 Thermostat that have been made are compared. Calibration data collection was carried out five times in accordance with the number of tool trials carried out. This XH-W3001 AC 220V Digital Thermostat Calibration is carried out when the temperature sensor is still at room temperature and data is generated below.

Table 1. Calibration Results of Digital AC 220V XH-W3001 Thermostat.

Test	Temperature (°C)		Temperature Changes (°C)
	Thermostat XH-W3001	Thermometer HTC-1	
1	28,8	28,5	-0,3
2	29,2	29	-0,2
3	28,6	28,5	-0,1
4	29,8	29,5	-0,3
5	30,2	30	-0,2

The table above shows the results of the calibration of the accuracy of the Digital Thermostat AC 220V XH-W3001 temperature sensor for measuring room temperature. It can be seen that the initial temperature reading (room temperature) made by the Thermostat XH-W3001 is greater between 0 to 1 ($0 < x < 1$) than the standardized tool, namely the HTC-1 type digital thermometer. Therefore it is necessary to change the initial temperature on the XH-W3001 Thermostat so that the temperature reading is the same as the HTC-1 thermometer. The method for calibrating the XH-W3001 Thermostat is by simultaneously pressing the lower limit button and the upper limit button, then adjusting the temperature by increasing or decreasing the temperature so that it is the same as the temperature on the HTC-1 thermometer. This calibration is done before the oven is used to dry black betel leaves.

1.1.1 Comparison with Previous Ovens

Table 2. Comparison of Oven Types Based on Specifications.

Test Type	Oven Type	
	PT FBION's conventional oven	Oven based Digital Thermostat AC 220V XH-W3001
Baking Capacity	500 gram	3 – 4 Kg
Lots of Baking	3 rack	3 rack
Shelves Burning Time	15 – 20 minute	50 – 60 minute
Fuel	Gas	Electricity
Heating Source	Fire	Heater
Temperature Control	Manual Gas Regulator Faucet	Digital Thermostat AC 220V XH-W3001
Temperature Indicator	Analog	Digital
Auto Cooling	There isn't any	Kipas Power
Auto Power Off	There isn't any	Available
Baking Ingredients	Stainless Steel	Plywood

The table above shows a significant difference from the two ovens that have been tested. In terms of the drying capacity of black betel leaves, the resulting difference can be seen. In the conventional oven owned by PT. FBION is only able to dry 500 grams of betel nut in one production by loading three drying pans on baking trays where the estimated drying time is 15 to 20 minutes. Meanwhile, an oven based on Digital Thermostat AC 220V XH-W3001 has a drying capacity of 3-4 kg of betel nut. black by loading three baking sheets for the drying process, where the temperature is stable temperature controlled by the XH-W3001 type thermostat, the oven will automatically turn off when the temperature has exceeded the desired temperature. For drying estimation, an oven based on Digital Thermostat AC 220V XH-W3001 uses a drying time ranging from 50 minutes to 60 minutes, and every black betel leaf drying that is done using this oven can make it easier for employees to work.

From the comparison that has been made to the conventional oven owned by PT. FBION with an oven based on Digital Thermostat AC 220V XH-W3001, the comparison of the efficiency values for black betel leaf drying time and the amount of production can be seen in the graph below.

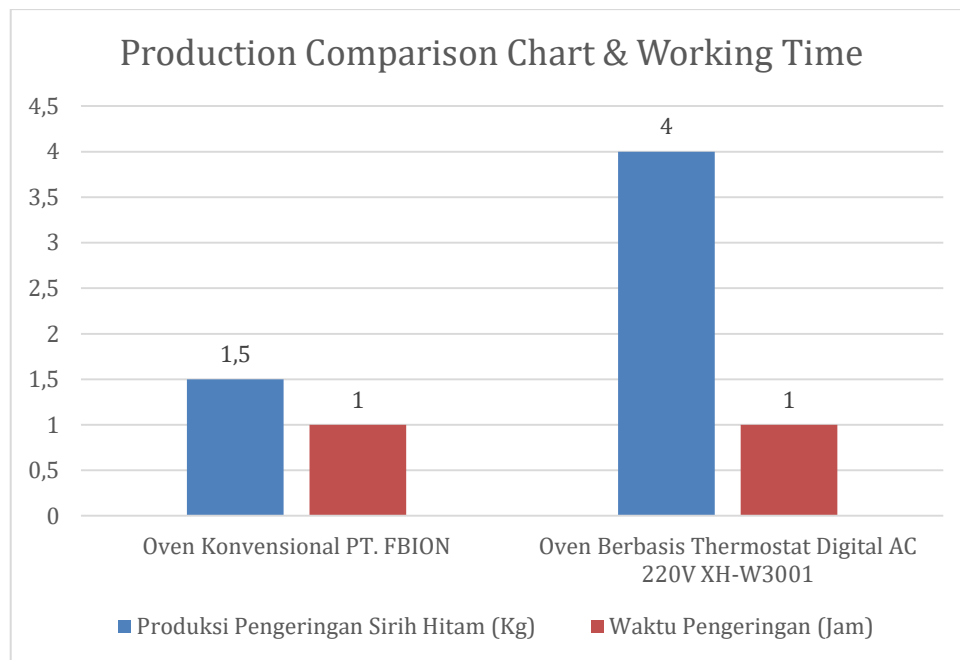


Fig. 11. Production Comparison Chart & Working Time.

The graph above shows the level of drying production which is marked with a blue histogram graph and the drying time is marked with orange color. It can be seen that there is a significant difference in the production of black betel drying between using conventional ovens from PT. FBION with Digital Thermostat AC 220V XH-W3001 based oven. In a conventional oven from PT. FBION, can only produce 1.5 kg of black betel drying in 1 hour. Whereas in an oven based on Digital Thermostat AC 220V XH-W3001 it can produce 4 kg of black betel drying with the same estimated time of 1 hour. Therefore, it indicates that an oven based on Digital Thermostat AC 220V XH-W3001 is worthy of replacing the conventional oven at PT. FBION before, because it is very efficient for use by PT. FBION is in the process of drying large quantities of black betel leaves in each of its daily production processes.

1.1.2 Comparison with Oven Now

The results of the comparison between the ovens in PT. FBION's 220V AC Digital Thermostat XH-W3001 based oven is quite a lot better than the company's ovens. As a follow-up to the development of this tool, it is necessary to have a comparison with the types of ovens currently sold in the market, namely the microwave. Based on the situation, there are several advantages and disadvantages between this developed tool and the newest type of microwave. The microwave provides many of the latest features that can be used by users automatically in the form of automation of temperature, time, humidity and even the drying and cooking processes. In addition, there is also a digital clock that is attached to the outside of the microwave to see the time.

The XH-W3001 AC 220V Digital Thermostat based oven has a larger capacity than the current electric ovens sold in the market. This large enough capacity turns out to require less power than today's electric ovens. The selling price of ovens on the market today is also more expensive than the production costs incurred for making this tool. This makes a dryer based on Digital Thermostat AC 220V XH-W3001 feasible to be developed.

1.1.3 Superiority

This tool has a large enough capacity in the drying process when compared to the existing oven at PT. FBION and electric ovens are now being sold in the market. This is proven by the capacity of this oven which reaches 3-4 kg, while the gas oven at PT. FBION and electric ovens now only hold 0.5-1 Kg. Therefore, this tool is very suitable for producing a product in relatively large

quantities. The temperature that can be adjusted automatically makes the advantages of this tool. While in some companies there are still many who use ovens with manual temperature settings, one of which is the oven at PT. FBION Karanganyar. Automatic temperature regulation in an oven is a new breakthrough in the industrial world, especially in the traditional herbal medicine industry from black betel leaves. The process of drying black betel leaves to become traditional herbal medicine requires drying equipment that can stabilize temperatures in the range of 40°C-45°C. This tool can be used to dry products automatically according to the desired temperature up to a maximum of 105°C. The process of operating this tool is also relatively easy because this oven does not have many buttons. This tool only has three buttons, namely the power switch button to turn the oven on and off, the upper limit button to set the upper temperature limit, and the lower limit button to set the lower temperature limit in the drying process. So if there is someone who wants to use this tool, it can be said that they will quickly understand how this tool works. A tool certainly has a work risk if used, as is the case with this 220V XH-W3001 AC Digital Thermostat based oven. Even though it has a work risk, this tool can be said to have a small work risk when compared to the dryers in PT. FBION. This is proven by the fact that the frame of the oven is made of an insulating material, so the limbs will not feel hot if they are unconsciously touching them. Making an oven from an insulating material will also not be flammable because the temperature used in the drying process is relatively low, which is below 45°C.

1.1.4 Weakness

The drying process carried out by this tool is quite long, because this tool only has one heating component and one fan component, so the air in the oven takes time to spread and reach the desired temperature. The large storage capacity also makes this oven extra necessary in drying. In addition, the framework made of insulating material is very slow in conducting heat, so the time needed to increase the temperature is of course also long. The 220V AC Digital Thermostat with type XH-W3001 is a thermostat for millions of people that is often used and easily accessible. This type of thermostat has only two buttons, namely the upper limit button and the lower limit button. Unlike the XH-W3002 type which has three buttons, namely the upper limit button, the lower limit button, and the automatic calibration button. Because it does not have an automatic calibration button feature, the calibration process is carried out for this thermostat manually by pairing it with a calibrator in the form of a standardized thermometer.

1.2 Tool Trial Results

Table 3. Results of Drying Black Betel Leaves.

P	LP	SP	SR	NH	LN	TN
1	50-60	40-45	28	3	12	36
2	50-60	40-45	29	3	11	33
3	50-60	40-45	28,5	3	13	39
4	50-60	40-45	29	3	12	36
5	50-60	40-45	30	3	13	39

Information:

P : Experiment

LP : Trial time (minutes)

SP : Drying temperature (°C)

SR : Room temperature (°C)

NH: How many times does the heater turn on (X)

LN: The duration of the heater is on 1 time (minutes)

TN: Total duration of heater on (minutes)

The test of the tool was carried out 5 times with a time of 50-60 minutes at a temperature of 40oC-45oC for each trial. Trial 1 was carried out with an initial temperature (room temperature) of 28°C. In this experiment it was found that the heater was turned on 3 times. The duration of the heater on

for one time is 12 minutes. While the total duration of the heater flame is 36 minutes. Trial 2 was carried out with an initial temperature (room temperature) of 29°C. In this experiment it was found that the heater was turned on 3 times. The duration of the heater on for one time is 11 minutes. While the total duration of the heater flame is 33 minutes. Trial 3 was carried out with an initial temperature (room temperature) of 28.5°C. In this experiment it was found that the heater was turned on 3 times. The duration of the heater on for one time is 13 minutes. Meanwhile, the total duration of the heater flame is 39 minutes. Trial 4 was carried out with an initial temperature (room temperature) of 29°C. In this experiment it was found that the heater was turned on 3 times. The duration of the heater on for one time is 12 minutes. While the total duration of the heater flame is 36 minutes. Trial 5 was carried out with an initial temperature (room temperature) of 30°C. In this experiment it was found that the heater was turned on 3 times. The duration of the heater on for one time is 13 minutes. Meanwhile, the total duration of the heater flame is 39 minutes.

CONCLUSION

The way to make a black betel leaf dryer (piper betle var nigra) based on the Digital Thermostat AC 220V XH-W3001 is by connecting the heating coil, power fan and digital thermostat, then when the temperature is at the upper limit or exceeds the upper limit, the heating coil and the power fan will turn off, both will turn on again when the temperature in the oven has reached and exceeds the specified lower limit. The trial results of the black betel leaf dryer (piper betle var nigra) based on Digital Thermostat AC 220V XH-W3001 have excellent temperature accuracy in the drying process of black betel leaves as evidenced by the use of this tool in testing the device with a temperature of 40°C-45°C, So this tool is feasible to use.

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Syahreza Figo Perdana

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