# Design and Construction of Automatic Salted Fish Drying Device Based on Microcontroller

Milda Yuliza [a,1,*], Yultrisna [a,2], Efrizon [a,3], Adi Chandranata [a,4], Ella Kurnia [a,5]

[a] *Electronic Engineering Department, Politeknik Negeri Padang, Limau Manis, Padang, 25164, Indonesia*
*E-mail: milda@pnp.ac.id*
**Corresponding Author*

**A B S T R A C T S**

An Automatic Salted Fish Dryer controlled by a microcontroller has been made based on a drying process that takes a long time, which is around 3-4 days and the weather is also sometimes unpredictable, thus inhibiting the productivity of making salted fish. The purpose of this study is to design a salted fish dryer that can work automatically to speed up the drying process of salted fish by maintaining a temperature that does not exceed 45 ° C to obtain a salted fish humidity of 40%. The research method starts from making a prototype and measuring system performance. The results of measuring the performance of drying salted fish using an automatic salted fish dryer are faster than the traditional method which requires a drying time of 3-4 days. By using an automatic dryer, it only takes 3-5 hours of drying and can reduce fish humidity by up to 40%, in accordance with SNI with a maximum drying temperature of 45 ° C. The DHT22 sensor is used to measure temperature and humidity, which is then displayed on the LCD. Overall, the tool can function well. Suggestions for further research, Hybrid energy sources can be added and condition monitoring can be done via the Internet of things (IoT).

**K E Y W O R D S**

*Salted Fish, Dryer, Heater, DHT22 Sensor, Buzzer, Microcontroller.*

## 1. INTRODUCTION

Indonesia is an archipelagic country, based on the Geospatial Information Agency, 70% of Indonesia's territory is ocean with a coastline of 99,093 km [1]. Indonesia has abundant marine economic resources, especially fisheries resources, which can be developed and can contribute to national income and the welfare of the community, especially fishermen [2]. One of the popular uses of fishery products in Indonesia is by preserving fish using salt, commonly called salted fish [3]. On a national scale, salted fish is a fishery product that has an important position, it can be seen that almost 65% of fishery products are still processed and preserved by salting [4]. The Indonesian government has designated salted fish as one of the nine staple foods of the public [5]. This shows that salted fish is not only popular with the lower class, but also the middle and upper classes. The attraction of this salted fish lies mainly in its distinctive taste, aroma and texture [6]. Currently, there is a salted fish processing industry but it still uses traditional methods in the drying process, one of which is in the Pasir Jambak Beach area. The drying process takes a long time, which is around 3-4 days and the weather is also sometimes unpredictable, thus inhibiting the productivity of making salted fish. Moreover, because it uses traditional methods that are exposed to dust and flies that directly touch the fish, it causes a lack of fish hygiene quality [7]. Based on these problems, this study created an automatic microcontroller-controlled salted fish dryer. This fish dryer works automatically using microcontroller control. Related research has been conducted previously, a study conducted by, using a DHT sensor and an Arduino microcontroller to control the temperature and humidity of anchovies. This research was conducted systematically starting from the process of making a dryer equipped with solar panels and a controller system and a rack for drying anchovies made in a portable form [8], [9].

The results of the study showed. The automation of the controller system used in this dryer works well when reading both the temperature and humidity of the drying room. Similar studies were also conducted by, using heating elements as a source of heating the drying rack, and fans as air circulation stabilizers, and LM35 temperature to determine the temperature inside the drying rack and Arduino Uno as a microcontroller programmed to run the system, the results of the study showed that drying Mackerel takes 2 to 3 hours, and drying anchovies takes 1 to 2 hours [10], [11]. Using charcoal fuel, research conducted by a fish dryer made with a capacity of 5 kg, dimensions of 100 cm long, 50 cm wide, and 90 cm high which has holes with a diameter of 1 cm with a total of 6 pieces that function to channel the remaining heat and evaporate water as a result of the drying process that occurs in the drying room, the results of the study showed that this dryer works well, taking 2 to 3 hours [12], [13], [14]. The purpose of this study is to design a salted fish dryer that can work automatically to speed up the drying process of salted fish by maintaining a temperature that does not exceed 45 ° C to obtain a humidity of salted fish of 40%. It is hoped that this research can overcome drying problems such as the length of drying time and also the quality of the salted fish produced [15].

## 2. RESEARCH METHODOLOGY

### *2.1 System Design*

Overall, this tool consists of important parts that are interrelated with each other, namely hardware and software. These two parts must be synchronized with each other so that the intent and purpose of making this tool is achieved and in accordance with expectations. The block diagram of the automatic salted fish drying machine system can be seen in Figure 1 and the control block diagram is shown in Figure 2.

Based on Figure 1 and Figure 2, the working principle of this automatic salted fish dryer is that the fish that are still wet and have been salted will later be arranged in such a way on each rack in the dryer. Inside the dryer there is a heating element or heater with a maximum temperature of 45 ° C which has been set in the program that functions to produce a heat source for the fish dryer. On the rack there is a DHT22 sensor that functions to measure the temperature and humidity in the salted fish dryer. The results of the temperature and humidity measurements read by the DHT22 sensor will later be displayed on the LCD screen. This fish dryer works automatically which has been controlled as a whole by the Arduino Uno microcontroller which if the humidity of the fish in the dryer has reached the desired humidity standard, the device will automatically turn off accompanied by the sound of a buzzer and the appearance of the word finished on the LCD. The ideal humidity standard for salted fish according to SNI 01-2721-1992 is a maximum of 40%. And to evenly dry the fish in the dryer, a fan is installed on each fish rack. Table 1 below is a design system for the work of the automatic salted fish dryer.

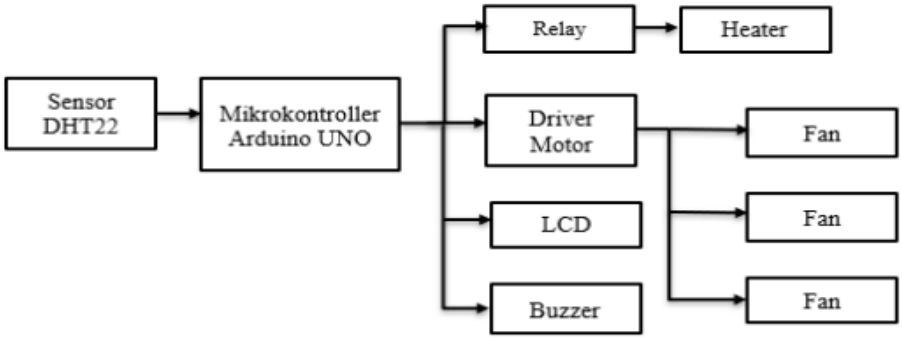


**FIG 1.** System Block Diagram

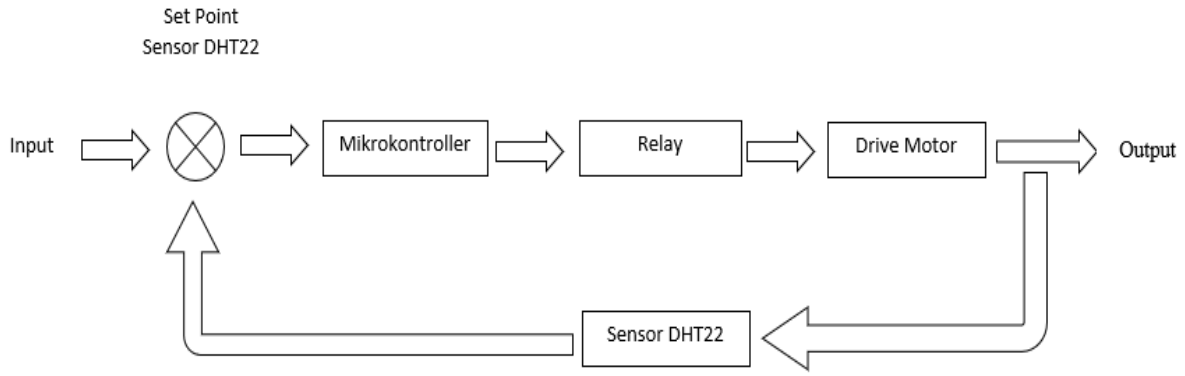


**FIG 2**. Control Block Diagram

**TABLE 1**. Design of Automatic Salted Fish Drying System

| Description | Condition | LCD Display |
|---|---|---|
| Temperature ≤ 32°C | Heater ON<br>Fan OFF<br>DHT22 ON | Temperature (°C)<br>Humidity (%) |
| Temperature< 45°C | Heater ON<br>Fan normal<br>DHT22 ON | Temperature (°C)<br>Humidity (%) |
| Temperature ≥ 45°C | Heater OFF<br>Fan Maksimum<br>DHT22 ON | Temperature (°C)<br>Humidity (%) |
| Temperature = 40% | Buzzer ON<br>Heater OFF<br>Fan OFF<br>DHT22 OFF | DONE |

*2.2. Hardware Design*

In hardware design, this is realized in the form of an electronic circuit. This design is carried out in stages for each existing component. Figure 3 shows the overall wiring design of the automatic salted fish dryer. Based on Figure 3, the power supply functions as the main voltage source for all 2-level circuits. The CT transformer used in this power supply is 5 Ampere and the voltage output is made in 2 pieces, namely +5V DC and +12V DC. This output has been regulated using the IC 7805 only because the +12V DC output comes directly from the CT Transformer. The DHT22 sensor is used to measure the temperature and humidity in the automatic fish drying machine during the drying process. Which later the data read by the DHT22 sensor will be sent to the Arduino Uno and the results read will be displayed on the LCD. The DHT22 sensor has 4 pins. The pins are connected to the microcontroller. Pin1 (Vcc) on the DHT22 sensor is connected to the +5V Arduino Uno pin, pin 2 (data output) on the DHT22 sensor is connected to pin 7 of the Arduino, pin 3 (N/C) on the DHT22 sensor is removed or not connected and pin 4 (GND) on the DHT22 sensor is connected to the GND pin on the Arduino. This relay circuit is used to activate and deactivate the heater. So the heater will not always be on to produce heat. In this automatic salted fish dryer, the relay functions to activate the heater and deactivate the heater when the temperature read in the dryer shows = 45°C and will be active again if the temperature is below 45°C. Basically, this circuit will be active when the Arduino provides data in the form of voltage output from the pin connected to the relay circuit. Then this voltage will enter the relay which will trigger movement of the magnet in the relay itself. When the magnet has shifted, the heater will be active.

The LCD functions as a display of temperature and humidity detected by the DHT22 sensor in the automatic fish dryer during the drying process. This automatic salted fish dryer uses a 16x2 LCD. There are 16 pins on the LCD. These pins will be connected to the I2C module. The use of this I2C module is to save the use of digital pins on the microcontroller. To activate the LCD that has been connected to the I2C module, only 4 pins are used. Pin 1 (Gnd), pin 2 (Vcc) Pin3 (SDA) and pin 4 (SCL). Pin 1 (Gnd) on the I2C module is connected to the Gnd pin on the microcontroller. Pin 2 (Vcc) on the I2C module is connected to the 5V pin of the microcontroller. Pin 3 (SDA) on the I2C module is connected to pin A4 on the microcontroller. Pin 4 (SCL) on the I2C module is connected to pin A5 on the microcontroller. DC fan is used to regulate air circulation in the automatic salted fish dryer when the fish is drying, where the fan rotation or speed is regulated by the L298N motor driver via the Arduino Uno microcontroller. When the temperature is read at 45 ° C, the fan rotates at a maximum speed of 225 RPM. And if the temperature is below 45 ° C, the fan rotation is normal. Pin out 1 on the motor driver is connected to the fan. While other pins such as the GND pin are connected to the GND pin on the Arduino and the IN1 pin is connected to the D10 pin on the Arduino Uno, then the Vcc pin on the motor driver is connected to the +5V pin on the Arduino. In this automatic salted fish dryer, the buzzer functions as a marker that the salted fish drying process is complete. The completion of the salted fish drying process occurs if the humidity read by the DHT22 sensor has reached 40%, then the buzzer is active and all drying elements such as the heater, fan and DHT22 sensor will turn off. The buzzer has 2 legs / pins, namely the Vcc pin and the GND pin.

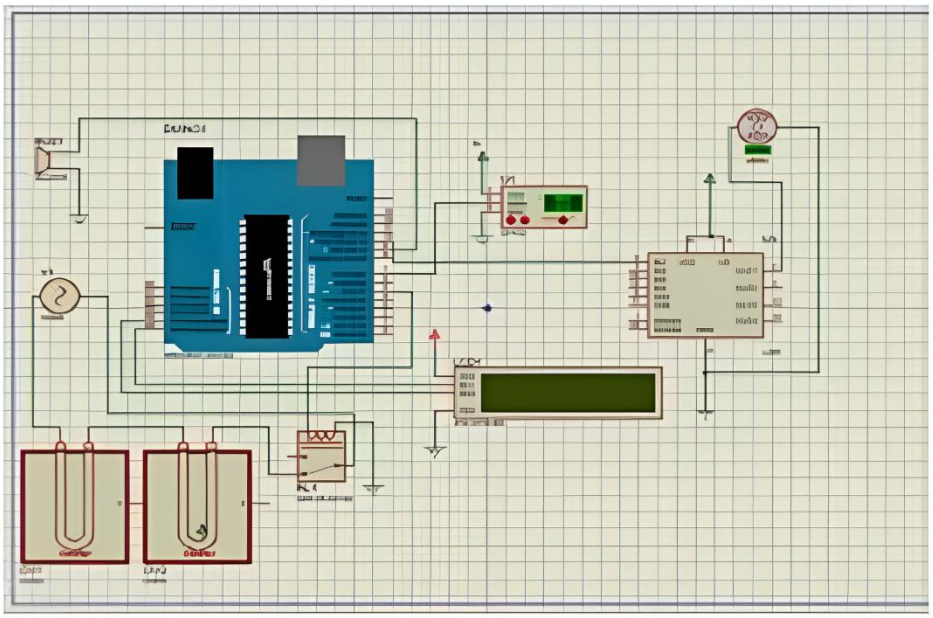

**FIG 3.** Electronic circuit configuration for automatic salted fish drying.

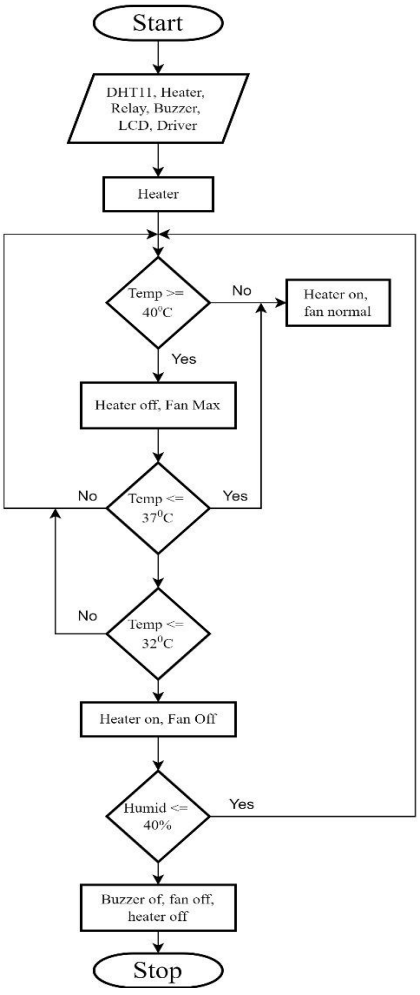


**FIG 4**. Tool Work Flowchart

*2.3. Software Design*

Software design consists of programs and flowcharts. To design software must start by making a flowchart to understand how the tool works. Based on Figure 4 the process starts from the initialization of the DHT22 sensor, relay, buzzer and heater, then the heater compares the detected temperature, if the temperature ≥ 45$^{O}$C then the heater is OFF, the FAN rotates to the maximum, If the temperature ≤ 37$^{O}$C then the heater is ON, the FAN rotates Normally. If the temperature ≤ 32$^{O}$C the heater is ON, the FAN is OFF and if the humidity ≤ 40% then the buzzer is ON, the FAN is OFF, the heater is OFF

*2.4. Designing the Mechanical Shape of Tools*

This automatic salted fish dryer is designed with a height of 120 cm, a length of 80 cm and a width of 50 cm. This tool is in the form of a box with three shelves inside the tool which will later be used to place the salted fish to be dried. This tool is made using a plate with a thickness of 1 mm. This tool can accommodate a maximum of 2 kg of wet fish for one drying. The mechanical image of the automatic fish dryer is shown in Figure 5.

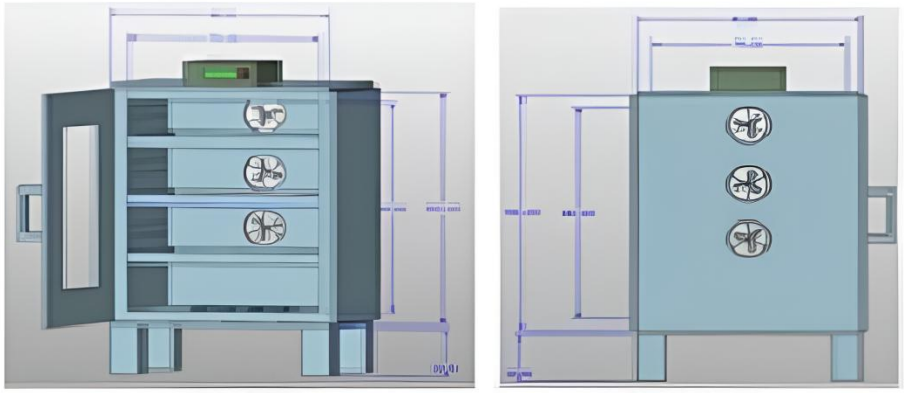

**FIG 5.** Mechanical Design of Automatic Salted Fish Dryer

## 3. RESULTS AND DISCUSSION

The purpose of testing and measuring this tool is to see whether each circuit block in the measured system is as expected, then the results of the testing and measurement are used as data that will later be analyzed. From the results of the testing and measurement, evaluation and improvement of the system can be carried out to obtain maximum results. The prototype of the tool is shown in Figure 6. The testing consists of (i) Arduino Uno Microcontroller Testing, (ii) DHT22 Sensor Testing, (iii) Relay Circuit Testing, (iv) Buzzer Testing, (v) Overall Testing

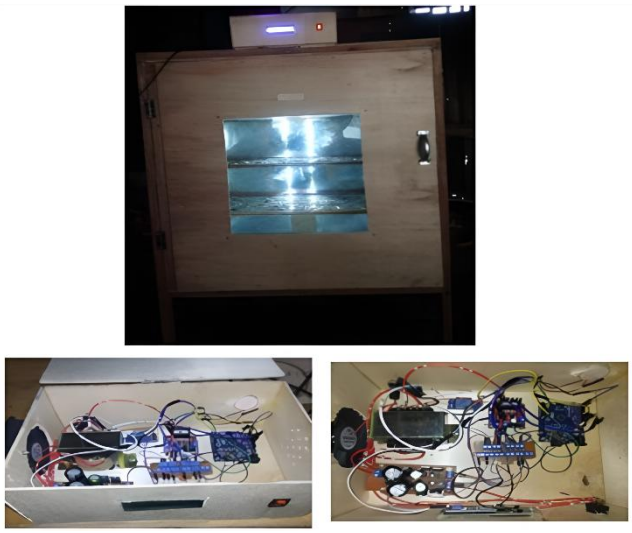

**FIG 6.** Prototype and tool sequence

*3.1. DHT22 Sensor Testing*

Testing was conducted to determine the operation of the DHT22 sensor. Testing was conducted when the DHT22 sensor was connected to a voltage source to detect the temperature of the fish drying room. The measurement points on the DHT22 sensor are at the output pin and the GND pin on the DHT22 sensor. The results of the sensor measurements are shown in Table 2.

**TABLE 2.** DHT22 Sensor Measurement Results

| Condition | Voltage | |
|---|---|---|
| OFF | 0,0 Volt | 0,0 Volt |
| ON | 5,09 Volt | DHT22 sensor reads temperature and humidity |

This test is done by connecting the microcontroller to a 5V power supply. From the data obtained, the DHT22 sensor voltage in an active or on state is 5.09 Volts and 0.0 Volts when the sensor is off. In an active state, the DHT22 sensor will read the temperature and humidity in the salted fish dryer where the temperature and humidity values will be displayed on the LCD. To see the accuracy of the temperature reading on the DHT22 sensor, a comparison of the temperature reading data between the DHT22 sensor and the Thermometer is carried out. Comparison of temperature reading data between the DHT22 sensor and the Thermometer can be seen in Table 3.

**TABLE 3.** Comparison of DHT22 Sensor Data with Thermometer

| Sensor measurements DHT22 | Thermometer measurements | Error (%) |
|---|---|---|
| 33.10 °C | 33.50 °C | 0,01 % |
| 36.30 °C | 36.40 °C | 0,002 % |
| 38.10 °C | 38.70 °C | 0,01 % |
| 40.00 °C | 40.40 °C | 0,009 % |
| Error Rate/Average | | 0,031 % |

Based on Table 3, the DHT22 sensor has a low error rate of 0.031%. So it can be said that the temperature reading on the DHT22 sensor is accurate.

*3.2 Relay Testing*

Testing is done on the relay circuit on the tool by activating the circuit and deactivating the circuit. When the circuit is in an active or inactive condition, the voltage will be measured at the connection point between the heater and the relay. The test results are shown in Table 4.

**TABLE 4.** Relay Test Results

| Condition | Voltage Read | Relay Condition |
|---|---|---|
| NC | 0,6 Volt | ON |
| NO | 4,98 Volt | OFF |

When the relay is in NC (normally closed) condition, the relay is in low condition and logic 1 (active) with a voltage of 0.6V. This relay is connected to the heater. While when the relay is in NO (normally open) condition where the relay will be logic 0 (not active) and the voltage read is 4.98V. It can be said that the relay will be active in low condition or at small or low voltage.

*3.3 Buzzer Testing*

The buzzer functions as an indicator or warning alarm when the drying process is complete, which is indicated by the amount of humidity read by the DHT22 sensor, which is 40%, so that it can make it easier for us to know that the drying process of salted fish is complete. Furthermore, testing the buzzer circuit is carried out using a multimeter also aims to determine the voltage conditions when the buzzer is used as a warning alarm. The measurement results are shown in Table 5.

**TABLE 5.** Buzzer Measurement Results

| Buzzer Condition | **Voltage Read** | **Logic** | **Description** |
|---|---|---|---|
| OFF | 0,0 V | 0 | Fish drying is still in progress |
| ON | 4,8 V | 1 | Fish drying already finished |

From the measurement data results in Table 5, the buzzer is active if given high logic (1), and the voltage on the buzzer when active is 4.8V. The buzzer will be active when the humidity read by the DHT22 sensor is 40% which indicates that the drying process of salted fish is complete.

*3.4 Testing of Salted Fish*

In addition to measuring temperature, the DHT22 sensor also functions as a humidity meter. The DHT22 sensor is used to measure the temperature and humidity inside the salted fish dryer during drying. The standard for humidity of salted fish is taken according to SNI 2721.2: 2009. The humidity value of salted fish according to SNI is a maximum of 40%. The length of time for drying salted fish is influenced by temperature, the amount of water content in the fish, and the thickness of the fish meat itself. During the drying process, heat is transferred from the drying medium to the material and also the transfer of water mass. The heat that causes changes in the mass of water from the material is due to the heat of evaporation. This change in water mass occurs when the water content in the fish has reached a saturated condition, causing the water contained in the fish to change from a liquid phase to vapor. Table 6 below is a table of experiments on drying salted fish with a maximum temperature of 50 ° C.

**TABLE 6.** Experiment of drying salted fish with a maximum temperature of 50°C.

| **Time** | **Temperature** | **Humidity** |
|---|---|---|
| 0 | 28.10°C | 75. 20 % |
| 30 minute | 36.40°C | 58.40% |
| 60 minute | 43.20°C | 51.10% |
| 90 minute | 45.80°C | 45.70% |
| 120 minute | 47.60°C | 40.00% |
| **Temperature Rate/Average** | | **40.22°C** |

**TABLE 7.** Drying of Anchovies with a Maximum Temperature of 50°C

| **Time** | **Temperature** | **Humidity** |
|---|---|---|
| 0 | 28.40°C | 85.30% |
| 1 hour | 37.20°C | 63.20% |
| 2 hour | 40.10°C | 63.20% |
| 3 hour | 40.10°C | 48.10% |
| 4 hour 20 minute | 48.50°C | 40.00% |
| **Temperature Rate/Average** | | **40.06°C** |

**TABLE 8.** Comparison of Traditional Drying Methods and Automatic Drying Equipment

| **No** | **Drying method** | **Temperatur** | **Fish Thickness** | **Drying Time** | **Water Rate** |
|---|---|---|---|---|---|
| 1 | Traditional with Solar thermal | 30-42°C | 6 mm | 2-3 Days | 40% |
| 2 | Automatic Dryer | 38-40°C | 6 mm | 1-8 hours | 40% |

In Table 6 and Table 7, it is found that the drying time of salted fish with a maximum temperature setting of 50°C can speed up the drying time of salted fish, which is 2 hours and minutes for drying taneman fish and 4 hours 20 minutes for anchovies with an average drying temperature of taneman fish of 40.22°C and an average drying temperature of anchovies of 40.06°C. However, the texture of the salted fish produced is not good, where the outside of the fish is dry but the inside of the fish is still wet. That is why in the next salted fish drying experiment, only a temperature of no more than 45°C was used to obtain salted fish with good texture and quality. Therefore, it is recommended not to exceed 45°C for drying salted fish in order to obtain good quality salted fish. Table 8 is a comparison table of drying salted fish in the traditional way and using an automatic dryer.

## 4. CONCLUSION

Based on the test results and analysis of the automatic microcontroller-based salted fish dryer, the conclusion is as. Drying salted fish using an automatic salted fish dryer is faster than the traditional method which requires a drying time of 3-4 days. By using an automatic dryer, it only takes 3-5 hours of drying and can reduce fish humidity by up to 40%, in accordance with SNI with a maximum drying temperature of 45 ° C.

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