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Design and Manufacture an Automatic Mushroom Sprinkler based Internet of Things to Increase Oyster Mushroom Productivity

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ABSTRAK

Jamur tiram merupakan salah satu bahan makanan non kolesterol yang bergizi tinggi dan banyak diminati oleh masyarakat. Selain itu, jamur tiram memiliki harga yang jauh lebih murah daripada daging ayam dan daging sapi. Dalam budidaya jamur tiram, suhu dan kelembaban merupakan faktor penting dalam keberhasilan budidaya. Suhu optimum untuk pertumbuhan jamur tiram adalah 16-25°C dan kelembaban ruangan ideal yang dibutuhkan adalah 80%-90%. Cara menjaga suhu kelembaban adalah dengan melakukan penyiraman atau pengkabutan. Saat ini masih banyak petani yang menggunakan sistem penyiraman secara konvensional yang tidak praktis, sehingga saat musim kemarau, produktivitas jamur tiram cenderung menurun karena kondisi cuaca yang panas dan perlu dilakukan penyiraman secara intens. Berdasarkan hal tersebut, perlu dikembangkan alat penyiraman jamur yang otomatis dan efisien. Metode penelitian yang digunakan adalah *Research* and *Development* (*R&D*). Hasil yang dicapai adalah rancang bangun alat penyiram jamur otomatis berbasis kontrol suhu dan kelembaban. Alat penyiram jamur otomatis ini memiliki komponen *blower*, piezoelektrik, mikrokontroller ATMega 16, sensor suhu DHT11 dan fitur *internet of things* (*IoT*). Kesimpulan pada penelitian ini adalah terciptanya alat penyiram jamur otomatis yang efisien dan mudah digunakan. Selain itu, hasil implementasi alat ini pada tempat budidaya dapat meningkatkan produktivitas jamur tiram mencapai 34,51%.

Kata kunci:
Alat Penyiram; Internet of Things; Jamur Tiram; Kelembapan; Suhu.

ABSTRACT

Oyster mushroom is one of the non-cholesterol food ingredients that have high nutrition and high demand by the public. In addition, oyster mushroom has a much cheaper price than chicken and beef. In the cultivation of oyster mushrooms, temperature and humidity are important factors in the success of cultivation, the optimum temperature for the growth of oyster mushrooms is 16-25°C and the ideal humidity required is 80%-90%. To maintain the temperature and humidity is to do watering or misting. Currently, there are still many farmers who use conventional watering systems that are not practical. Therefore, during the dry season, the productivity of oyster mushrooms tends to decrease due to hot weather conditions and intense watering needs to be done. Based on this, it is necessary to develop an automatic and efficient mushroom watering tool. The research method used is Research and Development (R&D). The result achieved is the design of an automatic mushroom sprinkler based on temperature and humidity control. This automatic mushroom sprinkler has a blower component, piezoelectric, ATMega 16 microcontroller, DHT11 temperature sensor, and internet of things (IoT) features. The conclusion of this research is the creation of an automatic mushroom sprinkler that is efficient and easy to use. In addition, the results of the implementation of this tool in the cultivation area can increase the productivity of oyster mushrooms by 34.51%.

Keyword:
Sprinkler; Internet of Things; Oyster Mushrooms; Humidity; Temperature.

1. INTRODUCTION

Oyster mushrooms are food that comes from the Basidiomycytes group, called oyster mushrooms due to their hoods are circular like oyster shells. The colors of the hoods vary from white, yellowish-white, gray, ash brown, some are even red and blue. The surface of the hood is slightly slippery but not sticky, with a diameter of 3 to 15 cm. Some of these mushrooms have branching stalks, the bodies or stems are white, short, and sideways [1]. White oyster mushroom (Pleurotus ostreatus) is one of the non-cholesterol food ingredients and is currently in great demand by people from various classes [2].

Oyster mushrooms have been widely cultivated in Indonesia, one of the reasons due to oyster mushrooms is the easiest to cultivate compared to other mushrooms. Moreover, the nutritional content of white oyster mushrooms is known to be much higher than other mushrooms, where every 100g (dry weight) of white oyster mushrooms has 128 calories, 27% protein, 1.6% fat, 58% carbohydrates, 51 mg of calcium, iron. 6.7 mg, vitamin B 0.1 mg [3].

Oyster mushrooms have sufficient nutritional content and are beneficial for human health. Oyster mushrooms are also believed to be efficacious as drugs for various diseases, such as liver, diabetes, anemia, as antiviral and anti-cancer, lowering cholesterol levels, increasing the body's resistance to polio and influenza attacks and malnutrition. [4]. Along with increasing knowledge, public interest in consuming white oyster mushrooms also increases around 20-25% per year. However, the increasing demand for white oyster mushrooms has not been able to be met by mushroom business actors [5]

In addition, oyster mushrooms have a much cheaper price than chicken and beef, which is IDR 10,000 to IDR 15,000 per kilogram. Meanwhile, the prices of chicken and beef are Rp. 36,600 and Rp. 125,700 per kilogram [6]. This is why oyster mushrooms are enjoyed by the people of Indonesia.

In the cultivation of oyster mushrooms, the temperature is an important factor in the successful cultivation of oyster mushrooms, the optimum temperature for the growth of oyster mushrooms is 16-25°C [7]. Room humidity is also very influential in oyster mushroom cultivation, where the ideal room humidity required is 80%-90%. Humidity must be maintained so that the substrate in the baglog does not dry out. How to maintain humidity is to do watering or misting in the morning and evening [1].

So far, watering plants to overcome temperature stability is operated manually. This method has problems, namely determining the time of watering, and farmers are forced to go back and forth so that it is quite exhausting for mushroom cultivators. In addition, during the dry season, controlling the temperature and humidity of the mushroom house is very difficult to do with conventional methods [8].

2. METHODS

2.1 Research Type

This study uses research development or Research and Development which is a research method used to make certain products and test the effectiveness of the product [9].

2.2 Research Stages

The stages of this research were carried out according to the type of R&D (Research and Development) which was modified in such a way as to suit the needs of the researcher.

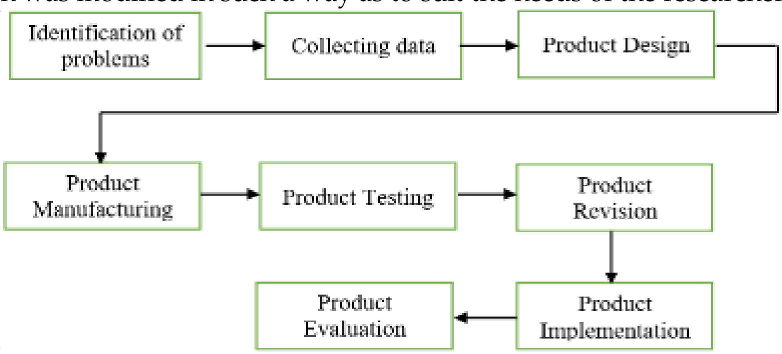

Figure 1 The stages of study

2.2.1 Identification of problems

Problem identification was carried out by field observations, which are visiting and interviewing the owner of the oyster mushroom cultivation in Geneng Village, Prambanan District, Klaten Regency regarding the difficulty of watering oyster mushrooms and asking about the problems being faced during the oyster mushroom cultivation process.

2.2.2 Collecting Data

Data collection was carried out by collecting the results of research studies regarding the condition of mushroom houses where oyster mushrooms are cultivated in Geneng Village, Prambanan District, Klaten Regency.

Figure 2 Data Collection Stages

2.2.3 Product Design

Product design is made using Autodesk Inventor software based on the results of field observations and data collection.

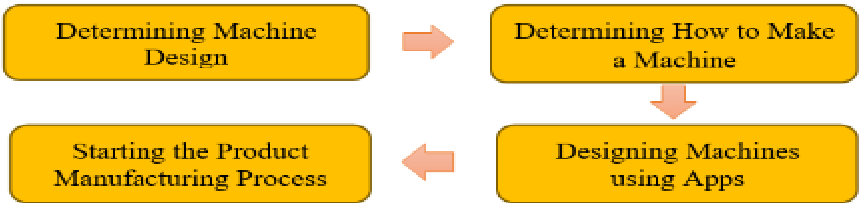

Figure 3 Product Design Stages

2.2.4 Product Manufacturing

Product manufacture has five steps, which are understanding 2D & 3D designs or working drawings of tools, surveying and materials selecting, processes manufacturing, assembling, and product finishing. The tools and materials used in this research adjust to the needs by considering the design of the working drawing and the expected output result.

The tools used in this research are divided into two, tools for manufacturing and tools for data collection. Tools for manufacturing include: lathe machine, plate bending machine, MIG welding machine, grinding machine, drilling machine, rivet plier, and spray gun. While the tools for data collection include: digital hygrometer, digital thermometer, and portable dust concentration measuring instrument.

In this research, the materials used are LCD 16x2, sensor DHT11, sensor PIR, servo SG90, module relay, Wemos D1, selenoid doorlock 12V, project board, water funnel, PVC pipe, microcontroller ATMega, earthenware jug, electric faucet, piezoelectric (mist maker), and blower.

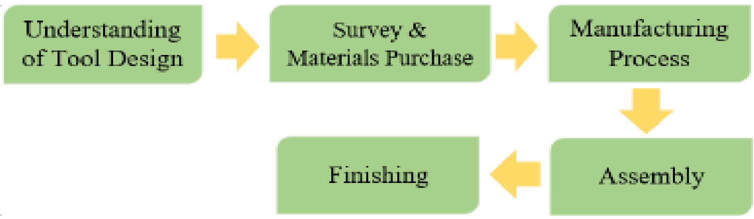

Figure 4 Manufacturing Process Schematic

2.2.5 Product Testing

Product testing was conducted by validating the product, there are:

a) Tool functionality

This test is carried out by operating the machine according to its function, which is to water the mushroom baglog. This test aims to determine whether the existing components are functioning properly.

b) Tool resistance

To test the durability of the tool, turning on the tool for 24 hours to monitor the automation and control system.

2.2.6 Product Revision

Product revisions are expected to be carried out if the test is not as expected. This is conducted by resetting the ATMega controller set on the device with the improvement of the SHT11 temperature sensor or improvements to the Internet of Things (IoT) connection.

2.2.7 Product Implementation

Product implementation is conducted by operating the machine in the actual conditions that exist in SMEs in oyster mushroom cultivation in Klaten. Then, compare the process of watering mushrooms using a machine with the conventional watering process.

2.2.8 Product Evaluation

The evaluation was conducted to obtain the information needed to achieve machine products that meet expectations so that the objectives of the research and making scientific journals can be achieved optimally.

3. RESULT AND DISCUSSION

3.1 Tool Design

3.1.1 Hardware Design

The design of the automatic mushroom sprinkler was made using the Autodesk Inventor application. The design is divided into outdoor design and indoor design. The outdoor design can be seen in Figure 5.

Figure 5 Outdoor design details

While in the indoor design, there is a description and placement of the components of the automatic mushroom sprinkler including 1) water funnel, 2) output pipe, 3) controller, 4) earthenware jug, 5) electric faucet, 6) piezoelectric (mist maker), 7) input pipe. and 8) blower. The indoor design can be seen in Figure 6.

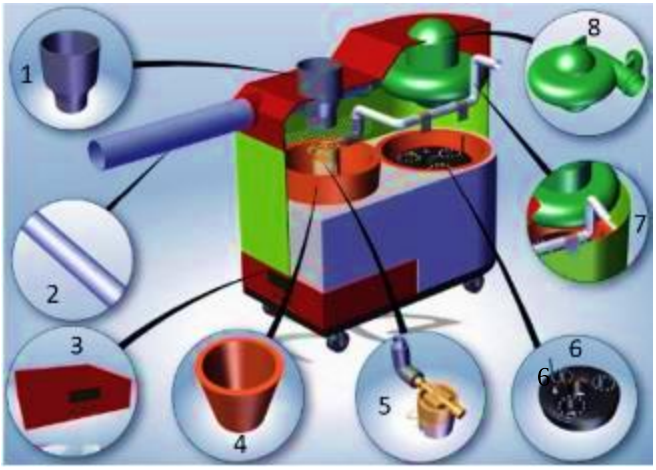

Figure 6. Indoor design details

3.1.2 Internet of Things (IoT) Design

This Automatic Mushroom Sprinkler is given a short name, namely APJAM. Giving the name to make it easier for the public to know, especially oyster mushroom cultivators. The Internet of Things application on this automatic mushroom sprinkler is useful for time and energy efficiency due to the tool user can more easily control and monitor the tool by just looking at the Android Smartphone. This is useful so that the user does not need to go back and forth to visit the mushroom house to monitor or activate the tool.

The steps for making IoT (Internet of Thing) on this mushroom sprinkler are the provision of Wemos D1 Mini Board ESP8266, Relay module, Breadboard, and jumper cables. Next, install the ESP8266 Hardware Package. After the hardware is installed, we conducted the component assembly process, and the last one is to create a Project in AgnosThings and write the code.

Figure 7 Illustration of IoT tool

3.2 How to Use and Performance of the Tool

The use and performance of the tool will be divided into three parts, namely how to use the operational tool, how to use the internet of things tools, and test the performance of the tool.

3.2.1 Operational Use of the Tool

The operational use of the tool provides information regarding how to activate the tool. The steps procedure for activating the tool are:

a) Connect the appliance plug to a power source.
b) Clean the inside of the tool if there is dirt that can interfere with the performance of the tool.
c) Make sure there is enough water in the earthenware jug.
d) Checking the mushroom sprinkler controller and calibrating its parameter.
e) Make sure other components such as blowers, piezoelectrics, and electric faucets can work properly.
f) Trying the performance of the tool manually by pressing the button on the controller.
g) Make sure the tool can work properly without any problems.

h) Set the mode to automatic if you want the device to turn on or off automatically. And manual mode if you want to operate manually.

3.2.2 How to Use the Internet of Things on the Tool

How to use the automatic mushroom sprinkler IoT application using an Android smartphone consists of several steps, such as:

a) Install the APJAM IoT (Internet of Things) application on your smartphone.
b) Open the installed APJAM IoT (Internet of Things) application.
c) Connect the application to the internet and connect via USB to the automatic mushroom sprinkler connected to the microcontroller.
d) Click “Start” to start using the application.
e) Then turn on/off the blower, mist maker/piezoelectric, and monitoring on applications that are already connected to the Internet of Things.
f) To get further information, click Continue, a menu of info related to the mushroom sprinkler will appear.
g) The APJAM info menu provides information about the temperature and humidity of the mushroom house that is connected to an automatic mushroom sprinkler.
h) When it's finished, please turn everything off and turn off the internet.

The IoT (Internet of Things) application on the automatic mushroom sprinkler which is abbreviated as APJAM can control the on/off on the blower, mist maker/piezoelectric, and monitoring on the APJAM that will be used where the green indicator is for on and red for off. In addition, APJAM's IoT (Internet of Things) application can provide information about the temperature and humidity of the mushroom house that is connected to the device. The application documentation can be seen in Figure 8.

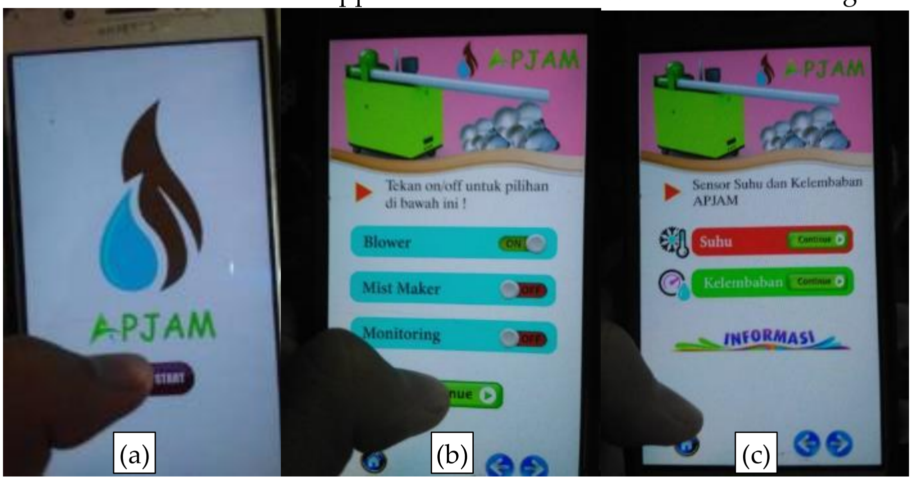

Figure 8 (a) Apjam home page; (b) Apjam main menu; (c) Apjam temperature & humidity menu

3.2.3 Result of Tool Performance Test

The performance test is a test conducted to determine the operational quality of the tool work. Performance tests include the following:

a) Installing the water inlet hose to the input pipe on the tool

If the automatic mode is on, then when the water volume is low, the electric faucet will open automatically and the water filling process will run. When the water is sufficient according to the set volume, the electric faucet will automatically close. Manual mode can be conducted by filling water through the water funnel contained in the tool until it is full.

b) Check and calibrate the controller

Inside the controller, there is information and settings in the form of temperature and humidity numbers. Make sure the temperature number listed is correct, namely 19°C - 25°C and humidity is 70% - 90%. If in automatic mode when the temperature and humidity are less than the minimum limit or exceed the maximum limit, the tool will activate automatically by utilizing the DHT11 temperature and humidity sensor. When active the tool will produce fog or cold dew. Apart from being used for watering, this mist can also be used to obtain the appropriate temperature and humidity for mushroom cultivation.

c) ***Piezoelectric work test/mist maker***
In manual mode, press the on button on the controller so that the tool will work including the fog generator (piezoelectric/mist maker). If the tool is working and can produce fog, then the piezoelectric performance is good.

d) ***Blower working test***
The blower on the device functions as a mist blower out through the output pipe. This blower works in conjunction with piezoelectricity, so when the piezoelectric is activated manually, the blower will also work. If it is appropriate then the blower performance has been good.

e) ***Checking the output pipe***
The output pipe serves as an outlet for the piezoelectric mist generated and blown by the blower. This pipe can be directed directly in the mushroom cultivation room or can be reconnected with pipes that will immediately flush each mushroom log bag. Make sure the path of the fog is not blocked or disturbed by dirt. If there is dirt that is blocking it, it can be overcome by cleaning it first.

3.3 Tool Implementation in Oyster Mushroom House

The automatic mushroom sprinkler is a technology that can lower the temperature and increase the humidity of the oyster mushroom cultivation environment. The process of lowering the temperature and increasing the humidity of the environment. This tool uses a combination of several main components, such as an earthenware jug, blower, ATMega8, and piezoelectric (mist maker).

The application of the mushroom sprinkler can be controlled manually or automatically. Before this tool is applied, the instrument is calibrated first. Manual performance when the on button is activated and the manual button is activated when the load is active. The load is in the form of piezoelectric and blower. Piezoelectric makes cold dew resulting from the combination with cooling the pottery so that the water temperature in the pottery drops by 5-10°C and the resulting dew reaches a temperature of 20°C and during testing with humidity reaching 90%. The cold dew is pulled out into the environment using a blower which provides an even cooler effect until the optimal temperature reaches 19°C. The process will continue to be active as long as the user does not press the off button.

APJAM as a mushroom sprinkler can work automatically by relying on the work of the temperature and humidity sensor as a detector. The automatic system flowchart from APJAM can be seen in Figure 9.

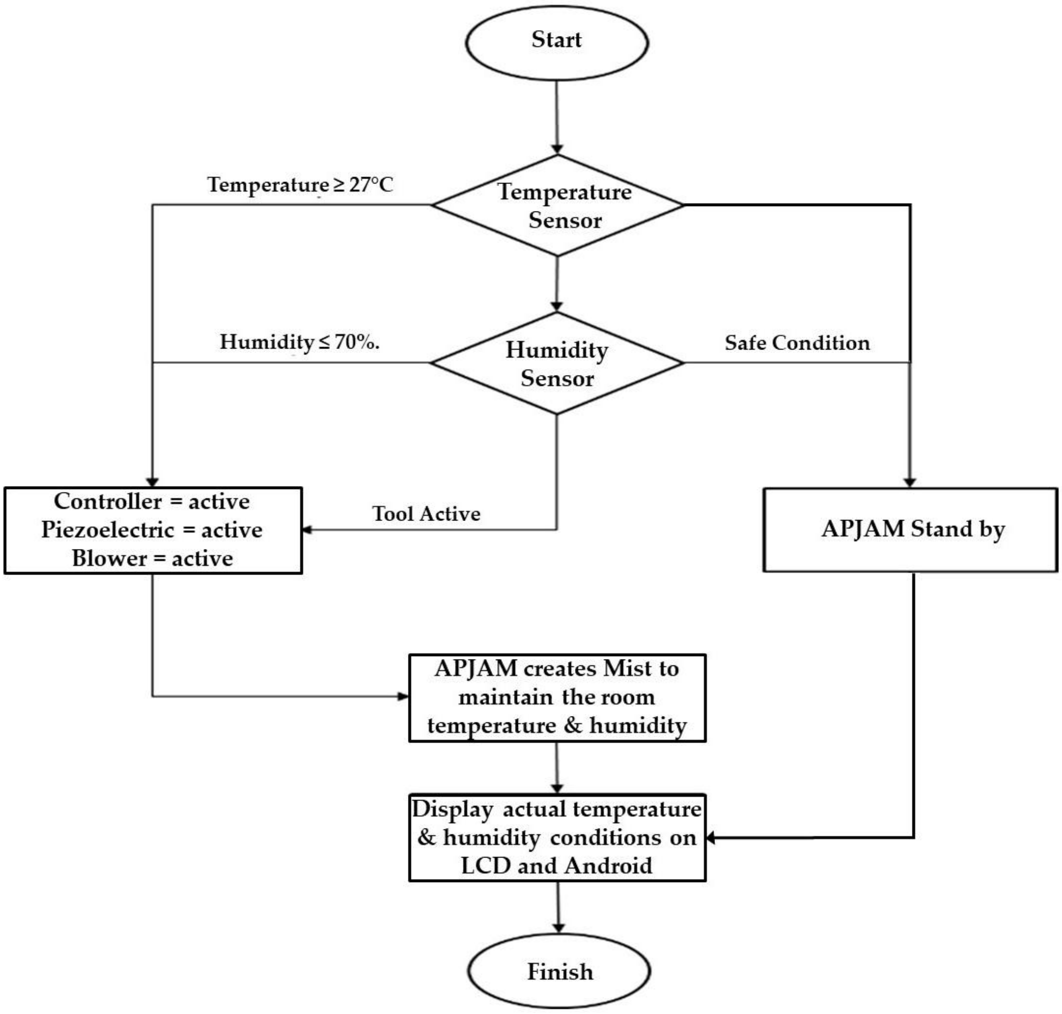

Figure 9 Automated System Flowchart

The principle of performance at the output load is the same as the performance system on automatic, in the automatic process the mushroom sprinkler load will turn off automatically when the temperature has reached 19°C while the relative humidity is 90% and will activate automatically when the temperature is 27°C or humidity 70%.

Figure 10 (a) Apjam final product; (b) Apjam Implementation; (c) Apjam in mushroom cultivation

The implementation program and the first trial of this tool will be carried out from early February 2021 until the end of May 2021. The location for the implementation of this program is at the Mushroom House where Oyster Mushroom Cultivation is located in Geneng Village, Prambanan District, Klaten Regency.

From the result that has been achieved in the application of automatic mushroom sprinklers, there has been an increase in the quality and quantity of mushroom production. The increase in physical quality that occurs is that the resulting oyster mushroom is chewier and the water content is appropriate, namely not too high and not too low. This is evidenced by the direct processing of oyster mushrooms by the user. This processing of oyster mushrooms is produced by cultivators to become crispy mushroom crackers, mushroom satay, mushroom pepes, mushroom nuggets, or sold raw.

Oyster mushrooms are very satisfying where Mr. Ingge's mushroom production which was previously only able to produce 69.25 Kg/Month, can increase to 93.15 Kg/Month, this increase is 34.51%. The perceived positive impact has increased the economic income of oyster mushroom cultivators.

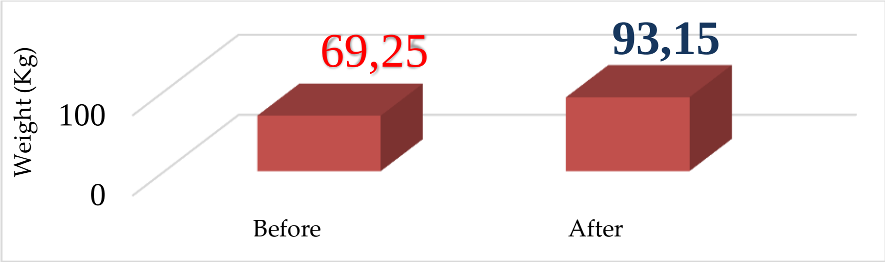

Figure 11 Comparison of Oyter Mushroom Production Quantities at Research Sites

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4. CONCLUSION

Based on the design and manufacture of an automatic mushroom sprinkler to increase the productivity of oyster mushroom cultivation, then the conclusions of this research are:

1) The automatic mushroom sprinkler has eight components, such as a water funnel, output pipe, controller, earthenware jug, electric faucet, piezoelectric (mist maker), input pipe, and blower, and is equipped with an internet of things (IoT) application feature called APJAM which allows users to control and monitor the device remotely.
2) The automatic mushroom sprinkler can control the temperature and humidity of the mushroom cultivation room optimally by using the easy method.
3) The implementation of the mushroom sprinkler that has been conducted in the oyster mushroom cultivation area, can increase the quality of oyster mushrooms due to the elasticity and moisture content of the mushroom is better than before using the tool, and the tool can increase the number of oyster mushrooms by 34.51%

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