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Application of Temperature and Humidity Control Technology in The Oyster Mushroom Cultivation Business

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Abstract

Temperature and humidity are critical factors in oyster mushroom cultivation, and as such, it is imperative to manage and regulate these variables with the aid of modern technology. The primary goal of this community service initiative is to enhance the productivity and quality of oyster mushrooms, while also fostering the sustainability of cultivation efforts. This method encompasses training sessions on proper temperature and humidity control techniques, the implementation of monitoring equipment, and the establishment of an optimal cultivation environment. The outcomes of these efforts have revealed a notable enhancement in both the production and quality of oyster mushrooms. Additionally, farmers have expressed an increase in technical knowledge and a deeper understanding of the advantages associated with appropriate environmental control. This technology holds the potential to elevate farmers' income and positively influence the cultivation environment. In summary, the implementation of temperature and humidity control technology yields tangible benefits, ultimately promoting the sustainability of oyster mushroom cultivation and contributing to the enhancement of farmers' expertise.

Keywords: *humidity control, oyster mushrooms, temperature control*

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Introduction

Mushrooms, especially oyster mushrooms, are commercial vegetable products that are easy to cultivate and develop (Wiardani., 2010). It requires relatively small land and utilizes readily available materials such as sawdust and cornstarch (Az-Zahra et al., 2021). Oyster mushrooms are versatile and can be further processed into various industrial products, ranging from small-scale to large-scale industries. Cultivating oyster mushrooms is particularly suitable for tropical regions like Indonesia (Rahmawati & Akhmadi, 2019). There is still a wide range of opportunities in the field of oyster mushroom cultivation, as it remains relatively rare in many parts of Indonesia, including Central Sulawesi. Data on oyster mushroom cultivation in Central Sulawesi shows fluctuating trends from 2014 to the present (Farhah et al., 2017).

Oyster mushroom cultivation represents an agricultural sector with significant economic potential. However, in practice, it faces several challenges, particularly in managing environmental factors such as temperature and humidity (N. Sasria et al., 2021). Mushrooms require special care, including regular watering and maintaining a humid environment, and even slight variations in sunlight exposure can affect their growth and harvest (Agustianto et al., 2021). Unsuitable environmental conditions can result in reduced productivity and quality, leading to financial losses for farmers (Pramudya et al., 2012).

In general, the optimal temperature for oyster mushroom cultivation during the mycelium formation phase ranges from 28°C to 30°C, with humidity between 50% and 60% (Amelia et al., 2017). However, during the fruiting body formation stage, air temperature between 25°C and 30°C and humidity between 70% and 95% are needed (Devi et al., 2018). Addressing these challenges underscores the need for the application of technology to optimize the cultivation environment. Temperature and humidity control technology is considered an effective solution to enhance production yield and oyster mushroom quality while ensuring the sustainability of cultivation efforts (H. Elfandari et al., 2021). By harnessing this technology, farmers can create an ideal environment for oyster mushroom growth.

This research aimed to apply temperature and humidity control technology to oyster mushroom cultivation. The research question explored how this technology can affect oyster mushroom productivity and quality and its impact on the sustainability of cultivation efforts. Through community engagement, farmers received training in the proper environmental management techniques, with the expectation of enhancing their knowledge and skills in managing oyster mushroom cultivation. Literature supports the idea that precise temperature and humidity control in mushroom cultivation can bring significant benefits, such as increased production, quality, and environmental stability. This technology has also proven to have a positive impact on other agricultural sectors, resulting in enhanced efficiency and productivity.

The implementation of temperature and humidity control technology in oyster mushroom cultivation is a crucial step in improving production yields, quality, and the sustainability of cultivation efforts. Through a community engagement approach, this research aimed to make a tangible contribution to the development of the oyster mushroom cultivation sector and improve the well-being of farmers involved in the process.

Methods

Location

The community engagement activities were carried out at the oyster mushroom cultivation site of Group Alsania47. This mushroom cultivation venture is located in Karanja Lembah sub-district, Mpanau, managed by Aldimas D. Samopena. The implementation of the community engagement program involved four lecturers and was supported by three students.

Implementation Method

The method used in this research is black-box testing or behavioral testing, focusing on the functional requirements of a system. Testing involves assessing the functioning of all the available functional features and comparing them with the entire set of functional features to examine software, hardware, and applications simultaneously (Agustianto et al., 2021). The research employed an experimental method involving the application of a humidity control system for oyster mushroom cultivation based on a 30 Wp photovoltaic (PV) system, which converts solar energy into electricity as an alternative energy source. It also used an Arduino Uno for mechanical control to automatically manage the humidity and watering process according to a predefined schedule.

Training Provided to Farmers

The training offered to the Alsania47 oyster mushroom farmer group encompasses the introduction to technology-based oyster mushroom cultivation and the application of zerowaste principles. The training focus consists of two components: the theoretical component, where participants receive theoretical knowledge, and the practical component, where participants engage in hands-on cultivation under the guidance of the community engagement team. Subsequently, the participants proceed to implement technology-based cultivation. Continuous mentoring includes weekly visits to the farmer groups to monitor the progress of the oyster mushroom cultivation process. This guidance was provided by both students and the supervising faculty members of the empowerment and development program for Alsania47 oyster mushroom cultivation. Monitoring and evaluation involve monthly meetings with the partners. The purpose of this monitoring and evaluation is to assess the progress of cultivation success and identify any issues, thus facilitating the discovery of appropriate solutions for the sustainability of the initiative.

Program Components

1. Identification
   The initiative began with an initial survey to identify the challenges faced by oyster mushroom farmers related to environmental temperature and humidity.
2. Farmer Training
   Intensive training sessions were provided to farmers on the techniques for precise temperature and humidity control. This includes theory, hands-on practice, and the use of temperature and humidity measurement tools.
3. Installation of Monitoring Equipment
   Monitoring equipment for temperature and humidity was installed in the oyster mushroom cultivation area. This equipment continuously monitors environmental conditions and transmits data to the monitoring system.
4. Cultivation Environment Adjustment
   Farmers were guided in adjusting the cultivation environment based on data provided by the monitoring equipment. Specific steps were taken to maintain optimal temperature and humidity.
5. Monitoring and Evaluation
   Ongoing monitoring of environmental conditions and mushroom growth was conducted. The data collected was used to evaluate the effectiveness of the temperature and humidity control technology.
6. Dissemination of Results

Results of the community engagement initiative were shared through various means, including seminars, workshops, and academic publications, to distribute knowledge to a wider audience.

7. Final Evaluation

   A final evaluation of the overall technology implementation process was conducted, collecting feedback from farmers and making adjustments to the methods used, if necessary.

Equipment Operation Procedure

1. Preparation and Material Selection

   Material selection aimed to choose suitable tools and materials through feasibility testing. This includes testing materials for resistance (load resistance) and verifying the proper functionality of electronic components.
2. Circuit Simulation

   Circuit simulation was performed to experiment with the working principles and functionality of the equipment, ensuring that it operates as intended and preventing errors in the PV-based humidity control device for oyster mushroom cultivation (Rukmi & Irawan, 2016).
3. Design

   As shown in Figure 1, the following aspects should be noted in the equipment circuit design:
   a. Current and Voltage: In the design of the PV-based humidity control device for oyster mushroom cultivation, a working voltage of 12V DC is required to operate the components and devices within.
   b. 12V DC Water Pump: In the design of the oyster mushroom cultivation equipment, a 12V DC water pump is used as the water supply system for the entire oyster mushroom chamber. Water is sprayed through nozzles, creating fine droplets at specific intervals. This is done to ensure even water distribution to all parts of the oyster mushrooms.
4. Equipment Fabrication
   a. Preparing Tools and Materials

      The tools and materials needed for the automated humidity control equipment for oyster mushroom cultivation include an Arduino, a gearbox motor, mechanical components, a control panel, and various tools such as grinders, electric drills, pliers, screwdrivers, hammers, brackets, measuring tools, and rivets.

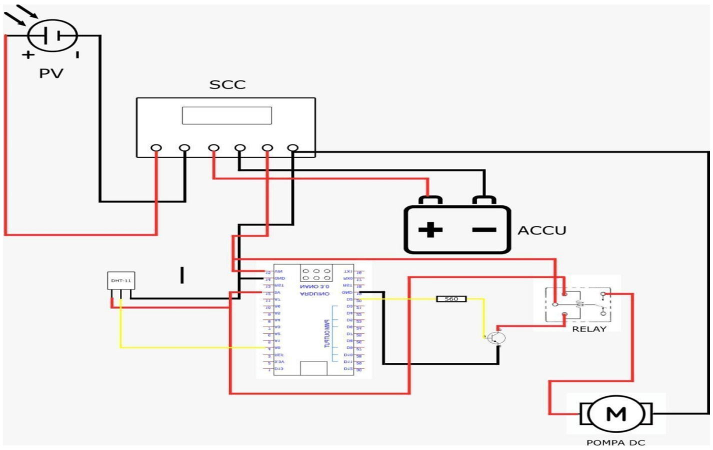

Fig. 1. Circuit design

b. Creating the Mechanical Housing for Oyster Mushroom Cultivation

   To create the mechanical component for humidity control in oyster mushroom cultivation, aluminum hollow sections were used as the primary material to build the cultivation chamber for housing the oyster mushrooms.

c. Installing Solar Panels (Photovoltaic Cells)

   A 30 Wp solar panel was mounted on the upper frame, facing the sun. It serves as the electrical power source, connected to a battery (Accu) to supply DC voltage to the other components.

d. Final Step in Equipment Design and Construction:

   The final step involves connecting all the components, where sensors and DC motors are connected to the microcontroller.

5. Implementation of the Technology

   The temperature and humidity control system for oyster mushroom cultivation based on photovoltaic technology represents an innovative development in the field of environmental control, specifically for maintaining the required temperature and humidity for oyster mushroom growth. The system detects temperature and humidity data through the DHT 11 sensor and transmits this data via serial communication to the microcontroller present in the Arduino UNO.

Results and Discussions

Results

The community engagement program involved the application of temperature and humidity control technology in the Alsania47 oyster mushroom cultivation venture. The primary aim of implementing this technology is to enhance the production of Alsania47 mushrooms by automating the environmental control of temperature and humidity within the mushroom chamber. It is expected that through this community engagement program, mushroom farmers would gain insights into expanding their production through the utilization of technology. The program was divided into two main components:

1. Training and Information Dissemination

   This phase was designed to introduce and share information about the community engagement program with the oyster mushroom farmers. Additionally, it provided essential knowledge about the technology used in the temperature and humidity control equipment. The process of training and information dissemination are shown in Figure 2.

   In this activity, the two-way communication between the facilitator and mushroom farmers includes:

   a. Participation in Training Sessions

      In these training sessions, farmers engaged in understanding the theory of temperature and humidity control, the use of monitoring tools, and hands-on practice in environmental cultivation management.

   b. Discussion and Q&A

      Participants actively participated in discussion sessions and Q&A to gain a deeper understanding of tool usage. Questions covered practical aspects and direct application in their cultivation conditions.

   c. Field Practice

      Providing mushroom farmers with the opportunity to directly engage in setting up tools in their own cultivation environments. This allows them to apply the knowledge gained in practical contexts.

2. Equipment Installation

   The equipment installation was aimed to equip oyster mushroom farmers with the knowledge and skills required for using and maintaining the equipment. Farmers were trained to become familiar with the equipment and perform routine maintenance to ensure optimal equipment performance. In the process of training on the use of temperature and humidity control technology in mushroom cultivation, community participation and activities play a key role in the successful implementation of the technology. The process of equipment installation is shown in Figure 3. The following were some community activities that performed:

Fig. 2. Conveying information about the usage and function of tools

a. Joint Monitoring

   Encouraging mushroom farmers to actively monitor the data generated by monitoring tools. This can enhance their sense of ownership in the process and the outcomes achieved.

b. Formation of User Teams

   Mushroom farmers can form user teams responsible for the maintenance and operation of the equipment. This not only divides the workload but also creates collective responsibility for the success of the implementation.

Fig. 3. Installation and assembly of tools

c. Information Dissemination within the Community

Mushroom farmers are expected to be agents of information dissemination. They can share knowledge and the benefits of temperature and humidity control technology with fellow farmers or members of the agricultural community.

Discussions

As shown in Figure 4, the placement and quantity of mushroom bags in the equipment box are critical parameters to be observed for achieving higher production. In Table 1, the growth of mushrooms in the equipment box is represented, showing that mushrooms can thrive well and reach their maximum potential, as indicated by the size and cap width of the mushrooms, along with the reduction in the mushroom bag's volume.

Fig. 4. Mushroom baglog seen from above

Table 1. Growth of fungus on the box

Day	Length and Width of The Hood	Color of The Hood	Length and Width of The Baglog	Mushroom
1	L : 0.5cm W : 0.5cm	White	L : 20cm W : 12cm	
2	L : 1 cm W : 1cm	White	L : 20cm W : 11,8cm	
3	L : 2 cm W : 2 cm	White edges and light yellow center	L : 20cm W : 11,5cm	
4	L : 3.3cm W : 3.3cm	White	L : 20cm W : 11,2cm	

Table 2. Equipment testing result

No	Time	PV Output		Battery Output		DHT11 sensor				DC Pump	
		Voltage (V)	Current (A)	Voltage (V)	Current (A)	Temperature DHT 11 (ºC)	Temperature Thermometer (ºC)	Humidity DHT11 (%)	Humidity Termohygrometer (%)	On	Off
1	10:00	12.74	0.16	11.96	0.7	32.8	30	73	75		✓
2	10:45	12.47	0.15	11.95	5.3	34.2	30	74	76	✓	
3	10:50	12.18	0.15	11.69	5.1	34.1	30	74	75	✓	
4	11:05	12.53	0.15	12.46	0.7	33.8	30	74	75		✓
5	11: 48	12.17	0.16	11.82	5.1	34.3	29	74	75	✓	
6	12:07	12.61	0.16	12.02	0.7	32.8	29	75	76		✓
7	13:25	12.10	0.13	11.89	5.1	33.1	29	75	76	✓	
8	13:58	12.12	0.11	11.87	0.7	32.8	29	75	76		✓
9	14:30	12.87	0.8	12.69	0.7	32.8	29	75	76		✓
10	15:00	12.89	0.9	12.72	0.7	32.8	29	76	76		✓
11	15:30	12.81	0.9	12.60	0.7	31.8	29	78	77		✓
12	16:00	12.73	0.5	12.60	0.7	31.8	29	78	77		✓

Based on Table 2, the results of testing temperature and humidity control devices in oyster mushroom cultivation based on photovoltaics are presented. To determine the accuracy of the program and the function of the circuit, testing was conducted by comparing the temperature and humidity readings of the DHT11 sensor with those of a thermometer and a thermohygrometer. In the experimental scenario, a temperature threshold value of 33ºC was used. If the temperature inside the oyster mushroom box exceeds 33ºC, the water pump DC motor will pump water, and the nozzle will spray water throughout the oyster mushroom box. From the data in the table above, the highest temperature and humidity were recorded under cloudy weather conditions at 34.3ºC and 78%, respectively, while the photovoltaic voltage output was 12.89 Volts. The lowest temperature and humidity recorded were 31.8ºC and 73%, respectively, with a photovoltaic voltage output of 12.10 Volts.

In addition to utilizing technology to improve mushroom farmers' production yields, it is also necessary to identify potential challenges faced by farmers in implementing temperature and humidity control technology in mushroom cultivation. Some aspects that require special attention include:

1. Implementation Costs
   Economic challenges related to the initial costs of purchasing and installing temperature and humidity control equipment, as well as the availability of funds for farmer training and periodic equipment maintenance.
2. Technical Proficiency
   Lack of understanding or technical skills among farmers in using and interpreting data generated by temperature and humidity measuring devices.
3. Limited Technology Access
   Challenges related to farmers' limited access to information and communication technology. This requires strategies to ensure accessibility to equipment and information.
4. Social and Cultural Factors
   Challenges associated with changes in traditional cultivation practices and societal perspectives toward new technology. It is crucial to understand and address cultural resistance to change.
5. Diverse Scale of Operations
   Challenges in accommodating the diverse needs and scales of operations among farmers. This requires solutions that can be tailored to the conditions and capacities of each individual farmer.

The implementation of temperature and humidity control technology in oyster mushroom cultivation can have economic and social impacts. Economically, the use of devices that can operate automatically can indirectly increase production quantity. Proper temperature and humidity control can significantly improve oyster mushroom yields, thereby generating more products for sale. Good temperature and humidity control technology can reduce production costs by optimizing the use of resources such as electricity and water.

Social impacts may involve the need for new technical skills or enhancements in system management jobs. By increasing production and efficiency, oyster mushroom farmers or cultivators can boost their income, which in turn can improve their and their families' welfare.

Engagement in the application of temperature and humidity control technology in oyster mushroom cultivation can be seen as a combination of research, innovation, and collaboration. Implementing temperature and humidity control technology involves initial research to understand the optimal conditions for oyster mushroom growth and the available technology to achieve it. This includes literature review and field research to gain deeper insights into factors affecting oyster mushroom growth. This engagement results from innovation in technology development to enhance temperature and humidity control. Innovations in hardware, software, and effective and efficient cultivation methods are involved. The ultimate goal of this engagement is to provide benefits to all involved parties.

Conclusion

In this modern era, the application of technology has had a significantly positive impact on various sectors, including agriculture. Through community engagement activities with the theme "Application of Temperature and Humidity Control Technology in Oyster Mushroom Cultivation," it can be concluded that this technological innovation has made a meaningful contribution to optimizing oyster mushroom production and enhancing the quality and efficiency of the cultivation process. In its implementation, this project has successfully provided a solution to the classic challenges faced by oyster mushroom farmers regarding stable and suitable temperature and humidity. This technology has helped increase the success rate of harvests, reduce losses due to climate variations, and minimize the risk of contamination. This not only has a positive impact on the productivity of farmers but also on the income and well-being of the communities around the Alsania47 oyster mushroom farmer group.

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