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Monitoring of Air Temperature and Humidity Inside and Outside Oyster Mushroom (*Pleurotus ostreatus*) House Using DHT11 Sensor

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ABSTRACT

Oyster mushrooms (*Pleurotus ostreatus*) require a humid environment and stable temperatures to grow optimally. One of the mushroom growing media, namely the mushroom house, which need to be regulated in temperature and humidity in order to produce high-quality mushrooms. Management of environmental conditions is essential, as significant changes in temperature and humidity can inhibit mold growth or even cause disease. This study aims to monitor the internal and external conditions of the oyster mushroom growing environment using a DHT11 sensor to obtain ideal growth conditions. This research was carried out through several stages, including the preparation of tools and materials, hardware design, layout arrangement, testing of temperature and air humidity control systems, and monitoring oyster mold growth. The results of the 20-day study showed that the internal temperature in oyster mushroom clusters was at the ideal temperature for oyster mushroom growth, which ranged from 25.3°C to 31.8°C, while the maximum humidity reached up to 98% at certain times. The external temperature of the mushroom house is in the temperature range of 28°C to 33.5°C with a relatively lower humidity, ranging from 73.2% to 91.2%. Humidity above 90% dominates most measurements, especially in the afternoon, creating ideal conditions for mold growth. The use of the DHT11 sensor in temperature and humidity measurements in this study was effective in recording significant daily fluctuations. The resulting data shows that the sensor is able to detect changes in temperature and humidity of the kumbung chamber and the environment.
Keyword: *DHT11, oyster mushroom, humidity, temperature*

ABSTRAK

Jamur tiram (*Pleurotus ostreatus*) membutuhkan lingkungan yang lembap dan suhu stabil untuk tumbuh optimal. Salah satu media tumbuh jamur, yaitu kumbung jamur yang perlu diatur suhu dan kelembapannya agar menghasilkan jamur berkualitas tinggi. Pengelolaan kondisi lingkungan sangat penting, karena perubahan suhu dan kelembapan yang signifikan dapat menghambat pertumbuhan jamur atau bahkan menyebabkan penyakit. Penelitian ini bertujuan untuk memantau kondisi internal dan eksternal dari lingkungan tumbuh jamur tiram menggunakan sensor DHT11 sehingga dapat diperoleh kondisi pertumbuhan yang ideal. Penelitian ini dilaksanakan melalui beberapa tahap, meliputi persiapan alat dan bahan, perancangan perangkat keras, penataan tata letak, pengujian sistem pengendalian suhu dan kelembapan udara, serta pemantauan pertumbuhan jamur tiram. Hasil penelitian selama 20 hari menunjukkan bahwa suhu internal dalam kumbung jamur tiram berada pada suhu ideal pertumbuhan jamur tiram, yaitu berkisar antara berkisar antara 25,3˚C hingga 31,8˚C, sementara kelembapan maksimal mencapai hingga 98% pada waktu-waktu tertentu. Suhu ekternal kumbung jamur berada pada kisaran suhu 28˚C hingga 33,5˚C dengan kelembapan relatif lebih rendah, berkisar antara 73,2% hingga 91,2%. Kelembapan di atas 90% mendominasi sebagian besar pengukuran, terutama pada sore hari, menciptakan kondisi yang ideal bagi pertumbuhan jamur. Penggunaan sensor DHT11 dalam pengukuran suhu dan kelembapan pada penelitian ini efektif dalam mencatat fluktuasi harian yang signifikan. Data yang dihasilkan

menunjukkan bahwa sensor mampu mendeteksi perubahan suhu dan kelembapan ruang kumbung dan lingkungan.
Kata kunci: DHT11, jamur tiram, kelembapan, suhu

1. Introduction

Mushroom cultivation in Indonesia is one of the promising business opportunities. In recent years, mushrooms have become increasingly popular among people as part of a healthy lifestyle. A variety of culinary creations made from mushrooms have developed, which has also driven the increase in demand. The high demand for mushrooms in Indonesia mainly comes from big cities, but small cities also show an increasing trend, especially from restaurants that focus on mushroom-based menus (Machfudi et al., 2021).

Fungi need a humid environment and stable temperatures to grow optimally. One of the mushroom growing media, namely mushroom house, needs to be regulated in humidity and temperature in order to produce high-quality mushrooms. Kumbung is a special house built to be used as a place to cultivate mushrooms for consumption and functions to protect the mushroom planting medium (baglog) from rainwater and direct sunlight as well as the possibility of the unexpected entry of other fungal spore contaminants. In the process of cultivating mushrooms in house, it depends on physical factors such as temperature, humidity, light, pH of the planting medium, and aeration, air (Arminarahmah et al., 2022).

This environmental control is crucial because drastic changes in temperature and humidity can inhibit the growth or even trigger diseases in fungi. Therefore, monitoring the environmental condition of the mushroom house is an important factor in mushroom cultivation. The success in cultivating oyster mushrooms is highly determined by the ability to maintain optimal environmental conditions in the mushroom house (Waluyo et al., 2018). The two main factors that play a big role in determining the growth and development of fungi are the temperature and humidity of the mushroom house (Hidayat et al., 2023). In general, the ideal temperature for oyster mushrooms is in the range of 24°C to 30°C, with humidity levels ranging from 80% to 90%. In addition, the intensity of light needed to support its growth is about ±300 lux (Akbar et al., 2021).

In this case, sensor technology such as the DHT11 installed on the Arduino becomes a practical solution for monitoring the temperature and humidity of mushroom house. DHT11 is a sensor used to detect temperature and humidity in room temperature and humidity control applications. The sensor works with a 3V to 5V DC power supply, capable of measuring temperatures in the range of 0°C to 50°C, as well as air humidity between 20% and 90% (Mableran, 2015). The DHT11 sensor is able to accurately detect temperature and humidity and transmit data to the arduino, which can then be displayed on the screen or sent to another device for further monitoring. The DHT11 sensor is a digital sensor used to measure the temperature and humidity around the mushroom cultivation area (Kristiyanti et al., 2022). This sensor has advantages in the form of a good level of stability and calibration, and is able to provide a fast and accurate response to data readings (Kurniawan, 2019). The DHT11 sensor is equipped with an NTC (Negative Temperature Coefficient) type thermistor to detect temperature, a resistive type humidity sensor, and an 8-bit microcontroller that functions to process data from both sensors. The measurement results are then transmitted through the output pin using a bidirectional single-wire format (Wicaksana, 2018). The DHT11 is one of the best quality sensors, based on its response, fast data reading, and anti-interference capabilities (Kusriyanto et al., 2017). The microcontroller is the brain in the control center that functions to control all components that have been assembled

In this study, the DHT11 sensor and Arduino Uno were used as the brains of all components. The tool works automatically and is applied to miniature oyster mushroom house. In the previous study, the tool could work well and in this study, the way the tool works is the same, but the difference is that this time the tool uses the concept of the internet of things so that farmers can always monitor and control the temperature and humidity in the house even from a distance (Devi et al., 2018). The microcontroller uses the ESP-32 Development Kit nodeMCU module which functions to receive sensor data and translate it into temperature in degrees Celsius (Hadi et al., 2022). With the use of this sensor, farmers can easily find out the environmental conditions of the house so that the ideal conditions for oyster mushroom growth can always be achieved.

One of the novelties of this research is the use of the DHT11 sensor in the application of temperature and humidity control in mushroom houses, which functions to detect and monitor environmental conditions automatically. Although the use of temperature and humidity sensors is common, the integration of the DHT11 with the Arduino microcontroller for control and monitoring in the context of mushroom cultivation is an innovation that makes it easy to monitor the condition of the mushroom house without requiring manual measurements that are often time-consuming and laborious. The use of the Arduino Uno as a controller to monitor temperature and humidity in mushroom houses provides added value in terms of automation. This system can reduce dependence on direct human supervision. With the use of sensors that are quite accurate and easy to integrate with microcontrollers, this tool offers an effective solution in maintaining the quality of the oyster mushrooms produced, by reducing the potential for losses due to uncontrolled temperature and humidity fluctuations. The DHT11, which is a cheap and easy-to-find sensor, is combined with the Arduino Uno to create an automated system that can monitor and regulate the condition of the mushroom house. This provides a cost-effective and easily accessible solution for mushroom farmers, including those in areas with limited access to high technology.

1.1. Research Objectives

This study aims to monitor the internal and external conditions of the oyster mushroom growing environment using a DHT11 sensor so that ideal growth conditions can be obtained.

2. Research Methods

2.1. Tools and Materials

The tools used in this study are DHT 11 sensor is used to measure air temperature and humidity levels in the surrounding environment, arduino uno R3 microcontroller, 16x2 LCD, Jumper Cable, Breadboard, laptop, mobile phone, USB cable, Charger head, Briquette printing machine, Oven, 1 inc PVC pipe, mushroom rack, resistor, and digital scale. The material used in this study is 100 oyster mushroom baglogs obtained from Lombok Mushroom Agro. The filling of the mushroom baglog consists of wood dust, bran, corn, mild and gibsum.

2.2. Method

This research was carried out on November 1-30, 2024, in Sandik Village, Batu Layar District, West Lombok Regency. This research was carried out in several stages, namely the preparation of tools and materials, hardware design, layout design, testing of temperature and air humidity control systems in mushroom clusters and the environment. This research is experimental with simulation experiments carried out through several stages of research, namely the preparation of tools and materials is carried out by preparing a mushroom house, mushroom rack, arduino uno microcontroller, DHT11 sensor, 16x2 LCD, USB cable, jumper cable, and laptop. Creating a circuit on an arduino using the C language. In order for the program to be uploaded to the arduino board, connect the USB cable that is already connected to the arduino board to the laptop and run the next steps on the software. The programming is carried out so that the microcontroller can carry out its work function as instructed. The commands given are in the form of code with the C language. C language is a language that is commonly used in everyday life, C language can be applied to all common operating systems such as windows, linux, and macOS.

2.3. Research parameters

The parameters of this study are monitoring temperature and humidity (RH) in oyster mushroom clusters and in oyster mushroom clusters through the use of DHT11 sensors.

3. Results and Discussion

The collection of temperature and air humidity data in oyster mushroom house aims to determine the temperature and air humidity conditions in the mushroom house which are important factors in mold growth. This observation was carried out 3 times a day, namely at 08.00 WITA, 12.00 WITA and 16.00 WITA. The observation data of temperature and air humidity inside the mushroom house can be seen in Table 1, and outside the mushroom house in Table 2.

Table 1. Temperature and Air Humidity Data in Oyster Mushroom House

Date & Time	Temperature (˚C)	Humidity (%)	Date & Time	Temperature (˚C)	Humidity (%)
1/11/2024 8:00:28	29,2	90,5	11/11/2024 8:00:29	28,4	89,5
1/11/2024 12:00:28	29,6	85,9	11/11/2024 12:00:29	30	88,5
1/11/2024 16:00:28	30,1	83,0	11/11/2024 16:00:29	29,5	98,0
2/11/2024 8:00:28	28,2	92,8	12/11/2024 8:00:29	25,5	92,2
2/11/2024 12:00:28	29,2	96,3	12/11/2024 12:00:29	30,2	91,0
2/11/2024 16:00:28	27,1	98,0	12/11/2024 16:00:34	28,4	96,0
3/11/2024 8:00:27	26,2	92,2	13/11/2024 8:00:34	26,5	92,2
3/11/2024 12:00:27	29,4	85,9	13/11/2024 12:00:34	30,2	92,0
3/11/2024 16:00:27	28,8	89,5	13/11/2024 16:00:34	29,8	98,0
4/11/2024 8:00:27	27,2	92,2	14/11/2024 8:00:34	28,4	85,5
4/11/2024 12:00:27	30,8	78,3	14/11/2024 12:00:33	30,8	87,0
4/11/2024 16:00:27	29,0	98,0	14/11/2024 16:00:33	29,2	98,0
5/11/2024 8:00:49	30,5	73,0	15/11/2024 8:00:34	30,2	74,5
5/11/2024 12:00:49	30,0	91,0	15/11/2024 12:00:33	30,2	82,5
5/11/2024 16:00:49	30,2	87,0	15/11/2024 16:00:33	28,6	94,0
6/11/2024 8:00:49	29,5	73,2	16/11/2024 8:00:34	27,4	89,0
6/11/2024 12:00:49	32,0	84,0	16/11/2024 12:00:29	30,8	87,5
6/11/2024			16/11/2024		

Date & Time	Temperature (˚C)	Humidity (%)	Date & Time	Temperature (˚C)	Humidity (%)
16:00:49	30,2	87,0	16:00:29	29,3	95,0
7/11/2024			17/11/2024		
8:00:33	29,2	91,3	8:00:34	28,4	90,8
7/11/2024			17/11/2024		
12:00:33	30,2	95,0	12:00:33	30,8	90,0
7/11/2024			17/11/2024		
16:00:33	29,0	95,0	16:00:33	25,3	98,0
8/11/2024			18/11/2024		
8:00:33	28,2	84,7	8:00:49	30,2	92,3
8/11/2024			18/11/2024		
12:00:33	29,3	93,0	12:00:49	30,1	98,0
8/11/2024			18/11/2024		
16:00:33	29,8	95,0	16:00:49	27,6	91,0
9/11/2024			19/11/2024		
8:00:29	27,2	85,5	8:00:49	27,5	90,0
9/11/2024			19/11/2024		
12:00:29	29,3	98,0	12:00:49	28,0	98,0
9/11/2024			19/11/2024		
16:00:29	25,8	98,0	16:00:49	28,5	98,0
10/11/2024			20/11/2024		
8:00:29	29,5	96,5	8:00:33	30,8	90,5
10/11/2024			20/11/2024		
12:00:29	29,5	94,0	12:00:33	30,2	88,5
10/11/2024			20/11/2024		
16:00:29	28,5	98,0	16:00:33	29,3	98,0

Table 2. Temperature and Humidity Data of the Air Outside the Mushroom House

Date & Time	Temperature (°C)	Humidity (%)	Date & Time	Temperature (°C)	Humidity (%)
26/11/2024			30/11/2024		
8:00:28	30,2	85,2	8:00:49	30,2	80,2
26/11/2024			30/11/2024		
12:00:28	32,5	76,8	12:00:49	33,5	74,2
26/11/2024			30/11/2024		
16:00:28	30,2	80,5	16:00:49	28,9	89,5
27/11/2024			1/12/2024		

8:00:28	29,5	87,2	8:00:49	29,5	87,5
27/11/2024			1/12/2024		
12:00:28	32,5	76,5	12:00:49	30,2	85,3
27/11/2024			1/12/2024		
16:00:28	30,8	79,5	16:00:49	28,5	89,5
28/11/2024			2/12/2024		
8:00:27	29,2	88,2	8:00:33	28,0	90,2
28/11/2024			2/12/2024		
12:00:27	32,5	77,3	12:00:33	32,2	82,4
28/11/2024			2/12/2024		
16:00:27	31,0	73,2	16:00:33	28,8	87,0
29/11/2024			3/12/2024		
8:00:27	31,3	80,0	8:00:28	28,5	91,2
29/11/2024			3/12/2024		
12:00:27	32,2	75,5	12:00:28	33,2	83,0
29/11/2024			3/12/2024		
16:00:27	29,4	90,2	16:00:28	29,6	85,5

Based on the temperature and air humidity data inside the mushroom house for 20 days, the microclimate conditions showed fluctuations affected by the measurement time. The room temperature of mushroom house ranges from 25,3°C to 30,8°C, with humidity reaching 98% at some given time. The general trend shows that humidity is relatively higher in the morning and evening than during the day. High humidity above 90% dominates most measurements, especially in the afternoon, creating an environment that favors mold growth. The conditions outside the mushroom house for 8 days showed higher temperatures and humidity than inside the house. The ambient temperature outside the mushroom house ranges from 28°C to 33,5°C, with a relatively lower humidity, ranging from 73,2% to 91,2%. The influence of external environmental factors such as the intensity of sunlight and wind greatly affects the increase in environmental temperature and humidity. Despite this, daily temperature and humidity trends show a similar pattern to those inside the house, with peak temperatures during the day and highest humidity in the morning.

The comparison between the two tables shows significant differences in microclimate conditions. Outside of mushroom house, temperature and humidity fluctuate more. On the other hand, the temperature and humidity conditions inside the mushroom house, the variation is more controlled with a maximum temperature of 30,8°C and humidity does not drop below 73%. This suggests that the environmental settings in the house create more specific conditions to support the specific needs of the mushroom, although it requires extra attention to maintain balance so as not to damage the cultivation process.

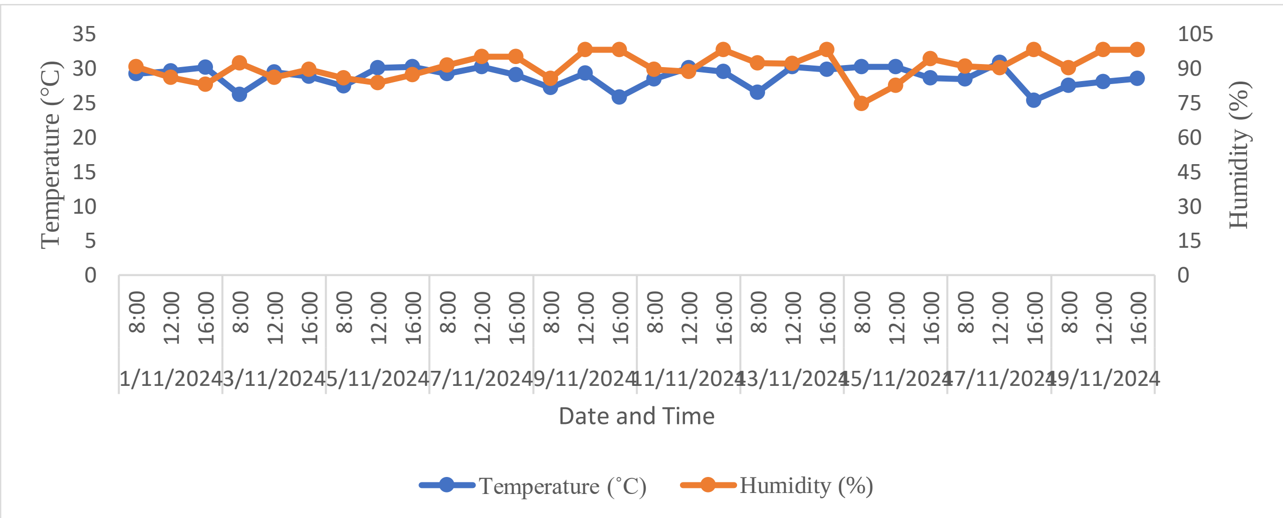

Figure 1. Graph of Temperature and Air Humidity in Mushroom House

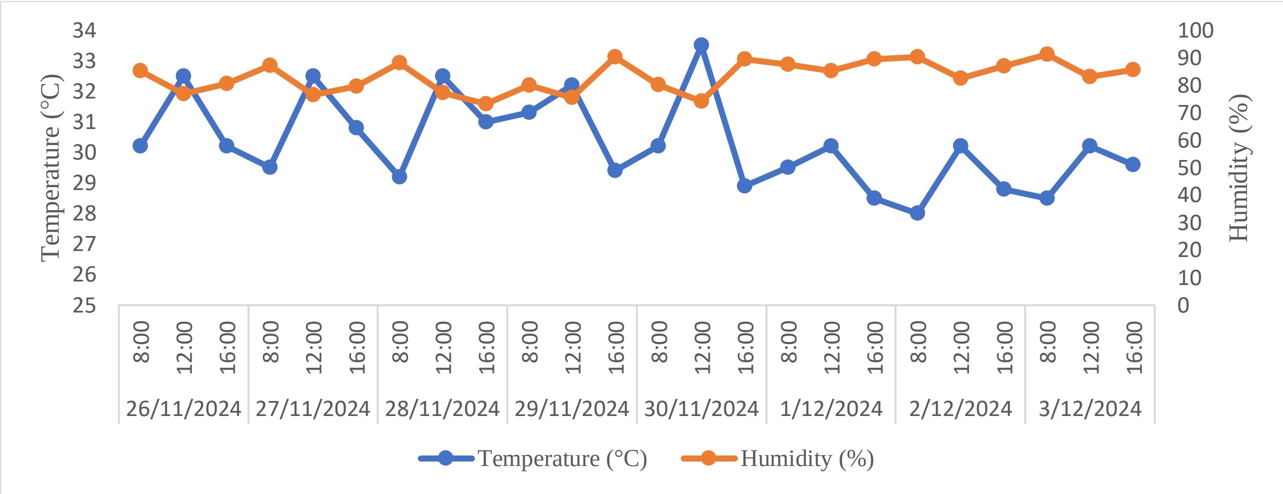

Figure 2. Environmental Air Temperature and Humidity Graph

Graphs 1 and 2 illustrate the differences in temperature and humidity patterns of the air inside and outside the mushroom house. Greater fluctuations outside the house indicate that this environment is difficult to control to support fungal growth. Graph 1 shows temperature and humidity data from within the mushroom clusters which tend to be more stable. The temperature in the mushroom house is maintained at the ideal condition for mushroom growth, which is in the temperature range of 25.3°C-31.8°C. This stability is influenced by artificial environmental factors, such as the regulation of humidity and temperature conditions that are always maintained in accordance with the environment in which the fungus grows, as well as more even air movement and sunlight intensity. This graph shows that the microclimate inside the kumbung is more dynamic and also more controlled compared to the outside conditions. This shows the importance of environmental management in the mushroom to create optimal conditions for mushroom cultivation. (Eteruddin et al., 2024) stated that temperature greatly affects productivity and the number of mushrooms produced, this is because temperature affects various fungal metabolic factors, including enzyme activity and fungal growth rate. (Rusjayanti et al., 2024) stated, the environmental temperature of oyster mushroom growth which is too high, which is around 32°C-34 °C, causes the quality of the oyster mushroom produced to be not good, ranging from the planting medium that experiences drought to the condition of the mushroom that is unhealthy and yellow. While (Hafiz et al., 2017) stated that the condition of the mushroom growth chamber that has an air humidity that is too high which is around 95 – 100% can cause the fungus to rot easily, meanwhile, the air humidity that is too low which is <80% can result in small fungal fruiting bodies, long and thin fruit stalks.

The use of the DHT11 sensor in temperature and humidity measurements in this study appears to be quite effective in recording significant daily fluctuations. The data produced shows that the sensor is able to detect changes in temperature and humidity in the kumbung room and the environment The reliability of this sensor can be seen from the consistency of the data that has succeeded in recording time patterns, such as higher temperatures during the day compared to morning and evening. In addition, the recorded humidity range reflects the sensor's response to varying environmental conditions inside and outside the fluke.

4. CONCLUSION

The conclusion of this study shows that the use of DHT11 sensor to measure temperature and humidity in oyster mushroom cultivation is very effective. This sensor is able to record microclimate fluctuations with the temperature of the mushroom house ranging from 25,3°C to 31,8°C and a maximum humidity of 98%. The microclimate inside the kumbung is more controlled compared to the outside conditions. The use of the DHT11 sensor and a viewer in the form of an LCD can take readings of the internal and external temperature and humidity of the mushroom house to see the difference in temperature and humidity within the mushroom house and outside the mushroom house.

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