The bamboo sawdust and addition of em4 as an alternative material for the cultivation of oyster mushroom (*Pleurotus ostreatus*)

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Abstract. Bamboo is a versatile and very close plant in people’s daily lives in Indonesia. However, bamboo waste is a problem that usually arises in bamboo-based industries. The residues in question are in the form of leftover pieces of bamboo, and the powder from the processing process. Bamboo is an organic material with lignin, cellulose, and hemicellulose, where the bamboo content can use as a medium for growing oyster mushrooms. This study aimed to determine the growth of fungi by utilizing bamboo waste as the primary raw material using EM4 as a starter. The method used in this study is mixing raw materials (the cultivation media), sterilizing raw materials, inoculating, maintaining, and harvesting. There are four treatments also of EM4 as a starter, namely: without the addition of EM4 (P1) as a control; 1 ml EM4 (P2); 3 ml EM4 (P3); and 5 ml EM4 (P4) in 50 ml of water. Bamboo sawdust added 3 ml of EM4 (P3) when mixing media is the best media cultivation. This media cultivation takes 63 days from media cultivation inoculated by fungi until the oyster mushrooms are ready to be harvested.

1. Introduction

White oyster mushroom (*Pleurotus ostreatus*) is one type of Non-Timber Forest Products (NTFPs). Oyster mushrooms are naturally easy to grow on rotten logs, where these oyster mushrooms remodel cellulose, hemicellulose, and lignin as a source of nutrition fungi. Widyastuti [1] states that many people have consumed this oyster mushroom. Oyster mushrooms have a high nutrient content, protein, fat, carbohydrate, calcium, iron, and vitamin B.

The process of mushroom cultivation is quite easy to do and can be grown in various media. It makes the oyster mushroom widely cultivated in Indonesia, both traditional and modern. In the process of mushroom cultivation, growing media in the cultivation of oyster mushrooms is one of the factors that can determine the growth of fungi. During this time, sawdust widely used as one of the growing media. Bamboo exploitation is very much done but it is not balanced with efforts to mass propagation [2]. The use of bamboo as raw material is not balanced with its preservation efforts. Other potential uses of cellulose media also need to be considered, one of which is bamboo waste.

Bamboo waste is a problem that usually arises in bamboo-based industries. The intended waste is in the form of the remaining pieces of bamboo and powder from the assessment process. During this time, the handling of this waste is still not appropriate, for example, by burning the remaining bamboo waste. As a result of the occurrence of environmental pollution, so it is necessary to use bamboo waste in order to reduce environmental pollution. Bamboo waste, which used as a growing medium, is one of the proper uses of waste and can produce new variations of the oyster mushroom growing media. Currently, the growing media is a mixture of rice husks, sawdust, coconut dregs, and coconut fibers.

In this study, bamboo waste used with the useful addition of microorganisms (EM4). EM4 functions to speed up the composting process so that the planting media can use more quickly later. Andayanie [3] said the addition of EM4 to the white oyster mushroom media serves to increase the fertility of the planting media in order to stimulate its growth towards optimal production. EM4
contains decomposing cellulose bacteria that can ferment organic material into inorganic compounds easily absorbed by plants. This research is essential so that it can see the growth of white oyster mushrooms on the planting media of bamboo powder waste added by EM4.

2. Materials and Methods

This research was conducted at the Laboratory of Forest Product Utilization and Management, Faculty of Forestry, Hasanuddin University. The tools used are hammer mill; 20 mesh and 40 mesh sieve; the scale; bucket; tarpaulin; plastic clip; polypropylene plastic size of 1 kg; paralon ring with a diameter of 5 cm and a length of 3 cm; tweezers; bunsen lamp; autoclave; storage shelf; thermometer; measuring cup: litmus paper (pH meter) and hand sprayer. The materials used in this study were white oyster mushroom culture (Pleurotus ostreatus), bamboo powder; rice bran; lime (CaCO₃); gypsum (CaSO₄); water; 70% alcohol; newsprint; label; fancy rope; rubber binder; and rubbing alcohol.

2.1. Growth Media Preparation of Pleurotus ostreatus

The main media used in mushroom growth is bamboo powder waste. Bamboo is split into several pieces and then cut into small pieces and dried in the sun to dry. After that, the bamboo milled using a hammer mill to a powder that can use as a growing medium.

There are four applied to carry out of the study is without the addition EM4 / control (P1), 1 ml EM4 (P2), 3 ml EM4 (P3), and 5 ml EM4 (P4). The mixture was then composted growing media for two days. Furthermore, the growing media in sterilization in an autoclave at 121°C for two hours. After that, the media is ready to inoculated with the fungus on the incubation chamber and continued with the maintenance of the fungus.

2.2. Variables Observed.

The variables observed in this study are:

a. Time mycelium growth on growth media after inoculation (day).

b. Time fruit body growth at the start of the planting medium filled with hyphae to grow pinhead (days).

c. The wet weight of mushrooms produced per planting medium. Measuring weight immediately after harvest mushrooms (fresh) mushrooms weight is calculated in grams.

d. Total production of each mushroom growing medium with a record number of fungi that grow on the media.

3. Results and Discussion

3.1. The Mycelium Growth Time.

Figure 1. shows the average length of growth of oyster mushroom mycelium after planting media inoculated with oyster mushroom culture. The results showed that the growing medium P3 and P4 as the fastest treatment experience where the oyster mushroom mycelium closure on day 39 of mycelium began to appear full, compared with growing medium P1 and P2 are the slowest to experience closure mycelium is on day 43.

The mycelium is a collection of some of the hyphae that are the threads that form a woven overlay useful as a network in the search for food sources [4]. Mycelial growth is the initial growth of the growth of oyster mushrooms. In this study, the length of mycelium growth ranged from 39 to 45 days. The range of this growth is much slower than the growth of oyster mushroom mycelium using sago pulp as the primary media that is 18-38 days [5]. According to Suharmowo et al. [4], the growth of mycelium in need of nitrogen results in the degradation of extracellular proteins to meet the fungus’s needs for growth. The appearance of white can characterize mycelium growth as a cotton-growing spread on the surface of the waste powder bamboo growing medium. Mycelium quickly covered the surface of the growing medium is regarded as the right treatment in the growth of oyster mushroom mycelium.
Mycelium growth quickly is also not free from the additional nutrients that are good on the oyster mushroom growing medium. Rice bran is a source of nutrients containing nitrogen, and potassium is adequate for the growth of mycelium. It reinforced by Haryani et al. [6] the opinion that the nutrients in the media were instrumental in the growth of oyster mushrooms. The added nutrients must be by the necessities of life mushrooms, such as carbohydrates, nitrogen, minerals, and vitamins, so that fungus can grow and develop properly. Oyster mushrooms media generally requires an element of C, N, and minerals. Elements C obtained from sawdust, of N from rice bran, minerals, and lime. In this study, all the elements required for mycelium nutrients also fulfilled by bran, gypsum, and lime. Irhananto [7] suggested that the length of mycelium fulfillment influenced by temperature, humidity, incubation site, and quality of the fungus culture used. The temperature used in this study is 23-30°C and 50-92% humidity. This condition is appropriate as proposed by Steviani [8] that the temperature and humidity needed for the growth of mycelium are between 22-29°C and 90-100%. The degree of acidity (pH) of planting medium in this study for six or pH neutral. Fintianingsih [9] argued that the pH range required for the growth of fungal mycelium between 4-7 pH (acidity level) would directly affect growth due to the ability of the fungal cell surface to absorb nutrients. Besides, each of the planting medium density also affects the distribution of mycelium. It is according to a statement Fauzia et al. [10] that if the planting medium is too dense, then the mycelium is also difficult to grow and spread to the entire surface of the planting medium. According to Indriyani [11], a bag with 1 kg capacity, should be filled with media as much as 800-1000 grams. This research uses polypropylene plastic bags the size of 1 kg with planting medium as much as 1000 grams. So the growth media used in this study by the growth of mycelium.

According to Andriyanto et al. [12], EM4 can accelerate the composting process and as the oyster mushroom growing medium. The addition of EM4 in this study did not affect significantly. However, the length of the composting can affect the formation of mycelium. It is in line with the results Andayanie [3], where the addition of EM4 does not affect the formation of a real or mushroom production. However, the length of composting influences the formation of mushrooms and the

**Figure 1.** The Mycelium Growth Time of *Pleurotus ostreatus* in various treatments.
harvest, which is the higher fresh mushroom weight. Other factors play a role in the formation of fungal mycelia, such as temperature, humidity, fungus incubation, and seed quality.

3.2. The growth of pinhead.
The duration of growth of fungal fruiting bodies is the time it takes from when the growing medium is covered by the mycelium and growing media in the ring lid open until pinhead grow. According to Fauzia et al. [10] is a pinhead of mushroom fruit body emergence would be calculated to start when inoculation to fruiting bodies such as the size of a pin ± 1 cm out of the mouth ring. Based on the results in the variable length of time, the appearance of pinhead oyster mushrooms obtained value, as shown in Figure 2. P3 growing medium added 3ml EM4 activator provides the best response to the growth of pinhead’s growth 21 days. On the contrary, the growing medium P1 is not added activator slowest EM4 responds to the pinhead’s growth of 28 days.

![Figure 2. Pinhead growth time of white oyster mushroom (Pleurotus ostreatus) in various treatments.](image)

On the pinhead growth, while the growth of fungal fruiting bodies is proportional to the extended closure of fungal mycelium. It is consistent with research Ilyas et al. [13] by which the growth of fungal fruiting bodies is proportional to the extended closure of fungal mycelium. If the growth of mycelium good, it will affect the speed of the formation of fruiting bodies (primordial).

Suriawiria [14] explains that the growth of oyster mushrooms strongly influenced by environmental factors like temperature, humidity, light, air circulation, and water. In this study, the temperature in the range 23-30°C incubation chamber with a humidity of 50-92%. This moisture maintained by spraying water regularly. It is consistent with the statement Wardi [15] that the pinhead growth requires an average room temperature ranges from 25-28°C if it is too cold fruit body contains much water will have an impact on decay, whereas if it is too hot, it will hampered growth pinhead. Sumarmi [16] describes pinhead growth as requiring an 80-90% humidity room with the desired substrate environment with a pH of 6-7.

3.3. White Oyster Mushroom Harvesting
Harvesting ware did if the fruit body size is quite large at around 5-10 cm. Harvesting ware did by pulling the entire clump fungi present until there are no mold parts left in the growing medium. Harvested mushrooms cleaned, and the bottom of the stem is cut [17].

3.3.1. Harvesting of fresh fruit body
The time needed for a pinhead to harvest is concise. Figure 3 shows the growth time from a pinhead to a fruiting body ready for harvest is 2-3 days. The results of variance showed that the addition of EM4 in the treatment of bamboo powder waste growing media did not have a significant effect on harvest time. Winarni and Rahayu [18] the rapid and length of time harvested related to the growth of pinhead in the media. Factors that affect harvests are nutrients, water, temperature, and humidity. Lack of nutrients and water can inhibit the growth of oyster mushrooms. It is consistent with the statement Parjimo and Agus [19], to stimulate growth and fruit body pinhead, require 80-90% humidity. Pinhead and fruiting bodies grow with humidity below 80% will be impaired nutrient absorption, causing drought and death. This moisture maintained by spraying water regularly.

![Figure 3](image)

**Figure 3.** Oyster mushroom harvest time for each treatment.

3.3.2. Weight of fresh fruit body
Figure 4 shows that the weight of the body wet white oyster mushroom highest is P3 using adding EM4 (3ml) with an average weight of 71 grams generated. While the lowest is in P1 with no added weight, EM4 produced 48 grams.

Good media is media that can produce the mushrooms with a high total wet weight. Based on the observation of the fresh weight of the oyster mushroom body weight, the heaviest is P3 with the addition of EM4 (3ml), the total weight produced is 71 grams. The growing medium P1 by not adding EM4, the resulting weight is only 48 grams. It presumed that the weight of the oyster mushroom fruit body influenced by the nutrients in waste bamboo powder form of lignin that play a role in the metabolism of the fungus fruit flesh lignin could add oyster mushrooms wet weight. Besides, another factor that influences is the water contained in the bamboo waste powder growing media, if the bamboo waste powder growing media lacks water, it will experience dryness in the baglog and will affect the wet weight of the body of the white oyster mushroom. Other influences are not separated

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| Treatment | Harvesting (days) |
|-----------|-------------------|
| P1 (Control) | 2 |
| P2 (1 ml) | 2 |
| P3 (3 ml) | 3 |
| P3 (5 ml) | 3 |
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![Graph]

**Graph.** Oyster mushroom weight for each treatment.
also by temperature and humidity. It is consistent with the statement Suriawiria [14] that the oyster mushroom wet weight is affected by nutrients such as carbohydrates and proteins, fertility growing media, as well as humidity and temperature mushroom room.

3.3.3. Number of fruiting body

Once the known wet weight of oyster mushroom, then count the number of white oyster mushroom fruit body growing on each treatment. Based on the results in a variable number of oyster mushroom fruit body obtained value, Figure 5. The average number of fruiting bodies of oyster mushroom harvest the highest of P1 without the addition of EM4 with 28 fruiting bodies. The average number of oyster mushroom fruit body to its lowest harvest on P3 using additional EM4 with an average of 21 fruiting bodies. The variance showed that the treatment of the growing media waste bamboo powder has no significant difference.

![Figure 4. Weight of fruit body.](image-url)
In this study, the number of fruit bodies influenced by the absorption of nutrients in the media. The nutrients contained in the scattered planting media will help the growth of the mushroom fruit body. In this growing medium, nutrition is fulfilled by the addition of bran in the formation of many mycelia so that it can form many fruit bodies as well. It is consistent with Mufarrihah [20] statement that less than the maximum results in the decomposition process nutrients absorbed for growth will be less than the maximum so that the production amount of fruit body will hamper. The decomposition process goes well; the nutrients absorbed for growth will also be maximal, so that the production of fruit body counts will be optimal. The number of fruit bodies also influenced by the number of pinheads that grow. The nutrients contained in the growing media spread on each pinhead that formed. Nutrients in the growing media also obtained from rice bran containing vitamin B. Besides, high potassium content will cause the enzymes to work smoothly, and the mushrooms get enough energy so that in pinhead formation smoothly and automatically, the number of fruit bodies formed is also significant.

According to Indriyani [11], on the formation of fruiting bodies, the necessary air temperature between 16-22°C with a humidity of 95-98%, with a relatively high content of oxygen gas and carbon dioxide gas demand is relatively low. In this study, the average air temperature at fruit growth was 23-30°C and humidity 50-92%. It can conclude that, if the temperature and humidity of the air during research have not been optimal for fruit body growth, but suitable and sufficient nutritional factors then energy for the metabolic process of fruit body growth, so that the resulting fruit body will also be optimal, and vice versa.

4. Conclusion
The addition of a 3 ml EM4 activator (P3 treatment) is the best treatment in the manufacture of growth media made from bamboo waste. P3 treatment resulted in an average complete closure of mycelium (39 days) and the fastest growth of a prospective oyster mushroom body (21 days) and a current weight of mushrooms (71 grams).

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