Growth and production of white oyster mushroom (*Pleurotus ostreatus*) by adding coconut water to agricultural waste as a carbon source media

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Abstract. White oyster mushroom is a mushroom consumption that is popular with people and has a high nutritional value. The growth medium for this fungus is a carbon-based agricultural waste that has a high lignocellulose content. The research objective is to discover the best growing media for the growth and production of oyster mushrooms. Three carbon source growing media used are oil palm empty fruit bunches, corn cobs, and sawdust. Media mixed with bran and lime then soaked up to 30% water, mixed with coconut water, and carried out sterilization for 8 hours. The study was arranged using a factorial design based on a randomized block design. Data collection is done by observing the time of the pinhead's emergence and the time taken by the fungus mycelium to fill the baglog. The results showed that the oil palm empty fruit bunches media gave the fastest growth of oyster mushrooms, which was 35 days with 14.5 fruiting fruit bodies. This shows another potential of oil palm empty fruit bunches as a cultivation medium, which so far has only been used for the polymer fiber and fertilizer industry.

1. Introduction

Agricultural waste production in Indonesia is very abundant. Agricultural wastes such as banana peels, rice straw, corn cobs, sugarcane bagasse, sawdust, oil palm empty fruit bunches, and coconut fiber still have high lignocellulosic content. Lignocellulose consists of three carbohydrate polymers, namely cellulose, hemicellulose, and lignin. Waste containing lignocellulose can be used as a carbon source [1]. This also happens in the livestock production process, which produces gas ammonia. However, the ammonia can be reduced by utilizing lime and soybean plants [2] Agricultural residues such as oil palm empty fruit bunches, corn cobs, and sawdust are well utilized as white oyster mushroom growing media.

Oyster mushroom (*Pleurotus sp*) is a consumption mushroom with high nutritional value. Some types commonly cultivated by the Indonesian people are white oyster mushroom (*P. ostreatus*), pink oyster mushroom (*P. flabellatus*), gray oyster mushroom (*P. sajor caju*), and abalone oyster mushroom (*P. cystidiosus*). White oyster mushroom is one type of wood fungus that can be eaten [3] and has a high nutritional value, namely carbohydrate, protein, fat, crude fiber, Ca, Fe, thiamin, riboflavin [4]. This mushroom can grow on various substrates that contain lignocellulose. One of the growing media that has not been utilized by the farming community is agricultural waste. These...
wastes include sawdust, corn cobs, and oil palm bunches. The farm waste contains many elements that plants need and can be used as a source for growing white oyster mushrooms.

Another nutrient source not utilized by farmers is coconut water, which contains sugar and micro minerals as a useful source of nutrition for mushrooms. Coconut water also contains organic acids and amino acids and contains sugar. It has the benefit of stimulating plant growth and can be added to the growing media of white oyster mushrooms (Pleurotus ostreatus). The research aims is to discover the best growing media for the growth and production of oyster mushrooms from agricultural waste.

2. Materials and Methods

2.1. Materials and Research Design

Materials used for the growing media from the agricultural waste of carbon sources obtained from farmers, namely oil palm bunches, corn cobs, and sawdust. The content is mashed and sifted, then each mixed with bran and lime. The media mixture was moistened with 30% water. The mixture was then given coconut water according to treatment. After that, it was composted for seven days. The media is put into a baglog size 18x30 cm, compacted, and sterilized by steaming for 8 hours. After being cooled to temperatures reaching 30°C, mushroom seeds are put into a baglog. Oyster mushroom seeds were obtained from mushroom farmers about 10 days after inoculation.

The research was arranged in an experimental form using a factorial design based on a Randomized Group Design. The first factor is the growing media, consisting of oil palm empty fruit bunches, corn cobs, and sawdust. The second factor is the provision of coconut water with 2 levels of maturity, namely young coconut water and old coconut water. This study consisted of 6 treatment combinations, and each combination consisted of 3 groups, so there were 18 experimental units.

2.2. Oyster Mushroom growth test on various media

The mouth of the oyster mushroom baglog, which has been filled with mycelium, is then opened. Daily fogging is carried out to maintain its moisture. The growth parameters of the oyster mushrooms were by measuring the time taken by the mycelium fungus to fill in the baglog and the first pinhead appearance.

2.3. Fresh Weight of oyster mushrooms on various media

Oyster mushrooms were harvested when the hood hasn't curled; the color hasn't faded, the spores haven't been released, the texture is still sturdy and flexible. Harvesting was done by pulling out without leaving a part of the fungus. The mushrooms were is harvested after 3 days of appearing pinhead.

3. Results and Discussion

3.1. Growth of White Oyster Mushroom Mycelium

White oyster mushrooms showed the ability to grow on all carbon source media that were tested in this study. The fungus produces quite a lot of fruiting body in all growing media (Figure 1).
Analysis of variance showed that the use of carbon source growing media had a significant effect on the growth rate of white oyster mushroom mycelium. The growth of white oyster mushroom mycelium was shown in Table 1.

**Table 1.** Growth of white oyster mushroom mycelium meets baglog (days) on the planting medium of carbon sources treated with coconut water.

| Growth of Oyster Mushroom | Coconut Water | Oil palm empty fruit bunches | Corncobs | Sawdust | Average |
|---------------------------|--------------|----------------------------|----------|---------|---------|
| The length of mycelium fills the baglog (days)  | Young coconut | 23.44 | 26.67 | 32.00 | 27.37 |
| Ripe coconut | 24.00 | 26.67 | 29.89 | 26.85 |
| Average | 23.72<sup>a</sup> | 26.67<sup>b</sup> | 30.94<sup>c</sup> | |
| Time for pinhead to appear (days) | Young coconut | 34.89 | 39.67 | 49.17 | 41.24 |
| Ripe coconut | 35.33 | 38.67 | 45.17 | 39.72 |
| Average | 35.11<sup>a</sup> | 39.17<sup>ab</sup> | 47.17<sup>c</sup> | |
| Number of fruit bodies (pieces) | Young coconut | 14.56<sup>d</sup> | 10.11<sup>c</sup> | 2.89<sup>a</sup> | 9.19 |
| Ripe coconut | 12.83<sup>cd</sup> | 11.67<sup>cd</sup> | 7.93<sup>b</sup> | |
| Average | 13.69<sup>c</sup> | 10.89<sup>b</sup> | 5.41<sup>a</sup> | |

Notes: Number followed by the same letters are not significantly different according to HST at 95% confidence level.

The oil palm empty fruit bunch media was able to grow mycelium white oyster mushrooms to fill the baglog faster than the other treatments, which was 23.7 days (Table 1). That time is influenced by the content of cellulose and hemicellulose in high oil palm empty fruit bunches. High cellulose and hemicellulose in oil palm empty fruit bunching waste break down into more straightforward materials. Its material is more readily decomposed than lignin so that it can be incorporated by fungal cells as nutrients. The oil palm empty fruit bunches hemicellulose content is 28.9 percent [5].

Cellulose and hemicellulose will turn into glucose, whereas lignin is resistant to microbial decomposition, so the weathering or degradation process becomes slow and requires more time. Therefore, the more cellulose and hemicellulose content in a type of media can increase the growth rate of white oyster mushroom mycelium. But high levels of lignin in a medium can inhibit the growth of white oyster mushroom mycelium. Cellulose is a carbon compound consisting of more than 1000 glucose units and can be decomposed by various cellulolytic organisms into pure C compounds. While lignin is a waste component that is relatively difficult to degrade. This compound is a structural polymer associated with cellulose and hemicellulose [6].

Oyster mushrooms' ability to grow on other carbon source media such as cocoa pods has also been reported. Seven days after inoculation in Petri dish, the growth of oyster mushroom mycelium reached a diameter of 7 cm in cellulose media, and 4.10 cm in lignin media [7,8].

While the use of coconut water at different maturity levels does not affect mycelium's growth rate, nutrients in coconut water have not been utilized optimally by white oyster mushrooms. It also happened in research [9], namely the provision of coconut water and demons (one of the growth regulators did not respond well to the growth of oyster mushroom mycelium. It was also shown in research conducted [10]. The provision of coconut water with different concentrations and ages gives the same effect on mycelium growth. Coconut water with different ages and levels is still unable to supply all the nutrient requirements needed for mycelium growth.

The speed of fungus mycelium filling the baglog on oil palm empty fruit bunches media also affected the rapid formation of a white oyster mushroom pinhead, which is 35.11 days after inoculation, as compared to the sawdust planting media whose pinhead appeared at 47.17 days. The
formation of fruit bodies or pinhead is indirectly affected by mycelium growth. Mycelium growth is the initial stage of fruit body formation. Mycelium serves to absorb water, nutrients, and organic matter from the media to stimulate the growth and development of white oyster mushrooms. High cellulose and hemicellulose content in oil palm empty fruit bunches waste will break down into more straightforward materials so that they can be used as nutrients to be absorbed into cells. Both of these elements will turn into glucose [11].

Table 1 also shows that the interaction between the types of growing media and the coconut water level has a significant effect on the number of white oyster mushroom bodies. The best growing media is oil palm empty fruit bunches, which is given young coconut water with average fruit bodies of 14.56 units. This amount is far more than the treatment of sawdust planting media that is 2.89 fruit bodies, whereas the production of the oyster mushroom fresh fruit body is shown in Figure 2.

![Figure 2. Fresh weight of oyster mushrooms (g) produced in various growth media sources of carbon.](image)

The use of oil palm empty fruit bunches as an oyster mushroom cultivation media is still rarely used and more directed at polymer fibers, soil conditioners, and fiberboard and biosilica fertilizer [12–14]. Oyster mushroom production is higher in oil palm empty fruit bunches, although not significantly different from corn cobs (Figure 2). Oil palm empty fruit bunches media, which has been used for oyster mushroom cultivation, can also be used as a planting medium for other commodities such as for horticultural plant cultivation. It contains carbon (C), which is quite high is 28.41%. It also contains N 2.42%, P 0.58%, K 0.95%, Na 0.51 ppm, Mg 0.53 ppm, and Fe 0.98 ppm [15].

The oil palm empty fruit bunches contain high cellulose, which white oyster mushrooms are needed for growth. Besides that, the lignin content is low, so it does not inhibit the growth of oyster mushrooms. The lowest growth and production of white oyster mushrooms were in sawdust media. Sawdust contains lignin, which is high enough that it takes a long time to be degraded by white oyster mushrooms as a substrate.

The mechanism of cellulose molecular breakdown is inhibited by the high degree of polymerization and crystallization and the lignin content that wraps the cellulose molecule. Delignification is a process of liberating lignin from a complex compound. This process is essential before the hydrolysis of cellulolytic material because lignin can inhibit the penetration of acids or enzymes before the hydrolysis takes place [16]. Oyster mushrooms, in addition to consumption mushrooms, and weathering fungi capable of producing lignocellulose enzymes characterized by the formation of clear zones in czapek dox, reach 75% [17].
The treatment of the use of coconut water at different levels of maturity did not affect the growing media used on the fresh weight of the white oyster mushroom body. Although it contains sugar, coconut water has a low matter content (2% to 5% wet basis) [18]. It can be the cause of the level of maturity of coconut water, which has no real effect on the growth and production of oyster mushrooms.

4. Conclusion
Oil palm empty fruit bunches media is the best medium for the growth and production of white oyster mushrooms with the fastest pinhead emergence of 35.11 days and produces an average fruit body of 14.56 pieces per baglog.

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