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The Effect of Banana Stem Powder on the Productivity of the Brown Oyster Mushroom (*Pleurotus cystidiosus*)

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Abstract

Background: Brown Oyster Mushroom (*Pleurotus cystidiosus*) is a type of mushroom with different advantages from other oyster mushrooms. Generally, farmers make planting media for brown oyster mushrooms made from sawdust, some of which come from sengon wood powder. The availability of raw materials for sawdust of sengon wood is increasingly difficult to obtain. So, we need other alternative materials as a source of nutrition, one of which is banana stem waste. This study aims to determine the effect of banana stem powder on the diameter of the cap, the number of fruiting bodies, and the wet weight of the fungus. **Methods:** This research uses a completely randomized design (CRD), which consists of one factor. This study used four treatments and three replications. Data was tested by quantitative descriptive analysis using the Analysis of Variance (ANOVA) test. Results showed that banana stem flour had a significant effect on all parameters. The JM2 treatment resulted in a cap diameter of 10.3 cm, 10.6 mushroom fruiting bodies, and 103.8 g wet mushroom weight. **Results:** showed that banana stem flour had a significant effect on all parameters. The JM2 treatment resulted in a cap diameter of 10.3 cm, 10.6 mushroom fruiting bodies, and 103.8 g wet mushroom weight. **Conclusions:** This study can provide new knowledge about mixed planting media with the addition of banana stem powder and can increase productivity on the parameters of mushroom cap diameter, number of mushroom fruiting bodies, and wet weight of mushrooms, which readers or researchers can use as a source or reference. Utilization of waste such as sawdust of sengon wood and waste of banana stem fronds for the cultivation of brown oyster mushrooms is one way of handling plantation waste.

Keywords: banana stem fronds; brown oyster mushrooms; productivity; sengon wood

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Introduction

The oyster mushroom (*Pleurotus ostreatus*) is a type of wood mushroom that mushroom farmers have widely cultivated. One of them is the brown oyster mushroom. The brown oyster mushroom has easily recognizable characteristics, including the shape of a cap with a diameter of 4-15 cm or more, a hood with a smooth surface when moist, the color of the cap is white-brown or reddish-brown when adults (Mudakir et al., 2014). The advantages of the brown oyster mushroom include a thicker fruit cap, a more delicious taste than other oyster mushrooms, and a longer shelf life (Masefa et al., 2016). The brown oyster mushroom has a higher nutritional content than other wood mushrooms. Brown oyster mushroom is a type of mushroom that the community has widely used as a source of healthy food and medicine. The nutritional content of brown oyster mushrooms includes vitamins B, C, and D, which are very high compared to other oyster mushrooms (Indratmi et al., 2021). Brown oyster mushrooms can supplement the body's immunity against disease (Khatun et al., 2015).

The main factor affecting the production and growth of oyster mushrooms is the growing medium. Oyster mushrooms are cultivated on media (baglog) derived from sawdust. The media usually contains nutrients for fungal growth, such as lignin, vitamins, nitrogen, carbohydrates (cellulose and glucose), and fiber. Generally, the powder used comes from sengon wood with a lignin content of 26.80%, hemicellulose of 24.59%, and cellulose of 49.90% (Rambey et al., 2019). Sengon wood powder is used as a medium for growing oyster mushrooms because it is a hardwood, is not gummy (because sapwood can inhibit the growth of oyster mushrooms), and does not contain oil or other chemicals. Therefore, sengon sawdust can be a growth medium for oyster mushrooms (Azizah et al., 2023). Currently, sengon sawdust is increasingly rare, so mushroom cultivation needs to be developed in various ways. One is by varying the growing media by providing additional organic matter besides sawdust (Ishak & Daryono, 2021). Alternative additional media that can be used to embody mushroom productivity is utilizing plantation waste, for example, banana stem waste.

Bananas are fruits that occupy the first position and are the most produced in Indonesia (Hidayati & Suhartini, 2018). According to the 2018 Annual Vegetable and Fruit Plant Statistics data, the production of banana plants is 11,258,986 quintals. According to the Central Bureau of Statistics and the Directorate General of Horticulture (2018), banana production in Indonesia always increases yearly. Based on the Central Statistics Agency (2015), Central Java Province is ranked fourth (12.38%) in the production of banana plants. Surakarta Regency, Central Java, Indonesia, is geographically based on agriculture, especially plantations. Banana plants have the potential to grow in plantation areas in Surakarta. Usually, banana plants only take the fruit and leave waste in leaves and stems.

Banana stem midrib contains sufficient amounts of cellulose but has not been utilized optimally (Amilia & Hidayanti, 2022). Banana stems contain 35% pentoses, 45% lignin, and 45% cellulose (Mumtazah et al., 2017). Comparison of fresh weight between banana stems, leaves, and fruit is 63.14 and 23%, with a fiber length of 4.20 to 5.46 mm, specific gravity of 0.29 g, cellulose substance between 60-65%, lignin 5-10 %, hemicellulose 68%, and extractive substances (Nurjannah et al., 2020).

Cultivating brown oyster mushrooms can be carried out with waste banana stems, which provides satisfactory results related to the production of enzymes in the media and the productivity obtained in mushroom cultivation (de Carvalho et al., 2012). Oyster mushroom cultivation technology in the Surakarta region is still slightly developed. The Surakarta region has high potential in oyster mushroom cultivation, with the large availability of agricultural waste, so this research needs to be carried out to disseminate the knowledge gained and spread the popularity of the brown oyster mushroom in the Surakarta region.

The purpose of this study was to determine the effect of brown oyster mushroom productivity on media substrates based on differences in media concentrations mixed with sengon sawdust and banana stem frond waste on the parameters of mushroom cap diameter, number of mushroom fruiting bodies, and wet weight of mushrooms.

Methods

This research utilized the waste of sengon sawdust and the waste of banana stem fronds on the productivity of brown oyster mushrooms. This research began from January 2023 to March 2023, from preparation, making media, planting mushrooms, treating and harvesting, and concluding. The materials used were sengon wood powder, banana stem powder, rice bran, agricultural lime, water, 75% alcohol, and brown oyster mushroom F2 seeds. The materials used are sengon wood powder obtained from waste wood craftsmen, banana stem powder obtained from banana plantation waste, rice bran, agricultural lime, water, alcohol, and F2 brown oyster mushroom seeds obtained from the Mushroom Cultivation Laboratory, Faculty of Teacher Training and Education, Muhammadiyah University of Surakarta.

This experiment used a completely randomized design (CRD) with a one-factor experiment, namely differences in the treatment of banana stem powder. This study consisted of four treatments with three repetitions to obtain 12 trials.

JM0: 1200 g of sengon wood powder and 0 g of banana stem powder
JM1: 1150 g of sengon wood powder and 50 g of banana stem powder
JM2: 1100 g of sengon wood powder and 100 g of banana stem powder
JM3: 1050 g of sengon wood powder and 150 g of banana stem powder

Procedure

Cut the banana stem fronds with a size of approximately 0.5 cm, then dry the banana stem fronds in the sun for 2 or 3 days, then pound the dry banana fronds. It mixed sengon wood powder, rice bran, agricultural lime, and banana stem frond powder. Mix all the ingredients evenly and add enough water, then compost the media by covering it with a tarp for 24 hours, then put the media in a plastic baglog and compact the media with a baglog compactor. After that, install a plastic ring and cover, and sterilize the baglog at 80°-90° °C for 8 hours, followed by the media cooling stage after sterilization for 24 hours (Nazar et al., 2021).

Carry out inoculation by preparing the tools and materials to be used, then sterilizing the tools and materials using 70% alcohol. The first step is to inoculate by opening the lid on the baglog. Next, prepare F2 brown oyster mushroom seeds. In making mushroom seeds, several steps must be carried out. The first stage is to take a pure culture of the fungus (F0), then plant F0 into the planting medium, which is called stage one breeding (F1 seeds), then lower the F1 seeds into the planting medium, which will later be called F2 seeds (Zarmiyeni, 2016). Then, put the F2 seeds on the surface of the baglog for about two tablespoons, then cover the media that has been filled with the seeds again using cotton. Incubation occurs at 60-80% humidity with a temperature of 22-28°C (Kusumawardani et al., 2021). Incubate in a dark, well-ventilated room until the mycelium fully penetrates the substrate's bottom (Dubey et al., 2019). Move the media into the lumbung when the growing mycelium has reached 100%, then open the ring and plug the baglog when the mycelium starts to turn yellow in the media. Opening the media aims to obtain sufficient oxygen for the growth of the mushroom-fruiting bodies.

Spraying water using a sprayer on the baglog planting medium, which is done once a day during the rainy season and 2-3 times a day during the dry season, spraying water on the baglog media aims to supply the water content in the substrate to support mycelium growth, (Soares et al., 2022).

Harvesting oyster mushrooms is characterized by the characteristics of the oyster mushroom caps that are enlarged and not broken. The size of oyster mushrooms that are not optimal cannot be harvested because it will reduce the weight of the harvest (Soares et al., 2022). Harvesting is done by removing all the clumps in the baglog. This is done so that the mycelium can grow back on the former mushrooms after harvesting.

Data analysis

Data analysis in this study used the SPSS 20 program. The observed data were tested for normality and homogeneity, then followed by the One Way Anova test at a 5% level to test the effect of each treatment on the productivity of the brown oyster mushroom (*Pleurotus cystidiosus*). Data collection was carried out by measuring several parameters on the brown oyster mushroom (*Pleurotus cystidiosus*), including the diameter of the cap (cm) by measuring the most optimal sample diameter of the mushroom cap for each unit in replicates for each treatment with the help of a measuring ruler, the number of fruiting bodies (fruit) This was done by calculating the total number of fruiting bodies, both large and small size categories in the baglog, and the wet weight of the mushrooms (g) weighing the weight (g) of the brown oyster mushrooms in each unit in replicates for each treatment when harvesting using a scale (Mudakir et al., 2014).

Result

This study aims to determine how the effect of a mixture of sengon sawdust and banana stem powder has the most optimal productivity of brown oyster mushrooms. Based on the results of the research that has been done, different averages for the parameters of cap diameter, number of fruiting bodies, and wet weight of the mushrooms are presented in Table 1.

Table 1. Average Productivity of Brown Oyster Mushroom

Treatment	Average Hood Diameter (cm)	Average Number of Fruit Bodies (Fruit)	Average weight wet (g)
JM0	9,3*	8*	97,6*
JM1	9,8	8,8	99,3
JM2	10,3**	10,6**	103,8**
JM3	10,3**	10	102

Description: lowest (*) highest (**)

Observation of the diameter of the cap of the brown oyster mushroom in this study was carried out for 45 days from the inoculation stage to the end of the harvest, then the data observed in the first and second harvests were averaged. The results of measuring the diameter of the brown oyster mushroom cap obtained different results in each treatment. Table 1. shows that the average cap diameter of the brown oyster mushroom obtained the highest results, namely in the JM2 and JM3 treatments, which had an average mushroom cap diameter of 10.3 cm, and the lowest cap diameter was in the JM0 treatment, which had an average mushroom cap diameter of 9.6 cm.

Observation of the number of brown oyster mushroom fruiting bodies in this study was also carried out for 45 days from the inoculation stage to the end of the harvest period, then the data observed in the first and second harvests were averaged. Measuring the number of mushroom fruiting bodies obtained different results in each treatment. Table 1 shows that the average number of mushroom fruiting bodies with the highest average yield was in the JM2 treatment, which had an average number of mushroom fruiting bodies of 10.6 fruit, and the lowest data was in the JM0 treatment, which had an average number of mushroom fruiting bodies of 8 fruit.

Observation of the wet weight of brown oyster mushrooms in this study was also carried out for 45 days, starting from the inoculation stage until the end of the harvest period. Then, the data observed in the first and second harvests were averaged. The results of measuring the wet weight of the fungus obtained different results in each treatment. Table 1. shows that the highest average wet weight of the mushrooms was in the JM2 treatment, with an average total wet weight of 103.8 g of mushrooms, and the lowest data was in the treatment, with an average wet weight of 97.6 g.

Discussion

Based on the table above, it can be seen that the average JM2 treatment has the most optimal results in terms of the diameter of the mushroom cap, the number of mushroom fruiting bodies, and the wet weight of the mushroom. The diameter of the mushroom cap showed that the average diameter of the brown oyster mushroom obtained the highest average results, namely in the JM2 and JM3 treatments, which had an average diameter of the mushroom cap of 10.3 cm. The lowest average was found in the JM0 treatment, with an average mushroom cap diameter of 9.6 cm.

Based on Table 1, the difference in the mean diameter of the mushroom caps in the studies that have been conducted showed different results, namely, the JM2 and JM3 treatments had a higher mean mushroom cap diameter when compared to the JM0 treatment, the JM2 and JM3 treatments were the most effective for the mushroom cap diameter. The JM0 treatment was insufficient to meet the nutrients needed for the growth and development of the fungus. The lowest diameter of the mushroom cap can also be caused by insufficient oxygen obtained for the fungus to grow, resulting in a small diameter even though the number of fruiting bodies produced is large. According to the research of Kurniawati et al. (2018), the air factor can influence the formation of the diameter of the mushroom cap. Lack of oxygen can inhibit the fungal metabolic system. If the fungus obtains sufficient oxygen, it will produce a cap diameter with a larger size. In contrast, the fungus that obtains low oxygen can inhibit the metabolic system in fungus (Rambey et al., 2020).

Based on Table 1., Observations on the number of fruiting bodies in each treatment ranged from 8 to 10.6 fruits. The number of fruiting bodies in the planting medium mixed with sengon sawdust and banana stem waste was higher than the results of the study (Rambey et al., 2019), showing the average number of fruiting bodies in the mixed planting media composition (200 g corn cobs and 700 g sawdust) as many as 8.4 pieces. This is because the nutrients obtained from the mixture of banana stem waste are greater than from the mixture of corncobs and sawdust. The number of fruiting bodies in the planting medium mixed with sengon sawdust and banana stem frond waste was lower than the results of the study (Rambey et al., 2020), showing the average number of fruiting bodies in the mixed planting media composition (300 g rice straw mixture, 100 g rice bran, lime 50 and sawdust 550 g) as much as 10.8 pieces. This is because the nutrients obtained from the mixture of banana stem waste are smaller than the mixture of corncobs and sawdust. This opinion is supported by Djarijah & Djarijah (2001), that without a sufficient mixture of nutrients, the number of fruiting bodies that grow will be small because oyster mushrooms require nutrients in the form of carbon, nitrogen, vitamins, and mineral compounds. Nitrogen is needed to form proteins, fats, and various organic compounds, and nitrogen is also useful for accelerating the growth of fungi (Mudakir & Hastuti, 2015). High concentrations of nitrogen sources cause inhibition of mycelium growth (Hoa & Wang, 2015). The lignocellulosic content of banana stems is 44.0% cellulose, 17.5% hemicellulose, and 37.3% lignin (Abdullah et al., 2013).

Based on Table 1, the observation of the addition of banana stem powder affected the wet weight of the brown oyster mushroom (*Pleurosus cystidiosus*). The JM2 treatment gave the most optimal results and produced an average wet weight of 103.8 g of mushrooms. However, the JM0 treatment gave the lowest yield and produced an average wet weight of 97.6 g. The JM2 treatment produced the highest wet weight because this was due to the addition of banana stem powder. The nutritional content of the banana stem midrib is 26.64% cellulose, 9.92% lignin, 24.31% ash, 8.62% dry matter, 4.81% crude protein, and 27.73% crude fiber (Dhamayanti et al., 2018). Lignin and cellulose nutrients in the banana stem midrib will be broken down into glucose and other compounds and used as an energy reserve to obtain optimal fresh weight. Oyster mushrooms require lignocellulose as a carbon source to obtain organic compounds as a constituent of the mushroom cells (Kurniawati et al., 2018). Research by Prayogo et al. (2018) states that the source of nutrients used in baglog growing media will affect the yield of mushroom production. The nutrients stored in the planting medium will be absorbed by the mushrooms so that they can increase the wet weight of the mushrooms (Maesaroh et al., 2021). The research of Rambey et al. (2019) states that the greater the number of fruit bodies obtained, the greater the wet weight obtained because each fruit body contains water, so the more fruit bodies, the higher the wet weight. The JM0 treatment produced the lowest wet weight because it was influenced by the absence of the addition of banana stem powder in the JM0 treatment, thus causing the nutrients contained in the JM0 media to be very low. The metabolism will be low in media with few nutrients, and the wet weight of the oyster mushrooms obtained will be low (Apriastuti, 2021). In addition, low wet weight can be caused by small fruiting bodies so that the water content in each fruiting body is small (Rambey et al., 2019).

Conclusions

Based on data on all parameters of the research results, it can be concluded that the use of planting media with a comparison of the concentration of JM2 (1100 g of sengon wood powder and 100 g of banana stem powder) obtained the highest results and the JM0 concentration treatment (1200 g of sengon wood powder and 1200 g of banana stem powder) 0 g) the lowest yield was obtained. Treatment of a mixture of sawdust of sengon wood and banana stem fronds as a planting medium affects the productivity of brown oyster mushrooms. Utilization of waste such as sawdust of sengon wood and waste of banana stem fronds for the cultivation of brown oyster mushrooms is one way of handling plantation waste.

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Declaration statement

The authors reported no potential conflict of interest

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