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The Effect of Cassava Peel Powder on the Productivity of the Brown Oyster Mushroom (*Pleurotus cystidiosus*)

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ABSTRACT

The oyster mushroom cultivation medium is generally sengon sawdust. As time goes by, there is a buildup of agricultural waste, one of which is cassava skin. Cassava peel contains nutrients that are in accordance with the nutrients needed as a medium for oyster mushroom cultivation. The purpose of this study was to determine the effect of a mixture of sengon sawdust and cassava peels with different weight ratios on the productivity of the brown oyster mushroom (*Pleurotus cytidiosus*). The research design used was a completely randomized design with 7 treatments, including M0, M1, M2, M3, M4, M5, and M6. Then the data were analyzed with One Way Anova using SPSS 20. The results showed that the M2 treatment (90% sengon sawdust + 10% cassava peel powder) had the highest average wet weight, namely 84.9 g, and the fastest *pinhead* appearance time, which was 40.2 days after inoculation. Then in the M5 treatment (75% sengon sawdust + 25% cassava peel powder), the highest average number of fruit caps was 22.8 fruit caps. And the One Way Anova test shows that all three parameters have F count > F table. Thus, there is an effect of adding media mixed with sengon sawdust and cassava peels with different weight ratios on the productivity of brown oyster mushrooms.

1. INTRODUCTION

Mushroom cultivation in Indonesia has been widely developed and has become a lucrative business opportunity for farmers. Some of the advantages of producing mushrooms include being easy to cultivate, not requiring large areas of land, a relatively fast production period, and relatively stable market selling prices (Wahyuningtyas and Damanhuri 2019) . The majority of mushrooms that are widely cultivated by farmers in Indonesia include oyster mushrooms, straw mushrooms, ear mushrooms, and button mushrooms. According to Jakiyah et al. (2017), there are several types of oyster mushrooms, including white oyster mushrooms, brown oyster mushrooms, white oyster mushrooms of the *Gray oster variety* , yellow oyster mushrooms, ash oyster mushrooms, and pink oyster mushrooms.

In the cultivation of oyster mushrooms, farmers generally use the media in the form of sawdust (Tolera and Abera 2017). The types of sawwood commonly used by mushroom farmers are sengon wood, teak wood, mahogany, candlenut wood, and rambutan wood (Nasution 2016) which are then added with bran, lime, and gypsum with a certain composition to support the growth of these mushrooms (Elfandari et al. al. 2021) .

The sawdust that is generally used by mushroom farmers is the sawdust from sengon wood because of its light characteristics, not gummy, and the texture are not too coarse. Suryani & Carolina 's research (2017) also states that sengon sawdust contains high cellulose, low lignin, is not gummy, easily absorbs and stores water, and has a fast drying and composting process. The chemical content in sengon sawdust is 49.40% cellulose, 24.10% hemicellulose, 23.55% lignin, and 4.67% extractive substances. These ingredients can support the productivity of oyster mushrooms. Cellulose and hemicellulose are substrates that fungi will break down into simpler components so that they are easily absorbed by fungi for growth (Adawiyah et al. 2017) .

As the industry develops, Elfandari et al. (2021) stated that sengon sawdust is increasingly difficult to obtain due to the reduced use of wood, which causes the price of sawdust to increase and results in increased mushroom production costs. Massive logging of forests and the conversion of forests into settlements have also been a factor in the reduced production of wooden crafts in Indonesia. In addition, sengon sawdust is also used for the manufacture of activated charcoal, charcoal briquettes, mixtures for making bricks, and others (Suparti and Marfuah 2015) . Thus, an alternative is needed to overcome this problem by utilizing waste in the form of cassava peels which can be used as a mixture of planting media in producing mushrooms.

Cassava skin waste can be found in *the home industry* for making cassava chips, cassava cheese, cassava tape, and many more. According to the Central Bureau of Statistics, cassava production in Indonesia in 2020 will reach 18.3 million tons. While the percentage of cassava skin is approximately 20% of the tuber. So that in 1 kg of cassava, 0.2 kg of cassava skin is produced, which is simply ignored (Ntelok, 2017) . According to Widyastuti (2019), in one year, the use of cassava reaches 18.9 million tons. This means that the white inner skin or cortex waste can reach 1.5-2.8 million tons while the brown outer skin waste or epidermis reaches 0.04-0.09 million tons. Therefore, the use of cassava peel waste needs to be increased, namely as an addition to the manufacture of oyster mushroom media.

The cellulose content in cassava peel is quite high, which ranges from 80-85% by weight of cassava peel (Santoso et al. 2012) . According to research by Sastri and Putra (2015) also states that cassava peel waste contains 43.63% cellulose, 36.58% starch, 10.38% hemicellulose, 7.65% lignin, and 1.76% other components. So that this cassava peel waste is considered capable of being an alternative in the addition of oyster mushroom growth media in the form of sengon wood powder, which is now increasingly difficult to find.

Based on Pratama's research (2017) which created an innovation in the form of using a mixture of cassava peel and sawdust of sengon wood as an alternative growth medium for white oyster mushrooms, the result is that white oyster mushrooms can grow optimally with a certain composition ratio. The parameters measured were total body weight, number of fruiting bodies, cap diameter, biological efficiency, and harvesting speed. The results of this study stated that white oyster mushrooms can grow optimally at a percentage ratio of 75% sengon wood powder and 25% cassava peel powder. This percentage produces the best white oyster mushroom production among other percentages. In addition, research by Wabali & Favor (2021) also states that mushroom cultivation can be increased by adding agricultural waste such as cassava peels. The addition of 10% cassava peel to the sawdust formulation increased the height, weight, *pileus diameter* and number of mushroom fruiting bodies. Then in this study, using an object in the form of brown oyster mushrooms and combined the two previous studies, which were arranged in a Completely Randomized Design (CRD) with an interval of 5%, including the addition of cassava skin by 5%; 10%; 15%; 20%; 25%; and 30% to determine the best percentage of addition of cassava skin to the productivity of brown oyster mushrooms.

In this study, the brown oyster mushroom is interesting for further research because it has various advantages compared to other types of oyster mushrooms. The brown oyster mushroom has a longer shelf life, a thick or chewy body texture, and a low water content, so it doesn't wilt easily after being harvested (Okere et al. 2021). The selling price at the farm level of brown oyster mushrooms is relatively more expensive than white oyster mushrooms (Ramadhan 2019). And according to Seswati et al. (2013), brown oyster mushrooms have a better taste than other types of oyster mushrooms. The results of this study, it is expected to be able to determine the effect of using a mixture of sengon sawdust and cassava peel media with different weight ratios on brown oyster mushrooms. In order to reduce the production of cassava skin waste in Indonesia.

2. MATERIALS AND METHODS

2.1 Place and time of research

research was conducted at the Mushroom Cultivation Laboratory for Biology Education FKIP Muhammadiyah University Surakarta from December 2022 to May 2023.

2.2 Tools and materials

The tools used include press machines, matches, tarpaulins, spirit burners, storage racks / lemurs, spatulas, digital scales, soil testers, Thermo hygrometers, sterilization cabinets, shovels, hoses, calculators, cameras, and stationery. As well as the materials used include sawdust of sengon wood, cassava peel powder, lime, 70% alcohol, water, polypropylene (PP) plastic measuring 30 cm x 18 cm, baglog rings, rubber bands, F2 white oyster mushroom seeds, F2 mushroom seeds, chocolate oyster.

2.3 Research methods

This study used a one-factor, Completely Randomized Design (CRD) method where the difference in the composition of the cassava peel mixed media was the main factor. The repetition treatment was carried out 3 times in 2 harvest periods. Observations were analyzed using descriptive quantitative data analysis. The parameters studied were the wet weight of the mushrooms, the number of mushroom caps, and the time of appearance of the first *pinhead* .

2.4 Experimental design

The experimental design of this study can be seen in Table 1.

Table 1. Experimental design

Test	M0	M1	M2	M3	M4	M5	M6
1	$M0_1$	$M1_1$	$M2_1$	$M3_1$	$M4_1$	$M5_1$	$M6_1$
2	$M0_2$	$M1_2$	$M2_2$	$M3_2$	$M4_2$	$M5_2$	$M6_2$
3	$M0_3$	$M1_3$	$M2_3$	$M3_3$	$M4_3$	$M5_3$	$M6_3$

Information:

M0 : Brown oyster mushroom with 100% sengon sawdust media
M1 : Brown oyster mushroom mixed with 95% sengon powder and 5% cassava peel
M2 : Brown oyster mushroom mixed with 90% sengon powder and 10% cassava peel
M3 Brown oyster mushroom mixed with 85% sengon powder and 15% cassava peel
M4 : Brown oyster mushroom mixed with 80% sengon powder and 20% cassava peel
M5 : Brown oyster mushroom mixed with 75% sengon powder and 25% cassava peel
M6 : Brown oyster mushroom mixed with 70% sengon powder and 30% cassava peel

2.5 Data collection technique

Data collection techniques used included measuring the wet weight of the mushrooms using digital scales, counting the number of oyster mushroom caps, and calculating the time the pinhead first appeared after inoculation. Then the data were analyzed with One Way Anova using SPSS 20 to determine the effect of the F test treatment at a significance level of 5% (0.05). The results of the observations were then analyzed using descriptive quantitative data analysis .

2.6 Stages of Research Implementation

In the preparatory stage, starting to carry out permits at the Mushroom Cultivation Laboratory for Biology Education, FKIP, Muhammadiyah University, Surakarta, then preparing tools and materials as well as lemur mushrooms to be used in the process of growing oyster mushroom media.

The stage of making the media begins with sorting and washing the cassava skins, then soaking them for 5 minutes to remove any dirt that sticks to the cassava skins. Then, dry the cassava skin for 4 days until completely dry. After drying, the cassava skin is mashed using a grinding machine so that the cassava skin becomes powder which can be mixed with sengon wood powder.

The next step is to compost the sengon sawdust media, which has been given additional ingredients such as lime, rice bran, and water overnight. After composting, mix the media with cassava peel powder according to a predetermined concentration. Then pack the media into *polypropylene plastic* and compact it using a press machine. Then attach the *baglog ring* and close it with the *baglog ring cover* .

The next stage is sterilization by placing and arranging *baglogs* into the sterilization cupboard. The working principle of sterilization is to utilize the heat of water vapor up to 100 ° C for 6-8 hours. This sterilization aims to suppress the growth of other microbes that can inhibit the growth of oyster mushrooms.

Inoculation is done by inserting the brown oyster mushroom F2 seeds into *the baglog* . Inoculation is done by opening the *baglog ring cover, unraveling the seeds, then inserting and spreading the seeds* evenly on the top of *the baglog* . Then close *the baglog* again. After that, arrange the baglog in an incubation room with minimal light. Aim for the mycelium to quickly spread.

Oyster mushroom maintenance after the incubation period until harvest is placed in the kampung. At this maintenance stage, the room temperature is always checked from 10 ° -27 ° C. If the temperature is lower or more, then the mushrooms will not grow optimally. Then, harvesting is done when *the pinheads*, mushroom stalks, and mushroom bodies begin to appear, with the cap widening in the shape of an umbrella.

3. RESULT AND DISCUSSION

3.1. Research result

The research began in December 2022, starting with the manufacture of cassava peel powder media, making brown oyster mushroom baglogs, and treating the kumbung until May 2023. Observations made included calculating the wet weight of the mushrooms, the number of mushroom caps, and the time the first pinheads appeared. The research results are presented in the form of tables and graphs as follows.

Table 2. Average Productivity of Brown Oyster Mushroom

Treatment	Wet Weight (g)		Average Wet Weight (g)	Number of Hoods (hood)		Average Number of Hoods (hood)	Emerging Pinheads (HSI)		Pinhead Appearance Rate (HSI)
Harvest	1	2		1	2		1	2	
M0	86.6	45.0	65.8	2.6	5.0	3.8*	40.0	79.0	59.5
M1	87.0	51.3	69.2	12.0	7.6	9.8	43.0	76.0	59.5
M2	101.6	68.3	84.9**	8.6	5.3	6.9	36.0	44.3	40.2**
M3	87.0	55.3	71.2	11.0	5.6	8.3	66.3	79.0	72.6*
M4	70.0	64.3	67.2	12.3	10.0	11.2	66.6	78.3	72.5
M5	72.5	58.5	65.5	31.0	14.5	22.8**	44.0	64.5	54.3
M6	62.5	65.5	64.0*	8.0	7.5	7.8	51.0	76.5	63.8

Description: (**) Best, (*) Worst

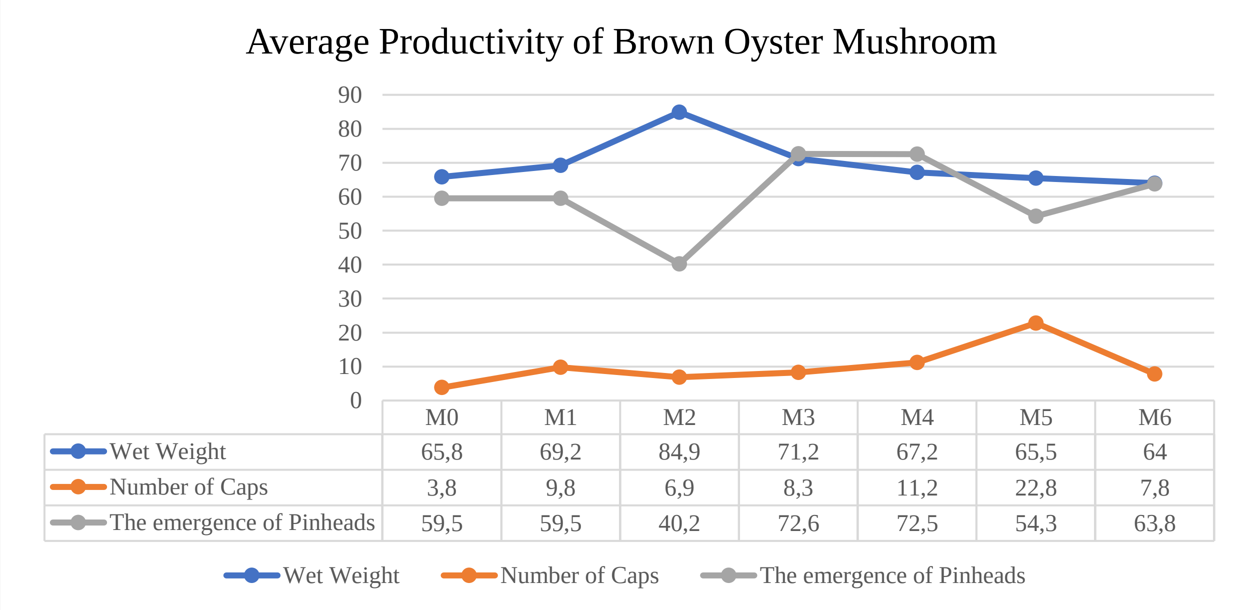


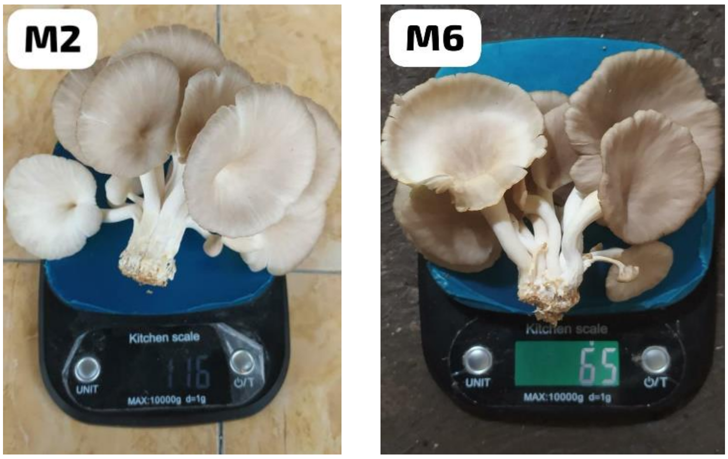
Figure 1. Brown Oyster Mushroom Productivity Graph

Table 3. F test results with SPSS 20

Parameter	F	Sig.	Information
Mushroom Wet Weight	2.553	.037	H_0 is rejected
Number of Mushroom Caps	2.591	.035	H_0 is rejected
The emergence of Pinheads	3.224	.013	H_0 is rejected

3.2. Discussion

The wet weight of the brown oyster mushroom in the M2 treatment (90% sengon sawdust + 10% cassava peel) was superior, with an average weight of 84.9 g compared to the other treatments, and the M6 treatment (70% sengon sawdust + 30% cassava peel) obtained the lowest wet weight with an average weight of 64.0 g. Adawiyah et al (2017) stated that the productivity of the total fresh weight of the fruit bodies of oyster mushrooms decreased because there were not many fruiting bodies that grew, and the ideal conditions needed by the mushrooms were not met. The ideal conditions are influenced by temperature and humidity. The range of temperature and humidity in week 1 to week 6 is 27.5 ° C - 29.6 ° C with humidity 84%-86%. While the 7th to 11th week is 32.9 ° C - 34.2 ° C with 69% -76% humidity. This temperature causes the formation of fruit bodies to be not optimal. In the formation of fruiting bodies, oyster mushrooms require lower temperatures, ranging from 22-28°C. This causes the wet weight of the brown oyster mushroom harvested in the first week to be superior to that of the mushrooms harvested in the last week. The pH level also affects the acidity of the media because fungi can only grow in places with an acidity level close to neutral (Erlinda et al. 2022). The pH level from week 1 to week 11 was relatively the same, ranging from 6-7. Then the One Way Anova analysis test was carried out with SPSS 20, showing that F count > F table, namely 2,553 > 2,372, so there was an effect of adding cassava peel powder with a different composition on the productivity of the brown oyster mushroom, namely on the wet weight parameter of the mushroom.



(a) (b)

Figure 2. Comparison of Highest (a) and Lowest (b) Wet Weight of Brown Oyster Mushroom

The number of mushroom caps in the M5 treatment (75% sengon sawdust + 25% cassava peel) was superior to the other treatments, with an average number of caps in one *baglog* of 22.8 caps. While the M0 treatment (100% sengon sawdust) with an average number of caps was 3.8 caps. According to research by Istiqomah & Fatimah (2014), The fruit bodies that are formed usually depend on the number of growing primordia. If there are many primordia, the number of fruiting bodies formed will also be large because the nutrients contained in the planting medium are spread over each primordia that forms. With a small number of caps, the growth of the caps can grow optimally and not crowd each other, while in the large number of caps, the growth of the caps will jostle each other, causing the mushroom caps to grow less than optimally. In addition, at a small number of caps, the distribution of food will be optimal because the nutrients in the growing media can be maximally absorbed by the mushrooms, but for a large number of caps, the nutrients in the growing media are not evenly distributed because there is competition between the mushroom caps in absorbing nutrients (Apriyani et al(Apriyani et al. 2020). Thus, the number of caps will affect the wet weight produced by the oyster mushrooms because the nutrients are distributed differently between the large and small number of caps in one *baglog* . Then the One Way Anova analysis test was carried out with SPSS 20, showing that F count > F table, namely 2,951 > 2,372, so there was an effect of adding cassava peel powder with a different composition on the productivity of the brown oyster mushroom, namely on the parameter number of mushroom caps.

(a)

(b)

Figure 3. Comparison of the Highest (a) and the Lowest (b) Numbers of Brown Oyster Mushroom Caps

The first *pinhead* to appear in the M2 treatment (90% sengon sawdust + 10% cassava peel) was faster than the other treatments, with an average *pinhead appearance* of 40.2 days after inoculation. Whereas the M3 treatment (85% sengon sawdust + 15% cassava peel) had the longest *pinhead* appearance time of 72.6 days after inoculation. *Pinhead* emergence time is influenced by the growth rate of the mycelium. If the mycelium spreads quickly, the formation of fruiting bodies will also be faster (Elfandari et al. 2021). And Agustine et al. (2017) states that the speed of mycelium growth is influenced by environmental factors such as the condition of the kumbung. Kumbung humidity in week 1 to week 6 is 84% -86%. While the 7th to 11th week is 69% -76%. This condition causes the humidity of the kumbung to decrease from the 7th to the 11th week. The lower the humidity of the kumbung will affect the decrease in the biological efficiency of the oyster mushroom. Kumbung humidity affects the humidity in the media. Kumbung humidity that is too low during the mushroom growth period can cause primordia to dry and not develop (Erlinda et al. 2022). So to get the ideal temperature and humidity, watering is always done regularly. Then the One Way Anova analysis test was carried out with SPSS 20, showing that F count > F table, namely 3,224 > 2,372, so there was an effect of adding cassava peel powder with a different composition on the productivity of the brown oyster mushroom, namely on the parameter when the first pinhead appeared .

Based on the data that has been obtained and the analysis that has been carried out, these three parameters indicate the effect of adding cassava peel powder with different compositions on the productivity of brown oyster mushrooms. It can be seen that the M2 treatment (90% sengon wood powder + 10% cassava peel powder) is treatment with the best results on both parameters, namely the wet weight of the fungus and the time of appearance of the first *pinhead* . This is in line with Wabali & Favor's research (2021), which created an alternative in the form of adding cassava peel powder to white oyster mushroom growing media with 8 different treatments. Optimal results were obtained by adding 10% cassava peel powder. According to him, sawdust supplementation with agricultural waste can improve several growth parameters. And the M5 treatment (75% sengon wood powder + 25% cassava peel powder) produced the highest number of fruit caps compared to other treatments. This is in line with Pratama's research (2017) using 4 types of treatment that the growing media for white oyster mushrooms mixed with 25% cassava peel powder can increase the productivity of white oyster mushrooms. Then the two studies were applied to varieties of brown oyster mushrooms, and the results showed the effect of adding cassava peel powder on the productivity of brown oyster mushrooms.

Nutrition for oyster mushroom growth in the form of cellulose is the largest substrate needed as a carbon source to obtain growth energy in the formation of mushroom fruiting bodies which are found in sengon wood sawdust and cassava peel powder (Erlinda et al., 2022 (Erlinda et al. 2022). The two substrates used in this study had a fairly high amount of cellulose, sawdust of sengon wood containing 49.40% cellulose, and the cellulose content of cassava peel was 43.63%. It is proven by the three parameters that have been tested, showing the effect of increasing in terms of the wet weight of the mushroom, number of mushroom caps, and the time of appearance of the first pinhead.

4. CONCLUSIONS

Based on the research that has been done, it can be concluded that the addition of cassava peel powder mixed with sengon wood powder has an effect on the productivity of the brown oyster mushroom. Brown oyster mushrooms with M2 treatment, i.e., variations in the composition of the planting medium 90% sengon sawdust and 10% cassava peel powder, obtained the best results on both parameters. On the wet weight parameter, the mushrooms obtained the best results, with an average wet weight of 84.9 g. Then on the parameter of the appearance of the first *pinhead*, *the pinhead* managed to appear the fastest with an average of 40.2 days after inoculation. On the parameter number of mushroom caps with M5 treatment, namely variations in the composition of the planting medium, 75% sengon sawdust and 25% cassava peel powder obtained the best results with an average number of fruit caps of 22.8 caps. Based on the One Way Anova analysis test, the three parameters have F count > F table. So that in this study, there was an effect of adding cassava peel powder on the productivity of brown oyster mushrooms.

Then the limitation in the research is the length of time for drying cassava peels which reaches 3 months, because at that time it has entered the rainy season. In addition, the limitations of tools to grind cassava skin into powder are also obstacles in this study.

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