The Use of Teak Leaves (*Tectonagrandis*) as Alternative Plantation Media for White Oyster Mushroom (*Pleurotusostreatus*)

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The Use of Teak Leaves (*Tectonagrandis*) as Alternative Plantation Media for White Oyster Mushroom (*Pleurotusostreatus*)

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Abstract. White oyster mushroom (Pleurotusostreatus) is one offavorite food in Indonesia because it contains high protein. The farmer uses sawdust as plantation media to supply white oyster mushroom nutrition because it contains lignin and cellulose. Teak leaves potentially use as plantation media because it contains lignin and cellulose. The aim of this research was to know the ability of teak leaves as an alternative plantation media. This research used 5 treatments of sawdust and teak leaves ratio K = 88% : 0%, P1 = 38% : 50%, P2 = 28% : 60%, P3 = 18% : 70%, P4 = 8% : 80%. The same ingredients in each baglog were 2% chalk, 10% bran and 60% water. Parameters used in this research were the growth rate of mycelium, the number of fruit body, fresh weight, dry weight, and water content. Data were analyzed statically. The result showed the P4 treatment with 80% of teak leaves in planted media can give an optimal growth rate of mycelium. The added of teak leaves also showed the insignificant result for the tested parameters if compared with the sawdust. It means that teak leaves can be used as alternative plantation media for white oyster mushroom.

Keywords**:** *white oyster mushroom, teak leaves, sawdust, plantation media*

1. Introduction

Oyster mushroom is one of the most consumed mushrooms in Indonesia. It has good taste, high nutrition and also processed to be some kind of food. Oyster mushroom's protein percentage was 27% and it was higher than chicken meat that has 18,20% protein and beef with 18,80% protein [1]. In case, oyster mushroom's price was cheaper than chicken meat and beef. Oyster mushroom's price was IDR 10.000-15.000 per kilogram [2], while chicken meat's price was IDR 31.468 and beef's price was IDR 117.726 per kilogram [3].

The increase of market demand gives an effect to the oyster mushroom farmer. The farmer usually uses sawdust as a plantation media. The more oyster mushroom produced, the more sawdust needed. In this case, the problem arises because not all of the farmer can supply more sawdust for oyster mushroom plantation media because of the availability of sawdust around the farmer's environment.

Oyster mushroom need nutrition sources such as lignin, cellulose, and hemicellulose that can found in almost every part of the plant, not only in wood [4].

Some research use part of plant beside wood for oyster mushroom plantation media were the use of leaves waste [5], the use of rice husk and banana leaves as an alternative media for sawdust substitute [6] and the use of soybean husk as addition ingredients in plantation media [7].

So far, there was no research that uses teak leaves as an alternative media for oyster mushroom even though Indonesia has many large teaks producing area such as Gunung Kidul, Yogyakarta. Teak leaves can be an alternative media because it has the same component with sawdust such as lignin and cellulose that needed for oyster mushroom's plantation media. Other than that, teak leaves were easier to obtain and rarely used especially dried teak leaves and it was probably cheaper than sawdust. The use of teak leaves as plantation media expected to replace the sawdust function as plantation media that going harder to get and became more expensive.

2. Methods

2.1. Preparation of Shredded Teak Leaves

Teak leaves were collected from the Center for Environmental Studies (CESSDU) of Sanata Dharma University located in Soropadan, Condong Catur, Depok, Sleman. Leave's characters used in this research was fallen leaves with yellowish until brown color. Teak leaves chopped with leaves chopping machine that produced coarsely shredded teak leaves. Then, teak leaves soaked inside a pool with full of clean water for 3 days to reduce tannin level inside the leaves. Tanin has the anti-bacterial and anti-fungi characteristic. Tanin also has a low pH that might be harmful to other organism used to decompose lignin and cellulose inside media and it can be hard for the oyster mushroom to absorb the nutrition. After soaked for 3 days, shredded teak leaves taken over from the pool and drained. Then, shredded teak leaves sieved until it has ±1 cm in size and drained until it has low water percentage.

2.2. Media Preparation

Dry shredded teak leaves and sawdust measured for every single treatment and combine with bran and chalk that has the same dose in every treatment. Bran and chalk composition used in every baglog were 10% bran and 2% chalk. Then, water added in the mixed media until it has 60%-65% of the water level.

Table 1. Oyster mushroom's plantation media composition per baglog.

Media Composition	Treatment									
	Control		P1		P2		P3		P4	
	%	g	%	g	%	g	%	g	%	g
Chalk	2	20	2	20	2	20	2	20	2	20
Bran	10	100	10	100	10	100	10	100	10	100
Shredded teak leaves	0	0	50	500	60	600	70	700	80	800
Sawdust	88	880	38	380	28	280	18	180	8	80
Total	100	1000	100	1000	100	1000	100	1000	100	1000

2.3. Baglog Production and Media Fermentation

Mixed media entered into baglog until it reaches 1 kg of weight. After that, media compacted and closed using a ring (a shortcut of a pipe). Then, media left out for 5 days for the fermentation process. The aim of fermentation was to decompose lignin and cellulose to smaller molecules so it can enter the cells and used to make new cells.

2.4. Sterilization

Sterilization carried out in a sterile room equipped with a steamer and used dry steam. That was good for baglog because it not too dry and not too wet because of the water steam. Sterilization

process carried out at a temperature 100°C and done in 6 hours. After that, baglog left out in the sterile room until it reaches 30°C.

2.5. Inoculation, Incubation, and Treatment

Inoculum inserted in a sterile way inside the plantation media from the open in the middle of a ring. The number of inoculum inserted inside the media was about 2 tablespoon in each baglog. Baglog closed with sterilized cotton then incubated in the room with baglog racks called "Kumbung". Incubation process lasts in 1 month or more until baglog surface full of mycelium. Mycelium's growth rate measured every 3 days with a ruler to know the length of mycelium seen on baglog surface. During the growth of mycelium, incubation room condition controlled to make the moisture level keep in 60%-70% and temperature in 28-30°C. After media fulfilled by mycelium, cotton pulled out to give an oxygen supply and space for fruit body growth. During fruit body growth, the temperature needed in the room was about 16-22°C and moisture level about 80-90%.

2.6. Harvest

Harvest has done in 5 days after the cotton pulled out. Mushroom characters that were ready to be harvested were bloom, white and have a non-stinging smell. The way to harvest was to pull out the mushroom until it's rhizoids part. This is really important to do because baglog still used in 2 harvests more. If rhizoids part still inside the baglog, then there will be contamination because of the rotten rhizoid.

2.7. Post-harvest

The harvested mushrooms then cleaned, the number of fruit body was calculated and measured to know the fresh weight. After that, mushrooms entered the oven with a temperature of 60°C in 24 hours until it has a constant number of dry weight. After getting the number of fresh weight and dry weight, then water contain inside the mushroom fruit body can be calculated.

3. Result

3.1. Mycelium growth rate

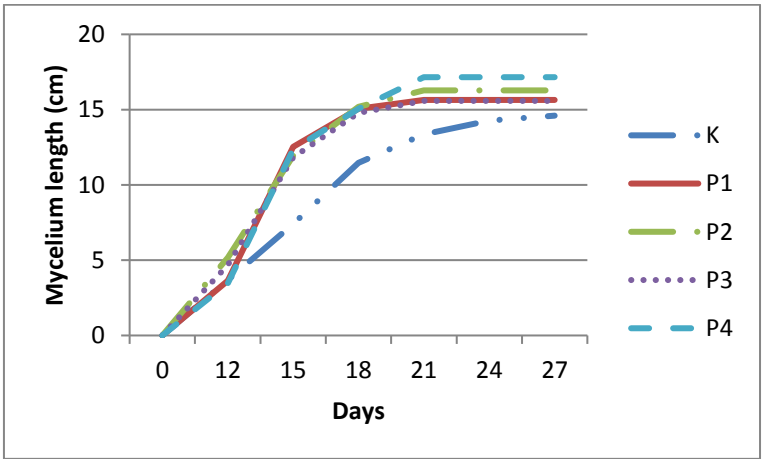

Figure 1. Oyster mushroom's mycelium growth rate.

Based on figure 1, we know that mycelium growth from day 0 until day 12 almost on the same line which means that every media can give the same nutrition for mycelium growth on that period. Mycelium growth rate starts to show the difference between every treatment after day 12. The growth rate on control shows the slowest rate compared to P1, P2, P3, and P4. It means that nutrition inside control baglog began to decrease while nutrition rate on P1, P2, P3, and P4 still have a lot of nutrients to support mycelium growth. After day 21, mycelium growth rate on P1, P2 and P3 getting slowly

while P4 still shows the increase of mycelium growth rate. The increase of P4 mycelium growth rate shows that P4 has the optimal rate of nutrients used to support the mycelium growth rate.

Based on the ANOVA test with α=0,05, the result was a sig. < 0,05 which mean that there was different between every treatment. To know which treatment that shows the different, then Duncan test used to show it and the result shows that there was a difference between Control (K) and P4 while P1, P2, and P3 didn't show the difference.

Table 2. Duncan test for the average number of mycelium growth.

Treatment	The average of mycelium growth
K	14,6[a]
P1	15,644[b]
P2	16,278[b]
P3	15,578[b]
P4	17,56[c]

Exp: Numbers followed by the same notation show that there was no different on α = 0,05

Based on mycelium growth rate on P4 that have 80% of teak leaves inside plantation media, shows that teak leaves might have a lot of cellulose and low level of lignin that make it became easier to decompose to another simple compound. So far, the lignin and cellulose content inside teak leaves never been analyzed and also not analyzed on this research so that was hard to compare the nutrients between teak leaves and sawdust. Media with the highest level of shredded teak leaves can make mycelium movement inside media getting more easier because it has the ability to save more oxygen inside. It was because the media was not too dense. Media with a high level of density will limit the movement of mycelium growth.

3.2. Number of Fruit Body

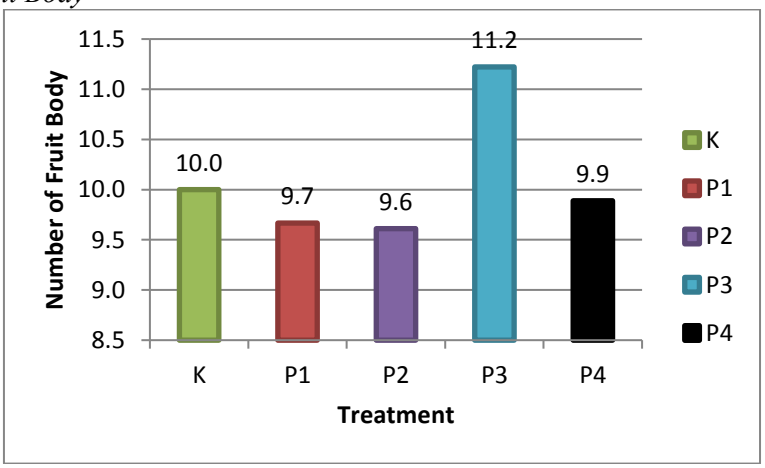

Figure 2. The average of oyster mushroom's fruit body.

The most number of fruit body was found on P3 with 70% teak leaves inside the media and followed by K, P4, P1, and P2 with each teak leave percentage were 0%, 80%, 50%, and 60%. If there was more teak leaves percentage inside media, the number of fruit body increase until it reaches a certain level of teak leaves percentage and start to decrease in certain teak leaves that has the highest number of teak leaves inside. This case shows that the more teak leaves inside media, the more

nutrient found. But there was an optimal number of nutrients absorbed to make fruit body which was P3 media that has 70% teak leaves while P4 has the highest nutrients but has the low number of fruit body because it wasn't an optimal nutrient to support fruit body formation.

The number of fruit body in P3 indicate an optimal number of Kalium (K) to support fruit body formation. Kalium used to activate the enzymes for protein production. Protein degraded and used by mycelium to produce fruit body [8]. The ability of media to decompose in an easier way can give an effect to fruit body production. If the media getting harder to decompose, then nutrients were harder to use by mushrooms. Indriyani(2014) explains that media with a high level of lignin were hard to decompose and this will cause the obstructed of nutrients absorptions and fruit body production [9]. Another element like Carbon (C) also needed to support fruit body production. This was explained by Kalsum, et al. (2011) that Carbon can found in monosaccharide, polysaccharides, cellulose and lignin form [10].

Oyster mushroom needs water for chemical particles transportation between cells and it will support the mycelium growth and development to produce fruit body and spore [10]. Based on statistic analyzed, the result was Sig.>0,05 which mean there was no effect from each treatment for the number of the fruit body.

3.3. Fresh weight

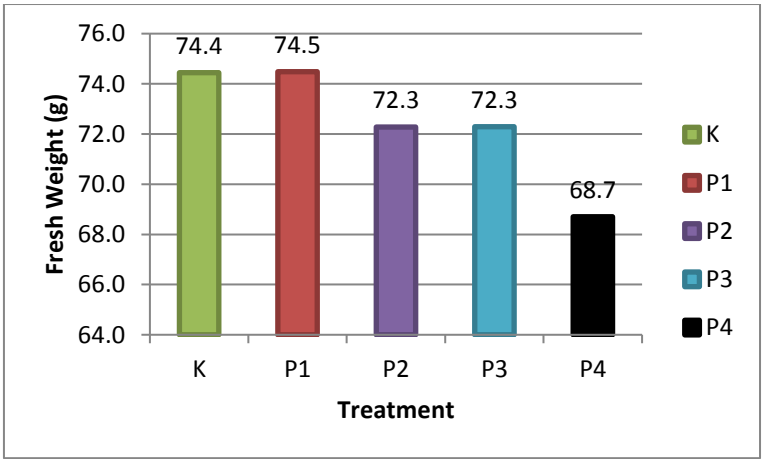

Figure 3. The average number of oyster mushroom's fresh weight.

The highest number of oyster mushroom's fresh weight was found on P1 with 50% of teak leaves while the lowest number of fresh weight found in P4 with 80% teak leaves. This case shows that media wit 50% teak leaves was an optimal media used to produce the highest number of fresh weight. Oyster mushroom's fresh weight were the accumulation between weight of mushroom's biomass and water percentage inside the fruit body.

Based on water evaporation and media dryness level, P1 with 50% teak leaves inside media shows an optimal number of mushroom's fresh weight because media became not too wet and not too dry. Water percentage inside media need to be controlled because the lowest and highest level of water maight be harmfull for mushrooms. If water percentage inside media was less than 45%, it will harm for mycelium growth and development. But if madea has too much water inside, it will cause mushroom decay [11].

There was some fruit body with large size but only have a little number of fruit body and it has the highest level of fresh weight in some clumps. This case prove that cells produced from cells division not only used toproduce the fruit body but also used to increase the diameter and fruit body thickness. Based on statistic tes, the result was Sig> 0,05. This mean that there was no effect from each treatment to oyster mushroom's fresh weight.

3.4. Dry weight

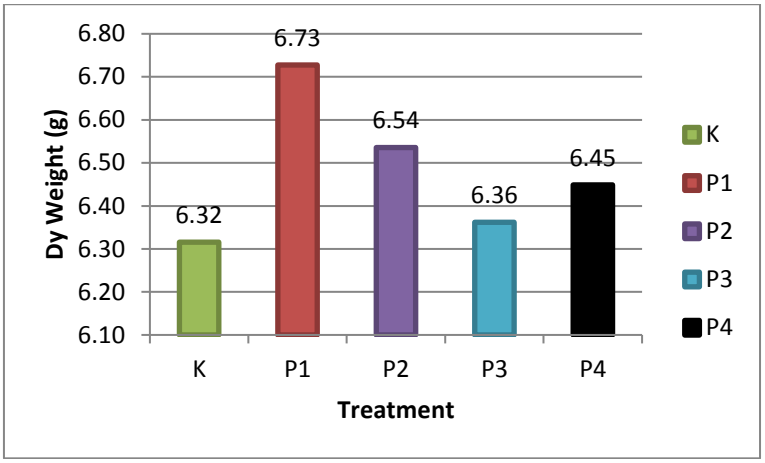

Figure 4. The average number of oyster mushroom's dry weight.

The highest number of dry weight was found in P1 while the lowest was in K. Dry weight was an accumulation of oyster mushroom biomass. When it was inside the oven, water evaporated while the biomass still inside the fruit body. The high level of fresh weight doen not determine the level of dry weight [12]. It was affected by water percentage inside media absorbed and accumulated inside the fruit body. Water percentage inside media affected by the different between media compisition.

Growing mushrooms on K media with 0% teak leaves have the high level of media density that cause water stay in media for a little longer. This will cause K media has the highest level of water inside and transfered to mushroom's fruit body. High level of water inside the fruit body can decrease the nutrients quality. That was the reason why mushroom on K has the lowest number of dry weight. In other way, P1 with 50% teak leaves have the optimal water level which mean not too wet but not too dry. With this optimal water level, water accumulation inside the fruit body would never decrease the nutrients quality inside the mushroom . That was the reason why mushroom on P1 treatment has the highest number of dry weight. Based on statistic test, the result was Sig. >0,05. This means that there was no effect from each treatment for the number of mushroom's dry weight.

3.5. Water level

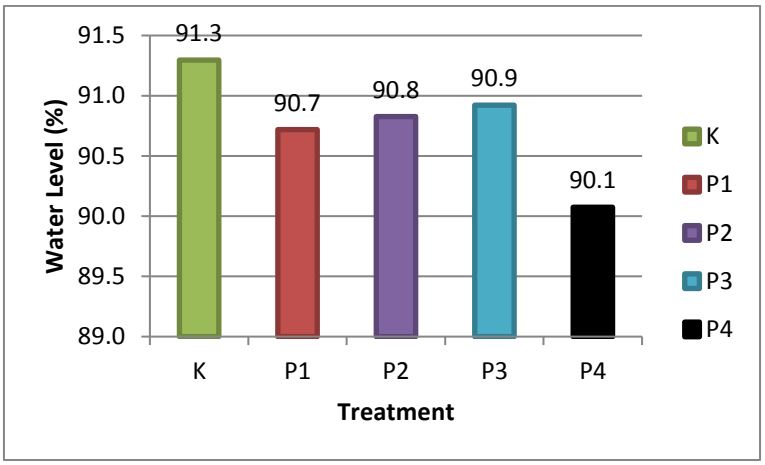

Figure 5. Oyster mushroom's water level.

The highest water level was found in mushrooms from K media while the lowest water level on P4. Mushrooms from K media has the comparable water level and fresh weight and it also inversely with the dry weight. On the other way, P1 has the comparable fresh weight and dry weight but inversely with the water level.

The water level inside the mushroom can be affected by media composition. The high water level inside mushroom on control media shows that sawdust has an ability to absorb and save a lot of water compared with mixed media. Based on the statistic test, the result was Sig.> 0,05. That means that there was no effect from each treatment for mushroom water level.

3.6. Temperature and Moisture

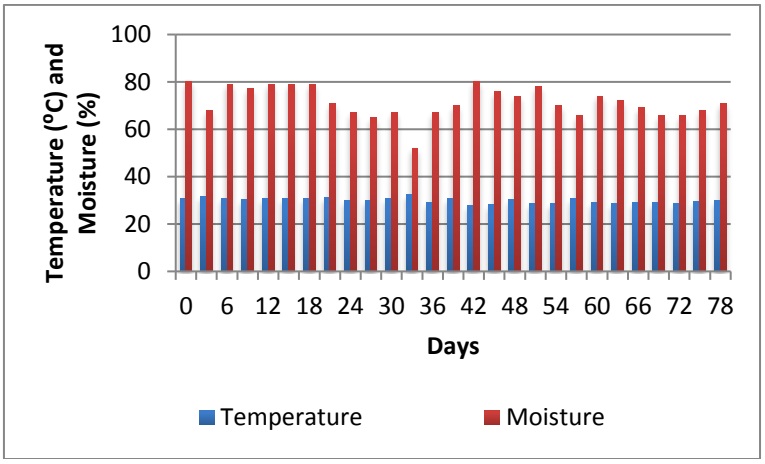

Figure 6. Measurement of temperature and moisture inside *Kumbung*

Temperature and moisture inside *Kumbung* need to be cared to make sure the condition still fulfill the requirements of mushroom growth and development. During mycelium formation, the requirements can't be fulfilled because the temperature was more than 30°C and moisture more than 70%. The requirements also can't be fulfilled on the first harvest and the second harvest from day 38 until day 78 where the temperature more than 22°C and moisture less than 80%. The unfulfilled requirements of temperature and moisture overcome by spraying clean water around baglog and *kumbung*. But it still can't help because bad aeration and dryness around *kumbung* that also caused by the dry season.

4. Conclusion

The addition of teak leaves inside the plantation media give an effect for mycelium growth rate but there was no effect on the number of fruit body, fresh weight, dry weight, and water level. Media with 80% teak leaves inside can give an optimal mycelium growth rate, but there was no teak leaves concentration that can give an optimal number for productivity. Shredded teak leaves also can use to replace sawdust for plantation media.

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