The Effect of Wood Species on The Growth of Two Kinds of Edible Mushroom Species

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ABSTRACT

So far, many species of edible mushrooms have been cultivated by the Indonesian farmer using Sengon sawdust as their medium. However, there has been no research which uses other wood species for the cultivation of those edible mushrooms. In Indonesia, there are several woody trees belonging to the Leguminosae family which are the same as Sengon that the potentiality is still unknown as the mushroom growth media. This study was carried out by growing ear mushrooms (Auricularia auricula-judae) and Shiitake mushrooms (Lentinula edodes) on media made from Gamal, Lamtoro, and Johar sawdusts. Fungal mycelia growth was measured by measuring the length of mycelia which appeared on the surface of the media every 2 days. An interaction between the wood species and the mushroom species on the growth of mycelia was found in this research result. Lamtoro and Gamal wood are species that good for the growth of ear mushroom mycelia with an average growth rate of 2.56 and 2.16 mm/day, while Gamal and Johar wood are best for Shiitake mushroom mycelia growth, with an average growth rate of 2.25 and 2.04 mm/day. The results of statistical analysis showed that there was no significant relationship between the chemical components of wood and mycelia growth rate of each mushroom species.

Keywords: edible mushrooms, gamal, johar, lamtoro, mycelia growth

Introduction

Currently, the edible mushroom, such as ear mushrooms (Auricularia auricula-judae), oyster mushroom (Pleorotus ostreatus), and Shiitake mushrooms (Lentinula edodes), cultivation in Indonesia has begun to develop quite high, especially in the wood-mushrooms species and there are many mushroom cultivation industries ranging from small to large classes that produce mushrooms. This happened because of the increasing need for mushroom consumption among the community. The average Indonesian mushroom consumption is 0.25 kg/capita/year (Ministry of Agriculture 2017). So far these mushroom species as above has been cultivated by the community by using Sengon wood as a medium.

Actually, Sengon is not the only wood which can be used as a medium. Quimio in Chang and Quimio (1982) stated that ear mushrooms can grow well on media made from Lamtoro (Leucaena leucocephala Lam de Wit) wood compared to media made from other woods. Therefore, there are only a few research that use other species of wood for the cultivation of edible mushrooms, especially in Indonesia.
In Indonesia there are several woody trees belonging to the Leguminosae family which are the same as Sengon whose properties of compatibility are unknown when used as a medium for fungal growth, including Gamal (*Gliricidia sepium* (Jaqc.) Steud.), Lamtoro (*Leucaena leucocephala* Lam de Wit) and Johar (*Senna siamea*). Wood from these trees is not widely used for industry because the shape and size of the main stem are not considerably good. Many people plant these trees as hedgerows and use their leaves as animal feed. So far, the wood from the tree trunks is only used as firewood, although there is a possibility that it can also be used as a medium for fungal growth. Therefore, it is necessary to do research to utilize these woods as a medium for fungal growth which is also an attempt to degrade the lignin content naturally. Each species of fungus has different requisites of growth conditions, especially the media, which is very influential on growth, fruiting bodies production, and its effectiveness in degrading lignin. This study aims to examine the effect of the interaction between types of media with the type of fungus on the growth of mycelia.

**Materials and Method**

**Material**

The materials used in this study were Gamal, Lamtoro, and Johar wood obtained from the yard or community forest in the Yogyakarta area. Two species of edible mushroom are *Auricularia auricula-judae* (ear mushrooms) and *Lentinus edodes* (Shiitake mushrooms). Chemicals for analyzing wood chemical components and for making mushroom media.

**Method**

**Analysis of chemical component**

Before the analysis of the chemical component content of wood was done, samples were refined first, using a rotary speed mill (P-14, Fritsch) and then sieved. The sample used is a sample that passes the size of 40 mesh but retained 80 mesh in size. Then, the sample was dried in an oven at 45°C. Soluble extractive levels of ethanol-toluene, holocellulose, α-cellulose, Klassen lignin, and acid dissolved lignin from the sample were measured using a method in accordance with what had been done previously (Irawati et al. 2012a). Analysis of the chemical content of wood was carried out using 3 replications for each sample.

**Making media**

Gamal wood, Lamtoro wood, and Johar wood are made of powder with a size of 9-80 mesh and then used as a medium for fungal growth. In the wood powder, 12.5% of rice bran is added as additional nutrients. The pH of the media is set in the range of 6-7 with the addition of CaCO₃ as much as 6% of the total media. Media moisture content is regulated by adding water to reaching 60-75%.

**Measurement of growth rate**

To measure the growth rate of mycelia, the media as much as 20 g with a moisture content of 60%, 65%, 70%, and 75% were put into a petri dish (diameter 90
Each combination of wood and mushrooms is made 5 times. Media that has been put into a petri dish, then sterilized in an autoclave at 121°C for 20 min, and inoculated with ear mushroom or shiitake mushrooms mycelium which were previously grown in PDA media (potato dextrose agar). Then, the inoculum was incubated in dark conditions (inside the incubator) with a breeding temperature of 25°C. The diameter of the mushroom colony was measured every 2 days in 4 directions until the growth of mycelia filled the entire petri dish (Irawati et al. 2012b)

Data Analysis

Two types of statistical analysis were used in this present study. For chemical contents parameter of wood, one-way anova was used. Furthermore, for mycelia growth rate parameter, it used two-way anova. The design model used for two way anova was Completely Randomized Design, using two treatment factors, which are: species of wood for media (A) and species of fungus (B). Factor A consists of 3 levels, which are: Gamal wood, Lamtoro wood, and Johar wood. While factor B is mushroom species, consisting of 2 levels, which are: Ear mushrooms and Shiitake mushrooms. The number of replications used is 3, therefore, the number of samples obtained is $3 \times 2 \times 3 = 18$ samples.

Result and Discussion

Chemical content

The average value of chemical content in sawdust and analysis of variance result in wood species factor are presented in Table 1. Extractives content, Klason lignin content, and the highest levels of $\alpha$-cellulose are found in Gamal wood and there is a highly significant difference statistically between the wood species with one another. The highest content of dissolved acid lignin is found in Johar wood and statistically, there is a highly significantly differed between one species of wood and another. Hemicellulose content were calculated based on the reduction between the content of holocellulose and $\alpha$-cellulose content. Statistically, there is no significant difference between hemicellulose content in Lamtoro and Johar wood, but there are significant differences in Gamal wood. Likewise with ash content, there is no statistically significant difference between ash content in Lamtoro and Johar wood, but there are significant differences in Gamal wood. Gamal wood possesses the highest ash content compared to the other two wood species.
components in the growth media (Obadi et al. 2003). In this study, there was no significant statistically relationship between the chemical components of wood and the mycelia growth rate.

Table 1. The average value of sawdust chemical content (%) and analysis of variance result 1 factor.

<table>
<thead>
<tr>
<th>Chemical content</th>
<th>Gamal</th>
<th>Lamtoro</th>
<th>Johar</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extractives content</td>
<td>5.18 ± 0.14 c</td>
<td>1.98 ± 0.20 a</td>
<td>3.12 ± 0.40 b</td>
<td>**</td>
</tr>
<tr>
<td>Klason lignin content</td>
<td>27.47 ± 0.39 c</td>
<td>22.00 ± 0.28 b</td>
<td>20.16 ± 0.79 a</td>
<td>**</td>
</tr>
<tr>
<td>Acid soluble lignin content</td>
<td>1.35 ± 0.05 a</td>
<td>1.48 ± 0.03 b</td>
<td>2.60 ± 0.01 c</td>
<td>**</td>
</tr>
<tr>
<td>Holocellulose content</td>
<td>83.85 ± 0.12</td>
<td>83.56 ± 1.07</td>
<td>84.97 ± 0.55</td>
<td>ns</td>
</tr>
<tr>
<td>α-cellulose content</td>
<td>53.72 ± 0.55 c</td>
<td>43.69 ± 0.97 a</td>
<td>47.15 ± 0.44 b</td>
<td>**</td>
</tr>
<tr>
<td>Hemicellulose content</td>
<td>30.12 ± 0.43 a</td>
<td>39.87 ± 2.05 b</td>
<td>37.82 ± 0.11 b</td>
<td>**</td>
</tr>
<tr>
<td>Ash content</td>
<td>1.79 ± 0.06 b</td>
<td>1.56 ± 0.11 a</td>
<td>1.44 ± 0.03 a</td>
<td>**</td>
</tr>
</tbody>
</table>

Remarks: Number which are followed by same alphabet in the same row shows no significant difference based on Tukey analysis at $\alpha = 5\%$. **: highly significant different $\alpha = 1\%$. ns: no significant difference.

**Mycelia growth rate**

The results of the measurement of growth rate on two mushrooms species and wood waste shown in Table 2, while the results of mycelia growth rate measurement are presented on Figure 1.

Table 2. The average value of mycelia growth rate (mm/ day)

<table>
<thead>
<tr>
<th>Wood species</th>
<th>Mushroom species</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ear mushroom</td>
<td>Shiitake</td>
</tr>
<tr>
<td>Gamal</td>
<td>2.16 ± 0.30</td>
<td>2.25 ± 0.22</td>
</tr>
<tr>
<td>Lamtoro</td>
<td>2.56 ± 0.02</td>
<td>1.41 ± 0.09</td>
</tr>
<tr>
<td>Johar</td>
<td>1.29 ± 0.49</td>
<td>2.04 ± 0.22</td>
</tr>
<tr>
<td>Average (%)</td>
<td>2.00</td>
<td>1.90</td>
</tr>
</tbody>
</table>

Statistically, there is a significant interaction between the factors of wood species and mushroom species on the mycelia growth rate. The results of post-hoc tests using the Tukey showed that Lamtoro wood gave the lowest growth rate of mycelia for Shiitake mushrooms as well as Johar wood for ear mushroom species. Further, it was significantly different from the combination of wood species and other mushroom species. The fastest growth of ear mushroom mycelia was found in media made from Lamtoro wood (2.56 mm/day) and Gamal wood (2.16 mm/day), while Shiitake mushroom mycelia grew rapidly on media made of Gamal wood (2.25 mm/day) and Johar (2.04 mm/day). The slowest growth of ear mushroom mycelia was found in media made from Johar wood, while the slowest growth of Shiitake mushroom mycelia was found media made from Lamtoro wood.

The growth rate of fungal mycelia is influenced by the content of chemical components in the growth media (Obadi et al. 2003). In this study, there was no significant statistically relationship between the chemical components of wood and the mycelia growth rate of each mushroom species (Table 3). This may be due to the limited
type of wood used (3 types) as a sample, therefore, that it is not enough to describe the
effect of each chemical component on the of mycelia growth rate. However, by observing
the magnitude of the correlation value (r) in each species of fungus, it is known that
different types of mushroom are affected by wood chemical components which are not
necessarily the same.

![Figure 1](image)

**Figure 1.** A. Graphic of ear-mushroom's mycelia growth; B. Graphic of Shiitake's mycelia
growth.

**Table 3.** Correlations between wood chemical content (%) and mycelia growth rate.

<table>
<thead>
<tr>
<th>Chemical content</th>
<th>r ear mushroom</th>
<th>r Shiitake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extractives content</td>
<td>0.54 ns</td>
<td>0.39 ns</td>
</tr>
<tr>
<td>Klason lignin content</td>
<td>-0.04 ns</td>
<td>0.85 ns</td>
</tr>
<tr>
<td>Acid soluble lignin content</td>
<td>0.68 ns</td>
<td>-0.99 ns</td>
</tr>
<tr>
<td>Holocellulose content</td>
<td>0.86 ns</td>
<td>-0.91 ns</td>
</tr>
<tr>
<td>α-cellulose content</td>
<td>0.53 ns</td>
<td>0.40 ns</td>
</tr>
<tr>
<td>Hemicellulose content</td>
<td>-0.40 ns</td>
<td>-0.53 ns</td>
</tr>
<tr>
<td>Ash content</td>
<td>-0.14 ns</td>
<td>0.89 ns</td>
</tr>
</tbody>
</table>

Remarks: ns is no significant difference. Negative (-) means negatively correlated.

The growth rate of ear mushroom mycelia tends to be influenced by the content
of wood holocellulose. The higher content of holocellulose in the wood, the higher
growth rate of the ear mushroom mycelia in this wood species. This may be because
holocellulose is a carbon source used by the ear mushroom mycelia to grow.

On the other hand, this is opposite with the growth rate of the inclined Shiitake
mushroom mycelia which is inversely proportional to the levels of dissolved acid lignin
and wood holocellulose. The high content of holocellulose in wood does not increase the
speed of growth of Shiitake mushroom mycelia. Wood lignin content shows a tendency
to affect in a directly proportional to the growth rate of Shiitake mushroom mycelia. This
might mean that in contrast to the ear mushroom, Shiitake mushrooms take carbon from wood lignin.

**Conclusion**

From the obtained results of this study, it can be concluded that there is an interaction between the wood species and the mushroom species on the growth of mycelia. Lamtoro and Gamal wood is the best species for the growth of ear mushroom mycelia, while Gamal and Johar wood is the best species for the growth of Shiitake mushroom mycelia.

**Acknowledgement**

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**References**


