Growth and productivity of oyster mushrooms (*Pleurotus ostreatus*) on media rice straw mixed with sawdust

R Rambey*, F M Simbolon and E B M Siregar
Faculty of Forestry, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.

E-mail: *ridahati2017@gmail.com

**Abstract.** *Pleurotus ostreatus* can be cultivated in a medium derived from wood dust or lignin which has been weathered and wrapped in plastic. The purpose of this research is to measure the effect of the composition of rice straw mixture on white oyster mushroom growing media on the growth and productivity of white oyster mushrooms (*P. ostreatus*) and get the best composition of planting media for growth and productivity of white oyster mushrooms (*P. ostreatus*). The research design used was a Completely Randomized Design consisting of six treatments. The treatment used is the composition of the planting media with a mixture of rice straw 0, 10, 20, 30, 40, and 50%.

The results showed that the mixture of rice straw resulted in mycelium growth and the age of harvest began to be longer. The composition of the best growing media for growth and productivity of white oyster mushrooms is a mixture of 30% rice straw (300-gram rice straw + sawdust 550 grams).

1. **Introduction**

*Pleurotus ostreatus* is a type of consumption mushroom that is famous with the public. White oyster mushrooms are included in the basidiomycetes group. Oyster mushrooms can be found naturally in the forest as saprophyte plants that live on softwoods and obtain food by utilizing the remnants of organic matter. The use sawdust media is commonly used, therefor there is a need for new innovations in the cultivation of oyster mushroom. Mushroom growth media used are usually derived from wood dust like sengon wood, mahogany and others. The use of rice straw is expected to increase the growth of white oyster mushroom.

One of the substitution materials that can be used is rice straw. Farmers usually do not use rice straw, rice straw is always discarded or burned after harvest. The amount of rice straw in Indonesia can reach 12-15 tons per hectare one harvest, or 4-5 tons of dry matter. For a year it is estimated that straw production can reach around 20 million tons [1]. Rice straw also contains lignin and cellulose which can be used as a mushroom growth media.

The main content of wood is cellulose of 39 to 55%, lignin of 18 to 33%, and hemicellulose of 21 to 24%. The content of rice straw consists of hemicellulose 27%, cellulose 39%, lignin 12%, and ash 11% [2]. Based on this, the author needs to conduct research on the growth and productivity of white oyster mushroom (*Pleurotus ostreatus*) on rice straw growing media as a substitute for sawdust.

This study aims to (1) To know the effect of rice straw mixture sawdust on white oyster mushrooms (*P. ostreatus*), (2) Finding the composition rice straw and sawdust of the best planting media for growth and productivity of *P. ostreatus*
2. Materials and methods

2.1. Preparation of material

Materials and equipment used include white oyster mushroom seeds (*P. ostreatus*), chopped rice straw with a size of 1-2 cm, wood sawdust, rice bran, lime (CaCO3), PP plastic (Polypropilen), baglog cover rings, spritus, elastic band, 10 cm x 10 cm sheet of paper to cover baglog, alcohol, water.

2.2 Preparation of planting media

The formulation planting media used in each treatment is presented in the following:

- **P0**: mixture rice straw 0 g, rice bran 100 g, chalk 50 and sawdust 850 g
- **P1**: mixture rice straw 100 g, rice bran 100 g, chalk 50 and sawdust 750 g
- **P2**: mixture rice straw 200 g, rice bran 100 g, chalk 50 and sawdust 650 g
- **P3**: mixture rice straw 300 g, rice bran 100 g, chalk 50 and sawdust 550 g
- **P4**: mixture rice straw 400 g, rice bran 100 g, chalk 50 and sawdust 450 g
- **P5**: mixture rice straw 500 g, rice bran 100 g, chalk 50 and sawdust 350 g

Research data were analysed by analysis of variance with linear models

\[ Y_{ij} = \mu + T_i + \varepsilon_{ij} \]  

(1)

Notes:

- **Yij**: The results of observations from various treatments of the composition of the planting media and replications
- **\( \mu \)**: Average
- **Ti**: Effect of various composition of the planting media
- **\( \varepsilon_{ij} \)**: Effects of experimental errors on various treatments of planting and replication media composition

2.3 Analysis of data

The data obtained were analysed by one-way analysis of variance with a confidence level of 95 and Duncan’s Multiple Range Test with a 95% confidence level.

3. Result and discussion

The planting of white oyster mushrooms is carried out in mushroom house located in the Faculty of Forestry, University of North Sumatra. Data on the measurement of all parameters is presented in Table 1.

3.1 The growth mycelium

Mycelium growth is the beginning of fungus growth. Mycelium growth was observed from the appearance of mycelium until the mycelium filled the baglog which was marked by all parts of the baglog being white. The time of mycelium growth in each treatment ranged from 36.4 to 45.2 days. The growth time of mycelium with rice straw mixture is slower when compared to the research of [3] which showed a mixture of 15% rice husk media and 15% dried banana leaf had the fastest time of mycelium growth which was 25.5 days while treatment without husk mixture rice and dried banana leaves have the longest growth of mycelium at 44 days.

The P1 treatment (10% rice straw mixture) had the fastest mycelium growth time and the P5 treatment (50% rice straw mixture) had the slowest mycelium growth. P1 treatment has faster mycelium growth time compared to other treatments because it is suspected that with 10% rice straw mixture the media composition in baglog is not too dense when compared to other media compositions so that mycelium propagation is faster. P5 treatment is suspected to have a high level of baglog density so that mycelium spreads longer. Rice straw has a greater volume than wood sawdust. Polypropylene
plastic used as a container for planting media (baglog) is the same size and filled with planting media with the same weight of 1000 grams so that the mixture of rice straw will affect the density of baglog. According to [4] the density of baglog with a mixture of rice straw is denser when compared to the mixture of other substitution media. According to [3] the level of baglog density affects the growth rate of mycelium. The denser the baglog, the more mycelium will travel more and more in the baglog.

According to [5] basically, the media for mushroom cultivation must contain carbohydrates as a source of C and protein as a source of N in order to obtain the optimal C / N value needed to support the growth and development of mycelium. Besides rice straw also contains 27% hemicellulose, 39% cellulose, and 12% lignin. Hemicellulose and cellulose are composed of sugar monomers such as glucose. Whereas cellulose is in the form of fibers and is bound by hemicellulose protected by very strong lignin [6] which causes mycelium to grow quickly and appear on bag log.

Results of the research showed the composition of the planting media with a mixture of rice straw significantly affected to the growing of P. ostreatus mycelium. Duncan Multiple Range Test results show the mycelium growth time at P0, P1 is significantly different from P5. In the measurement of the time of growing mycelium, it can be concluded that the composition of the planting media with the optimal straw mixture for the time of growing mycelium P. ostreatus is addition 10% rice straw. The greater the number of rice straw compositions added the longer the mycelium growth time.

Table 1. Average data measured by all parameters

| Parameters                        | Treatments | 0   | P1  | P2   | P3   | P4   | P5   |
|-----------------------------------|------------|-----|-----|------|------|------|------|
| The growth of mycelium (day)      | 37 a       | 36.4 a | 37.6 ab | 42 bc | 42 bc | 45.2 c |
| The age of harvesting (day)       | 55 bc      | 51.8 a | 53.2 ab | 57 bc | 57.8 cd | 61 d |
| Number of fruiting bodies (Fruit) | 7.4 ab     | 6.6 ab | 6.8 ab | 10.8 b P | 5.6 a | 5 a |
| Weight wet (gram)                 | 144        | 145 | 145 | 160* | 135 | 133 |
| Diameter of hood (cm)             | 12.20      | 12.47* | 12.18 | 10.73 | 11.83 | 11.75 |
| Area of hood (cm²)                | 127.95     | 129.38* | 119.50 | 90.75 | 119.12 | 110.15 |
| Length of mushroom stalk(cm)      | 9 ab       | 10.3 b | 7.6 a | 8.4 ab | 8.6 ab | 7.4 a |

Note (*): The best average value

3.2 The age of harvesting (day)

Age of harvest starts is calculated from the beginning of inoculation until the mushrooms are ready to harvest with the characteristics of the fruit hood has opened perfectly. Age of harvest starting at each treatment ranged from 51.8 to 61 days. Age of harvesting with mixed rice straw was faster than [6] which showed that the treatment of coconut stem powder growing media had a faster harvesting age of 55.17 days while the longest starting harvesting time was on wood planting media, rubber is 62.71 days. The P1 treatment had the fastest harvesting age and the P5 treatment had the slowest harvesting age. According to [7] the faster the spread of mycelium, the faster the formation of fruit bodies. The P1 treatment had the fastest harvesting age because mycelium growth in the P1 treatment was the fastest among the other treatments so that the formation of the fruiting body was faster. According to [8] the energy obtained from cellulose, lignin, pectin, and nutrients in the media is used for the spread of mycelium. Mycelium which spreads in the form of primary mycelium which then becomes
secondary mycelium by thickening (primodia) to form buds (potential fruiting bodies) and continue to develop into basidiocarp (fruiting bodies).

DMRT results show that harvest age at P1 is significantly different from P0, P3, P4 and P5. The age of harvesting P1 is 51.8 (day).

3.3 Amount of fruiting bodies (fruit)
Amount of fruiting bodies measured had size of 3 cm. The top surface of the hood is slippery, the bottom surface is layered like soft white gills and the edges are bumpy. The amount of fruiting bodies in each treatment ranged from 5 to 10.8 pieces. The amount of fruiting bodies in rice straw mixed planting media is less than the results of [8] showing the average number of fruiting bodies is the composition of the growing media (1100 gram sawdust, 100 gram rice bran and 100 gram coconut fiber powder) as much as 11.78 fruit while the number of fruiting bodies at least in the composition of the planting media (2000 gram sawdust, 200 grams of bran and 100 grams of coconut fiber) as many as 8.67 pieces. This is presumably because the nutrients obtained from the rice straw mixture are smaller than the coconut coir powder mixture. This opinion is supported by [9] who state that without adequate nutrient mixtures the number of fruiting bodies that grow will be small because oyster mushrooms require nutrients in the form of carbon compounds, nitrogen, vitamins, and minerals. Most carbon compounds are used as an energy source as well as an element of growth.

P3 treatment had the most amount of fruiting bodies and the smallest number of hoods that were found in treatment P5. One of the factors that influence the formation of oyster mushroom is the adequate nutrition obtained from the growing media.

According to [10] the amount of fruiting bodies is influenced by the number of pinheads that grow. Results of the analysis of variance showed the composition media planting used rice straw did not significantly affect the amount of fruiting bodies with a 95% confidence interval.

3.4 The wet weight
The wet weight measurements were carried out at harvest time by measuring the weight of all oyster mushroom caps on each baglog. Wet weight in all treatments ranged from 133 - 160 grams. The wet weight of the rice straw mixture media is greater when compared to the research of [11] which shows the highest weight of P. ostreatus in the composition of the growing media (20 grams of empty palm oil bunches and 25 grams of tofu pulp) with an average wet weight of 140 while the lowest wet weight at harvest in the treatment (40 grams of oil palm empty fruit bunches and 25 grams of tofu waste) with an average wet weight of 90 grams. This is thought to be due to the influence of nutritional content.

In addition, according to [10] mushrooms have sufficient energy reserves to produce optimal fresh weight because the elements contained in the media can be evenly decomposed at the time of fruit body formation so that can be used by mushrooms. At first, the mycelium absorbs of existing nutrients and then remodel other nutrients for its production.

3.5 Diameter of the hood
Measuring diameter of the hood was done by measure the diameter of largest hood on each baglog. The diameter of all treatments ranged from 10.73 to 12.47 cm. The diameter of the hood in the rice straw mixture media is wider when compared with the results of the study of [12] which showed that in media without rice bran mixture the widest hood diameter was 8.12 cm while the 7% rice bran mixture had the smallest diameter of 7.7 cm. The P1 treatment had the widest diameter and the P3 treatment had the smallest diameter.

The P3 treatment produced the smallest mushroom cap diameter. That was caused by the growth in the number of fruit bodies P3 produced the most fruit body so as to produce a hood with the smallest diameter. The growth of many mushroom hoods and crammed into each other causes the mushroom hood to grow to a maximum. Other factors that influence the formation of the diameter of the hood according to [13] is air. Oxygen-deprived fungi can inhibit the metabolic system in fungi. A sufficient diameter of the hood diameter of oxygen produces a larger diameter size.
3.6 The area of hood

The area of the hood is the surface area of the oyster mushroom hood. Measurement of hood area was conducted by measuring the largest hood area in each baglog. The area of the hood is obtained by drawing the surface of the hood on millimeter paper. The area of the oyster mushroom hood is shown in the covering area of all treatments ranged from 90.75 to 129.38 cm². P1 treatment had the biggest covering area and P3 treatment had the smallest covering area. The treatment hood area P1 has the largest hood diameter. This is because the P1 treatment also has the widest average diameter. A wider hood diameter will produce a larger hood area.

Carbohydrate content affects the area of the fungus hood. According to [14] carbohydrates are an energy source for the growth of fungi from the formation of primordia (pinhead) and support nutrition for the growth of fungal hoods until the growth and development of fungal caps are maximal.

3.7 The Length of mushroom stalk

Height of the fruiting body stalks throughout the treatment ranged from 7.4 to 10.3 cm. The height of the stems in the rice straw mixed planting media is greater than the results of the research of [15] which showed 40% bagasse mixture treatment had the highest fruit stalk height was 6.06 cm while the smallest fruit stem height was treatment without bagasse mixture that was 4.57 cm. P1 treatment had the highest fruit stalk height and the smallest fruit body stalk height contained in the P5 treatment. According to [14] a good growth of mycelium will result in good fungal growth including the growth of the fruit body stalk length. The P1 treatment has the fastest / best mycelial growth so that P1 also has the highest fruit stalk height [15] states that sufficient nutrients or nutrients can stimulate the growth of the stem height. Another factor influencing the height of the fruit stalk is the environmental factor which is in accord with the [13] which states that the growth of fungi there are two important components that are very influential, namely oxygen and carbon dioxide. The influence of carbon dioxide that is too excessive on growth causes the stems to become very long (high) and the formation of the hood becomes abnormal. During the mushroom growth, environmental conditions must have high humidity and low light.

P1 treatment has the fastest mycelium growth time and harvesting age so that to measure the growth of fungi can be concluded that P1 treatment is the best treatment. In general, the quality of oyster mushrooms is determined by the size including the unit of weight of the mushroom and the diameter of the hood. P3 treatment has the smallest diameter but the diameter of P3 has met the criteria for harvesting oyster mushrooms and is suitable for sale. P3 treatment has a higher hood weight compared to other treatments. In general, the price of oyster mushrooms is calculated based on the wet weight of the mushroom. In the measurement of mushroom productivity, it can be concluded that P3 treatment is the best treatment.

4. Conclusion

Addition rice straw to the planting media P. ostreatus affected are the mycelium growth parameters and age of harvest but did not significant effect the parameters of the number of hoods, wet weight, hood diameter, hood area, and stem height. The composition of the best growing for the growth of P. streatus is a mixture 100 g rice straw + 750 g wood sawdust). Amount of 10% rice straw mixture treatment is suspected to have optimal media density for the growth of white oyster mushrooms. The composition of the best growing media for the productivity of white oyster mushrooms is a mixture of 30% rice straw (300 g rice straw + sawdust 550 grams). The treatment of 30% rice straw mixture is thought to have nutrient content in the form of optimal carbohydrates for the productivity of white oyster mushrooms.
References

[1] Lebu B 2013 Pra rancangan pabrik pembuatan bioetanol dari jerami padi dengan kapasitas 1000 ton/tahun [Pre-design bioethanol manufacturing plant from rice straw with a capacity of 1000 tons/year] Bachler Thesis Universitas Sumatera Utara, Medan, Indonesia

[2] Karimi K, Kheradmandinia S and Taherzadeh MJ 2006 Conversion of rice straw to sugars by dilute-acid hydrolysis Biomass and Bioenergy 30(3) p 247-253

[3] Suparti and Marfuah L 2015 Produktivitas jamur tiram putih (Pleurotus ostreatus) pada media limbah sekar padi dan daun pisang kering sebagai media alternatif [Productivity of white oyster mushroom (Pleurotusostreatus) on rice husk waste media and dry banana leaf as alternative media] Bioeksperimen: Jurnal Penelitian Biologi 1(2) p 37-44 DOI: 10.23917/bioeksperimen.v1i2.876

[4] Widiwurjani 2010 Menggali potensi seresah sebagai media tumbuh jamur tiram putih (Pleurotus ostreatus) [Exploring the potential of litter as a medium for growing white oyster mushrooms (Pleurotus ostreatus)] (Surabaya, Indonesia: Unesa University Press)

[5] Sumiati E and Shopa GA 2009 Aplikasi jenis bahan baku utama dan bahan aditif terhadap kualitas media bibit induk jamur shiitake [Application of raw material and additive material on the quality of shiitake mushroom seedling media] Jurnal hortikultura 19(1) p 49-50

[6] Afief MF and Siagian B 2015 Respon pertumbuhan dan produksi jamur tiram putih (Pleurotus ostreatus) terhadap berbagai media serbuk kayu dan pemberian pupuk NPK [Response of Growth and Production of White Oyster Mushroom (Pleurotus ostreatus) To Various Wood Powder Media and Giving NPK Fertilizer] Jurnal Agroekoteknologi 3(4)

[7] Sumiati E, Suryaningsih E and Puspitasari 2006 Perbaikan Produksi Jamur Tiram dengan Modifikasi Media Bahan Baku Utama Media Bibit [Improvement of the White Oyster Mushroom (Pleurotusostreatus) Strain Florida with Modification of Main Raw Materials Substrate] Jurnal hortikultura 16(2) p 96-17

[8] Reyeki S 2013 Pemanfaatan Serbuk Gergaji Kayu Sengon (Albizia falcata) dan Bekatul Sebagai Media Tanam Budidaya Jamur Tiram Putih (Pleurotus ostreatus) dengan Penambahan Serbuk Sabut Kelapa (Cocos nucifera) [Utilization of Sengon Wood Sawdust (Albizia falcata) and Rice bran as a Growing Media for White Oyster Mushroom Cultivation (Pleurotusostreatus) with the addition of Coconut Fiber (Cocos nucifera)] Bachelor Thesis Universitas Muhammadiyah Surakarta, Sukoharjo, Central Java, Indonesia

[9] Djarirah NM and Djarirah AS 2001 Budidaya jamur kucing pembibitan dan pemeliharaan [Ear Mushroom Cultivation, Nurseries and Maintenance] (Yogyakarta, Indonesia: Kanisius)

[10] Mufarrihah L 2009 Pengaruh penambahan bekatul dan amplus tahu pada media terhadap pertumbuhan dan produksi jamur tiram putih (Pleurotus ostreatus) [Effect of Addition of Rice bran and Tofu Sandpaper on Media on Growth and Production of White Oyster Mushrooms (Pleurotus ostreatus)] Bachelor Thesis Universitas Islam Negeri Malang, Malang, Indonesia

[11] Setiagama R 2014 Pertumbuhan dan produktivitas jamur tiram putih (Pleurotus ostreatus) dengan komposisi media tumbuh serbuk gergaji kayu sengon, tandan kosong kelapa sawit, dan ampas tahu yang berbeda [Growth and productivity of white oyster mushroom (Pleurotus ostreatus) with composition of sengon wood sawdust growing media, oil palm empty fruit bunches, and different tofu dregs] Bachelor Thesis Universitas Muhammadiyah Surakarta, Surakarta, Indonesia

[12] Setiadi AR, Ade FY and Lubis RR 2015 Pengaruh takaran dosis bekatul pada medium serbuk kayu karet terhadap hasil produksi jamur tiram putih (Pleurotus ostreatus) [The effect of rice doses dose on rubber wood powder medium on production of white oyster mushroom (Pleurotusostreatus)] Jurnal Ilmiah Mahasiswa FKIP Prodi Biologi 1(1)

[13] Islami A, Purnomo AS and Sukses 2013 pengaruh komposisi ampas tebu dan kayu sengon sebagai media pertumbuhan terhadap nutrisi jamur tiram (Pleurotus ostreatus) [The Effect of Sugarcane Bagasse and Sengon Composition as Growth Media on Oyster Mushroom (Pleurotusostreatus) Nutrition] Jurnal Sains dan Seni POMITS 2(1) p 1 – 4
[14] Sari, I M 2015 Pengaruh media dengan penambahan ampas kelapa terhadap pertumbuhan dan perkembangan jamur tiram putih (Pleurotus ostreatus) dan sumbangsihnya terhadap mata pelajaran biologi sma kelas X semester I materi fungi [The influence of the media by the addition of coconut pulp to the growth and development of white oyster mushroom (Pleurotus ostreatus) and its contribution to the biology subjects of high school class X semester I of fungi material] Bachelor Thesis Universitas Islam Negeri Raden Fatah, Palembang, Indonesia

[15] Dasa KS, Astutik A and Hamzah A 2011 Pemanfaatan Bagas Sebagai Campuran Media Pertumbuhan Jamur Tiram [Utilization of Bagasse as Mixture of White Oyster Mushroom Growth Media] Buana Sains 11(2) p 195-201