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Potential of Sengon Sawdust and Rice Straw as Cultivation Media for White and Yellow Oyster Mushrooms (*Pleurotus sp.*)

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ABSTRACT

***Pleurotus* sp., oyster mushrooms are a commonly cultivated using sengon (*Paraserianthes falcataria*) wood sawdust, while straw may be added as an alternative substrate. This study aimed to analyze the effect of media containing different compositions of sengon and straw on the growth and production of oyster mushrooms. Analysis of research data was conducted using Completely Randomized Factorial Design (CRFD). The first factor is the type of mushroom, namely the white oyster mushroom and the yellow oyster mushroom. The second factor is the type of media composition, which consists of 4 media compositions, among them are formula 1, 72% sengon sawdust without straw flakes and formula 1 as control, formula 2, 36% sengon sawdust with 36% straw flakes, formula 3, 24% sengon sawdust with 48% straw flakes and formula 4, 18% sengon sawdust with 54% straw flakes. Each formulation also contained rice bran, gypsum lime, dolomite lime, corn grits, and sufficient clean water. The results showed that in the vegetative phase, all compositions did not have many different growth ranges, from 0,57-0,59 cm/day. The generative phase, which requires the shortest harvest time, is Formula 3, which is 16 days. The total wet weight and the highest efficiency value were obtained in Formula 4 with a total wet weight of 126,16 g and a biological efficiency value of 60,07%. Therefore, Formula 4 is recommended because it has better productivity and biological efficiency values, while Formula 3 can be considered if the cultivation goal is to speed up the oyster mushroom harvest time.**

Keywords: compositions, edible, influence, *Pleurotus sp.,* waste

INTRODUCTION

Forests provide both timber and non-timber forest products. One of the timber products is edible mushrooms (Herliyana & Muhyi 2023). Mushrooms have a very high potential in agriculture, forestry, industry, environmental management, food, and medicine (Suriawiria 2002). One type of mushroom that can be utilized as an edible fungus is the white oyster mushroom (*Pleurotus ostreatus*), which now plays an important role as a commercially consumed mushroom (Chang & Miles 2004; Herliyana *et al.* 2015). White oyster mushrooms contain antioxidant compounds (Vieira *et al.* 2013) and have good nutritional content beneficial for humans. The nutritional content of white oyster mushrooms includes 6.0% protein and 57.5% carbohydrates, which are higher, and 3.9% fat, which is lower compared to beef (Martawijaya & Nurjayadi 2011). According to Herliyana *et al.* (2015), the β-glucan content in white oyster mushrooms is 6.6 g/100 g, or 6.7% of the fresh weight of the fruiting body, constituting 77% of the total carbohydrates present.

Another type of mushroom is the yellow oyster mushroom (*Pleurotus citrinopileatus*), which contains 22.10% protein, 1.32% fat, and 20.78% carbohydrates. The fiber content in yellow oyster mushrooms serves as a good source of micronutrients and antioxidant components. Oyster mushrooms have low carbohydrate, fat, and calorie values, making them suitable as a dietary option for individuals with diabetes, cholesterol, and hypertension (Widyastuti & Tjokrokusumo 2021). AccordiWg to Synytsya *et al.* (2009), the β-glucan compounds found in *Pleurotus* species have been widely used as food supplements, one of which functions as a prebiotic.

The demand for oyster mushrooms continues to increase by 10% each year. However, production has experienced a significant decline. In 2021, oyster mushroom production fell to 90.42 tons, a 97.27% decrease compared to the previous year. This highlights the need to improve mushroom cultivation on both small and large scales, where factors such as substrate composition and environmental conditions play a crucial role in production.

Sengon (*Paraserianthes falcataria*) sawdust is widely used as a substrate in oyster mushroom cultivation due to its good cellulose, hemicellulose, and lignin content. However, the availability of sengon sawdust is becoming increasingly limited due to its use in other industries. Therefore, there is a need to find alternative, more readily available substrates.

Rice straw and sengon sawdust can be used as alternative substrates. The availability of sawdust waste in Indonesia is estimated at 0.78 million m³ per

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year (Mutiara *et al.* 2016; Erawati & Fernando 2018). Based on the Agricultural Statistics Database of the Indonesian Ministry of Agriculture, total rice production in 2025 will reach 60,206,843.73 tons and produce large amounts of rice straw. However, the utilization of rice straw is still very limited, where approximately 62% of the straw will be burned or returned to the soil, 31-39% is used as animal feed, and only 7–16% is used for industrial purposes (Hanafi & Aryani 2023). Rice straw contains lignocellulose in the form of 34.2% cellulose, 24.5% hemicellulose, and 23.4% lignin (Nauval *et al.* 2024). In addition, sengon sawdust waste contains 26.8% lignin (Martawijaya *et al.* 1989; Ginting *et al.* 2013). The content of sengon sawdust and rice straw can be the main nutrient for mushrooms and support the acceleration of mushroom growth (Nauval *et al.* 2024). Straw waste, which is often discarded or burned by farmers, can be reutilized to reduce production costs and mitigate environmental pollution. The utilization of rice straw as an alternative substrate can enhance sustainability and efficiency in oyster mushroom cultivation. The hypothesis in this study is that the difference in the composition of sengon wood sawdust and rice straw in oyster mushroom cultivation media can have an effect on the growth and production of oyster mushrooms. This study aims to analyze the effects of different compositions of sengon sawdust and rice straw as cultivation media on the growth and production of oyster mushrooms.

METHODS

Time and Place Research

The study was carried out from September 2022 to February 2023 at the Forest Pathology Laboratory, Department of Silviculture, Faculty of Forestry and Environment, IPB University, and at the mushroom cultivation site on Jalan Hegarmanah RT 01/RW 08, Gunung Batu, West Bogor, Bogor City.

Tools and Material

The tools used in this study were Laminar Air Flow (LAF), drum, scissors, bottles, spatulas, stainless steel, furnaces, Bunsen burners, matches, drums, sprayers, thermohygrometers, scales, baglog racks, ovens, cameras, microscopes, petri dishes, and stationery. The materials used were white oyster mushroom seeds and yellow oyster mushrooms, sengon sawdust, straw, corn grits, bran, dolomite lime, cotton, clear plastic, rubber bands, gypsum lime, clean water, PDA (Potato Dextrose Agar), and alcohol.

Research Procedure:

Media Making

The media is made from two main ingredients: sengon powder and straw. The ingredients are weighed according to their composition. The weight of each main ingredient composition is divided into 4 formulas as follows (Table 1)

Making Baglog

Making baglog is done by preparing all the ingredients according to the ingredients that have been made according to formula composition, but for corn grits, mix all the ingredients by stirring them homogeneously on a base (large plastic) and mix the water slowly. After all the media is in the plastic, air circulation is maintained, and contamination is minimized.

Composting

After the composting period, the media is sterilized using hot steam or steaming using a drum instead of an autoclave. The use of drums as a sterilization tool can affect the quality and quantity of mushrooms (Fatmawati *et al.* 2023). All baglogs are arranged in a drum and then steamed for pasteurization for 7 hours. Combustion can be done using a 3 kg LPG gas cylinder at a temperature of 90–100℃. The reason for burning using LPG gas is that the heat produced is stable and can reach the inside of the baglog. After sterilization is complete, the baglog is left overnight before inoculation.

Inoculation

The inoculation process is carried out in the LAF room to minimize contamination. The method is done by opening the baglog cover, then the end of the baglog is brought close to the Bunsen burner, the mushroom seeds used are taken using a spatula, and inserted through the end baglog hole. The mushrooms used are white oyster mushrooms and yellow oyster mushrooms. Each mushroom seed is a subculture. The mushroom seeds used for inoculation into each baglog are 20 g. A 20g mushroom seed mass was used to ensure uniform inoculum concentration in each treatment. The inoculation processes were carried out aseptically using sterilized equipment.

Table 1 Main ingredients composition of cultivation media for white and yellow oyster mushrooms (*Pleurotus sp.*)

Formula	Sengon sawdust (%)	Rice straw flakes (%)	Rice bran (%)	Gypsum lime (%)	Dolomite lime (%)	Corn grits (%)	Water
Formula 1	72	0	15	1.5	1.5	10	Sufficient
Formula 2	36	36	15	1.5	1.5	10	Sufficient
Formula 3	24	48	15	1.5	1.5	10	Sufficient
Formula 4	18	54	15	1.5	1.5	10	Sufficient

Incubation

After the inoculation stage or transfer of seeds into the planting medium, the baglog is then incubated. Incubation is done by storing the baglog in a mushroom house or a special room for vegetative growth (mycelium growth). After the mycelium fills the baglog, all the baglogs containing oyster mushrooms are moved to the generative period room, placed on the mushroom rack in a horizontal position.

Maintenance and Observation

During the maintenance period, the condition of the incubation room is set at a temperature of 22–28℃ and a humidity of 60-80%. The condition of the baglog is checked periodically. If the baglog looks dry, it is sprayed with air using a sprayer. Incubation ends with the mycelium appearing white, spread evenly covering the entire surface of the baglog. Next, observe the vegetative phase, which is the mycelium growth phase from the initial inoculation until it fills the entire surface of the media/substrate (full mycelium growth), with variables including the length of the mycelium spreading evenly to fill the baglog. To fill the baglog (Herliyana and Muhyi 2023). The generative (reproductive) phase or growth of the mushroom fruit bodies in each formula, with observation variables including the average diameter of the fruiting cap and the average length of the stalk (Herliayana & Muhyi 2023).

Data Analysis

The experimental design used in this study was a Factorial Completely Randomized Design (RALF). The first factor was the type of mushroom, consisting of two levels. The second factor was the use of media composition, consisting of 6 levels. Each treatment uses 3 replications. Data processing uses SAS 9.3.1 software and Microsoft Excel 2019. Analysis uses the analysis of variance test (ANOVA test and Duncan's further test for factors that have a significant effect on the parameters. According to Mattjik and Sumertajaya (2013), the model used is as follows:

$$Yijk = \mu + \alpha i + \beta j + (\alpha\beta)ij + \varepsilon ijk$$

Description:
Yijk: Response influence on the kth replication that obtains the i-th level of the fungus type factor and the j-th level of the media composition factor.
μ: Average value of the actual response influence.
αi: Main influence of the i-th level of the fungus type factor.
βj: Main influence of the j-th level of the media composition factor.
(αβ)ij: The interaction effect of the *i*-th level of the mushroom type factor and the *j*-th level of the media composition factor.
εijk: The error effect on the *k*-th replication receiving the *i*-th level of the mushroom type factor and the *j*-th level of the media composition factor.

RESULTS AND DISCUSSION

Observation of Environmental Conditions

The research was conducted in a mushroom house with variations in temperature and humidity observed in the morning, afternoon, and evening. Afternoon temperatures reached up to 30℃ with 90% humidity, while temperatures decreased in the evening. According to Rochman (2015), the optimal temperature for oyster mushroom growth is between 24–28℃, and temperatures above 30℃ may inhibit its growth. The mushroom house was equipped with doors, windows, and racks for placing baglogs, all of which influenced mushroom growth. Additionally, it was located near a water source to support optimal environmental conditions.

Effect of Media on the Vegetative Phase

The growth phase in oyster mushroom cultivation consists of two stages: the vegetative phase and the generative (reproductive) phase. The vegetative phase, also known as the incubation period, refers to the stage where the mycelium grows from the initial inoculation until it completely colonizes the surface of the media/substrate (full mycelial growth) (Herliyana *et al.* 2008).

The average results showed no significant effect (Table 2). The composition of each treatment was as follows: Formula 1 consisted of 72% sengon sawdust; Formula 2 consisted of 36% sengon sawdust and 36% rice straw flakes; Formula 3 consisted of 24% sengon sawdust and 48% rice straw flakes; and Formula 4 consisted of 18% sengon sawdust and 54% rice straw flakes. The composition selection is based on the content of each composition, such as sengon, which contains 49.4% cellulose, 24.1% hemicellulose, and 26.5% lignin (Trisanti *et al.* 2016; Syafitri *et al.* 2022). These contents can be a source of energy for oyster mushroom growth. In addition, rice straw in oyster mushroom growth media contains sugars and mineral salts (N, P, K, and so on), so it can be used as a growth medium for oyster mushrooms (Wahyuningsih *et al.* 2022).

The results of Duncan's test indicated that both mushroom type and media composition treatments had no significant effect on mycelial growth. According to Herliyana (2014), mycelium will continue to grow as long as the combination of various environmental factors remains supportive. These environmental factors include humidity, temperature, light intensity, pH, and the C/N ratio. Aini and Kuswytasari (2013) stated that the optimum temperature required for mycelial growth ranges from 22°C to 28°C, with humidity between 60% and 70%. Devi *et al.* (2018)

noted that unsuitable temperature and humidity conditions affect the mycelial growth of mushrooms. Optimal environmental conditions occurred in the morning and afternoon, while during midday, high temperatures and low humidity could inhibit mycelial growth (Ikhsan 2017). In addition, media that are too dense are suspected to hinder mycelial development. Untung and Triono (2013) mentioned that overly compact baglogs may obstruct the spread of mycelium; therefore, baglog filling should be adjusted to match the size of the plastic used. The rate of mycelial growth is shown in Figure 1 and Figure 2.

Effect of Media on the Generative Phase

The generative phase is the stage in which secondary mycelium aggregates to form an organized network and develops fruiting bodies (basidiocarps) that produce basidiospores (Steviani 2011). This phase is closely related to the harvesting period of mushrooms.

Table 2 Duncan test results on the effect of mushroom type and growth media on mycelial growht

Treatments	Mycelial Growth (cm/day)
Mushroom type	
White oyster	0,57[a]
Yellow oyster	0,57[a]
Media	
Formula 1	0,57[a]
Formula 2	0,55[a]
Formula 3	0,59[a]
Formula 4	0,58[a]

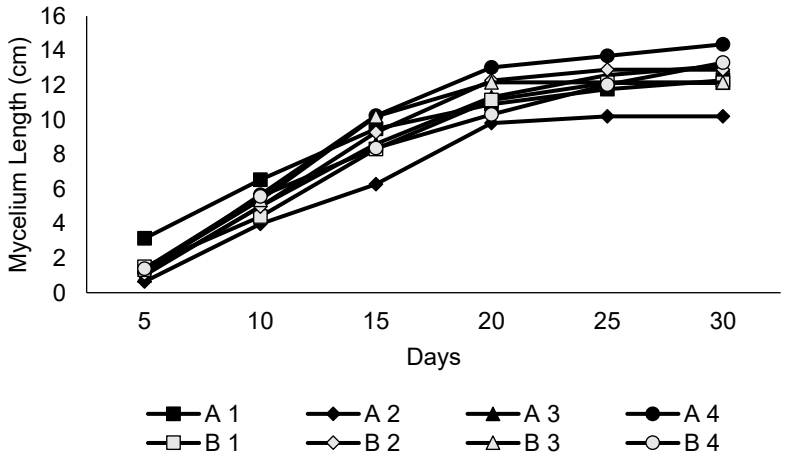

Figure 1 The rate of mycelial growth. A1: White oyster mushroom + formula 1; A2: White oyster mushroom + formula 2; A3: White oyster mushroom + formula 3; A4: White oyster mushroom + formula 4; B1: Yellow oyster mushroom + formula 1; B2: Yellow oyster mushroom + formula 2; B3: Yellow oyster.

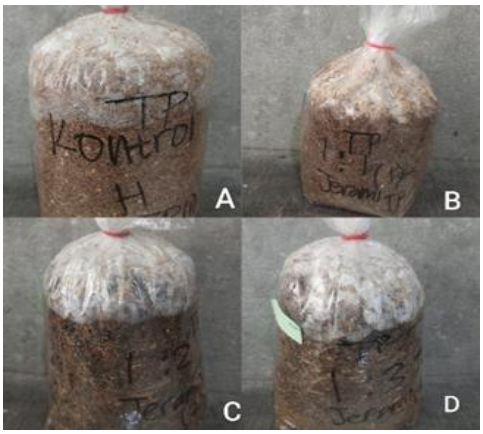

Figure 2 Mycelial growth on different media: (A) Media formula 1, (B) Media formula 2, (C) Media formula 3, (D) Media formula 4.

Yellow oyster mushrooms showed a faster generative growth phase compared to white oyster mushrooms, possibly due to genetic factors, environmental conditions, and suboptimal light intensity (Table 3). Adequate light intensity is needed to stimulate the formation of fruiting bodies, with sunlight exposure of about 60–70% during the fruiting body development phase (Sugianto 2015). The growth media also affected the generative growth phase, with Formula 3 (which had a higher straw content) showing the fastest development, while Formula 1 (containing only sengon sawdust) resulted in the longest growth duration, although harvest was still achievable within one month. A good substrate is said to support mushroom harvest within one month and can continue to produce for four to five months (Kalsum *et al.* 2011). Rice straw contains lignocellulose in the form of 34.2% cellulose, 24.5% hemicellulose, and 23.4% lignin (Nauval *et al.* 2024). These components can provide a nutrient source for oyster mushroom growth.

The results showed that the interaction between mushroom type and media during the generative phase was influenced by the nutritional quality of the growth substrate. Sengon sawdust and rice straw both contain sufficient nutrients to support mushroom development. Treatment B4 (yellow oyster mushroom with more straw than sengon) showed the fastest generative growth rate at 15 days, while treatment A1 (white oyster mushroom with sengon sawdust only) showed the slowest growth at 33 days (Figure 3). This is presumed to be due to the nutrient composition, as media with higher lignin content, such as sengon sawdust, can inhibit the development of mycelium and fruiting bodies (Aini & Kuswytasari 2013). The lignin content in sengon sawdust and rice straw is 26.50% and 12%, respectively, which aligns with the results of this study.

Effect of Media on the Morphological Characteristics of Mushroom Fruiting Bodies

The morphological characteristics of oyster mushroom fruiting bodies observed and measured included cap diameter, number of caps, total fresh weight, and stalk length. The analysis results of two mushroom types across four media formulas are shown in Table 4**.**

The results of the study showed that the mushroom type treatment had a significant effect on the number of stipes, cap diameter, and number of caps, but no significant effect on the total fresh weight. The media type treatment had no significant effect on any of the

Table 3 Duncan test results on the effect of mushroom type and growth media on the generative phase

Treatments	Generative Phase (day)
Mushrooms Type	
White Oyster	27[a]
Yellow Oyster	19[b]
Media	
Formula 1	30[a]
Formula 2	21[b]
Formula 3	18[b]
Formula 4	21[ab]

Note: Values followed by different letters in the table indicate significant differences at the 5% level based on Duncan's Multiple Range Test. Treatment composition: Formula 1: 72% sengon sawdust; Formula 2: 36% sengon sawdust, 36% rice straw flakes; Formula 3: 24% sengon sawdust, 48% rice straw flakes; Formula 4: 18% sengon sawdust, 54% rice straw flakes

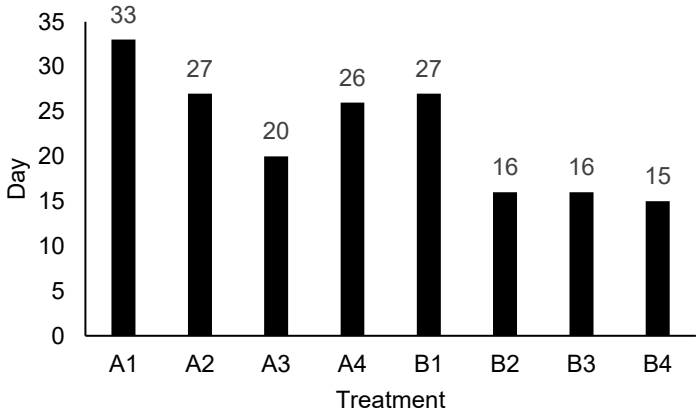

Figure 3 Generative growth rate across all treatments. A1: White oyster mushroom + Formula 1; A2: White oyster mushroom + Formula 2; A3: White oyster mushroom + Formula 3; A4: White oyster mushroom + Formula 4; B1: Yellow oyster mushroom + Formula 1; B2: Yellow oyster mushroom + Formula 2; B3: Yellow oyster mushroom + Formula 3; B4: Yellow oyster mushroom + Formula 4.

measured parameters, including stipe number, cap diameter, number of caps, and total fresh weight. Meanwhile, the interaction between mushroom type and media type had a significant effect only on cap diameter, but no significant effect on stipe number, number of caps, and total fresh weight. The morphological characteristics of mushrooms under each treatment can be seen in Table 5.

The results showed that the stipe length of oyster mushrooms ranged from 3.48 to 6.77 cm. White oyster mushrooms had the longest stipe length at 6.77 cm, while yellow oyster mushrooms had a shorter stipe length of 3.48 cm. The media treatment resulted in stipe lengths ranging from 4.44 to 5.61 cm, with the longest stipes observed in Formula 3 (5.61 cm) and the shortest in Formula 1 (4.44 cm). The average number of caps in yellow oyster mushrooms was 9, which was higher than in white oyster mushrooms, which averaged 5 caps. Among the media treatments, the highest number of caps was observed in Formula 1 (8 caps), followed by Formula 2 (7 caps), and Formula 3 (6 caps).

The genetic differences between the two oyster mushroom species are presumed to be the main factor influencing the observed differences in stipe length, cap diameter, and number of caps (Figure 4 and Figure 5). Observations on the cap diameter of oyster mushrooms showed significant variation. The mushroom type treatment resulted in cap diameters ranging from 3.92 to 7.36 cm, with white oyster mushrooms having the largest diameter at 7.36 cm, while yellow oyster mushrooms had a smaller diameter of 3.92 cm. Under the media treatment, cap diameters ranged from 4.89 to 6.69 cm, with Formula 1 producing the widest caps (6.69 cm) and Formula 4 producing the smallest (4.89 cm).

Cap diameter is influenced by the number of fruiting bodies formed; fewer fruiting bodies generally result in larger cap diameters. In addition, cap size is affected by the concentration of substrate components used in

Table 4 ANOVA test results on the effect of mushroom type and media on mushroom morphological characteristics

Parameter	Treatment		
	Mushrooms type	Media	Interaction
Average stipe length (cm)	0.0003*	0.6878^{tn}	0.4127^{tn}
Average cap diameter (cm)	0.0001*	0.0888^{tn}	0.0083*
Total number of caps (units)	0.0075*	0.5774^{tn}	0.6480^{tn}
Total fresh weight (g)	0.2521^{tn}	0.0682^{tn}	0.6157^{tn}

Note: The values presented in the table are F-test values: * indicates that the treatment has a significant effect at the 5% level; ns indicates that the treatment has no significant effect.

Table 5 Duncan test results for stipe length, number of caps, and cap diameter of mushrooms

Treatment	Stipe length (cm)	Number of caps	Cap diameter (cm)
Mushrooms type			
White oyster	6.77^{a}	5.00^{b}	7.36^{a}
Yellow oyster	3.48^{b}	9.00^{a}	3.92^{b}
Media			
Formula 1	4.44^{a}	6.00^{a}	6.69^{a}
Formula 2	5.37^{a}	8.00^{a}	5.67^{ab}
Formula 3	5.61^{a}	6.00^{a}	5.32^{ab}
Formula 4	5.07^{a}	7.00^{a}	4.89^{b}

Note: Values followed by different letters in the table indicate significant differences at the 5% level based on Duncan's Multiple Range Test. The treatment compositions showed a significant effect at the 5% level. formula 1: 72% sengon sawdust; formula 2: 36% sengon sawdust, 36% rice straw flakes; formula 3: 24% sengon sawdust, 48% rice straw flakes; formula 4: 18% sengon sawdust, 54% rice straw flakes.

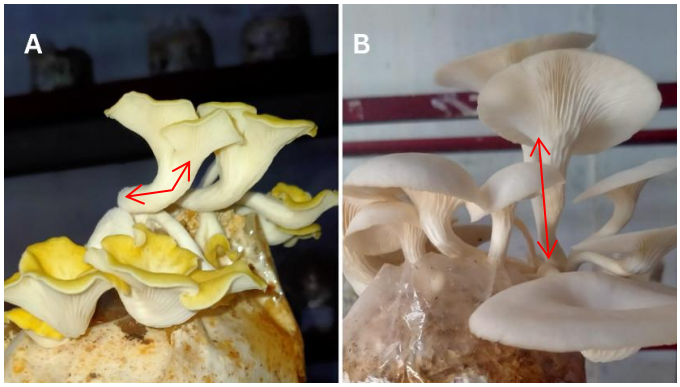

Figure 4 Stipe length results of oyster mushrooms: (A) stipe length of yellow oyster mushrooms, (B) stipe length of white oyster mushrooms.

the growing media to meet the physiological needs of the mushroom. The cap diameters produced in this study are presented in Figure 6.

The fresh weight of mushrooms reflects the number of fruiting bodies produced; the higher the fresh weight, the greater the mushroom growth (Kurniati *et al.* 2019). The total fresh weight value is used to calculate Biological Efficiency (BE), which represents the percentage efficiency of mushrooms in utilizing the substrate to form fruiting bodies. BE is calculated by comparing the fresh weight of the fruiting bodies to the dry weight of the substrate, multiplied by one hundred percent. The higher the fresh weight of the mushrooms, the higher the BE value, indicating the success of mushroom cultivation (Herliyana 2007; Sholihah *et al.* 2018). The effects of mushroom type and media on fresh weight and biological efficiency (BE) values are presented in Table 6.

The results of the study showed that Formula 4 medium produced the highest biological efficiency (BE), reaching 60.07%, while Formula 1 had the lowest, at 39.89%. This result supports the statement that BE is directly proportional to the fresh weight of mushrooms. Low BE values (below 70%) are related to the number of harvests, as this study was conducted with only two harvests (Kenanga *et al.* 2014), and pest attacks on baglog media also affected the results. Sengon wood, which has high cellulose content but low lignin, is not recommended as a cultivation medium because lignin plays a role in slowing down microbial decomposition (Wahyuddin *et al.* 2021). Previous studies have shown the effect of different compositions of sawdust and straw on oyster mushroom growth (Hariadi *et al.* 2013). Treatment A4 (white oyster mushrooms with 18% sengon sawdust and 54% straw) yielded the highest fresh weight and BE at 131.09 g and 62.42%, respectively. In contrast, treatment B1 (yellow oyster mushrooms with 72% sengon sawdust) resulted in the lowest fresh weight and BE, at 90.17 g and 39.20%, respectively. According to Sholihah *et al.* (2018), a good BE value for the oyster mushroom industry ranges from 40–90%.

Pests and Diseases in Media and Fruiting Bodies

Pests and diseases are major constraints in oyster mushroom cultivation that can reduce productivity. The pests and diseases commonly attacking oyster mushroom baglogs are influenced by both internal and external factors. A common internal factor is the pathogenic fungus *Trichoderma* sp., while the most dominant external factor is caterpillars (Mona *et al.* 2022). Such contamination is generally caused by unstable or unsuitable environmental conditions, as well as errors during inoculation or sterilization

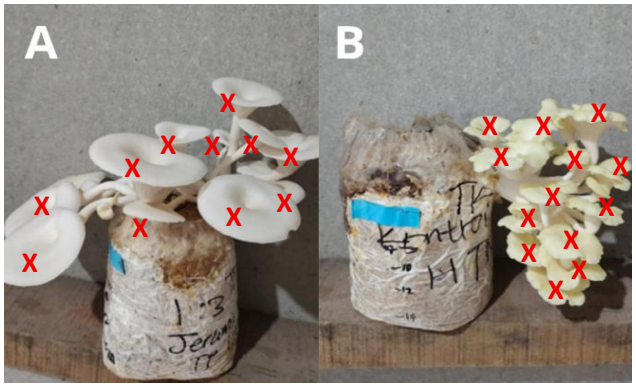

Figure 5 Number of caps results of oyster mushrooms: (A) number of caps in white oyster mushrooms, (B) number of caps in yellow oyster mushrooms.

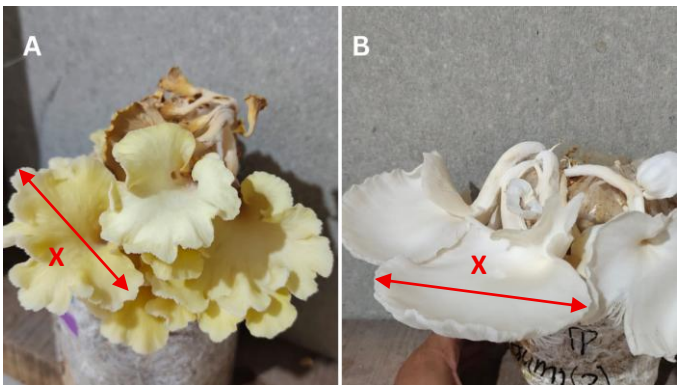

Figure 6 The results of oyster mushroom cap diameter measurements are shown in Figure X. As illustrated, yellow oyster mushrooms (Figure X-A) had smaller cap diameters, while white oyster mushrooms (Figure X-B) exhibited significantly larger cap diameters.

processes. During observations, pests and diseases were found on both the baglog medium and the mushroom fruiting bodies. The diseases identified on the growing media included *Trichoderma* sp. and *Mucor* sp., as shown in Figure 7**.**

According to Mulyanto and Susilawati (2017), pathogenic fungi commonly found on baglogs include *Trichoderma* sp., *Fusarium* sp., *Aspergillus* sp., and *Mucor* sp., which are usually caused by poor cleanliness of the mushroom house (kumbung) and improper sterilization processes. The growth of *Mucor* sp. on baglogs is characterized by black spots around the baglog, which occur due to insufficient sterilization. Proper sterilization should be carried out through pasteurization at temperatures not exceeding 100°C for four hours (Nisa *et al.* 2025)

Contamination can also occur during the inoculation process if the mushroom spawn is not handled carefully. During the study, green patches caused by *Trichoderma* sp. were observed, which inhibit oyster mushroom growth by extracting nutrients from the growing media. This type of contamination opens the door for secondary pest infestations, such as flies, mites, termites, spiders, and worms, which further disrupt mushroom development. Pests observed in the baglogs during the study included mites, as shown in Figure 8.

Table 6 Duncan Test results for the Interaction between mushroom type and media on total fresh weight and biological efficiency

Treatment	Total Fresh Weight (g)	Biological Efficiency (%)
A1	93.33^{a}	40.58^{b}
A2	110.67^{a}	52.21^{ab}
A3	137^{a}	65.24^{a}
A4	131.09^{a}	62.42^{ab}
B1	90.17^{a}	39.20^{b}
B2	109.64^{a}	52.21^{ab}
B3	99.31^{a}	47.29^{ab}
B4	121.22^{a}	57.72^{ab}

Note: Values followed by different letters in the same column indicate significant differences at the 5% level based on Duncan's Multiple Range Test. Treatment descriptions: A1: white oyster mushroom + formula 1. A2: white oyster mushroom + formula 2. A3: white oyster mushroom + formula 3. A4: white oyster mushroom + formula 4. B1: yellow oyster mushroom + formula 1. B2: yellow oyster mushroom + formula 2. B3: yellow oyster mushroom + formula 3. B4: yellow oyster mushroom + formula 4.

Figure 7 Diseases in growing media: (a) growth of *Mucor* sp., on baglog, (b) grwoth of *Trichoderma* sp., on baglog.

Figure 8 Mite infestation in baglog media.

Tyrophagus putrescentiae mites are capable of developing on several edible mushroom species, including oyster mushrooms (*Pleurotus ostreatus*), due to their high tolerance to temperature and air humidity, making them cosmopolitan organisms (Madyaningrana & Apra 2021). These mites thrive optimally at temperatures between 10°C and 30°C with 70% humidity and can influence the mushroom's life cycle under air humidity levels of 80–90% and substrate moisture content of 50–70% (Kheradmand *et al.* 2007; Harjaka *et al.* 2010).

Early symptoms of mite infestation appear as white spots on the baglog, which later spread more extensively. The mites extract fluids from the mycelium, inhibiting fruit body formation and causing the mushrooms to wilt and dry out, eventually leading to crop failure. This study shows that mites can cause significant crop loss in oyster mushroom cultivation due to nutrient and moisture depletion caused by their activity (Harjaka *et al.* 2010).

To minimize damage caused by pests and diseases, it is essential to conduct proper sterilization of the baglogs and exercise caution during the inoculation of oyster mushroom spawn. If contamination has already occurred, infected baglogs should be discarded to prevent further spread. Pest and weed control can be achieved by maintaining cleanliness in and around the mushroom house. Additionally, all stages of oyster mushroom cultivation from seeding and planting to harvesting must be carried out under sterile conditions to prevent contamination (Mona *et al.* 2022).

CONCLUSION

The media used during the vegetative phase did not show significant effects on mycelial growth. However, in the generative phase, the fastest fruit body formation occurred on Formula 3 medium (24% sengon sawdust and 48% rice straw flakes). The growing media did not have a significant effect on stipe length, cap number, or cap diameter, but the type of mushroom had a significant influence on these parameters. The best total fresh weight and biological efficiency were observed in Formula 4 medium (18% sengon sawdust and 54% rice straw flakes), applicable to both white and yellow oyster mushrooms. All media compositions used in this study provided favorable biological efficiency values for oyster mushroom cultivation.

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