Growth And Yield Performance of Oyster Mushroom (*Pleurotus Ostreatus*) Cultivated in Different Biowastes.

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Abstract

Cultivation of oyster mushroom by utilizing the biowastes as alternative substrates to saw dust is an efficient biowaste management practice as well as it reduce the burden on depending saw dust for mushroom cultivation. The objective of this study is to determine the growth and yield performance of oyster mushrooms (Pleurotus ostreatus) growing in different biowastes. Experiment has four treatments including with the addition of substrates as banana leaves (T1), groundnut shells (T2), palmyra leaves (T3), and sawdust (control-T4). It was arranged in a complete randomized design with five replicates. The spawns were inoculated into sterilized substrates under aseptic conditions. The growth and development of mushrooms were monitored daily. Data were analyzed by ANOVA (analysis of variance), and Duncan's Multiple Range Test (DMRT) using SPSS 24. The results revealed that oyster mushrooms can grow on all three biowastes with varying growth performance. The mean number of days required to complete the mycelium growth, pin head formation, and fruiting body formation were less in sawdust, and banana leaves used as a substrate. Growth, yield attributes and biological efficiency of mushroom were significantly higher in sawdust, and banana leaves were second highest. The present study concludes that there is potential to utilize banana leaves and saw dust as substrate for mushroom cultivation. Further studies are needed to find the actual combination of banana leaves and sawdust for better yield and growth performances.

Keywords: biological efficiency, bio wastes, oyster mushroom, yield parameters, growth parameters

Introduction

The edible fungi are commonly known as mushrooms and they grow on a wide range of substances. Mushrooms are cultivated worldwide for its food value and medicinal properties (Chang et al.,1996). Oyster mushrooms (Pleurotus sp.) are the second most popular mushroom in the world that can be cultivated easily with less investment and supplies (Alemu et al.,2015). The mushroom are rich in protein, vitamins, and minerals content and contain low level of fat and cholesterol. (Girmay et al.,2016). Utilization of biological wastes for mushroom cultivation is one of the best ways to covert inedible bio waste into nutrition rich source. Therefore, mushroom cultivation is considered as one of the best bio-waste management practices (Tefera.,2017).

In northern province, the agricultural wastes such as banana leaves, groundnut shell, palmyra leaves, coconut coir, rice straw and sawdust (collected from sawing mill mainly it contains coconut sawdust) are available abundantly with high cellulose, hemicellulose and lignin contents. However, disposal of these wastes is a problematic issue in the region. Many of these ligno- cellulose wastes are allowed to accumulate on the ground or be burnt which causes serious environmental pollution, sanitary problems and ground water contamination. Recycling organic waste through proper biotechnological methods reduce the environmental pollution and accumulation of organic wastes. Therefore, this study focused on analyzing the yield and growth performance of oyster mushroom (Pleurotus ostreatus) using different bio-wastes in order to encourage proper bio waste management practices along with income generation.

Methodology

Study location.

The cultivation of mushroom was carried out at the District Agricultural Training Center (DATC), Muruganoor, Vavuniya. Growth conditions were maintained; temperature 25°C-30°C and humidity 80-90%.

Preparation of substrates.

Substrate was prepared based on the standard formula practiced by the farmer (Table 01). The banana leaves, groundnut shells, palmyra leaves were dried in sunlight and ground by hand motor

and pestle. Saw dust was dried and sieved by a 2mm size sieve plate. Water was added gradually to the pile, and a handful of the pile was squeezed by hand to confirm that the substrate had reached the ideal water content (without leakage of water during squeezing).

The mixed substrates were packed in polypropylene bags (33cm x17.8cm). The neck portion of substrate bags were covered with PVC pipes (3 cm long and 2-4 mm thickness). Cotton wool, paper sheets and rubber bands were used to close the opening of the bags.

The substrate bags were sterilized using steam as mentioned below. The metal barrel was filled with water up to the 25cm level and the poly propylene bags with substrate were kept on the wire mesh in the metal barrel. The bags were sterilized for 4 hours. The top layer bags were turned up- side down for effective sterilization. Bags were allowed to cool at room temperature for four hours and then transferred into the inoculation room.

Table 1: The substrate used for mushroom cultivation

Material	**Treatment -1 Banana leaves**	**Treatment -2 Groundnut shell**	**Treatment 03 Palmyra leaves**	**Treatment 04 Saw dust (control)**
Main substrtate (g)	500g	500g	500g	500g
Rice bran (g)	50g	50g	50g	50g
Green gram powder	40g	40g	40g	40g
Lime powder	10g	10g	10g	10g
$MgSO_4$(teaspoon)	½ teaspoon	½ teaspoon	½ teaspoon	½ teaspoon

Inoculation

The oyster mushroom spawn was obtained from District Agricultural Training Center (DATC) Thirunelveli, Jaffna. Two teaspoons of mushroom spawns were introduced into each bag and cotton wool was inserted into the PVC tubes at the neck of the bags. The bags were shaken gently for proper distribution of the spawns. The openings of the bags were covered by paper.

Incubation

The bags were arranged in Complete Randomized Design (CRD) on the wooden racks inside the incubation room and 3cm spaces were left between treatments for aeration. (Figure 01) Mycelia formation was monitored regularly by observing the development of white threads through the substrates.

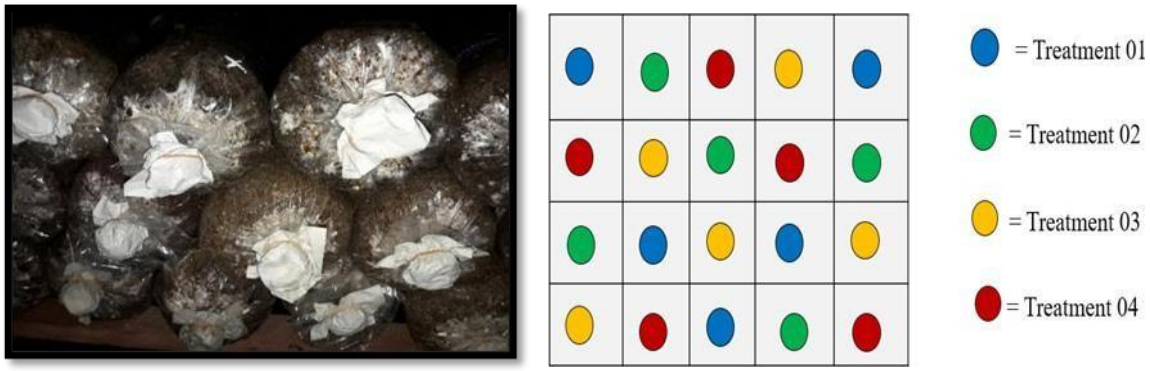

Figure 1: Experimental design (CRD)

Fructification

The bags were then transferred to the fructification rooms after mycelium growth covering 2/3 of bags portion. The bags were opened to enhance flushing. Water was sprinkled regularly in the fructification room to provide moisture and humidity for the growth of mushrooms.

Determining the time required for the growth phases.

The growth of mushrooms was monitored daily. Growth parameters including time (number of days) required to complete the initial Mycelia growth at circular portion around the neck of the bags, and 1/3and 2/3 part of bags with mycelia, pinhead formation, and fruit body formation

Figure 2: Mycelia formation(a), Pinhead formation (b), fruiting body formation(c)

Evaluation of growth and yield attributes of oyster mushroom

Growth and yield attributes were recorded during first round of harvest. Five matured fruiting bodies were randomly selected from each treatment and stipe length (cm) and piles diameter(cm) were measured. The stipe length was measured from the tip of the stipe to the base of the caps. (Garo, G., & Girma, G.,2016).

The bio efficiency of mushrooms

The fruiting bodies harvested after 45 days of fruiting from 03 bag and measured the total fresh yield of the mushroom. The biological efficiency (yield of fresh mushroom per kg substrate on dry weight basis. The dry weight was calculated by addition of dry weight of main substrate used for a bag, dry weight of Rice bran added, dry weight of green gram powder added and weight of lime poweder added) (Table 01)) was calculated by given formula used by Elenwo *et al.*,2007 and Tefera.,2017.

$$\text{Biological efficiency} = \frac{\text{Weight of fresh mushroom harvested (g)}}{\text{Weight of dry substrate (g)}} * 100\%$$

Data analysis

Collected data were analysed using SPSS Version 25.0 and significant differences among treatment were analysed with ANOVA (Analysis of variance) and means days of growth phases and means

for yield attributes were compared by using Duncan's multiple range test (DMRT) at P-value≤0.05, Cl=95%.

Results and Discussion

Determining the time required for growth phases of oyster

mushroom Growth of mycelium

The growth of mycelia was observed daily. As per Table 2, the mean days required for initial mycelia growth and 1/3 mycelia growth on sawdust and banana leaves substrate were less without significant differences. It was observed that mean number of days required for mycelium growth is high on substrate added with Palmyra leaves and groundnut shell than sawdust and banana leaves. Overall, mean days required for initial mycelium growth and 1/3 mycelia growth on saw dust were 4-6 days and 13-19 days respectively. The least time required for mycelium growth confirmed the high growth rate of the mushroom on different substrates.

The time required for 2/3 growth of mycelia on sawdust and banana leaves substrates was 23 and 26 days respectively. The growth pattern was similar between the palmyra leaves and groundnut shells substrates and was of lesser rate (Table 2). The study by Girmay et al, (2016) reported that, the completion of spawn running on saw dust is 20 days.

Pinhead formation

As per the table 2, pinhead formation was initially observed in sawdust (control) and banana leaves containing substrates. Significantly less number of days were taken for pinhead formation on sawdust and banana leaves compared to other substrates. The time required for pinhead formation on sawdust and banana leaves were 35 and 36 days, respectively. The study by Girmay et al, (2016) reported that, Pin-head formation occurred quickly in cotton seed (17 days), followed by sawdust (29 days); while it took relatively longer time in wheat straw (33 days).

Fruiting body formation

It was observed that Fruiting bodies appeared on sawdust substrate containing bags at a significantly shorter time period compared to other substrates. Specifically, sawdust substrate required 43 days, while banana leaves required 46 days for this phase. Our findings highlight mushrooms' efficient and rapid growth on sawdust, with similar results observed in banana leaves substrate, indicating the potential for faster growth on these materials. The other substrates also show the growth, but it requires lager time duration compared to sawdust. Girmay *et al*, (2016) reported that, the time required for maturity of fruiting bodies varied from 27 days (for cotton seed) to 40.67 days (for wheat straw). The cropping period for the other two substrates (sawdust and paper waste) was 37 and 39 days.

Evaluation of growth and yield parameter of oyster

Growth parameters

Pileus diameter and stipe length of the mushroom were measured during first harvesting. Table 3 shows that; The mean stipe length was highest in sawdust compared to other treatments. There were no significant differences in stipe length among other treatments. The banana leaves and sawdust have significantly similar and highest mean diameter of pileus than other treatments.

Piles diameter and stipe length of the mushroom may have been influenced by substrate combination, environmental and management factors (Alemu *et al.*,2015). The study conducted by Girmay et al. (2016) shows that the pile's diameter and stipe length of mushroom on sawdust were 7.7 3cm and 3.29 cm, respectively, and the pileus diameter and stipe length on sawdust were 4.38 cm and 4.16 cm respectively in the present study. Garo, G., & Girma, G. (2016) reported that the stipe length and pilus diameter on groundnut shell were 2.5 cm and 0.47 cm, respectively.

Yield

The fresh weight of mushrooms during first harvest was significantly high in sawdust compared to other substrates. The second highest was observed on banana leaves containing substrate. There were no significant differences observed between the fresh weight of Palmyra leaves and the groundnut shells. Nearly 65 g of mushroom were harvested from sawdust (600 g dry weight of substrate) and banana leaves produce 36 g during the first-round of harvesting. A study by Alam *et al.*,2008 showed that the quality and the quantity of mushroom is affected by various factors which include differences among strains, the substrate composition, cultivation method and harvesting stage.

Biological efficiency (BE)

The biological efficiency of mushroom was calculated by using the fresh weight of first round of harvesting. Significantly higher BE was observed on sawdust (Table 4). The banana leaves showed second highest level. Study by Girmay *et al.*, (2016), reported that, the biological efficiency of oyster mushroom on sawdust was 9.73%. As per the present study the BE of mushroom growing on saw dust is higher compare to other treatment. Temperature influences the BE. Garo, G., & Girma, G. (2016) demonstrated that, higher temperature of the environment, faster the growth of the mycelium and spawn running but with lower yield and Biological efficiency.

Conclusion

The study evaluated the growth and yield performance of oyster mushroom (*Pleurotus ostreatus*) in different bio wastes including banana leaves, groundnut shell, palmyra leaves and saw dust. Time required for growth phases is less in sawdust and similar results were observed when banana leaves were used as a substrate. There is no significant difference between the 1/3 mycelia formation, Pinhead formation and Piles diameter of mushroom on sawdust and banana leaves used as a substrate. Fruiting body formation, stipe length and Fresh weight of first round harvesting were significantly highest in sawdust, and second higher performance was observed in banana leaves compare to other wastes. The overall study concludes; the banana leave is the potential substrate for mushroom cultivation. further studies are suggested to cultivate oyster mushroom with the combination of sawdust and measure the growth and yield parameters.

Table 2: Time required for growth phases of oyster mushroom cultivation (days).

Substrate	Growth phases				
	Mycelia inversion			Pin head formation	Fruiting body formation
	Circler potion of the bottle neck of bags	1/3 of bags	2/3 of bags		
Banana leaves	4.2 ± 0.45^{b}	14.8 ± 0.84^{c}	26.2 ± 1.30^{b}	36.6 ± 0.55^{c}	46.6 ± 1.14^{b}
Ground nut shells	5.4 ± 0.54^{a}	18.2 ± 0.45^{a}	29.8 ± 1.30^{a}	41.8 ± 1.09^{a}	49.6 ± 0.55^{a}
Palmyra leaves	5.2 ± 0.45^{a}	16.8 ± 0.84^{b}	30.2 ± 1.09^{a}	40.2 ± 1.30^{b}	48.6 ± 0.55^{a}
Saw dust(control)	4.6 ± 0.88^{b}	13.8 ± 1.30^{c}	23.4 ± 0.89^{c}	35.6 ± 1.14^{c}	43.8 ± 1.14^{c}

Note: Each value represents Mean ± SD of samples (n=5), values represent with the same superscript letter along the column are not significantly different (P-value=0.000).

Table 3: Growth and yield parameter of oyster mushroom in different bio wastes

Substrate type	Stipe length(mm)	Pileus diameter(mm)	Fresh weight(g) (1st round harvesting)
Banana leaves	31.00 ±2.45^{b}	38.8 ± 4.32^{a}	36.33 ± 3.78^{b}
Ground nut shells	28.00 ± 2.92^{b}	27.20 ± 3.96^{b}	14.00 ± 2.65^{c}
Palmyra leaves	30.60 ± 1.14^{b}	28.40 ± 2.70^{b}	18.33 ± 1.53^{c}
Saw dust	41.60 ± 2.51^{a}	43.80 ± 4.02^{a}	64.33 ± 10.50^{a}

Note: Each value represents Mean ± SD of samples (n=5), values represent with the same superscript letter along the column are not significantly different (P-value=0.000).

Table 4: Biological efficiency of mushroom indifferent bio wastes

Substrates	Dry weight of Substrate	Mean Weight of fresh mushroom(g)	Biological efficiency
Banana leaves	600g	36.33	7.27%
Groundnut shell	600g	14.00	2.33%
Palmyra leaves	600g	18.33	3.06%
Sawdust(control)	600g	64.33	10.72%

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