ISSN (Online): 2091-2609
DOI Prefix: 10.3126/ijasbt
International Journal of Applied Sciences and Biotechnology (IJASBT)

Research Article

Effect of Various Substrates on Growth and Yield Performance of Oyster Mushroom (*Pleurotus ostreatus*) in Chitwan, Nepal

Hom Prasad Sitaula[1*], Roshan Dhakal[1], Geetesh DC[1], Dharmendra Kalauni[1]

[1]Agriculture and Forestry University (AFU), Chitwan, Nepal

Abstract

An experiment was conducted at Rampur, Chitwan, Nepal to find out the growth and yield performance of oyster mushroom (*Pleurotus ostreatus*) in Completely Randomized Design (CRD).The treatment includes the four different substrate i.e. paddy straw (100%), maize cob+ paddy straw (1:1), sugarcane bagasses+paddy straw (1:1) and sawdust+ paddy straw (1:1). The parameters taken for the observation during the experiment were colonization period, fruit initiation period, length of stalk, diameter of stalk, diameter of pileus, fresh weight of the first and second flush of mushroom and also the biological efficiency (BE) of various substrates. Among the used substrates, the time for colonization and fruit initiation was found to be shorter in case of the paddy straw i.e.18.25 days and 21.75 days respectively. However, the length of stalk was highest in sugarcane bagasses+paddy straw (1:1) i.e.6.10 cm, but the diameter of stalk and pileus were highest in paddy straw i.e.0.80 cm and 7.90 cm respectively. Similarly, the biological efficiency was found to be highest in case of the paddy straw (96.29688 %) followed by maize cob+paddy straw (1:1), sugarcane bagasses+ paddy straw (1:1) and sawdust+ paddy straw (1:1) respectively.

Keywords: Substrates; Mushroom; Biological efficiency (BE); Pleurotus ostreatus.

Introduction

Mushrooms are one kind of edible fungi belonging to the genus *Pleurotus* under the class Basidiomycetes (Mondal *et al*. 2010). Oyster mushroom (*Pleurotus ostreatus*) is an edible mushroom having outstanding flavor and taste. Recently, its importance and nutritive value has been realized and well utilized in human consumption diet. There are several species of *Pleurotus* identified in the world. Most of them are suitable for cultivation. Some *Pleurotus* species are *Pleurotus ostreatus*, *Pleurotus columbinus*, *Pleurotus florida*, *Pleurotus salignus*, *Pleurotus spodoleucus*, *Pleurotus pulmonarius;* and *subspices* are *Pleurotus sajor-caju*, *Pleurotus sapidus*, *Pleurotus populinus*, *Pleurotus cornucopiae*, *Pleurotus djamor*, *Pleurotus flabellatus*, *Pleurotus eryngii*, *Pleurotus cystidiosus*, *Pleurotus calyptratus*, *Pleurotus dryinus*, *Pleurotus purpureo-olivaceus* and *Pleurotus tuber-regiu* (Nadir *et al.*, 2016). However, the most important cultivated species is *Pleurotus ostreatus*, being easier to cultivate, favorable to eat, and grow economically on different kinds of organic waste raw material (Kong, 2004).

Cite this article as:

H.P. Sitaula et al. (2018) Int. J. Appl. Sci. Biotechnol. Vol 6(3): 215-219. DOI: 10.3126/ijasbt.v6i3.20859

[1]*Corresponding author
Hom Prasad Sitaula,
Agriculture and Forestry University (AFU), Chitwan, Nepal
Email: sitaulabikram306@gmail.com

Peer reviewed under authority of IJASBT

Scientific classification of oyster mushroom according to Randive (2012) is as the following:

Kingdom – Fungi

Phylum – Basidiomycota

Class - Agaricomycetes

Order - Agaricales

Family - Pleurotaceae

Genus – Pleurotus

Species - *Pleurotus ostreatus*

Pleurotus spp. can consume a vast variety of crop residues because it has a great ability to grow on residues (Mamiro & Mamiro, 2011) and it is a saprotroph that acts as a primary decomposer of wood, especially deciduous trees, and beech trees in particular (Phillips, 2006).

It was discovered that several species can grow on lignocelluloses, forest by- products and agricultural wastes (Carrera, 1998). Mushroom substrate may be defined as a kind of lignocellulose material which supports the growth, development and fruiting of mushroom (Miles, 1998). Oyster mushroom may be grown on wide range of plant waste as substrate e.g. sawdust, paddy straw, sugarcane baggage, corn stalk, corn cobs, waste cotton, leaves and pseudo stem of banana, water hyacinth, duck weed, rice straw etc. does not require costly processing method and enrichment material (Quimio, 1980; Chow, 1980; Bano *et al*., 1979). However the experiment was conducted on rice straw and banana leaves at various compositions with a view to determine the cheapest substrate with best yield performance (Mondal *et al*., 2010). These mushroom substrates must be adjusted to a pH range of 6 to 8 by adding gypsum (Kong, 2004).

Ecological requirements of oyster mushrooms vary at the various stages of growing period. The optimal temperatures for growing mycelia and pin forming are between 20 to 30 ^{0}C and 10 to 20^{o}C respectively. Substrate moisture should be 60 to 75%, but it should be 80 to 95% during the fruiting, because 80% or over of the fruit body is water (Nadir *et al*, 2016). *Pleurotus ostreatus* is different from the other cultivated mushroom which prefers a low level of light during its growth. Oyster mushroom naturally grows in the forest and since the forest light is bluish, fluorescent light can be used for lighting (Kong, 2004).

Material and Methods

Experimental Sites and Design

The experiment was conducted on the mushroom (*Pleurotus ostreatus*) in the green house of Agriculture and Forestry University, Chitwan, Nepal. The trail was carried out on Completely Randomized Design (CRD) with four replications and four treatments. The four treatments included (T1) paddy straw (100%), (T2) maize cob+paddy straw (1:1), (T3) sugarcane bagasses+ paddy straw (1:1) and (T4) sawdust+ paddy straw (1:1).

Materials Used

The various materials used during the experiments as given below:

1) Spawn
2) Substrates: Paddy straw, Sugarcane bagasses, Sawdust, Maize cob
3) Plastic Bags
4) Steam treatment tank
5) Jute Bags
6) Water
7) Chemicals: Bavistin, Calcium carbonate.

Spawn Source

The wheat grain spawn of *Pleurotus ostreatus* was obtained from the commercial mushroom growing farm situated near the Agriculture and Forestry University (AFU).

Preparation of Substrates

The various types of substrates used during the experiment were paddy straw, maize cob, sugarcane bagasses and sawdust. The paddy straw and maize cob were obtained from the Agronomy farm of University, sawdust was brought from the nearby furniture industry and sugarcane bagasses was obtained from the juice seller which were situated near to University. Among those substrates paddy straw and sugarcane bagasses were chopped into the small pieces of about 5 cm long. Similarly, the other two substrates i.e. maize cob and sawdust were grinded to make the fine structure. Thus, prepared substrates were then soaked into the water for about 3.5 hours. After that, the each substrate were packed into the separate large sized bag and stream sterilized. The substrate were treated in the stream water tank for about 4 hrs then allowed to cool in the clean and disinfected surface (using calcium carbonate).

Bagging of Substrates and their Maintenance

After cooling the substrates, polythene bags (50cm x 30cm) were filled. During the bagging, spawn was kept on every 6cm thick layer of the substrate. Around five thick layers were made and spawn was kept in between the every layer of the substrates (@ 125gm/bag). The mouth of the plastics bag were then closed tightly and pores were made on the each plastic bag. The treatments like maize cob+ paddy straw, sugarcane+ paddy straw and sawdust+ paddy straw, were prepared by thoroughly mixing them at 1:1 ratio and then used for bagging. The bags were then kept under the dark mushroom growing house. The inside temperature (20-30^{o}C) and relative humidity (80-90%) were maintained at various growing stages of mushroom by hanging the wet jute bags around the wall of the house and keeping the floor wet. Water was sprayed about 4-5 times a day on the jute bag and floor. After proper colonization and initiation of the fruiting body, about 4-5 vertical cut were made on the each

packed plastic bag using sharp blade for the proper growth and development of the mushroom.

Harvesting, Data Collection and Analysis

The mushroom was harvested with the help of sharp knife as they attained the proper size. The data regarding to the period of colonization and fruit initiation, fresh weight of harvested mushroom at first and second flushes, diameter of pileus and stalk and length of stalk were taken. BE was calculated as fresh weight of harvested mushrooms (g) / dry weight of substrate × 100 (Pokhrel, 2016).

Finally, the analysis of the data was carried out using Microsoft Excel and R-STAT software. Standard procedures followed for recording and analyzed the data on different yield parameters and means were compared using LSD test at 5% level of significance (Bhuiyan *et al.,* 2008).

Result and Discussions

Colonization and Fruit Initiation Period

The period required for the colonization was found significantly highest for the maize+paddy straw (20.50 days) which was statistically at par with sugarcane bagasses+paddy straw (20.00 days), whereas significantly lowest for the paddy straw (18.25 days) which was statistically at par with sawdust+paddy straw (19.00 days) respectively as shown in Table 1.

Similarly, period required for the fruit initiation was found significantly highest for the sugarcane bagasses+paddy straw (23.25 days) and lowest for the paddy straw(21.75 days) respectively as shown in Table 1.

Length of Stalk, Diameter of Stalk and Pileus

The length of the stalk was found significantly highest for the sugarcane bagasses+paddy straw (6.10 cm) which was statistically at par with maize cob+paddy straw (5.79 cm) and paddy straw (5.56 cm) respectively. However, length of stalk was found significantly lowest for the sawdust+paddy straw (4.70 cm) as shown in Table 2.

The diameter of stalk was found significantly highest for the paddy straw (0.80cm) and lowest for sugarcane bagasses+paddy straw (0.63cm). Similarly, the diameter of the pileus was found significantly highest for the paddy straw (7.90 cm) which was statistically at par with maize cob+paddy straw (7.50 cm) and lowest for the sugarcane bagasses+paddy straw (5.30 cm) which was statistically at par with sawdust+paddy straw (5.75 cm) respectively as shown in Table 2.

Table 1: Time taken for colonization (days) and fruit initiation (days) of mushroom on various substrates.

Substrate	Colonization period (days)	Fruit initiation period (days)
1. Paddy Straw	18.25^{b}	21.75^{b}
2.Maize cob+Paddy Straw(1:1)	20.50^{a}	23.00^{a}
3.Sugarcane+Paddy Straw(1:1)	20.00^{a}	23.25^{a}
4.Sawdust+Paddy Straw(1:1)	19.00^{b}	22.50^{ab}
LSD Value	0.861	1.13
CV (%)	2.47	3.25

(Figure in a column having common letter(s) does not differ significantly at 5% level of significance.)

Table 2: Measurements of length of stalk (cm), diameter of stalk (cm) and diameter of pileus (cm) of mushroom on various substrates.

Substrate	Length of stalk (cm)	Diameter of stalk (cm)	Diameter of pileus (cm)
1. Paddy Straw	5.56^{a}	0.80^{a}	7.90^{a}
2.Maize cob+Paddy Straw(1:1)	5.79^{a}	0.73^{ab}	7.50^{a}
3.Sugarcane+Paddy Straw(1:1)	6.10^{a}	0.63^{c}	5.30^{b}
4.Sawdust+Paddy Straw(1:1)	4.70^{b}	0.69^{bc}	5.75^{b}
LSD Value	0.811	0.0786	0.459
CV (%)	9.51	7.16	4.51

(Figure in a column having common letter(s) does not differ significantly at 5% level of significance)

Fresh Weight and Biological efficiency

The total fresh weight of the first and second flush was found significantly highest for maize cob+paddy straw (718.7 gm) followed by sugarcane bagasses+paddy straw (527.8 gm), sawdust+paddy straw (459.0 gm) and lowest for paddy straw(408.3gm) respectively as shown in the Table 3.

But regarding to the biological efficiency, paddy straw showed significantly highest biological efficiency (96.29688%) followed by maize cob+paddy straw (74.09293%), sugarcane bagasses+paddy straw (71.90742%) and lowest for sawdust+paddy straw (71.05248%) respectively as shown in Table 3.

The period for spawn running (colonization) was ranged from 18.25-20.5 days in our experiment which was similar to the study carried out by Ahmed (1998), who also reported spawn running of *P. ostreatus* completed within 17–20 days on different substrates. The variation in the number of days taken for a spawn to complete colonization of a given substrate is a function of the fungal strain, growth conditions and substrate type (Chang & Miles, 2004). Similarly, the period for the pin head formation (fruit initiation stage) was found to ranges from 21.75-23.25 days in our experiment which was also found similar to the study carried out by Fan *et al*. (2000), they reported pin-head formation of oyster mushroom cultivated in different substrates ranged from 20–23 days.

The colonization period was found lower for rice straw (paddy straw) followed by sugarcane bagasses and sawdust, as shown in the experiment conducted by Sharma, *et al*.,(2013). Similar result for colonization was found for paddy straw but in case of other two, the period was shorter for sawdust followed by sugarcane bagasses in our experiment. These two substrates were used by well mixed with the paddy straw at the ratio 1:1, which results the lesser time for colonization on those substrates as compared to their experiment, where they used those substrates solely without mixed with paddy straw.The main function of rice straw is to provide a reservoir of cellulose, hemicelluloses and lignin which is utilized during the growth and fructification (Yildiz *et al*., 2002)

Pleurotus ostreatus showed the better yield performance in paddy straw (100%) with respect to the dry weight of the substrate as compared to other. Khadka & Parajuli (2013), has explained that paddy straw is suitable substrates for *Pleurotus ostreatus*, which was also proved by our experiment. The increase in the yield of mushroom in paddy straw is due to easier way of getting sugars from the cellulosic substances (Ponmurugan, Sekhar, & Sreeshakti, 2007). Whereas, sawdust and sugarcane bagasse also contain high amount of lignin. Low degradation of lignocellulosic substances of sawdust by *P. ostreatus* might be another factor affecting the overall low yield values from sugarcane bagasse and sawdust (Sharma *et al*.,2013).

Table 3: Effect of substrates on fresh weight of first flush (gm) and second flush (gm), total fresh weight (gm), dry weight (gm) and biological efficiency (%) of the various substrates.

Substrate	Fresh weight per ball (gm)				
	1st flush (gm)	2nd flush (gm)	Total yield (gm)	Dry weight per ball (gm)	Biological efficiency (%)
1. Paddy Straw	276.8^{c}	131.5^{d}	408.3^{d}	424.00^{d}	96.29688^{a}
2.Maize cob+Paddy Straw(1:1)	401.3^{a}	317.4^{a}	718.7^{a}	970.00^{a}	74.09293^{b}
3.Sugarcane+Paddy Straw(1:1)	305.2^{b}	222.6^{b}	527.8^{b}	734.00^{b}	71.90742^{c}
4.Sawdust+Paddy Straw(1:1)	277.0^{c}	182.0^{c}	459.0^{c}	646.00^{c}	71.05248^{d}
LSD Value	1.29	1.29	2.18	1.54	0.267
CV (%)	0.266	0.392	0.268	0.144	0.221

(Figure in a column having common letter(s) does not differ significantly at 5% level of significance.)

Conclusion

From the present study it can be concluded that paddy straw alone is the best substrate for the growth and development of the oyster mushroom (*Pleurotus ostreatus*). So, paddy straw solely can be used for its higher production as compared to other supplements like sawdust, maize cob and sugarcane bagasses. Further studies can be done thoroughly modification of environment making suitable temperature and humidity for the better growth and development of oyster mushroom.

Acknowledgement

We are highly thankful to Prof. Dr. Sundarman Shrestha who helped and guided us to conduct this experiment and also going through the manuscript.

References

Ahmed S (1998) Development of mushroom varieties suitable for rural level in Bangladesh. *Report presented in BARC Annual Review Programme* 72–73.

Bano Z, Nagaraja N, Rajrathnam S and Pathwardhan MV (1979) Cultivation of *Pleurotus* spp. In a village model hut. *Indian Fd Packer* **33**(6): 9-25.

Bhuiyan MM, Rahman MM, Afroze F, Sutradhar GN and Bhuiyan MS (2008) Effect of phosphorus, molybdenum and Rhizobium on growth and nodulation of mungbean inoculation. *J Soil Nature* **2**(2): 25-30.

Carrera DM (1998) *Cultivation of Oyster Mushrooms*. McGraw-Hill Yearbook of Science & technology.

Chang S and Miles P (2004) *Mushrooms: cultivation, nutritional value, medicinal effect, and environmental impact*, 2nd eds. Boca Raton: CRC Press.

Chang ST and Miles PG (1988) Edible Mushroom and their cultivation. CRC press, Inc. Boca Raton, Florida U.S.A. **27**: 83-88. DOI: 10.1201/9780203492086

Chow LP (1980). Utilization of cotton waste substrate with temperature treatment for cultivation of oyster mushroom in Singapore. *Singapore J Pri Ind* **8**(10): 21-27.

Fan L, Pandey A, Mohan R and Soccol C (2000). Use of various coffee industry residues for the cultivation of Pleurotus ostreatus in solid state fermentation. *Acta Biotechnol* **20**: 41–52. DOI: 10.1002/abio.370200108

Khadka RB and Parajuli GP (2013). Performance of Two Oyster Mushroom Species (*Pleurotus ostreatus* and *P. florida*) on Different Substrates Composition in Western Terai of Nepal. *Nepal Agric Res J* **13**: 48-54.

Kong W (2004) *Oyster Mushroom Cultivation* (Descriptions of Commercially Important Pleurotus species). Mushroom Growing Handbook 1, Mushworld 54-61.

Mamiro DP and Mamiro PS (2011) Yield and Mushroom Size of Pleurotus Grown on Rice Straw Basal Substrate Mixed and Supplemented with Various Crop Residues. *Journal of Animal & Plant Sciences* **10**(1): 1211- 1218.

Miles PG and Chang ST (1998) *Edible Mushroom and their cultivation*. Florida, U.S.A: CRC press.

Mondal SR, Rehana MJ, Noman MS and Adhikary SK (2010) Comparative Study on Growth and Yield Performance of Oyster Mushroom (Pleurotus Florida) on Different Substrates. *Journal of Bangladesh Agricultural Univeristy* **8**(2): 213–220.

Nadir HA, Ali AJ and Muhammed GA (2016) Determination of Yield and Quality of Oyster Mushroom (*Pleurotus florida*) Using Different Substrates in Halabja , Kurdistan. *Plant Production* **7**: 787–790.

Phillips R (2006) Mushroom. McMilan.

Pokhrel CP (2016) Cultivation of oyster mushroom: a sustainable approach of rural development in Nepal. *Journal of Institute of Science and Technology* 21(1): 56-60. DOI: 10.3126/jist.v21i1.16050

Ponmurugan P, Sekhar Y and Sreeshakti T (2007) Effect of various substrates on the growth and quality of mushrooms. *Pak J Bio Sci* 10: 171-173. DOI: 10.3923/pjbs.2007.171.173

Quimio TH (2004) *Oyster Mushroom Cultivation, Mushroom Growing Handbook1*, Mushworld 4-12.

Randive S (2012) Cultivation and Study of Growth of Oyster Mushroom on Different Agricultural Waste Substrate and Its Nutrient Analysis. *Advances in Applied Science Research* **3**(4): 1938-1949.

Sharma S, Yadav RK and Pokhrel CP (2013) Growth and Yield of Oyster mushroom (*Pleurotus ostreatus*) on different substrates. Journal on New Biological Reports 2(1): 3-8.

Yildiz S, Yildiz U, Gezer E and Temiz A (2002) Some lignocellulosic wastes used as raw material in cultivation of the *Pleurotus ostreatus* culture mushroom. *Pro Biochem* **38**: 301-306. DOI: 10.1016/S0032-9592(02)00040-7