PERFORMANCE OF DIFFERENT SUBSTRATES ON THE PRODUCTION OF OYSTER MUSHROOM (*Pleurotus florida)* AT GOKULESHWOR, DARCHULA

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Abstract: A research was conducted at Gokuleshwor VDC of Darchula district during 2015 to determine the performance of different substrate for the production of Oyster The research was carried out by growing *florida species of Pleurotus (Oyster Mushroom),* on five different substrates namely banana leaves, rice straw, wheat straw, mixture of rice and wheat straw and saw dust under one factor CRD design with four replication during summer with an average daily temperature of 26^0C- 30^0C and RH ranging from 80 to 100%. Among the five different treatments banana leaves was found to be suitable as it obtained more total yield per five kg of substrate i. e. 4.76 kg followed by other substrates. The saw dust gave lowest yield i.e. 0.97 kg which may be due to presence of different phenolic compounds. The duration of first mycelium colonization, fruiting and harvesting was shorter in banana leaves followed by other substrates and longer in saw dust. Longer stipe length was obtained from banana leaves (6.41 cm) and wider Cap diameter was obtained from wheat straw (9.87 cm) followed by other substrates. Similarly, the maximum final substrate weight per ball was obtained from saw dust i.e. 4.56 kg followed by other substrates and minimum in banana leaves i.e. 2.12 kg. In conclusion banana leaves was found best substrate for production of *P. florida* as it gave the highest B:C ratio (3.13) followed by rice straw (2.10) among the substrate used.

Keywords: Colonization, Fruiting, Mushroom, Substrates and Yield

INTRODUCTION

Mushrooms are the fruiting bodies of macrofungi. They are neither plants nor animals but they have been placed in a kingdom of their own called the kingdom of Myceteae. The term mushroom resembles to those

fungi that have stem (stipe), cap (pileus), hymenium (lamellae) and spores which are present on the underside of the cap (Masarirambi *et al.*, 2011). They have heterotrophic mode of nutrition as they lack chlorophyll.

Both edible/medicinal and poisonous species can be categorized under mushroom. In Nepal roughly 110 mushroom species are edible, 45 are toxic and 13 have medicinal value (Poudel and Bajracharya, 2011). In fiscal year 2013/14 fresh mushroom production was 1900 mt, similarly in fiscal year 2014/15 production was 2700 mt and in fiscal year 2015/16 production was reached to 9300 mt and mushroom seed production in fiscal year 2013/14, 2014/15 and 2015/16 was 333505, 425000 and 1488000 bottles respectively showing production of mushroom seed and fresh mushroom in recent years is rapidly increasing (MoAD, 2074; MoAD, 2015/16). Oyster mushroom (*Pleurotus spp.*) is very popular edible mushroom due to its excellent flavor and taste. Oyster mushrooms (*Pleurotus* spp.) were more recently domesticated, and now rank second in world production and first rank in Nepal. In Nepal three species of Oyster mushroom namely *Pleurotus sajor-kaju P. ostreatus* and *P. florida* are available. A high nutritional value of dried oyster mushrooms has been reported with protein (25-50%), fat (2-5%), sugars (17-47%), mycocellulose (7-38%) and minerals (potassium, phosphorus, calcium, sodium) of about 8-12% (Stanley, 2011). Edible mushrooms are also rich in vitamins such as niacin, riboflavin, vitamin D, C, B1, B5 and B6 (Ahmed et al., 2009).

The different species of *Pleurotus* normally grow within a temperature range from 15-25^{o}C and on various agricultural waste materials as substrate (Hasan *et al*., 2010). Although *Pleurotus* is leading mushroom in country most of the production relies on *P. sajor-kaju* and is only confined in winter season. Still there is very negligible supply of oyster mushroom in summer season although the demand is increasing day by day. So, *P. florida*; a species of oyster mushroom growing easily in warmer condition may be the best alternative for the year round supply of Oyster mushroom supporting summer season. *P. florida* gives the highest yield at 30 ^{o}C and is preferred for summer season cultivation (Uddin *et al.*, 2010). It can be grown on substrates rich in cellulose hemicellulose and lignin such as agro byproducts like rice straw, wheat straw, leaves and banana leaves, saw dust, sugarcane baggase, corncob, waste papers etc.

In Nepal although Plant Pathology Division (PPD) introduced cultivation technology of Oyster mushrooms in 1981 the growth rate of this sector is not satisfactory. Most of farmers are confined to winter season for mushroom cultivation using rice straw as they are not familiar with efficiency and methods of *Pleurotus* mushroom production using other agro byproducts. *Pleurotus* cultivation is bioconversion exercise which greatly reduces pollution and is an efficient source of protein. In tune with the contemporary problem the present study was carried out to evaluate the performance of different agro based residues on the yield performance of *Pleurotus* mushroom and to find out the benefit cost ratio of *Pleurotus florida* mushroom production using different substrates specially in summer season.

MATERIALS AND METHODS

A field experiment was carried out at Gokuleshwor bazaar of Darchula district of Nepal during 5 August to 15 November 2015. The experiment was conducted in completely randomized design (CRD) with 5 treatments and 4 replications. Thus, there were altogether 20 bags each of 5kg and variety used was *Pleurotus florida.*

The treatments consisted of rice straw (t1), wheat straw (t2), 1:1 mixture of rice straw and wheat straw (t3), banana leaves (t4) and saw dust (t5) as substrates. These substrates were chopped into small pieces of 1-2 inch (if required), overnight soaked, thoroughly washed with clean water and excess water was allowed to drain down so that water didn't ooze out when squeezed with hand. Then each substrate were individually sterilized by steam using metallic drum for 2 to 3 hrs and were allowed to cool to normal temperature or 20-25^{0}c, which was then filled into plastic bags of size 16''X24'' making five layer each of 5 kg. Spawning was done at periphery of each layer with 20 gm in lower four layers and 25 gm in uppermost layer, then after the bags were tied at the mouth and few holes were made for aeration around the periphery plastic bag and were incubated in dark and ventilated room at around 30^{o}C.

After the substrates were fully colonized with mycelium then the plastics were removed and each ball was established into wooden platform in dispersed light condition for growing mushroom. Watering was done in 2-3 times a day depending upon substrate and temperature after 7-10 days fruiting bodies were appeared which were ready for harvest in further 3-5 days. In the similar second and third harvests were taken. Then number of days to full colonization, number of days to first fruiting, harvesting duration, total mushroom yield, mushroom pileus diameter, stipe length and final substrate weight were observed and B:C ratio was calculated. Observed data were then analyzed by using M-stat-c. Analysis of variance (ANOVA) was used to test differences among the treatments and means were separated using Duncan's multiple range test (DMRT) at the 5 % level of significance.

RESULTS AND DISCUSSION

Five different types of substrates were compared with respect to production of Oyster mushroom. The various substrates used in this study showed variation in spawn run, duration of first fruiting, days to harvests, stipe length, pielus diameter, total yield and final substrate weight.

Effect of different substrates on 1st colonization duration, 1st fruiting duration, 1st harvest duration, 1st yield, 1st harvest stipe length and 1st harvest cap diameter of oyster mushroom

Analysis of variance (ANOVA) revealed highly significant results among the tested substrates ($p \leq 0.01$) in first colonization, first fruiting, first harvest duration, first harvest yield, first harvest stipe length and cap diameter. Banana leaves required least time for mycelium colonization (18.5 days) followed by rice straw (21 days), wheat straw (21.5 days), mixture of rice and wheat straw (22.75 days) and longest duration was required for saw dust (42 days). Similarly, first fruiting and first harvest was also found to be faster in banana leaves (19.5 and 23 days) followed by rice straw (23 and 26.25 days), respectively. Highest fruiting and harvest duration was recorded in saw dust (44 and 50.25 days) respectively. In case of yield from first harvest higher yield was obtained from banana leaves (530 gm) followed by rice straw (463.8 gm), wheat straw (390 gm), mixture of rice and wheat (373.8 gm) and the lowest yield was obtained from saw dust (98.75 gm). In case of stipe length from first harvest was obtained in banana leaves (6.76 cm) followed by wheat straw (6.62 cm), mixture of rice and wheat straw (6.07 cm), rice straw (6.02 cm) and shortest was obtained from saw dust (4.6 cm). For cap diameter, it was found highest from wheat straw (9.87 cm) followed by banana leaves (9.17 cm), rice straw (8.96 cm), mixture of rice and wheat straw (8.11 cm) and lowest in saw dust (7.14 cm) under similar environment (Table 1)

Mondal *et al.,* (2010) found similar result according to him, the presence of right proportion of alpha-cellulose, hemicellulose and lignin is responsible for higher mycelium running rate in banana leaves and rice straw and for the higher mycelial growth in banana leaves and rice straw the suitable C: N ratio might be responsible which in turn gives higher yield. Lower mycelium running rate aggravates for lower yield in saw dust which might be due to presence of various kinds of polyphenolic substances, low content of cellulose and low moisture holding capacity. Similar result was found by Chang & Quimio (1982) and (Gohl, 1993). The type of agricultural wastes, single or mixtures of two different agricultural wastes used in preparing the farm substrates may be responsible for change in the stipe length, pileus width and overall yield of the mushrooms grown in the different farm substrates. Similar result was found by Chukwurah (2013). Also the major ecological factors such as temperature, humidity, fresh air and compact material affect stalk height, stalk diameter and cap size in mushroom (AMGA, 2004).

Table 1. Effect of different substrates on first mycelium colonization duration, first fruiting duration, first harvesting duration, first yield, first harvest stipe length and first harvest cap diameter of *Pleurotus* mushroom

Treatments	Mycelium Colonization duration	Fruiting duration	Harvesting duration	Yield (gm)	Stipe length (cm)	Cap diameter (cm)
Rice straw	21.00c	23.00b	26.25c	463.8b	6.02a	8.96ab
Wheat straw	21.50bc	23.50b	26.75c	390.0c	6.62a	9.87a
Rice+wheat mix	22.75b	24.50b	28.00b	373.8c	6.07a	8.11bc
Banana leaves	18.50d	19.50c	23.00d	530.0a	6.76a	9.17ab
Saw dust	42.00a	44.00a	50.25a	98.75d	4.6b	7.14c
Mean	**25.15**	**26.90**	**30.85**	**371.25**	**6.01**	**8.65**
LSD	1.39	1.69	0.97	65.59	1.077	1.22
SEm(±)	0.46	0.56	0.32	21.76	0.35	0.40
CV%	3.6	4.18	2.09	11.72	11.88	9.38
Probability	0.00	0.00	0.00	0.00	0.00	0.00

Treatment means are separated by Duncan's Multiple Range Test (DMRT) and the columns represented by the same letter (s) are not significantly different among each other at 5%

Effect of different substrates on mean yield and final substrate weight of Oyster mushroom

Analysis of variance showed highly significant result ($p \leq 0.01$) between the final mean yield and final substrate weight of oyster mushroom between the different substrate used as treatments. Highest final mean yield was obtained by banana leaves (1190 gm) followed by rice straw (973.8 gm), wheat straw (832.5 gm) and mixture of rice and wheat straw (826.3 gm) respectively. The lowest final yield of oyster mushroom was obtained by saw dust (242.5 gm). In case of final substrate weight of banana leaves had lowest weight (2.12 kg) followed by rice straw+wheat straw mix (2.98 kg), rice straw (3.05 kg), wheat straw (3.30 kg) and highest in saw dust (4.56 kg) (Table.2). This suggests that the substrate which is used more by enzymatic activity of fungus gives more yields but in case of mix substrate the result didn't satisfy this as water holding capacity of mixture was relatively low. Thus, it indicates that higher percentage of biological use efficiency of banana leaves substrate

According to Mamiro and Mamiro (2011) the reason for higher yield from banana leaves rather than rice straw may be due to the high water holding capacity of banana leaves. Different kinds of polyphenolic substances in saw dust may results the lowest mycelium running rate (Chang & Quimio, 1982).

Table 2 . Effect of different substrates on total yield and final substrate weight of *Pleurotus* mushroom under Gokuleshwor condition

Treatments	Total yield (gm)	Final substrate weight (kg)
Rice straw	973.8b	3.05b
Wheat straw	832.5c	3.30b
Rice+wheat mix	826.3c	2.98b
Banana leaves	1190.0a	2.12c
Saw dust	242.5d	4.56a
Mean	**813**	**3.20**
LSD	122.9	0.42
SEm(±)	40.77	0.14
CV%	10.03	8.85
Probability	0.00	0.00

Treatment means are separated by Duncan's Multiple Range Test (DMRT) and the columns represented by the same letter (s) are not significantly different among each other at 5%

Economic Analysis

Table3. Total Cost

Treatments	Cost of materials	Rate of substrates(10 kg)	Total cost
Rice straw	455	Rs. 100	555
Wheat straw	455	Rs. 50	505
Mix of rice & wheat straw	455	Rs. 75	530
Banana leaves	455	-	455
Saw dust	455	Rs. 20	475

Table4. Benefit from selling of mushroom

S.N.	Treatments	Average yield per	Total yield	Rate (Rs./kg)	Benefit (Rs.)

		bag (kg)	(kg)		
1	Rice straw	0.9738	3.89	300	1167/-
2	Wheat straw	0.8325	3.33	300	999/-
3	Rice straw+wheat straw	0.8263	3.30	300	990/-
4	Banana leaves	1.1900	4.76	300	1428/-
5	Saw dust	0.2425	0.97	300	291/-

B-C Ratio:

It is defined as the ratio of gross benefit from selling of output to the total cost incurred during production. If B:C is greater than 1, the project is accepted and vice-versa. Higher value of B:C indicates higher level of feasibility of the project in economical aspect. In our study, B-C ratio of different treatments was as follows:

t1-Rice straw= 1167/555=2.10

t2-Wheat straw=999/505=1.97

t3-Mix of rice & wheat straw=990/530=1.86

t4-Banana leaves= 1428/455=3.13

t5-Saw dust= 291/475=0.62

Benefit- Cost result showed that higher economic benefit was obtained from use of banana leaves as substrate for cultivation of *P. florida* with highest B: C ratio (3.13) followed by rice straw (2.10), wheat straw(1.97) and mixture of rice and wheat straw (1.97). But B: C was found less than 1 in case of saw dust (0.62) indicating some problems in gaining yield with respect to cost expense. Similar, results was found by Mamiro and Mamiro (2011). The low yield in saw dust might be due to lowest mycelium running rate which might be due to presence of different kinds of polyphenolic substances, low content of cellulose and low moisture holding capacity. Similar result was found by Chang & Quimio (1982) and (Gohl, 1993).

CONCLUSION

From the results obtained through our research banana leaves is more efficient for the production of *Pleurotus florida* mushroom in summer season as compared to rice straw, wheat straw, mixture of rice and wheat straw

and saw dust as the total yield and B:C ratio both are higher in case of banana leaves than others. So, banana leaves could be one of the best substrate for production of *Pleurotus florida* mushroom in summer which will reduce the short supply of mushroom during summer condition and may also provides reasonable price to the farmers.

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