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Performance of different substrates on the production of oyster mushroom (*Pleurotus florida)*

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Abstract
A research was conducted during 2018 to determine the performance of different substrate for the production of Oyster mushroom. The research was carried out by growing *Pleurotus florida* species of (Oyster Mushroom), on nine different substrates namely Wheat Straw, Banana leaves, Sarpat grass, Saw dust, Paddy straw, Paddy husk, Ragi leaves, Maize leaves, Bamboo leaves under one factor CRD design with three replication during winter with an average daily temperature of 18 °C- 25 °C and RH ranging from 80 to 100%. Among the nine different treatments paddy straw was found to be suitable as it obtained more total yield (374.17 gm.) per followed by other substrates. The sarpat grass gave lowest yield i.e. (195.08 gm.) which may be due to presence of different phenolic compounds. The duration of first mycelium colonization, fruiting and harvesting was shorter in paddy straw followed by other substrates and longer in Banana leaves. Longer stipe length was obtained from paddy straw (7.66 cm) and width of pileus was obtained from paddy straw (8.83 cm) followed by other substrates.

Keywords: paddy straw, growth, yield, *pleurotus florida*, pileus, mycelium colonization

Introduction
Oyster mushroom, *Pleurotus* spp. a macro fungus with a distinctive fruiting body, is a unique biota which assembles its food by secreting degrading enzymes. The genus *Pleurotus* (oyster mushroom) is an organoleptic fast growing fungus, which decomposes the complex organic materials to generate simpler compounds for its nutrition. Since centuries, mushrooms have been recognized as important food item and their usage is being increased day by day for their significant role in human health, nutritional and medicinal properties (Mshandete, 2011) [2]. 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 °C and 10 to 20 °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) [3]. Most organic matters containing cellulose, hemicelluloses and lignin can be used as mushroom substrate i. e. rice and wheat straw, banana leaves, cottonseed hulls, corncob, sugarcane bagasse, sawdust, waste paper, leaves, and so on. The amount of nutrition requirement differs according to mushroom species and types of substrate used. The Pleurotus mushroom requires low amount of nitrogen but more carbon source. This study was designed to identify the alternative substrates from various agricultural and forest residue. So the main objective of study to determine the effect of different agro based residues on the yield performance of oyster mushroom.

Materials and Methods
The experiment was carried out at the laboratory and Mushroom Crop Room, Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P, India during the period of October 2018 to January 2019. Inoculum multiplication, substrate preparation, inoculums of substrates, maintenance of beds and for harvest, the methods proposed by (Survase, 2012 [6]; Vijay and Sohi, 1987) [7]. Yield of mushrooms and their biological efficiency was determined by using the formula (Siddhant *et al*., 2013) [5].

Substrate preparation
The wheat (*Triticum* aestivum) straw, Banana (*Musa sp*.) leaves, Maize (*Zea mays*) leaves Bamboo (*Bambusa vulgaris*) leaves, Sarpat (*Tripidium bengalense*) grass, Saw dust, Ragi (*Eleusine coracana*), Paddy (*Oryza sativa*) husk were chopped into small pieces of 3 cm.

Hundred litres of tap water was filled in plastic drum. The water was mixed with bavistin (0.03%), calcium carbonate (2 g) and formalin (2%) to make solution with water. Each substrate was put in separate plastic drums covered with the lid and kept it in for 18 hours. After sterilization of the substrates in the solution the excess water was drained out and each substrate was spread out as thin layer on sterilized floor in a shaded area. Sixty per cent moisture content in the straw was tested by taking a handful of straw and squeezing tightly. When the water did not drip out and the hand felt the wetness of the straw. Then substrates were processed for spawning.

Results and Discussion

Days taken for complete spawn run *Pleurotus Florida*.
Results of Table no.1 on effect of the substrates on number of days taken to complete spawn run of *Pleurotus florida* indicates that the treatments on number of days whereas the minimum time taken for complete spawn run of *Pleurotus florida* indicates that the treatment T_4 (paddy straw) was found significantly reduced days of complete spawn run duration as compared to T_8 (bamboo leaves), T_0 (wheat straw), T_1(banana leaves), T_6 (ragi leaves), T_2 (sarpat grass) and T_3 (saw dust). Whereas the maximum time taken for complete spawn run was observed in T_3 (Saw dust - 19 days), T_2 (sarpat grass) and T_6 (ragi leaves).

Table 1: Effect of different substrates on growth parameters on Oyster mushroom (*Pleurotus Florida*)

Treatment No.	Treatment details	Days taken for complete spawn run	Days taken for primordial initiation	Days taken for formation of fruiting bodies	Days taken for mature fruiting bodies	Width of pileus (cm)	Length of stipe (cm)	Biological Efficiency (%)
T_0	Wheat Straw	16	19	23	24	8.16	6.36	117.75
T_1	Banana leaves	17	20	24	28	7.13	6.96	84.33
T_2	Sarpat grass	18	22	25	27	7.00	6.20	72.09
T_3	Saw dust	19	23	26	26	6.76	7.00	87.36
T_4	Paddy straw	14	17	20	22	8.83	7.66	121.69
T_5	Paddy husk	15	18	21	23	8.33	7.45	118.99
T_6	Ragi leaves	18	21	25	27	6.83	6.84	122.00
T_7	Maize leaves	15	18	22	25	8.36	7.29	92.59
T_8	Bamboo leaves	16	19	23	25	7.80	6.88	91.21
	C.D. (P = 0.05)	1.897	1.513	1.513	1.897	0.914	0.828	45.32
	SEm (±)	0.333	0.509	0.509	0.638	0.184	0.279	15.25
	SEd (±)	0.471	0.720	0.720	0.903	0.260	0.394	21.57
	C.V.	6.723	4.484	3.798	4.403	6.924	6.931	6.98

Days taken for primordial initiation of *Pleurotus Florida*.
Results on effect of substrates on number of days taken for primordial initiation of *Pleurotus florida* shows that the treatment T_4 (Paddy straw 17 days) was found significantly reduced days for initiation primordial of as compared to T_8 (bamboo leaves 19 days), followed by T_0 (wheat straw 19 days), T_1 (banana leaves 20 days), T_6 (Ragi leaves 21 days), T_2 (sarpat grass 22 days) and T_3 (saw dust 23 days) [Table 1].

Number of days taken for formation of fruiting bodies
Results of number of days taken for formation of fruiting bodies of *Pleurotus Florida* show that the treatment T_4 (paddy straw) significantly reduced to developed fruiting body of *Pleurotus Florida* as compare with T_7 (maize leaves), T_8 (bamboo leaves), T_0 (wheat straw), T_1 (banana leaves), T_6 (ragi leaves), T_2 (sarpat grass) and T_3 (saw dust). [Table 1]

Number of days taken for mature fruiting bodies
Effect of substrates on number of days for mature fruiting bodies of *Pleurotus florida* shows that the treatment T_4 (paddy straw) was found significant showed the shortest duration (22 days) to complete spawn run. Whereas the maximum time taken for complete spawn run was observed in T_1 (Saw dust - 28 days). [Table 1]

Width of pileus (cm)
Results of width of pileus (cm) of *Pleurotus Florida* shows that the treatment T_2 (Sarpat grass) was found significantly lesser the width of pileus as compared with the other substrates. However, the width of pileus in T_0 (wheat straw), T_1 (Banana leaves), T_6 (ragi leaves) T_7 (Maize leaves) significantly increased from T_3 (saw dust), T_4 (paddy straw), T_5 (Paddy husk) and T_8 (bamboo leaves). [Table 1]

Length of stipe (cm)
Length of stipe of *Pleurotus Florida* shows that the treatment T_6 (Ragi leaves) found significantly increase from T_5 (Paddy husk) and T_2 (Sarpat grass). [Table 1]

Biological efficiency (%)
Biological efficiency (%) of *Pleurotus florida* indicates that the T_4 (Paddy straw) was found to significantly increased biological efficiency (121.69%) as compared to other substrates whereas minimum biological efficiency was recorded in T_1Banana leaf (84.33%), T_3 - Saw dust (87.36%) and T_8 - Bamboo leaves (91.21%). [Table 1]

Table 2: Effect of different substrates on Yield (gm.) and economics of the treatments of *Pleurotus Florida*

Tr. No.	Details of Treatment	Yield (gm.)					Total cost of cultivation	Gross return	Net profit (□)	C: B ratio
		1st Picking	2nd Picking	3rd Picking	4thPicking	Total Yield (kg)				
T_0	Wheat straw	387.33	308.00	252.66	245.33	3.58	72.93	119.33	46.40	1: 1.64
T_1	Banana leaves	317.33	248.00	125.66	171.00	2.58	84.93	86.20	1.27	1: 1.01
T_2	Sarpat grass	228.00	218.66	170.00	163.66	2.34	60.93	78.03	17.10	1:1.28
T_3	Saw dust	266.66	289.66	253.00	246.00	3.16	60.93	105.53	44.60	1:1.73
T_4	Paddy Straw	447.66	351.00	352.66	345.33	4.49	60.93	149.67	88.73	1:2.46

T_5	Paddy husk	336.66	391.33	361.00	352.33	4.32	60.93	144.13	83.20	1:2.37
T_6	Ragi leaves	288.66	346.66	308.33	297.33	3.72	60.93	124.10	63.17	1:2.04
T_7	Maize leaves	327.33	309.33	257.33	247.66	3.42	81.93	114.17	32.23	1:1.39
T_8	Bamboo leaves	290.33	259.00	275.33	267.66	3.27	84.93	109.23	24.30	1:1.29
	C.D.(P = 0.05)	34.795	34.366	4.610	25.619					
	SEm (±)	11.710	1.707	1.552	8.622					
	SEd (±)	16.561	2.414	2.194	12.194					
	C.V.	6.317	6.544	1.027	5.753					

Effect of different substrates on Yield (gm) and economics of the treatments of *Pleurotus Florida*

Yield (gm.) 1st picking

Yield of *Pleurotus florida* on 1st picking shows that the treatment T_4 (Paddy straw) was found to give significantly higher yield (447.67 g) as compared to the three substrates whereas minimum yield was recorded in T_2 – Sarpat grass (228.00 g), T_3 – Saw dust (266.67 g) and T_6 – Ragi leaves (288.67 g). [Table 2]

Yield (gm.) of 2nd picking

Yield of *Pleurotus florida* on 2nd picking shows that the treatment T_5 (Paddy husk) was found to give significantly higher yield (391.33g) as compared to the the substrates whereas minimum yield was recorded in T_2 – Sarpat grass (218.67g), T_1 – Banana leaves (248.00g) and T_8 – Bamboo leaves (259.00g). [Table 2]

Yield (gm.) 3rd picking

Effect of different substrates on yield (gm) of *Pleurotus florida* on 3rd picking shows that the treatment T_5 (Paddy husk) was found to give significantly higher yield (361.00g) as compared to the substrates whereas minimum yield was recorded in T_1 – Banana leaves (125.67g), T_2 – Sarpat grass (170.00g), and T_0 – Wheat straw (152.67g). [Table 2]

Yield (gm.) 4th picking

Yield (gm) of *Pleurotus florida* on 4th picking shows that the treatment T_5 (Paddy husk) was found to give significantly higher yield (352.33g) as compared to the other substrates whereas minimum yield was recorded in T_2 - Sarpat grass (163.67g), T_1 - Banana leaves (171.00g), and T_0 - Wheat straw (245.33g). [Table 2]

Total Yield (kg)

Total yield (kg) of *Pleurotus florida* shows that the treatment T_4 (Paddy straw) was found to give significantly higher yield (4.49 kg) as compared to the other substrates whereas minimum yield was recorded in T_2 - Sarpat grass (2.34 kg) and T_1 - Banana leaves (2.58 kg).[Table 2]

The economics and cost benefit ratio of *Pleurotus Florida*

Among all the treatments, T_4 Paddy Straw proved to be the most profitable treatment with B: C of 1:2.46 followed by T_5 Paddy husk (1:2.37), T_6 Ragi leaves (1:2.04), T_3 Saw dust (1:1.73), T_0 Wheat straw (100%) (1: 1.64), T_7 Maize leaves (1:1.39), T_8 Bamboo leaves (1:1.29) whereas, T_1 Banana leaves is the least profitable treatment with the B: C of (1: 1.01). [Table 2]

In this study, the number of days taken for complete spawn run of *Pleurotus Florida* ranged between 14-19 days. Treatment T4 (paddy straw) was found significantly reduced days of complete spawn run duration (14 days). Similarly, days taken for primordial initiation (17 days), days taken for formation of fruiting bodies (20 days) and days taken for mature fruiting bodies (22 days) was recorded in treatment T_4 (Paddy straw). The maximum width of pileus (cm) and length of stipe (cm) were also recorded in T_4 Paddy Straw (8.83 cm and 7.66 cm respectively). The maximum yield taken on 1st, 2nd, 3rd, 4th pickings indicates that the higher yield (g) was obtained in T_4-Paddy straw (447.67g, 391.33g, 361.00g and 352.33g respectively.) the maximum biological efficiency and cost benefit ratio was also recorded in T_4-Paddy straw (121.69% and 1:2.46 respectively). The main function of rice straw is to provide a reservoir of cellulose, hemicelluloses and lignin which is utilized during the growth and fructification of oyster mushroom (Yildiz *et al.*, 2002) [8]. Therefore, in this study similar results were obtained which might be because rice straw contained sufficient amount of necessary nutrients for the growth of oyster mushroom. Kumari and Achal (2008) [1] stated that colonization of the substrate was completed within 20 days of inoculation. The size of fruiting bodies was higher in case of paddy straw (T_4) than in all other substrates. This is probably due to higher degradation of various constituents of the substrate paddy straw. The yield was significantly highest obtained in the first flush of all treatments. The highest yield and biological efficiency (%) was obtained from rice straw which may be due to easier way of getting sugars from the cellulosic substances (Ponmurugan *et al.*, 2007) [4].

Conclusion

The results obtained in the first trial indicates that the minimum number of days taken for complete spawn run (14 days), days taken for primordial initiation (17 days), days taken for formation of fruiting bodies (20 days) and days taken for mature fruiting bodies (22 days) was recorded in treatment T_4 (Paddy straw). The maximum width of pileus (cm) and length of stipe (cm) were also recorded in T_4 Paddy Straw (8.83 cm and 7.66 cm respectively). The maximum yield taken on 1st, 3rd, 5th and 7th day indicates that the higher yield (g) was obtained in T_4-Paddy straw (447.67 g, 391.33 g, 361.00g and 352.33 g respectively.) the maximum biological efficiency and cost benefit ratio was also recorded in T_4-Paddy straw (121.69% and 1:2.46 respectively)

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