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Effect of different botanicals along with wheat straw on growth and development of oyster mushroom (*Pleurotus Florida*)

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Abstract
Mushrooms are recognized as nutritionally functional food and a source of physiologically beneficial and nontoxic medicines. Oyster mushroom (*Pleurotus* spp.) is an efficient lignin degrading mushroom and can grow well on different types of lignocellulosic materials including agricultural and forest waste. Cultivation technique for oyster mushroom is very simple and the production cost is low, which gives consistent growth with high biological efficiency. Plant derivatives have shown considerable promise as an effective alternative of chemicals. To develop a suitable method for substrates treatment, 13 different plants extract (leaf powder) were mixed with wheat straw. The most effective treatment was found in T_5 (Wheat straw + Beal leaves) significantly superior among all, for cultivation of oyster mushroom (*Pleurotus Florida*). The duration of first mycelium colonization, fruiting and harvesting was shorter in (Wheat straw + Beal leaves 14 days) followed by other substrates and longer in T_{13} (Wheat straw + Betel vine leaves-22 days). Longer stipe length, width of pileus, biological efficiency (%) and yield was significantly increased in Wheat straw + bael leaf followed by other substrates.

Keywords: Wheat straw, bael leaf, *Pleurotus Florida*, oyster mushroom, plant extract

Introduction
Oyster mushroom (*Pleurotus Florida*) is one type of wood fungus that can be consumed and currently can also cultivate. An attractive feature of oyster mushrooms is that they can utilize a large variety of agricultural waste products and transform the lignocelluloses biomass in to high quality food, flavor and nutritive value (Jain and Vyas, 2003) [5]. Oyster mushroom cultivation now has the opportunity to be developed by people around the forest; this supported by the availability of raw materials for growing media substrates, namely sawn wood dust, which is quite abundant Hidayat (2011) [4]. Oyster mushroom (*Pleurotus* sp.) is the third most important edible mushroom cultivated worldwide Das and Kalita (2006) [2]. It can efficiently decompose lingo-cellulose without chemical or biological pre-treatment because it possesses an enzymatic complex system that includes phenol oxidizes and peroxidases Maria *et al* (2011) [7]. Amendment of mushroom growth substrates with botanical leaves is not a common practice Ogbe and Affiku (2012) [8]. However, there are several reports on the rich nutritional and phytochemical profiles of these botanicals that are rarely given a place in the daily menu of the people Osabor *et al.* (2010) [10], Agba (2015) [1]. Yet, they are naturally growing and of cosmopolitan occurrence in our environment. In this study, growth substrates were amended with botanical leaves powder of various plant to improve the productivity of the growth substrates (banana leaves and banana leaves/sawdust) for the cultivation of *P. Florida*.

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 2019 to January 2020. Inoculum multiplication, substrate preparation, inoculums of substrates, maintenance of beds and for harvest, the methods proposed by (Survase, 2012 [11]; Vijay and Sohi, 1987) [12].

Preparation of master spawn
Clean wheat grains were paraboiled in tap water (1:1 w/v). After boiling, excess water was drained of by spreading the grains on wire mesh/sieve. Then these were spread on surface sterilized (4% formalin) polythene sheet to which calcium sulphate @ 2% and calcium

carbonate @ 5% were mixed on dry weight basis. About 250g quantity of treated grains was filled in 500 ml capacity conical flasks. These flasks were plugged with non-absorbent cotton and sterilized in an autoclave at 15 psi pressure for 20 minute for two consecutive days. After cooling at room temperature, the flasks were transferred in a laminar air flow cabinet, where they were exposed to UV light for 20 minutes and then aseptically inoculated with fresh mycelial bits taken from the previously prepared pure culture slants. Inoculated flasks were incubated at 28±2 °C for 16-18 days. These flasks were shaken intermittently to facilate through spreading on the mushroom mycelium on the grains. After three weeks of incubation, the grains in flasks were fully covered with the mycelium of *P. Florida.* Thus the master spawn was prepared (Joshi *et al.,* 2018) [6].

Preparation of botanical leaf powder

The selected botanicals Lemon (*Citrus Limon*), *Lantana camera*, Guava (*Psidium guajava*), Mango (*Mangifera indica*), Drumstick (*Moringa oleifera*), Pepal (*Ficus religiosa*), Castor (*Ricinus communis*), Aonla (*Phyllanthus emblica*), Betel vine (*Piper betle*), Beal (*Aegle marmelos*), Banyan (*Ficus benghalensis*), Mulberry (*Morus Alba*) and Neem (*Azadirachta indica*)) were procured from different locations in and around the university. All the botanicals were weighed, washed and air dried. It was then grinded to make fine powder with the help of grinder following (Vishwakarma *et al.*, 2017) [13] after that it was powdered and packed in bags and sealed. The bags with leaf powder were autoclaved at 121°C at 15psi for 30 minutes. After sterilization the leaf powder was mixed with wheat straw for spawning Then all 13 treatments including control and each treatment was replicated 3 times to achieve the desired objectives.

Results and discussion

Days taken for complete Spawn run

Days taken to complete spawn run of *Pleurotus florida* indicates that the treatment T_5 (Wheat straw+ Beal leaves- 14 days) was found significantly reduced days of complete spawn run as compared to T_1 (Wheat straw + Drumstick leaves- 16 days), T_9 (Wheat straw + Peepal leaves - 18 days), T_0 (Wheat straw - 18 days), T_6 (Wheat straw + Mulberry leaves- 19 days), T_{12} (Wheat straw + Aonla leaves - 20 days), T_{10} (Wheat straw + Banyan leaves- 20 days), T8 (Wheat straw + Mango leaves- 20 days), T_7 (Wheat straw + Lantana leaves- 20 days), T_2 (Wheat straw + Neem leaves- 20 days), T_{11} (Wheat straw + Guava leaves- 21 days), T_4 (Wheat straw + Lemon leaves- 21 days) all other substrate which showed the shortest to whereas the maximum time taken to complete spawn run was observed in T_3 (Wheat straw + Castor leaves – 21 days) T_{13} (Wheat straw + Betel vine leaves – 22 days) [Table 1].

Days taken for primordial initiation

number of days taken for primordial initiation of *Pleurotus florida* indicates that the treatment T_5 (Wheat straw+ Beal leaves- 17 days) was found significantly reduced days for primordial initiation as compared to T_1 (Wheat straw + Drumstick leaves- 18 days), T_0 (Wheat straw- 20 days), T_9 (Wheat straw + Peepal leaves- 21 days), T_6 (Wheat straw + Mulberry leaves- 21 days), T_{12} (Wheat straw + Aonla leaves- 22 days), T_{10} (Wheat straw + Banyan leaves- 22 days), T_8 (Wheat straw + Mango leaves- 23 days), T_7 (Wheat straw + Lantana leaves- 23 days), T_3 (Wheat straw + Castor leaves – 24 days), T_2 (Wheat straw + Neem leaves- 24 days) and T_{11} (Wheat straw + Guava leaves- 25 days) all other substrate which showed the shortest to whereas the maximum time taken for primordial initiation was observed in T_4 (Wheat straw + Lemon leaves- 25 days), T_{13} (Wheat straw + Betel vine leaves - 26 days) [Table 1].

Table 1: Effect of wheat straw along with botanicals on days of growth parameters of Oyster mushroom *Pleurotus Florida*

Tr. 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 (Control)	18	20	22	24	8	6.93	134.19
T_1	Wheat straw + Drumstick	16	18	18	21	8	7.10	138.69
T_2	Wheat straw + Neem	20	24	20	26	6	5.70	90.49
T_3	Wheat straw + Castor	21	24	26	27	6	5.66	63.48
T_4	Wheat straw + Lemon	21	25	25	28	6	5.53	75.95
T_5	Wheat straw + Bael leaves	14	17	19	21	9	7.12	140.07
T_6	Wheat straw + Mulberry	19	21	23	26	8	6.63	132.70
T_7	Wheat straw + Lantana	20	23	25	27	6	5.82	96.31
T_8	Wheat straw + Mango leaves	20	23	22	25	7	6.30	122.09
T_9	Wheat straw + Peepal leaves	18	21	23	26	8	6.80	124.06
T_{10}	Wheat straw + Banyan	20	22	21	25	6	5.93	95.69
T_{11}	Wheat straw + Guava	21	25	21	26	7	6.26	97.024
T_{12}	Wheat straw + Aonla	20	22	22	25	8	6.38	130.42
T_{13}	Wheat straw + Betel vine	22	26	22	26	5	5.26	77.14
	C.D. (P = 0.05)	2.189	2.096	3.223	1.672	0.796	0.974	24.99
	SEm (±)	0.756	0.724	1.113	0.577	0.275	0.336	8.62
	SEd (±)	1.069	1.024	1.574	0.816	0.389	0.475	12.20
	C.V.	6.789	5.643	8.732	3.966	6.798	9.320	6.60

Days taken for formation of fruiting bodies: Days taken for formation of fruiting bodies of *Pleurotus florida* indicates that the treatment T_1 (Wheat straw + Drumstick leaves- 18 days) was found significantly reduced days of complete spawn run as compared to T_5 (Wheat straw+ Beal leaves- 19 days), T_2 (Wheat straw + Neem leaves- 20 days), T_{11} (Wheat straw + Guava leaves- 21 days), T_{10} (Wheat straw + Banyan leaves- 21 days), T_{13} (Wheat straw + Betel vine leaves - 22 days), T_{12} (Wheat straw + Aonla leaves- 22 days), T_8 (Wheat straw + Mango leaves- 22 days), T_0 (Wheat straw- 22 days), T_9

(Wheat straw + Peepal leaves- 23 days), T_6 (Wheat straw + Mulberry leaves- 23 days) and all other substrate which showed the shortest to whereas the maximum days taken for formation of fruiting bodies was observed in T_7 (Wheat straw + Lantana leaves- 25 days) T_4 (Wheat straw + Lemon leaves- 25 days), T_3 (Wheat straw + Castor leaves – 26 days) [Table 1].

Days taken for mature fruiting bodies

Days taken for mature fruiting bodies of *Pleurotus florida* indicates that the treatment T_5 (Wheat straw+ Beal leaves- 21 days) was found significantly reduced days of complete spawn run as compared to T_1 (Wheat straw + Drumstick leaves- 21 days), T_0 (Wheat straw- 24 days), T_{12} (Wheat straw + Aonla leaves- 25 days), T10 (Wheat straw + Banyan leaves- 25 days), T_8 (Wheat straw + Mango leaves- 25 days), T_{13} (Wheat straw + Betel vine leaves – 26 days), T_{11} (Wheat straw + Guava leaves- 26 days), T_9 (Wheat straw + Peepal leaves- 26 days), T_6 (Wheat straw + Mulberry leaves- 26 days), T_2 (Wheat straw + Neem leaves- 26 days), T_7 (Wheat straw + Lantana leaves- 27 days) and all other substrate which showed the shortest to whereas the maximum Days taken for mature fruiting bodies was observed inT_3 (Wheat straw + Castor leaves – 27 days), T_4 (Wheat straw + Lemon leaves- 28 days) [Table 4.1].

Width of pileus (cm)

Width of pileus (cm) of *Pleurotus florida* indicates that the treatment T5 (Wheat straw + beal leaves - 9 cm) was found significantly higher width of pileus (cm) as compared to T_1 (Wheat straw + Drumstick leaves – 9 cm), T_0 (Wheat straw - 8cm), T_{12} (Wheat straw + Aonla leaves - 8cm), T_{10} (Wheat straw + Banyan leaves – 6 cm), T_8 (Wheat straw + Mango leaves - 7cm), T_{11} (Wheat straw + Guava leaves- 7cm), T_9 (Wheat straw + Peepal leaves- 8cm), T_6 (Wheat straw + Mulberry leaves- 8cm), T_2 (Wheat straw + Neem leaves- 6cm), T_7 (Wheat straw + Lantana leaves- 6cm), T_3 (Wheat straw + Castor leaves - 6 cm), T_4 (Wheat straw + Lemon leaves- 6cm), T_{13} (Wheat straw + Betel vine leaves – 5cm) [Table 1].

Length of stipe (cm)

Length of stipe (cm) of *Pleurotus florida* indicates that the treatment T5 (Wheat straw+ beal leaves – 7.12 cm) was found significantly higher width of pileus (cm) as compared to T_1 (Wheat straw + Drumstick leaves – 7.10cm), T_0 (Wheat straw - 6.93cm), T_{12} (Wheat straw + Aonla leaves – 6.38cm), T_{10} (Wheat straw + Banyan leaves -5.93cm), T_8 (Wheat straw + Mango leaves - 6.30cm), T_{11} (Wheat straw + Guava leaves- 6.27cm), T_9 (Wheat straw + Peepal leaves- 6.80cm), T_6 (Wheat straw + Mulberry leaves- 6.63cm), T_2 (Wheat straw + Neem leaves- 5.70cm), T_7 (Wheat straw + Lantana leaves- 5.82cm) T_3 (Wheat straw + Castor leaves - 5.66cm), T_4 (Wheat straw + Lemon leaves- 5.53cm), T_{13} (Wheat straw + Betel vine leaves – 5.26cm) [Table 1].

Biological efficiency (%)

Biological efficiency (%) of *Pleurotus florida* indicates that the T_5 (Wheat straw + bael leaf) was found to significantly increased biological efficiency (140.07%) as compared to other substrates whereas minimum biological efficiency was recorded in T_3 - Wheat straw + Castor (63.48%), T_4 - Wheat straw + Lemon (75.95%), and T_{13} - Wheat straw + Betel vine (77.14%) [Table 1]

Yield (gm.) 1st picking

Yield (gm.) of *Pleurotus florida* on 1st picking shows that the treatment T_5 (Wheat straw + Beal leaves) was found to give significantly higher yield (429.67g) as compared to the other substrates whereas minimum yield was recorded in T_{13} - Wheat straw + Betel vine leaves (203.00g), T_4 - Wheat straw + Lemon leaves (206.00 g) and T_3 – Wheat straw + Castor leaves (229.67 g) [Table 2].

Yield (gm.) 2nd picking

Yield (gm.) of *Pleurotus florida* on 2nd picking shows that the treatment T_0 (Wheat straw) was found to give significantly higher yield (371.33g) as compared to the other substrates whereas minimum yield was recorded in T_2 - Wheat straw + Neem leaves (218.67g), T_3 - Wheat straw + Castor leaves (248.00g) and T_{13} – Wheat straw + Betel vine leaves (259.00 g) [Table 2].

Table 2: Effect of wheat straw along with botanicals on yield and Cost benefit ratio of Oyster mushroom *Pleurotus Florida*.

Tr. No.	Details of Treatment	Yield					Total cost of cultivation	Gross return	Net Profit (□)	C:B ratio
		1st Picking	2nd Picking	3rd Picking	4th Picking	Total Yield (kg)				
T_0	Wheat straw	394.00	371.33	222.66	309.00	3.89	27	129.70	102.0	1:3.80
T_1	Wheat straw + Drumstick leaves	393.33	341.33	390.33	350.33	4.42	30	147.53	117.3	1:3.92
T_2	Wheat straw + Neem leaves	231.33	155.66	153.00	180.33	2.16	24.7	72.03	47.28	1:1.91
T_3	Wheat straw + Castor leaves	229.66	160.66	115.33	164.66	2.01	24	67.03	43.03	1:1.79
T_4	Wheat straw + Lemon leaves	206.00	172.00	140.00	170.33	2.06	24	68.83	44.83	1:1.87
T_5	Wheat straw + Beal leaves	429.66	362.00	362.00	370.00	4.57	26.25	152.37	126.1	1:4.80
T_6	Wheat straw + Mulberry leaves	353.66	295.66	290.33	278.66	3.65	26.25	121.83	95.58	1:3.64
T_7	Wheat straw + Lantana leaves	285.00	218.00	208.00	202.66	2.74	21.75	91.37	69.62	1:3.20
T_8	Wheat straw + Mango leaves	360.66	250.00	300.66	234.66	3.43	26.25	114.60	88.35	1:3.37
T_9	Wheat straw + Peepal leaves	399.33	291.00	278.00	305.00	3.82	26.25	127.33	101.0	1:3.85
T_{10}	Wheat straw + Banyan leaves	276.66	236.66	250.00	217.66	2.94	26.25	98.10	71.85	1:2.74
T_{11}	Wheat straw + Guava leaves	323.00	221.33	248.00	253.00	3.13	24	104.53	80.53	1:3.36
T_{12}	Wheat straw + Aonla leaves	378.66	287.33	250.33	271.33	3.56	24	118.77	94.77	1:3.95
T_{13}	Wheat straw + Betel vine leaves	203.00	162.33	169.66	166.33	2.10	69	70.13	1.13	1:0.02
	C.D. (P = 0.05)	7.052	5.564	3.667	32.454					
	SEm (±)	2.435	1.921	1.266	6.120					
	SEd (±)	3.443	2.717	1.791	8.656					
	C.V.	1.323	1.321	0.909	7.897					

Yield (gm.) 3rd picking

Yield (gm.) of *Pleurotus florida* on 3rd picking shows that the treatment T_1 (Wheat straw + Drumstick leaves) was found to give significantly higher yield (390.33g) as compared to the other substrates whereas minimum yield was recorded in T_3 – Wheat straw+ Castor leaves (115.33g), T_4 – Wheat straw + Lemon leaves (140.00g), and T_2 – Wheat straw + Neem leaves (153g) [Table 2].

Yield (gm.) 4th picking

Yield (gm.) of *Pleurotus florida* on 4th picking shows that the treatment T_5 (Wheat straw + Beal leaves) was found to give significantly higher yield (370 g) as compared to the other substrates whereas minimum yield was recorded in T_3- Wheat straw+ Castor leaves (164.67 g), T_{13}– Wheat straw + Betel vine leaves (166.33g), and T_7- Wheat straw + Lantana leaves (202.67 g) [Table 2].

Total yield (kg)

Total yield (kg) of *Pleurotus florida* shows that the treatment T_5 (Wheat straw + Beal leaves) was found to give significantly higher yield (4.57 kg) as compared to the other substrates whereas minimum yield was recorded in T_3 - Wheat straw+ Castor leaves (2.01 kg), T_4- Wheat straw + Lemon leaves (2.06 kg) and T_{13} – Wheat straw + Betel vine leaves (2.10 kg) [Table 2].

The results obtained in the 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 (18 days) and days taken for mature fruiting bodies (21 days) was recorded in treatment T_5 -Wheat straw + Beal leaves. The maximum width of pileus (cm) and length of stipe (cm) were also recorded in T_5 -Wheat straw + Beal leaves (9.00 cm and 7.12 cm respectively). The maximum yield taken on 1st, 2nd, 3rd, 4th pickings indicates that the higher yield (g) was obtained in T_5 -Wheat straw + Beal leaves (429.67 g, 371.33 g, 390.33 g and 370.00 g respectively.) the maximum biological efficiency and cost benefit ratio was also recorded in T_4-Paddy straw (140.07% and 1:4.80 respectively). The artificial application of nitrogen rich source during the mycelial growth stage gives very good results regarding early primordial initiation. (Onyango *et al*., 2011) [9]. It can be concluded that a nitrogen rich source application during spawn running speeds up the fungal mycelium growth and gives early primordial emergence. The large sized fruit bodies are considered to be of good quality and rated highly in mushroom production (Fan *et al.*, 2006) [3].

Conclusion

There are many factors which affect the yield, compost preparation moisture level and temperature fluctuation cause low yield. When pH, moisture level and C/N ratio is best then maximum number of pinheads and mushrooms formed. Plant extract has shown considerable promises as an effective alternative for minimizing the infection of competitor moulds and diseases of oyster mushroom. Leaf powder (extract) of Beal (*Aegle marmelos*) could be used as an alternative source for substrate along with wheat straw has the potentiality to suppress the mycelium growth of competitor moulds. Extract of these plants not only protect the environment and human health from hazardous effects of chemicals but also minimize the cost of cultivation.

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