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Effect of Different Substrates on Yield Potential of *Pleurotus* spp. in West Bengal

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A B S T R A C T

Three species of Oyster mushroom like, *Pleurotus ostreatus*, *Pleurotus sajor-caju*, *Pleurotus florida* mother culture were procured from DMR, Solan and wild collected strain was collected from Bankura district in West Bengal during the monsoon season of 2017-18. The experimental fruiting trials were conducted under the mushroom house conditions using three substrates viz. Paddy straw, Paddy straw + Sugarcane bagasse (1:1) and Sugarcane bagaase to observe variation in spawn run days, pinning initiation and biological efficiency. Among the four spp/ strains, three *Pleurotus* spp showed fruiting while the one ssp./strain collected from the wild did not grow under the mushroom house conditions. Also, it was observed that the spawn run was most quick with (12.78 days) and pinning initiation (10.28 days) was most quick with Sugarcane bagasse as substrate. While the biological efficiency was observed to be highest with paddy straw as substrate ranging from 93.2-84.6% followed by the mixture of Paddy straw and Sugarcane bagasse ranging from 80.4- 75.6 % and the least was exhibited by sole use of Sugarcane bagasse from 67.6% - 41.6%. Thus, paddy straw stood out as an outstanding substrate to be used in West Bengal for cultivation of *Pleurotus* spp.. However, more experiments using more number of substrates are required to be done before any conclusion.

Introduction

Pleurotus is generally known as Oyster mushroom all over the world and Dhingri in India (Lovkesh *et al.*, 2006). Mushroom has been defined as a macro-fungus with a distinctive fruiting body, which can be epigeous or hypogenous, large enough to be seen with the naked eye and to be picked by hand (Chang and Miles, 1989). Oyster mushroom is one of the most popular edible mushroom and belong to the genus *Pleurotus* and the family *Pleurotaceae*. *Pleurotus* was first cultivated in Germany as a subsistence measure during World War I (Flack, 1917) and is now grown commercially around the world for food. Oyster mushroom is one of the most commonly sought wild mushrooms, though it can also be cultivated on straw and other media. *Pleurotus* mushrooms are primary decomposers of hardwood trees and are found worldwide. This mushroom has

basidia with four basidiospores and a tetra polar mating system. Its hyphae have clamp connections in most members of the genus, Fruiting bodies as well as active mycelia of *Pleurotus* species also possesses a number of therapeutic properties like anti-inflammatory, immune-stimulator and anticancer activity, immunomodulatory, ribonuclease activity and many other activities (Patel *et al.,* 2012). Studies have demonstrated that Oyster mushrooms are healthy foods, which are low in calories and fat, rich in protein, chitin, vitamins and minerals (Manzi *et al.,* 1999). At present, the annual production of button mushroom is 94676 mt and ranks 1st in India and 2nd is Oyster mushroom with a production of 21272 mt. West Bengal rank 6th in Oyster mushroom production in India. *Pleurotus* spp. are popular and widely cultivated throughout the world (Mane *et al.,* 2007; Alam and Raza, 2001; Shah *et al.,* 2004; Flores 2006).

In the present study *Pleurotus* spp. were cultivated under the mushroom house conditions to determine the most efficient substrate, optimum temperature and other growth parameters suitable for high yield under West Bengal climatic conditions. The mushroom production comes out as an excellent alternative to deal with the economic crisis for the family and society. Representatives of genus *Pleurotus* form a heterogeneous group of edible species of high commercial importance (Zervakis *et al.,* 2004). The species of genus *Pleurotus* show great diversity in their adaptation to the varying agro-climatic conditions. This flexible nature of the genus gives it more importance than any other cultivated mushroom (Zadrazil and Dube, 1992).

In India, *Pleurotus* cultivation was standardized by Bano and Srivastava (1962) utilizing *P. flabellatus* and the first domesticated species was *P. ostreatus*. Later, *P. sajor-caju* gained much importance after Jandaik and Kapoor (1974) first reported its cultivation on banana pseudo stem and chopped paddy straw. Different substrates have been used by several workers for the cultivation of *Pleurotus* spp. viz. cotton waste (Chang *et al.,* 1981), jowar straw and groundnut pod (Khandar *et al.,* 1991), wheat straw (Gupta and Langer, 1988), rubber wood waste (Mathew *et al,* 1991). Thomas *et al.,* (1998) have reported rice straw, as the most widely used substrate in Asia for the cultivation of *Pleurotus* spp. Mendeel *et al.,* (2005) used cardboard, saw dust and plant fibres for the cultivation of *Pleurotus* spp.

Similarly Mendez *et al.,* (2005) utilized maize and pumpkin straw as substrates. Several diverse substrates like lignocellulosic materials (Yildiz *et al.,* 2002), unpretreated spent beer grains (Wang *et al.,* 2001), banana and rice straw (Bonatti *et al.,* 2004), various dry weed plants (Das and Mukherjee, 2007), peat moss based substrate (Tawiah and Martin, 2006) have also been used for the cultivation of *P. ostreatus*. Silva *et al.,* (2002) have used cotton peel as substrate for *P. pulmonarius*. Wheat bran supplemented with umbrella plant was used for cultivation of *P. eryngii* (Ohga and Royse, 2004). Thus, the present study was carried out with the objective to determine the high yielding *Pleurotus* spp. using three substrates viz. Paddy straw, Paddy straw and Sugarcane Bagaase, Sugarcane Bagaase. Also, to determine which *Pleurotus* spp took minimum and maximum days for spawn run, pinning initiation and biological efficiency.

Materials and Methods

The experiment on mushroom (*Pleurotus* spp.) was conducted in the laboratory of plant Pathology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India, during the year 2017-2018.

Collection, isolation and maintenance of pure culture

Three species of Oyster mushroom like, *Pleurotus ostreatus*, *Pleurotus sajor-caju*, *Pleurotus florida* mother culture were procured from DMR, Solan (Table 1) and wild collected strain was collected from Bankura district in West Bengal during the monsoon season of 2017-18 i.e July-August. Isolations from the fresh specimen, collected from the wild were made following the standard tissue culture technique (Gomborg, 2002). The sterilized bits were then transferred to Yeastal Potato Dextrose Agar medium slants and incubated at 22 $\pm$ 2^{o}C. The stock cultures were maintained in the refrigerator at 4^{o}C. Sub-culturing of the stock cultures was done after a period of 7-10 days on fresh YPDA slants.

Spawn preparation and spawning

The procured/ collected *Pleurotus* spp./ strains were evaluated for their spawning behaviour following the standard technique of (Munjal, 1973). Incubated bottles were shaken at weekly intervals until the mycelium spread completes all over the wheat grains. Fully colonized spawn bottles were then used for the spawning of the bags. Fresh spawns were prepared separately for each experiment. For conducting fruiting trials of various species/strains, cloth bags were filled with 250 gms of wheat straw. The bags were dipped in water overnight and were pasteurized in hot water at 65-70^{o}C for 6 hours and then boiled in a drum for 1.5 to 2 hours. Wheat straw was cooled after spreading on a sterilized polythene sheet and tightly filled in polypropylene bags having small holes for aeration. Layer spawning was done and the bags were tied at the top and properly labelled. Spawned bags were kept in the mushroom house (Temperature 22 $\pm$ 2^{o}C and relative humidity 80-85%) for spawn run. After complete spawn run, the bags were torn opened and hanged with the help of plastic rope on an iron frame for fruiting. The data on spawn run, pinning initiation, fruiting behaviour and yield pertaining to various isolates were recorded.

Substrates preparation and spawning

For conducting the fruiting trials of different species/strains, substrates used was fresh paddy straw, sugarcane bagasse and paddy straw with sugarcane bagasse (1:1) free from any noticeable contaminants for cultivation. The 250 gm of dry substrate was filled in a cloth bag. The bags were dipped in water overnight and were pasteurized in hot water at 65-70 ^{O}C and then autoclaved at 22 lbs p.s.i and 126 ^{O}C temperature. The substrate was cooled after spreading on a sterilized polythene sheet and tightly filled in polypropylene bags having small holes for aeration. Layer spawning was done and the bags were tied equidistantly at the top on stands made of bamboo and were labeled properly.

Preparation of mushroom bed

Spawned bags were kept in the mushroom house (Temperature 22 ± 2 ^{0}C and Relative Humidity 80-85%) for spawn run. After complete spawn run, the bags were torn opened and hanged with the help of plastic rope on a bamboo frame for fruiting. The data on spawn run, pinning initiation, fruiting behavior and yield pertaining to various isolates were recorded.

Harvesting of a mushroom

Harvesting was done when the small primordia converted into a full grown sporophore. Sufficient water was sprinkled to each bed thrice a day. After 1-2 days of cutting of the bag, primordia appearing on the surface, and finally first flush of mushrooms were harvested within 3-5 days. The fully developed fresh mushrooms before they

curled up were harvested by slight pulling and twisting the fruiting bodies were collected in polythene bags. Successive 2-3 flushes were harvested from the same bed at an interval of 7-10 days. All the beds were allowed to be kept for 45-50 days from the date of spawning.

Weighing of mushroom

The freshly harvested mushrooms were immediately weighing with the help of single pan balance and moisture per centage was calculated using standard methods (Asharaf, J. *et al.*, 2013).

Yield and biological efficiency

Total weight of all the fruiting bodies harvested from all the two pickings were measured as total yield of mushroom. The biological efficiency (yield of mushroom per kg substrate on dry wt. basis) was calculated by the following formula Chang *et al.*, (1981).

$$\text{B.E. (\%)} = \frac{\text{Fresh weight of mushroom}}{\text{Dry weight of substrate}} \times 100$$

The moisture content of mushroom was calculated by the following formula –

$$\text{Moisture content (\%)} = \frac{\text{Weight of fresh sample} - \text{weight of dry sample}}{\text{Weight of fresh sample}} \times 100$$

Results and Discussion

Collection and culture

Mycelial cultures of three species of *Pleurotus* were procured from DMR, Solan and one was collected wild from Bankura district of West Bengal during the monsoon months of 2017-18. Thus a total of four species/strains were taken for further studies as shown in (Table 1).

Morphological studies:

Fruiting behavioir

The procured/ collected *Pleurotus* spp./ strains were evaluated for their spawning behaviour following the standard technique of (Munjal, 1973). The experimental fruiting trials were conducted under the mushroom house conditions showing variation in spawn run days, pinning initiation and biological efficiency (Table 2) (Fig. 1, 2 and 3). Among the four spp/ strains, three *Pleurotus* spp showed fruiting while the one ssp./strain collected from the wild did not grow under the mushroom house conditions. Also, it was observed that the spawn run (12.78 days) and pinning initiation (15.78 days) was quick in *Pleurotus* florida (P3) followed by *Pleurotus Ostreatus* (P1*)* and *Pleurotus sajor-caju* (P2). Maximum biological efficiency of 95.20 % per cent was recorded in *Pleurotus sajor-caju* (P2) followed by *P. Ostreatus (P1)* with 93.20% on the basis of two flushes using the paddy straw as substrate and a moisture percentage of 89.14 % in *Pleurotus sajor-caju* (P2) followed by 87.38% in *Pleurotus florida* (P3) (Table 3 and 4).

It was observed that the spawn run (10.57 days) and pinning initiation (13.57) was quick in *Pleurotus*-florida (P3) followed by*P. Ostreatus* (P1) and *P. sajor-caju* (P2). Maximum biological efficiency of 80.40 per cent was recorded in *P. sajor-caju* followed by 79.80 in *P. Ostreatus* on the basis of two flushes using the Paddy straw and Sugarcane baggase (1:1) as substrate and a maximum moisture percentage of 90.12 % in *Pleurotus sajor-caju* (P2) followed by 89.56 % in *Pleurotus florida* (P3) (Fig. 4).

Table.1 Procured/ collected spp./strains of *Pleurotus*

Collection from DMR, Solan	Culture/ Species/ Strain
P1	*Pleurotus Ostreatus*
P2	*Pleurotus sajor-caju*
P3	*Pleurotus florida*
Collection from DMR, Solan	**Culture/ Species/ Strain**
P4	Unidentified

Table.2 Fruiting behavior of *Pleurotus* spp using Paddy straw, Paddy straw+ Sugarcane and Sugarcane Bagasse as substrate

P1	16	16	15	20	20	19	93.2	79.8	41.6	86.87	88.1	85.64
P2	19	19.8	18	23	23.8	22	95.2	80.4	57.2	89.14	90.12	88.38
P3	12.78	10.57	10.28	23	23.8	22	84.6	75.6	67.6	87.38	89.56	91.2

Table.3 The mean average yield of *Pleurotus* spp on different substrates during the Ist flush

1ST HARVESTING				
	PS	**P+S**	**S**	**Mean (spp)**
P1	242	205	124	190.333
P2	247	229	169	215
P3	222	196	184	200.667
Mean (substrate)	237	210	159	
	Spp	**Substrare**	**Spp X substrate**	
CD	3.456	3.456	5.986	
SE m	1.22	1.22	2.114	

Table.4 The mean average yield of *Pleurotus* spp on different substrates during the Ist flush

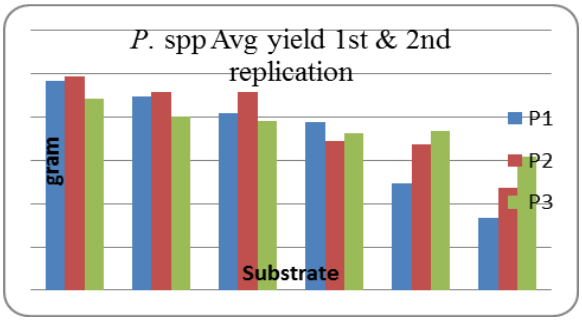
2ND HARVESTING				
	PS	**P+S**	**S**	**Mean (spp)**
P1	224	194	84	167.333
P2	229	173	119	173.667
P3	201	182	154	179
Mean (substrate)	218	183	119	
	Spp	**Substrare**	**Spp X substrate**	
CD	3.405	3.405	5.897	
SE m	1.202	1.202	2.082	

Fig.1 *Pleurotus* ostreatus cultivation picture in different substrate i) Paddy Straw ii) Paddy Straw +Sugarcane Bagasse iii) Sugarcane Bagasse

Fig.2 *Pleurotus sajor-caju* cultivation on different substrates i) Paddy Straw ii) Paddy Straw +Sugarcane Bagasse iii) Sugarcane Bagasse

Fig.3 *Pleurotus florida* cultivation on different substrate i) Paddy Straw ii) Paddy Straw +Sugarcane Bagasse iii) Sugarcane Bagasse

Fig.4 The average yield of *Pleurotus* spp. using Paddy straw, Paddy straw+ Sugarcane Bageese and Sugarcane Bagasse as substrates



It was observed that the spawn run (10.28 days) and pinning initiation (13.28) was quick in *Pleurotus florida* (P3) followed by *P. Ostreatus* and *P. sajor-caju.* Maximum biological efficiency of 67.60 percent was recorded in *P. florida followed by P. sajor-caju* on the basis of two flushes using the Sugarcane baggase as substrate. and a maximum moisture percentage of 91.20% in *Pleurotus florida* (P2) followed by 88.38 % in *Pleurotu sajor-caju.* Varying period of spawn run and pinning initiation has been reported for various species on different substrates by several workers from time to time (Baysal *et al.,* 2003). The biological efficiency was observed to be highest with paddy straw as substrate ranging from 93.2-84.6% followed by the mixture of Paddy straw and Sugarcane bagasse ranging from 80.4- 75.6 % and the least was exhibited by sole use of Sugarcane bagasse from 67.6% - 41.6%. Thus, paddy straw stood out as an outstanding substrate to be used in West Bengal for cultivation of *Pleurotus* spp. However, more experiments using more number of substrates are required to be done before any conclusion.

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