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Evaluation of different strains of oyster mushrooms for yield performance

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Abstract

Oyster mushrooms have palatable, beneficial and pharmaceutical values and can grow on byproducts used as a substrate, which are considered waste obtained from agriculture, households, and industries. These can effortlessly degenerate agricultural residues, can be cultivated in a varied temperature range, require less time to grow and are not frequently attacked by various pathogens and pests. A research study was conducted to evaluate six strains of Pleurotus species (PL-1, PL-2, PL-3, PL-4, PL-5 and PL-6) for yield performance using wheat straw as substrate. The highest yield was produced by PL-3 (414.4 g/bag), followed by PL-2 (399.8 g/bag) and PL-5 (379.2 g/bag), whereas the lowest yield was found in the PL-4 (192.6 g/bag) strain. The maximum biological efficiency was recorded in PL-3 (69.07 per cent) followed by PL-2 (66.62 per cent) and PL-5 (63.2 per cent) strains. Hence, it can be concluded that oyster mushrooms hold the potential for the valorization of agro-industrial waste among urban and rural communities, not only minimizing environmental impact but also fostering economic development and self-sufficiency.

Keywords: Biological efficiency, Oyster mushroom, Strains, Wheat straw, Yield performance.

Introduction

Mushrooms are macrofungi with distinguishable spore-producing fruiting structures. These distinctive macrofungi congregate their nutrients through the release of enzymes capable of degrading complex organic compounds. On degradation, the fungus grows on its substrate to produce simple nutritional compounds (Chang and Miles 1992). Mushrooms grow on byproducts used as substrate, which are considered waste obtained from agriculture, household and industries. The cultivation of mushrooms represents an economic biotechnological

process to convert agricultural and forest leftovers (Wood and Smith 1987). It is an environmentally favourable technology in which the mycelium of these macrofungi releases extracellular enzymes capable of degrading and assimilating lignocellulose material, thus reducing pollution.

Among the various mushroom species cultivated globally, Pleurotus species, commonly referred to as oyster mushrooms, are extensively grown. They rank second in popularity for cultivation, following Agaricus bisporus, commonly known as the button mushroom (Sánchez, 2010; Kües and Liu, 2000). Different species of oyster mushrooms are popular and grown around the globe, mainly in Europe, America, Asia, for their easy, economic production technology and great biological efficiency (Mane *et al*., 2007).

Besides Pleurotus *species* have gained excessive interest because of their palatable, beneficial and pharmaceutical values (Garcha *et al*., 1993). Oyster mushrooms can effortlessly degenerate agricultural residues and can be cultivated at a varied temperature range (Sánchez, 2010). If compared to other edible mushrooms, oysters require less time to grow and are not frequently attacked by various pathogens and pests (Tesfaw *et al*., 2015; Baysal *et al*., 2003). Nitrogen, carbon and inorganic compounds are essential nutrients for *Pleurotus species.* These can be cultivated on various substrates. Oyster mushrooms are a storehouse of proteins, minerals like potassium, calcium, iron, phosphorus, sodium and vitamins like niacin, riboflavin, folic acid, thiamine (Szabová *et al*., 2013). In spite of all these properties, *Pleurotus species* have pharmaceutics value for lowering blood sugar (Nayak *et al*., 2021) and cancer therapy (Sivrikaya *et al.,* 2002; Nayak et al., 2022).

A huge amount of left-over agricultural waste composed of lignocellulose is available in equatorial and semitropical regions. Such agricultural residues are commonly left to decay in the field or burned (Szabová *et al*., 2013). Utilizing locally obtainable substrate to grow *Pleurotus species* is helpful to convert agricultural residues into consumable biomass of commercial and nutritional value (Tesfaw *et al*., 2015). The objective of this study was to identify high-yielding strains of oyster mushrooms, focusing on various yield parameters such as fruit body per bag, average weight of the fruit body and biological efficiency using wheat straw as substrate.

Materials and methods

Study area and experimental materials

The study was conducted at the Mushroom Research and Training Centre (MRTC) of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. In the present investigation, a comparative cultivation of a strain of oyster mushroom was performed. Six strains of oyster mushrooms, namely PL-1, PL-2, PL-3, PL-4, PL-5 and PL-6, were taken and cultivated on wheat straw for their yield performance.

Preparation of spawn

Spawn was prepared from six different strains of *Pleurotus* (PL-1, PL-2, PL-3, PL-4, PL-5 and PL-6) using wheat grains, following the protocol standardized by Garcha (1993). Wholesome, unbroken grains of wheat were used. The wheat

grains were first cleansed with water, followed by boiling (grain:water, 1:25, w/v) and tenderized without the seed coat being ruptured. An excess amount of water was rinsed off and dried on a sieve overnight. Thereafter, commercial-grade calcium carbonate and gypsum were added to the boiled wheat grains in the proportion of 4:1 (w/w), i.e., 15 gram per kilogram of wheat grains. The cleaned glass bottles were then filled with wheat grains and corked with nonabsorbent cotton. At 22 lbs of steam pressure (126˚C) the bottles were sterilized for 90 minutes. After sterilization, the glass bottles were removed from the autoclave and in order to avoid clumping, the bottles were shaken.

Afterwards, the grain-filled bottles were inoculated with a portion of the 7–10-day-old pure culture of the particular strain. The glass bottles inoculated with pure culture were incubated for 10 days at 25±1˚C. The inoculated bottles were occasionally shaken, resulting in the separation of threads of mycelium, got blended well with the wheat grains and were kept under observation to check the mycelium run. Thereafter, the grains, when covered by mycelium, were used as spawn.

Substrate preparation and spawning

The wheat straws were taken and sun-dried, followed by the chopping of the straw into 4 cm lengths. The chopped straw was immersed in water and soaked overnight prior to preparing the substrate. An excess amount of water was drained and laid down on the floor, sterilized with ethanol and allowed to sun dry until there was 70% moisture content in the substrate, which was checked with the hand fist. Finally, the substrate was used for the cultivation of oyster mushrooms.

The spawning was done at 3% of ready substrate and the spawned substrate was filled into the polybag at 2 kg per bag. Five replications of each strain were maintained with six bags per replication, respectively.

Cropping and cultivation

For the cultivation of oyster mushrooms, bags inoculated with each strain were placed in a dark room, as suggested by Chang and Miles (2004), to initiate the growth of the mycelium. The bags were observed regularly and on generous growth of mycelium in the bags, the polythene bags were cut off with a sterilized blade or cutter. On removal of the polythene bags, the pin heads started to appear. Soon the bags were moved to the cropping room, where the bags inoculated with a specific strain of *Pleurotus species* were placed on the racks. The spacing maintained between each bag was 15–20 cm. Adequate ventilation was maintained in the cropping room by the occasional opening of the door every two to three days. Moisture in the inoculated bags was assured by spraying water twice a day in order to keep the colonized bags moist. The temperature of the crop room and relative humidity were checked and maintained with a thermohygrometer, with the occasional spray of water in the range of 70–75%.

Collection of data

Regular monitoring on a daily basis of inoculated bags was done for the growth and development of oyster mushrooms. Data were recorded with respect to the number of fruiting bodies, yield, average weight per fruit body, and morphological parameters of the strains. Parameters of growth like pileus diameter (cm), stipe diameter (cm), stipe length (cm) and colour

were documented (Table 1). At the time of harvesting, yield parameters like the number of fruiting bodies and the weight of oyster mushrooms were recorded. Mushrooms were harvested by severing the mushroom stalk above the surface of the bag. For evaluating the yield performance of each strain, biological efficiency and yield were calculated (Table 2).

$$\textbf{Biological efficiency (\%)} = \frac{\text{Weight of fresh mushrooms harvested per bag}}{\text{Weight of dry substrate per bag}} \times 100$$

Strain	Stipe Length (cm)	Stipe Diameter (cm)	Pileus Diameter (cm)
PL-1	1.79	0.61	6.7
PL-2	2.48	0.85	7.96
PL-3	1.77	0.86	6.45
PL-4	1.67	0.57	5.96
PL-5	2.48	0.75	6.49
PL-6	1.65	0.76	6.97
CD 5%	0.18	0.17	0.22
CV	0.50	1.29	0.57

Results

Six different strains of *Pleurotus species* (Fig. 1) with reference to production were compared. The strains used exhibited varied performance in harvest and morphological characteristics.

Morphological variation of different strains of oyster mushrooms

On analyzing the strains of *Pleurotus species* (PL-1, PL-2, PL-3, PL-4, PL-5 and PL-6), it was found that strains PL-2 and PL-5 were recorded with the highest stipe length (2.48 cm), followed by PL-1 (1.79 cm), PL-3 (1.77 cm), PL-4 (1.67 cm) and PL-6 (1.65 cm), respectively. Strain PL-3 (0.86 cm) was recorded with the highest stipe diameter, followed by PL-2 (0.85 cm), PL-6 (0.76 cm), PL-5 (0.75 cm), PL-1 (0.61 cm), and PL-4 (0.57 cm). Maximum pileus diameter was recorded for strain PL-2, followed by strains PL-6, PL-1, PL-5, PL-3 and PL-4, respectively (Table 1). In terms of yield, there is a positive correlation between the size of the pileus and the overall yield.

Table 1: Morphological variation of different strains of oyster mushroom

Yield performance of different strains of oyster mushrooms

In terms of number of fruit bodies, strain PL-3 produced the maximum number of 83 fruit bodies, followed by PL-5 and PL-6; however, strain PL-2 produced the least number of 59 fruit bodies (Table 2). The highest yield was produced by PL-3 (414.4 g/bag), followed by PL-2 (399.8 g/bag) and PL-5 (379.2 g/bag), whereas the lowest yield was found in the PL-4 (192.6 g/bag) strain (Table 2). The biological efficiency was highest for strain PL-3 (69.07%) and lowest for strain PL-4 (32.1%).

Discussion

In terms of number of fruit bodies, strain PL-3 produced a maximum of 83 fruit bodies, followed by PL-5 and PL-6; however, strain PL-2 resulted in a minimum of 59 fruit bodies. The fruiting body of the mushroom is the commercially valuable edible part. Among the four cultivation steps in mushroom production, maintaining

the spawn bags for fruiting body production is relatively manageable for poor farmers or rural individuals. Kitamoto et al. (1995) reported that the presence of glucose, fructose, and trehalose in the substrate could contribute to an increased number of effective fruiting bodies.

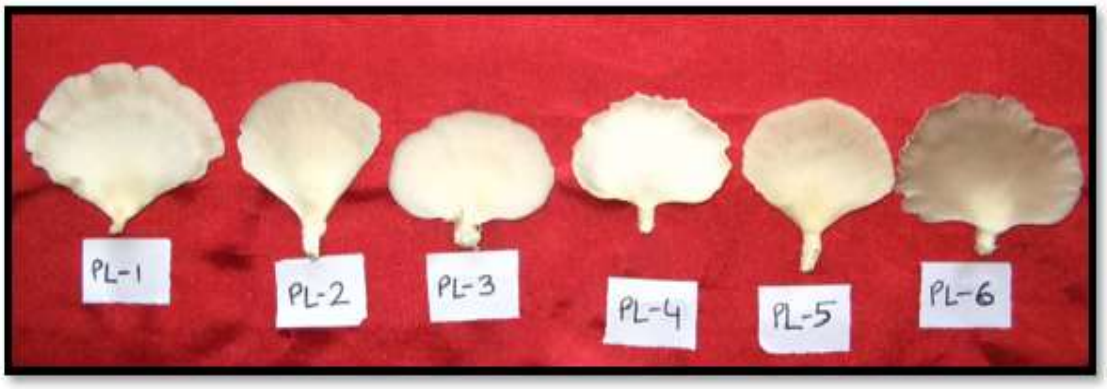

Fig. 1: Six different strains of *Pleurotus species*

Table 2: Yield performance of different strains of oyster mushrooms

Strain	Fruiting body per bag		Avg. wt./fruit body (g)	Biological Efficiency (%)
	No.	Wt.		
PL-1	62.56	325.40	5.20	54.23
PL-2	59.00	399.80	6.78	66.63
PL 3	83.04	414.40	4.99	69.07
PL-4	40.48	192.60	4.76	32.10
PL-5	78.56	379.20	4.83	63.20
PL-6	69.80	318.40	4.56	53.07
CD 5%	15.68	63.44	--	--
CV	18.12	14.21	--	--

The continuous cultivation of oyster mushrooms over the years has resulted in a decline in productivity. Hence, the selection of new strains becomes essential to achieve higher yields and meet the demands of consumers, particularly for underprivileged farmers lacking sterilization and incubation facilities. The rate of sporophore formation by each strain plays a crucial role in oyster mushroom production. In this experiment, significant differences were observed in sporophore production among all the strains utilized. The highest yield was produced by PL3 (414.4 g/bag), followed by PL-2 (399.8 g/bag) and PL-5 (379.2 g/bag), whereas the lowest yield was found in the PL-4 (192.6 g/bag) strain (Table 2).

Biological efficiency is a very good standard parameter to determine the efficiency of substrate conversion in fruiting bodies. The maximum biological efficiency was recorded in PL-3 (69.07 per cent) followed by PL-2 (66.62 per cent) and PL-5 (63.2 per cent) strains. The lowest biological efficiency was found in the PL-4 (32.1 percent) strain. The highest weight per fruit body was recorded at 6.78 g in PL-2, followed by PL-1 and PL-3, but the lowest weight was 4.56g per fruit body in the PL-6 strain (Table 2).

The maximum 2.48-cm stipe length was recorded in PL-2 and PL-5, followed by PL-1. The stipe diameter of all strains ranged from 0.57cm (PL-4) to 0.86cm (PL-3). However, the maximum pileus diameter of 7.96 cm was measured in PL-2, followed by PL-6 (6.97 cm) and PL-1 (6.7cm) and the pileus diameter of the remaining strains varied from 5.96 cm to 6.7 cm (Table 1).

(a) Strain PL-3 **(b) Strain PL-2**

Fig. 2. High yielding strains of oyster mushroom

Conclusion

From the research conducted, it can be concluded that the strains PL-2 and PL-3 of *Pleurotus species* exhibited substantial performance in terms of yield. Stipe length, stipe diameter and pileus diameter were crucial in attributing the morphological characteristics of different strains of oyster mushroom. By harnessing the palatable, beneficial, and pharmaceutical values of oyster mushrooms, rural communities can capitalize on their potential by utilizing agricultural, household, and industrial waste as substrates, not only minimizing environmental impact but also fostering economic development and self-sufficiency.

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