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Effect of Various Substrates on Growth and Yield Performance of *Pleurotus ostreatus* (Jacq. Fr.) Kumm.

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Abstract:

The cultivation of *Pleurotus ostreatus* (Jacq. ex. fr) Kummer, an oyster mushroom, has been evaluated on three lignocellulosic by-products. The yields of mushroom on the different substrates were 174.02g, 206.96g and 120.03 g for rice straw, soyabean Straw, and Red Gram Straw respectively. For soybean straw, paddy straw, and red gram straw, the highest Biological efficiency was 62.202%, 42.217%, and 32.402%, respectively. The largest yield was harvested from paddy substrate, followed by soyabean substrate; while, the least was obtained from red gram substrate. Paddy straw and soyabean straw appeared to be the best alternative substrate for the cultivation of oyster mushrooms, according to the yield and Biological efficiency of the examined substrates.

Keywords: Argo-wastes, Biological efficiency, Fruiting body

Introduction:

Mushroom, a macro fungus with a distinct fruiting body, is a separate biota that builds its food by secreting degrading enzymes. It decomposes the complex organic components (the substrate) on which it grows to produce simpler compounds for nutrition (Chang and Miles, 1992). These substrates are typically regarded as trash since they are by-products of houses and agriculture. If these wastes are irresponsibly dumped or burned in the environment, it will create environmental contamination and subsequently pose health risks. These wastes, if irresponsibly disposed of in the surrounding environment by dumping or burning, may create pollution and, as a result, health dangers.

They are, however, resources in the wrong location at the wrong time, and mushroom growing may use these resources (wastes) to its benefit (World Bank, 2004). Mushroom farming, which is said to be the only commercially feasible bio-technology approach for converting waste plant leftovers from forests and farms (Wood and Smith, 1987), falls squarely into this category. Mushroom farming method is ecologically benign; mushroom mycelia may create a collection of complex extracellular enzymes that can digest and use lignocellulosic wastes, lowering pollution.

Recent research has shown that mushroom mycelia can significantly contribute to the restoration of harmed environments (myco-restoration) through myco-filtration (using mycelia to filter water), myco-forestry (using mycelia to restore forests), myco-remediation (using mycelia to remove toxic waste), and myco-pesticides (using mycelia to control insect pests) (Stamets, 2005). With the use of these techniques, a healthy ecosystem might be created with no residual harm from the use of fungi. Not only can mushrooms transform lignocellulosic waste products into human food, but they can also create noteworthy nutraceuticals, which offer several health advantages. They provide users with access to a high-quality additional vegetable and supplement the diet with high-quality proteins, minerals, and vitamins, all of which can directly benefit human health and fitness. Eating mushrooms has a nutritional value equivalent to eggs, milk, and meat.

Humans' immune systems and quality of life would be strengthened by the bio active compounds that can be extracted from medicinal properties mushrooms. Mushrooms provide a high level of essential amino acids, which are near to what the body requires. Additionally, mushrooms are simple to digest and free of cholesterol (Oei, 2003). The spent substrate, which is entangled with many mushroom threads (collectively referred to as mycelia) after mushroom harvesting, may also be utilized as animal feed (more palatable), bio fertilizer for soil fertility enrichment, and biogas (Alice and Kustudia, 2004).

Mushroom farming may also be a labor-intensive agricultural activity, which benefits those looking for work and money, especially young people and women in underdeveloped nations. Since mushrooms are generally quick-growing organisms, mushroom farming as a short-term agricultural venture can provide immediate advantages to the society. While most primary production methods are often constrained by the availability of land, growing mushrooms takes up comparatively little place since they may be stacked utilizing shelf-like culture systems. Therefore, it is envisaged that the hobby of mushroom cultivation would grow into a significant cottage business under initiatives for integrated rural development. Small-scale farmers as well as landless laborers and other economically underprivileged members of communities would benefit from this (Shah *et al.,* 2004).

In general, mushroom production techniques are essential for combating the food scarcity, declining quality of human health, and environmental pollution that people are continually confronted with and may continue to face as the world's population grows. Despite having so many benefits, the mushroom business in India still needs a lot more technology adoption and know-how. Despite having a nice climate, plenty of space and manpower, and decent water supplies, India hasn't paid much attention to growing or using mushrooms up until now.

With this rationale, the current study was started to explore how the potential development and yield performance of oyster mushrooms were affected by the application of various organic wastes, in this case, paddy straw, soybean straw, and Red Gram straw. The purpose of the study is to assess the viability of mushroom cultivation in the study area for the improvement of the livelihood of the local people and to facilitate the adoption of technology for oyster mushroom production using agricultural wastes.

Materials and Methods:

Study area and experimental materials:

From December 2022 to February 2023, the study was carried out at Govt. V. Y. T. PG Autonomous College Durg, Hemchand Yadaw University. For the purpose of cultivating oyster mushrooms, the substrate quality of three different substrates Paddy Straw, Soyabean Straw, and Red Gram Straw was assessed. Red Gram, soybean, and paddy straw were gathered in the Durg district. *Pleurotus ostreatus* (Jacq. Fr.) Kumm spawn was taken from the Indira Gandhi Krishi Vishwavidyalaya at Raipur mushroom department.

Processing of the substrate and spawning:

The substrates were allowed to dry in the sun for 05 days. Three different types of substrates, including paddy straw, soya-bean straw, and Red Gram straw, are employed in chemical sterilizing. 20L of water should be combined with 20ml of formaldehyde and 7.5g of 50% WP carbendazim. After that, immerse each substrate in water overnight. Dry the substrate in the air for a little while after an overnight soak. Take the polythene bags and distribute the substrate equally (45 x 30 cm) inside each one. Then fill the bags with the fully grown spawn, and distribute the substrate uniformly once again. Straw that has been pasteurized and with 2% spawn is put into bags. Prepare numerous beds in the same manner, and secure the sacks. After that, the bags were gently packed to prepare them for spawn runs (development).then small holes were made in the bags for respiration of the mycelium. Spawned bags were stacked in a closed posture on racks in orderly and tidy locations. Water was sprayed twice daily on the walls and floor to regulate the temperature (17-28°C) and humidity (65-85%).When the bags were completely coated in white mycelium, it took 18 to 24 days. The mean radial growth per week and the spawn run period to total colonization were recorded.

Harvesting of the mushroom:

The bags were placed on horizontal racks in a cropping house, a wooden frame building covered in woven matting, after the spawn run was finished. After that, the bags were unsealed, and the mats received twice-daily watering in an effort to raise the humidity and promote fruit body production. 26–28°C and 90–95% relative humidity were present within the home. It was noted how many days passed before the mushroom appeared for the first time. The weight of fresh mushrooms expressed as a percentage of the dry weight of the substrate was used to calculate the biological efficiency, or BE.

Data collection and analysis:

Every day, the mushroom's development and growth were observed. It was noted how many days it took from inoculation to the point at which the mycelium was fully developed, how long it took from opening the plastic bags to pinhead for motion, and how long it took from releasing the bags to the first round of harvesting. Before each harvest, growth metrics such as stipe length (cm), stipe diameter (cm), pileus diameter (cm), and pileus thickness (cm) were measured using a slide caliper. At the time of harvest, additional yield metrics were noted, including the total fresh weight (g) of the mushrooms and the quantity of fruiting bodies per bunch. Mature fruiting bodies (white in color, with up curving pileus) were gathered by slicing the base with a sharp blade slightly above the surface of the substrate. During the experiment, first harvesting of mushroom harvesting was performed across all substrate types. Yield and biological efficiency were evaluated to assess mushroom growth performance on various substrates. As a result, biological yield (g) was calculated by weighing the entire cluster of fruiting bodies without removing the stalk bases, while economic yield (g) was calculated by weighing all of the fruiting bodies on a substrate after removing the stalk bases. Finally, biological efficiency (%) was estimated in the following manner:

$$B.E. = \frac{FWm(g)}{DWs(g)} \text{ X } 100\%$$

where, B.E. is Biological Efficiency (%); FWm is total weight (g) of fresh mushroom yield, and DWs is dry weight of substrate(g).

Then, analysis of variance (ANOVA) was computed using SPSS version 20, and mean values of all the parameters and the standard errors of each parameter were separated using LSD at 5 % level of significance.

Result and Discussions:

Colonization and Fruit Initiation Period:

Fig. 1 shows the overall time necessary for mycelial running, pin-head formation (primordium commencement), and fruiting body maturity. Mycelial running is the spread and colonization of fungal hyphae across the substrate. The mycelial growth was faster on soyabean straw (14 days) than on paddy t straw (15 days) and Red Gram straw (19 days).

The interim period of pin-head formation varied with substrates, ranging from 17 to 33 days after spawn seeding. Pin-head formation occurred quickly in soyabean straw (17 days), followed by Paddy straw (21 days), while it took relatively longer time in Red Gram straw (28 days). Besides, the observation on the density of mycelia reveals that Soyabean straw have higher mycelia density as compared to that of paddy straw and Red Gram straw.

In a similar vein, the time required for maturity of fruiting bodies varied from 21 days (for soyabean straw) to 24 days (for Paddy Straw). The cropping period for the other substrates (Red Gram straw) was 32 days, which is more or less close to the maximum period recorded on Red Gram straw.

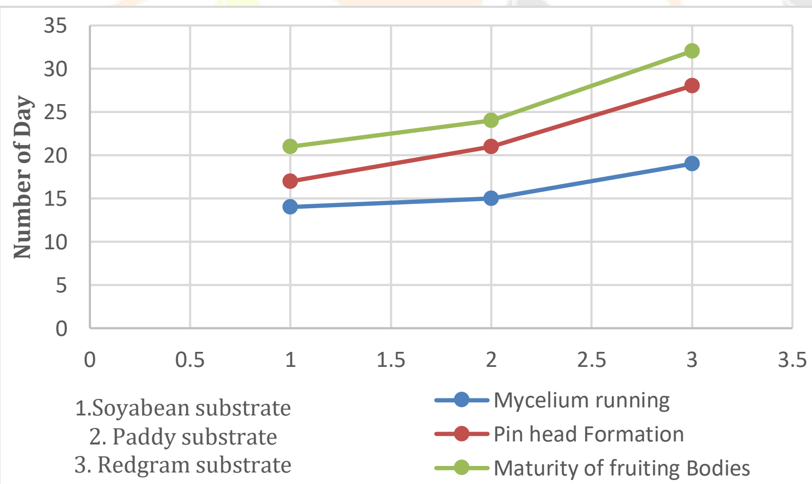

Fig. 1-Colonization and Fruit Initiation Period

Biological Yield:

Results of the yield components (yield attributes) of oyster mushroom grown in each substrate are presented in Table 1. Accordingly, it was found that the product from Red Gram Substrate has a relatively better growth in terms of diameter and thickness of the pileus, and diameter and length of the stipe. Moreover, the number of well developed fruiting bodies was also recorded. It was observed that the number of fruiting bodies was significantly higher in the culture of Paddy Substrate than the other substrates. The lowest number of fruiting bodies was recorded in soyabean substrate. Matured fruiting bodies of oyster mushroom were harvested and weighed to determine biological.The biological yield (g) was calculated by weighing the entire cluster of fruiting bodies without removing the stalk bases.

Table no. 1: Yield attributes of *Pleurotus ostreatus* grown on different substrates-

Parameters	Paddy Substrate	Soyabean Substrate	Red gram substrate
No. Of Fruiting Bodies	19	13	12
Pileus diameter(cm)	6.85	7.84	9.44
Pileus thickness(cm)	0.59	0.38	0.51
Diameter of Stipe(cm)	1.34	1.25	1.59
Length of stipe(cm)	1.64	1.8	2.78

Mean values under the same category that bear different superscript letters are significantly different(a<0.05).

Biological Efficiency:

The biological yield harvested to the dry weight of each substrate was calculated to measure Biological Efficiency, which is used to assess the effectiveness of substrate conversion in mushroom culture. According to Table 2, results of the biological efficiency varied significantly among the substrates used. The highest percentage of biological efficiency was obtained from soyabean substrate; while the least was observed in Red Gram substrate.

Table no. 2- Biological efficiency of *Pleurotus ostreatus* on different substrate

Substrates	Substrate dry weight(g)	Weight of fresh mushroom (g)	Biological efficiency (%)
Paddy	885.94	174.02	42.217%
Soya bean	332.72	206.96	62.202g
Red gram	370.43	120.03	32.402g

Mean Value under the same column that bear different superscript letters are significantly different (a<0.05)

Our experiment's spawn running (colonization) time ranged from 14 to 20 days, which was comparable to Ahmed's (1998) study, which found that *Pleurotus ostreatus* spawn running on various substrates took 17 to 21 days to complete. The difference in the time it takes a spawn to finish colonizing a certain substrate depends on the fungus strain, growth circumstances, and substrate type (Chang & Miles, 2004). Similarly, the period for pin head formation (fruit initiation stage) was found to range from 21 to 30 days in our experiment, which was similar to the study conducted by Fan *et al.,* (2000), who reported pin-head formation of oyster mushroom cultivated in different substrates ranged from 20 to 23 days.

Pleurotus ostreatus outperformed the others in terms of yield performance in soyabean straw and paddy straw (100%) with regard to the dry weight of the substrate. According to Khadka and Parajuli, (2013), paddy straw is a suitable substrate for *Pleurotus ostreatus*, which our experiment confirmed. The improved method of extracting sugars from cellulosic substances has resulted in an increase in mushroom yield in paddy straw (Ponmurugan, Sekhar & Sreeshakti, 2007).

Conclusion:

From the present study it can be concluded that paddy straw and soyabean straw alone is the best substrate for the growth and development of the oyster mushroom (*Pleurotus ostreatus*). So, paddy straw and soyabean straw solely can be used for its higher production as compared to other supplements like red gram. Further studies can be done thoroughly modification of environment making suitable temperature and humidity for the better growth and development of oyster mushroom (*Pleurotus ostreatus*).

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