EFFECT OF DIFFERENT SUBSTRATE ON THE YEILD AND GROWTH PERFORMANCE OF OYSTER MUSHROOM (*Pleurotus ostreatus)*

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ABSTRACT

The University of Agriculture Peshawar in Pakistan conducted research on the impact of various substrates on oyster mushroom output and growth performance from January to May 2022. An edible macro-fungus called a mushroom is grown in several nations utilizing agricultural waste. Agro-based lingo-cellulosic waste and leftovers are bio-converted throughout the mushroom production process. Because mushrooms grow using agricultural waste, its gardening is similar to sustainable farming. This study's goals were to develop oyster mushroom Pleurotus ostreatus using a variety of substrates, including paddy straw, wheat straw, peanut straw, brassica straw, and sawdust, as well as to produce spawns from wheat substrate. The substrates were soaked for 16–18 hours at the course of the night and then removed and autoclaved for one hour to sterilize them. After that it was placed in polythene bags, and spawn was added in the appropriate amount. Following packaging, spawn sacks were put in a closed posture with a temperature of roughly 180-28^{0} C and humidity was kept at a constant level by misting twice daily. Result revealed that Paddy straw showed minimum number of days required for mycelium growth (18), pin head formation (25) and for maturation of fruiting bodies (28) also shows maximum value for number of fruiting bodies (26.27), pileus diameter (6.04), pileus thickness (0.63), strip girth (4.73), strip length (2.07) and biological yield (1083), followed by wheat, sawdust, peanuts, and brassica straw. This study concludes that the Oyster mushroom, *Pleurotus ostreatus* grown well in Paddy straw when compared with other substrates and also it is confirmed that the spawn produced from Wheat grain have more potential than other spawns.

Keywords: Oyster mushroom, Mushroom substrate, Effect of mushroom substrates, Growth performance of mushrooms, Yield performance of mushrooms

1- INTRODUCTION

Oyster mushrooms (*Pleurotus ostreatus*), an edible fungus with great flavour and taste, when produced, make mushroom industry the profitable one. It is a member of the order agricals, class basidiomycetes, and subclass hollobasidiomycetidea. Across the world, it is grown in temperate and subtropical regions and naturally exists on forested slopes. Incorporating unconventional crops into the current agricultural system can assist small farmers to improve their social and economic conditions. Artificial mushroom production technology is a relatively new discovery. A niche alternative for farmers with limited land, small-scale mushroom growing offers a possibility for those interested in starting a second business. If agricultural and food processing by-products are employed as the growing medium for edible fungi, mushroom farming can play a significant part in managing farm organic wastes. After that, the used substrate can be composted and added directly to the ground. Since the beginning of life on earth, fungi have been active. The primary draw for man as a food source is the edible quality of mushrooms, which are newly spore-bearing fungi. Wild varieties of edible mushrooms have occasionally been found to be unappealing and less delicious. Nevertheless, mushrooms are recognized to have a variety of purposes in both food and medicine. (Beetz and Greer, 2004).

In Zimbabwe, oyster mushrooms (*Pleurotus ostreatus*) have been found to be a great food source for reducing hunger since they can grow quickly, use agricultural wastes, require less land, and use less water than other field crops (Tavarwisa *et al*., 2021). Because of its wonderful flavor and beneficial health and nutritional qualities, oyster mushrooms are commercially grown all over the world (Tesfaw *et al*., 2015). Many nations, including Ghana and China are using mushrooms as a relish. In Asian nations like China and Korea, mushrooms are used to create very pricey sauces and soups. Mushrooms are regarded as a particularly rich source of non-starchy carbohydrates, dietary fibre, proteins, most amino acids, minerals, and vitamins (Zied *et al*. 2017, Yao *et al.*, 2019). They serve as a meat alternative in vegetarian diets and are a good source of protein. Oyster mushrooms have a 25-30% protein, a 2.50% fat, a 17-44% sugar, a 7-38% mycocellulose, and a mineral content of about 8-12% (potassium, phosphorus, calcium, and sodium) (Stanley *et al*., 2012). Furthermore, given their chemical makeup, mushrooms have immune-stimulatory and anticancer action in addition to having a significant amount of dietary fiber (Cheung. 2013;

Lemieszek and Rzeski, 2012). The mushrooms also have anticancer, anti-diabetic, and antioxidant effects (Meng *et al*., 2016; Murillo. 2020).

Substrate composition has a considerable impact on mushroom development and nutritional makeup (Bellettini *et al*., 2019; Sebaaly *et al*., 2019). Mushrooms may be able to thrive on specific ligno-cellulosic materials, including sawdust (Hanafi *et al*., 2018), soybean straw, wheat straw (Cao *et al*., 2019), groundnut shells (Mane *et al*., 2007), newspaper and tea leaves (Jain, 2005), cotton waste and paddy straw (Ashraf *et al*., 2013), and date palm waste (Alananbeh et al., 2014). However, Due to its effective lignin-degrading property, the optimum substrate for mushrooms should have nitrogen, carbohydrates, cellulose, and lignin for rapid growth (Das and Mukherjee., 2007). Over 201,000 kilograms (kg) of mushrooms were exported by Pakistan in 2016 for a total export price of $12.930 million. The value of mushroom exports increased phenomenally, and during the same year, they also contributed more than 25% of the $101 million in total vegetable exports. In Pakistan, varied agriculture needs to be developed. Unfortunately, a big portion of Pakistan's population does not view mushrooms as important food items. This may be due to a lack of affordable mushrooms and a lack of awareness about mushrooms. To meet the demands of a balanced diet, the farmer should step forward and start commercially growing edible mushrooms like oyster mushrooms (*Pleurotus ostreatus*). The investigation of oyster mushroom cultivation on various substrates, including paddy straw, wheat straw, peanut straw, brassica straw, and sawdust, is the goal of this study.

MATERIAL AND METHODS

For seven days, Malt Extract Agar medium was used to grow a mushroom culture (MEA). The media was prepared, sterilized, and given time to set up slantwise. A piece of *Pleurotus ostreatus* soft tissue was solidified and then Individual MEA slants were aseptically transferred from there into the laminar airflow chamber. After inoculation, the cultures were incubated at 25 °C until sufficient growth was attained. After being transferred to perti plates with MEA medium, the slant culture was cultured for seven days at 25 °C. The agar media was covered by mycelia growth after seven days, and the culture was used to make spawn (Girmay *et al*., 2016). Wheat is used as the source material for spawn. The grains were spawned by following the procedure of (Mondal, 2010; Ayodele, 2007). .

Different substrates (paddy straw, Wheat straw, Peanuts straw, Saw dust, Brassica straw) were taken. The substrates were soaked for 16 to 18 hours at night. Then removed and autoclaved for a full hour. They were dried in the shade after sterilization. Following that, spawns were added in accordance with how the substrates had been bagged in polypropylene. The bags were then gently sealed for spawn development after being gently pressed. After that, tiny holes were made in the bags for the mycelium to breathe, and cotton was inserted into these holes to filter contaminated air. The temperature of the spawned bags was set between 180 and 280 degrees Celsius, and the humidity was maintained by twice-daily water spraying (Oei, 2006). Maintaining a suitable moisture level encourages the growth of mushrooms (Abdul, 2011). After inoculation, the mycelia start to develop.

Collecting and analyzing data

The mushroom's development and growth were monitored every day. It was noted how many Slide callipers were used to measure the growth metrics stipe length (cm), stipe diameter (cm), pileus diameter (cm), and pileus thickness (cm) prior to each harvest (cm). Other yield indicators, such as the quantity of fruiting bodies per bunch and the total fresh weight (g) of the mushrooms, were also recorded at the time of harvest. Sharp blades were used to cut through mature fruiting bodies, which are white in colour and have pilei that point upward. Three rounds of mushroom harvesting were conducted over the course of the experiment using various substrate types. Calculations were made to determine yield and biological efficiency in order to assess how well mushrooms grew on various substrates. Hence, the total weight of the cluster of fruiting bodies without the base of the stalks was used to calculate the biological yield (g), while the total weight of the fruiting bodies on the substrate was used to calculate the economic yield (g). The biological efficiency was then determined using the formula

$$\%BE = (FW_m/DW_s) \times 100.$$

BE is for biological efficiency, FWm stands for total fresh weight (g), and DWs stands for substrate's dry weight (g).

RESULTS:

The results from mycelia running, pin head formation and the maturation of fruit bodies are illustrated in the following lines. Five types of substrates as paddy straw, peanut straw, brassica straw and sawdust were compared with each other for cultivation of mushroom.

Table 1. Number of days required for mycelium growth, pin head formation and maturation of fruiting bodies in different substrate.

Treatment	No. of days req. for mycelium growth	No. of days req. for pin head formation	No. of days req. for maturation of fruiting bodies
Paddy straw	18	25	28
Wheat straw	21	27	30
Peanuts straw	18	29	33
Saw dust	20	27	29
Brassica straw	18	25	28

Mycelium growth

The appearance of fungal growth/whitish growth in different substrate took 16 to maximum 21days; however, the effect of substrate remained non-significant (Table 1). The highest mean days were, however, taken by wheat straw (21) while the lowest mean values of (18) was recorded in the paddy straw. The non-significant variation among substrate reveals that all of the tested substrates could be used. Khan *et al* (1991) reported that various available agricultural wastes and substrates containing wheat straw give an optimum linear growth of mycelia.

Pin head formation:

Required days for pin head formation ranges from 24-30 (table 1). However due to maximum variation among the replication it did significantly varied among substrate. 29 days is the highest value recorded in peanut straw while 25 days, recorded lowest in paddy straw in three replications. The days for pin head formation by each substrate are non-significant, but it could be changed by increasing the spawning rate. By increasing the spawning rate the time required for spawn running reduces (Biswas *et al.* 1997).

Maturation of fruiting bodies:

Analysis of variance shows that there is significant difference between the number of days required for maturation of fruiting bodies (p=0.02). The highest mean value (33.33) was recorded in peanut straw while the lowest mean value (28.33) was recorded in the paddy straw in all the three replication (table 1). This meant that paddy straw took less time than even the commonly used wheat straw 30 days. However there was no growth in the brassica substrate and hence could not be used for mushroom cultivation in the present scenario.

Number of Fruiting bodies:

Paddy straw shows significantly higher number of fruiting bodies while lowest were shown by peanut straw (Table 2). The fruiting body in any substrate ranges from 20.6-28.5 with mean highest in paddy straw and minimum as 21.97 in peanut straw. The data in the table shows that paddy straw had higher number of fruiting bodies than commonly used wheat straw in the present situation.

Table 2. Number of fruiting bodies, pileus diameter and Pileus thickness bodies influenced by different substrate

Treatment	**No. of fruiting bodies**	**Pileus diameter**	**Pileus Thickness**
Paddy straw	26.27	6.04	0.63
Wheat straw	24.93	5.61	0.54
Peanuts straw	21.97	4.01	0.42
Saw dust	23.38	4.43	0.46
Brassica straw	0	-	0

Pileus diameter:

The mean pilues diameter range from 4.01 to 6.06 cm considering the whole data (table 2) and there were significant variation among the substrate. The lowest mean pileus diameter as 4.01cm was recorded in peanut straw followed by 4.43 cm in saw dust substrate while the mean highest pileus diameter as 6.04 cm was recorded in paddy straw that was even higher than commonly used wheat straw substrate. It was reported that under similar environment and cultural practices cap diameter was also found highest from rice straw i.e. 5.14cm followed by wheat straw, banana leaves and lastly sugarcane bagasse which were 4.1 cm, 3.47cm and 3.25 cm respectively.

Pileus thickness:

Analysis of variance shows that pileus thickness significantly varied among substrate (table 2). The highest mean value is 0.63 cm was recorded in paddy straw while the lowest mean value is 0.42 cm was recorded in peanut straw. The values of pileus thickness are in report ranges.

Strip Girth:

In different substrate analysis of variance showed significant variations for stripe diameter of mushroom grown in different substrate. The highest stripe diameter is 4.77 cm was recorded in paddy straw that was significantly higher than peanut straw and saw dust substrate but similar to wheat substrate (table 3). The wheat straw produced mushroom that had mean stripe diameter of 4.69 cm that was statistically superior to peanut straw and saw dust substrate. Shah *et al*. (2004) found that on different substrate the length of oyster mushroom stripe varies from 1.93 cm to 2.97 cm.

Table 3. Strip girth, Strip length and biological yeild influenced by different substrate.

Treatment	Strip Girth	Stripe length	Biological Yield
Paddy straw	4.77	2.07	1083
Wheat straw	4.69	1.81	1035
Peanuts straw	3.06	1.03	528
Saw dust	3.42	1.02	900

Brassica straw	-	0	0

Stripe length:

Paddy straw produced significantly taller stripes of mushrooms than all the tested substrates in the given conditions (Table 3). Mean stripe length ranges from 1.02 cm to 2.08 cm considering all the date with highest mean value of 2.07 cm in paddy straw and minimum of 1.02 cm in saw dust. The higher stripe length than even wheat straw by 10% signifies its suitability for cultivation in the given experimental condition. Various spawn of oyster mushrooms were investigated and obtained larger mushrooms with loner stripe length on substrate inoculated with grain spawn (Aslam, 1996).

Biological Yeild (gbag^{-1})

Fresh weight of mushrooms was recorded in gram/bag after making three flushes from each block. Data in table 3 shows the sum of three plucking that ranged from 535 to 1080 gbag^{-1}. It is to mention here that one pot each in peanut starw and saw dust did not produced mature mushroom whereas all the three bags (replicates) of brassica substrate failed to produce any mushroom. The paddy straw and wheat straw produced the highest mean yield of 1083 and 1035 gbag^{-1} respectively that indicated their suitability for mushroom cultivation. Saw dust substrate produced mushroom of 900 g/bag that was significantly lower than paddy straw and wheat straw but still very much higher than 528 gbag^{-1} produced in peanut straw substrate. Mushrooms grown in the rice agricultural waste substrate have more efficiency in the absorption of available nutrients than the substrate composed of other agricultural wastes (Dubey *et al.*, 2019).

5- DISCUSSION:

According to the current study, paddy straw provided P. ostreatus mycelia with a relatively higher rate of growth than the other substrates (Wheat, Peanuts, Saw dust and Brassica straw). On each substrate, the mycelia ran for an average of roughly 22 days. The completion of spawn running on paddy straw waste was reported by Onuoha *et al*. (2009) to take 15 days, but other researchers using the same substrate reported it to take between 13 and 16 days (Patra and Pani 1995; Jiskani 1999). The difference in the time it takes a spawn to fully colonise a specific substrate depends on the fungal strain, the growth environment, and the type of substrate (Chang and Miles 2004). According to Oei (1991), some nutrients are necessary for the growth of mushroom mycelia; as a result, the use of supplements can boost mushroom output by supplying these particular nutrients. When mycelial development colonized substrates, pin-head formation (premordium initiation) was noticed. The time needed for pin-head formation is comparable to other studies i.e. Ahmed (1998) reported that oyster mushroom cultivation in different substrates required pin-head formation to occur between 23 and 27 days after spawning, while Fan *et al*. (2000) reported that it took place between 20 and 23 days. This study clearly showed that the total cropping time for oyster mushrooms varied depending on the different substrates utilized. According to reports, large-sized fruit bodies are a sign of excellent quality and high ratings for mushrooms (Onyango *et al*. 2011), but this is actually a sign of inferior quality since such fruit bodies frequently shatter during packaging, which lowers the quality of the mushrooms. According to Amin *et al*. (2007) and Shah *et al*. (2004), oyster mushroom stripes on different surfaces ranged in length and diameter from 1.93-2.97 cm and 0.74-1.05 cm, respectively. The variability among substrates caused pileus thickness and diameter to vary from 0.45-0.70 cm and 4.85-8.95 cm, respectively (Shah *et al*., 2004). The 20% rice husk in weight substrate produced the best production of P. ostreatus, according to Baysal et al. (2003). Ruhul Amin *et al*. (2007) calculated the maximum biological yield to be 247.3g/packet and discovered that the trend in economic yield was related to various additives at various levels. According to (Khanna and Garcha, 1981), oyster mushrooms cultivated on paddy straw can take up to 104 days to produce a harvestable crop. The changes in the growing environment and physiological requirements for mushroom culture, such as the constant temperature, humidity, and lighting patterns, were the cause of these variations in cropping times. The use of various substrates was shown to have an impact on the yield components of P. Ostreatus. In terms of the diameter and thickness of the pileus as well as the diameter and length of the stipe, paddy straw produced a considerably better growth. The research proved that the use of various substrates has a substantial impact on oyster mushroom output (both biological and commercial yield). Paddy straw produced the highest yield, followed by wheat straw, while saw dust produced the lowest. The biological effectiveness of the various substrates also differed. When various lingo-cellulosic materials were utilized as substrates for the development of oyster mushrooms, variable ranges of biological efficiency (BE) have been recorded (Liang *et al*. 2009).

6-CONCLUSION

Oyster mushroom is an edible mushroom which can be grown on various substrates like Paddy straw, wheat straw, Brassica straw, peanuts straw, Saw dust etc. This study confirmed that the Oyster mushroom, *Pleurotus ostreatus* grown well in Paddy straw when compared with other substrates and also it is confirmed that the spawn produced from Wheat grain have more potential than other spawns. To fully understand the mushroom's numerous socioeconomic and environmental significances, additional research must be done on the possible effects of various agricultural and industrial wastes on oyster mushroom growth, their economic viability, and other associated issues.

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