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Studies on Standardization of Production Technology of Oyster Mushroom

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ABSTRACT

In the present investigation, attempts were made to evaluate different substrate quantities to get higher biological efficiency. Two strains of oyster mushroom (PL-19-05 and PL-19-06) were cultivated by using different quantities of wheat straw (2 kg, 3 kg, 4 kg and 5 kg). Among four substrate quantities, early spawn run (9.50 days and 11.00 days) and pin head initiation (19.25 days and 19.00 days) were observed at 2 kg substrate quantity for PL-19-05 and PL-19-06 strains, respectively, followed by 3 kg, 4 kg and 5kg substrate quantities. Maximum yield was obtained at 5 kg substrate quantity for both strains. But biological efficiency was highest at 3 kg of substrate quantity which was 75.73% and 89.98 % for PL-19-05 and PL-19-06 strains, respectively, increase or decrease in quantity of substrate ensued in low biological efficiency. Based on the results, 3 kg substrate quantity is suggested as optimum substrate quantity for sub-humid conditions of Udaipur region to get higher biological efficiency and easy handling.

Key words : *Oyster mushroom, Spawn run, Mushroom production technology*

Introduction

Mushroom are saprophytic fungi with distinct fruiting bodies which are fleshy in nature. They belong to the class *Agaricomycetes* and Phylum *Basidiomycota*. The *Pleurotus* spp. of the class basidiomycetes belongs to a group known as ''white rot fungi'' (Tsujiyama and Ueno, 2013) as they produce a white mycelium and are generally cultivated on non-composted lignocellulosic substrates. Its cultivation has been increased tremendously throughout the world because of their abilities to grow at a wide range of temperature and utilizing various agro-based residues (Sharma *et al.,* 2013). Due to their capacity to grow on a variety of substrates and simple cultivation techniques, oyster mushrooms are India's second most popular mushroom species. *Pleurotus* is the only oyster mushroom genus with the highest number of species cultivated commercially.

To live a healthy and active life, humans require a wide range of nutrients, that can only be obtained *via* a well-balanced diet. Mushrooms are high in fiber, carbs, proteins, all of the necessary amino acids, dietary fiber and a strong source of vitamin D, C, B6 (riboflavin), and niacin (Ahmed *et al.,* 2009) but low in fat and calories (Deepalakshmi and Mirunalini, 2014). Today Indian government is recommending mushrooms for mid-day meal in schools opening more opportunities for consumption of mushrooms as health food. In the crisis of COVID-19, mushroom particularly oyster mushroom with higher vitamin D content may play a very crucial role to improve immunity. Mushrooms are considered the world's third kingdom and are a good veggie alternative. Mushrooms are not only a good source of nutrients,

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but they also known for their medicinal properties (Mshandete, 2011) like immuno-modulation, anti-cancer, anti-hypertensive, antioxidant (Roupas *et al.,* 2012), anti-diabetic, antiviral, antibacterial *etc*. (Lavi *et al.,* 2010) and antifungal activities.

In COVID-19 crisis, many farmers and entrepreneurs are showing interest in mushroom cultivation due to loss of jobs, unemployment, low cost agro-business to mention a few. There is urgent need to provide low cost, ready to use technology that can be deployed in cost effective indigenous setups. The introduction of oyster mushroom helped us to grow mushroom throughout the year. As a labor-intensive management mushroom production generates a huge number of direct and indirect employment opportunities in cultivation, marketing and marketing operations and also providing opportunities for processing enterprises (Islam *et al.,* 2013). Mushroom cultivation required low capital and low technical skills and it is easy to cultivate mushrooms on a small scale in an indoor setting, with a high return on investment. Women can grow mushrooms in their own houses similar to rearing poultry with a little money. As a result, mushroom cultivation not only empowers rural women, but also helps to alleviate poverty on a local level (Easin *et al.,* 2017). It can be grown successfully all over the world especially in the tropical and sub-tropical regions under controlled and semi-controlled conditions.

The mushroom cultivation is environmentally friendly, capable of converting the lignocellulosic waste materials into food, feed and fertilizers. They are saprophytic fungi and have the ability to degrade lignocellulosic materials by their extensive enzymes (Sardar *et al.,* 2020). They can add value to low-cost products as agro-waste (Ahmed *et al.,* 2013; Dahmardeh, 2013). The substrates on which the mushrooms are grown can be utilized as a biofertilizer to improve soil fertility, animal feed, and a raw material for biogas production. As a result, mushroom growing is considered to be environmentally benign, as it has no negative impact on the environment when compared to other crop cultivation. The raw materials use in oyster mushroom cultivation are easily available and it can be grown successfully in various climatic condition. For the cultivation of mushroom, it is necessary to understand the standard technology and its favorable climate. Therefore, study's goal is to analyze various substrate quantities in order to improve biological efficiency.

Materials and Methods

Optimization of substrate quantity

The present experiment was conducted during the rainy season (August to October) 2019-20 at the Mushroom Laboratory of the Department of Plant Pathology, Rajasthan College of Agriculture, Udaipur, Rajasthan. The Directorate of Mushroom Research, Chambaghat, Solan, provided the pure culture of oyster mushroom strains. Furthermore, the culture was replicated on 2% malt extract agar medium and kept pure in test tube slants using 2% malt extract agar media by repeated subculturing.

Spawn preparation

Mushroom mycelium grows on grains, which are then used as seed of mushroom. Wheat grains were steeped in water overnight and then half-cooked, with the surplus water decanted off and then grains were allowed to surface dry and cooling. On a wet weight basis, these half-cooked grains were mixed with 1% calcium carbonate after cooling. Grains were thoroughly mixed before filling to two-thirds capacity in glass bottles and polypropylene bags, with the mouth tightly plugged with a cotton plug and then sterilized at 20 psi (126.5 ^{o}C) for two hours. After allowing each bag and bottle to cool at room temperature, they were vigorously shaken, placed in a laminar air flow chamber and exposed to UV radiation for 20 minutes. Bottles and bags were inoculated aseptically with fully grown pure culture or 10-12 g mother grain spawn, then gently shaken to disperse the inoculums evenly. The spawn run was completed in 10-12 days and the grain spawn was ready to use.

Preparation of substrate and spawning

Wheat straw was chopped and soaked in fresh water overnight, for sterilization of the wheat straw water was chemically treated with bavistin (4g), formalin (150 ml), and nuvan (15 ml) per 100 liters of water. After soaking the straw overnight, the excess water was drained off by spreading it on a raised wire mesh frame. When a wetted straw was squeezed in the hand, water did not trickle down from the palm, indicating that the water level was optimal. For early and better spawn run,moisture was most important factor because excess moisture causes straw to rot, whereas a lack of moisture results in delayed spawn run.

Two strains of oyster mushroom (PL-19-05 and PL-19-06) were cultured with four different amounts of substrate (2 kg, 3 kg, 4 kg, and 5 kg on wet weight of straw) with four replications of each in completely randomized designto determine the optimum substrate quantity. This experiment was conducted during August 2019. Layer spawning was carried out at a three per cent spawn rate. For filling the different quantities of straw, different sizes of polybags were used.

Crop management and harvesting of mushroom

The spawned bags were placed in racks. After 15-20 days, the spawn run was completed, and the bags were fully covered with white mycelium. The polybags were gently removed and watering started one day after the polythene cover was removed. Proper ventilation of room was maintained by opening of windows (2-3 days). Water was sprayed on walls of the room and bags by 2-3 times to maintain the temperature and relative humidity. The first primordia appeared 3-4 days after the polybags were removed and they matured in about 1-2 days. The mature mushroom was plucked by turning it clockwise from the base to uproot it. The harvested mushroom fruiting bodies were weighed for the calculation of the biological efficiency (Deora *et al.*, 2021).

$$\text{Biological Efficiency (\%)} = \frac{\text{Fresh weight of mushroom (g)}}{\text{Dried weight of Substrate (g)}} \times 100$$

Results

***Pleurotus* strain-PL-19-05**

Data presented in the Table 1 clearly depicts that the increasing quantity of substrates significantly increased, the time taken to spawn run, pin head initiation, yield and average number. The minimum time taken for spawn run and pin head initiation was recorded 9.50 days and 19.25 days respectively at 2 kg substrate quantity, while maximum was recorded at 5.0 kg substrate quantity (14.25 days and 23.75 days, respectively).

Data recorded for yield (g) indicated (Table 1) that the maximum yield of fruiting bodies (1191.25 g kg^{-1} of substrate weight) with maximum number of fruit bodies (195.25) was obtained at 5 kg substrate quantity, which was significantly superior over rest of lower quantity of substrates. However, the least yield (490 g kg^{-1} of substrate quantity) was recorded at the substrate quantity of 2.0 kg. Further, data showed that the maximum biological efficiency (75.73 per cent) was obtained at 3 kg substrate quantity followed by 2 kg and 4 kg substrate quantity. Minimum biological efficiency (71.48 per cent) was obtained at 5 kg substrate quantity. Again, maximum average weight of fruiting body (6.43 g) and the maximum diameter of the pileus 6.70 cm were recorded at 3.0 kg substrate quantity. The maximum length (4.25 cm), which was significantly superior over rest levels of substrate quantity and maximum diameter (1.35 cm) of the stipe were observed at substrate quantity of 4.0 and 5.0 kg, respectively.

***Pleurotus* strain- PL-19-06**

Similarly, *Pleurotus* strain PL-19-06 showed same trend as PL-19-05 when use different quantity of substrate was used. Data in (Table 2) indicated that the spawn run (11 days) and pin head initiation (19 days) were accomplished earliest by using 2.0 kg substrate quantity. Maximum biological efficiency 89.98 per cent along with the yield of 899.75 g kg^{-1} of substrate dry weight were obtained with substrate

Table 1. Effect of different substrate quantity on growth parameters, yield and morphology ofPL-19-05strain of *Pleurotus* mushroom

Substrate quantity (kg)	Average Spawn run (Days) (Days)	Average Pin head initiation	Average Yield (g) (%)	Average Biological efficiency (g)	Average fruit body weight bodies	Average number of fruit (cm)	Average Pileus diameter (cm)	Average Length of stipe (cm)	Average Diameter of stipe
2	9.50	19.25	490.00	73.50	5.95	88.50	6.38	3.33	0.95
3	11.25	20.00	757.25	75.73	6.43	135.50	6.70	3.08	1.08
4	13.50	21.75	967.25	72.55	6.18	164.75	5.73	4.25	1.33
5	14.25	23.75	1191.25	71.48	6.40	195.25	6.35	3.73	1.35
SEm±	0.49	0.51	19.03	1.91	0.10	6.14	0.11	0.09	0.07
CD (P=0.05)	1.51	1.56	58.64	NS	0.30	18.92	0.34	0.28	0.21

Table 2. Effect of different substrate quantity on growth parameters, yield and morphology of PL-19-06 strain of *Pleurotus* mushroom

Substrate quantity (kg)	Average Spawn run (Days)	Average Pin head initiation (Days)	Average Yield (g)	Average Biological efficiency (%)	Average fruit body weight (g)	Average number of fruit bodies	Average Pileus diameter (cm)	Average Length of stipe (cm)	Average Diameter of stipe (cm)
2	11.00	19.00	592.75	88.91	5.98	96.75	5.33	4.00	1.33
3	12.25	21.75	899.75	89.98	6.45	135.00	5.65	5.05	1.60
4	15.50	23.50	1197.00	89.78	6.85	183.00	7.20	3.15	1.80
5	15.25	26.75	1382.00	82.92	6.28	237.50	5.88	4.18	1.30
SEm±	0.55	0.71	26.86	2.62	0.10	6.41	0.30	0.08	0.06
CD (P=0.05)	1.69	2.20	82.75	NS	0.30	19.76	0.93	0.24	0.19

quantity of 3.0 kg. However, the minimum biological efficiency was observed at 5 kg substrate quantity. Further, the results revealed that the average fruiting body weight and avg. number were recorded maximum with the substrate quantity of 4.0 and 5.0 kg per bag, respectively, which were significantly superior over rest of the substrates' levels.

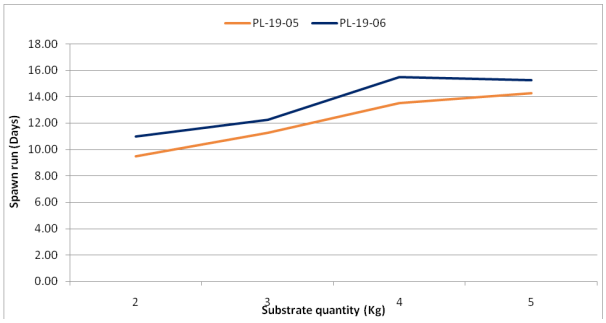

Fig. 1. Average number of days taken in spawn run completion under different substrate quantity by the strains PL-19-05 and PL-19-06

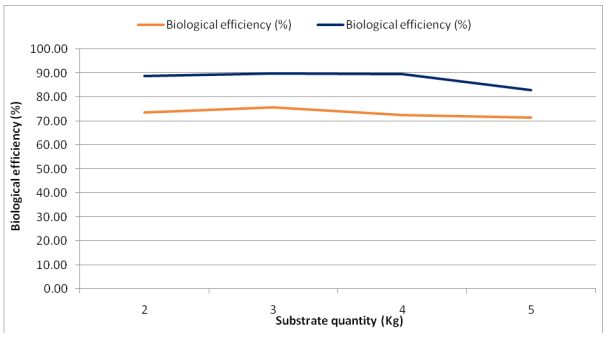

Fig. 2. Biological efficiency obtained under different substrate quantity by the strain PL-19-05 and PL-19-06

Discussion

Results revealed that increase in quantity of substrates has been significantly increased the time taken to spawn run, pin head initiation, yield, average number and weight of fruiting bodies, diameter of the pileus and length of stipe of *Pleurotus* strain. In present investigation, the increase in substrate quantity has significant effect on yield but insignificant effect on biological efficiency of *Pleurotus* strains. Biological efficiency of oyster mushroom was highest at 3 kg of substrate quantity, increase or decrease in quantity of substrate ensued in low biological efficiency. Hence, 3 kg substrate quantity was sufficient over others. Kumar (2005) concluded that 3 kg and 4 kg straw with 3% spawn dose gave the highest biological efficiency. Patel and Trivedi (2014) also found that fresh fruit body yield and biological efficiency were obtained maximum by using 3 kg substrate quantity with 150 gm of spawn dose. Deora *et al.* (2021) observed that 3 kg and 4 kg straw with 3 % spawn dose gave maximum yield and biological ef-

Plate 1. Effect of different substrate quantity on fruiting

ficiency (40%) than other treatments (2 kg and 5 kg). The reason for this might be that as the quantity of straw increased, the surface area got increased and ultimately reducing the time to be taken for the spawn run. As a result, it becomes more susceptible to contaminant fungi, which has a direct impact on mushroom yield. However, Zireva *et al.* (2007) concluded that 6 kg of substrate per tray would result in optimal yield among 2, 4, 6, 8, and 10 kgwheat straw.

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