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Studies on the Effect of Different Combinations of Soybean Straw and Sugarcane Bagasse on Yield of Oyster Mushroom

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Abstract

The present investigation on "Studies on the effect of different combinations of soybean straw and sugarcane bagasse on yield of oyster mushroom" was conducted to evaluate different substrates combinations for growth and yield of oyster mushroom. The present study focused on evaluating the growth and yield of Pleurotus spp. using different different substrate combinations of wheat straw, soybean straw and sugarcane bagasse which have economic approach in agro industry as the residues are readily available. Therefore, the aim of this study was to investigate the feasibility of different substrate combinations for cultivation of oyster mushroom. The experiments consist of six treatments with four replications in complete randomized design. Treatments of experiment are T_1 - Soybean straw, T_2 - Sugarcane bagasse, T_3 - Soybean straw (75%) + Sugarcane bagasse (25%), T_4 - Soybean straw (50%) + Sugarcane bagasse (50%), T_5 - Soybean straw (25%) + Sugarcane bagasse (75%), T_6 - Wheat straw. Average fruit weight varied from 5.93 to 8.34 g. The treatment T_3 - Soybean straw (75%) + Sugarcane bagasse (25%) recorded maximum average fruit body weight (8.34g) and treatment T_2 - Sugarcane bagasse (100) recorded the minimum average fruit weight (5.93 g). The number of fruits (per kg dry substrate) for first, second and third harvest varied from 49.16 to 97.41, 45.33 to 84.10 and 21.92 to 37.1 respectively. The treatment T_3 - Soybean straw (75%) + Sugarcane bagasse (25%) recorded maximum numbers of fruits per kg dry substrate for first and third harvest 97.41 and 37.1 fruits respectively while the treatment T_4 - Soybean straw (50%) + Sugarcane bagasse (50%) recorded maximum number of fruits per kg dry substrate (84.10 fruits) for second harvest. The total yield of fresh oyster mushroom varied from 711.6 to 1101.11g per kg dry substrste. The treatment T_3 - Soybean straw (75%) + Sugarcane bagasse (25%) gave maximum yield (1101.11 g per^{-1} kg dry substrate) and the treatment T_2 - Sugarcane bagasse (100%) recorded with the minimum yield (711.6 g per kg dry substrate).

Key words : Soybean straw, sugarcane bagasse, dry substrate, wheat straw, oyster mushroom.

Mushroom belongs to the group of fungi and it has the ability to convert cellulosic and lingolytic plant wastes into palatable food. A toadstool or mushroom is a spore-bearing, fleshy plant organ of a fungus that grows above ground, on soil or on its food supply. Mushroom references are available in ancient literature like 'Vedas' and Bible'. There are different kinds of mushroom having various size, shape, colour, edibility and appearance. There are approximately 5000 different types of mushrooms found all over the world. Out of this, more than 2000 species are edible and 300 belonging to 70 genera are reported from India. Among this few species have been brought under cultivation on commercial scale. Out of 200 edible species of prime mushroom, about 80 species have been grown experimentally, 20 cultivated commercially and 4 and 5 species produced on industrial level throughout the world (Chang and Miles, 1989). Mushrooms are known vegetarian's meat due to the rich source of minerals and proteins. The proteins of mushroom are considered to be intermediate between that of vegetables and animals. Amino acids required for different biological activities in human body were also found in oyster mushroom. Oyster mushroom productivity is maximum in a very short time providing more protein per unit area than any other crop. Due the high content of nitrogen and protein, which increases the biological efficiency of oyster mushroom. Oyster mushroom also produces metabolites of medicinal and pharmacological value, such as antimicrobials, immune stimulants, antioxidants and antitumourals. Pleurotus is an efficient lignin degrading mushroom and can grow well on different types of substrates containing lignocellulolosic materials. *Pleurotus* spp. can grow well in variable temperature conditions; hence they are ideally suited for cultivation throughout the year in tropical regions of the world. They are able to colonize and degrade a large variety of lignocellulosic residues and required very short time for the growth than other edible mushrooms (Singh *et al*., 2019).

Pleurotus species' fresh fruiting bodies have a high moisture content (90.8%) and both fresh and dried oyster mushrooms are high in proteins (30.4%), fat (2.2%), carbohydrates (57.6%), fibre (8.7%) and ash (9.8%) with 345 K cal of energy per 100 g of dry weight. It also contains vitamins like thiamin (4.8 mg), riboflavin (4.7 mg) and niacin (1087 mg) as well as minerals (Pandey and Ghosh, 1996). Protein content of mushrooms varies from 4 to 44% according to the species (Crisan and Sands, 1978). *Pleurotus sajor-caju* is a commercially cultivated species of oyster mushroom. *P. sajor-caju* has high protein content and a low fat content. It also contains vitamins (B1, B2, C), minerals (P, Na, Ca), and a high content of fibres and carbohydrates. Pleurotus sajor-caju exhibited strong antioxidant properties. It also showed moderate antibacterial activity against Streptococcus aureus and Vibrio cholerae. The presence of vitamins and carotenoids in P. sajor-caju can also play a protective role in diseases such as cancer and cardiovascular disease. The species is also known to possess antineoplastic (inhibiting or halting the development of a tumor, i.e., neoplasm) properties (Chandraprakash *et al*., 2022).

Oyster mushrooms are the easiest, fastest and cheapest to grow, require less preparation time and production technology. Also, the first flush is usually large, without the need for compost, manure, limestone, casing or temperature shocks. With more than 100% biological efficiency, coupled with its distinctive flavour, aroma and excellent drying and preservation qualities, it is assured a unique status as a delicacy (Mandeel *et al*., 2005). Various agricultural by-products are being used as substrates for the cultivation of the oyster mushroom. Some of these wastes include banana leaves, peanut hull and corn leaves, mango fruits and seeds, sugarcane leaves, wheat and rice straw (Cangy and Peerally, 1995). Agricultural wastes such as maize cob, maize straw, wheat straw, palm kernel cake, cotton seed hull, saw dust, spent grain; grass families are good materials for farm substrate production. *Pleurotus* are efficient lignin degraders, which can grow on different agricultural wastes which makes *P. sajor-caju* cultivation as an excellent alternative for production of mushrooms when compared to other mushrooms (Kausar, 1998). In Europe, wheat straw is used, while in South East Asian countries sawdust is more common. The majority of these substrates can be used as animal feed. However, their low digestibility, low protein content and high lignin content render them unpopular and unacceptable (Mandeel *et al*. 2005). The mushroom yield was related to chemical and biological composition of the substrate which is important for the growth of mushroom than other substrates (Tsegaye and Tefera 2017).

Material and Methods

During the present research work on "Studies on the effect of different combinations of soybean straw and sugarcane bagasse on yield of oyster mushroom" a set of experiment was carried out at All India Coordinated Research

Project on Mushroom, College of Agriculture, Pune. During present investigation the master spawn of Pleurotus sajor-caju was maintained and used from the AICRP on Mushroom, College of Agriculture, Pune. For bed preparation, high density polythene bags were used. For cultivation of oyster mushroom chopped dried soybean straw, sugarcane bagasse and wheat straw was used. Before bed filling, the fumigation of room was done by using Formaldehyde (37-41%) @ 2%. To avoid any harmful effect of formaldehyde, essential tools such as the well sanitized hand gloves and mask were used. For fumigation of oyster mushroom cultivation room, formaldehyde (37-41%) @ 2% was used. In addition, Bavistin and copper Sulphate were also used @ 10% for fumigation of mushroom growing rooms. The bold seeded whole wheat grains were weighed and rinsed 2-3 times in tap water. The vase was filled with water until the grains were just immersed. The grains were boiled in hot water to prevent starch from escaping. After cooking, the grains were spread over a large wire gauze mesh to drain extra water. Overnight, the grains were maintained in a ventilated atmosphere. Based on the weight of these boiled grains, 4 percent calcium carbonate was mixed the next morning. Mother spawn was prepared in conical flasks, whereas commercial spawn was prepared in heat resistant polypropylene bags. The cooked grains were packed to 3/4 capacity in these conical flasks and polypropylene bags (size 20cm x 30cm gauge 175) and then plugged with non-absorbent cotton. The polypropylene bags and conical flasks were sterilized in an autoclave at 20 pounds PSI for 1 hr. After sterilization, the bags and flask were cooled and thoroughly shaken. The flask and bags were placed in a sterile (UV-sterilized) laminar flow chamber. The experiments consist of six treatments with four replication in complete randomized design. T_1 - Soybean straw, T_2 - Sugarcane bagasse T_3 - Soybean straw (75%) + Sugarcane bagasse (25%), T_4 - Soybean straw (50%) + Sugarcane bagasse (50%), T_5 - Soybean straw (25%) + Sugarcane bagasse (75%), T_6 - Wheat straw. The watering was taken off for a day before harvesting. Harvesting of fruiting bodies was done before shedding of spores. The total number of fruiting bodies and fresh weight was noted immediately after harvesting.

Results and Discussion

1. Average fruit weight : Results of the average fruit body weight are presented in Table 1. the average fruit body weight was determined by selecting 10 mature fruit bodies at random from each treatment. Average fruit weight varied from 5.93 to 8.34 g. The treatment T_3 - Soybean straw (75%) + Sugarcane bagasse (25%) recorded maximum average fruit body weight (8.34g) and treatment T_2 - Sugarcane bagasse (100) recorded the minimum average fruit weight (5.93 g). The treatment T_3 - Soybean straw (75%) + Sugarcane bagasse (25%), T_1 - Soybean straw (100%) and T_4 - Soybean straw (50%) + Sugarcane bagasse (50%) were found to be at par with each other. The treatment T_3 - Soybean straw (75%) + Sugarcane bagasse (25%) observed significantly superior to rest of the treatments.

Table 1. Effect of different substrate combinations on average fruit body weight (g) of the oyster mushroom

Treatments	**Average fruit weight (g)**
Soybean straw (100%)	7.57^{bc}
Sugarcane bagasse (100%)	5.93^{a}
Soybean straw (75%) + Sugarcane bagasse (25%)	8.34^{c}
Soybean straw (50%) + Sugarcane bagasse (50%)	6.99^{abc}
Soybean straw (25%) + Sugarcane bagasse (75%)	6.55^{ab}
Wheat straw (100%)	6.68^{ab}
SE(m) ±	0.50
C.D @ 5%	1.50

The results are harmony with those of Deora *et al*. (2021), who found that Pleurotus eryngii had an average fruit body weight ranging from 25.3 to 96.4 g. In the experiments with *Pleurotus* spp., Sharma and Jandaik (1983) found that the fruit body weight ranged from 5.0 to 5.8 g. Hassan *et al*. (2010) found that the average fruit body weight in Peshawar ranged from 2.3 to 9.7 g. According to Khade *et al*. (2019), the average fruit body weight of *Hypsizygus ulmarius* ranged from 2.72 to 10.64 g.

2. Number of fruits per kg dry substrate : Results of the numbers of fruits per kg dry substrate at every harvest are presented in Table 2.

2.1. First harvest : Number of fruits per kg dry substrate at first harvest varied from 49.16 to 97.41. The maximum number of fruits (97.41) per kg dry substrate was found in T_3 - Soybean straw (75%) + Sugarcane bagasse (25%) while the treatment T_2 - Sugarcane bagasse (100) recorded the minimum number of fruits (49.16) per kg dry substrate. T_1 - Soybean straw (100%) and T_3 - Soybean straw (75%) + Sugarcane bagasse (25%) were found to be at par with each other. The treatment T_3 - Soybean straw (75%) + Sugarcane bagasse (25%) was found to be significantly superior over rest of treatments.

2.2. Second harvest : Number of fruits at second harvest varied from 45.33 to 84.10. The treatment T_4 - Soybean straw (50%) + Sugarcane bagasse (50%) observed with maximum number of fruits (84.10) per kg dry substrate and treatment T_2 - Sugarcane bagasse (100) recorded the minimum number of fruits (45.33) per kg dry substrate. The treatment T_4 - Soybean straw (50%) + Sugarcane bagasse (50%) reported maximum number of fruits than rest of treatments.

2.3. Third harvesting : Number of fruits for third harvest varied from 21.92 to 37.1 fruits per kg dry substrate. Maximum number of fruits (37.1) per kg dry substrate were found in T_3 - Soybean straw (75%) + Sugarcane bagasse (25%) and the treatment T_2 - Sugarcane bagasse (100) recorded the minimum number of fruits (21.92) per kg dry substrate. The treatment T_3 - Soybean straw (75%) + Sugarcane bagasse (25%), T_1 - Soybean straw (100%) and T_4 - Soybean straw (50%) + Sugarcane bagasse (50%) were statistically at par with each other.

The data obtained correspond with Khade *et al*. (2019) findings that *Hypsizygus ulmarius* generated 6.11 to 89.56 fruit bodies per bed. The findings are in comformity with those of Deora *et al*. (2021), who reported that *Pleurotus eryngii* produced 9.4 to 32.8 fruit bodies per bed. Gaikwad (2004) also reported that the total number of fruits produced by *Pleurotus sajor-caju* ranged from 125 to 200. *Pleurotus sajor-caju* produced a maximum of 65 fruit bodies per bed, reported by Shukla and Jaitley (2011).

3. Yield of oyster mushroom : Results of

Table 2. Effect of different substrate combinations on number of fruits (per kg of dry substrate) after spwan run of oyster mushroom

Treatments	Number of fruits		
	First harvest	Second harvest	Third harvest
Soybean straw (100%)	95.58^{d}	53.92	32.67^{bc}
Sugarcane bagasse (100%)	49.16^{a}	45.33	21.92^{a}
Soybean straw (75%) + Sugarcane bagasse (25%)	97.41^{d}	68.66	37.1^{c}
Soybean straw (50%) + Sugarcane bagasse (50%)	78.91^{c}	84. 10	33.08^{bc}
Soybean straw (25%) + Sugarcane bagasse (75%)	76.32^{c}	46.58	27.42^{ab}
Wheat straw (100%)	60.75^{b}	54.46	26.42^{ab}
SE(m) ±	2.47	13.44	2.58
C.D @ 5%	7.38	NS	7.73

Table 3. Effect of different substrate combinations on yield of oyster mushroom

Treatment	**Total yield ($g\ kg^{-1}$ dry substrate)**
Soybean straw (100%)	1039.54^{c}
Sugarcane bagasse (100%)	711.60^{a}
Soybean straw (75%) + Sugarcane bagasse (25%)	1101.11^{c}
Soybean straw (50%) + Sugarcane bagasse (50%)	889.70^{b}
Soybean straw (25%) + Sugarcane bagasse (75%)	821.67^{ab}
Wheat straw (100%)	851.21^{ab}
SE(m) ±	49.44
C.D @ 5%	148.02

the yield performance are presented in Table 3. the yield of oyster mushroom varied from 711.60 to 1101.11g per kg dry substrate. The treatment T3- Soybean straw (75%) + Sugarcane bagasse (25%) recorded maximum yield (1101.11g kg^{-1} dry substrate) and the treatment T_2 - Sugarcane bagasse (100) recorded the minimum yield (711.60 g per kg dry substrate). T_1 - Soybean straw (100%) and T_3 - Soybean straw (75%) + Sugarcane bagasse (25%) were found to be at par with each other.

The treatment T_3 - Soybean straw (75%) + Sugarcane bagasse (25%) was found significantly superior to rest of treatments.

According to Dubey *et al*. (2019) the maximum yield (1515g) of oyster mushroom was recorded in paddy straw substrate followed by banana leaves (517.5g), wheat straw (480g) and sugarcane bagasse (98.75g). The findings correspond with those of Deora *et al*. (2021), who also reported that the yield of *P. eryngii* on wheat straw and rice straw was 767.4 g kg^{-1} and 884.0 g kg^{-1} dry substrate, respectively. Dhobale (2023) determined the yield of P. sajor-caju on wheat straw to 706.82 g kg^{-1} to 1306.82 g kg^{-1} dry straw. Sawant *et al*. (2022) measured the yield performance of P. sajor-caju on soybean straw, wheat straw, and sugarcane trash and found that it generated 752.64 g kg^{-1}, 654.01 g kg^{-1}, and 635.14 g kg^{-1} dry substrate, respectively.

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