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Performance of Different Substrates on Growth, Yield and Biological Efficiency of Oyster Mushroom Varieties

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Abstract

A study was conducted to analyze the suitability of local substrates like maize stalk, arecanut husk, coconut leaf stalk and bunch waste for production of oyster mushroom. Quickest spawn run was observed in 22.5 days and first crop was harvested in 27.0 days in the maize stalk substrate. Further, the maximum yield of 297 gm per cover was recorded in maize stalk substrate followed by 277 gm per cover of paddy straw. Highest biological efficiency of 84.79 per cent was also observed in maize stalk followed by 55.40 per cent in paddy straw. Maize stalk as substrate required 36 man hours of labour to produce 100 kg of oyster mushroom and the production cost incurred was Rs. 3,246 per 100 kg. The net returns from maize stalk as substrate was Rs. 6,751 per 100 kg of mushroom and BC ratio was 3.09 which were highest among all the substrates. Paddy straw performance was also good with BC ratio of 2.72.

Keywords: Oyster mushroom, Substrate, Maize stalk, Biological efficiency

Mushrooms also called 'white vegetables' or 'boneless vegetarian meat' contain ample amounts of proteins, vitamins, fibre and certain medicinal properties. It contains 25-30 per cent protein (dry weight) which is higher than those of vegetables and fruits and is of superior quality. Mushrooms are now getting significant importance due to their nutritional and medicinal value. Today, mushroom cultivation is being done in about 100 countries. At present world production is estimated to be around 5 million tones and is ever increasing.

Mushroom cultivation is bio-conversion of ligno cellulosic wastes into edible protein. Oyster mushroom is consumed for its taste and medicinal and nutritional properties. It contains proteins, vitamins, and crude fibre and has been recommended to patients with cholesterol related ailments (Wakchaure, 2011).The large amount of agricultural wastes and congenial climatic conditions provide tremendous scope for oyster mushroom cultivation in Karnataka. Though agricultural wastes like paddy straw, maize stalk, etc. are available sufficiently, they are not being utilized properly. They are neither used as fodder nor as other useful material except as fuel.

Oyster mushroom can be grown on various substrates including paddy straw, maize stalks or cobs, vegetable plant residues, bagasse, etc. (Hassan *et. al.,* 2011). Traditionally, the oyster mushroom (*Pleurotus* spp.) is largely grown on paddy and wheat straw which have become costlier because of their several other uses. The above conditions call for a search of alternative materials which should be available in sufficient quality throughout the year at a relatively cheaper price. Keeping this in view, the present investigation was carried out to search out non-conventional agricultural waste for the successful cultivation of oyster mushroom.

Bengaluru city in Karnataka state is known for its cosmopolitan culture. Presence of large number of food outlets across the city has compounded the demand for fruits and vegetables including mushrooms. It is estimated that the demand for mushrooms in Bengaluru city is about 5 tons per day which is being met by supply from adjacent states like Andhra Pradesh and Tamilnadu.

Bengaluru city is surrounded by Bengaluru rural district where agriculture is the major occupation. Annual rainfall is 837 mm and net irrigated area is restricted to 18 per cent of total sown area. The major crops grown are finger millet (38,884 ha) and maize (14,867 ha) under dryland conditions. Finger millet straw is

used as feed for farm animals. When it is unavailable, maize stalk is used as feed for farm animals. Otherwise it is burnt by the farmers resulting in wastage of 50,000 tons of maize stalk every year. Further, Bengaluru rural district also produces 18,184 thousand coconut nuts and 1644 tons of processed arecanut per year. This indicates availability of about 600 tons of arecanut husk and 500 tons of coconut leaf stalk and bunch waste every year.

Paddy straw, though well suitable for mushroom cultivation, it is not available in Bengaluru rural district due to absence of permanent irrigation facilities. High cost of paddy and finger millet straws discourages their use for mushroom cultivation. Hence, this study was initiated to study the suitability of different locally available materials as substrates for oyster mushroom cultivation.

Methodology

An On-farm testing was conducted at Krishi Vigyan Kendra, Bengaluru Rural district during 2016-17 with the objective to assess different local crop wastes as substrate for oyster (*Pleurotus* spp.*)* mushroom cultivation. The spawn of *Hu* variety was obtained from Indian Institute of Horticultural Research (IIHR), Bengaluru. The following substrates of agricultural wastes were used as treatments.

Technological Options

FP : Paddy straw as substrate using local methods

TO_1 : Paddy straw as substrate – IIHR, Bengaluru

TO_2 : Maize stalk as substrate - TNAU, Coimbatore

TO_3 : Arecanut husk as substrate - CPCRI, Kasargod

TO_4 : Coconut leaf stalk and bunch waste) as substrate – CPCRI, Kasargod

Bed preparation and spawning : All these substrates were shade dried and chopped in 5 cm size pieces and thoroughly washed and soaked in fresh water for 24 hours. Then it was pasteurized at 75±5^{0}C for 1 hour. After cooling, transparent polythene bags of 30x15 cm size were filled using 2-3 kg moist substrate as per treatments with five layer spawning @ 70 gm spawn per bag. They were kept in dark and well ventilated room at ambient temperature of 18-20 ^{0}C.

Spawn run : After complete spawn run, the bags were transferred to cropping room. The cropping room temperature was maintained between 22±1 ^{0}C and humidity at 80 per cent. The polythene bags were removed by sterilized sharp blade. After 2 to 3 days of removal of polythene bags, sufficient numbers of pin heads were observed which were allowed to mature for another 2-4 days.

Trails : Four trails were conducted during October - January in 2016-17.

Observations recorded : Data on period of spawn run, days of first and second harvest, yield, labour (manhours) per 100 kg mushroom, production cost per 100 kg mushroom (Rs.), net returns per 100 kg mushroom (Rs.), B:C Ratio and suitability of substrate (%) were recorded.

Biological efficiency : Total weight of the fruiting bodies harvested from all the two pickings were measured as total yield of mushroom. The biological efficiency (yield of mushroom per kg substrate on dry weight basis) was calculated by the following formula (Abena *et al.,* 2015).

$$\text{B.E (per cent)} = \frac{\text{Fresh weight of mushroom}}{\text{Dry weight of substrate}} \text{ X } 100$$

Results and Discussion

Several edible mushrooms have been successfully cultivated at commercial level worldwide using lignocellulose wastes as substrates. Various crop residues have been reported to have been used in producing oyster mushrooms either as main substrates or in combinations with supplements (Ashraf *et. al.,* 2013). The response of the different substrates used shows differences in respect of time taken for formation of pinheads, maturation of fruiting bodies, period between flushes, number of flushes, and yield.

The mycelia spread was recorded on 20 days after inoculation of spawn of the variety *Hu* and the results are presented in Table 1.

TABLE 1

Effect of different substrates on mycelia spread of variety *Hu* on 20 days after spawn inoculation at five layers

Treatment	1st layer (cm)	2nd layer (cm)	3rd layer (cm)	4th layer (cm)	5th layer (cm)	Mean (cm)
FP - Paddy straw using local methods mean (cm)	2.2	2.3	2.3	2.4	2.2	2.28
T1- Paddy straw	3.5	3.6	3.2	3.6	3.0	3.38
T2 - Maize stalk	4.4	4.5	4.4	4.5	4.8	4.52
T3 - Arecanut husk	3.4	3.6	3.2	3.0	3.2	3.28
T4- Coconut leaf stalk and bunch waste	2.6	2.2	2.4	2.3	2.7	2.44

The results revealed that the substrate maize stalk recorded maximum mycelia spread of 4.52 cm followed by paddy straw (3.38 cm) and least growth was recorded in farmers practice (2.28 cm). Maize stalk and paddy straw substrates decompose quicker than arecanut husk and coconut leaf stalk and bunch waste. This might have encouraged better mycelia spread. These results agree with Asefa Keneni and Lakew Wondimu, 2016 who reported that maize stem : cotton seed waste (60:40 and 20:80) showed the fastest mycelial extension followed by (70:30 and 10:90).

The lowest days taken for complete spawn running was 22.5 and 25.5 recorded in maize stalk and paddy straw, respectively and maximum days of 31.0 days in coconut leaf stalk and bunch waste. Further, the substrate maize stalk took 27.0 and 36.0 days for first and second harvest, respectively. All the substrates took 9 to 12 days from first harvest to second harvest (Table 2).

The substrates used in the study exhibited variation in spawn run, days to harvests and yield. The quickest spawn run and duration of first harvest of 22.5 days and 27.0 days was recorded in the maize stalk substrate. Further, the maximum yield of 297 gm per cover was recorded in maize stalk substrate followed by 277 gm per cover of paddy straw (Table 3). These results agree with Demisie Ejigu and Tadesse Kebede, 2015 who quoted that the highest yield of mushrooms

TABLE 2

Effect of different substrates on number of days taken for complete spawn running (days of spawn running) and on number of days taken for first and second harvest

Treatment	Spawn running days	Days for first harvest	Days for second harvest
FP - Paddy straw using local methods	28.0	36.0	48.0
T1 - Paddy straw	25.5	29.5	40.0
T2 - Maize stalk	22.5	27.0	36.0
T3 - Arecanut husk	26.5	30.5	42.5
T4 - Coconut (leaf stalk + bunch waste)	31.0	35.0	45.5

in first flush was obtained in maize stalk (0.71 kg), in second flush was obtained in, Wheat + Teff + Faba bean stalk (0.38 kg) and third flush was obtained in saw dust + faba bean stalk (0.25 kg). Highest biological efficiency of 84.79 percent was observed in maize stalk followed by 55.40 per cent in paddy straw.

Maize stalk as substrate used 36 manhours of labour to produce 100 kg of oyster mushroom and the production cost incurred was Rs. 3,246 per 100 kg. The net returns from maize stalk as substrate was Rs. 6,751 per 100 kg of mushroom and BC ratio was

TABLE 3

Effect of different substrates on yield, biological efficiency, labour requirement net returns and BC ratio of mushroom cultivation

Parameters	FP - Paddy straw using local methods	T1 - Paddy straw	T2 - Maize stalk	T3 - Arecanut husk	T4 - Coconut (leaf stalk+ bunch waste)
Yield (gm/one cover)	146	277	297	210	221
Biological efficiency (%)	29.25	55.40	84.79	42.00	29.47
Labour (manhours) per 100 kg mushroom	59	42	36	41	57
Production cost per 100 kg mushroom (Rs.)	6200	3675	3246	4230	5115
Net Returns per 100 kg mushroom (Rs.)	3,800	6,325	6,751	5,770	4,885
BC Ratio	1.61	2.72	3.09	2.37	1.96
Suitability of substrate (%)	35	52	77	46	36

3.09 which were highest from among all the substrates (Table 3). The performance of maize stalk as substrate was followed by that of paddy straw with the BC ratio of 2.72.

Maize stalks have higher lipid components than cobs and husks (Naraian *et al.,* 2009). The lipids present in the maize stalks might have contributed to the high biological efficiency 44.4 per cent (60.1% for sawdust) which represents the usable and available nutrients in a growing media (Abena *et al.,* 2015). This enabled better release of nutrients required for the mushroom particularly for its spawn run and pin head development. This resulted in better yield in maize stalk and paddy straw substrates and higher biological efficiency which in turn helped to achieve high net returns per 100 kg mushroom and BC Ratio. The highest yield of mushroom grown on maize stalk treated with the hot water and the lowest yield grown on teff straw treated with cold water may be due to the narrow C:N ratio of the maize stalk which provided enough nutrients and could be due to the effective pasteurization of the substrate with hot water in order to protecting unnecessary fungal pathogens that, might have occurred during the growing season of mushrooms (Demisie Ejigu and Tadesse Kebede, 2015).

Pleurotus spp. mushroom was found to utilize paddy straw substrate and it was observed suitable for spawn run, yield and biological efficiency. Highest biological efficiency of 84.79 per cent and 55.40 per cent was observed in maize stalk substrate and paddy straw. The variation in biological efficiency of different substrates might be due to low lignolytic activity of the substrates used.

The commercial production of oyster mushroom is largely determined by the availability and utilization of cheap materials of which, agricultural lingo-cellulosic waste represents the ideal and most promising substrate for cultivation. The maize stalk as substrate performed promisingly compared to other substrates. Its local availability throughout the year, ease in preparation for mushroom cultivation and cost effectiveness can be considered for practical and economically feasible mushroom cultivation. Utilization of maize stalk agro-waste for the production of oyster mushroom would prove to be more economical and ecologically practical.

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