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CULTIVATION OF OYSTER MUSHROOM: A SUSTAINABLE APPROACH OF RURAL DEVELOPMENT IN NEPAL

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ABSTRACT

This study attempts to investigate the easily acceptable and low cost technology of Oyster mushroom cultivation. Locally and easily available substrates such as corn cob, vegetable residue and waste paper were examined with the supplementation of rice bran and chicken manure separately. During the study mycelial growth, spawn run, pin head formation, yield and biological efficiency were observed. Best mycelial extension, early pin head formation and better yield were observed in corn cob substrate followed by paper waste and vegetable residue. Among the substrates used, corn cob showed the highest yield with range from 99.08 to 109.50 % biological efficiency, whereas 69.81 to 88.36 % and 52.26 to 65.22 % biological efficiency was observed in paper waste and vegetable residue respectively. Rice bran was the best supplement for the promotion of growth and development of Oyster mushroom.

Keywords: Low cost technology, Oyster mushroom, Sustainable approach, Biological efficiency

INTRODUCTION

Mushrooms are saprophytic fungi growing on dead organic matters of vegetative origin and can utilize almost all forest and agricultural residues as substrates (Adejoye *et al.* 2006). *Pleurotus* spp, commonly known as Oyster mushroom, are decomposer of wood and vegetable residues (Zadrazil & Kurtzman 1981). In nature, *Pleurotus ostreatus* is active lignin degrader in the forest therefore it appears in cluster on dead trees from late fall to spring. It is distributed all over the world especially in subtropical and temperate forests zone.

The consumption of mushrooms by humans is an age-old practice. However, in recent days mushroom has become a part of every continental dish because of its good taste, flavor and nutritional value. It contains large amount of nutrients, proteins, vitamins, minerals, fiber etc., and hence can be considered as pool of nutrients. The discovery of bio-active compounds, including anti-tumor substances has stirred a growing interest in such mushrooms from industry, the media and the scientific community (Pokhrel *et al.* 2006).

Cultivation of Oyster mushroom with agricultural residues, such as rice and wheat straw is a value added process to convert these materials into human food (Pokhrel *et al.* 2013). It represents one of the most efficient biological ways by which these residues can be recycled (Madan *et*

al. 1987). Mushroom cultivation not only helps to reduce the protein deficiency especially in developing countries like Nepal but also increases income of the rural poor people. The objectives of rural development in developing countries are mainly diversification of rural income and attaining a competitive structure for agriculture in order to increase job opportunities and development (Sharma *et al.* 2013). Mushroom cultivation can be a big source of income through rural development program for farmers if they are made aware its cultivation process and its importance. By taking into consideration of drought and food and nutrition security problems in some countries, mushroom production could be an alternative source to overcome these problems. In addition, livelihood can be improved because the demand of mushroom has been increasing due to increasing population, market expansions and changing of consumer behavior (Celik & Pekker 2009). The raw materials which can be applied for Oyster mushroom cultivation are cheaply available in farmer's yards and easily cultivated in various climatic conditions as a fast maturing crops. Therefore the aim of the study is to evaluate the growth and yield of *P. osteratus* on locally available substrates with supplementation in ambient environmental conditions which can be easily applied by farmers from hinterlands.

MATERIALS AND METHODS

The spawn of *P. osteratus* was obtained from Nepal Agricultural Research Council (NARC) Khumaltar, Nepal. The used strain is commercially supplied by NARC. The preparation of substrate from the raw materials was based on dry weight basis. Corn cob, paper waste (print paper waste) and vegetable residue were the substrate used in this research and mixed with supplement. At first, the paper waste was collected from the premises of Tribhuvan University, Kirtipur, which were dumped during the student's election. Corn cob was brought from Kanchanpur district. Vegetable residue was collected from Kalimati vegetable market. All the substrates were chopped into small pieces and separately supplemented with chicken manure and rice bran at the proportion of 9:1 (w:w) and mixed thoroughly. The substrate without supplement was considered as control. Each of these treatments along with control was replicated five times during the experiment. Those mixtures were then soaked in tap water for about three hours and moisture was adjusted to about 60-65%. One kg of wet substrate was placed into polypropylene bag of dimension 20cm × 15cm and autoclaved at 121°C for one hour and was allowed to cool overnight. Each bag was inoculated with 3 % w/w of grain spawn and the mouth of the bags were closed with cotton plug and tied with rubber band. Inoculated bags were then kept in dark room at the room temperature of 15 – 19°C. After the substrate has been colonized with mycelium the polypropylene bags were cross slashed to allow the mushroom to grow out. These bags were watered (sprayed) twice a day to maintain humidity as well as moisture.

Mycelial growth was observed regularly and growth was recorded on weekly basis. Days to colonization, pinhead and fruit body formation were also recorded. Mushroom yield was recorded by weighing the fresh mushroom. The numbers of mushroom produced were counted. Besides, the weight size and biological efficiency (BE) were also determined. The data were recorded for the first and second flushes. Yield was determined by weighing and counting of fruit bodies. BE was calculated as fresh weight of harvested mushrooms (g) / dry weight of substrate × 100.

The size of mushrooms was calculated by total weight of fresh mushroom harvested/total number of mushroom harvested (Pokhrel *et al.* 2013).

RESULTS

Mycelia extension on different substrates with supplements is shown in Table 1. Corn cob showed the faster mycelium run with rice bran supplement (20.50 cm) followed by chicken manure (19.25 cm) and control (18.40 cm) in four-week incubation. Paper waste supplemented with rice bran showed faster mycelial growth (18.00 cm) during the spawn run followed by chicken manure (17.00 cm) and control (17.00 cm). Vegetable residue supplemented with rice bran showed higher mycelial growth (16.94 cm) followed by chicken manure supplement (15.71 cm) and control (15.53 cm). Among all substrates used, corn cob was the best substrate followed by paper waste and vegetable residue for mycelia extension. Similarly rice bran showed the best supporter of growth.

Table 1. Comparison of weekly mycelial growth of *P. osteratus* on different substrates (Mean ± SD n=5).

Substrates	Supplements	I week (cm)	II week (cm)	III week (cm)	IV week (cm)
Corn cob	Control	4.12±0.3	8.32±0.1	12.60±0.6	18.40±0.2
	Rice bran	4.75±0.5	8.62±1.1	16.00±1.4	20.50±1.5
	Chicken manure	4.27±0.5	8.57±1.1	12.85±2.1	19.25±2.9
Vegetable residue	Control	3.96±0.6	7.14±0.8	11.06±1.3	15.53±1.2
	Rice bran	4.15±0.2	7.08±0.5	11.89±1.3	16.94±1.1
	Chicken manure	4.04±0.5	7.72±0.5	11.31±1.6	15.71±2.2
Paper waste	Control	3.38±0.3	8.00±1.2	12.37±2.2	17.00±0.4
	Rice bran	4.27±0.3	8.34±0.3	12.54±0.3	18.00±0.6
	Chicken manure	3.64±0.5	8.05±0.7	12.54±0.3	17.00±0.4

Days for colonization, primordial formation and first harvest were different in each substrate with supplements. The fastest colonization period (34 days), primordial formation period (37.10 days) and first harvest period (40.20 days) were recorded

from corn cob with rice bran supplement whereas the slowest colonization period (39 days), primordial formation period (44.80 days) and first harvest period (48.70 days) was found in vegetable residue (control) among all treatments (Table 2).

Table 2. Comparison of colonization period, primordial formation and first harvest days of *P. osteratus* on different substrates (Mean ± SD, n= 5).

Substrates	Supplements	Colonization (days)	Primordial formation (days)	First harvest (days)
Corn cob	Control	35.00±0.1	38.00±1.0	41.40±0.6
	Rice bran	34.00±0.3	37.10±0.5	40.20±1.0
	Chicken manure	36.20±1.0	39.20±1.3	43.80±1.0
Paper	Control	36.25±0.8	39.21±0.5	43.00±1.0
	Rice bran	35.80±1.1	38.00±1.5	41.40±2.0
	Chicken manure	36.10±0.7	40.20±0.1	44.20±2.1
Vegetable residue	Control	39.00±1.0	44.80±3.1	48.70±3.0
	Rice bran	37.10±0.4	42.00±2.1	45.30±1.8
	Chicken manure	38.20±1.3	43.40±2.0	47.60±2.8

Two flushes yield were recorded during the experiments. The study showed that different substrate and supplements influenced varying yields. Total yield, BE and mushroom size are presented in Table 3. The total yield in corn cob with rice bran (602.50g) was highest followed by chicken manure (545g) and control (506g) respectively. Following the corn cob second highest yield was recorded from paper waste with rice bran supplement (486g), with chicken manure supplement (430g) and control (385g). The total yield was recorded in vegetable residue with rice bran supplement (358.70g) and chicken manure supplement (303.75g) and control (287.50g).

Among three different substrates best yield was recorded from corn cob followed by paper waste and vegetable residue, where as rice bran was the best supplement which is consistent in all substrates used in the experiment. The biological efficiencies ranged from 91.99 to 109.50 % in corn cob, similarly 69.81 to 88.36 % in paper waste and 52.26 to 65.22 % in vegetable residue. In comparison to second flushes, yield was higher in the first flush in all substrates. The larger size of mushroom was recorded from vegetable residue with control (10.31g) whereas smaller size was found in paper waste with chicken manure supplement (6.08 g) among all the treatments.

Table 3. First and second flush of *P. osteratus* on different substrates (Mean ± SD, n= 5)

Substrates and Supplement	First flush (g)	Second flush (g)	Total Yield (g)	Biological efficiency (%)	Mushroom size (g)	
Corn cob	Control	316.00±18.2	190.00±7.90	506.00±13.9	91.99±2.5	8.15±0.7
	Rice bran	352.50±11.9	250.00±15.81	602.50±23.2	109.50±4.2	8.05±0.2
	Chicken manure	339.00±16.7	206.00±5.5	545.00±18.17	99.08±3.4	8.91±0.4
Paper waste	Control	234.00±8.9	151.00±12.7	385.00±18.5	69.81±3.4	6.35±0.2
	Rice bran	289.00±7.4	190.70±10.4	486.00±14.7	88.36±2.7	8.23±0.8
	Chicken manure	243.00±7.6	177.00±12.5	430.00±19.1	76.35±3.5	6.08±0.2
Vegetable Residue	Control	186.25±9.5	101.25±8.5	287.50±6.5	52.26±1.2	10.31±0.6
	Rice bran	197.50±14.4	161.25±21.0	358.70±534.2	65.22±6.2	10.09±0.6
	Chicken manure	190.00±14.7	113.75±9.5	303.75±22.9	55.22±4.2	10.13±0.6

DISCUSSION

Growing Oyster mushrooms are becoming more popular throughout the world because of their abilities to grow at a wide range of temperature utilizing various lingo-cellulose materials (Pidgeon & Anderson 1981, Mueller & Gawley 1983). The capacity of *Pleurotus* species to grow on agricultural residue is due to their ligninolytic enzymes and other adaptive enzymes which are generally necessary for completion of fungal life cycle (Martinez *et al.* 1994, Jennings & Lysek 1999). Mycelial growth is a fundamental step that creates suitable internal conditions for mushroom cultivation. Thus, excellent growth of mycelium is a very important factor in mushroom cultivation (Pokhrel *et al.* 2009). Fastest mycelial extension, early pin head formation and better yield were observed in corn cob substrate followed by paper waste and vegetable residue respectively. In all substrates, mycelial growth was highly influenced by rice bran supplement compared to chicken manure, whereas poor growth was observed in control. This study revealed that addition of supplements not only enhance the growth and development of mycelia or spawn running but also enhance pin head development, fruit body formation and mushroom yield. Das and Mukherjee (2007) analyzed that organic supplements such as rice bran mixed with *Leonotis* species as substrate increased not only growth parameter but also increased the yield of mushroom of *P. ostreatus*. Baysal *et al.* (2003), reported spawn running, pin head formation and fruit body development and mushroom yield of Oyster mushroom on waste paper substrate with chicken manure and rice bran. In this study fast mycelial growth and better yield may be due to the high quality nutritional value in combination of both substrate as a corn cob and rice bran as a supplement and followed by paper wastes and vegetable residue with rice bran. In addition to that, higher levels of water soluble sugars in corn cob, particularly hemicelluloses could induce higher growth, prior to the breakdown of lignin and cellulose. In return, the highly colonized substrate had high mycelial density. This result is supported by the result of Philippoussis *et al.* (2006). They found that the mycelia growth and yield of *Lentinula edodes* were high in different substrates with different supplements. Zhang *et al.* (2002) studied *Pleurotus sajor-caju* mushroom cultivation in two substrates, rice straw and wheat straw in the two forms of grinding and chopping and he observed that ground rice straw yielded higher

mushroom growth rate than the chopped straw. This is because it ruptured the cell wall of the straw to a greater degree, potentially making the nutrients in the straw more accessible for mushroom growth. Similar result was obtained in our study because the ground forms of corn cob substrate showed fast mycelial growth, primordial formation, fruiting bodies formation and highest yield of mushroom. In the present result, the fruiting bodies appeared 3-5 weeks after primordial formation and took 34-46 days after inoculation of spawn. These findings are in conformity with those of Tan (1981), who reported that *P. ostreatus* and other species on cotton waste took 2-3 weeks for fruit body formation after the colonization of substrate.

CONCLUSIONS

Mushrooms are very rich source of protein and hence could be more effective in decreasing protein deficiency as well as malnutrition problem in rural areas of Nepal. Besides, strengthening mushroom production across the country could be the best alternative agriculture business and employment opportunities in the rural areas, and best way of income generation for disadvantageous groups and small family farms. The study revealed that corn cob substrate with rice bran supplement showed the superior mycelia growth, faster spawn run and better yield among all the treatments including control. Corn cob supplemented with rice bran could be alternate substrate for the cultivation of *P. ostreatus*. Rice bran can be used as the best supplement for the cultivation of Oyster mushroom.

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