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RESEARCH ARTICLE

Evaluation of different casing materials formulation on yield related parameters of *Calocybe indica*

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ABSTRACT

Casing soil formulations were prepared from farm yard manure, garden soil and sand with different combinations which were chemically sterilised and used for casing the mushroom bags of *Calocybe indica*. In the present study, out of various casing material combinations FYM: Garden soil :Sand (2:1:1) having pH (8) and 3 cm width were found suitable and showed best result in yield as well as biological efficiency.

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INTRODUCTION

Calocybe indica, a tropical edible mushroom, belongs to the family Tricholomataceae of the order Agaricales (Purkayastha and Chandra, 1976). It is becoming more popular, due to its robust size, attractive colour, sustainable yield, delicious taste, and unique texture (Amin *et al.,* 2010). *Calocybe indica* is rich in protein, lipids, mineral, fibre, carbohydrate, and is abundant with essential amino acids (Alam *et al.,* 2008; Mallavadhani *et al.,* 2006). It is an excellent source of thiamine, riboflavin, nicotinic acid, pyridoxine, biotin, and ascorbic acid (Breene, 1990). India has good environmental conditions for the commercial cultivation of *Calocybe indica*. This mushroom requires a temperature of 30~35°C and a relative humidity of 70~80% for cultivation, which is congenial to the environmental conditions in our country. A wide range of diverse cellulosic substrates are used for cultivating mushrooms. The production of *Calocybe indica* depends on top dressing after the substrate has been fully colonised with mycelium. After complete mycelial formation casing is done to provide a reservoir of water for the developing fruiting body. Different materials are used in the shape of casing throughout the world, but in India afew casing substances have been developed and suggested for use. Mantel (1973) recommended the use of compost with slaked lime and sand(4:1:1). Later Hayes and Shandilya (1977) and Shandilya and Agarwal (1983) recommended farm yard manure and loam soil (1:1 v/v) as a standard casing material for mushroom cultivation. Garcha (1993) suggested farm yard manure and two yrs. old compost (1:1) as a good casing material under north Indian conditions. Beside physical, chemical and biological factors of the suitable casing material, cost and availability are more important factors in successful application and acceptance by the mushroom growers. The aim of the present study is to evaluate some more casing mixtures for the cultivation of *Calocybe indica* growers.

MATERIAL AND METHODS

The substrate (wheat straw) was chopped 3-4 cm, soaked

in water tank (clean water) for 15-18 hours and allowed to imbibe water. After soaking period was over, the excess water in the substrate was drained. Substrates were pre-treated by using chemical sterilized solution of carbendazim 50 per cent (75 ppm), formalin (500 ppm) and Nuvan (65 ppm) for 14 hours (Krishnamurthy 2004). The excess water present in the chemically pasteurized straw substrate was dried out to attain the approximately moisture content of 70 per cent. The sterilized substrates were mixed with mushroom spawn in high density polythene bags (45 cm x 60 cm) with layer spawning was followed as per standard procedure Pandey and Tewari (1993). In each bag 3 kg wetted wheat straw (1 kg dry weight) was filled.

The casing material / soil mixture in was chemically sterilized by drenching with 2 per cent formalin solution two weeks before using exposing the casing soil for escape of the excessive formalin in to the atmosphere. The pH of the medium was adjusted from 7.0 to 8.5. For determination of pH, 10 g of casing samples were collected on the day of casing from casing material used, 100 ml of distilled water was added in every sample and shaken well.The suspensions were kept for one hour at room temperatures and pH of the sample was measured using electronic digital pH meter (Electronic Instrument Limited). Then it was added over the mycelial impregnated substrate from 1 cm to 4 cm thickness. Un-supplemented control bags were kept for control. The mouth part of the bag was covered with either formalin treated or autoclaved newspaper to prevent the insect and weed moulds. After casing, the filled bags were shifted to cropping room where temperature of 25-32^{0}C and relative humidity of 85-90 per cent was maintained. During fruiting, 3-4 fresh air circulations were given into the cropping room. Light watering was done twice a day and ruffling of the casing soil surface was done intermittently for good aeration. Each treatment was replicated four times. Matured fruiting bodies were harvested and observations regarding the number and average fruit body weight were recorded. Biological efficiency was calculated as a ratio between the fresh weight of harvested mushrooms and the dry weight of substrate per bag and was expressed in per cent. Data pertaining to yield were analyzed statistically in completely randomized block design.

RESULTS AND DISCUSSION

The effect of different casing soil formulations on yield and yield related parameters of *Calocybe indica* is presented in Table 1. Perusal of data indicate that in the casing treatments where FYM : garden soil : sand were used in 2:1:1 and 3:2:1 ratio gave early case run (18 and 20.5 days), which were significantly superior to FYM : garden soil (2:1:0) and 3:1:0 ratio where case run took place in (21.5 days). All the casing treatments initiated the pinhead uniformly in 6-7 days. The data related to mushroom yield indicated that treatments FYM: garden soil: sand was significant over FYM: garden soil alone. Study showed that FYM: garden soil :sand gave better results registered mushroom yield of 730 g and 717 g/ kg of dry straw as compared to FYM : garden soil 3:1:0 and 2:1:0 where mushroom yield of 580 g and 545 g was harvested. As regards average fruit body weight, there seems to be positive results between FYM: garden soil with sand. FYM: garden soil: sand (2:1:1) gave heavy fruit weight of (61.3 g) followed by (59.15g) in (3:1:1) over the FYM: garden soil alone 2:1 (54.5 g) and 3:1 (51 g). Early case run, pining, first harvest and better yield of *Calocybe indica* was shown in the combine casing soil mixture of FYM: garden soil: sand, which may be due to the presence of rich microbial flora in the FYM, pore space of the soil and water holding capacity due to presence of sand that may help in the formation of large sporophore thus increasing the productivity of mushroom. The important role of such microflora has been reported by Hayes and Shandilya (1977). The present findings is also supported by Raina *et al.* (2002), who evaluated the fourteen combinations of two year old FYM, three year old spent compost, garden soil and sand as casing material for *Agaricus bisporus* cultivation. They reported higher yield with the combination of FYM + garden soil + soil (4:2:1) followed by FYM + sand (3:1) and lower yield in garden soil alone. Delayed case run, pinning and first harvest recorded with the FYM: garden soil alone could well be attributed to the poor porosity low aeration in the casing soil as it contained more percentage of clay. Flegg (1953) also observed the similar findings.

Table 1 : Effect of soil casing material formulations on yield and yield related parameters of milky mushroom

Treatments ratio	Case run (Days)	Pinhead formation (DAS)	Mushroom yield ` (g/bag)	Avg. fruit weight (g)
3:02:01	20.50	26.5	717	59.15
2:01:01	18	26.5	730	61.3
3:01:00	21.50	27.5	580	51
2:01:00	21.50	28.6	545	54.5
CD	0.98	1.17	8.46	6.57
SE(m)	0.32	0.38	2.72	1.98

FYM: Garden Soil : Sand

Data regarding the effect of casing soil pH on case run, pinhead formation, total mushroom yield and average fruit body weight have been depicted in Table 2. The data revealed that with the increase in pH range from neutral (7.0) towards alkaline (8.5), there was corresponding decrease in case run period and thereafter it showed an increasing trend. The early case run in 15.5 days was observed at pH 8.0 which was 4 days earlier as compared to the treatment where casing soil pH was adjusted at 7.0. The effect of casing soil pH range seems to be naturalistic on pinhead initiation which was uniform at 4 days at pH 7.0, 7.5, 8.0 and 8.5, but the minimum 19.5 days pH (8.0) to pinhead initiation were observed. Krishnamoorthy (2004), suggested using steamed garden soil (clay loam with pH around 8.0) as a casing material for *Calocybe indica*. However, the data on total mushroom yield showed a perceptible increase in mushroom yield with increase in pH up to 8.0. Maximum mushroom yield of 617.5g per kg dry straw was recorded at pH 8.0 followed by 590 g per kg dry straw at pH 7.5 and the lowest mushroom yield of 345 g per kg dry straw was recorded with pH 7.0. The results showed that pH more than 8.0 decreased the yield of mushroom. The lowest fruit body number (13.5) was observed at pH 7.0 which gradually increased to 15.5 with increase in casing pH on 7.5 to 8.5. However the maximum fruit body number (17.1) was observed at pH 8.0. Lambert and Humfeld (1939) and Park *et al.* (1971) have reported that higher mushroom yield seems to be associated with more number of fruiting bodies and higher average fruit body weight which ranged between 44.5g to 47.5g as against 39.0g in control. These observation have been supported by Tewari *et al.* (2003), who recommended optimum casing soil pH in the range of 7.8 – 7.9 for better fruiting in *Calocybe indica*.

The effect of depth of casing soil on yield and related parameters of *Calocybe indica* have been reflected in Table 3, where the data indicate that with the increase in casing soil depth, there was corresponding delay in the case run period. Early case run was 11.5 days observed in 1 cm casing depth which gradually increased to 12.5,16.5 and 18.0 days with increasing casing depth at 2,3 and 4 cm, respectively. However, pinhead formation occurred in 2-4 days after complete case run in all the treatments. In case of mushroom yield data, the trend was reverse and maximum mushroom yield of 430 g was observed at casing depth of 3 cm which decreased to 265 g/kg dry straw with decrease in casing soil depth to 1 cm. From Table 3, it was evident that higher yield seems to be associated with more number of fruit bodies harvested and higher average fruit body weight. The average fruit body weight also showed a resembling trend. In case of casing soil depth at 1cm, it was 12.5 g which rose to 47.5 g at casing depth of 3 cm and then decreased to 42.5 g at 4 cm casing soil depth. But contrary to present observations, Krishnamurthy and Muthuswamy (1997) got maximum biological efficiency (100-142g) at 2 cm depth. Sharma *et al.* (1997) while evaluating the various casing materials at different thickness reported biogas spent slurry and two year old cow dung at a thickness of 2.5 cm as best casing material for *Calocybe indica* giving biological efficiency of 100 and 98.70 per cent, respectively. In the present investigation, the fruit bodies were heavy and robust with long and stout stripe when depth of casing soil was adjusted on 3 cm, which resembled to the findings given by Sharma *et al.* (1997).

Table 2 : Effect of soil pH on yield and yield related parameters of milky mushroom

Treatments soil (pH)	Case run (Days)	Pinhead formation (DAS)	Mushroom yield ` (gm/bag)	Avg. fruit weight (g)
7.0	19.5	23.4	345.0	39.0
7.5	17.5	21.5	590.0	46.5
8.0	15.5	19.5	617.5	47.5
8.5	16.6	20.5	552.5	44.5
CD	3.2	3.1	34.08	2.7
SE(m)	1.0	1.0	10.29	0.9

Table 3 : Effect of casing depth on yield and yield related parameters of milky mushroom

Treatments depth(cm)	Case run (Days)	Pinhead formation (DAS)	Mushroom yield ` (gm/bag)	Avg. fruit weight (g)
1.	11.5	13.5	265	12.5
2.	12.5	16.0	315	27.5
3.	16.5	20.5	430	47.5
4.	18.0	21.5	415	42.5
CD	4.84	5.97	18.29	6.62
SE(m)	1.35	2.51	5.23	2.00

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