Environment and Ecology 36 (3) : 788—793, July—September 2018
Website: environmentandecology.com ISSN 0970-0420

Effect of Single or Combined Substrates or Substrates Enriched with Vermicompost on Growth Parameters and Yield of *Calocybe indica*

N. Kudada, N. Kumari, A. Saurabh

Received 3 March 2018; Accepted 6 April 2018; Published on 21 April 2018

Abstract An experiment was conducted to know the effect of single or combined substrates or substrates enriched with vermicompost on growth parameter and yield of *Calocybe indica*. The treatments viz., Wheat straw (WS) only, Paddy straw (PS) only, 75% WS + 25% Vermicompost (VC), 50% WS + 50% VC, 75% PS + 25% VC, 50% PS + 50% VC and 25% WS + 25% PS + 50% VC were included. Minimum spawn run days (19.00 days), pinhead initiation after casing (5.33 days), days for first harvest (5 days), maximum number of pinhead/bed (24.33), number of sporophore/bed (16.00), yield/bed (1696.48 g) and maximum biological efficiency (113.09%) were recorded by the treatment T_4 containing 50% WS + 50% VC. Lowest yield and biological efficiency was observed in the treatment T_2 containg paddy straw only with 1297.83 g and 86.52%, respectively.

Keywords *Calocybe indica*, Substrates, Vermicompost, Yield, Biological efficiency.

N. Kudada*, N. Kumari, A. Saurabh
Department of Plant Pathology,
Birsa Agricultural University,
Ranchi 834006, Jharkhand, India
e-mail : narendra.kudada2701@gmail.com
*Corresponding author

Introduction

Speciality mushroom is a term given to a group of mushrooms, which are common in a particular area or country. Along with some mushroom genera (*Pleurotus* sp. *Volvariella, Lentinus, Auricularia*) *Calocybe indica* also comes under speciality mushrooms. Milky mushroom (*Calocybe indica*) has become the third commercially grown in India after button and oyster mushrooms. This is a tropical mushroom which is a seven months crop from March—September. This mushroom is gaining popularity due to its attractive robust, white sporocarps long shelf life and taste. Presently button and oyster mushrooms are commercially cultivated in tropical and subtropical regions of India. The oyster mushrooms can be easily grown under natural condition whereas button mushrooms require controlled conditions. Huge inputs are required to provide ideal condition for button mushrooms.

Therefore, button mushroom cultivation is beyond the reach of ordinary farmers. The milky mush-

Table 1. Effect of substrates single or substrates enriched with vermicompost on yield of *Calocybe indica*.

Treatments	Average spawn run days	Average pinhead initiation (days) after casing	Average days for first harvest	Average No. of pinhead/bed	Average No. of sporophore/ bed	Average yield/bed (g)	Biological efficiency (%)
T_1-Wheat straw (WS) only	21.00	6.66	6.33	17.67	13.66	1312.99	87.53
T_2-Paddy straw (PS) only	21.33	7.00	6.66	18.00	13.66	1297.83	86.52
T_3-75% WS+25% VC (vermicompost)	20.33	5.66	6.00	20.00	14.66	1492.68	99.51
T_4-50% WS+50% VC	19.00	5.33	5.00	24.33	16.00	1696.48	113.09
T_5-75% PS+25% VC	20.66	6.33	6.00	19.66	14.66	1479.48	98.63
T_6-50% PS+50% VC	20.33	5.66	5.33	22.00	15.33	1576.84	105.12
T_7-25% WS+25% PS+50% VC	20.66	6.00	5.66	21.67	14.33	1461.94	97.46
SEm ±	0.33	0.31	0.25	0.21	0.21	30.75	
CD at 5%	1.02	0.87	0.77	0.66	0.62	94.20	
CV%	2.84	4.84	4.45	3.59	3.88	5.58	

room requires 25–35°C temperature. This mushroom has an immense potential in production in the plain region of India due to its better temperature tolerance (30–35°C). Due to variation in temperature, button mushroom cannot be cultivated throughout the year. The white milky mushroom (*Calocybe indica*) can tolerate temperature upto 35°C and can be exploited during lean period. *Calocybe indica* is the third important commercially grown mushroom in India after button and oyster mushroom. It is normally grown on humus and at high temperature on summer season. Milky mushroom can be cultivated on varieties of Celluloxic substrates like paddy straw, wheat straw alone or in combination of vermico mpost. Vermicompost improves soil structure, increases water infiltration, retention and availability to plants helps the microbial mineralization and enhances availability of major nutrients, micronutrients and also contains enzymes, vitamins, antibiotics and growth hormones. In view of the importance of mushroom cultivation, the present study was carried out to know the effect of substrates alone or enriched with vermicompost on time taken for spawn run, pinhead initiation, growth and yield of *Calocybe indica*.

Materials and Methods

The trial was conducted at mushroom production unit room in Department of Plant Pathology, Faculty of Agriculture, Birsa Agricultural University, Ranchi, Jharkhand. The experiment was conducted in the month of Au gust to September, 2012 and the temperature and relative humidity of the cropping room ranged from 30–35°C and 80–85%, respectively. 18 to 20 days old spawn raised on wheat grain through standard technique were used during experimentation. The experiment was laid out in completely randomized design (CRD) with seven treatments viz., T_1-Wheat straw (WS) only, T_2-Paddy straw (PS) only, T_3-75% wheat straw + 25% vermicompost (VC), T_4-50% wheat straw + 50% vermicompost, T_5-75% paddy straw + 25% vermicompost, T_6-50% paddy straw + 50% vermicompost, T_7-25% wheat straw + 25% paddy straw + 50% vermicompost. These treatments were replicated three times. Wheat straw and paddy straw were used as substrates. Milky mushroom cultivation using chopped paddy straw substrates in polypropylene bags (60 cm × 40 cm of 100 gauges) (Pani 2012) with layer spawning was followed. The bottom of the bag was tied with a rubber band to make a cylindrical shape to the bed. Then the bag is sterilized with spirit dipped cotton by swapping and then the bag was turned over so that the tied portion comes inside. Bottom of the bag was slightly widened. The bag was filled with alternate layers of straw (1.5 kg sterilized dry straw per bag) and spawn (300 g/kg of dry straw). Press it with palm to let the air go out. The bag was then tied with a rubber band along with a label of the species and date of spawning. About 10–15 holes were made into the polythene bags for the exchange of air and gases. Spawned bag was stacked in racks which were arranged in spawn running room. During

Table 2. Yield performance of *Calocybe indica* on substrates enriched with varmicompost.

Treatments	Average length of stipe (cm)	Average diameter of stipe (cm)	Average diameter of pileus (cm)	Average weight of sporophore (g)
T_1-Wheat straw only	13.32	6.50	10.35	96.12
T_2-Paddy straw only	12.86	6.47	10.32	95.01
T_3-75% WS+25% VC	13.98	7.80	11.50	101.82
T_4-50% WS+50% VC	15.88	8.54	12.58	106.03
T_5-75% PS+25% VC	13.86	7.68	11.38	100.92
T_6-50% PS+50% VC	14.87	8.10	11.80	102.86
T_7-25% WS+25% PS+ 50% VC	13.68	7.55	11.20	102.02
SEm ±	0.28	0.27	0.23	1.03
CD at 5%	0.83	0.82	0.70	3.13
CV%	3.87	3.90	3.58	4.78

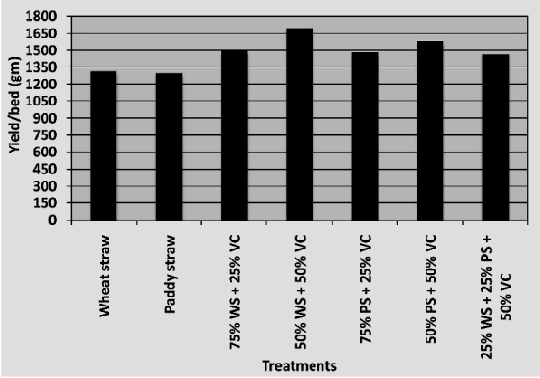


Fig. 1. Effect of substrates enriched with vermicompost on yield of *Calocybe indica*.

spawn running period, temperature of 26 ± 4°C was maintained. These partially controlled conditions were maintained for 20 to 25 days for complete spawn running period when whitish cottony mycelia growth completely covered the straw in polythene bags. The polythene bags were cut into two halves with a hacksaw blade.

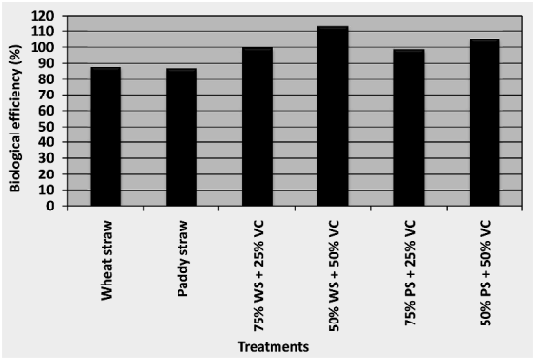
Ten days after spawning, casing mixture were prepared in the ratio of 1:1 by using Garden soil (pH 5.3) and two years old farmyard manure (FYM, pH 6.45). The casing mixtures was chemically sterilized by spraying with 2% formalin and then covered with polythene sheet for 3 days. The media were turned on alternate days for 4 days to remove the fumes of formalin from the casing mixture. Beds were kept on racks in cropping room for fruiting after casing. During this period the temperature and humidity for fruiting were maintained 30–35°C and 80—85%, respectively. Ventilation was reduced after casing of beds. Watering was done two times a day by a hand sprayer and it was with held a day before harvesting. Observations regarding time taken (days) for spawn run, pin head initiation after casing, first picking, days for number of pinhead/bed, number of sporophore, biological efficiency and yield were recorded. Fully matured sporophores of white milky mushroom were harvested from each bed and fresh weight was determined immediately and recorded the length and diameter of stipe, and pileus and weight of sporophore. Biological efficiency of mushroom was calculated by using the following :

$$\text{Per cent biological efficiency} = \frac{\text{Fresh weight of mushroom (g)}}{\text{Dry weight of substrate (g)}} \times 100$$

Statistical analysis of data was done by using appropriate program. In order to compare the effect of different casing thickness simple completely randomize design (CRD) was used. Critical difference (CD) calculated at 5% level of significance were used for comparison of difference between the treatment means.

Results and Discussion

Vermicompost at different concentrations were used on two substrates namely wheat straw and paddy straw in the experiment. Effect of substrates enriched with vermicompost on yield and biological efficiency of *Calocybe indica* are re-presented by Figure 1 and 2, respectively. The result indicated that the time taken (days) for spawn run in different treatments ranged from 19 days to 21.33 days. Minimum period was recorded for colonization in T_4 (50% wheat straw + 50% vermicompost) with 19 days which found to be significantly superior to other treatments. This was



\

Fig. 2. Effect of substrates enriched with vermicompost on biological efficiency of *Calocybe indica*.

followed by T_3(75% wheat straw + 25% vermicompost) (20.33 days) and T_6 (50% paddy straw + 50% vemicompost). Maximum period (21.33 days) was record for complete colonization in T_2 (paddy straw only). These findings are similar to the results reported by Garcia et al. (2005) who observed that on coir pith it took about 13 to 20 days for spawn run. The early pinhead initiation and days for first harvest were observed in treatment 50% wheat straw + 50% vermicompost followed by 50% paddy straw + 50% vermicompost.

The time taken (days) for pinhead initiation in different treatments ranged from 5.33 days to 7 days Table 1. Shortest period (5.33 days) was observed in T_4 (50% wheat straw + 50% vermicompost) which was found statistically at par with T_3 (75% wheat straw + 25% vermicompost), T_6 (50% paddy straw + 50% vermicompost) and T_7 (25% wheat straw + 25% paddy straw + 50% vermicompost). Longest period (7 days) was observed in T_2 (paddy straw only). The present results are in agreement with Garcia et al. (2005) who reported that the days for pinhead initiation and days for first harvest together ranged between 10 to 15 days. Minimum number of sporophore, yield and biological efficiency were observed in treatment 50% vermicompost + 50% wheat straw. The days for first harvest from the day of pinhead formed was noted. It was observed between 5 days to 6.66 days for different treatments. Shortest period (5 days) was observed in T_4 (50% wheat straw + 50% vermicompost) which was found statistically at par with T_6 (50% paddy straw + 50% vermicompost) and T_7 (25% wheat straw + 25% paddy straw + 50% vermicompost). Longest period (6.66 days) was observed in T_2 (paddy straw only) and 6.33 days in T_1 (wheat straw only).

Maximum number of pinhead (24.33) per bed was observed in T_4 (50% wheat straw + 50% vermicompost) which was found to be significantly superior to other treatments. Minimum number of pinhead (17.67) per bed was observed in T_2 (paddy straw only) followed by 17.67 in T_1 (wheat straw only). The total number of sporophores per bed harvested in different treatments ranged from 13.66 to 16.00. Maximum number of sporophores (16.00) per bed was harvested in T_4 (50% wheat straw + 50% vermicompost) which were found to be significantly superior to other treatments. This was followed by T_6 (50% paddy straw +

Table 3. Cost of cultivation of the production of per bed fresh mushroom of *Calocybe indica* using different concentration of vermicompost enrichment in substance. Paddy straw (chopped) @ Rs 6/kg; Wheat straw (chopped) @ Rs 2/kg; Vermicompost @ Rs 8/kg. Spawn @ Rs 10.50/bag (300 g wheat grain based spawn); Polythene bag @ Rs 2/bag; Miscellaneous charges @ Rs 3/ bag; Mushroom selling price @ Rs 100/kg fresh mushroom.

Treatments	Total inputs (Rs)	Yield/bed (g)	Gross income (Rs)	Net benefit (Rs)	Net benefit cost ratio (Rs)
T_1-Wheat straw (WS) only	37.55	1313.33	131.33	93.78	2.49
T_2-Paddy straw (PS) only	39.05	1298.33	129.83	90.78	2.32
T_3-75% WS + 25% VC (vermicompost)	31.50	1516.00	151.60	120.10	3.81
T_4-50% WS + 50% VC	47.55	1763.00	176.30	128.75	2.70
T_5-75% PS + 25% VC	51.05	1488.33	148.83	97.78	1.91
T_6-50% PS + 50% VC	52.55	1676.35	167.63	115.08	2.18
T_7-25% WS + 25% PS + 50% VC	49.55	1583.00	158.30	108.75	2.19

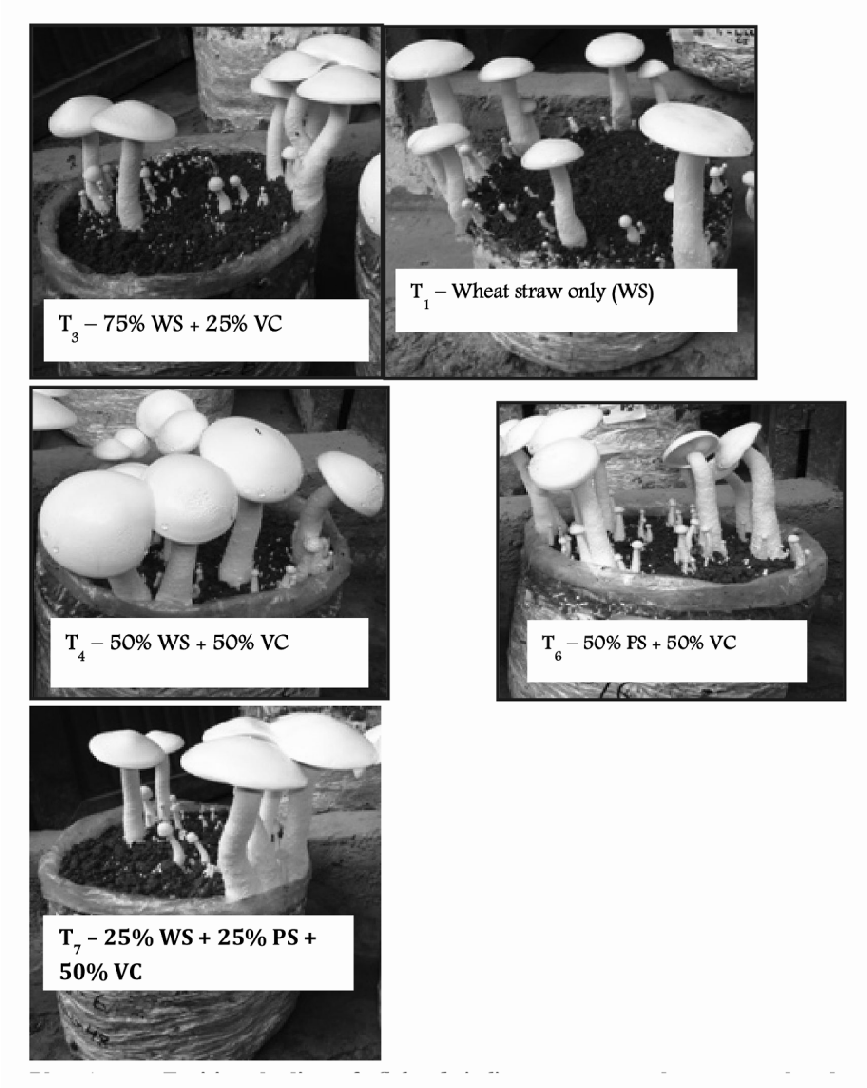


Fig. 3. Fruiting bodies of *Calocybe indica* grown on substrates and substrates enriched with vermicompost.

50% vermicompost) with 15.33 and in T_3 (75% wheat straw + 25% vermicompost) with 14.66 and T_5 (75%paddy straw + 25% vermicompost) with 14.66 number of sporophores per bed. The yield per bed in different treatments varied from 1297.83 g to 1696.48 g. Maximum yield (1696.48 g) per bed was recorded in T_4 (50% wheat straw + 50% vermicompost) which was found to be significantly superior to other treatments. This was followed by T_6 (50% paddy straw + 50% vermicompost) with 1576.84 g and T_3 (75% paddy straw + 25% vermicompost) with 1492.68 g. The lowest yield was observed in T_2 (Paddy straw only) with 1297.83 g. These results are in agreement with the earlier workers. Yadav (2006) have reported that there were better yields when vermicompost was included in substrates formulation in cultivation of *Agricus bisporus*. Salam et al. (2004) showed a positive impact with enhanced growth and yield of *Pleurotus* spp. analyzed that the vermicompost and vermiwash in substrates and casing enriched the growth and

yield of milky mushroom.Salam et al. (2004) also obtained 368.00 g of yield and biological efficiency 147.20% on wheat straw. Maximum biological efficiency was observed in T_4 (50% wheat straw + 50% vermicompost) with 113.09% followed by T_6 (50% paddy straw + 50% vermicompost) with 105.12% and T_3 (75% wheat straw + 25% vermicompost) with 99.51%. Minimum biological efficiency (86.52%) was recorded in T_2 (paddy straw only). Vermicompost is rich in nutrients and growth regulators. It is known to increase yield. Garcia et al. (2005) obtained 285.00 g of yield on coir pith and on coconut leaf stalk biological efficiency of 62.72% was observed in *Pleurotus* by Bhawna and Thomas (2003).

The results presented in Table 2, Figure 3 revealed that the length of stipe (15.88 cm), diameter of stipe (8.54 cm) and diameter of pileus (12.58 cm) were observed maximum in T_4 (50% wheat straw + 50% vermicompost) which was found to be significantly superior to other treatments. The maximum diameter of stipe (8.54 cm) was recorded in T_4 (50% wheat straw + 50% vermicompost) which was found statistically at par with T_6 (50% paddy straw + 50% vermicompost) (8.10 cm) and T_3 (75% wheat straw + 25% vermicompost) (7.80 cm). Weight of sporophore was highest in T_4 (50% wheat straw + 50% vermicompost) with 106.03 gand lowest in T_2 (paddy straw only) with 95.01 g. Vermicompost being nutrient rich also contain growth regulators and hormones which could be the reason for increased size and weight of the sporophore (Jarial and Shandilya 2005). The economics of different substrates enriched with vermicompost at different concentration and data so obtained are presented in Table 3. The results showed that 75% wheat straw + 25% vermicompost gave highest net benefit-cost ratio of 3.81 followed by 50% wheat straw + 50% vermicompost with 2.70. Least net benefit-cost ratio (1.91) was obtained in 75% paddy straw + 25% vermicompost. In the treatments involving vermicompost, spawn run period was reduced. This may be because of larger surface area provided by vermicompost for early colonization. Maximum size (length of stipe and diameter of pileus) and weight of sporophores were observed in treatment 50% wheat straw + 50% vermicompost. This result indicated that the size and weight of the sporophores was increased in treatments containing 50% of vermicompost. Vermicompost was used for substrate enrichment at different concentration with paddy straw and wheat straw. Treatment containing 50% wheat straw + 50% vermicompost gave early spawn run, maximum number of sporophores, size (length of stipe and diameter of pileus) and weight of sporophores, yield and biological efficiency as compared to other treatments. The yield and other yield attributes were found minimum in treatment wheat straw only and paddy straw only. 75% wheat straw + 25% vermicompost gave highest net benefit-cost ratio of 3.73 followed by 50% wheat straw + 50% vermicompost with 2.56. Least net benefit-cost ratio (1.89) was obtained in 75% paddy straw + 25% vermicompost. From the present study, it can be concluded that 50% wheat straw plus 50% vermicompost can be used as best enriched substrates to get a good yield of *C. indica* the study proved that 50% wheat straw plus 50% vermicompost took minimum days for spawn run, pinhead formation after casing, for first harvest 5.0 days with highest number of sporophore (16.00), length of stipe (15.88 cm), highest diameter of stipe (8.54 cm), diameter of pileus (12.58 cm), highest weight of sporophore (106.03 g) maximum yield (1696.48 g) and highest biological efficiency (113.09%) as compare to other substrates.

References

Bhawna AK, Thomas VG (2003) Biological efficiency of different *Pleurotus* species on the leaf stalk biomass from coconut palm. Mushroom Res 12 (2) : 97—100.

Garcia BS, Royse DJ, Sanchez JE (2005) Vermicompost in substrate and casing formulae for the production of brown *Agaricus bisporus*. http:esanchez@tap.ecosur.edu.mx.

Jarial Rs, Shandilya TR (2005) Mushroom yield and quality characteristics as influence by various casing meterials in *Agaricus bisporus*. Mushroom Res 14 (2) : 64—67.

Pani BK (2012) Sporophore production of milky mushroom (*Calocybe indica*) as influence by depth and time of casing. Int J Adv Biol Res 2 (1) : 168—170.

Salam AS, Geetha D, Suharban M, Nair KH (2004) Coir pith a non-conventional substrate for *Calocybe indica* (milky mushroom) production. Mushroom Res 13(2) : 60—64.

Yadav RS (2006) Use of vermiproducts in the cultivation of milky mushroom (*Calocybe indica*). MSc (Ag.) thesis. UAS, Dharward.