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# Evaluation of different substrates and casing materials on the growth and yield of *Calocybe indica* for its cultivation in Kashmir

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*Calocybe indica* is one of the best edible mushroom, which can be grown at high temperature or summer season. It is popular because it has good nutritive value and can be cultivated in a shorter time period than of Button mushroom. The current investigation was undertaken to evaluate locally available agro-wastes for cultivation of milky mushroom. Different agro-wastes (paddy, oat, barley, buckwheat and wheat straw) were evaluated for fast spawn run. Fastest colonisation was observed in Paddy straw substrate (31 days) followed by oat straw substrate (33 days). FYM, Cocopeat, Sawdust and Sand(25%) +Soil(75%) were used as casing materials with different casing thickness (1.5 cm,2.0 cm, 2.5 cm) to evaluate the total yield and Biological efficiency of *Calocybe indica*. The highest total yield (606.67 g) and best biological efficiency (101.11%) were also obtained in the same treatment followed by sand (25%)+soil(75%) combination treatment. The FYM (2 cm thick) was the best casing material and the rice straw was the best substrate for the commercial cultivation of *Calocybe indica*.

**Keywords :** Biological efficiency, *Calocybe indica*, casing material, spawn, substrate, yield

## INTRODUCTION

*Calocybe indica* is ranked as the third most extensively cultivated mushroom in India, following the button and oyster mushroom varieties. *Calocybe indica* is widely referred to as the milky mushroom because to its visually appealing milky white sporocarp. The species is commonly referred to as the white summer mushroom (Phutela and Phutela, 2012). In some places it is called “Kuduk”, “dudhichhata” and “dudhachhatu” (Purkayastha and Chandra, 1974). Milky mushroom is robust, fleshy, umbrella like structure, milky white in color and considered as boon to human health and nutrition ( Barman *et.al.* 2018).

The global mushroom industry has expanded very rapidly in the last two decades by the addition of newer types of mushrooms for commercial cultivation. The total mushroom production in the world accounts to a value of 40 million tons while production of mushroom in China in 2017 was 31.7 million tons which is roughly 47% of the world supply of mushroom (Chang and Miles,2004). China is the world’s leader in production, consumption and export of mushroom followed by USA (11%), Netherlands (7%), Poland, Spain, France, Italy, Ireland, Canada and UK. The total mushroom production in India is about 0.18 million tons (Jahan and Singh 2019) of which major share (80%) goes to button mushroom and rest of the share (20%) goes to tropical mushrooms such as oyster, paddy straw and milky mushrooms. From 2010-2017, the mushroom industry in India has registered an average growth rate of 4.3% per annum. Out of the total mushroom produced, white button mushroom share is 73% followed by oyster mushroom (16%), and milky mushroom **(7%).***Calocybe indica* is a tropical mushroom native to India

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whose cultivation is predominant in Tamilnadu and now expanding in different parts of the country due to its longer shelf life and adaptability to warm and humid conditions. Over a decade, commercial production of this mushroom variety has assumed greater impetus in India, uplifting rural livelihood. These mushrooms grow every year from May to August, which normally coincides with sufficient rainy showers.

The nutritive value of *Calocybe indica* is comparable with other edible mushrooms. Milky mushroom contains 17.69% protein, 4.1% fat, 3.4% of crude fibre and 64.26% carbohydrates, mature sporocarps contain 4% soluble sugars, 2.9% starch and 7.43% ash. It has most of the mineral salts required for human body such as potassium, sodium, phosphorus, iron and calcium (Barman *et. al.*, 2015). Due to its alkaline ash and high fibre content, it is highly suitable for people with hyperacidity and constipation.

The cultivation technology of milky mushroom is very simple, involves less cost and can be cultivated throughout the year in the entire plains of India. The cultivation process resembles that of oyster mushroom but for the additional process of casing. *Calocybe indica* can be grown on wide range of substrates like straw of paddy, wheat, ragi, maize/bajra/cotton stalks and leaves, sugarcane bagasse, cotton and jute wastes, dehulled maize cobs, soya bean hay, groundnut haulms, tea/coffee waste etc., containing lignin, cellulose and hemi cellul-oses,With the simpler technology and less requirement of air-conditioning, this mushroom may prove to be an alternative to button mushroom without incurring high infrastructural costs. Milky mushrooms are valued for their taste and texture and are used in a variety of culinary dishes. The commercial cultivation of milky mushrooms has become an important income source for farmers, particularly in regions of India. The mushroom's potential for year-round cultivation and its relatively short growth cycle make it an attractive choice for small-scale and large-scale growers.

Bioconversion of agricultural wastes for production of milky mushroom has been demonstrated (Kumar and Chandra, 2013). *Calocybe indica* has capacity to convert huge lignocellulosic biomass waste into human food ( Thakur and Singh, 2020). The present study is concentrated on the use of different lignocellulosic sources as the substrates for the cultivation. Kashmir valley is a treasure for these substrates. The present study is therefore aimed to test their suitability as substrate for profitable milky mushroom production. Also, such a study has not been carried out in Kashmir.

## MATERIALS AND METHODS

### *Pure culture*

Pure culture of button mushroom was prepared under own plant pathology laboratory of FoA,Wadura, SKUAST-K ( Fig.1).

**Fig. 1**: Mycelial growth of *Calocybe indica* in Petri plate

### *Experimental Site*

The experiment was conducted in Division of plant pathology, Wadura SKUAST-K, Shalimar located in upcountry north zone of Kashmir at an Elevation of 1524 m above sea level.

### *Substrate selection and preparation*

Five different agro-wastes (Paddy, Oat, Barley, Buckwheat and Wheat straw) were evaluated for fast spawn run as they are readily and locally available in plenty. All the substrates were procured from the Faculty of Agriculture, SKUAST-K Wadura Campus.

The substrate shall be chopped into 2 to 3 inch pieces in order to improve the water holding capacity of the substrates and soaked in water containing Carbendazim (7 gm) and Formalin (125ml) for 14 - 18 hours. The straw shall be taken out from the solution and spread on the treated floor with 2% formalin for 2 hours to drain out excess of water. A moisture content of about 60 percent was maintained in the wet substrate prior to spawning.

### Filling and spawning

Filling and spawning of substrates were done simultaneously. Filling of substrates in polythene bags was done in layer wise method. Multiple layered Spawning was adopted @ 4 percent by wet weight of the prepared substrate. Cultivation was done in high-density polyethylene bags (Pani and Das, 1998). After spawning the top of ploythene bags was tied with rubber band and about 4-5 holes with sterilised pin were made per bag for proper aeration. These spawned bags were then placed in the mushroom cropping room at above 80% RH and 28 $\pm 2^0$ C temperature for incubation.

### Casing

It takes about 20 days when substrate is fully colonized and bags are ready for casing. Sufficient amount of light, proper ventilation, optimum temperature (28-30°C) and required humidity (70-80%) was maintained during entire cropping period. The walls and floor of cropping room were watered daily to maintain requisite humidity. The polythene bags were opened from top only, when different substrates were fully covered with whitish mycelium and casing was done with different substrates and at different depths. The case run period was about 18-20 days.

## RESULTS AND DISCUSSION

### Evaluation of locally available agro-wastes for commercial cultivation

Five locally available substrates were evaluated for cultivation of *Calocybe indica*. The results are presented in Table 1.

### Time taken for complete spawn run

Different substrates were varied significantly to time taken for complete spawn run. Data presented in Table 1 revealed that the days taken for spawn run on different substrates ranged from 31.67 days to 42.67 days. Minimum days required for spawn run in paddy straw (31.67 days) which was significantly better over rest of all the treatments followed by oat straw (33.33 days) While maximum days required for spawn run in treatment T5 (Buckwheat straw) i.e. 42.67 days thus, this treatment was inferior in comparison to the others. Effect of age and quantity of spawn on milky mushroom production has been analysed by Pani ( 2011). Impact of different substrates for spawn production and production of milky mushroom has been reported by Maurya *et.al.*(2019).

### Total Yield

Data presented in Table 2 revealed that the total yields of sporocarps were measured for each treatment. The accumulations of three flushes were noted as the total mushroom yield. Significant results were obtained by evaluating different substrate in this parameter. Out of these twelve treatments of paddy straw, FYM with 2 cm casing depth had highest yield (606.67 g) in the total three flushes followed by Sand + Soil at 2 cm casing depth (582.17 g) and these treatments were at par with each other. Whereas the lowest total yield 316.17 g was obtained in case of Sawdust (at 1.5 cm casing depth) in the total three flushes which was inferior over all the treatments ( Fig.2 ).

### Biological efficiency

Biological efficiency ranging between 52.69% to 101.11% was recorded in *Calocybe indica* (Table 2). Maximum Biological efficiency (101.11%) was recorded on FYM casing material at 2 cm casing depth. Whereas least Biological efficiency was recorded on Sawdust at 1.5 cm casing depth (52.69%).Minimum days required for spawn run in paddy straw (31.67 days) which was significantly better over rest of all the treatments followed by oat straw (33.33 days), while maximum days required for spawn run in treatment T5 (Buckwheat straw) i.e. 42.67 days thus, this treatment was inferior in comparison to the others (Table 1, Fig.3). These findings are similar to those of previous studies using *Calocybe indica* (Tandon and Sharma, 2006). The

**Table 1:** Evaluation of different substrates for complete colonization of mycelia of *Calocybe indica*

| Substrates | Days required to complete spawn run after spawning |
|---|---|
| Paddy straw | 31.67 |
| Oat straw | 33.33 |
| Barley straw | 35.33 |
| Buck wheat straw | 42.67 |
| Wheat straw | 35 |
| SEm± | 0.70 |
| CD | 2.20 |
| CV | 3.40 |

**Table 2 :** Total Yield and Biological efficiency of *C. indica* on different casing materials

| Casing | Total yield in different depths of casing materials(gms) | | | Biological efficiency(%) at different thickness of casing | | |
|---|---|---|---|---|---|---|
| | 1.5 cm | 2 cm | 2.5 cm | 1.5 cm | 2 cm | 2.5 cm |
| FYM | 435.17 | 606.67 | 577.50 | 72.53 | 101.11 | 96.25 |
| COCO PEAT | 388.50 | 548.33 | 487.67 | 64.75 | 91.39 | 81.28 |
| SAW DUST | 316.17 | 392.00 | 371.00 | 52.69 | 65.33 | 61.83 |
| SAND + SOIL | 403.67 | 582.17 | 537.83 | 67.28 | 97.03 | 89.64 |
| SEm± | 9.11 | 19.26 | 19.36 | 1.52 | 3.21 | 3.23 |
| CD | 29.71 | 62.80 | 63.13 | 4.95 | 10.47 | 10.52 |
| CV | 12.27 | 18.80 | 20.39 | 12.27 | 18.80 | 20.39 |

presence of the right proportion of á-cellulose, hemi-cellulose, pectin, and lignin was the probable cause of the higher rate of mycelium in the paddy substrate. A suitable ratio of carbon to nitrogen might have been responsible for the higher mycelial growth. The capacity of mushrooms to grow on ligo-cellulosic substrates is related to the vigor of their mycelium (Permana *et al*. 2000). Substrates containing glucose, fructose, and trehalose producedthe highest yield, whereas abnormal fruiting and very lees yield were produced in glycerol, xylose, sucrose, and fructose. The optimal fruiting body productionoccurred on glucose and fructose containing substrates (Ashrafuzzaman *et al*. 2009). Fruiting bodies of *Calocybe indica* were formed in five different substrates. Maximum Biological efficiency (101.11%) was recorded on FYM casing material at 2 cm casing depth. Whereas least Biological efficiency was recorded on Sawdust at 1.5 cm casing depth (52.69%).The findings of the present study are comparable with

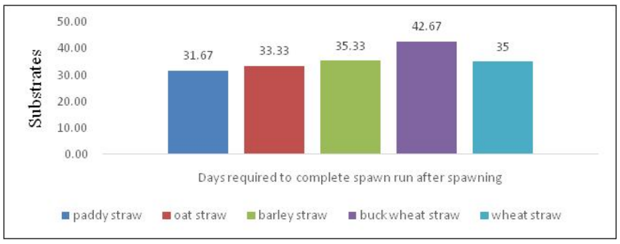


**Fig. 2:** Evaluation of different substrates for complete colonization of mycelia of *Calocybe indica*

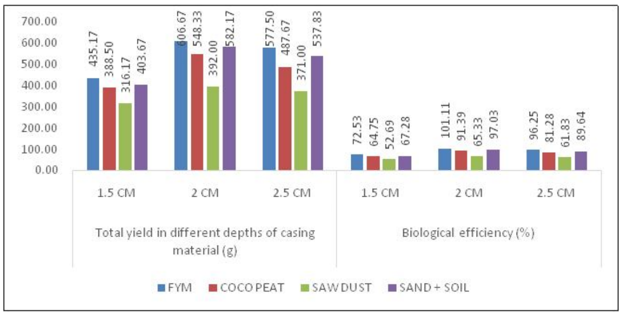


**Fig. 3:** Total Yield and Biological efficiency of *C. indica* on different casing materials

### *Effect of different casing materials and thicknesses on yield and Biological efficiency*

FYM, cocopeat, sawdust and sand (25%) + soil(75%) were used as casing materials with different casing thickness (1.5 cm,2.0 cm, 2.5 cm) to evaluate the yield and biological efficiency of *Calocybe indica*. The results indicate that the number of effective fruiting bodies, the total yield and biological efficiency were statistically similar in FYM and sand+soil casing materials tested. Maximum biological efficiency (101.11%) was recorded on FYM casing material at 2 cm casing depth. Whereas least Biological efficiency was recorded on Sawdust at 1.5 cm casing depth (52.69%).These findings are comparable with data from a study using Agaricusbisporus, because it grows well in composting casingmaterials. The effects of three different thicknesses of FYM, cocopeat, sawdust and sand (25%) +Soil(75%) as casing materials on the yield


**Fig. 4** : Bagging of substrate (A). Different casing materials ( B). Stages in growth of *Calocybe indica* fruit body ( C-F)

those of previous studies using *C. indica* (Eswaran and Thomas, 2003, Barman *et.al.*2015). Rice straw was the best substrate, followed by wheat straw. Therefore, cellulose-rich organic substrates are suitable for cultivating mushrooms. Besides, pruned tea leaves have also been demonstrated for its utilization for the cultivation of *Pleurotus* species (Roy and Chakraborty, 2018).

and biological efficiency of *Calocybe indica* are presented in Table 2. The highest and lowest biological efficiencies were 2 cm (101.11%) of fym and 1.5 cm (24.7%) of sawdust, respectively (Fig. 2) The casing layer is an essential component for the artificialcultivation of *Calocybe indica*. The casing layer must be very loose ; otherwise, the primordia cannot penetrate from the bottom to the top ofthe casing layer (Sassine *et al*., 2005) . The 2 cm casing layer thickness of FYM seemed to be the most efficient, which likely played a role in stimulating the initiation of the fruiting body (Colak , 2004). Thus, the 2 cm thick casing of farm yard manure was the best casing material and the rice straw was the best substrate for the commercial cultivation of *Calocybe indica*. Impact of different spawn substrates and various agricultural wastes on yield potential of *Calocybe indica* (APK-2) have been reported ( Amin *et.al.* 2010; Senthilnambi *et.al.*2011; Selvaraju *et.al*. 2015; Renganathan and Saravanan, 2018; Kerketta *et.al.* 2018). Effect of different agro-wastes, casing materials and supplements on the growth, yield and nutrition of milky mushroom has been illustrated by Sardar *et.al*. (2020). Responses of various casing materials on growth and yield of *Calocybe indica* ( Sharma *et.al.* 2021) and the biological efficiency of white button mushroom under the agro-ecological condition of West Bengal have been demonstrated ( Shanmugaraj *et al*. 2021). Fruit bodies of *C.indica*, along with substrates and casing material have been depicted in Fig.4.

## DECLARATION

Conflict of Interest. Authors declare no conflict of interest.

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