Research Article

Continuous Production of Pleurotus Florida and Calocybe Indica by Utilizing Locally Available Lignocellulosic Substrates for Additional Income Generation in Rural Area

Karuppuraj Velusamy, Chandra Sekarenthiran Subramanian, Perumal Karuppan*
Shri A. M. M. Murugappa Chettiar Research Centre (MCRC), Taramani, Chennai, India.
***Corresponding author's E-mail:** perumalk@mcrc.murugappa.org

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ABSTRACT

Agricultural wastes are generated in rural areas can be effectively utilized for production of mushroom as food supplements as well as for income generation. The present research explored some of the unexplored locally available lignocellulosic substrates such as paddy straw, reeds, banana stem, sugar cane bagasse milled and crushed, sugar cane leaves, coir pith, sorghum husk and sun flower stem for field scale production of *Pleurotus florida* and *Calocybe indica.* The field level cultivation was carried out by 137 farmers and produced totally 15.33 tonne of *P. florida* and *C. indica* with an aggregate bioefficiency of 58.52 % and 60.38 % respectively. The produced mushrooms generated an additional income and also consumed as nutritional supplement.

Keywords: Additional income, Bio efficiency, *Calocybe indica,* Field scale, Lignocellulosic substrates, Nutritional supplement, *Pleurotus florida*.

INTRODUCTION

Agricultural activity generates large amount of biomass rich in cellulose, lignin and hemicelluloses. India is blessed with varied agro-climate, abundance of agricultural wastes and manpower making it most suitable for cultivation of temperate, subtropical and tropical mushrooms. A lot of biological waste is generated in rural areas and this waste could be effectively utilized for mushroom cultivation, converting them into protein rich palatable food. Most of the agricultural wastes primarily used as cattle feed and remaining million tons of agricultural wastes are discarded, burned and neglected. It can help in recycling the organic wastes into profitable products.[1] The FAO has been actively promoting mushroom cultivation for rural development and food security in developing countries.[2]

The rural people considered mushrooms as 'meat for the poor' since the other sources of protein available. The cultivation of mushroom serves as the most efficient and economically viable biotechnology for the conversion of lignocelluloses waste materials to high quality food and this will naturally open up new job opportunities especially in rural areas.[3] Fresh mushrooms are in good demand locally and fetch a relatively high market price. Mass production of mushroom at commercial level will give a remedy for conversion of waste into nutritious food and also creates self employment as well as additional income.[4-5] Mushroom cultivation does not require a lot of land and is a viable and attractive activity for both rural farmers and semi-urban dwellers. Mushroom growing does not require significant capital investment and the scale of cultivation can be large or small based on the capital and labor availability. Indirectly, mushroom cultivation also provides opportunities for improving the sustainability of small farming systems through the recycling of organic matter, which can be used as a growing substrate and then returned to the land as fertilizer.[6] This research paper describes cultivation of edible mushrooms on different locally available lignocellulosic substrates and it's utilized for food as well as income generation to rural sustainable development.

MATERIALS AND METHODS

Mushroom Strain

The pure mycelial cultures of *P. florida* and *C. indica* was obtained from Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu, India and maintained at 25°C. Pure culture was stored at 4°C.

Production of spawn (P. Florida and C. Indica)

Sorghum grains were half boiled for 30 min in boiling water until they become soft. Cooled grains were mixed with calcium carbonate (2 %, W/W). Half boiled grains were individually filled (250 g/bag) in a poly propylene bags (13 × 26 cm) and plugged with non absorbent cotton. The grain filled bags were sterilized in autoclave at 15 lb pressure (121 °C) for 90 min and allowed to cool at room temperature. Seven days old mycelial discs (5 mm) of *P. florida* and *C. indica* was aseptically inoculated in the spawn bags and incubated at 28 ± 2°C and dark chamber for 15 - 25 days.

Mushroom bed preparation of P. Florida and C. Indica

Substrates Collection

The locally available lignocellulosic substrates such as reeds (RD), paddy straw (PS), banana stem (BS), sugar cane bagasse milled (SBM) and crushed (SBC), sugar cane leaves (SCL), coir pith (CP), sorghum husk (SH) and sun flower stem (SFS) were utilized for field scale mushroom cultivation. The substrates were collected from local farmer's field and chopped individually into 5 cm length.

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Mushroom Bed Preparation

Mushroom beds were prepared in polypropylene bags of size (30 × 60 cm). The substrates were sterilized at 121℃ for 90 minutes and shadow dried up to 60% moisture. The cylindrical polypropylene bags were filled up to 7-8 cm layer height with the processed substrates and 10 g of bed spawn was inoculated on the substrate along the circumference of the bags. The substrate was again layered to 5 cm height and spawn was inoculated along the corners of the mushroom beds with gentle pressing of the substrate in each layer for tight packing. The process was repeated until eight layers of spawn and substrate (90 cm) were packed. The inoculated bag was perforated (12 no's) with sterilized teasing needles.

The beds were incubated for 15 to 17 days to complete the spawn run and maintained temperature at 25-28 ℃ with relative humidity of 85 %.

Casing Soil Application

After the complete colonization of mycelium in the *C. indica* mushroom beds, the cylindrical beds were cut horizontally into two equal halves. Over the each half bed, alkaline soil utilized as casing materials, it was steamed for 1 hour and applied 1-2 cm height.

P. Florida mushroom shed construction and maintenance

P. florida mushroom shed was erected towards east to west direction using locally available materials like coconut thatches, bamboo poles, sticks and wood's pillars. The height of the mushroom shed was 8 feet, length 15 feet and breadth 10 feet. The window of the shed was meshed with net properly to prevent the entry of mosquitoes and flies. The temperature in the mushroom growing room was maintained at 22 - 28 ℃ and the humidity was maintained between 75 to 90 %. The floor of the shed was filled with sand up to 1 feet and water was sprinkled (300 L) thrice in a day. Wet gunnysacks were tied along the corners of the shed to maintain humidity. A hygrometer (Equinox) was kept inside the shed and thrice a day the temperature and humidity were recorded until the final harvest of the fruit body of *P. florida*.

C. Indica mushroom shed construction and maintenance

Rectangular pit was dug at east to west direction. The inside of pit wood pillar was buried in the ground; it was in the four corner side of pit. The bamboo poles were connected with wooden pillar. The small size bamboo pole bended like curve shape, it was connected with big size of bamboo poles. The side wall of the mushroom sheds was constructed with clay soil for getting favorable humidity. The west side of mushroom shed wall was fixed with one window and east side was fixed with one door. The bottom of the shed was filled with sand to a height of 15 - 20 cm. The partially sunken chamber lined with blue colored high density tarpauline (silpauline) sheet (90 Gram per square meter) as roof materials. Inside the mushroom shed the temperature and relative humidity was maintained between 28-32 ℃ and 80-90 % respectively.

Intensive Mushroom Cultivation Training to Farmers

Totally 137 no's farmers and Self help women from nine different villages of Tamil Nadu, India were selected for mushroom cultivation and training. Ten days intensive training programme was conducted to the farmers. During the training period, the farmers were trained on spawn production, oyster, milky mushroom cultivation, casing procedures, shed construction, shed maintenance and harvesting methods.

Yield and Bio efficiency

Total weight of all the fruiting bodies harvested from all the four pickings were measured as total yield of mushroom. The bio efficiency (yield of mushroom per kg substrate on dry wt. basis) was calculated by the following formula.[7]

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

RESULTS AND DISCUSSION

P. Florida mushroom production

Totally 16.526 tonne of different lignocellulosic substrates were utilized and 8.792 tonne of *P. florida* fruit bodies was produced by 95 farmers with an aggregate bio efficiency of 58.52%. The harvested mushrooms were utilized for their own use and also sold out in the local markets. Totally 1.639 tonne of mushrooms was utilized for their personal use as a supplementary food and 7.173 tonne of mushrooms was sold out in local markets (Table 1). Totally 9.795 tonne of different lignocellulosic substrates were utilized and 6.541 tonne of *C. indica* fruit bodies was produced by 42 farmers with an aggregate bio efficiency of 60.38%. The harvested mushrooms were utilized for their own use and also sold out in the local markets. Totally 1.478 tonne of mushrooms was utilized for their personal use as a supplementary food and 5.063 tonne of mushrooms was sold out in local markets (Table 2). Training programme and cultivation of *P. florida* and *C. indica* by selected beneficiaries was shown in plate 1.

The current research investigated on the growth and yield of *P. florida* of different agro-industrial and agricultural substrates. The results indicated that the growth and yield of *P. florida* and *C. indica* varied widely, depending on the kind of substrate used. *P. florida* can be easily cultivated on wheat, paddy, barley, oat and gram straw, maize leaves, empty corn cobs, millet heads, cotton waste, sugarcane baggasse, banana pseudo stem, saw dust, logs, straw papers and manure.[8-13] Several research discussed on the fruiting ability of *C. indica* was cultivated with various lignocellulosic substrates. *C. indica* cultivated on variety of substrates and paddy straw and maize stalks recorded the maximum bio efficiency 145 % and 130 %.[14-17] Sunflower stalks and sugarcane bagasse produced higher yield of *C. indica* than paddy straw.[18]

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Table 1: Field scale cultivation of *P. florida* utilized different lignocellulosic substrates

Name of the substrates	Total no's beneficiaries utilized	Total tonne of substrates utilized	Total tonne mushroom produced	Total tonne mushroom consumed	Total tonne of mushroom sold	Total additional income generated (Rs)and @ kg Rs 40/-	Bioefficiency (%)
RD	65	14,646	7596	1420	6176	2,47, 040	51.86
PS	9	840	590	124	466	18,640	70.23
BS	5	250	145	35	110	4,400	58.00
SBM	3	345	205	23	182	7,280	59.42
SBC	5	45	30	5	25	1,000	66.66
SCL	2	234	145	19	126	5040	61.96
CP	2	76	17	3	14	560	22.36
SH	2	56	45	6	39	1560	80.35
SFS	2	34	19	4	15	600	55.88
Total	**95**	**16.526**	**8.792**	**1.639**	**7.173**	**2,86,120**	**58.52**

Key: RD- Reeds, PS- Paddy straw, BS – Banana stem, SBM – Sugar cane bagasse milled, SBC – Sugar cane bagasse crushed, SCL – Sugar cane leaves, CP – Coir pith, SH – Sorghum husk, SFS – Sun flower stem, (kg/shed) – Kilogram per shed, Rs. - Rupees.

Table 2: Field scale cultivation of *C. indica* utilized different lignocellulosic substrate

Name of the substrates	Total no's beneficiaries utilized	Total tonne of substrates utilized	Total tonne mushroom produced	Total tonne mushroom consumed	Total tonne of mushroom sold	Total additional income generated (Rs)	Bioefficiency (%)
RD	23	7503	4969	1195	3774	226440	66.22
PS	8	855	785	196	589	35340	91.81
BS	2	357	145	22	123	7380	40.61
SBM	2	250	178	19	159	9540	71.20
SBC	2	175	120	10	110	6600	68.57
SCL	2	245	135	11	124	7440	55.10
CP	1	125	35	6	29	1740	28.00
SH	1	145	96	10	86	5160	66.20
SFS	1	140	78	9	69	4140	55.71
Total	**42**	**9.795**	**6.541**	**1.478**	**5.063**	**3,03,780**	**60.38**

Key: RD- Reeds, PS- Paddy straw, BS – Banana stem, SBM – Sugar cane bagasse milled, SBC – Sugar cane bagasse crushed, SCL – Sugar cane leaves, CP – Coir pith, SH – Sorghum husk, SFS – Sun flower stem, (kg/shed) – Kilogram per shed, Rs. - Rupees.

Plate 1: Training programme and cultivation of *P. florida* and *C. indica* by selected beneficiaries

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The national schemes introduced new technique for the cultivation of exotic mushroom species which were even though suitable to the local conditions, but did not suit the taste preferences of the local people. Over 2,500 people have benefited from the introductory and advanced courses in mushroom cultivation, of which only 200 growers were in the business of mushroom cultivation.[19] There is a need to encourage small scale cultivation of edible mushroom so as to improve utilization, create jobs for the youth and to eradicate malnutrition. This implies that edible mushroom cultivation though season plays an important role in income generation and job creation for the rural folks.[20-21]

CONCLUSION

The field scale cultivation of edible mushroom was considered as the most efficient and economically viable biotechnological intervention for the conversion of lignocelluloses waste into high quality protein food. The mushroom will naturally open up new job opportunities in rural areas and eradicate the malnutrition.

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