



Enhancing the Biological Efficiency of Paddy Straw Mushroom (*Volvariella volvacea*) using Semi-composting Method of Cultivation in Odisha

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ABSTRACT

Background: Paddy straw mushroom (*Volvariella volvacea*) commonly known as the straw mushroom, in India, commonly referred to as "Pual mushrooms", "Pala chhatu" in odia belongs to Phylum-Basidiomycota, Class-Basidiomycetes, Order-Agaricales, Family-Pluteaceae and Genus *Volvariella*. It is being the third most important cultivated mushroom in the world is well known for its pleasant flavour and taste.

Methods: An experiment was conducted to evaluate paddy straw and other locally available substrates for production of paddy straw mushroom (*Volvariella volvacea*) in Odisha under semi-compost method. Substrates viz. Paddy straw (crumpled and uncrumpled), Paddy straw+ Banana leaves (3:1, w/w), Paddy straw+ Cotton waste (3:1, w/w), Paddy straw+ Water hyacinth (3:1, w/w), Paddy straw + Banana leaves +Water hyacinth (2:1:1, w/w) were partially decomposed and evaluated against traditional undecomposed method of cultivation.

Result: Paddy straw (uncrumpled/hand threshed/bundled), when semi-composted, sustained significantly higher mushroom yield (15.63% BE) as compared to the yield (11.50% BE) obtained from its un-decomposed state in traditional method of cultivation. When other wastes such as cotton waste, banana leaves and water hyacinth were mixed with un-crumpled straw, the biological efficiency increased further (16.06 -19.29% BE). Paddy straw mixed with cotton waste (3:1, w/w) sustained the highest yield potential (19.29% BE). It was also recorded that semi composted crumpled/ cattle threshed paddy straw (12.0% BE) was statistically at par with the non-composted uncrumpled/ hand threshed paddy straw (11.50% BE) in supporting the mushroom yield.

Key words: Mushroom yield, Semi-composted substrates, Straw mushroom.

INTRODUCTION

Mushroom is very nutritious and environment friendly crop additionally to numerous medicinal values. Mushroom contain low protein amount than the animals but way more in case of plants. Except iron it contain higher amount of fiber, essential amino acids and minerals (Jaiswal *et al.*, 2024). They have a profound ability to boost immune system, fight cancers and improve functioning of important organs, as they are full of proteins, vitamins, minerals, amino acids, antibiotics and antioxidants (Verma and Singh, 2017). Paddy straw is the main substrate used for straw mushroom cultivation in Odisha and elsewhere. The low biological efficiency (10-15%) and inconsistent yield are the major limiting factors for higher commercial success of the crop. Moreover, the crumpled straw generated from bullock/ tractor-driven threshing or from harvesting by combined harvesters is reported to be unsuitable for mushroom cultivation (Pani, 2011 and Sahoo, 2014). It is reported that higher and more stable yield (30-40% BE) could be obtained through adoption of indoor method of farming (Ahlawat and Tewari, 2007) using cotton waste as substrate. When a combination of paddy straw and cotton waste was used, it sustained a biological efficiency of 21.8 to 27% (Quimio and Royse, 1990). As cotton wastes are not available in Odisha and their collection from outside would increase the cost of production and it was thought imperative to evaluate paddy straw and other locally

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available substrates under semi-compost method for production of straw mushroom (*Volvariella volvacea*) in Odisha. It is imperative to note that the production of bundled straw has been constantly on the decline after introduction of combined harvesters in rice cultivation which generate crumpled straw instead of bundled straw. The substrates used in cultivating edible mushroom requires varying degree of pre-treatments in order to promote the growth of mushroom mycelium by excluding other competitor microorganisms. Sterilization using hot water, steam or chemical methods is done to disinfect the substrate.

However, sterilization is not an ideal disinfection method as it kills both beneficial and harmful organisms in the substrate. Pasteurisation of the substrate seems to be the better alternative which permits re-growth of beneficial organisms during the cooling period (Gowda and Manvi, 2019). The broader objective of the present study was to compare semi-compost method with traditional method for paddy straw mushroom production from bundled straw and to find suitability of crumpled straw as a substrate for mushroom cultivation.

MATERIALS AND METHODS

The study was undertaken at the SOA Mushroom Unit, Siksha 'O' Anusandhan (Deemed to be university) in the year 2023-24. The growing room was provided with concrete racks with provision of introducing steam in to the room. This was accomplished by allowing the steam from an improvised boiler which was evenly distributed through pipes with small holes. There was also the provision of exhaust fans to remove the hot air whenever required. The concrete floor was covered with 6" thick sand which was kept wet throughout the cropping period for maintenance of adequate humidity. Wet gunny bags were also used in the windows to increase humidity inside the room. In the semi-compost method of paddy straw mushroom cultivation, the bundled paddy straw was used as substrate (Chopped paddy straw- 300 Kg, wheat bran @ 6% or 18 Kg, chicken manure @ 1.5% or 4.5 Kg, calcium carbonate @ 2% or 6 Kg) unless otherwise stated. Paddy straw was chopped into 2-3 inches. The cut pieces were spread in a thin layer and kept wet for 24 hours by sprinkling water. Care was taken so as to maintain 70 to 80% moisture in the wet straw. All the ingredients were mixed with the wet straw excluding calcium carbonate and a heap of 1.5m × 1.5 m × 1.5 m was made. It was covered by a thin polythene sheet. A turning was given on the second day and the heap was restored. The second turning was given on the 3rd or 4th day, calcium carbonate was mixed thoroughly and heap was restored again. Calcium carbonate which removes the stickiness of compost to avoid anaerobic condition and increases the pH. Compost was ready on the 6th day. Temperature of the heap was checked regularly. It was 68-70°C during the composting process. Then it was transferred to the growing unit and compost beds of 15 cm height were prepared on wet paddy straw bundles. Length and width of the beds were 2 m and 0.5m, respectively. The beds were exposed to steam for about 1hour. After the temperature of the room was brought down to room temperature (about 35-38°C), spawn bits were applied on the beds @ 0.4% of the wet weight of the compost and then covered another thin layer (2 inch) of semi compost. The beds thus prepared were covered with polythene sheets till the pin heads appear. The room temperature was maintained at 32-34°C during spawn run period. The beds started fruiting in about 9-10 days. In this semi-composting method of cultivation, both crumpled and un-crumpled

paddy straw were used to prepare beds separately. Paddy straw bundles were also used in combination with banana leaves, cotton waste and water hyacinth in 3:1 ratio (w/w). In another combination, paddy straw bundles, banana leaves and water hyacinth were used in 2:1:1 proportion (w/w). Besides cotton waste all other substrates were chopped into 2 to 3-inch pieces and soaked in water for 6 to 8 hours. Cotton waste was used as such. Spawning @ 3% of dry weight of substrate was done. Incubation of semi-compost beds and their maintenance were followed as per stated procedure. Fruiting bodies were harvested from a total of two flushes at egg stage and fresh weights were immediately recorded. The experiment was conducted in Complete Randomised Design (CRD) with three replications for each substrate. Standard yield parameters were recorded and yield data were analysed statistically. The yields obtained from these composted substrates were compared with the yield obtained from traditional method of cultivation using un-decomposed paddy straw bundles.

RESULTS AND DISCUSSION

Data presented in (Table 1) revealed that the substrates possessed varied yield potential vis-a-vis the traditional method of straw mushroom production using non composted paddy straw (bundled). Paddy straw (uncrumpled / hand threshed / bundled), when used as semi-composted substrates, was a better substrate for straw mushroom cultivation (15.63% BE) than when used un-decomposed in traditional method (11.50% BE). When other wastes such as cotton waste, banana leaves and water hyacinth were mixed with un-crumpled straw, the biological efficiency was found to increase further (16.06 -19.29% BE). Paddy straw mixed with cotton waste (3:1, w/w) sustained the highest yield potential (19.29% BE). It was also recorded during the investigation that, semi composted crumpled/ cattle threshed paddy straw was statistically at par with the non composted uncrumpled/ hand threshed paddy straw in supporting the sporophore production. This can be highly rewarding considering the fact that these were traditionally been poor mushroom substrates and there is a rising accumulation of cut pieces of straw due to increasing use of combined harvester in paddy crop now-a-days.

This is a new method of production of straw mushroom from semi-composted straw. It is preferred over the traditional method as the productivity in this method was found to be higher than the traditional method. Paddy straw (uncrumpled / hand threshed / bundled), when semi-composted was a better substrate for straw mushroom cultivation than when used un-decomposed in traditional method. This might have been due to variations in their physical properties, bulk density, water retention capacity, availability of pore space and nutritional composition (Pani, 2011).

The importance of semi-composted paddy straw in promoting higher yield of straw mushroom has been reported by various workers (Ahlawat and Tewari, 2007; Quimio,1993; Thakur and Yadav, 2006; Ahlawat, 2011).

Table 1: Evaluation of different substrates for production of paddy straw mushroom *Volvariella volvacea* under semi-composting method.

Treatment /substrates	Days for pinhead appearance	Days for 1 st harvest	No of fruiting bodies	Yield (g)	Weight of fruiting bodies (g)	BE (%)
T1:Paddy straw (uncrumped)	9	14	132	2346	17.77	15.63**
T2:Paddy straw (crumpled)	13	16	107.48	1802	16.76	12.01**
T3: Paddy straw + Banana leaves (3:1, w/w)	10	15	148.34	2455	16.55	16.36**
T4: Paddy straw + Cotton waste (3:1, w/w)	8	13	160.68	2894	18.07	19.29**
T5: Paddy straw + Water hyacinth (3:1, w/w)	11	15	137.4	2410	17.54	16.06**
T6: Paddy straw + Banana leaves + Water hyacinth (2:1:1, w/w)	10	15	157.81	2506	15.88	16.7**
T7: Traditional method (without composting)	10	14	43.67	805	18.43	11.50*
CD(0.05)						1.34
SE(m)±						0.43

Each observation was the average from three replications. **Calculated on the basis of wet weight of compost, *Calculated on the basis of dry weight of paddy straw.

However, the findings of earlier workers (Sahoo, 2014) could achieve only 7.36 to 7.51% BE of straw mushroom using partially composted paddy straw substrate. This could be due to difference in substrate composition. Mixing of cotton waste banana leaf and water hyacinth with paddy straw, either alone or in combinations, enhanced mushroom yield where subjected to their availability and taking in to account the cost benefit ratio. Water hyacinth is a cellulose rich weed plant which is abundantly available free of cost in many parts of the country. Dried banana leaves are also available in the commercial banana plantations in few pockets of the state. The use of cotton waste (Patra and Pani, 1997), banana leaf (Patra and Pani, 1995) and water hyacinth (Pani and Mohanty, 1998) as substrates have been demonstrated in other cultivated mushrooms.

Moreover, the SMS (Spent Mushroom Substrate) generated from this method can directly used as a source of manure in the crop fields. Minimum incidence of diseases and pests was also found which could be due to high temperature generated during composting and further subjecting the semi compost to steam pasteurization. Though the results of the above study were quite encouraging, there is need to further standardize the substrate composition for further enhancement in the mushroom yield.

CONCLUSION

The traditional method of paddy straw mushroom production, more often associated with low and erratic yield, should substituted with new semi-compost method of production to achieve higher and stable mushroom yield. Moreover, the uncrumped straw, hitherto considered as a poor substrate, can be successfully used for growing mushroom in the new semi-composting method. Depending upon their availability and cost factor, cotton

waste, banana leaves and water hyacinth may be mixed with straw during the process of semi composting to increase the biological efficiency of straw mushroom further.

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Conflict of interest

All authors declared that there is no conflict of interest.

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