

## An Overview and study on Paddy Straw Mushroom and its Market from Anandapur District Odisha

Aditya Kumar Sahoo, Shweta Meshram

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### ABSTRACT

Mushrooms are often defined as “a macro-fungus with distinctive regenerating fruiting bodies, epigeous or hypogeous, large enough to be seen with opened eyes. Mushrooms are well liked for their nutritive and flavored food value. Among all the edible mushrooms paddy straw mushroom (*Volvariella volvacea*) is very popular for its flavor, taste, crude fibers, ash and high protein content. These mushrooms have enormous demand in eastern states like Odisha and West Bengal. This mushroom has certain advantages like requirement of the tropical or sub-tropical climate, fast rate of growth, easy cultivation technology and good acceptability at consumers’ level. Favorable surrounding helps for mushroom production in that area. It needs temperature (25-35) and relative humidity 80-90% for proper growth and development. Various methods are used to strengthen the biological efficiency of *Volvariella volvacea*, but cage method is that the simplest cultivation method. It has low

production cost and cropping duration relatively of 15 days. It grows well in both outdoors and indoors conditions. Anyhow, various molds overrun the beds at different stages of crop growth and reduce productivity. *Aspergillus* spp., *Coprinus* spp., *Rhizopus* sp. is frequently seen in mushroom beds in both outdoor and indoor conditions. In present study we have discussed in detail regarding the *Volvariella* spp. *Volvariella* sp and provides details of observations from mushroom production unit near Anandapur, Odisha which provides information about production unit and way of cultivation of paddy straw mushroom from this region.

**Keywords** Paddy straw mushroom, Marketing, Favorable surrounding.

### INTRODUCTION

*Volvariella volvacea*, commonly known as the straw mushroom, paddy straw mushroom or the Chinese mushroom, belongs to the family *Pluteaceae* of the Basidiomycetes (Singer, 1991). The mushroom defined as “a macro fungus with an individual fruiting body, are often seen within the eye and to be picked up by hand” (Chang and Miles 1992). The mushroom fruiting body could also be umbrella like or of varied

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Aditya Kumar Sahoo, Shweta Meshram\*  
School of Agriculture, Lovely Professional University, Phagwara-144411  
Email: shweta.26662@lpu.co.in  
\*Corresponding author

other shapes, size, and color. Commonly it comprises of a cap or pileus and a stalk or stipe, but others have further added structures like veil or annulus, a cup or volva. Mushrooms are heterotrophs in nature. They are Achlorophyllous in nature. They cannot create nutrients by photosynthesis, but take it from their surroundings (Palitha Rajapakse 2011). There are over 2000 mushroom varieties identified round the globe. However, not all mushrooms are edible. Some are poisonous or harmful and cause major digestion issues if consumed. This happens due to certain toxic substances present in them. Edible mushrooms are a rich source of vitamin B and good source for potassium and phosphorous too. Nowadays, mushrooms gain popularity not in India but everywhere the planet for his or her nutrient and medicinal value. It is used as a food, as a drugs and as a tonic (Chang 2007). Mushrooms are good sources of sugars, crude fibers, minerals and contain some essential amino acids. Mushrooms contain 80-90% water, 3% protein, 4% carbohydrates, 0.1% fats, 1% minerals and some quantity vitamins (Tripathy and Sahoo 2010, Bolton and Blair 1982, Zakhary *et al.* 1984). Mushroom cultivation gains huge impact in industry thanks to its low input and better return rate. Several substrates rich in organic matters have been using for mushroom cultivation. Vegetable waste paddy straw, wheat straw, dried banana leaves have used because the substrate for mushroom cultivation. Paddy straw mushroom (*Volvariella volvacea*) are generally known as the rice straw mushroom or the Chinese mushroom. It belongs to the family Platanaceae of the Basidiomycetes (Singer 1991). Paddy Chinese mushroom is additionally referred to as warm mushroom because it grows in relatively higher temperature. It is an edible mushroom in eastern states like Odisha and West Bengal. It was 1<sup>st</sup> cultivated in China in 1822 (Ahlawat and Tewari 2007). It is a fast-growing mushroom under favorable growing conditions.

Total crop cycle is completed within 3-4 weeks. This mushroom can use wide selection of cellulosic materials and therefore the C: N ratio needed is 40 to 60, quite high as compared to other cultivated mushrooms. It can be grown quite quickly and easily on uncomposted substrates such as paddy straw and cotton waste or other cellulosic organic wastemateri-

als (Ahlawat and Kumar 2005). Eastern Indian states comprise of Northeastern region (Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Tripura, Sikkim and Assam), West Bengal, part of Bihar, Jharkhand and Odisha has good potential and scope for paddy Chinese mushroom cultivation thanks to the wide availability of basic substrate (paddy straw) and favorable temperature. The high-temperature requirement 26°C to 30°C for mycelium development and 34 to 37°C for fructification, relative humidity 70-90% also make it, a good choice for adoption in round the year cultivation of mushrooms (Biswas 2014).

Various substrates are used, for cultivation of paddy straw mushroom (*Volvariella* spp.) Some of these agricultural wastes include banana leaves, rice bran, wheat bran, sugarcane baggage (Tripathy and Sahoo 1999), wheat and rice straw (Cangy and Peerally 1995). After the production of mushroom, the leftover is generally used for animal feed. Due to the assembly of mushrooms, the wastes are composed of the foremost quantity of nutrients and have more digestibility capacity (Chandra and Chaubey 2017).

It has been deliberated as one of the easiest and simplest mushrooms to cultivate. Cultivation of paddy straw mushrooms is normally done in outdoor conditions. Various contestant moulds have seen within the Chinese mushroom beds during the fruiting stage. Many competitors' moulds such as *Coprinus* spp., *Mucor* sp., *Aspergillus flavus*, *Penicillium* spp., *A. niger*, and *Rhizopus oryza* have been recorded in the beds. *Coprinus* spp. growth is more in both outdoor and indoor farming surrounding or condition. However, outdoor farming recorded more bed contamination (46.8%) as compared to the indoor one (27%) (Chinara Mahapatra 2014).

Use of 2 % calcium carbonate solution for a pre-soaking substrate for eight hours was significantly superior among the treatments in giving a higher yield with a corresponding biological efficiency of 14.52 %. Use of streptomycin (0.01%) and benomyl (0.2%) reduce the emergency of *Corpinus* spp. (Chinara and Mohapatra 2014).



Fig. 1. Paddy straw mushroom cycle (Le VinhThuc *et al.* 2006).

### Morphological Characteristics and life cycle of paddy straw mushroom

This genus took its name from ‘Volva’ means a wrapper, which fully covers the main fruiting body during the young stage. The fruiting body conformation or formation starts with distinct tiny clusters of white hyphal aggregates or summations called primordia and is followed by successive stages named as “button”, “egg”, “elongation” and “mature”. Differentiation or distinction can be seen first at the ‘button’ stage. At maturity, the buttons enlarge and umbrella like regenerating fruiting bodies comes out after the rupture of the volva.

The mature fruiting body can be differentiated into the following structures. In contrast or discrepancy to green plants, utmost mushroom species are haploid and diploid phase is normally or typically transient and restricted to the basidium. Generally, there are six different stages in paddy straw mushroom cycle (Samarawira 1979). When mycelium starts to develop, the mushroom begins its first stage of development called the pinhead stage (Ahlawat and Tewari 2007) the entire structure may be a group of hyphal cells. It’s characterized by tiny white clusters with an internet of hyphal cells. Tiny button stage, only the highest of the veil is brown, while the remainder is white. Both the button and pinhead stages have formed from the weave of hyphae. It’s followed by the button stage during which buttons have egg-shaped structure and covered with a lay-

er of tissue (Thuc *et al.* 2019). The stalk (stipe), gills (lamellae) and cap (pileus) are seen inside the button when it’s cut length wise. During this stage, the mushrooms have sold within the market at a premium price. At egg stage, the pileus is beginning of the veil and therefore the veil remains as Volva. The dimension of the pileus is extremely small at this stage. The elongation stage occurs when volva starts to rupture, exposing the stalk and therefore the cap. This stage is lesser than the mature stage. The last, stage maturity has characterized by the fully opened cap with the brownish-pink gills of its lower surface (Sahoo *et al.* 2012). At the maturity stage, the spawns (basidiospores) begin to discharge to the environment (Ahlawat and Tewari 2007).

**Volva:** The universal veil is understood as a plant structure and it remains a lot of or less distinct within the adult mushroom as a cup-like structure at the bottom of the stem.

**Stipe:** Off-white to dull brown in color, long, spherical with a smooth surface and no annulus. The stem enlarges slightly to a bulbous base, that is cased with a definite membranous plant structure. The annulus or ring-like structure on the stem is prominently absent during this mushroom.

**Pileus:** The umbrella-like fleshy structure connected to the stem. The dimension of the cap is littered with

environmental factors, however typically, it's around 5-15cm broad.

**Gills:** The vertical, radial plates on the lower surface of the cap are lamellae or gills. All gills are with a whole margin and rough edges; however, the dimensions vary from one-quarter of the radius of the cap to the complete size.

### Biological characteristics

The fruiting body of the paddy Chinese mushroom is split into six totally different developmental stages that embody pinhead, small button, button, egg, elongation and mature stage. Each has its own morphology and anatomy.

**Pinhead stage:** During this stage fruit body is of the confines of a pinhead during which the veil is spotlessly white or colorless. In mechanical drawing the plant part and stem aren't visible. The full structure is a knot of hyphal cells.

**Tiny button:** Each the small button and pinhead stages are fashioned from interwoven hyphae. In a very young small button, solely the highest of the veil is brown, whereas the remainder is white.

**Button stage:** This stage of the paddy straw mushroom is over subscribed within the market at a premium worth. During this stage the full structure is wrapped by a coat, that is named because the plant structure. Within the veil, closed plant part exists. *Per se* the stem isn't visible but in longitudinal section of mushroom it's visible.

**Egg stage:** This stage conjointly fetches premium costs within the market and at this stage, the pileus is pushed out of the veil and therefore the veil remains as plant part. The stem is once more not visible at this stage. The lamellae of this stage don't bear basidiospores. The dimensions of the plant part stay terribly little up to this stage.

**Elongation stage:** The plant part remains shut and therefore the size is smaller than mature stage, while the stem attains the utmost length. The stem is marked with waterproof drawing ink.

**Mature stage:** At mature stage, the structure is split into 3 regions:

(i) Pileus or cap, stem or stalk and plant part or cap. The plant part is connected within the Center with stem and of sometimes six to twelve cm in diameter. The grownup plant part is circular in form with a complete margin and sleek surface. The surface is dark gray at center and light weight gray close to the margin. The lower surface of the pileus bears lamellae

**Table 1.** The common methodology and style employed for paddy straw mushroom cultivation.

Method	Description
Bed method	It is the simplest method of bed preparation (Akinyele <i>et al.</i> 2005). For creating these beds, four paddy straw bundles were placed side by side on the bamboo stage and another four bundles placed similarly but from the other direction in order that, the open ends of all the bundles should overlap one another. An equivalent method is followed for the second; third, fourth layer. Up to 500 g. of spawn is employed per bed. Spawns are utilized in layers, leaving some margins (Biswas and Layak 2014).
Cage method	In this method, well drain soaked straws are used. Ten bundles of straw placed uniformly within the cage at rock bottom layer (1.00m × 0.50 m × 0.25m). Within the same manner, the second layer bundles were placed. An equivalent process is followed up to 6 layers. Spawn is placed between layers. Then a transparent polyethylene sheet is roofed and tied it with jute string (Biswas 2014).
Heap method	In this method, a straw bundle is placed within the zig-zag method. This method is far almost like the cage method. Six layered of straw and a depth of two feet was prepared. Spawning was done between all six layers. The bed was compacted and watered if needed to take care of the moisture.
Spiral method	Water-soaked bundles are bound with a thread. Then 500 g of spawn is mixed with the bundles to organize the bed. The spawned substrate was then covered with a skinny polythene sheet (Ahlawat and Tewari 2007).

and their variety varies from 280 to 380. The lamellae vary in size from full size to one quarter size of plant part. Beneath the magnifier, every lamella is seen to be composed of three layers of interlocking hyphae. The outmost layer is named the reproductive structure and it forms the club-shaped basidia and therefore the cystidia. The basidia bear basidiospores, sometimes one basidium bears four basidiospores. The basidiospores vary in shape: egg formed, spherical or rounded. The colors of basidiospores once more vary and it's going to be of sunshine yellow, pink or dark brown.

### Existing methodology available for paddy straw cultivation

Prepare a raised platform of about 1 m long and 0.75 m in breadth with a deal wood hand or flank and keep it over a support by arranging bricks on all four corners. The paddy straw is whisked into to weigh about kg each. The straw bundles are kept in water to get soaked for 12-18 h. Ten bundles are taken out and drain the excess water. Place the bundles over the platform with their butt on one side. Build the next layer by placing the butt towards the contrary direction. (These 8 bundles make subcaste of bed or layer of bed). Place a little amount or volume of spawn 8-12 cm inside the periphery at an interval of 10- 15 cm right along the fringe or periphery. A spoonful of coarsely crushed dhal powder is applied before placing the spawn. Place the bundles at right angles to the former layer in crisscross fashion to form the third layer. Place the straw bundles with contrary butt ends to form fourth layer. Spawn this layer as stated over. Place another subcaste of straw bundles over this and don't apply spawn. Pressure the bed to form it as compact as possible and canopy it with a transparent polythene sheet. Keep the beds undisturbed for a couple of days.

### Different methods of bed preparation

A variety of waste materials have been used for cultivation of the paddy straw mushroom, which include: Paddy straw (Chang 1965), water hyacinth (Chang and Mok 1971), oil palm bunch (Naidu 1971), oil palm pericarp waste (Graham and Yong 1974, Yong and

**Table 2.** There are mainly three methods which improve the productivity of mushroom cultivation.

Methodology	Description
Soaking	Required size bundles are taken and soaked in water for 8-10 hours. Some amount of lime is added to the answer to take care of the pH. Bundles are taken out of solution then kept in an inclined manner to get rid of excess water. Then the method of formation of beds starts after 2 hours (Renato Reyes, 2016).
Composting	The composting period generally takes 14 days. During the first seven days of composting, the bed is covered with plastic sheets to induce the growth decomposers. (Choudhary <i>et al.</i> 2009). In this period, mycelia growth started. 8-10 days' time period there is the growth of pinheads of mushroom (KNisa <i>et al.</i> 2019).
Fruiting and harvesting	Mainly three stages of fruiting are seen. These are at bottom stage, egg stage and elongation or mature stage. Harvesting of mushroom generally done at the bottom stage. Profitability is more when mushrooms are harvested at bottom stage (Tripathy and Sahoo 2010).

Graham 1973), banana leaves and saw dust (Chua and Ho 1973), cotton waste (Chang 1974, Hu *et al.* 1973, Yau and Chang 1972), sugarcane bagasse (Hu *et al.* 1973, 1976 and 1976).

Paddy straw mushroom prefers high cellulose, low lignin containing substrate and produces a family of cellulolytic enzymes (Ahlawat *et al.* 2008). The cultivation of *Volvariella* is a smaller amount sophisticated, less extensive and can be rewarding in tropical and subtropical climates (Sukara *et al.* 1985). Before 1970, it had been only paddy straw, which was in use for paddystraw mushroom cultivation. Still, in 1971, cotton waste (Ginning mill waste) was first introduced because the heating material for growing of straw mushroom followed by complete relief of paddy straw with cotton waste by 1973 in Hong Kong. This was almost the turning point within the history of paddy mushroom cause cotton waste gives more stable yield (30 to 40%) along with early fructification and harvesting. After relinquishment of cotton waste, the cultivation of paddy Chinese mushroom has become semi-industrialized in Hong Kong, Taiwan, Indonesia, China and Thailand.

Commonly, four methods of bed preparation used

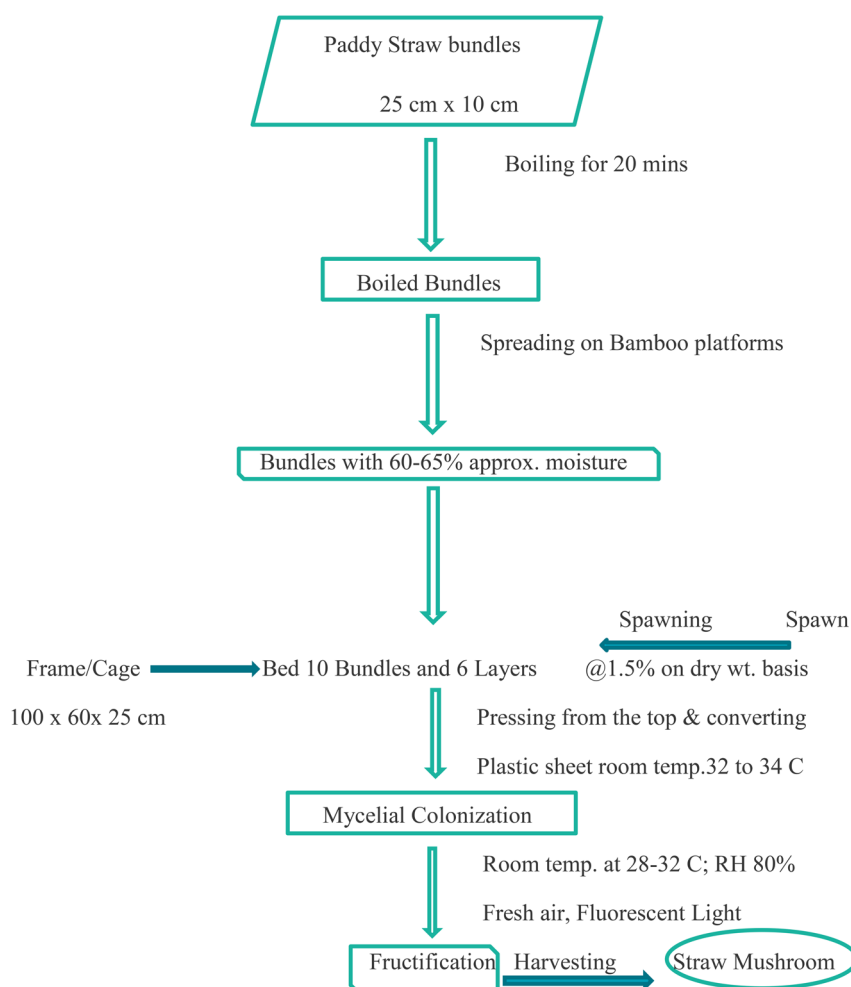


Fig. 2. Putative representation mushroom cultivation process based on previous studies (Ahlawat and Tewari 2007).

for mushroom cultivation. i.e., Bed method, Heap method, Cage method and Spiral method. It mainly depends upon the farmer what method of bed preparation is straight forward to cultivate. Cage method is one among the simplest methods of bed preparation because it has commonly employed by many farmers.

#### Cultivation technology of paddy straw mushroom (*Volvariella volvacea*)

Traditionally cultivated of mushroom was done with uncomposed and unpasteurized bundles of banana

leaves (Belewu 2005) (Chua *et al.* 1973) or paddy straw (Banik and Nandi 2000) tied at both ends and laid one on top of the other two ends for the formation of beds. However, the yield on mushroom beds is unstable and irregular due to microbial contamination and fluctuating environmental conditions. To enhance the productivity indoor cultivation of paddy straw mushroom using rice straw because the main substrate was started (Zikriyani 1951). Rice straw or stubble is usually used as bedding materials or substrates (Khan 1991). These materials collected from the sector must be sun-dried to take care of the moisture of straw.

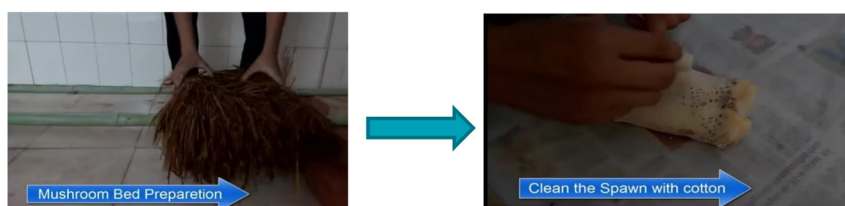


Fig. 3. Making of mushroom bed and cleaning the mushroom spawn with cotton.



Fig. 4. Applying those spawns on the beds in well mannered.

Royse *et al.* (1991) they're tied into bundles then dig the specified size.

## MATERIALS AND METHODS

### Existing methods available for paddy straw mushroom cultivation

Following general methods and procedures are summarized here which are used for paddy straw mushroom cultivation.

#### Outdoor method

The best place to cultivate paddy straw mushroom outdoors is in shade created by trees or creepers. The

steps involved are as follows (Chang 1982 and Ho 1985). Preparation of raised platform either with sand or bamboo poles or wooden or rustic planks or bricks. Preparation of bundles of 40 cm long and 10 cm range or breadth. Soaking of bundles in flowing water or in 2%  $\text{CaCO}_3$  solution. Driving of bamboo pole into the central end of every bed. Preparation of layer of bundles followed by spawning. Laying down of 4 layers of bundles during summer months and seven layers during rainy season. Beating of bed with 20cm deep subcaste of rice straw followed by covering with polythene sheet. Removing of polythene sheet after 4 days and sprinkling of water carefully on 6<sup>th</sup> day. Spraying of water are often avoided during season. Prohibit spraying of water after appearance of the mushroom pinheads. In present study from mushroom



Fig. 5. Applying pulse powder on the platform in layered manner..

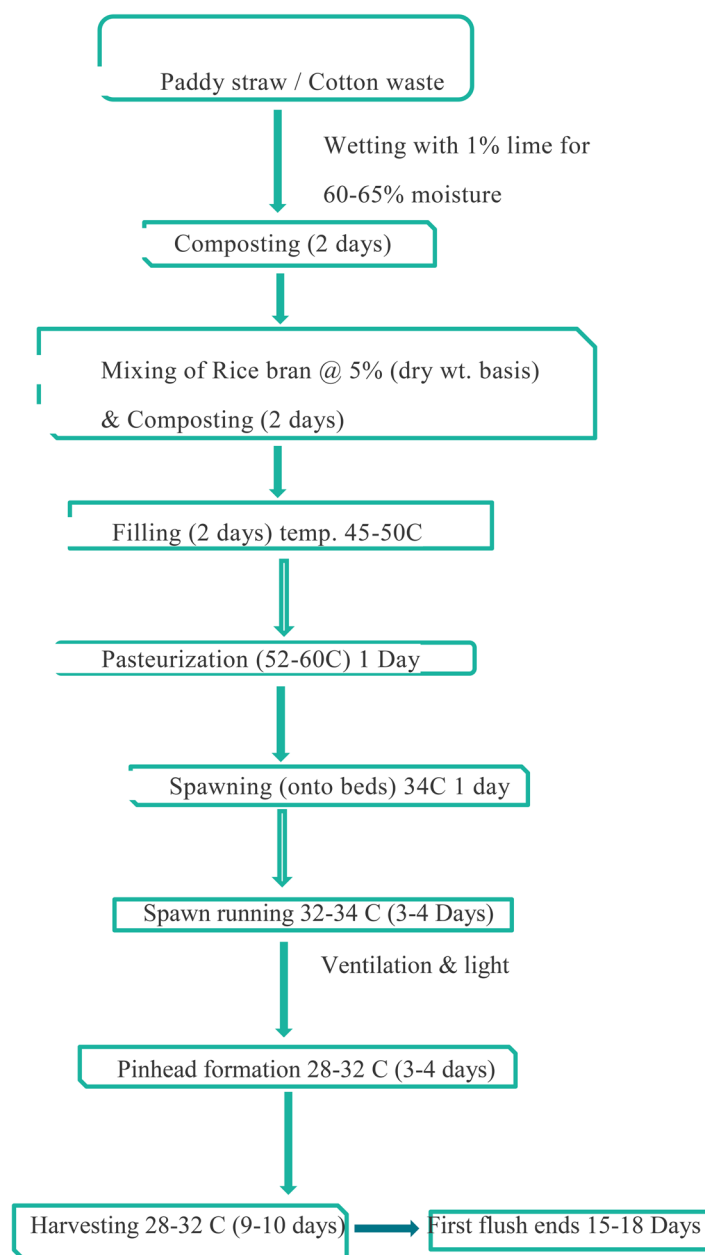


Fig. 6. Indoor method of paddy straw mushroom cultivation.

trader unit following procedure were understood.

#### INDOOR METHOD

The indoor method is often divided into following 5 steps (Quimio 1993)

i) *Substrate*: Cotton waste is that the preferred sub-

strate for cultivation of paddy Chinese mushroom by this method. However, paddy straw also can be used. Cotton waste is preferred over paddy straw because it contains more cellulose and hemi-cellulose. The fine texture of cotton waste helps in retention of moisture, which minimizes the water requirement at later stages





Fig. 7. On farms hands on practice of mushroom cultivation.

of cropping and thus helps in avoiding damage to mushroom primordia

ii) *Compost preparation*: Substrate is wetted with 1% lime (on dry weight basis) and for cotton waste, a square wooden rack (92x92x28cm) is employed for holding a layer of cotton waste about 30cm deep. The workers are wont to tread the cotton waste in order that it absorbs enough water. After first layer is trodden another layer is applied. This process is repeated until the specified quantity is trodden. However, just in case of paddy straw, pile is formed (1.5 m high x 1.5 m wide) by adding enough water mixed with 1% lime. The pile is additionally made with wet cotton waste and left to ferment within the open but under cover during season or extreme cold. First turning is given after 2 days and 5% rice bran is mixed just in case of paddy straw substrate and water is added if needed. However, nothing is added just in case of cotton waste substrate. Again, pile is made and left for fermentation for subsequent.

#### Method and procedure studied from local mushroom unit

#### Procedure for data collection in existing study

#### from Anandpur district

Initially, local from locality and supermarkets was contacted and started data collection from the mushroom farm. Sai Shankar mushroom traders unit was selected for further observation. After an extensive interaction sessions and study, significant information collected during my training.

Table. 3 Marketing data analysis and collection of information.

Particulars	Remarks
1. Name of unit	Sai Shankar mushroom traders
2. Type of mushroom	Paddy straw mushroom
3. Local name	Kutta chhatu / Pala chhatu
4. Source	Super market & Local vendors
5. Packaging	Packets & cartons
6. Price	260 Rs per kg (paddy straw)
7. Storage Condition	Packing in 75 $\mu$ thick high impact polystyrene punnets with 1.2% perforations as primary package and subsequently stored in expanded polystyrene (EPS)
8. Approx cost	180/kg
9. Optimum Condition	28-to-38-degree C. & R.H. is of 57-60% and ideal temp for spawn run is 30-to-35-degree C. While 28 to 32 degree C for fruiting
10. Address	Anandapur, Odisha 758020



Fig. 8. Water is gently sprinkled over the mushroom beds and then covered with plastic sheet.

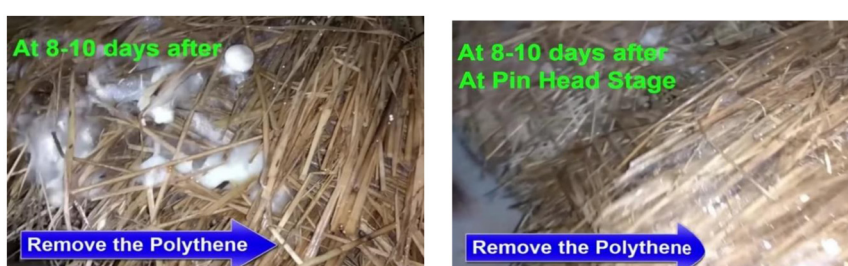


Fig. 9. Polythene sheet as removed and pin head stage was observed.

## RESULTS AND DISCUSSION

(Locality: Fakirpur, Anandapur, Odisha)

### Harvesting of mushrooms

The straw mushroom is harvested earlier than the volva breaks or simply after rupture. These stages are referred to as because the button and egg stages.

This mushroom grows at excessive temperature and moisture consequently grows fast. So, for harvesting of straw mushroom at precise circumstance it must be harvested two times or three times in a day (morning, noon and afternoon). This mushroom usually takes 9-10 days from spawning to reap of first crop and the primary flush normally exist for three days, which represent approximately 70 to 90% of the predicted mushroom yield. The intervening length of three to five days require through watering and keeping of optimum conditions within the rooms. The subsequent flush will once more live on for 2-3 days and



Fig. 10 . Mushroom is picked up when it reaches bud stage.



Fig. 11. Final mushroom product ready for commercial purpose.

yields less mushroom than the primary flush. The 2d flush brought simplest 10 to 30% of the entire crop. On accomplishing the harvestable size, the fruiting our bodies ought to be cautiously separated from the beds/substrate base via way of means of lifting and shaking barely left or proper after which twisting them off. The mushrooms ought to now no longer be reduce off via way of means of knives or scissors from the bottom of the stalk, due to the fact the stalks left at the back of at the bed/substrate will rot and can be attacked via way of means of Pests and moulds, which in flip will break the mushroombed.

## CONCLUSION

As we recognize cultivation of mushrooms and specially the tropical mushrooms are the easiest manner of agri waste reutilization within side the shortest viable length with an additional advantage of manufacturing a pleasant food, owning correct share of critical amino acids, elements, fiber, ash and fatty acids. The extra gain with paddy straw mushroom is its shorter existence cycle, speedy growing, easy cultivation technique, highly acceptable at customer stage due to texture and aroma. However, the bottle neck of decrease biology efficiency has nearly been taken care of out after bringing in of cotton waste because the substrate; however, a great deal extra studies paintings is wanted for growing appropriate

processing technology like button and different commercially grown mushroom. On the other hand, present study provides important information of saucerful mushroom trading unit from Odisha region that will help or assist inspiring entrepreneurs to adopt mushroom cultivation as profession

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