

## Cultivation of Paddy Straw Mushroom (*Volvariella volvacea*)

Paddy straw mushroom is an edible mushroom of the tropics and subtropics. It was cultivated in China as early as in 1822. Around 1932-35, the straw mushroom was introduced into Philippines, Malaysia, and other South-East Asian countries by overseas Chinese. In India, though Su and Seth were the first to cultivate this mushroom in 1940; but first scientific cultivation of *Volvariella diplasia* using spawn was successfully done at Coimbatore by Thomas *et al.* in 1943. Presently this mushroom is also being cultivated in several countries including India. In India 19 edible species of *Volvariella* have been recorded but cultivation methods have been devised for three of them only viz; *V. esculenta* (Mass) Sing., *V. diplasia* (Berk and Br.) Sing. and *V. volvacea* (Bull ex Fr.) Sing.

The optimum temperature and moisture for the growth of this mushroom are 35°C and 57-60%, respectively. It can be cultivated in North-Indian plains from July to September and in peninsular India from March to November. However, in the hilly areas during the November to January months artificial heating is necessary to raise the environmental and bed temperature but in the plains, artificial heating can be minimized by the incorporation of *Melia azadirachta indica* and *Tamarindus indicus* leaves in alternate layers.

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## A. Morphological characteristics

This genus takes its name from 'Volva' means a wrapper; which completely envelops the main fruiting body during the young stage. The fruiting body formation starts with distinct tiny clusters of white hyphal aggregates called primordia and is followed by successive stages named as 'button', 'egg', 'elongation' and 'mature'. Differentiation can be seen first at the 'button' stage. At maturity, the buttons enlarge and umbrella like fruiting bodies emerge after the rupture of the volva. The mature fruiting body can be distinguished into the following structures (Fig.1).

- **Volva:** The universal veil is known as volva and it remains more or less distinct in the adult mushroom as a cup like structure at the base of the stipe.
- **Stipe:** Off-white to dull brown in colour, long, round with a smooth surface and no annulus. The stipe enlarges slightly to a bulbous base, which is encased with a distinct membranous volva.
- **Pileus:** The umbrella like fleshy structure attached to the stipe. The size of the pileus is affected by environmental factors, but generally it is around 5-15cm broad. The 'annulus' or ring like structure on the stipe is conspicuously absent in this mushroom.
- **Gills:** The vertical, radial plates on the lower surface of the pileus are lamellae or gills. All gills are with entire margin and fimbriate edges, but the size varies from one quarter of the radius of the pileus to the full size.

The top surface of the cap is soft and smooth in texture. The colour of the fully-grown pileus is greyish white with a reddish tinge. The grey being dominant in the centre of the cap. The stipe of the umbrella tapers from the base to the apex and is solid, smooth and white in colour. The stipe is easily separable from the pileus at its junction. The gills are also free from stipe. The pileus is initially well shaped but later becomes convex to umbonate.



Fig.1: Different structure of *V. Volvacea* fruiting body

## B. Nutritive value

The excellent unique flavour and textural characteristics distinguish this mushroom from other edible mushrooms. The nutritive value of paddy straw mushroom is affected by the method of cropping and the stages of maturation. Available data reveal that on fresh weight basis it contains around 90% water, 30-43% crude protein, 1-6% fat, 12-48% carbohydrates, 4-10% crude fibre and 5.13% ash. The fat content increases with the maturation stage and the fully mature fruiting body contains as high as 5% fat. The N-free carbohydrates increases from button stage to the egg stage levels, remains constant at the elongation and drops at the mature stage. The crude fibre remains at almost same level in first three stages and increases at mature stage. The egg stage contains highest level of protein, which decreases at mature stage. Ash content remains almost similar at all the developmental stages.

**Table 1. Proximate composition of paddy straw mushroom**

Contents	Composition (quantity/100g fresh mushroom)
Moisture	90.40 (g)
Fat	0.25 (g)
Protein	3.90 (g)
Crude fibre	1.87 (g)
Ash	1.10 (g)
Phosphorus	0.10 (g)
Potassium	0.32 (g)
Iron	1.70 (g)
Calcium	5.60 (mg)
Thiamine	0.14 (mg)
Riboflavin	0.61 (mg)
Niacin	2.40 (mg)
Ascorbic acid	18.00 (mg)

The straw mushroom is known to be rich in minerals such as potassium, sodium and phosphorus. Potassium constitutes the major fraction of the major elements, followed by sodium and calcium. The levels of K, Ca and Mg remain almost same at different developmental stages, except that of Na & P, which drops at elongation and at mature stages. The contents of minor elements namely Cu, Zn and Fe did not vary much at different stages of development.

The levels of thiamin and riboflavin in paddy straw mushroom are lower than *A. bisporus* and *Lentinula edodes*, while niacin is at par with these two mushrooms. At all the stages lysine is the most abundant essential amino acid and glutamic acid and aspartic acid are the most abundant non-essential amino acids. Tryptophan and methionine are lowest among essential amino acids. The

level of phenylalanine increases nearly one fold at elongation stage, while lysine decreases to about half of its value at the button stage. The straw mushroom is comparable to that of the other mushrooms both in terms of amino acid composition and the percentage of essential amino acids in the total amino acids. In fact, paddy straw mushroom contains high percentage of essential amino acids in comparison to other mushroom and the abundance of lysine is very important. The other three amino acids namely leucine, isoleucine and methionine are low in paddy straw mushrooms.

**Table 2. Amino acid contents of paddy straw mushroom**

Amino acid	Composition (mg/100g protein)
Leucine	3.5
Isoleucine	5.5
Valine	6.8
Tryptophane	1.1
Lysine	4.3
Histidine	2.1
Phenyl alanine	4.9
Threonine	4.2
Arginine	4.1
Methionine	0.9

### C. Spawn preparation

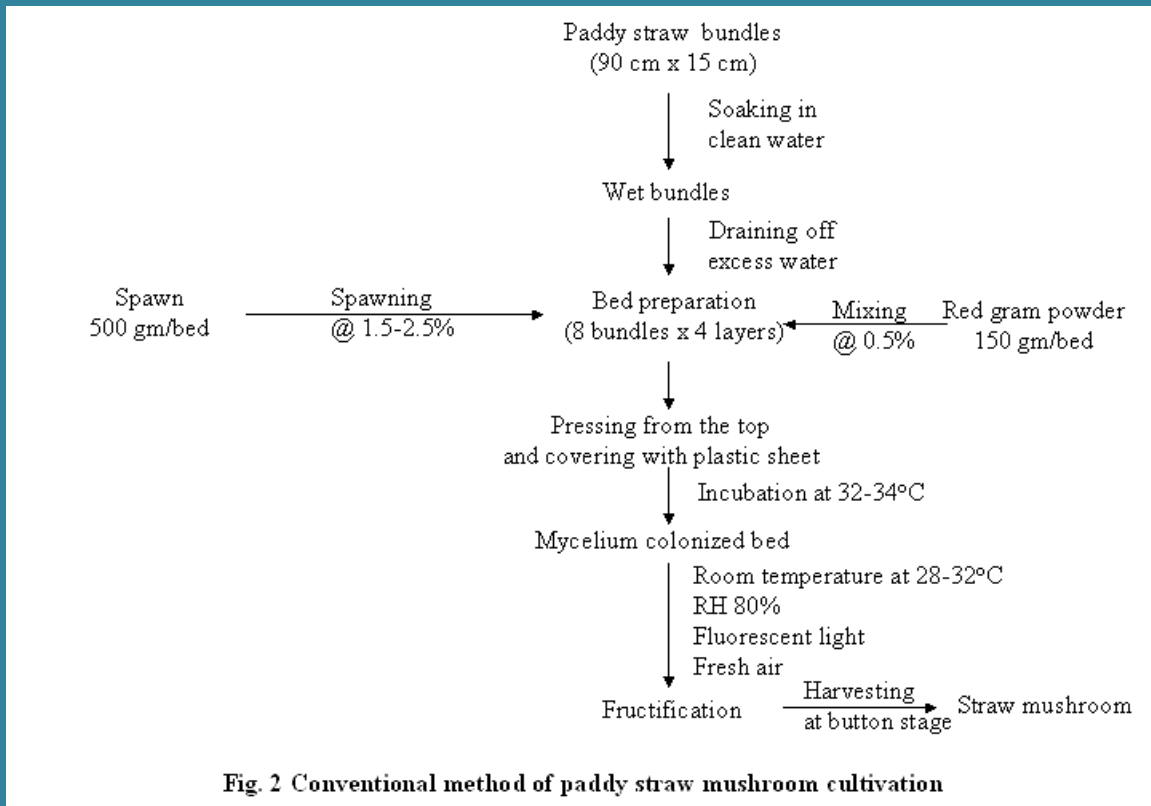
The ready-to-mix spawn (seed) can be prepared on the chopped paddy straw. The fresh dried paddy straw is to be cut (2.5 to 5.0 cm long) and soaked in clean water for 2-4 h in a drum. The soaked straw is drained on sieve for 30 min, followed by mixing of CaCO<sub>3</sub> and CaSO<sub>4</sub> @ 2.0 and 1.0%, respectively on dry weight basis. Thoroughly mixed spawn substrate is filled up to half portion in polypropylene (PP) bags (25 cm x 12 cm) of 100 gauge thickness. The PP bags are closed by creating neck on top of the bags with the help of a plastic ring, plugged with non-absorbent cotton and to be sterilized at 22 pound square inch pressure for 1.5 hour in an autoclave. After sterilization, the bags are put under UV light for 30 minutes on laminar flow bench. The contents in bags are mixed by shaking once or twice and inoculated with 20-30 grains of master spawn prepared by following the same protocol as described above just by replacing paddy straw with wheat grains as the basal ingredient and PP bags with empty glass glucose-saline bottles as the container. The inoculated bags are incubated at 32 ± 2°C for 8 days in BOD incubator. The fully colonized bags are removed from the incubator and placed at the ambient temperature of 16-25°C for chlamydospores development and storage till further use.

## **D. Cultivation**

### **1. Conventional method**

Different steps involved in this method are as follows (Fig.2)

- Preparation of paddy straw bundles of 0.75 – 1.0 kg (80-95cm long & 12-15 cm wide) preferably from hand threshed paddy.
- Immersing the bundles in clean water for 12-18 hours in a cemented water tank.
- Draining out of excess water by placing bundles on raised bamboo or cemented platform.
- Making bed by placing 4 bundles side by side & another four bundles similarly but from the opposite side forming one layer of eight bundles.
- Preparation of second, third & fourth layer by intermittent spawning between first and second, second and third and third and fourth layers.
- Spawning the entire surface of different layers of the beds leaving margin of 12-15 cm from edges at a space of 5 cm apart.
- Sprinkling red gram powder over the spawned surface.
- Using 500 gm spawn and 150 g of red gram powder for a bed of 30-40 kg paddy straw.
- Pressing of bed from the top and covering with clean polythene sheet for maintaining required humidity (80-85%) and temperature (30-35°C).
- Removal of polythene sheet after 7-8 days and maintain a temperature of 28-32°C with 80% humidity.
- Mushroom will start appearing after 4-5 days of sheet removal & will continue for next 20 days.
- After crop harvest the left over substrate can be converted in to manure for its use in the fields.



### Note

- For hot regions the width of bed can be decreased by placing first layer of 4 bundles followed by another layer of 4 bundles from opposite side but directly on the first layer. It is to be followed by 3<sup>rd</sup>, 4<sup>th</sup> & 5<sup>th</sup> layers. The 5<sup>th</sup> layer can be of bundles or of loosened paddy straw.
- The size of beds may vary from 100 cm × 100 cm × 100 cm; 60 cm × 60 cm × 30 cm; 60 cm × 60 cm × 120 cm.
- Alternatively the beds can be prepared with the help of boxes of 80 × 80 × 10 cm & 60 × 40 × 30 cm size. In this method the material is to be chopped to a uniform length of 20cm & followed by filling in box parallel with the length of the box. It is followed by soaking of the material along with box in 2% CaCO<sub>3</sub> solution for 2 hrs or until the straw becomes dark brown. It is followed by draining of excess water & spawning the substrate at a depth of 5 cm from the sides of the box, followed by plugging the openings with previously water soaked newsprint. The boxes are to be incubated at a temperature of 35 to 38°C with RH of 75% for next 4-5 days, followed by lowering of temperature to 28 to 30°C with 75 to 85% RH along with introduction of fresh air. Use of superfine mist is recommended for maintaining humidity in the room. Spray fine mist of water if drying of beds is noticed; further for good harvest maintain proper aeration, temperature and humidity. This can be best achieved by controlling the ventilation/AHU's.

## **a. Improved cage -Cultivation (Fig. 4)**

### **a. Material required**

1. Paddy straw bundles	60/Cage
2. Spawn bottle	2/Cage
3. Wooden cage	1 No. (1 m x 50 cm x 25 cm)
4. Drum	1 No. (100 liters cap.)
5. Polythene sheet	4 meters
6. Binding thread	3 meters
7. Sprayer/Rose can	1 No.
8. Dithane Z-78/Bavistin	1 Pkt.
9. Malathion	1 bottle (250 ml)
10. Dettol/Formalin	1 bottle (1/2 liter)
11. Dao (Hand chopper)	1 No.
12. Thermometer	1 No.

### **b. Methodology**

Select dry, fresh and hand-threshed paddy straw free from moulds and leafy portion (Fig.3). Make 25 cm long and 10 cm thick bundles @ 60 bundles for each cage (Bed).

- Soak the bundles in boiling water for 20-30 minutes followed by cooling and draining off excess water.
- Disinfect the cage and polythene sheet with 2% formaline or dettol solution.
- Arrange ten straw bundles uniformly in the cage as the bottom layer and put some spawn grains over and inside the bundles. Put up a second layer of ten bundles over the first and spawn as before. Repeat this till six layers of bundles are achieved or till the entire cage is filled.
- Spray 0.1% Malathion and 0.2% Dithane Z-78 solutions all over the bed. Cover with polythene sheet and bind securely with a binding thread.
- Keep the spawned cages in a room or under a shed for spawn run. A warm place with temperature around 30°C is helpful for better spawn run.
- Remove the polythene sheet after the spawn run is complete. Maintain high humidity in the bed and room till pinheads appear.
- Pinheads appear within 10-15 days after spawning. Harvest mushrooms at the egg stage.
- Continue water spray for the next flush of mushrooms to appear within a week or so.



Fig.3. Stages of paddy straw mushroom cultivation

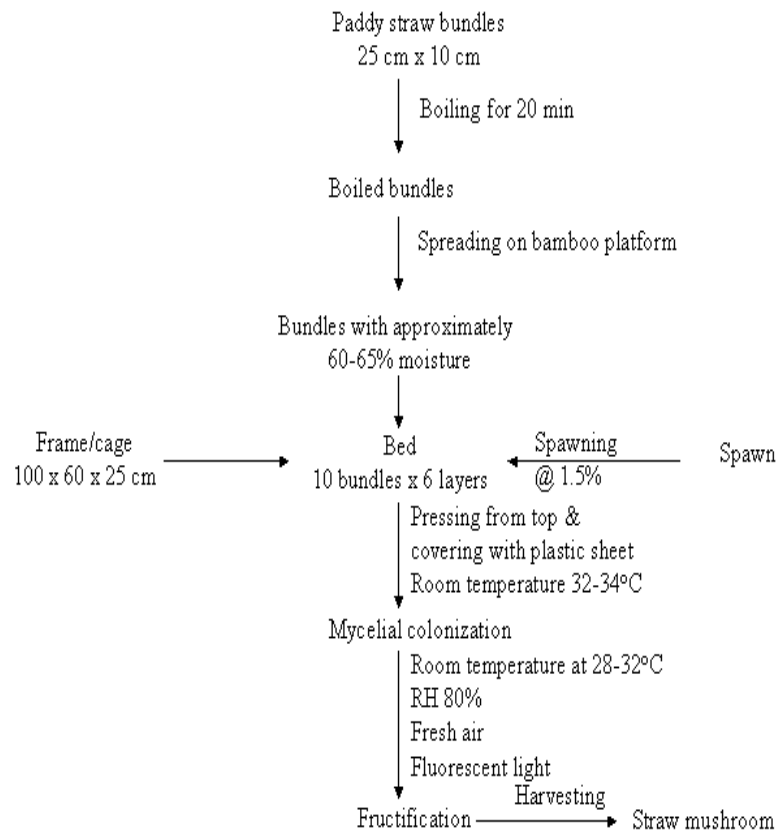


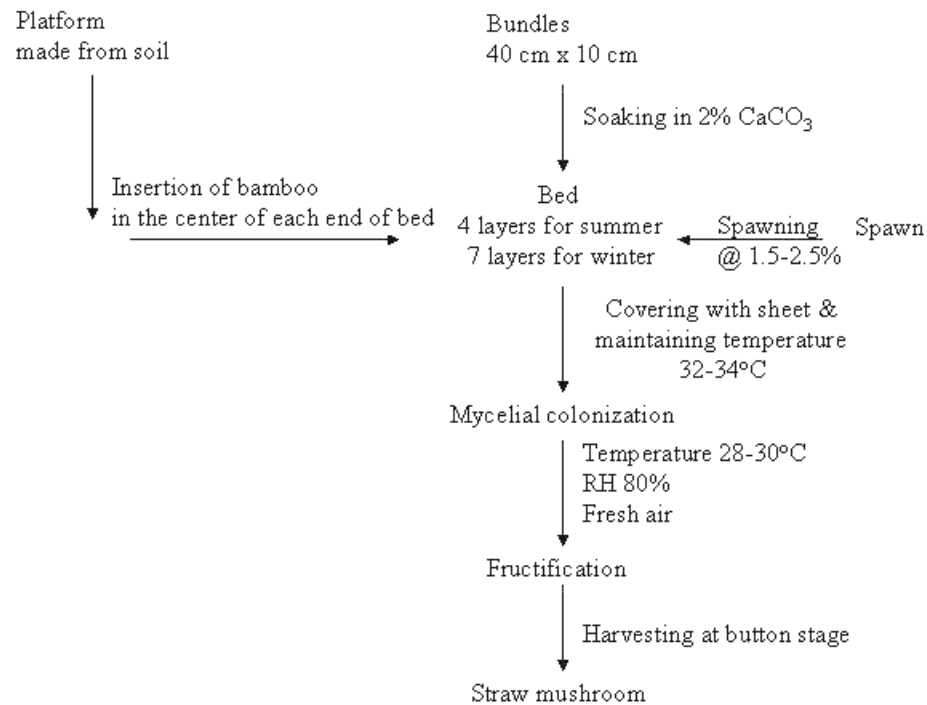
Fig 4 Cage method of paddy straw mushroom cultivation

### 3. Outdoor method

The best place to cultivate paddy straw mushroom outdoor is under shade created by trees or creepers. The steps involved are as follows (Fig. 5).

- Prepare a raised platform either from sand or bamboo poles or wooden planks or bricks.
- Prepare bundles of 45 cm length and 10 cm width.
- Soak the bundles in running water or in 2% CaCO<sub>3</sub> solution.
- Prepare a layer of bundles (5 bundles × four layers) followed by spot spawning and covering spawn with gram dal powder.
- Lay 4 layers of bundles during summer months & 7 layers during rainy season.
- Topping of bed with 20 cm deep layer of rice straw followed by covering with polythene sheet.
- Remove polythene sheet after 4 days & sprinkle water carefully on 6<sup>th</sup> day. Water spray can be avoided during rainy season.
- Water should not be sprayed after appearance of mushroom pinheads.





**Fig 5 Out door method of paddy straw mushroom cultivation**

#### 4. Indoor method

The indoor method can be divided into following 5 steps (Fig 6& Fig. 7):

##### a. Substrate

Cotton waste is the preferred substrate for cultivation of paddy straw mushroom by this method. However, paddy straw can also be used. Cotton waste is preferred over paddy straw as it contains more cellulose and hemi-cellulose and the fine texture of cotton waste helps in retention of moisture, which minimize the water requirement at later stages of cropping and thus helps in avoiding damage to fruiting primordia.

##### b. Compost preparation

Substrate (cotton ginning mill waste or paddy straw + cotton ginning mill waste in 1:1, w/w ratio) is wetted for first 2 days with sufficient treading of the cotton waste so that it absorbs sufficient water. After 2 days of substrate wetting, poultry manure is added @ 5.0% to the wetted substrate and pile (1.5 m high x 1.5 m wide) is raised. However, nothing is added in cotton waste substrate. First 2 turnings are given at an interval of one day each and calcium carbonate @ 1.5%

(dry wt basis) is added at third turning and the substrate is left for fermentation for next 2 days.

### c. Bedding and Pasteurisation

After 4 days of outdoor composting, the compost is spread on shelves and the thickness of the substrate varies in different season from 5 cm to 10 cm. During summer months lesser thickness is needed, while higher in winter to preserve moisture & heat. The compost surface is made even by pressing it lightly. After 8-12 hours of compost filling live steam is introduced in the room. A temperature of 60-62°C is maintained for 4-5 hours for cotton waste compost & 65°C for 6 hrs for paddy straw compost. After pasteurisation, the compost is kept at a temperature of 50°C for next 24-36 hrs & followed by its natural cooling. The compost is spawned when substrate temperature reaches 35°C.

### d. Spawning

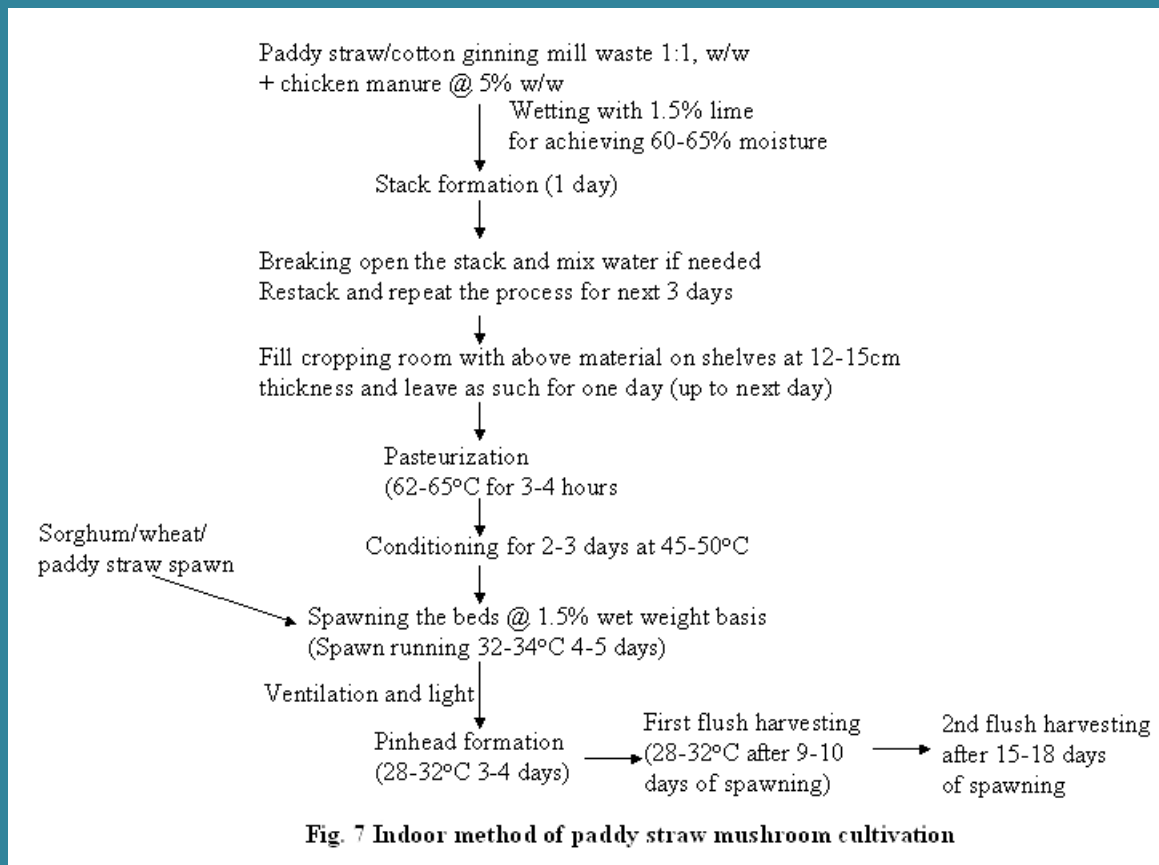
The compost is spawned with fresh spawn @ 1.5% (dry weight) or 0.4% (wet weight) basis of the compost. The pieces of broken spawn are inserted at a depth of 2 to 2.5 cm at a distance of 12 to 15 cm apart. The spawn is covered with displaced compost & the bed is covered with thin plastic sheet. The room temperature is maintained at 32 to 34°C during spawn run & at this temperature the compost will be colonized with in next 4-5 days in cotton waste based



Fig.6. Pictorial depiction of different stages of *V. Volvacea* cultivation using indoor method

### e. Fructification & Crop Management

During spawn running water & light are not needed but a little ventilation is required. By the end of 3-4 days fluorescent light along with little more ventilation is provided in the rooms. The plastic sheets are removed on 4-5<sup>th</sup> day, followed by little water spray on the beds. The pinhead will start appearing on 5<sup>th</sup> - 6<sup>th</sup> day of spawning. After another 4 to 5 days, the first flush of mushroom is ready for harvest. The desired conditions needed for better fructification are temperature 30°C, relative humidity 80%, fluorescent light & intermittent fresh air. The quick growth rate of this mushroom demands ample supply of water & oxygen. However, watering of the compost is not quite recommended as it lowers the temperature & suffocates the tiny primordia, which reduces the yield. Crop management to achieve the best possible combination of light, temperature, ventilation, relative humidity & compost moisture is in fact an art of judgement, experience & effort.



### 5. Chinese Cultivation Practice

The method adopted at Green Poplar Village, Ping-Shan County, Hebei Province, China is mentioned below.

#### **a. Compost preparation**

- Overnight soaking of wheat straw (10-15 cm long pieces) in 1% CaCO<sub>3</sub> solution.
- Draining off of excess water by placing straw on ground.
- Piling the material and covering with plastic sheet.
- Compost turn the material (compost) after 1 to 2 days interval preferably when the pile temperature reaches at 50°C.
- Fill compost in 70 × 35 × 22 cm size frame, first by putting a layer of compost followed by spawning on four sides of this layer along with some wheat bran. The second layer is placed on top of the first, followed by spawning and adding wheat bran around the edges. The third layer & fourth layers are added like the first & second layers.

#### **b. Arrangement of bed blocks**

- Soil base is raised several centimetres, which surrounds the base of the frame.
- The blocks are arranged in two rows with a gap of 20-25 cm in between.
- Popular branches are used to provide roofing on the blocks and are bowed in a shape to form the frame.
- Plastic sheet is spread over the frame & which in turn covered by straw.
- Temperature of around 33 to 35°C is maintained.

#### **c. Harvesting of mushrooms**

- Pinheads appear after 4-5 days of spawning.
- Total 9-10 days are taken for first harvest after spawning & the first flush lasts for 3 days accounting around 75% of the total yield.
- The bed blocks are watered with 0.5% CaCO<sub>3</sub> & covered again.
- The second flush appears after few days & this flush accounts for rest 25% of the total yield.
- 4 to 5 crops are harvested each year.

#### **d. Spent compost**

- The spent compost is dried & used for producing *Pleurotus sajor-caju* with BE around 80%.
- After *P. sajor-caju* production the spent compost can be used as a good soil conditioner.

#### **Important guidelines for obtaining healthy mushroom crop**

- Compost moisture should be in the range of 60 to 65%.
- Immediately spawn the compost as and when its temperature reaches at 35°C followed by covering the compost with plastic sheets for next 4 days. Temperature should be around 35°C during this period.
- No ventilation during first 3 days following spawning.

- Removal of plastic sheets after 4 to 6 days after spawning & sprinkling of water on bed surface followed by ventilating the cropping room.

#### **D. Harvesting**

The straw mushroom is harvested before the volva breaks or just after its rupture. These stages are called as the button & egg stages. This mushroom grows at high temperature with high moisture so it grows very fast and hence it has to be harvested twice or thrice in a day (morning, noon and evening). This mushroom usually takes 9-10 days from spawning to harvest of first crop and the first flush normally keeps on for 3 days, which constitutes about 70 to 90% of the expected mushroom yield. The intervening period of 3 to 5 days require thorough watering and maintenance of optimum conditions inside the rooms. The next flush again remains for 2-3 days and yields less mushroom than the first flush. The second flush adds only 10 to 30% of the total crop.

Fruit bodies ready to harvest should be carefully separated from the beds/substrate base by lifting & shaking slightly left or right and then twisting them off. The mushrooms should not be cut off by knives or scissors from the base of the stalk, as stalks left behind on the bed/substrate will rot and may be attacked by pests and moulds leading to decrease in yield in subsequent flushes.

#### **E. Trouble shooters**

- **Poor mycelial run:** Insufficient food in the compost, inadequately beaten or too compact compost bed or poor quality spawn.
- **Presence of contaminants:** Temperature might not have been high enough during pasteurization to kill the contaminants or the steam might not have reached upto the core of the compact compost or the use of contaminated spawn.
- **Strong ammonia smell:** Excessive use of nitrogen source or improper conditioning at Phase-II of composting.
- **Mycelium drying out:** Scarcity of water or excessive ventilation.
- **Failure to form fruiting body:** Deficiency of light, degenerated spawn or too old spawn, excessively high temperature or poor ventilation.
- **Death of young mushroom:** Degeneration of spawn, insect infestation, insufficient oxygen, excessive CO<sub>2</sub>, sharp temperature fluctuations or diseases caused by fungi or virus.
- **Growth of Coprinus:** Excessive nitrogen, old and poor quality straw or excess heat of the compost bed.

## Competitor Moulds and Diseases in paddy straw Mushroom Production and Their Management

Paddy straw mushrooms are subject to a number of destructive diseases/competitor moulds like *Mycogone perniciosa*, *Scopulariopsis fimicola* and *Verticillium* spp. in other countries. In India, large number of competitor moulds and few diseases has been reported on this mushroom. *Chaetomium* spp., *Alternaria* sp. and *Sordaria* sp. have been commonly observed as contaminants on wheat, kans, maize, barely and jowar beds but not only paddy straw bundles. A 'button-rot' disease caused by *Sclerotium* sp. and bacterial 'button-rot' have been also recorded. Combination of insecticide, fungicide and antibiotic (Malathion 0.025% + Dithane Z-78 or benomyl 0.025% + tetracycline 0.025%) are recommended for the management of pests and diseases. Several other competitor moulds namely, *Coprinus aratus*, *C.cinereus*, *C.lacopus*, *Psathyrella* sp., *Penicillium* spp., *Aspergillus* spp., *Rhizopus* sp., *R.nigricans* and *Sclerotium* spp. have been reported from the substrate. Partial sterilization of the straw and sprays on the beds with captan and zineb (0.2%) has been recommended for reducing the damage. *Rhizoctoria solani* has been recorded on the substrate, which reduces the sporophore formation and causes malformation of fruiting primordia.



**Ink cap**



**Green mould**

### Pests

Information concerning insect-pests of *Volvariella* sp. is scanty. However, phorid fly larvae damage the developing mycelium during the spawn run stage. Infestation by mites *T. dimidiatus*, *H. heinemanni* and *H. miles* has also been reported by Das (1986). However, there is no information as management on these pests.

## Abiotic disorder

As compared to white button mushroom, there are few physiological disorders recorded in straw mushrooms. Leaking and weeping symptom is observed at DMR in certain occasions. The study on abiotic disorders in straw mushroom is in nascent stage.



Weeping straw mushroom

## Spent Mushroom Substrate

### Characteristics

The spent substrate of paddy straw mushroom (*V. volvacea*) varies in its pH from 8.47 to 9.05. The other parameters *viz.*, conductivity, total dissolved solids, dissolved oxygen and bulk density are 1.10 mmhos/cm, 147 ppm, 0.20 ppm and 0.46 g/cm<sup>3</sup>, respectively. Particle density and porosity are 1.55 g/cm<sup>3</sup> and 35.00% respectively. The contents of major elements like nitrogen, phosphorus and potassium are 1.52%, 0.75% and 169 ppm, respectively. The SMS also contains calcium (1055 ppm), sodium (71.00 ppm) and nitrates (3.17 ppm). The heavy metals lead and cadmium are found absent.

### Utilities

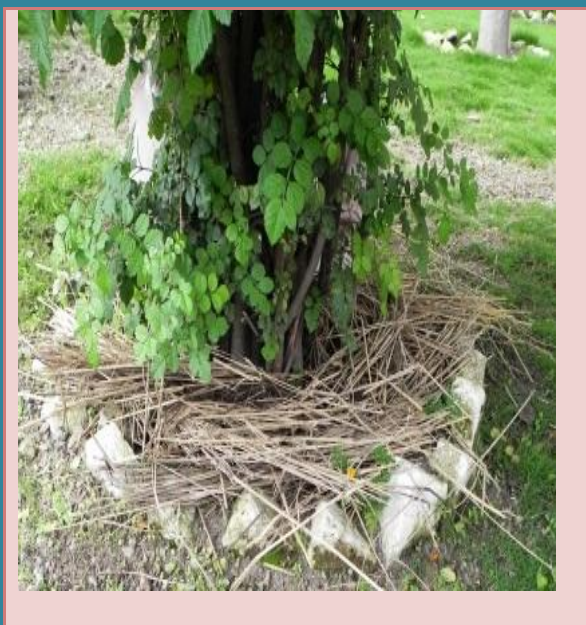
i) **Biogas:** As indicated above, SMS obtained after paddy straw cultivation can be utilized for producing biogas, and the sludge accumulated in biogas tank can be used as casing material for button mushroom. Again the SMS thus generated can again be used as manure for raising the crop. The use of SMS for biogas production has multiple benefits, such as possibility to utilize feed stocks of high moisture content, ability to be scaled to suit family as well as community needs, effluent (sludge) with properties of good manure can replace chemical fertilizers, and can give indirect economic benefits to the users. The increased susceptibility and nitrogen contents of spent substrate are reported to be the reasons behind higher percentage of gas yield. Solids

from biogas digester act as good manure for nursery raising as well as for the vegetable crops.

**ii) Vermicomposting:** Recently, SMS has also found uses as the feeding material for vermicompost. In case of vermicompost preparation, the SMS from paddy straw mushroom has been found suitable. Fresh as well as 15-20 days old rotten SMS from paddy straw mushroom is an acceptable material for the worms to multiply and convert it in to manure for field crops. The SMS either alone or in different combinations with FYM, agricultural and vegetable farming wastes (depending upon the availability) is a good medium for effective vermicomposting by following the standard protocol (Fig.4.) The time period for vermicomposting using SMS varies between 2 to 2.5 months.

**iii) Mulch**

Fresh oyster SMS contains enough macro pores and void spaces. Hence application of oyster SMS as mulch in soil reduces water evaporation and soil temperature by restricting water translocation and sunlight. In addition, it helps to control the growth of weeds naturally. The use of SMS as mulch will have additional advantages for increasing soil carbon and providing nutrients.





- iv) **Casing soil:** Another use of SMS in mushroom cultivation is as casing material for button mushroom. The initial experiments suggest that the use of fully weathered spent compost from paddy straw mushroom as casing material can give higher mushroom yield than the conventional casing materials such as FYM + SMS of button mushroom, SMS from button mushroom or coir pith + FYM based casing material.
- v) **Bioremediation:** The degradation of various chemicals in environment depends upon the prevailing physical and chemical conditions and the nature of microorganisms thriving within the system. SMS from button mushroom has the ability to chemically adsorb the organic and inorganic pollutants, and in addition it also contains diverse category of microbes having capability of biologically breaking down of the organic xenobiotic compounds present in soil and water. Although the SMS from this mushroom has not been studied much for its role in bioremediation activities. Although it has been found to be good source of cellulolytic enzymes and source of various microorganisms with their ability to degrade various pollutants including decolourization of the textile effluent.
- vi) **Cultivation of other mushrooms:** The SMS from paddy straw mushroom has been studied for the cultivation of *Pleurotus* spp. with success.
- vii) **Animal feed:** The SMS from *Volvariella volvacea*, particularly one, where the mushroom has been grown on rice straw and banana leaves has been tried for feed for the sheep.
- viii) The cellulolytic bacteria from *Volvariella volvacea* have been exploited for production of alternative fuel and vermiculture.