



### CULTIVATION TECHNIQUE OF MUSHROOM

N. N. Chaudhary\*, R. L. Kalasariya, K. D. Parmar, N. R. Chauhan, N. S. Litoriya and P. G. Shah

AINP on pesticide Residues, ICAR Unit- 9, Anand Agricultural University,  
Anand-388 110, Gujarat. Email: [nnchaudhary1991@aau.in](mailto:nnchaudhary1991@aau.in)

Mushrooms are being used as food since time immemorial. India is primarily agriculture based country blessed with a varied agro-climate, abundance of agricultural waste and manpower, making it most suitable for cultivation of all types of temperate, subtropical and tropical mushrooms. As a medicine mushroom is used where penicillium is used for production of penicillin, antibiotic used to fight infections. As an industrial, Yeasts are used in making wine; beer and bread, some species of penicillium are used for make Roquefort cheese (Technical sheet of popular science, 2012). The cultivation techniques were perfected for about twenty mushrooms and about dozen of them have been recommended for commercial cultivation. However, only six mushrooms are widely preferred for large-scale cultivation (Thapa *et. al.*).

#### They are as under:

1. Paddy straw mushroom
2. Oyster mushroom
3. Button mushroom
4. Milky mushroom
5. Shiitake mushroom
6. Jew's ear mushroom

#### Cultivation technique of Mushrooms:

##### Cultivation Technology of Paddy Straw Mushroom (*Volvariella volvacea*, *V. diplasia*)

**a) Nutritional value:** Paddy straw mushrooms are very tasty and good flavored. These are known to be very nutritious having 26-30 % protein, 9-12 % fiber, 9-13 % ash, 45- 50 % carbohydrate and also rich in minerals, vitamins c and vitamin b.

**b) Spawn production:** Spawn is produced either in rice straw or rye, sorghum, millet or wheat grains. The mycelium in spawn bottle is fast growing; rhizomorphic to cottony, color is typically whitish to grayish white.

**c) Cultivation:** Commonly cultivated varieties of paddy straw mushroom (*Volvariella*) are *V. volvacea*, *V. diplasia* and *V. esculenta*. This mushroom is commonly cultivated on paddy straw in the open as well as inside a mushroom house. Open cultivation method is very common among marginal and small growers.

#### 1. Open air cultivation:

**a) Preparation of beds and spawning:** In this method 100 x 60cm size foundation beds of 15-20 cm height are made with the help of bricks or mud under the shade, to save them from rains or direct sunlight. Paddy straw bundles of 7-8 cm diameter are made by tying them at one end. These bundles are soaked in water for 16-18 hours in a water tank. For chemical sterilization of the straw, bavistin 7g and formalin 125 ml can be added in 100 liter of water. After dipping bundles in water, cover the water tank with the polythene sheet. Later, bundles are taken out and excess water allowed draining out on a cemented floor. A bamboo frame exactly of the size of the bed on foundation is kept on the floor. Now place four bundles of paddy straw (water soaked) side by side over bamboo frame, keeping tied end in one

direction. Place another set of four bundles over it but this time tied end in opposite direction. In this way 8 bundles make the first layer of bundles. Scatter the grain spawn about 8-12cm from the edges of the layer bundles. Spread the spawn along with powdered arhar pulse or gram flour. Wheat bran or rice bran can also be added. Place the second row of the bundles and spawn on it as described earlier. Likewise third and fourth layer of bundles are also placed and spawned. Finally, the square shaped bed is covered with a transparent polythene sheet and bed temperature of  $32 \pm 1^\circ\text{C}$  is maintained. Within 7-8 days mushroom mycelium permeates the straw completely and at this stage the plastic cover is removed. If the surface of the bed appears to be dry, spray water with the help of water sprayer at least once in a day.

**b) Fruiting and harvesting:** Mushroom fruiting occurs nearly 18-20 days after spawning at favorable moisture and temperature conditions. Fruiting continues for another 10-12 days. In paddy straw alone, yield of 12-14 kg/100 kg of wet substrate can be obtained. Harvesting of mushroom is done when vulvas just breaks and mushroom exposes from inside. In any case mushroom should be harvested before it opens. Paddy straw mushrooms are very delicate in nature and can be stored under refrigerated condition for 2-3 days only. Drying of mushroom can be done under shade or in sunlight.

**Indoor Cultivation:** Indoor cultivation of paddy straw mushroom is done inside the mushroom house on pasteurized compost.

**a) Substrate:** Suitable substrates for paddy straw mushroom cultivation are banana leaves, paddy straw, cotton waste etc. For indoor cultivation, rice straw and cotton wastes in 50:50 ratio is preferred which gives more consistent yield.

**b) Composting:** The composting process involves two phases: phase I is an outdoor process while phase II involves pasteurization and conditioning of the compost.

**Phase I (Outdoor composting):** This mushroom requires very little nitrogen for its growth. Paddy straw and cotton wastes when used in 50:50 ratio, will provide 1.4% nitrogen, while some nitrogen is generated by the microorganisms during composting and spawn running processes. The pre-wetted straw and cotton waste are mixed thoroughly and then piled up. Pile raised is narrow with a height of 1.5cm. After 2 days, first turning is given to this pile. During this turning, rice bran @ 50 % (w/w basis) is added. Watering is done if required. Remake the pile and leave it for another 2-3 days and only then the compost becomes ready for phase II.

**Phase II (Indoor composting):** After phase-I, compost is taken inside the mushroom house, placed on the shelves and preheated at  $40-45^\circ\text{C}$ . Now supply the steam in the mushroom house for 2-3 hours so as to raise the temperature of the house to  $60-65^\circ\text{C}$ . This temperature is maintained for another 2-3 hours. The steam supply is then cut off and fresh air given. In next 8 hours temperature of the mushroom house goes to  $50-52^\circ\text{C}$ , which is maintained for another 12 hours or till the smell of ammonia persists in the compost. This process is completed in 4-5 days.

**Spawning and Cropping:** When treated beds do not have the smell of ammonia and temperature of the compost cools down to  $34-38^\circ\text{C}$ , spawning is done @ 2% of the compost (w/w). After spawning, doors of the mushroom house are closed for 3-4 days. Temperature during this period remains between  $34-38^\circ\text{C}$  (but should not be less than  $30^\circ\text{C}$ ). R.H. is to be maintained between 80-85 % by regularly spraying the water. Little aeration is also provided.

Within 4-5 days, mushroom mycelium spreads in the compost. Then temperature of the mushroom house is lowered to 28-30°C by opening ventilators. If bed surface appears dry, water is again sprayed. During next 2-3 days, doors are kept open to allow some light. This condition is maintained till sufficient amount of fruit bodies are formed. When primordial formation is completed, air of the room is circulated for at least 5 minutes for 5-6 times a day. Bed temperature is kept below 32°C and RH between 85-90%. In next 4-5 days mushrooms become large enough for harvesting.

**d) Harvesting:** Fruit bodies are harvested when they become mature and before the cap opens completely, mainly in its egg form. The fruit bodies have got very low keeping quality and hence consumed immediately or they can be canned or dried and packed in sealed polythene bags so that these may be kept for a longer period. Cropping cycle lasts for 7-12 days in two flushes.

**e) Yield and Marketing:** Yield varies from 25-45 kg per 100 kg straw. Due to very low keeping quality, these mushrooms cannot be stored even in the refrigerator for more than 15-24 hours. Generally mushrooms are sold fresh or in canned form but rarely in dried form.

## **2. Cultivation Technology of Oyster Mushrooms (*Pleurotus spp.*) (Thapa *et. al.*)**

This mushroom is also known as Oyster mushroom. Word “Pleurotus” comes from the Greek word –“Pleuro” which means formed laterally or in sideways position, referring to the lateral position of the stem relative to the cap. The species epithet- “ostreatus” refers to its oyster shell like appearance and colour.

**Natural Habitat:** It is a wood decomposing, saprophytic or parasitic fungus which grows abundantly on standing and fallen forest plants like alder, cottonwood, maple etc; found abundantly in river valleys and the fruit bodies appear in the falls, early winter and spring.

**Nutritional Value:** It contains 91% water and 9% dry weight; 30.4 % crude protein and 109 mg niacin/100 g dry weight. The spores of oyster mushrooms may be allergic causing breathing problem to some and sometimes difficult to digest for some people. It contains more protein than found in button mushroom.

**Cultivation:** Oyster mushroom (*Pleurotus spp.*) is commonly called Dhingri in India. It has oyster like shape because of that it is popularly known as oyster mushroom. Its cultivation can be done on number of agricultural wastes and organic waste materials. The important substrates include straw of different cereals, sugarcane bagasse, cotton waste, jute, groundnut pod shells, small wood pieces, saw dust, maize cobs, banana pseudo stems, etc. depending upon the widespread availability of these materials. Commonly cultivated species of *Pleurotus* includes *P.sajor-caju*, *P.ostreatus*, *P.florida*, *P.cornucopiae*, *P.eryngii*, *P. flabellatus*, *P.opuntiae*, *P.platypus*, *P.cystidiosus* and *P.columbinus*. Different species are grown under different agro climatic conditions.

**a. Substrate preparation:** It is commonly cultivated on wheat or rice straw, due to their easy availability in large quantities. The straw of 4-6cm size is taken and dipped in cold water for 10-12 hours. Straw can be sterilized by various methods as given below:

- **Hot water treatment:** The soaked straw is dipped in hot water at 80°C for 2 hours. Hot water treatment makes hard substrate soft so that growth of the mycelium takes place very easily. This method is not suitable for large scale commercial cultivation.

- **Steam pasteurization:** In this method pre-wetted straw is pasteurized by passing steam for 2-3 hours. This method is used for commercial cultivation.
- **Chemical sterilization technique:** In this method 7.5g bavistin and 125 ml formalin are dissolved in 100 liter of water and slowly poured on the heap of wheat straw. Soaked straw is covered with a polythene sheet. After about 18 hours the straw is taken out and out the excess water.

**b. Spawning:**

- The process of spawn making is the same as in *Agaricus*. The normal rate of spawning in pasteurized substrate is 1.5-2.0 % of the wet substrate, however it is slightly higher (2.0-2.5%) in unpasteurized material. The spawning is usually done in layers or even in spawning care should be taken that the spawn gets uniformly mixed with the substrate, while in layer method the spawn is mixed after each layer of 3-4 cm thickness of straw.
- Polythene bags (50 x 75cm) have been found to be the best and cheap container for *Pleurotus* cultivation. Before filling the substrate in polythene bags, holes of about 1cm diameter should be made at 10-15 cm distance all over the surface for diffusion of gases and heat generated inside. After filling the substrate in the bags, the mouth of the bag should be tied with thread and kept at 22-26°C temperature on shelves in a mushroom house for spawn run. R.H. of mushroom house should be maintained between 80-85%.

**C. Cropping and management:** Within 15-18 days of filling and spawning, white cottony growth of the mycelium spreads in these bags which can be noticed easily. These bags are cut open and kept in mushroom house on racks, 25-30cm apart from one another or these may also be hanged on nylon ropes keeping some distance between them. Water is sprayed over them to maintain 80-85 % RH in mushroom house and also temperature between 22-26°C. Pinning starts in next 4-5 days and fruit bodies become fully grown within a week of pinning.

**d. Harvesting:** The cropping stage lasts for 30-45 days at 20-25°C, 85-92 % humidity and less than 600ppm CO<sub>2</sub>. Approximately 4-6 air changes per hour and light 200 Lux / hour to 12 hour per day are most stimulatory. The mature mushrooms are harvested individually before incurved margin expand to plane by slightly twisting and lifting the fruit bodies with the help of two fingers and a thumb. The lower root portion is removed with the help of a knife.

**e. Yield:** The average yield comes around 100-125 kg mushrooms /100 kg dry straw.

**f. Marketing and preservation:** The Oyster mushrooms are packed in perforated polythene bags in different packing after proper cleaning. These are either sold fresh in the market or stored in a deep freeze for 4-6 days. Canning can also be done for long term storage but it is not recommended as these can easily be dried in the sun or in a mechanical dehydrator and kept for a longer period when packed in air tight packing. For cooking the dried mushrooms, these have to be dipped in lukewarm water for 15- 20 minutes. Pickle making is also an easy and economic method of their preservation.

**3. Cultivation Technology of White button mushroom (*Agaricus brunnescens*) (Verma *et.al.*)**

White variety -----A. *brunnescens* var. *Albidus*,

Brown variety -----A. *brunnescens* var. *bisporus*

Cream variety -----A. *brunnescens* var. *avellaneous*

This mushroom is commonly found growing in soil enriched with cow dung, horse dung or forest litters in temperate climate. A most widely cultivated mushroom in the world. The name *Agaricus* originated from the Greek word agar icon with a Scythian people called agari who were knowing the use of medicinal plants and employed a fungus called agaricum, *Brunnescens* means brown in Latin. It is also called as *A. bisporus* because of the two spored basidium. White button mushroom is thick fleshed, robust with thin gills on the underside of the cap that are pinkish white in early age and darkening to chocolate brown at maturity. Mycelium is dingy white, moderately rhizomorphic.

**Nutritional Value:** Button mushrooms contain 90-92 % water and only 8-9% dry matter. Also contains 3.92% protein, 1.09% crude fiber, 1.25% ash, 0.19% fat and 56mg. niacin /100g weight.

**Spawn production:** The Master culture and spawn are produced on wheat or rye grains buffered with Calcium carbonate and Calcium sulphate.

**Cultivation:** Button mushrooms, including the high temperature species *A. bitorquis* (20-25°C) require well decomposed manure for its cultivation which is prepared by long method or the pasteurization method of composting by mixing wheat or rye straw with supplements like chicken manure, cotton seed cake, wheat bran, urea, gypsum etc. The prepared compost is filled in polythene bags or wooden trays, spawned by through or layer spawning method and incubated in a closed room at 25±1°C and 90% relative humidity with high concentration of carbon dioxide (5,000 to 10,000 ppm) in the absence of light. After 10 -15 days of incubation, when mycelium of spawn completely impregnates the compost, it is covered with 1-1.5 inch layer of sterilized wet casing mixture containing FYM alone or FYM + spent compost or FYM+ forest soil or soil+ sand + coco coir or sand + soil + paddy ash or peat soil . The mycelium of button mushroom will not fructify unless it is covered on the surface with a layer of fine casing mixture.

**Composting yard:** The compost should be prepared on well cleaned concrete or pacca floor, which should be at a higher level so that the run-off water does not collect near the heap. Composting is usually done in the open, but it has to be protected from rain by covering it with polythene sheet. It can also be done in a shed with open sides or a large room to shelter it from rain.

**Compost filling in trays:** The compost when ready for filling and spawning has a dark brown colour and no trace of ammonia. The pH is neutral or near neutral. The compost should not be too dry or too wet at the time of filling in the trays, which can be determined by the palm test. For this purpose a small quantity of compost is taken into the hand and pressed lightly, if a few drops of water ooze out of the fingers then it are of right consistency. The prepared compost is now filled in trays, which may be of any convenient size but depth should be 15-18 cm. A standard size of tray is 100 cm x 50 cm x 15 cm.

**Spawning:** Spawning means sowing the beds with the mycelium (spawn) of the mushroom. The grain spawn is scattered on the surface of the tray bed which is covered with a thin layer of compost. Spawning can also be done by mixing the spawn with compost before filling it in trays. Five hundred gram spawn is sufficient for five trays of standard size. After spawning, the compost surface is covered with old newspaper sheets, which are wetted by sprinkling water to provide humidity. The trays after spawning are stacked vertically one over the other

in 4-5 tiers.

The room should be maintained around 25°C. The humidity should be built up by frequently watering the floor and walls. The room may be kept closed as no fresh air is needed during the spawn run. White cottony mycelium spreads and permeates through the compost. Eventually the compost surface gets covered with the mycelium. It takes 12-15 days for complete spawn run.

**Casing:** After the spawn run is complete as is evident by white cottony growth, the surface of the compost is covered with 3 cm layer of casing soil. A suitable casing soil can be prepared by mixing equal parts of well rotten cow dung and garden soil. The casing material is sterilized to kill insects, nematodes and molds. The casing soil is spread over a plastic sheet and treated with formalin by sprinkling. The treated soil is piled up in a heap and covered with another plastic sheet for 48 hours. The soil is turned frequently for about a week to remove all traces of formalin which can be tested by smelling. After casing, the temperature of the room is maintained at 25°C for further three days, after which it must be lowered to below 18°C.

**Cropping and Harvesting:** The first flush of the pin heads become visible 15-20 days after casing or 35-40 days after spawning. Small white buttons develop 5-6 days after pin head stage. The right stage of harvest is when the caps are still tight over the short stem. Harvesting is done by holding the cap with forefingers slightly pressed against the soil and twisting it off. Mushroom can also be harvested by cutting off with a sharp knife at soil level.

**Storage:** The mushrooms are best consumed fresh. Storage in refrigerator for a few days is possible if they are placed between moist paper towels.

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